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THE REPUBLIC OF THE UNION OF MYANMAR

PREPARATORY SURVEY FOR INTENSIVE AGRICULTURE PROMOTION PROGRAM IN THE REPUBLIC OF THE UNION OF MYANMAR

FINAL REPORT

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
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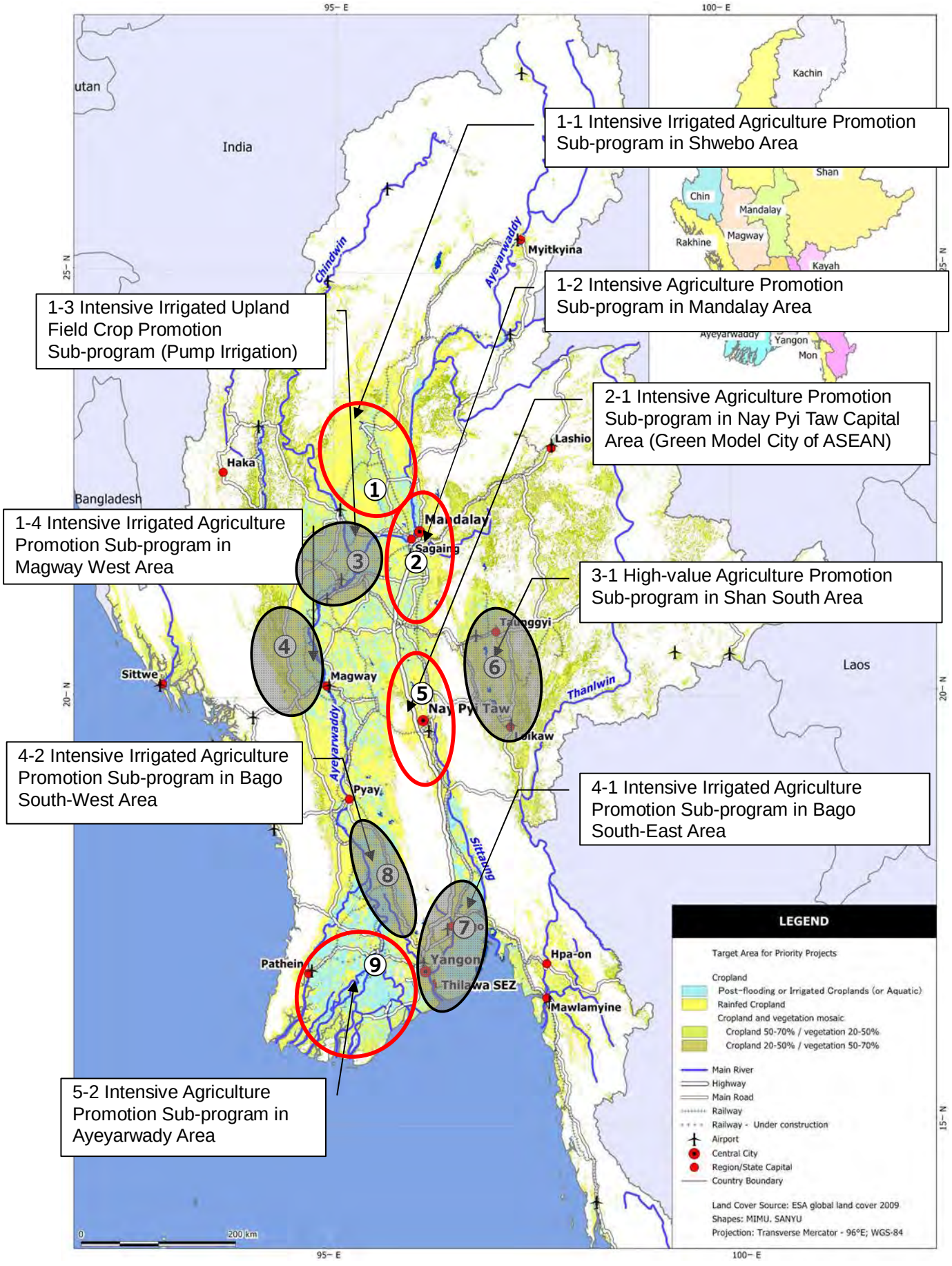

LOCATION MAP: PREPARATORY SURVEY FOR INTENSIVE AGRICULTURE PROMOTION PROGRAM

This map shows potential areas identified based on existing available data and field surveys. Green color indicates potential areas where people have already practiced irrigated agriculture and/or rain-fed farming. Out of the first screened 9 priority areas, 4 top priority areas, marked by red-circle, have been selected for pre-feasibility study under this Survey.

EXECUTIVE SUMMARY

PREFACE

0.1 Submitted herewith is the final report prepared at the end of "the Preparatory Survey for Intensive Agriculture Promotion Program (PIAP)". A survey team organized by JICA headquarters commenced a series of field surveys for the Preparatory Survey from 19th April 2015, and this report presents major findings, identified top priority 4 areas for the promotion of intensive agriculture through screening process, and pre-feasibility level study results, out which a series of intensive agriculture promotion programs are presented.

1. RATIONALE OF THE SURVEY

1.1 Farming in Myanmar is characterized by labor-intensive agriculture and most farm households depend on farm labors. For example, a survey[1] revealed that payment to the farm labors had shared as much as 45%, 49% and 26% for summer paddy, monsoon paddy and black gram respectively in the production costs excluding own household labor cost. Paddy is the staple food and most important crop in Myanmar while black gram earns the biggest share of export value in agricultural commodities; yet these major crops are heavily dependent on farm labors in the production according to the survey.

1.2 However, with the current economic development, the trend of labor movement from rural areas to urban areas or from agriculture sector to construction sector may be accelerated. This trend, if continues, makes it difficult to secure farm casual labors as the farmers are to face acute shortage of farm casual labors. To cope with this situation, the current labor-intensive agriculture shall be transformed to modern capital-intensive agriculture with farm mechanization, introduction of quality seeds and well managed fertilizer/chemicals, introduction of improved post-harvest techniques, etc.

1.3 Further to above interventions, production infrastructure and also food distribution network shall be improved and enhanced. Production infrastructure includes irrigation facilities which can provide stable water for crops, farm roads which facilitate marketing, and farmland consolidation which can exploit maximum potential of agriculture mechanization. Advancing food distribution supported by food value chain improvement shall also be undertaken, for delivery of affordable-priced foods to all the people who work in other industries comes into sight. Thus, all these issues strongly suggest that the nowadays Myanmar needs to promote modernized intensive agriculture, and hence this Survey is conducted.

2. CHALLENGES & OPPORTUNITIES IN MYANMAR AGRICULTURE

2.1 In Myanmar, two climatic periods exist, namely rainy season and dry season, by rough classification. During monsoon season, monsoon paddy is most exclusively cultivated. On the other hand, one year is classified into 3 periods from daily life point of view; namely, dry season is further divided into two sub-periods, in which part of dry season beginning soon after the end of rainfall is called winter period because atmospheric temperature is low, and later part that lasts until the onset of the next rainy season is called summer period because the highest atmospheric temperature prevails in this period.

2.2 Of the 7 basins in Myanmar, such 2 basins as Ayeyarwady ï Chindwin and Sittaung are the most

[1] Source: Preparatory Survey for the Project for Rehabilitation of Irrigation Systems, August 2014. Note that the payment to the farm labors was estimated by aggregating such cost of; seeding & transplanting, fertilizer application, pesticide/ fungicide application, herbicide application, weeding, harvesting, transporting (farm to dry yard), and drying/ packing, which are in most cases undertaken by farm casual labors.

potential basins for irrigation development. In Myanmar, there are over 250 irrigation dams constructed by Irrigation Department, especially after 1988. Most of these irrigation dams have been constructed on the tributaries of the Ayeyarwady river and Sittaung river[2]. It means that the potential arears to promote intensive agriculture can be found within the basin of these rivers, especially in such areas where extent of irrigated farmland has been established. In addition, though the catchment area of Bago river is small, only 5,300 sq.km, there are irrigation dams.

2.3 The staple food is rice in Myanmar, which is cultivated wherever during monsoon season. With irrigation summer paddy is also cultivated. After monsoon paddy has been harvested, farmers usually cultivate pulses, which requires less farm input as compared with paddy. Pulses are grown under residual moisture, not irrigated. Then, there are great number of farmers who cultivate oil crops such as sesame, groundnut, sunflower, etc., some of which are irrigated. These are the most important and popular crops in Myanmar.

2.4 Paddy production of aggregated monsoon and summer started sharply increasing in the early 2000s, peaking in 2010 with a total amount of 32.6 million tons of production. However, after that it has dropped to a level of around 28 million tons of production. Paddy production is prevalent in such regions as Ayeyarwady being the biggest production area (30% of the whole production as of 2013/14), followed by Bago region (18%), and further by Sagaing (14%). In Myanmar, a typical person is assumed to consume about 160 kg of white milled rice per annum. Estimated available white rice per person as at 2013/14 is about 255 kg in the country, indicating big surplus for export.

2.5 A continuous increase trend of world rice export over years provides an opportunity to Myanmar of exporting rice to the world market. The export from Myanmar has increased recent years to the level over 1 million tons. However, the share of Myanmar export rice is still far below than those counterpart countriesô export volume. This comparison indicates there should be an opportunity for Myanmar to further export rice to the world market. In fact, National Export Strategy of Rice, 2015-2019, formulated by Ministry of Commerce, states in its Action Plan ó*export 4 million tons of rice, becoming the worldôs fourth largest exporter of riceô*.

2.6 After monsoon paddy has been harvested, farmers cultivate pulses in many places by utilizing residual moisture. Pulse cultivated in large area in lower Myanmar is black gram while green gram becomes popular as going to mid and upper Myanmar. Chick pea and pigeon pea are also joining the green gram in the mid and upper Myanmar. As at year 2013/14, nation wide productions are 1.58 million ton, 1.45 million ton, 0.85 million ton, and 0.60 million ton for black gram, green gram, pigeon pea and chick pea respectively. Therefore, the major ones are black gram and green gram.

2.7 It can be known that Indiaôs pulses import shares about 20% to maximum 30% of what is traded in the world pulse trade market since year 2001. Responding to the Indiaôs demand, Myanmar has been exporting pulses to India. Though export quantity has fluctuated by year, there is a tendency of increasing over years especially in case of black gram, reaching about 500,000 ton per year. Though the green gram is exported more to other countries than India, still India imports green gram at the level of about 100,000 tons per year. From this examination, it can be concluded that the pulses produced in Myanmar have an opportunity of being exported more to India.

2.8 Oil crops in Myanmar are ground nut, sesame, and sunflower, productions of which as of year 2013/14 are 1.50 million tons, 0.91 million tons, and 0.46 million tons respectively. Though these oil crops are cultivated mostly in Year, upland field, under rain-fed condition, nowadays there are irrigation areas where sesame is cultivated, e.g. in Magway area. Groundnut production areas are

[2] Note that no dam has been constructed on these main rivers. All the dams have been constructed on the tributaries on these main trunk rivers.

somewhat diversified as; Sagaing sharing 34% of the whole production, Magway with 23% share, and followed by Mandalay with 13% share, which are all located in Central Dry Zone. For sesame, Magway is the biggest production area sharing as much as 43%, followed by Sagaing (29% share) and by Mandalay (15% share).

2.9 There are varieties of vegetables in Myanmar. Popularly produced vegetables are, according to the production volume, tomato, cabbage, cauliflower, mustard, bitter gourd, radish, watermelon, lettuce, carrot, asparagus, etc. Most of them are better produced in highland, e.g. Shan plateau though such vegetables as lettuce, mustard, water melon, bitter gourd can also be well produced in lowland. Larger vegetable grown areas by region are Sagaing, Ayeyarwady, Bago, Magway, Mandalay and then Shan South. However, looking at the production of such selected vegetables as tomato, cabbage, cauliflower in basket per 1,000 acre farmland, Shan South shows the outstanding vegetable production.

2.10 The main production areas of rice is Ayeyarwady, Bago region, and Sagaing region. For domestic transaction of rice, the product flows from these production areas to deficit areas including Magway region, Chin state and Mandalay region. The distribution route of pulses, beans, and oil crops is almost the same as paddy; however, the large amount of them is exported to India via Yangon port. India is a gigantic importing country of pulses and beans. Shan is a major production area of garlic, potatoes, cabbage, cauliflower, broccoli, chinese cabbage, asparagus and leafy vegetables. There vegetables are marketed to major consumption areas in almost all regions such as Yangon, Mandalay, Nay Pyi Taw, Myingyan, Magway , and Pathein.

2.11 As for international demand, Myanmar has largely depended on two big countries: China and India. Therefore, diversifying destination for export is critical issue since the commodity price in the importing countries has been changing every time. So far, Myanmar has advantages for exporting agricultural products characterized as low quality with low price because procurement cost in Myanmar is cheaper than its competitors. The next challenge is to improve quality of the products, establish quality control, and in addition plant quarantine may have to be focused in order to target more diversified countries for export.

2.12 In Myanmar, distribution mainly depends on natural temperature due to insufficient electricity. However, the demand for refrigerated/frozen foods is increasing. Responding to the market requirements, cold-chain preparation has been accelerated in the Yangon-Mandalay national highway, which is the main artery of surface transportation in Myanmar. However, cold chain has to connect with entire supply chain. Government support will be helpful if they assist private investment near from production sites (e.g. movable low-temperature storages) so that companies may easily prepare their own cold chain.

3. PRIORITY AREA IDENTIFICATION AND SCREENING

3.1 Based on land use demarcated by satellite data (ESA, global land cover map 2009), present agricultural situation, food production and distribution network, and irrigation data provided by ID and WURD, priority areas for promoting intensive agriculture have been examined. Taking into account the potential of agricultural production supported by infrastructure and also opportunities of exploiting market potential, following areas are recommended as the 1st-screened priority areas; namely total 9, in which mostly there are clusters of irrigation schemes so far developed.

Table 3.1 First Screened Priority Area (Total 9 Areas)

No.	Area/ Location	Program Title
1	Shwebo	1-1 Intensive Irrigated Agriculture Promotion Sub-program in Shwebo Area
2	Mandalay	1-2 Intensive Agriculture Promotion Sub-program in Mandalay Area
3	Chindwin-Ayeyarwady	1-3 Intensive Irrigated Upland Field Crop Promotion Sub-program (Pump Irrigation)
4	Magway West	1-4 Intensive Irrigated Agriculture Promotion Sub-program in Magway West Area
5	Nay Pyi Taw	2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area
6	Shan South	3-1 High-value Agriculture Promotion Sub-program in Shan South Area
7	Bago South-East	4-1 Intensive Irrigated Agriculture Promotion Sub-program in Bago South-East Area
8	Bago South-West	4-2 Intensive Irrigated Agriculture Promotion Sub-program in Bago South-West Area
9	Ayeyarwady	5-1 Intensive Agriculture Promotion Sub-program in Ayeyarwady Delta Area

Note: No.5 of 2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area is corresponding to (Green Model City of ASEAN) concept presented by the Union Agriculture Minister.
Source: JICA Survey Team

3.2 Out of the above 9 first-screened priority areas, such 3 areas were dropped by 2nd-screening as; Chindwin-Ayeyarwady area (No.3), Shan South area (No.6) and Bago South-West area (No.8). Chindwin-Ayeyarwady area has been developed as pump irrigation schemes, which still have difficulty of receiving on-time electricity due to shortage of power supply over the country, leading to less scheme sustainability. Shan South is in fact very famous for vegetable production over the country, suggesting high potential of promoting intensive agriculture. However, in this area, a technical cooperation type assistance with enhanced agricultural extension is highly recommended. Therefor, this Shan South could be excluded. Bago South-West area are relatively new, giving less priority on the rehabilitation of irrigation facilities.

3.3 Of the 6 second-screened areas of 1) Shwebo, 2) Mandalay, 4) Magway West, 5) Nay Pyi Taw, 8) Bago South-East, and 9) Ayeyarwady, those areas except for Magway West and Bago South-East were finally selected as the top 4 priority areas, which are to be undertaken for pre-feasibility study during the Phase 2 survey starting in August till December 2015. To select the final top 4 priority areas, the Team has examined several factors and development indexes such as potential of food value chain development, potential of further yield increase, potential of crop diversification, level of rehabilitation needs, potential of irrigation expansion, and return against the expected investment as the major ones, and further the poverty level, relevancy to 2-pole development strategy as well as to Myanmar Industry Development Vision.

3.4 Of the factors/ indicators, IRR (internal rate of return) of Bago South-East is the lowest amongst the 2nd-screened 6 areas whereby there is a difficulty of selecting Bago South-East area as one of the final priority areas from the view point of economic justification though the area is endowed with transportation network and also located near Yangon, the biggest consumer area in Myanmar, leading to high potential of facilitating food value chain. A major reason of low return is attributed to the high investment cost of sea water prevention sluice gates to be required in lower part ï coastal part - of Bago South-East area.

3.5 Of the 5 priority areas, Magway West was further dropped. Magway West is located in a very remote area and agriculture commodities are more or less transacted within the region with some amount of pulses and oil crops for export. Given this situation, there is a difficulty pertinent to this area in promoting capital-based intensive agriculture. Though once the area was challenged by a high poverty ratio, the poverty ratio was very much improved, say from 43.9% in 2005 to 28.2% in 2010, the highest decrease of 15.7% among 2nd-screened 6 areas (considered as region). Though Magway may still need development assistance, the intervention should be of basic infrastructure establishment while the need of promoting intensive agriculture at this moment cannot be high, whereby dropped from the final selection.

Table 3.2 Screening of Selecting Top 4 Priority Areas by 2-level Indexes

Area	IRR	FVC	Yield	Div'n	Rehab. Need	Exp'n	Poverty	2-pole	MIDV
Shwebo	◎	○	○	○	◎	○	△	○	○
Mandalay	○	◎	○	◎	◎	△	○	◎	◎
Magway West	○	△	○	○	◎	△	○	○	○
Nay Pyi Taw	○	◎	◎	◎	△	○	○	○	○
Bago South - East	△	◎	◎	○	○	◎	△	△	◎
Ayeyarwady	◎	○	◎	△	○	○	◎	△	○
Following 3 areas already dropped by 2nd screening									
Chindwin – Ayeyarwady	-	△	◎	◎	○	△	○	○	△
Shan South	-	○	○	◎	△	△	○	△	○
Bago South - West	-	○	◎	△	△	◎	△	△	○

Note: FVC means the possibility of facilitating food value chain; Divn means the possibility of crop diversification; Expn means the possibility of expanding irrigable area based on water availability; IRR is internal rate of return (no conversion factors are counted in this estimation); MIDV means Myanmar Industry Development Vision. Source: JICA Survey Team

4. DEVELOPMENT STRATEGY AND DIRECTION

4.1 As the result of the screening, 4 areas of Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady have been selected. Specific features, issues and development opportunities of each area have been examined, based on which development directions for each area are presented as following:

1) Shwebo Area

Shwebo Area is a rice producing area in the Upper Myanmar. Particularly, the area is a production center of ñShwebo Paw Sanò, which is a high value variety of monsoon paddy for domestic markets, and is possible for double cropping in irrigated area. To increase food supply to the rice shortage area in the CDZ and Mandalay in which accumulation of manufacturing industry is progressing, improvement of production infrastructure, including irrigation facility rehabilitation and land consolidation, is important to materialize stable supply of basic food such as rice. In addition, by enhancing collaboration with stakeholders, quality improvement and intensification of agro-products supply chain as a whole should be promoted.

2) Mandalay Area

Neighboring to Mandalay city, promotion of agro-processing industry, development of value chain (improvement in farming techniques, improvement of post-harvest handling technologies, farm road construction, provision of cold storage, improvement in packaging technologies, plant quarantine) should be facilitated. Further, taking advantage of accumulation of varieties of agricultural products owing to location situated at the center of national level transportation network (MDY-YGN, MDY-Muse, MDY-Tamu and MDY-CDZ), the area can be promoted as the center of agricultural products distribution in Upper Myanmar. Thus, this will lead the area to be developed as the center for promotion of food processing industries.

3) Nay Pyi Taw Area

Taking the advantages as having abilities to attract customers being the capital of the nation and the favorable location situated at the middle between Yangon and Mandalay, demonstration and extension of advanced farming model should be promoted. Nay Pyi Tawôs important role is thus primarily to demonstrate advanced agricultural technologies (mechanization, water saving irrigation, hydroponic farming system, green house farming, and organic farming, etc.), maintaining a harmonious balance with environment, as a Green Model City. In addition, thanks to the most stable power supply in the country, food processing industry promoted in this area has a great potential to spearhead its industry within the country.

4) Ayeyarwady Area

Ayeyarwady Delta is internationally recognized rice producing area of Myanmar, and takes the substantial responsibility for the nationôs food security. To enhance supply capacity of rice, it is important to increase productivity of rice through land consolidation and farm mechanization, in addition to the strengthening of flood protection dike and drainage. On the other hand, villages in the delta area are segmented by unnumbered rivers and creeks, resulting in high cost and time consuming transportation of agricultural products. To mitigate the constraints on agro-products distribution, improvement of distribution infrastructure including upgrade of farm-to-market roads (FMRs), a part of the regional roads, bridges and river ports are required.

5. DEVELOPMENT PLAN AND THE COST

5.1 Based on the direction set by priority area above mentioned, following program components are proposed; namely, the components are firstly demarcated into 2 groups of productivity increase and agribusiness promotion, and then where a specific component is required in a priority area is marked:

Table 5.1 Program Components of the Priority Areas

Component	Shwebo	MDLY	NPT	AYWDY
I. Component for Productivity Increase				
1. Agriculture Extension Strengthening	○	○	○	○
2. Irrigation Rehabilitation	○	○	○	
3. Polder and Drainage Improvement				○
4. Land Consolidation	○	○	○	○
5. Agricultural Machinery Station Enhancement	○		○1/	○
6. Agricultural Machinery Dissemination (TSL)	○	○	○	○
7. Flood Monitoring System Establishment	○			○
8. Plant Breeding Enhancement			○	
II. Component for Agribusiness Promotion				
9. Farm-to-Market Road (FMR) Improvement	○	○	○	○
10. Jetty Improvement	○	○		○
11. Market Improvement (District level)	○			○
12. PPP Wholesale Market Establishment (Mandalay)		○		
13. Wholesale Market Development (New)			○	
14. Small and Medium Agro-enterprise Promotion (TSL)	○	○	○	○
15. Supply Chain Improvement of Rice	○	○	○	○
16. Value Chain Enhancement of Vegetables & Fruits		○		
17. Food Processing Industry Promotion		○		
18. Dissemination of Advanced Farming Technologies			○	
19. Plant Protection and Quarantine Enhancement	○2/	○2/		○3/

Note: MDLY means Mandalay, NPT is Nay Pyi Taw, and AYWDY stands for Ayeyarwady, and TSL is Two Step Loan

1/ Agricultural machinery station in NPT should have a function of a machine testing center, which issues certificate for a properly and legally produced machine.

2/ Plant Protection and Quarantine center proposed for Shwebo is the same as the one proposed for Mandalay. Therefore, the center should be established in Mandalay city or its suburban area.

3/ Plant Protection and Quarantine center for Ayeyarwady should be established in Yangon, namely, an existent PPDôs laboratory in Yangon should be renovated.

5.2 A total 19 components/ sub-program have been identified in order to promote intensive agriculture in the priority areas. Each of the priority areas should implement a package, or combination, of the components depending upon the potentials and constraints that each of the areas has. Following tables summarize the components/ sub-programs that each of the priority areas should implement with 3 levels of priority; namely, A, B, and C. Priority level óAô means its implementation should be urgently needed with the highest priority; óBô needs the implementation with higher priority while the óCô means the components should still be implemented with priority:

Table 5.2 Shwebo Program Components and the Priorities

Component: Shwebo	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	A	Yield is still low as compared to the potential.
2. Irrigation Rehabilitation	B	Irrigation facilities are fairly maintained.
4. Land Consolidation	B	Need to implement step by step with mechanization.
5. Agricultural Machinery Station Enhancement	B	Some available from private farmers/ companies.
6. Agricultural Machinery Dissemination (TSL)	A	Mechanization be progressed due to labor shortage.
7. Flood Monitoring System Establishment	C	Flood takes place, but not disastrous.
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	B (A)	Fairly maintained except Old MC inspection road Old Main Canal maintenance road be paved.
10. Jetty Improvement	C	Major mode of transportation is by road.
11. Market Improvement (District level)	C	Major distribution of rice to Mandalay, then Muse.
14. Small & Medium Agro-enterprise Promotion	A	Aged rice milling machines be renovated.
15. Supply Chain Improvement of Rice	A	Both high value rice and for export being produced.
19. Plant Protection and Quarantine Enhancmđ	B	Mandalay be given the highest priority.

Note: MC means Main Canal. Source: JICA Survey Team

Table 5.3 Mandalay Program Components and the Priorities

Component: Mandalay	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	B	Yields are fairly high already, but still need.
2. Irrigation Rehabilitation	A	Facilities are vey aged, and need rehabilitation.
4. Land Consolidation	C	Indian Loan is to cover 10,300 acres within the area.
6. Agricultural Machinery Dissemination (TSL)	B	Very needed but fairly accessible to Mandalay agents.
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	B	Overall condition is fairly passable.
10. Jetty Improvement	B	Need very much but better by another whole set of prj.
12. PPP Wholesale Market Establishment	A	Due needed as the Mandalay being the center of UM.
14. Small & Medium Agro-enterprise Promotion	B	Needed as rice milling machines are aged.
15. Supply Chain Improvement of Rice	B	Needed including marketing & processing.
16. Value Chain Enhanđ of Vegetables & Fruits	C	Needed but not in urgent.
17. Food Processing Industry Promotion	A	Mandalay being center of UM, this should be promoted.
19. Plant Protection and Quarantine Enhancmđ	A	Need one central PP laboratory in UM.

Note: UM means Upper Myanmar. Source: JICA Survey Team

Table 5.4 Nay Pyi Taw Program Components and the Priorities

Component: Nay Pyi Taw	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	A	NPT being the capital, be strengthened.
2. Irrigation Rehabilitation	B (A)	Government & donors have contributed fairly. However, Paung Laung be completed at soonest time.
4. Land Consolidation	C	IFAD and Indian Loan to contribute total 22,500 acre.
5. Agricultural Machinery Station Enhancement	B	Has a function of machine testing center
6. Agricultural Machinery Dissemination (TSL)	B	Needed and under progressing fairly.
8. Plant Breeding Enhancement	A	Needed at DAR HQs
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	B (A)	Except a part of Paung Laung area, fairly passable. Rural roads in Paung Laung area be paved.
13. Wholesale Market Development (New)	C	Current markets operated well, though need improvemđ
14. Small & Medium Agro-enterprise Promotion	A	Can well promote thanks to the stable power supply
15. Supply Chain Improvement of Rice	B	Fairly needed.
18. Advanced Farming Technologies	A	NPT being the capital, demonstration be the highest.

Source: JICA Survey Team

Table 5.5 Ayeyarwady Program Components and the Priorities

Component: Ayeyarwady	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	A	Paddy quality be improved from seed to harvest.
3. Polder and Drainage Improvement	B	Fairly managed and maintained by ID.
4. Land Consolidation	B	Needed since there area lots of areas.
5. Agricultural Machinery Station Enhancemđ	B	Needed due to labor and animal shortage.
6. Agricultural Machinery Dissemination (TSL)	A	Needed due to labor and animal shortage.
7. Flood Monitoring System Establishment	C	Chinese government to support.
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	A	Needed very much due to poor road and bridges.
10. Jetty Improvement	C	Needed but at latter stage accepted.
11. Market Improvement (District level)	C	Major rice distribution to Mandalay and Yangon.
14. Small & Medium Agro-enterprise Promotion	A	Needed much to renovate aged rice milling machines.
15. Supply Chain Improvement of Rice	B	Rice being produced largest, needed in this area.
19. Plant Protection and Quarantine Enhancmđ	B	Need to improve PPD in Yangon.

Source: JICA Survey Team

5.3 Based on the 3-level categorization of the component priority, A, B and C, the program costs are also summarized by such categorized group. It is noted that 2-Step loan is excluded from the summation of the cost in the table as the loan is implemented over wide coverage of the country, and accordingly it can not be categorized into a specific priority area. Likewise, wholesale markets planned with PPP scheme are excluded, which are the wholesale market in Mandalay and another one in Nay Pyi Taw area. This is because the wholesale markets are to be implemented by a private initiative, so that the markets should be differentiated from the ones initiated by the government with donor assistances.

Table 5.6 Cost Categorized According to the 3-level Priority

Priority Area	Priority Level	Cost of Components					
		(million Kyats)			(million JPY)		
Shwebo Area	A	24,270			2,840		
	B	145,863	(A+B)	(A+B+C)	17,066	(A+B)	(A+B+C)
	C	5,179	170,133	175,312	606	19,906	20,511
Mandalay Area	A	151,426			17,717		
	B	50,015	(A+B)	(A+B+C)	5,852	(A+B)	(A+B+C)
	C	23,025	201,441	224,466	2,694	23,569	26,263
Nay Pyi Taw Area	A	37,841			4,427		
	B	48,980	(A+B)	(A+B+C)	5,731	(A+B)	(A+B+C)
	C	5,895	86,820	92,715	690	10,158	10,848
Ayeyarwady Area	A	35,476			4,151		
	B	81,572	(A+B)	(A+B+C)	9,544	(A+B)	(A+B+C)
	C	8,180	117,047	125,228	957	13,695	14,652

Note 1: There are components, only parts of which are categorized in ÒAÓ but the rest are still in ÒBÓ such as farm-to-market roads in Shwebo and Nay Pyi Taw area and irrigation scheme (Paung Laung scheme) in Nay Pyi Taw area. In these cases, the costs are divided into the groups, A or B, according to the detail cost categorization.

6. IMPLEMENTATION ARRANGEMENT

6.1 There are total 19 components, and a set of combination of them needs to be implemented in order to promote intensive agriculture in the priority areas, depending upon the characteristics of those areas. To implement those components, relevant government offices should undertake the responsibility as well as the leading roles, to which donors could contribute with a series of schemes including loan provision. Following table shows indicative schemes in cases that; 1) ODA scheme(s) is to be applied, and 2) schemes other than ODA are to be applied:

Table 6.1 Program Components and Potential Implementation Scheme

Component	Potential ODA Scheme	Executing Organization
III. Component for Productivity Increase		
1. Agriculture Extension Strengthening	Loan (Project)	Department of Agriculture (DOA)
2. Irrigation Rehabilitation	Loan (Project)	Irrigation Department (ID)
3. Polder and Drainage Improvement	Loan (Project)	Irrigation Department (ID)
4. Land Consolidation	Loan (Project)	Irrigation Department (ID) Agricultural Mechanization Depôt (AMD)
5. Agricultural Machinery Station Enhancement	Loan (Project)	AMD
6. Agricultural Machinery Dissemination (TSL)	Loan (TSL), 1/	ID
7. Flood Monitoring System Establishment	Loan (Project)	ID (canal maintenance road) Depart. Of Rural Developôt (rural road) Highway Department (regional road)
8. Plant Breeding Enhancement	Grant Aid	DAR
IV. Component for Agribusiness Promotion		Inland Water Transport Department
9. Farm-to-Market Road (FMR) Improvement	Loan (Project)	Local Gvt (development committee)
10. Jetty Improvement	Loan (Project)	
11. Market Improvement (District level)	Loan (Project)	Myanmar Agricultural Developôt Bank
12. PPP Wholesale Market Establishment (Mandalay)	Loan (OIL), 2/	PPP (Private company)
13. Wholesale Market Development (Nay Pyi Taw)	Loan (OIL)	PPP (Private company, or NPT CDC)
14. Small & Medium Agro-enterprise Promotion (TSL)	Loan (TSL), 1/	Small & Medium Industry Developôt Bank
15. Supply Chain Improvement of Rice	TCP, 3/	DOA
16. Value Chain Enhancement of Vegetables & Fruits	TCP	DOA
17. Food Processing Industry Promotion	TCP	DOA (Post harvest Tech. Training C.)
18. Dissemination of Advanced Farming Technologies	TCP	DOA
19. Plant Protection Enhancement	Grant Aid	Plant Protection Division, DOA

Note: 1/ TSL means Two Step Loan, 2/ this loan could be provided by ñOverseas Investment and Loanò scheme. The scheme aims at promoting economic development of developing countries through providing loan to development projects implemented by private sector. 3/ TCP means technical cooperation project, one of JICAÕs technical cooperation schemes.

6.2 To implement various components in a priority area by a project loan needs to establish well workable management structure. Though there is a regional government and the program is to be implemented at regional level, the regional government is a political establishment without technical offices. The lead executing organization for the overall implementation should, therefore, be the MOAI through its Department of Planning (DOP). The DOP should oversee the implementation of program components and provide administrative support to the Project Management Offices (PMOs).

6.3 The program operation and management should be the responsibility of DOP from the central to the field level through its PMOs. The PMOs are composed of the Central Project Management Office (CPMO) at the DOP Central Office, and the Regional Project Management Office (RPMO), well supported by a team of consultants. Relevant departments under MOAI should second their technical and management officers to the PMO. The participating departments under MOAI are DOA, AMD, and ID. Further to these organizations under MOAI, there are other participating agencies from different ministries as Department of Rural Development (DRD) under Ministry of Livestock, Fisheries and Rural Development (rural road), Highway Department (HD) under Ministry of Construction, etc.

7. PROJECT EVALUATION

7.1 EIRR and NPV are calculated by priority areas in order to judge the project viability in economic term, and the results are summarized below. Regarding irrigation rehabilitation including agricultural extension strengthening, the largest project component, Shwebo shows more than 15%

opportunity cost ratio even only with yield increase (Base 0ô). This region has the largest irrigable area, while cost per acre is the smallest. Moreover, the farm gate price of monsoon paddy is the highest because ñShwebo Pawsanò variety is well-known as a bland rice variety in Myanmar. Therefore, this area should have largest potential in investment:

Table 7.1 Economic Internal Rate of Return (%) and Net Present Value (million Kyats)

Case	Shwebo		Mandalay		Nay Pyi Taw		Ayeyarwady	
	IRR	NPV	IRR	NPV	IRR	NPV	IRR	NPV
Irrigation Rehabilitation								
Base0ô*1 (only yield increase)	15.1%	496	8.4%	-31,697	16.9% (4.5%)	3,162 (-9,028)	8.7%	-9,457
Base0*1 (Yield & area expansion)	21.3%	29,092	16.3%	7,540	18.8% (10.1%)	6,629 (-4,974)	16.4%-	2,628
Base1*1 (pulses introduced)	23.2%	39,791	22.5%	51,700	22.1% (17.3%)	13,216 (2,741)	-	-
Base2*1 (Sesame introduced)	24.6%	47,803	21.1%	40,297	22.0% (14.7%)	13,096 (-376)	-	-
Land Consolidation								
Base0*2	12.9%	779	16.6%	3,141	10.8%	-277	12.5%	464.1
Road Rehabilitation								
Base0*2	20.5%	9,366	19.7%	9,060	12.9%	466	12.9%	956

*1: NPV is calculated at 15% discount ratio., *2: NPV is calculated at 12% discount ratio (Unit: Million Kyat).

Note: Reference case without Paung Laung irrigation scheme is shown in parenthesis

Source: JICA Survey Team, refer to Appendices-V

7.2 In Nay Pyi Taw, the mid and downstream area of Paung Laung irrigation scheme is designed to irrigate a total paddy field of 35,000 acre during monsoon season while actually irrigated area for the last 5 year is only 4,106 acre. Therefore, given an additional 4.8 billion Kyats, the Paung Laung irrigation scheme is expected to complete, benefitting the huge paddy area. Considering this sunk costs, new beneficial area will be generated upon Paung Laung irrigation scheme completion. As a result, Nay Pyi Taw shows more than 15% opportunity cost ratio in all base cases. On the other hand, the Team also calculated IRR and NPV ignoring Paung Laung irrigation scheme, which could not exceed 15% opportunity cost except Base 1 case.

7.3 For land consolidation, Nay Pyi Taw shows less return than 12% opportunity cost ratio. In Nay Pyi Taw, the planting ratio of summer paddy and pulses are relatively low (for example, as compared to Ayeyarwady, 33.3 percent versus 42.2 percent for summer paddy, also, 60.0 percent versus 65.6 percent for black gram), and farm-gate price of monsoon paddy is the lowest among 4 priority areas. Therefore, the land consolidation in Nay Pyi Taw area resulted in lower rerun of the investment. As for other priority areas, they show more than 12% opportunity cost ratio with Mandalay achieving more than the 15%. In Mandalay, not small number of farmers have already introduced three-cropping pattern which generates very high cropping ratio of pulses (e.g. chick pea).

7.4 Road rehabilitation component exceeded 12% opportunity cost ratio in all the 4 priority areas; however, only Shwebo and Mandalay showed more than 15%. This difference may come from unit cost of gravel roads. In Nay Pyi Taw and Ayeyarwady, the cost of gravels is considerably expensive as compared to other priority areas, approximately more than 4-5 times higher than those of other areas. In fact, the road rehabilitation component in the areas of Nay Pyi Taw and Ayeyarwady includes regional roads, which would benefit not only farming but also regional economies. Therefore, with further investigation considering other regional transportations such as non-agricultural commodities, the return would be higher enough.

8. CONCLUSION

8.1 This Preparatory Survey, taking the points below into account, concludes that Myanmar should take actions to move from the current labor-intensive agriculture to a modern capital based intensive agriculture. In this regard, this preparatory survey has identified 4 priority areas, i.e., Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady, and presented an intensive agriculture promotion program by each of the priority areas.

8.2 The Government of Myanmar should, with reference to the programs presented by this preparatory survey, start internal discussions as well as consultations with potential donors engaged in agricultural and rural development sector on which ones out of the 4 priority areas should be put into implementation first, and then which area be the next, so on. Upon the discussions and decision made, the Government should embark on the next step, which is the feasibility study for the top priority area(s), possibly in collaboration with donor(s).

1) Agricultural sector plays a quite important role in Myanmar, making up 31.3% of GDP (2013/14), 19.8% of export (2013/14), and as large share as 61.2% of employed population (2011/12). Self-sufficiency rate of rice is well over 100% and its export volume reached as much as 1.7 million tons in fiscal year 2014/15, bringing nearly US$ 645 million of export earning. Myanmar is also a major exporting country of pulses among ASEAN members, mainly targeting India, and the cropping area has increased from 730,000 ha in 1988/89 to as much as 4.5 million hectare in 2013/14.

2) Meanwhile, the current farming in Myanmar is characterized by labor-intensive agriculture and most farm households depend on farm labors. However, with the current economic development, the trend of labor movement from rural areas to urban areas or from agriculture sector to construction sector could be accelerated, making it difficult to secure farm labors. To cope with this situation, the current labor-intensive agriculture should be transformed to modern capital-intensive agriculture with farm mechanization, introduction of quality seeds and well managed fertilizer/chemicals, introduction of improved post-harvest techniques, and also improvement of supply/ distribution chain, etc.

3) From macro point of view, agriculture sector holds surplus labors in rural areas before industrialization. Industrialization promotes labor shift from relatively low value-added industries including agriculture sector to high value-added industries such as manufacture industry and/or service sectors, resulting in economic growth. If the industrialization progresses further, industry sector peels off labor forces from agriculture sector, and accordingly the surplus labor in the agriculture sector in turn reaches bottom. The bottom is so called ñLewis Turning Pointò, after which the wages will start increasing due to tightening of demand and supply balance.

4) A theory of development economics indicates that labor shortage in rural area increases farming costs through wage increase, which results in increase in selling price of agricultural products. Increase in food prices in urban areas would seriously affect household economy of urban labors, and, as a general rule, could cause the wage increase in industry sector. This wage increase will result in weakening of competitive power of the industry sector in the world market, leading to a gear down of the industrialization process.

5) To mitigate rapid progress of the negative scenario of industrial development above-mentioned, it is important to supply cheaper staple food constantly through increase in basic food production including rice, the staple food of Myanmar people. For this purpose, shifting from the labor intensive farming currently practiced in wide range of Myanmar to the capital intensive with labor saving agriculture is due necessary in this country. Shifting to the modern capital intensive

agriculture thus contributes to assuring the continuous provision of affordable and stable food, and thereby able to keep the progress of industrialization.

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V. PROJECT EVALUATION
VI. ENVIRONMENT
VII. PDM AND PO (FOR TECHNICAL COOPERATION PROJECTS)

ACRONYMS AND ABBREVIATIONS

AED	Agricultural Extension Division
AMD	Agriculture Mechanization Department
CARTC	Central Agriculture Research and Training Centre
CBM	Central Bank of Myanmar
CD	Cooperative Department
CIF	Cost, Insurance and Freight
CSO	Central Statistical Organization
DALMS	Department of Agricultural Land Management and Statistic (former SLRD)
DAR	Department of Agriculture Research
DOA	Department of Agriculture
DAR	Department of Agriculture Research
DP	Department of Planning (former Department of Agricultural Planning)
ECC	Environmental Conservation Committee
FAO	Food and Agriculture Organization
FHH	Farm Household
FOB	Free on Board
GAD	General Administration Department (under Ministry of Home Affairs)
GDP	Gross Domestic Product
GOJ	Government of Japan
GOM	Government of Myanmar
GRDP	Gross Regional Domestic Product
HDI	Human Development Index
HH	Household
ICM	Integrated Crop Management
ID	Irrigation Department
IMT	Irrigation Management Transfer
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
LBVD	Livestock Breeding and Veterinary Department
MADB	Myanma Agricultural Development Bank
MC	Ministry of Cooperatives
MEPE	Myanmar Electric Power Enterprise
MFI	Micro Finance Institution
MFTB	Myanma Foreign Trade Bank
MICB	Myanma Investment and Commercial Bank
MOAI	Ministry of Agriculture and Irrigation
MOECAF	Ministry of Environmental Conservation and Forestry
MOEP	Ministry of Electric Power
MOF	Ministry of Forestry
MOLF	Ministry of Livestock and Fisheries
NGO	Non-Government Organization
NPK	Nitrogen, Phosphate, Potassium
ODA	Official Development Assistance
OFID	OPEC Funded International Development

PIM	Participatory Irrigation Management
PPP	Public Private Partnership
RRB	Report Review Body
SLRD	Settlement and Land Records Department (now, DALMS)
TS	Township (the smallest administrative unit where government institutions are placed)
UNDP	United Nations Development Programme
WFP	World Food Programme
WRUD	Water Resources Utilization Department (merged into ID as of 2015)
YAU	Yezin Agriculture University

FARMLAND TERMS IN MYANMAR

Le	Paddy land or wet land which can be used as paddy land
Yar	Upland
Kaing	Farmlands which appear in the flood lands in Ayeyarwady River as the water recedes
Kyun	Farmlands which appear on the alluvial sandbars in Ayeyarwady River as the water recedes

UNIT CONVERSION

1 basket	Paddy	20.9 kg
1 basket	Wheat	32.7 kg
1 basket	Maize (seed)	24.9 kg
1 basket	Sorghum	28.1 kg
1 basket	Sesame	24.5 kg
1 basket	Mustard	26.1 kg
1 basket	Sunflower	14.5 kg
1 basket	Groundnut	11.4 kg
1 basket	Butter Bean	31.3 kg
1 basket	Sultani	31.3 kg
1 basket	Sultapya	31.3 kg
1 basket	Chickpea	31.3 kg
1 basket	Pebyugalay	31.3 kg
1 basket	Pegyi	31.3 kg
1 basket	Pegyar	31.3 kg
1 basket	Pigeon Pea	32.7 kg
1 basket	Black Gram	32.7 kg
1 basket	Green Gram	32.7 kg
1 basket	Bocate	32.7 kg
1 basket	Soybean	32.7 kg
1 basket	Cowpea	32.7 kg
1 basket	Peyin	32.7 kg
1 basket	Sadawpea	32.7 kg
1 basket	Payazar	32.7 kg
1 basket	Pe-nauk	32.7 kg
1 basket	Other Pulses	31.7 kg

Rice (1) basket	16 pyi
	75 pounds
	34.0136 kilograms
Rice (1) pyi	4.6875 pounds
	2.1258 kilograms

Rice (1) can	0.5859 pound
Rice (1) kilogram	3.7636 cans
1 pyi	8 nohzibu
1 basket	16 pyi
1 viss	1.633 kg
1 viss	3.6 pounds
1 lb (pound)	0.453 592 kg
1 kilogram	2.205 pounds
1 ton (long ton)	2240 pounds
1 metric ton	1000 kilograms
	2204.623 pounds
1 kg	0.6124 viss
1 pound (lb)	0.4536 kg
1 kg	2.2046 ponds
1 gallon	4.5461 litre
1 litre	0.2200 gallon
1 inch (in.)	2.54 cm
1 feet (ft.)	30.5 cm
1 meter	3.279 feets
1 kilometer	0.621 mile
1 mile	1.601 kilometer
1 acre (ac)	0.40468 ha
1 hectare (ha)	2.471 ac
1 ac-ft	1233.4 cum
1 cum	0.00081 ac-ft
1 square kilometer	0.386 sq.mile
1 sq.mile	2.5907 sq.km
1 cusec (cubic feet per second)	28.317 liters per second
1 liter per second	0.0353 cusec (cubic feet per second)
1 sud = 100 cu-ft	2.8317 cubic meter
1 Psi	0.0703 kg/sqcm
1 kg/sqcm	14.22 Psi (pound-force per square inch)

CURRENCY EQUIVALENTS (AS AT DECEMBER 2015)

1 US$	=	122.85 Japanese Yen (TTB)
1 Kyat	=	0.095 Yen
1 US$	=	1293 Myanmar Kyats
1 lakh	=	100,000 Kyats

MYANMAR FINANCIAL YEAR

April 1 to March 31

PART I RATIONALE AND PRIORITY AREAS SELECTION

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MAIN REPORT

PART I
Rationale and Priority Areas Selection

CHAPTER 1 RATIONALE AND GOAL OF THE SURVEY

Submitted herewith is the final report prepared for the 'Preparatory Survey for Intensive Agriculture Promotion Program (PIAP)'. A survey team organized by JICA headquarters commenced a series of field surveys for the Preparatory Survey from 19th April 2015, and this report presents all the major findings, identification of potential areas, pre-feasibility study results for the top 4 priority areas, and conclusion and recommendations.

1.1 Rationale of the Survey

Agricultural sector in Myanmar makes up 31.3%[1] of GDP (2013/14), 19.8%[2] of export (2013/14), and 61.2% of employed population (2011/12). Self-sufficiency rate of rice is well over 100% and its export volume reached as much as 1.7 million tons in fiscal year 2014/15, bringing in nearly US$ 645 million (source: Ministry of Commerce). Myanmar is also a major exporting country of pulses among ASEAN members, mainly targeting India, and the cropping area has increased from 730,000 ha in 1988/89 to as much as 4.5 million hectare[3] in 2013/14.

Meanwhile, farming in Myanmar is characterized by labor-intensive agriculture and most farm households depend on farm labors. For example, a survey[4] revealed that payment to the farm labors had shared as much as 45%, 49% and 26% for summer paddy, monsoon paddy and black gram respectively in the production costs excluding own household labor cost. Paddy is the staple food and most important crop in Myanmar while black gram earns the biggest share of export value in agricultural commodities; yet these major crops are heavily dependent on farm labors in the production.

However, with the current economic development, the trend of labor movement from rural areas to urban areas or from agriculture sector to construction sector may be accelerated. This trend, if continues, makes it difficult to secure farm casual labors as the farmers are to face acute shortage of farm casual labors. To cope with this situation, the current labor-intensive agriculture shall be transformed to modern capital-intensive agriculture with farm mechanization, introduction of quality seeds and well managed fertilizer/chemicals, introduction of improved post-harvest techniques, etc.

Further to above interventions, production infrastructure and also food distribution network shall be improved and enhanced. Production infrastructure includes irrigation facilities which can provide stable water for crops, farm roads which facilitate marketing, and farmland consolidation which can exploit maximum potential of agriculture mechanization. Advancing food distribution supported by food value chain improvement shall also be undertaken, for delivery of affordable-priced foods to all the people who work in other industries comes into sight. Thus, all these issues strongly suggest that the nowadays Myanmar needs to promote modernized intensive agriculture, and hence this Survey is conducted.

1.2 Purpose of and Outputs from the Survey

The purpose of the Preparatory Survey is to 'contribute to realizing an intensive modern agriculture in Myanmar'. In order to achieve this purpose, following 3 outcomes have to be attained through the

[1] Source: Ministry of National Planning and Economic Development. The 31.3% is made up of 25.6% of agriculture, 8.7% of Livestock & Fishery, and 0.4% of Forestry.

[2] Source: Ministry of National Planning and Economic Development. This 19.8% is only for the share of crop product while share of crop product and livestock & fishery product makes up of as much as 31%.

3 Source: 2014 Myanmar Agriculture at a Glance, Source：Settlement and Land Records Department

[4] Source: Preparatory Survey for the Project for Rehabilitation of Irrigation Systems, August 2014. Note that the payment to the farm labors was estimated by aggregating such cost of; seeding & transplanting, fertilizer application, pesticide/ fungicide application, herbicide application, weeding, harvesting, transporting (farm to dry yard), and drying/ packing, which are in most cases undertaken by farm casual labors.

process of the Survey. These outcomes and background of the survey are diagrammatized in Figure 1.2.1 and Figure 1.2.2.

1) To select high-prioritized irrigation areas for the promotion of intensive modern agriculture (3-4 areas are to be proposed).

2) To work out programmes for the realization of intensive agriculture in above selected irrigation areas, and

3) To collect basic information required for application of a loan for the components suitable for ODA loan projects.

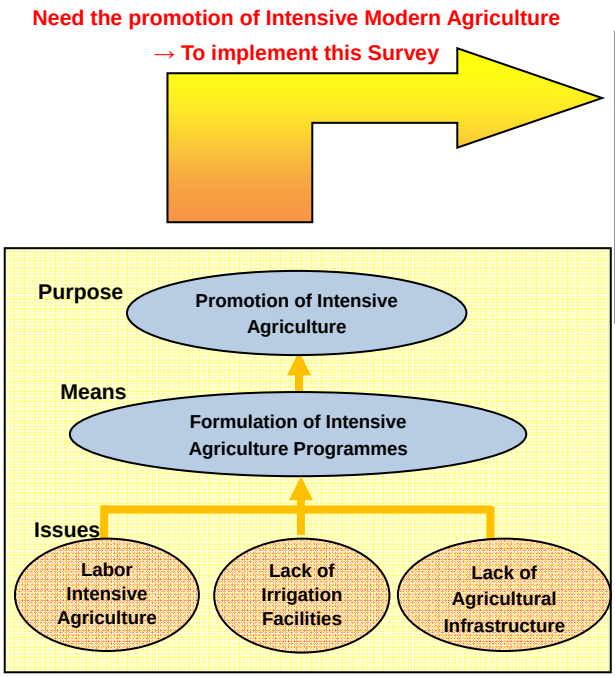


Figure 1.2.1 Background of the Study

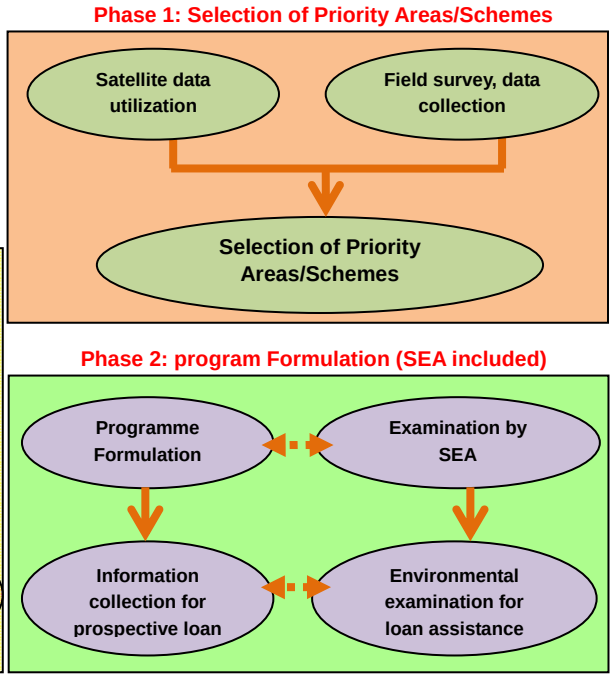


Figure 1.2.2 Study Outputs & Major Works

1.3 Scope and Schedule of the Survey

To attain the survey objective aforementioned, this Survey conducts following activities, which are the scope of the Survey;

1) Preparation and discussion over Inception Report, Interim Report, Draft and Final Reports,
2) Confirmation of the validity of promoting intensive agriculture,
3) Setting of selection criteria of the priority areas, and the selection (finally 4 areas),
4) Formulation of intensive agriculture promotion program,
5) Confirmation & recommendation of implementation structure for the program implementation,
6) Basic information collection for suitable Yen loan components, and
7) Environmental and social examination/ consideration for the potential loan components.

To attain the objective, this Survey is carried out in a phasing manner divided into two: Phase 1 deals mainly with selection of the priority areas (3-4 areas); Phase 2 undertakes the formulation of intensive agriculture program for the selected areas. Whole survey is to be completed within 11 months from April 2015 to February 2016. On the way, an interim report is produced in July 2015 summarizing Phase 1 results, and the final report is submitted by the end of February 2015. Following are the

overall work schedule of the Survey:

Table 1.3.1 Overall Survey Schedule and Farmland Consolidation

Quarter	A	M	J	J	A	S	O	N	D	J	F	M	Remarks
Phase 1 Selection of priority areas													
Phase 2 Formulation of the programs													
Report		ICR		ITR					DFR		FR		

Where; IC/R: Inception Report, ITR: Interim Report, DFR: Draft Final Report, FR: Final Report

1.4 The Survey Area

The Survey area covers whole Myanmar, and of course focus shall be given to potential crop lands where there are number of irrigation schemes whereby intensive agriculture can be promoted. In this regards, central part of Myanmar starting from coastal area toward Sagaing region will be given high priority including Shan state where high valued vegetables have been produced. Following table shows general feature of the Survey area:.

Table 1.4.1 Population, Sown Area, and Irrigation Rate of the Townships of Survey Area

Location and Area	Area (km2)	Population (2010)	Population Density (people/km^2)	Total Sown area (acre)	Irrigated area 2012-13 (acre)	Irrigation Rate (%)
Sagaing Region	94,582	6,541,000	69	9,557,734	1,089,503	11.4%
Mandalay Region	37,008	8,422,000	228	5,589,303	631,372	11.3%
Magway Region	44,801	5,623,000	126	8,070,036	468,185	5.8%
Bago Region	39,387	6,008,000	153	6,151,251	371,167	6.0%
Shan State	155,734	5,660,000	36	4,194,450	524,671	12.5%
Ayeyarwady Region	35,123	8,041,000	229	8,000,430	1,515,449	18.9%
Yangon Region	10,167	7,023,000	691	2,123,863	217,749	10.3%
Taninthary Region	43,328	1,714,000	40	1,443,783	17,285	1.2%
Kachin State	89,003	1,579,000	18	1,081,572	104,791	9.7%
Kayah State	11,728	356,000	30	325,738	47,341	14.5%
Kayin State	30,370	1,816,000	60	1,511,825	77,165	5.1%
Chin State	36,004	554,000	15	340,701	25,844	7.6%
Mon State	12,292	3,137,000	255	1,859,430	64,629	3.5%
Rakhine State	36,762	3,306,000	90	1,755,994	71,306	4.1%
Whole Country	676,288	59,780,000	88	52,006,110	5,226,457	10.0%

Data Source: Statistic Year Book 2011, Settlement and Land Record Department (for Irrigation area)

Looking at the upper part of the above table where most of the potential regions/state are located, irrigation ratio ranges from 5.8 % to as high as 18.9 %. Lowest irrigation ratio can be found in Magway and Bago regions in which hilly and mountainous areas are prevalent; such areas towards western direction in Magway and almost middle part in Bago region. As Ayeyarwady region falls in a delta area, irrigation coverage is naturally large, showing the highest ratio of 18.9% over Myanmar.

1.5 Implementation Arrangement of the Survey

For the implementation of the Survey, JICA has organized a JICA Survey Team, which is composed mainly of SANYU Consultants Inc. The major counterpart organizations of the Survey are Irrigation Department and Department of Agriculture; the former being in charge of construction and maintenance of irrigation schemes while the latter being in charge of agriculture extension. Since two departments are directly related, Department of Planning (DOP, former Department of Agricultural Planning) is in the position of overall coordination (see below figure).

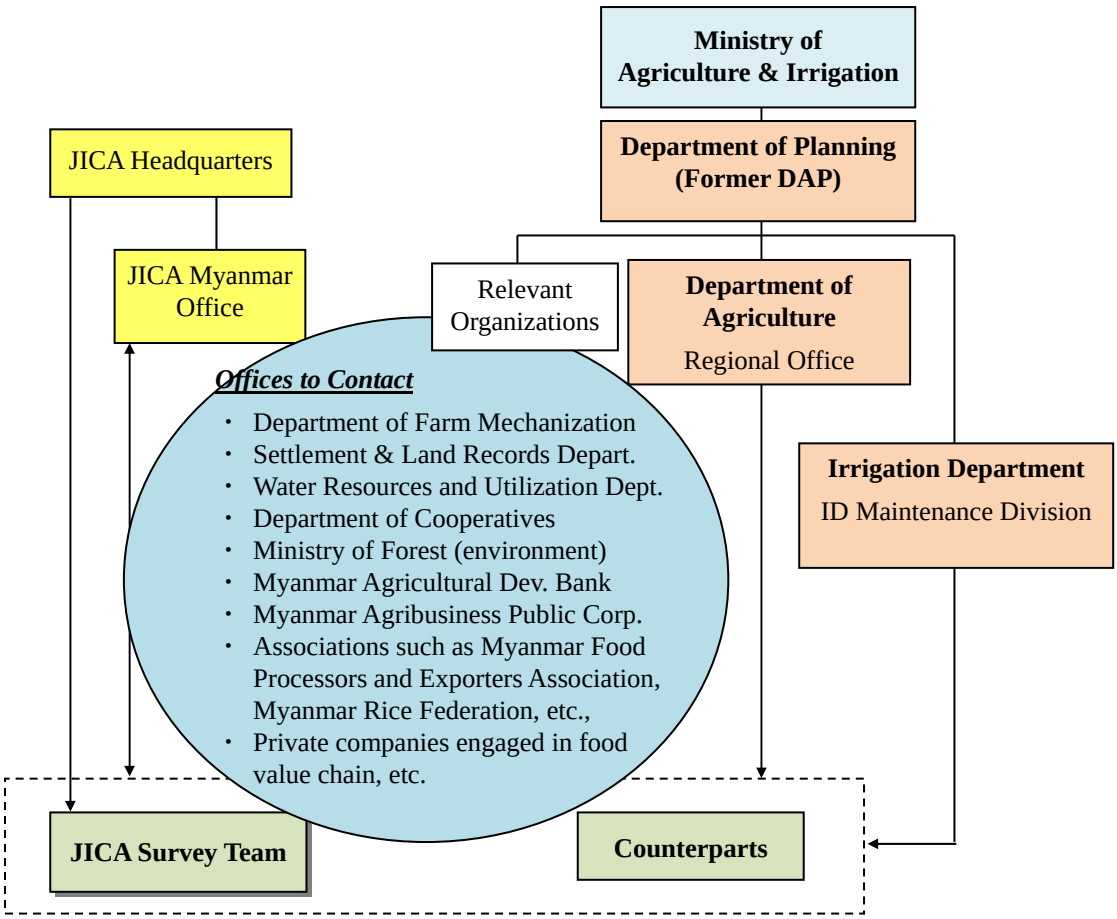


Figure 1.5.1 Implementation Arrangement

Table 1.5.1 Implementation Arrangement for the Survey

Items of Survey	Data and Information	Source and Data / Information
Irrigations Systems & Diagrams	Existing Situation	ID Maintenance Divisions
Rehabilitation Plan	Present and Past Activities	ID Construction Circle and Maintenance Divisions
Agriculture Data	Crop Production, Sowing, Yield	DOA, SLRD
Farmer Data	Farm Land and Farm household	SLRD, TS Administration Office
Food Value Chain	Whole Sale Market, Market	City Council, DOA, Private Companies
Price and Cost	Unit Price, Work Plan	ID, Construction BOQ Standard, DOA
Environmental & Social Consid'n	EIA Regulation	Ministry of Forest, DOP

Source: JICA Survey Team (2015)

Aside from the government offices afore-mentioned, the Team is to contact management authorities of whole sale markets and also private entities engaged in food/crop distribution and food value chain. When planning intensive agriculture promotion, not only production side but also distribution covering up to consumers have to be focused.

1.6 Factors Driving Intensive Agriculture in Myanmar

Intensive agriculture is defined as a farming system characterized by an increased use of land with higher capital investment, achieving high production with less labor input per unit area. This intensive agriculture needs; 1) well established production infrastructure, e.g. irrigation & drainage facilities, 2) farm mechanization often accompanied with land consolidation, 3) increased, but regulated, use of agro-inputs, etc. Intensive here means capital-intensive and not labor-intensive. Following discuss the rationale of why intensive agriculture needs to be promoted in Myanmar.

There are general rules in the relationship between economic development and population change. For example, as a country develops, decline of population in younger generations takes place, leaving less number of working population. This situation requires to transform current labor-intensive agriculture into capital-intensive agriculture including agriculture mechanization. Further, as a country develops, migration from rural area to urban area takes place, leaving less number of farmers or farm casual labors in rural areas.

1.6.1 Decline in Younger Generations

Particularly in Myanmar context, decline in younger population can already be seen. Latest census survey was conducted in 2014 but the population cohort is not available yet. Therefore, we refer to a estimated population structure by a UN office as shown in Figure 1.6.1, and also a household survey result conducted in Bago West area in 2012 covering 250 households. As shown in Figure 1.6.1, decline in the generations below age 30 can be seen, presenting dwindling population in younger generations.

Figure 1.6.1 was made to cover overall Myanmar while the result in Figure 1.6.2 shows only some specific rural areas located near Pyay town in Bago West area to be benefited by an Yen Loan project, Bago West Irrigation Development Project. Almost all of the residents are Burmese, and the result shows very sharp decline in the younger generations below age 30. In general, a society where high status is given to women can achieve high rate of adaption of family planning, leading to decline of number of children in a family. This general rule may have well applied in such society shown in Figure 1.6.2.

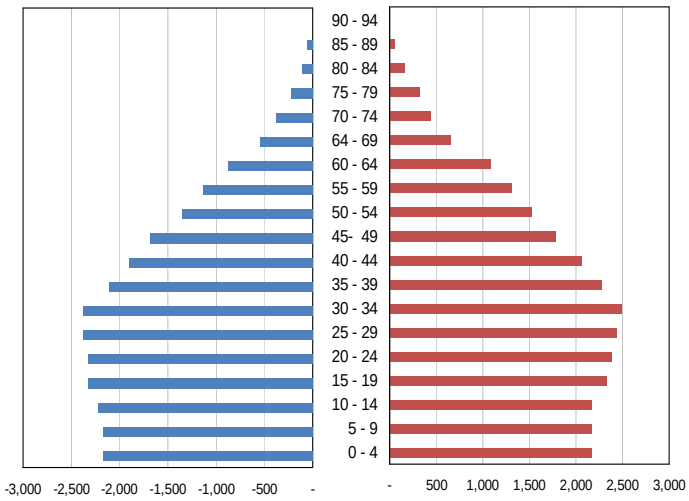


Figure 1.6.1 Population Cohort in Myanmar (2015)
Source: United Nations, Department of Economic and Social Affairs, Population Division.

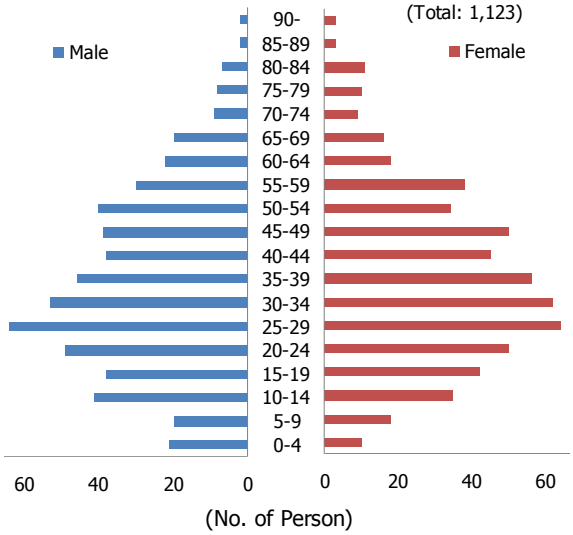


Figure 1.6.2 Population Cohort in Bago West Rural Area (2012)
Source: Preparatory Survey fro Rehabilitation of Irrigation System in Bago West (JICA)

Though the data is limited, it is obvious that there is already a decline in younger generations of Myanmar society, and most probably shaper decline in the Burmese society. Burmese people are prevalent in those priority areas to be identified in this Survey. Therefore, the agriculture in the priority areas will be facing workforce shortage in its future accrued from the decline of the number of young generations. This inevitably implies that capital based intensive agriculture accompanied with farm mechanization shall be pursued.

1.6.2 Migration from Rural to Urban Areas

Figure 1.6.3 comparatively shows shares of the population who live in rural area and urban area over the past 30 years for ASEAN countries. There is an obvious tendency that as time passes by, or as those countries have been economically developed, the shares of urban population have increased.

China shows the sharpest increase in the urban population, followed by Thailand especially after year 2000, and further followed by Lao PDR and Vietnam.

In fact, the increases of urban population for Myanmar and Cambodia are not as high as those of other countries. However, the share of urban population in Myanmar has already reached 33% in year 2013, meaning one out of every 3 persons now live in urban areas. The increase would be further accelerated as the Myanmar had opened the country just sometime ago, year 2011. Over coming years, migration from rural areas to urban areas will continue in Myanmar, leaving less workforce in primary agriculture sector. This situation also upheld the needs of promoting capital-intensive agriculture in Myanmar.

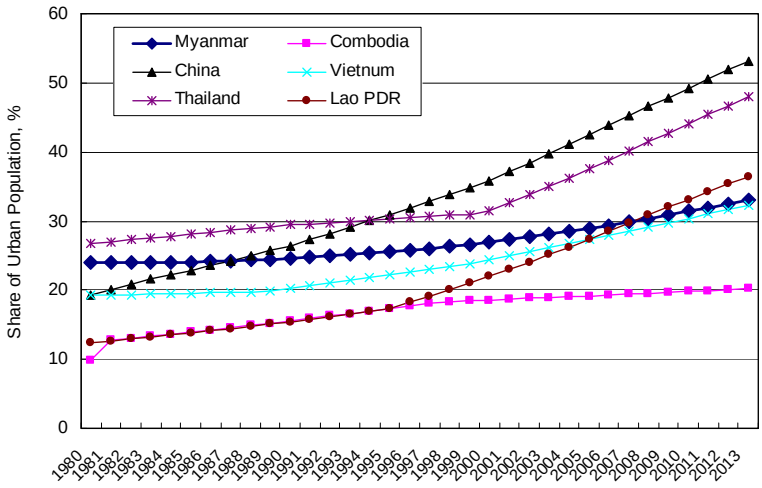


Figure 1.6.3 Share of Rural and Urban Population in ASEAN Countries
Source: Data from database: World Development Indicators

1.6.3 Farm Casual Labor in Myanmar Agriculture

Myanmar had long practiced a quasi seclusion policy, and even after having abandoned the policy, there had been a period during which economic activities were very dormant. During this period, one may say that a large number of unemployed population had emerged in rural areas and whereby they had to engage themselves in farm casual laboring. In fact, most of the farmers nowadays could be said a sort of farm manager, who employs farm casual labors in different sort of farm works starting from land preparation, sowing, weeding, watering, and then harvesting, etc.

There was a household economic survey conducted in 2008 – 2009 under Central Dry Zone Poverty Reduction Program Study (JICA, 2010), covering 400 households. The survey explored the household expenditure pattern aiming at grasping their poverty level. Figure 1.6.4 and Figure 1.6.5 depict their expenditure pattern, which clearly shows that a large share of expenditure goes to the wage payment of farm casual labors.

In most of developing countries, farmers usually spend the largest share of the payment to the purchase of agriculture inputs, especially chemical fertilizer. However, the survey result reveals that approximately one-third of whole expenditure goes to the wage payment for farm casual labors. The expenditure on the purchase of agriculture input comes second, sharing only 19%. This expenditure pattern provides a picture of Myanmar agriculture, or at least agriculture practiced in the Central Dry Zone, very much dependent upon farm casual labors.

The farm casual labors had to stay in rural areas, surviving hand to mouth living, since there were not much employment opportunities other than their rural areas. However, things have changed and nowadays construction and also service sectors had started thriving. There are more opportunities of employment in those sectors. Though there may be a difficulty for them to engage in service sector, it is easier for them to engage in construction sector.

The payment is higher in the construction sector, e.g., minimum 3,000 to maximum 7,000 Kyats per day for the unskilled labor in the construction sector vs. 2,500 to 4,000 Kyats per day in farm casual

labor[5]. Given this difference, farm casual labors would accelerate the migration from agriculture sector to construction sector. This movement had already started and farmers interviewed by JICA team often claimed nowadays' shortage of farm casual labor, which results in increase of wage payment. This situation will inevitably requires capital-based intensive agriculture promotion more accompanied with farm mechanization.

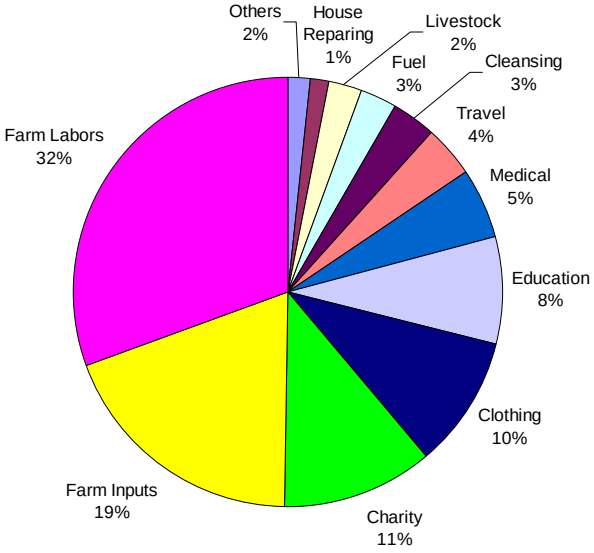


Figure 1.6.4 Share of Expenditure for CDZ Farmer Households
Source: Central Dry Zone Poverty Reduction Program Study (JICA, 2010), 400 HHs covered

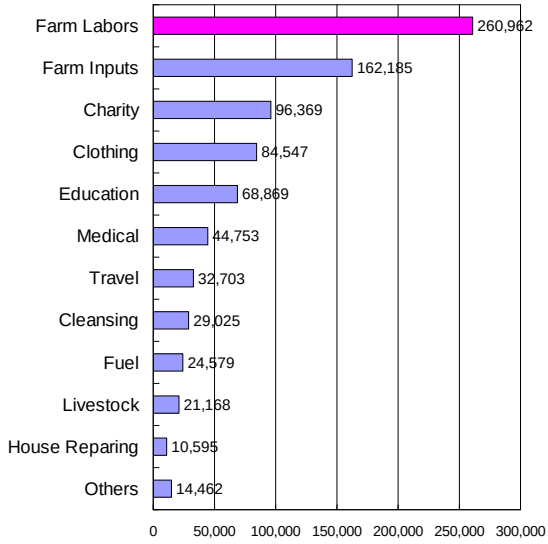


Figure 1.6.5 Expenditure for CDZ Farm Household
Source: Central Dry Zone Poverty Reduction Program Study (JICA, 2010), 400 HHs covered

1.7 Agriculture Mechanization and Land Consolidation

1.7.1 Agriculture Mechanization

To promote intensive agriculture, farm mechanization is one of the musts. As afore-mentioned, farm casual labors and also farm workforce are expected to decline according to the migration of workers to construction sector and decline young generations. It means that agriculture sector should accelerate the farm mechanization. Farm mechanization is currently mandated by Agricultural Mechanization Department (AMD) under MOAI, and this area shall involve private sector participation a lot. Following explores the level farm mechanization in Myanmar from different angles.

Table 1.7.1 summarizes the dissemination of major farm machineries in Myanmar as at March 2012 (Source: AMD). As shown in the table, there are total 10,490 tractors and 206,263 hand tractors, 41,289 threshers, and only 131 combined harvesters. Tractors, though the number is not much, are mostly used in Yangon, Bago East and Shan South, followed by Ayeyarwady region. Hand tractors are currently over 200,000 available in Myanmar, and about one-third of them are utilized in Ayeyarwady region. Threshers are mostly used in Ayeyarwady region and Sagaing region which are huge paddy production area.

Table 1.7.1 Major Agriculture Machineries Available in Myanmar as at March 2012

Region/ State	Tractor	Hand Tractor	Thresher	Combine Harvester
Sagaing	891	25,754	8,051	29
Mandalay	469	10,983	2,938	22
Magway	631	4,477	1,113	

[5] According to interviews conducted in June 2015, for the construction sector, a typical unskilled labor is paid to 3,000 - 4,000 Kyats per day for Nay Pyi Taw to 6,000 - 7,000 Kyats in Mandalay and Yangon. On the other hand, a farm casual labor is paid only 2,500 Kyats per day in Magway region, 4,000 Kyats per day in Ayeyarwady region, and 4,000 - 5,000 Kyats per day in Shan state.

Region/ State	Tractor	Hand Tractor	Thresher	Combine Harvester
Nay Pyi Taw	153	2,630	922	6
Bago East	1,978	15,800	1,450	3
Bago West	379	16,608	2,204	6
Ayeyarwady	917	73,815	19,131	
Shan East	66	5,882	225	8
Shan South	1,665	9,604	545	15
Shan North	350	3,799	584	
Kachin	265	7,628	966	
Kayah	72	1,583	107	
Kayin	140	4,845	315	
Taninthayi	167	3,496	922	2
Mon	441	4,654	81	
Rakhine	45	1,434	75	
Yangon	1,861	13,271	1,660	40
Total	10,490	206,263	41,289	131

Source: Agriculture Mechanization Department (March 2012), MOAI

Figure 1.7.1 shows number of tractors and hand tractors per 1000 farm households in major agricultural regions. As is clearly illustrated, dissemination of tractors is very limited and even Bago East, where the highest number of tractors can be seen, has only 8 nos of tractors per 1,000 farm households. Hand tractors are more found in those regions; however still the dissemination is low. For example, there are bout 104 hand tractors per 1000 households in Ayeyarwady region where the highest dissemination can be seen. This means only one out of every 10 farm households has jut one hand-tractor. Obviously this level of machinery dissemination is not enough to cope with labor shortage becoming acute in rural areas.

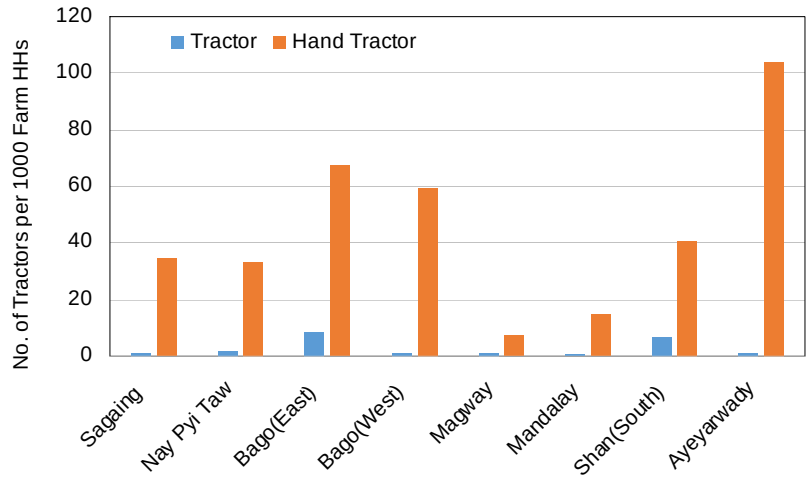


Figure 1.7.1 Dissemination of Tractors and Hand Tractors per 1000 Farm HHs

Source: AMD (2012), and SLRD for Farm HHs.

Figure 1.7.2 compares number of tractors per 100 sqkm arable land amongst Asian countries. Though the data covers only up to year 2000, the tractor's availability as per unit sqkm area is very low in Myanmar and Cambodia. In fact, the number is only about 10. On the other hand, the number in Thailand had almost reached to about 300, and that of Philippines did more than 100 numbers. Approximately 10 number of tractor is not obviously enough at all to prepare for that large unit area of 100 sqkm arable land (equivalent to 1,000 ha). The figure implies a great deal of needs of introducing more number of tractors in Myanmar agriculture.

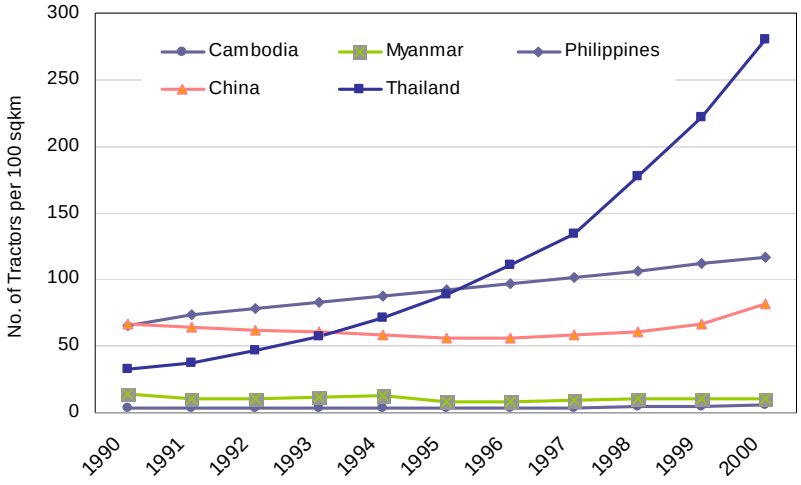


Figure 1.7.2 Dissemination of Tractors as per No. per 100 sqkm Arable Land

Source: World Development Indicators

Further, following Figure 1.7.3 illustrates net capital stock in agricultural machineries per farm household at constant price of 2005. The net capital of Myanmar farmers is very low though there are still 2 countries, whose capitals are lower than that of Myanmar, such as Lao PDR and Cambodia. The capital of a typical Myanmar farmer is only US$ 67 in late 2000s while that of Vietnam is almost US$ 300 and that of Malaysia is just over US$ 300. There is still need for Myanmar to accumulate farm machineries in terms of capital as compared to neighboring countries.

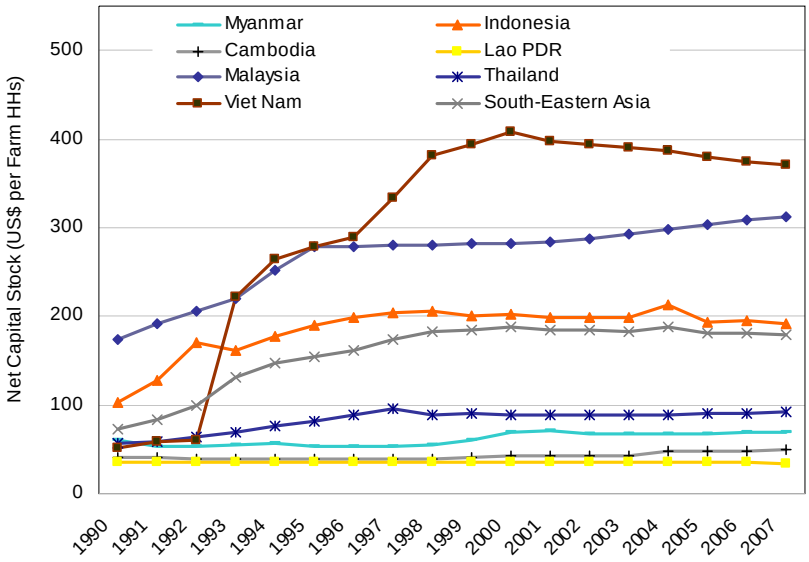


Figure 1.7.3 Net Capital Stock of Farm Machineries per Farm HHs

Source: FAOSTAT

1.7.2 Farmland Consolidation

Farmland consolidation is very often accompanied with farm mechanization. In fact, to fully and effectively utilize farm machineries, rugged farmlands should be levelled and regularly shaped. Also, when equipped with irrigation canal, drainage canal and farm road, highly efficient farm management can be realized, leading to ideal intensive agriculture. Following table summarizes the farmland consolidation implemented till April 2015 in Myanmar.

Table 1.7.2 Farmland Consolidation Work Implemented in Myanmar as at April 2015

Region/State	1995-2011	Implemented Acre					Farm Area	Share
		2011-2012	2012-2013	2013-2014	2014-2015	Total, acre	acre	%
Sagaing	133	80	576	140	610	1,539	6,368,801	0.02
Mandalay	1,747	420	836	421	879	4,303	3,615,998	0.12
Magway	26	211	120	153	469	979	3,289,492	0.03
Bago	80	2,754	1,827	1,539	1,238	7,438	3,642,424	0.20
Ayeyarwaddy	222	277	358	208	2,934	3,999	5,698,807	0.07
Shan	-	-	-	100	349	449	1,971,242	0.02
Kachin	-	-	-	558	802	1,360	817,369	0.17
Kayah	-	-	10	109	313	432	119,030	0.36
Kayin	-	-	150	117	1,054	1,321	227,696	0.58
Tanintharyi	-	-	-	100	100	200	649,940	0.03
Mon	-	100	140	105	400	745	1,741,195	0.04
Rakhine	-	100	100	100	739	1,039	1,207,717	0.09
Yangon	22,424	2,763	999	364	170	26,720	1,962,879	1.36
Total	24,632	6,705	5,116	4,014	10,057	50,524	31,312,590	0.16

Source: Agriculture Mechanization Department (April 2015), MOAI

Farmland consolidation in Myanmar had started in mid 1990s as pilot basis. During the previous government era, a total of 22,424 acre farmland had been consolidated. Then, under the present government, an annual plan is formulated and according to the budget availability, land consolidation has been put into implementation. By April 2015, a total of 50,524 acre farmland has been consolidated including the area implemented by the previous government. Out of the consolidated area, Yangon region has received the biggest area of land consolidation, 26,720 acre equivalent to about half of the total area consolidated.

However, if compared with overall farm land, the consolidated area is still very minimal. There is a total farmland area of as much as 31,312,590 acre[6] (12,525,000 ha) in Myanmar. The actually consolidated area of 50,524 shares only 0.16% of the whole farmland area. Even the consolidated area in Yangon region shares only 1.36% of the region's farmland.

In fact, unit implementation cost of land consolidation is not much, say about 500,000 Kyats per acre[7]; however due to the huge farmland area over the Country, total needy budget becomes a great huge amount. If 10% of the whole farmland is to receive consolidation work, the total required budget will be approximately 1.6 trillion Kyats (equivalent to about US$ 1.5 billion). There is a long way to implement land consolidation over certain range of the farmland.

1.8 Agriculture Sector Development Policies and Plans in Myanmar

1.8.1 Relevance in National Development Plan

As per national development plans, Myanmar prepared the National Comprehensive Development Plan (NCDP) covering 2011 to 2030. This plan presents national development vision, objectives and strategy toward the target year of 2030, graduating to middle income country. This plan is divided into 4 stages of 5-year each development plan. The first 5-year develop plan (2011-15) was already formulated and at present the second stage 5-year plan (2016-2020) is under preparation. Note that the 1st 5-year national development plan is not officially opened.

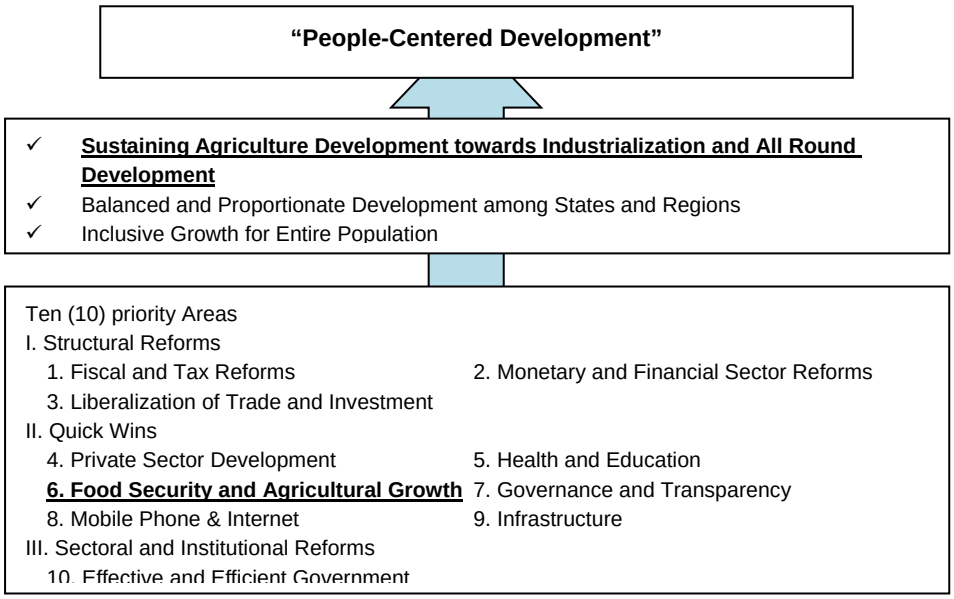


Figure 1.8.1 Structure of Framework on Economic and Social Reform: FESR (2013-2015)
Source: Ministry of National Planning and Economic Development

To prepare for the national develop plans, there is a framework and guidelines called Framework on Economic and Social Reform (FESR, 2013 – 2015), prepared at the end of year 2012 (see Figure 1.8.1). This FESR clearly shows the direction, strategies, and priority areas in preparing the national

[6] This area does not include the farmland area of Chin state since no land consolidation has been done in Chin state.

[7] Land consolidation cost varies depending upon the level of the work. In general, ID & AMD carry out land consolidation work at a unit cost of approximately 400,000 – 600,000 Kyats per acre. Whereas, donor implemented farmland consolidation usually entails higher unit construction cost; for example JICA spent 1.8 million Kyats per acre for a pilot project carried out in 2013 in Nay Pyi Taw area, and JIID (Japan Institute of Irrigation and Drainage) spent 2.6 million Kyats per acre for another pilot project carried out in Bago East in 2014.

development plans, whereby we can know what areas are given priority by the Myanmar government. As summarized in the figure, the FESR upholds agriculture development as one of the top strategies to realize the overall direction of 'People-Centered Development'. Accordingly, one of the 10 priority areas identified in the FERS is 'Food Security and Agriculture Growth'.

The first strategy towards 'People Centered Development' is the Sustaining Agriculture Development towards Industrialization and All Round Development. Here is found the relationship between agriculture development and industrialization, a linage of the 2 sectors. By promoting intensive agriculture, staple food, rice, can be provided to whole nation at a reasonable price, which in turn contribute to stabilize the people's life as well as keeping the wage for workers engaged in industry sector at a reasonable range, or competitive level as compared to other countries which are trying to export manufactured goods to the world.

Intensive agriculture always accompany with farm mechanization, leading to release of farm casual labors from rural area to urban and other sectors than agriculture. They can be engaged in construction sector as well as can be employed in manufacturing sector, leading the country to industrialization. It is therefore pointed out that the intensive agriculture promotion pursued in this Survey is well in line with the direction of the development that the FESR upholds.

In terms of the priority area No.6. 'Food Security and Agricultural Growth', the food security here should mean the safe and assured quality of food free from harmful matters, e.g. chemicals, since the country has already achieved more than 100% staple food self-production. In this regards, plant protection including inspection of residual chemicals should be enhanced, which is also considered in line with the promotion of intensive agriculture. The program to be formulated in this Survey is to include plant protection institutionalization as well.

In addition, Myanmar should also have more varietal foods, especially vegetables. As middle class social stratum is growing up, dietary preference is to change, e.g. from consuming energy based staple food to more diversified foods including vegetables. Intensive agriculture promotion is to seek a linkage between the production area and big consuming areas while trying to diversify production commodities. It is therefore meant that the promotion of intensive agriculture is well fit in the priority No.6 'Food Security and Agricultural Growth'.

Concerning the Agricultural Growth of Priority Area No.6 'Food Security and Agricultural Growth', almost all the irrigable areas primarily produces monsoon paddy and summer paddy according to the water availability. Though pulses are mostly cultivated after monsoon paddy, they grow with residual moisture not requiring irrigation at present. Then, the rice and pulses are in fact already much more produced than what the nation consumes. It is therefore that the rice and pulses to be produced in future and with the intensive agriculture should be more export oriented though certain share of them are already directed to export.

To secure export competitiveness against other major export countries, e.g. Thailand and Vietnam in case of rice, quality as well as safety should be well taken into consideration. The intensive agriculture promotion program should therefor explore components which can improve quality and also safety. In terms of quality, necessary components from seed management to post-harvest specially in case of paddy will be undertaken, and also plant protection component is to be included in the program.

1.8.2 Relevance in Agricultural Development Plan

The national development plan is composed of all the sector development plans, one of which is of course agriculture sector development plan (20 years). The vision and strategies stated in the agriculture sector development plan is as follows: in order to achieve sustainable agriculture, 1) to obtain most of the market share of regional and global market of special food and agro-based value

added products, 2) to promote food security of rural people, and 3) to increase green growth production in conformity with sound environment, not negatively affecting natural environment.

In line with above 3 strategies, there are ways the agriculture sector should implement. They are; 1) to get better competitive advantage than the developed neighboring counties, 2) to meet knowledge and technology know-how of rural people at the same level of the developed neighboring countries, and 3) to increase rural industrial and social infrastructure just as neighboring countries.

With above, short-term objectives are; 1) to develop agriculture productivity, 2) to promote productivity of rural agro-based small – medium enterprises, 3) to invite foreign investment into agriculture sector for technology, investment, market and job opportunities, 4) to obtain local and international access and to improve infrastructure market information, 5) to develop agriculture theoretical research and applied research, 6) to reduce transaction cost of value chain from farm to consumer.

In line with strategy setting-up above-mentioned, the Ministry held a workshop on 2-3 November 2012, and identified 11 priority areas to be tackled to meet the strategies and objectives mentioned above:

1) To implement high yield and quality seeds production and distribution,
2) To utilize natural inputs for soil enrichment with systematic & synchronized application of fertilizer,
3) To build up value added agro-products and agro-based industries,
4) To transform the conventional farming to mechanized farming,
5) To transform the rain-fed conventional farming to irrigated farming system,
6) To conduct research and develop advanced agricultural technologies,
7) To encourage the promotion of domestic and foreign investment,
8) To increase accuracy in agricultural statistics,
9) To develop sustainable market,
10) To review and evaluate the existing agricultural laws and regulations in line with current economic situation, and
11) To promote the role of information and media.

The intensive agriculture promotion undertaken under this Survey is; 1) to increase yield and production by means of infrastructure improvement, 2) to facilitate vale chain improvement accompanied with establishment of wholesale market, improvement of loading/unloading ports meant for agriculture commodities, 3) to facilitate farm mechanization together with land consolidation. These are very much relevant to most of the above objectives and prioritized areas.

CHAPTER 2 THE SURVEY AREA

This chapter examines the survey area from different aspects. At first, climate and water resources in Myanmar is described, followed by agricultural production by crop and by region/state. In addition, briefly explored are agricultural product distribution as well as food value chain presently established, and transportation availability and future improvement plans.

2.1 Climate and Water Resources

2.1.1 Climate: Temperature and Rainfall

In Myanmar, two climatic periods exist, namely rainy season and dry season, by rough classification. On the other hand, one year is literally classified into 3 periods; namely, dry season is further divided into two sub-periods, in which part of dry season beginning soon after the end of rainfall is called winter period because atmospheric temperature is low, and later part that lasts until the onset of the next rainy season is called summer period because the highest atmospheric temperature prevails in this period.

The Team has collected rainfall and temperature data at such places representing major agriculture production areas such as Sagaing, Mandalay, Magway, Bago, Ayeyarwady, and Nay Pyi Taw. Those data are presented below with overall rainfall distribution contour map. Rainfall varies very much from coastal area to mountainous area with a specific character in the central part of Myanmar. The central part is called Central Dry Zone (CDZ) where annual rainfall is usually less than 1,000 mm associated with semi-arid landscape.

Onset of rainy season is attributable to southwesterly monsoon blowing from Bengal Bay. This monsoon wind blows towards mountain ranges of Rakhine and Tanintharyi extending along western edge of the Union. Whereas, because the monsoon wind is intercepted by these mountain ranges, a hinterland of these mountain ranges - the CDZ - receives much less rainfall, entailing to occurrence of a semi-arid zone. Dry wind blowing from south to northern direction finally hits a high mountain range extending along the border with China, in which the air is quickly cooled down and started falling rain.

As mentioned above, areas receiving much rainfall are western part of the country, coastal areas and northern edge of the country while driest climate shows up in the Central Dry Zone with medium range of rainfall in the Shan highland. The first areas receive over 3,000 mm annual rainfall and in places it reaches over 4,000 mm while the CDZ receives less than 1,000 mm in most of the years. The Shan highland usually receives an annual rainfall of about 1,500 mm.

Temperature less varies as compared to rainfall. Most of the places show high temperature, especially in the Central Dry Zone area. In this area,

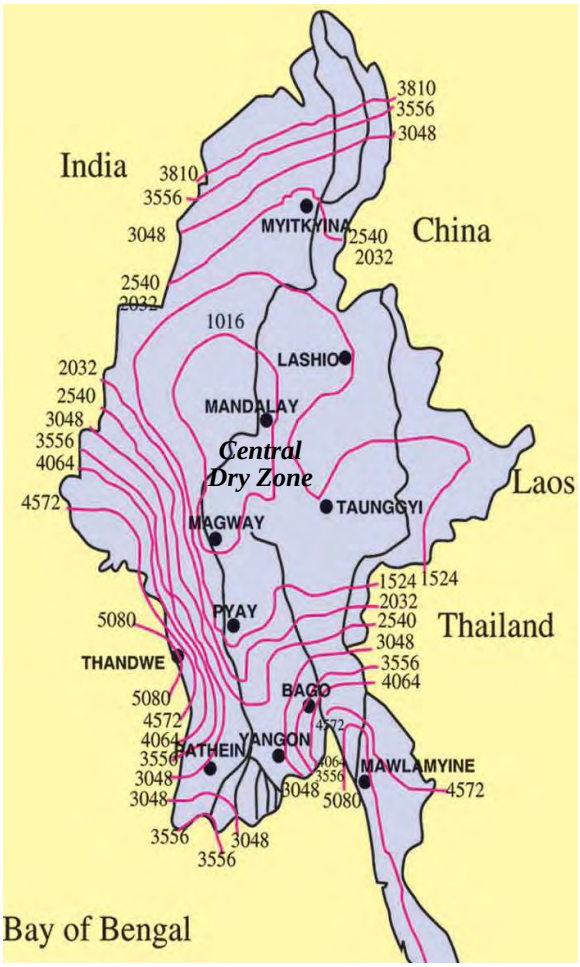


Figure 2.1.1 Rainfall Counter in Myanmar
(source: ID)

maximum monthly temperature, which shows up in April, comes nearly to 40 degree Celsius and sometimes even over the temperature. Though the Ayeyarwady region is located southern part from the CDZ, the temperature is relatively lower than those CDZ areas due to the existence of abundant water surface. Shan highland, of course, shows cooler temperature unlike the other parts. Average maximum temperature ranges from 16 to 23 degree Celsius only.

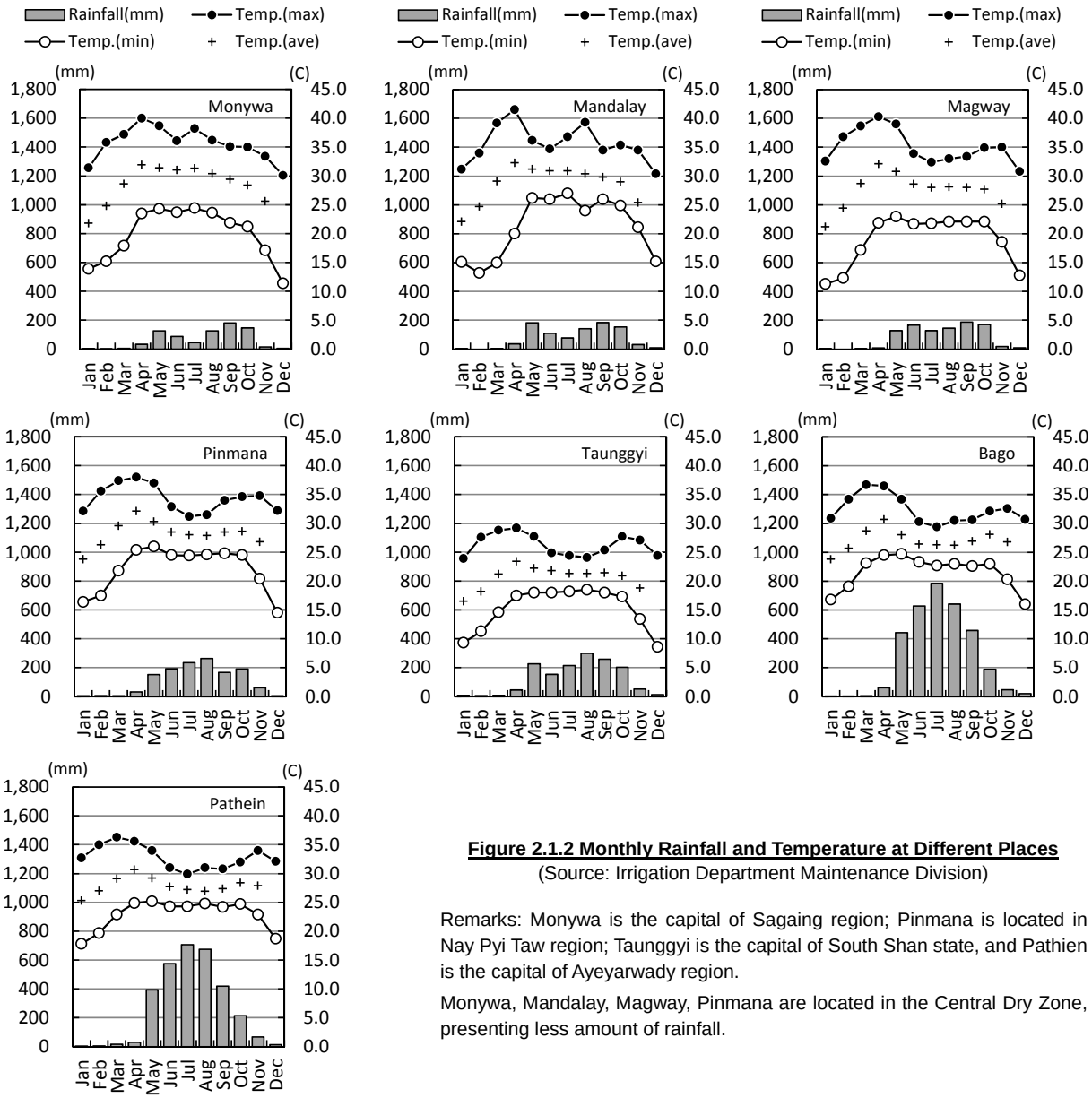


Figure 2.1.2 Monthly Rainfall and Temperature at Different Places
(Source: Irrigation Department Maintenance Division)

Remarks: Monywa is the capital of Sagaing region; Pinmana is located in Nay Pyi Taw region; Taunggyi is the capital of South Shan state, and Pathien is the capital of Ayeyarwady region.

Monywa, Mandalay, Magway, Pinmana are located in the Central Dry Zone, presenting less amount of rainfall.

2.1.2 Water Resources

Myanmar is endowed with abundant water resources, though the resources are characterized with its uneven spatial and temporal distribution. The monthly distribution of river flows closely follows the pattern of rainfall, which means that about 80 % flows during the monsoon season (May-October) and 20 % in the dry season (November-April). The north-south direction of Myanmar's mountain ranges is reflected in the flow of its major rivers, of which two are international. There are 7 river basins as follows:

1) Ayeyarwady - Chindwin river basin, which is almost entirely located in Myanmar, drains 58 % of the territory. It can be divided into three sub-basins: Upper Ayeyarwady, Lower Ayeyarwady and Chindwin.

2) Sittaung river basin, which is also entirely located in Myanmar to the east of the downstream part of the Ayeyarwady, drains 5.4 % of the territory.

3) Thanlwin (Salween in Thailand, Nu in China) river basin drains 18.4 % of Myanmar territory, mainly the Shan plateau in the east. The source of the river is in China and, after entering the country, forms the border with Thailand for about 110 km.

4) Mekong (Lankang in China) river basin drains 4.2 % of the territory in the far east and forms the border with Lao People's Democratic Republic.

5) Rakhine (Arakan) coastal basin in the west drains into the Bay of Bengal.

6) Tanintharyi (Tenasserim) coastal basin in the south drains into the Andaman Sea.

7) Bago basin in the eastern Bago area, which drains into Yangon river and then the Andaman Sea. This river is very small, catchment area of which is only 5,300 km^2. However there are irrigation dams constructed in the catchment area.

Figure 2.1.3 Major Basins in Myanmar
Source: Irrigation Department

Table 2.1.1 Water Resources in Myanmar

River Basin	Catchment Area, km^2	Inflow, km^3	Remarks
Chiundwin	115,300	141.29	
Ayeyarwady (upper)	193,300	227.92	
Ayeyarwady (lower)	95,600	85.8	
1) Total of above 3 basins	404,200	455.01	
2) Sittaoung	34,400	41.95	
3) Thanlwin (in Myanmar)	158,000	257.92	
4) Mekong (in Myanmar)	28,600	17.63	
5) Rivers in Rakhine state	58,300	139.25	
6) Rivers in Tanintharyi Division	40,600	130.93	
7) Bago River	5,300	8.02	
Total	737,800	1,081.88	

Source: FAO aquastat, WEPA (http://www.wepa-db.net/policies/state/myanmar.htm#

Of the 7 basins, such 2 basins as Ayeyarwady – Chindwin and Sittaung are the most potential basins for irrigation development. In Myanmar, there are over 250 irrigation dams constructed by Irrigation Department, especially after 1988. Most of these irrigation dams have been constructed on the tributaries of the Ayeyarwady river and Sittaung river[1]. It means that the potential arears to promote intensive agriculture can be found within the basin of these rivers, especially in such areas where extent of irrigated farmland has been established. In addition, though the catchment area of Bago river is small, only 5,300 km^2, there are irrigation dams.

The total water withdrawal in 2000 was about 33.23 km^3, of which around 29.58 km^3 (89 percent) for agriculture, 3.32 km^3 (10 percent) for municipalities and 0.33 km^3 (1 percent) for industries (see Figure 2.1.4)[2]. Approximately 30.24 km^3, or 91 percent of the total water withdrawal, comes from surface water and 2.99 km^3, or 9 percent, from groundwater (Figure 2.1.4). Groundwater is mostly

[1] Note that no dam has been constructed on these main rivers. All the dams have been constructed on the tributaries on these main trunk rivers.

[2] Source: Irrigation in Southern and Eastern Asia in figures - AQUASTAT Survey - 2011

used for domestic purposes with an exception of groundwater irrigation development in Chaung Oo (Pauk Inn) area, Sagaing region.

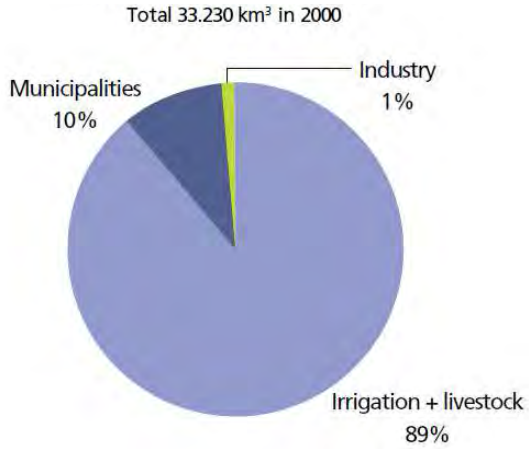


Figure 2.1.4 Water Withdraw by Sector
Source: FAO AQUASTAT

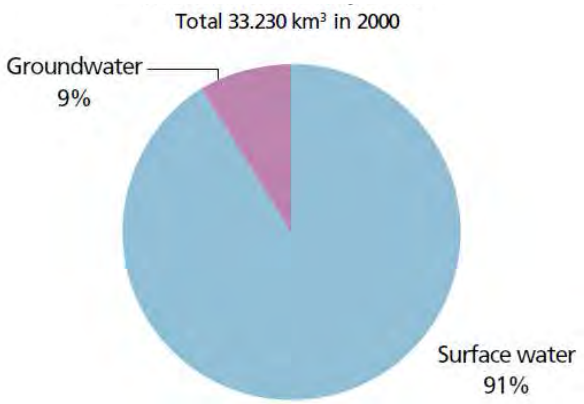


Figure 2.1.4 Water Withdraw by Source
Source: FAO AQUASTAT

2.2 Agriculture Production and Export of Crop Commodities

2.2.1 Agriculture Production by Region and by Crop

The staple food is rice in Myanmar, which is cultivated wherever during monsoon season. With irrigation summer paddy is also cultivated. After monsoon paddy has been harvested, farmers usually cultivate pulses, which require less farm input as compared with paddy. Pulses are grown under residual moisture, not irrigated. Then, there are great numbers of farmers who cultivate oil crops such as sesame, groundnut, sunflower, etc., some of which are irrigated. These are the most important and popular crops, which are discussed below:

1) Paddy Production

Figure 2.2.1 shows the trend of overall paddy production by region/ state (aggregated production by monsoon and summer paddy. As is indicated, the production started sharply increasing in the early 2000s, peaking in 2010 with a total amount of 32.6 million tons of production. However, after that it has dropped to a level of around 28 million tons of production. This drop may have reflected what was inflated under the previous government, during which rice production was a must wherever possible.

The paddy production of monsoon and summer altogether is prevalent in such regions as Ayeyarwady being the biggest production area (30% of the whole production as of 2013/14), followed by Bago region (18%), further

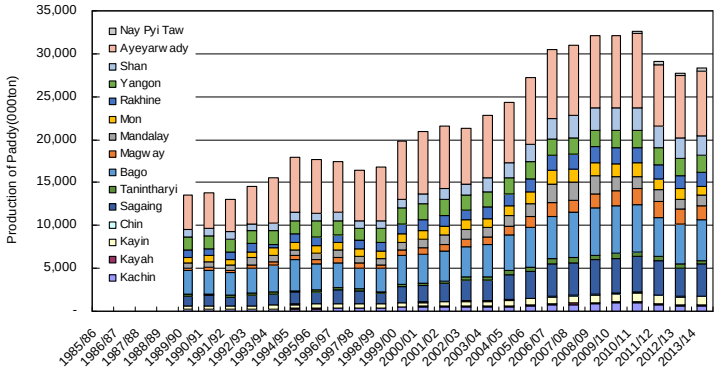


Figure 2.2.1 Trend of Paddy Production by Region/ State
Source: Myanmar Agriculture Statistics, CSO, MONP&ED

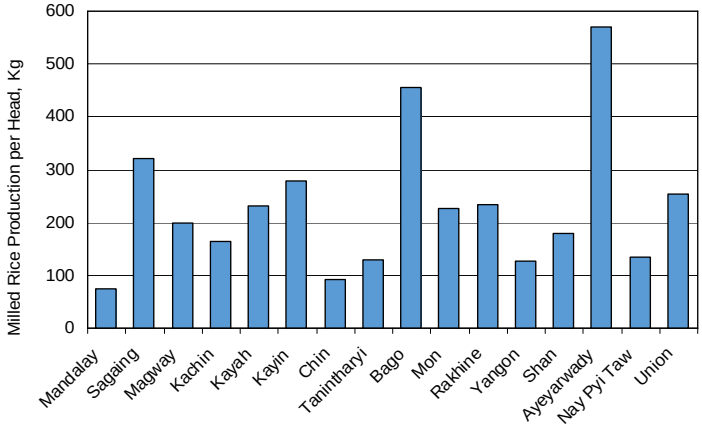


Figure 2.2.2 Rice Production Available per Population (2013/14)
Source: Myanmar Agriculture Statistics, CSO, MONP&ED

by Sagaing (14%). With such production, a possible consumption available per population is estimated in the Figure 2.2.2. The chart shows the milled rice availability per person in the region/ state by considering 20% loss as post harvest loss and 55% of the milling recovery rate. In Myanmar, a typical person is assumed to consume about 160 kg of white milled rice per annum. With this figure, obviously the country is already in surplus of rice production. Estimated available white rice per person as at 2013/14 is about 255 kg in the country, indicating big surplus for export.

Summer paddy is produced only with irrigation. Figure 2.2.3 illustrates the summer paddy production by region/ state over years. The total summer paddy production is around 5 million tons per annum as at year 2013/14, which shares about 18% of the whole production, meaning the monsoon paddy shares 82% of the whole production. The major production area for summer paddy is Ayeyarwady region, sharing as much as 51%, approximately half, followed by Sagaing (15%) and further by Bago (9%).

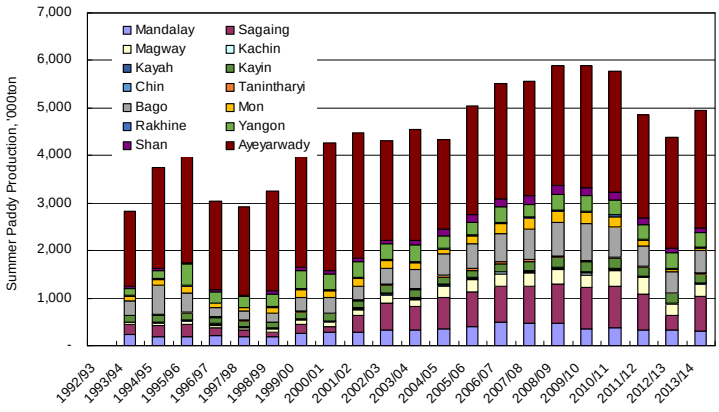


Figure 2.2.3 Summer Paddy Production by Region/ State

Source: Myanmar Agriculture Statistics, CSO, MONP&ED

2) Pulses Production

After monsoon paddy has been harvested, farmers cultivate pulses in many places by utilizing residual moisture. Pulse cultivated in large area in lower Myanmar is black gram while green gram becomes popular as going to mid and upper Myanmar. Chick pea and pigeon pea are also joining the green gram in the mid and upper Myanmar. As at year 2013/14, nation wide productions are 1.58 million ton, 1.45 million ton, 0.85 million ton, and 0.60 million ton for black gram, green gram, pigeon pea and chick pea respectively. Therefore, the major ones are black gram and green gram, which are further detailed below:

Figure 2.2.4 shows the trend of black gram production over years by region/ state. The production has continuously increased over years reaching approximately 1.6 million tons per annum for the recent years. The biggest production area is Bago and then Ayeyarwady region. Bago region shares about 47% of the total production and that of Ayeyarwady does 38%. These 2 regions, located in lower and coastal area of Myanmar, shares most of the black gram production, reaching to 85% of the whole production.

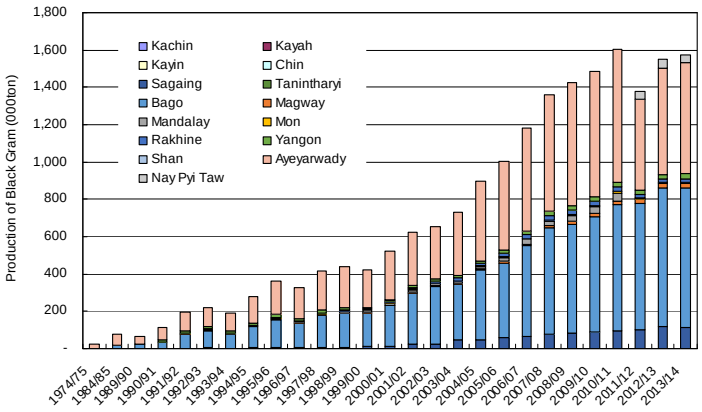


Figure 2.2.4 Black Gram Production by Region/ State

Source: Myanmar Agriculture Statistics, CSO, MONP&ED

Figure 2.2.5 depicts the same of green gram over years by region/ state. The production trend is more or less same as that of black gram but the production area is more diversified than black gram. The green gram is produced in Magway (26% share), Bago (24%), Sagaing (19%), Yangon (12%), and Ayeyarwady (7%), etc.

Though the pulses are not irrigated at present, but gown under residual moisture in the soils, if given irrigation the yield will increase. Pulses do not require much water but approximately less than one-third of what the paddy requires. However, to irrigate pulses, there is a challenge at moment. There are outlets installed at an point, which covers at least 50 acre to maximum 100 acre unit area, along the distributary canals in the ID constructed irrigation scheme. After the outlets, farmers are supposed to construct field channels to distribute irrigation water timely and equally over the outlet-command area.

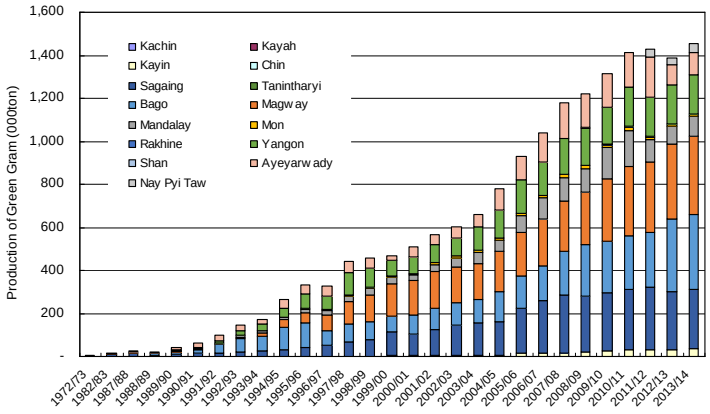


Figure 2.2.5 Green Gram Production by Region/ State
Source: Myanmar Agriculture Statistics, CSO, MONP&ED

However, this arrangement has not been put into implementation in many irrigation schemes, whereby most of the irrigation for paddy is carried out by plot-to-plot irrigation. With this plot-to-plot irrigation, pulses planted alongside the canal or near the outlet will be inundated and therefore hindered for growth. Though the yield is to increase definitely if the pulses are irrigated even only one-time during the growing period, the present on-farm arrangement does not allow the irrigation on pulses.

3) Oil Crop Production

Oil crops in Myanmar are ground nut, sesame, and sunflower, production of which as of year 2013/14 are 1.50 million tons, 0.91 million tons, and 0.46 million tons respectively. Ground nut is the most produced oil crop and sesame exported from Myanmar is very famous especially in Japanese market. Though these oil crops are cultivated mostly in Yar, upland field, under rain-fed condition, nowadays there are irrigation areas where sesame is cultivated, e.g. in Magway area.

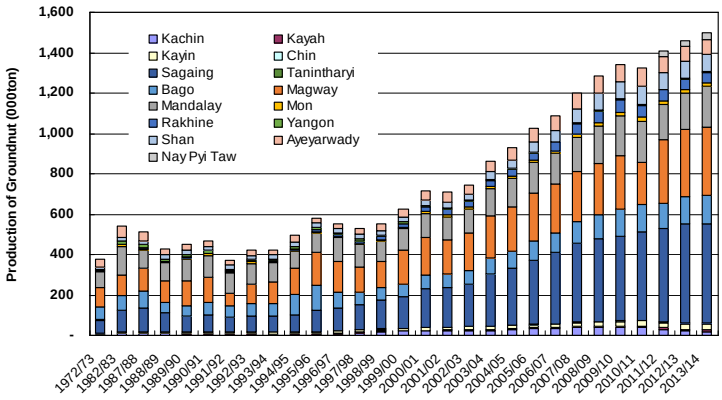


Figure 2.2.6 Groundnut Production by Region/ State
Source: Myanmar Agriculture Statistics, CSO, MONP&ED

Figure 2.2.6 shows the long term trend of ground nut production by region/ state. Since the beginning of 2000s, the production started increasing and present production level is nearly about 1.5 million tons as afore-mentioned. Production areas are somewhat diversified as; Sagaing sharing 34% of the whole production, Magway with 23% share, and followed by Mandalay with 13% share, which are all located in Central Dry Zone.

Figure 2.2.7 summarized the long term production trend of sesame by region/ state. The production trend is more or

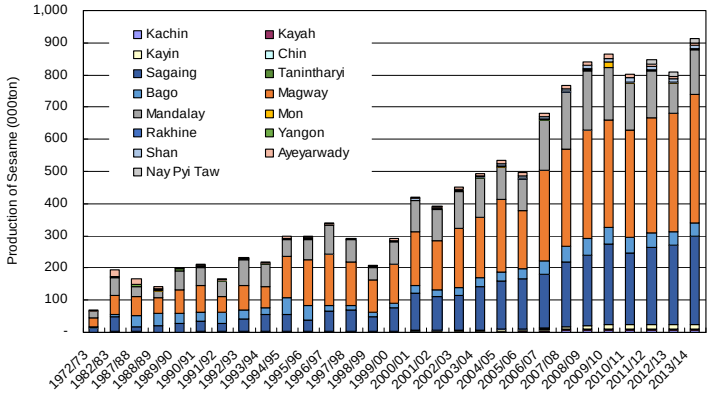


Figure 2.2.7 Sesame Production by Region/ State
Source: Myanmar Agriculture Statistics, CSO, MONP&ED

less same as that of ground nut; namely, the production started increasing after early 2000s, and during the last 5-6 years it is a range of 0.8 to 0.9 million tons per annum. Magway is the biggest production area sharing as much as 43%, followed by Sagaing (29% share) and by Mandalay (15% share).

4) Vegetable Production

There are varieties of vegetables in Myanmar. Popularly produced vegetables are, according to the production volume, tomato, cabbage, cauliflower, mustard, bitter gourd, radish, watermelon, lettuce, carrot, asparagus, etc. (see Table 2.2.1). Most of them are better produced in highland, e.g. Shan plateau though such vegetables as lettuce, mustard, water melon, bitter gourd can also be well produced in lowland.

Table 2.2.1 Vegetable Production by Kind as at Year 2013/14

Vegetables	Sown Acre	Harvest Acre	Yield (bsk/ac)	Production (basket)	Remarks
Tomato	278,557	278,336	3,036	845,028,190	
Cabbage	75,996	75,996	3,800	288,751,836	
Cauliflower	65,024	65,024	3,481	226,324,050	
Mustard	90,907	90,907	2,021	183,710,673	
Bitter gourd	56,273	56,273	3,067	172,616,081	
Radish	51,696	51,696	2,993	154,742,977	
Watermelon	45,454	45,454	3,109	141,337,109	
Lettuce	27,587	27,587	1,743	48,084,632	
Carrot	6,526	6,526	2,031	13,257,420	
Asparagus	2,035	2,035	1,115	2,268,628	
Other Vegetable	665,769	664,806	2,532	1,683,472,662	

Source: SLRD (2013/14)

Figure 2.2.8 shows the vegetable sown area by region/ state, which indicates larger vegetable grown area to be Sagaing region, Ayeyarwady region, Bago region, Magway region, Mandalay region and then Shan South. One may think the trend is somewhat different from what is generally felt, e.g. Shan South area is the best and famous vegetable production area, though the vegetable sown area in Shan South is not much comparable to those regions. This is because the farm land area in those regions are much bigger than that of Shan South, for the vegetable sown area also becomes large.

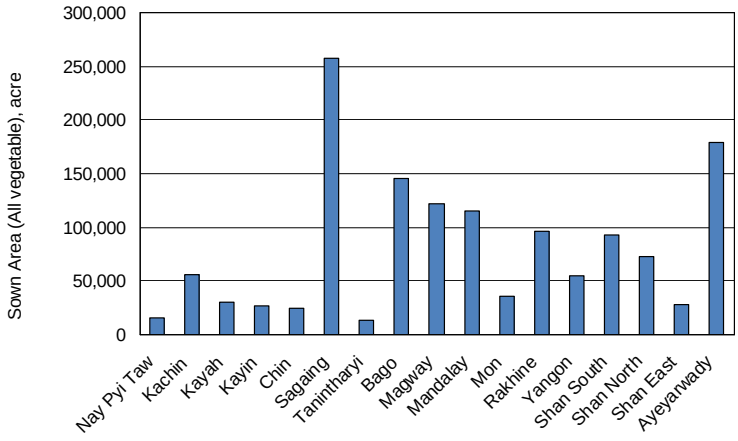


Figure 2.2.8 Vegetable Sown Area by Region/ State

Source: Myanmar Agriculture Statistics, CSO, MONP&ED

With this in mind, Figure 2.2.9 indicates the production of selected vegetables such as tomato, cabbage, cauliflower and mustard in basket per 1,000 acre farmland by region/ state. With these figures, Shan South shows the outstanding vegetable production in terms of 1,000 acre farmland except mustard which can be grown in lowland as well.

At present, no mass vegetable production is practiced under gravity irrigation. Vegetables are cultivated under rain-fed, though the quality gets deteriorated very easily with rain-fed condition, and they are also grown with irrigation in such areas as Kaing Kyun[3], small river diversion scheme areas,

[3] Kaing Kyun is a farmland which appears on the alluvial sandbars in Ayeyarwady river as the water recedes or in the flood lands as the water recedes.

and areas equipped with pumps. Though gravity irrigation, especially basin irrigation method, is not suitable for irrigating vegetables, at least irrigation scheme can avail of water up to just nearby vegetable grown areas. With the water available in nearby canal, vegetable cultivation can be diversified and enlarged.

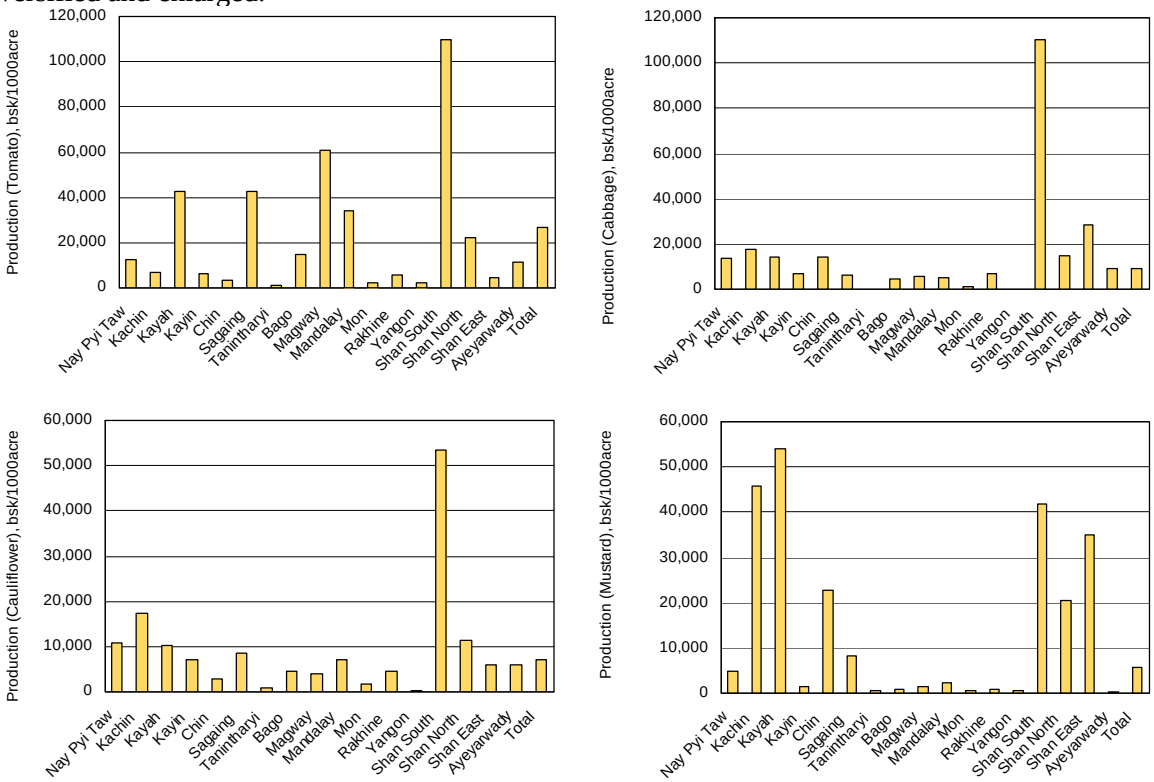


Figure 2.2.9 Selected Vegetable Production by Region/ State

Source: Myanmar Agriculture Statistics, CSO, MONP&ED

2.2.2 Export of Crops and Relevant Potential

The biggest productions in irrigable area are no doubt paddy and pulses. Since these agriculture commodities are already in surplus within Myanmar, further production should of export oriented. Figure 2.2.10 summarizes the rice volume traded in the world (refer to the left Y-axis) and by major production countries such as Thailand, Vietnam, USA, India and also Myanmar (right Y-axis).

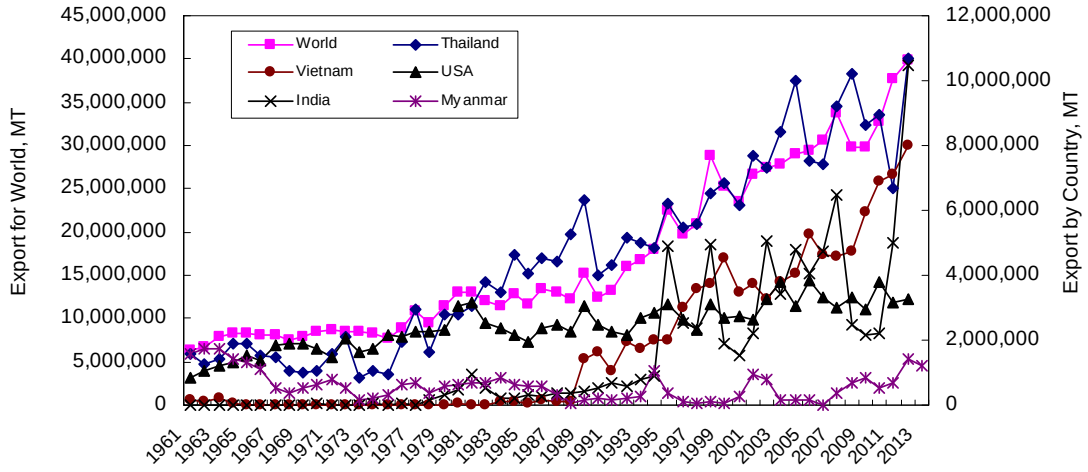


Figure 2.2.10 Long Term Trend of Milled Rice Export by World and by Country

Source: FAOSTAT, http://faostat3.fao.org/home/index.html#DOWNLOAD, For the years from 1992 to 2014 of Myanmar, Ministry of Commerce

As is well illustrated, the traded amount has been continuously increasing, and reaching nearly about

40 million tons for the recent years. By county, Thailand comes first as the biggest rice export country, followed by Vietnam, and India in case of year 2012 where there has been a huge fluctuation due to unstable rainfall, further followed by USA. Thailand in recent years exports approximately 10 million tons of milled rice (5% broken) to the world market, followed by Vietnam with about 8 million tons export (the export in 2013 by India was about 10.4 million tons, while in other years it is lower than 6 million tons).

The continuous increase trend over years shown in Figure 2.2.10 provides an opportunity to Myanmar of exporting rice to the world market. The export from Myanmar has increased recent years to the level over 1 million tons (see Figure 2.2.11). However as compared in Figure 2.2.10, the share of Myanmar export rice is still far below than those counterpart countries' export volume. This comparison indicates there should be an opportunity for Myanmar to further export rice to the world market.

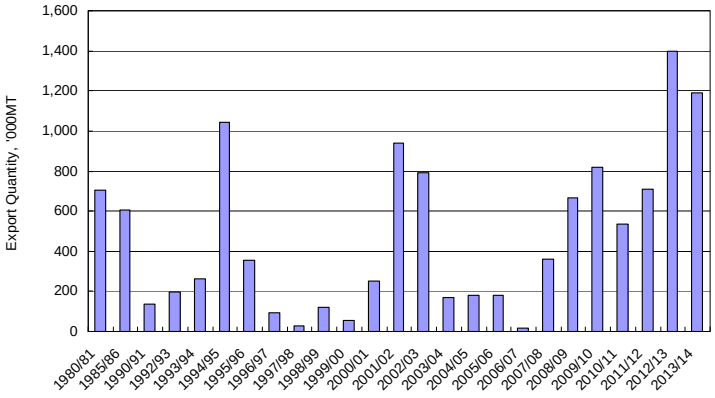


Figure 2.2.11 Rice Export from Myanmar

Source: Myanmar Agriculture Statistics, CSO, MONP&ED

In fact, National Export Strategy of Rice, 2015-2019, formulated by Ministry of Commerce, states in its Action Plan that 1) to export 4 million tons of rice, becoming the world's fourth largest exporter of rice, 2) to increase the number of markets annually importing US $ 5 million or more of Myanmar rice from 10 to 30, 3) to increase the percentage of milled rice (HS 100630) within total rice exports from 44 % in 2012 to 67 % (i.e. reduce the percentage of broken rice – HS 100640), and 4) to increase the number of Myanmar traders exporting more than 100,000 tons of rice per year from 3 to 15. As are stated in the strategy, Myanmar government intends to increase rice export by almost 3 folds from present 1.2 – 1.4 million tons to 4 million tons per annum.

To export the rice to the world market, price should be a key factor in the competitiveness in addition to the quality. Figure 2.2.12 compares the Myanmar FOB price of rice to that of Thailand FOB rice price for the months of year 2009 to June 2015. It is shown that the price of Thailand rice has been around US$ 500 per ton though it has dropped to about US$ 400 level in recent months while that of Myanmar rice been approximately US$ 330 per ton. It means that the Myanmar rice is cheaper than that of Thailand by about 20% to 30%.

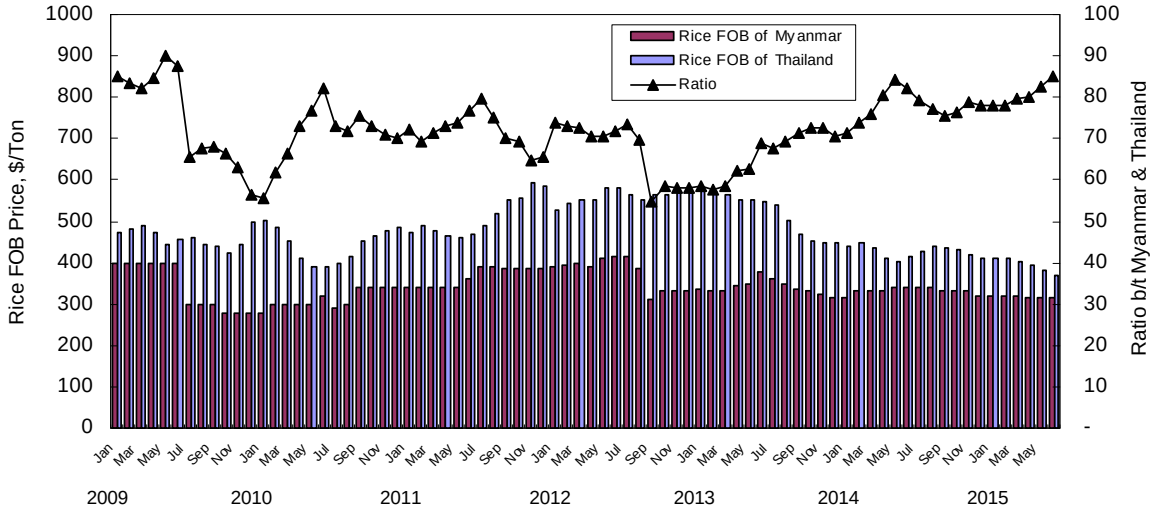


Figure 2.2.12 Comparison of Myanmar Export Rice and Thailand Export Rice (FOB price)

Source: FAOSTAT, http://faostat3.fao.org/home/index.html#DOWNLOAD

Of course, the cheap price of Myanmar rice does not automatically have a competitive power against Thailand rice. The price difference comes not only from the production cost but also from the quality. In fact, as at now, the quality of Myanmar rice is not as good as that of Thailand. Therefore, Myanmar should try to improve the quality of rice in order to compete in the world export market of rice; or otherwise the export target countries remain very specific, e.g. west African countries whose purchasing power is not high, preferring cheaper rice.

In above regard, it can be said that the Myanmar has a competitive price power in exporting rice to the world market, especially less developed countries, e.g. West African countries. Provided that quality of Myanmar rice is improved, the Country would have enough competitive power in exporting the rice not only to less developed counties but also to the whole world market. Therefore, it can be concluded that the paddy to be produced more in the target priority areas will not end up in just surplus but contribute to raising the farmers income.

2) Potential of Pulses Production

Paddy, as aforementioned, is the major crop during rainy season while black gram and green gram are the ones cultivated during winter season. In Myanmar, in fact, pulse production is not as traditional as paddy. Before 1990, the production of pulses had been very little. In fact, pulse production in Myanmar was driven into flourish by a huge demand from the neighbor country, India. By the demand, Myanmar started producing huge amount of pulses, and the productions of black gram and green gram have been skyrocketing reaching over 1.6 million ton and 1.4 million ton respectively for the whole county (see Figure 2.2.4 and Figure 2.2.5).

India has been reducing the share of primary sector's contribution in the national GDP. In fact, India changed its national policy from a planned economy to a capitalist economy in 1991, from which the share of primary sector started further diminishing in its national GDP as shown in Figure 2.2.13. In early 1990s, the share of primary sector had been around 30%, which had reduced to lower than 20% in the early 2000s, and as at now the primary sector's share in the national GDP is mere 17% only.

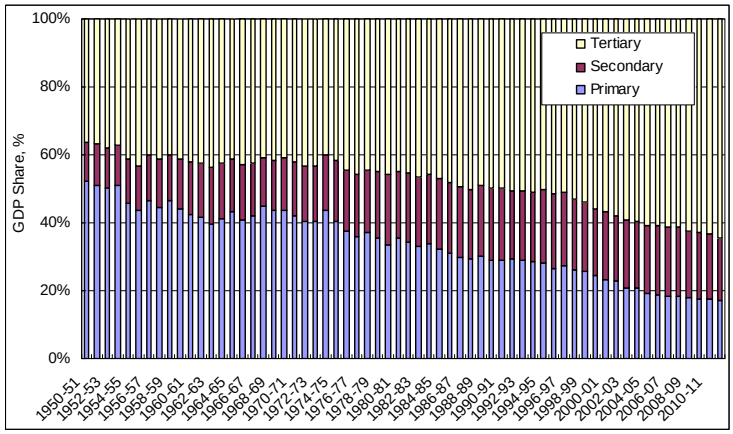


Figure 2.2.13 Change of GDP Share by Sector in India

Source: Central Statistics Office (CSO), India

Corresponding to the reduction of the primary sector's share in the national GDP, India started importing pulses from late 1980s. Figure 2.2.14 shows the world export and import, and India's import for pulses. It can be known that India's pulses import shares about 20% to maximum 30% of what is traded in the world pulse trade market since year 2001. Depending upon the weather

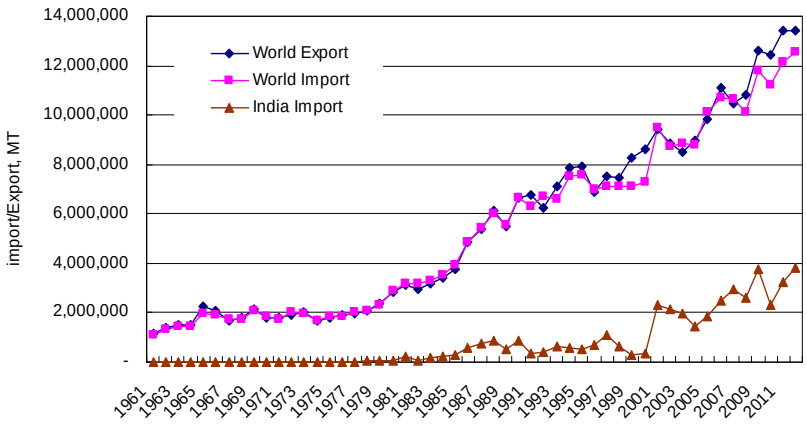


Figure 2.2.14 Long Term Trend of Pulses Export/Import

Source: FAOSTAT. http://faostat3.fao.org/home/index.html#DOWNLOAD

condition (rainfall amount) in India, pulse production in the country has been very much fluctuating, and so has been the India's import for pulses. In any case, though, India would continue importing huge amount of pulses, the 2nd staple food of the nation, taking into account the GDP trend wherein primary sector's share has very much diminished.

Responding to the India's demand, Myanmar has been exporting pulses to India. Figure 2.2.15 shows the black gram export while Figure 2.2.16 shows the green gram export to India and to other countries. Though export quantity has fluctuated by year, there is a tendency of increasing over years especially in case of black gram. Though the green gram is exported more to other countries than India, still India imports green gram. In addition, pigeon pea and chick pea are also exported mainly to India. From this examination as well as from the India's GDP position, it can be concluded that the pulses produced more in the priority areas will contribute to raising the farmers income by exporting to India.

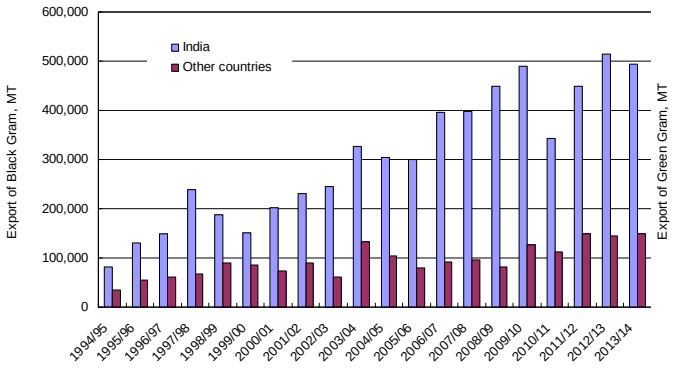


Figure 2.2.15 Export of Pulses/Black Gram from Myanmar
Source: Ministry of Commerce

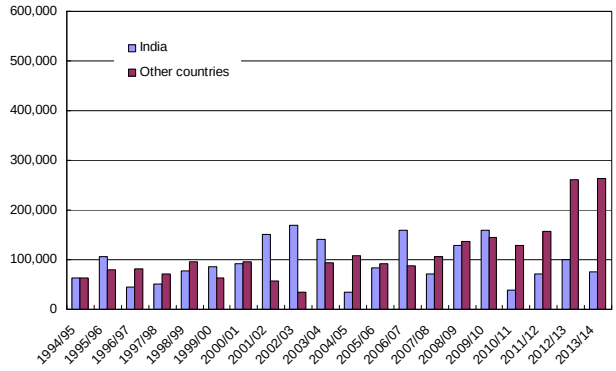


Figure 2.2.16 Export of Green Gram from Myanmar
Source: Ministry of Commerce

2.3 Agricultural Product Distribution and Marketing

2.3.1 Market Demand of Agricultural Products

Myanmar is an agricultural country, and about 31.3% of GDP is earned by agriculture, livestock, fishery, and forestry in the 2013/14 fiscal year[4]. Myanmar has been self-sufficient in the staple food, i.e., rice, thus in recent years rice is exported to a large extent. Domestic consumption of rice may have been stable since long time ago though there may be a bit of decrease for urban population in recent years. According to Figure 2.3.1, the consumption trend of wheat and products shows slightly increase, while vegetables consumption shows rapid increase over the five decades. Following discusses market demand for rice, pulses, and vegetables:

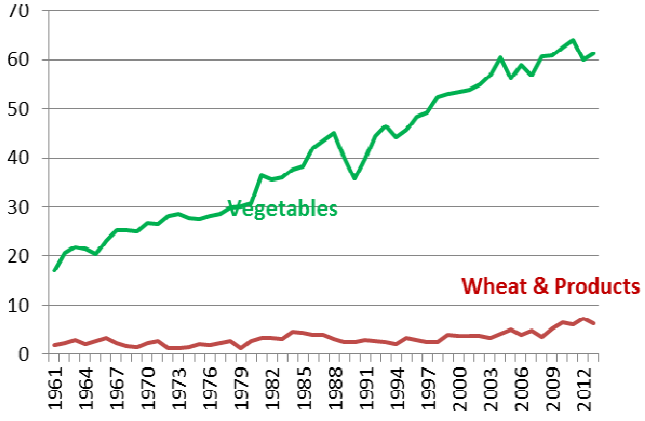


Figure 2.3.1 Consumption Trend of Selected Products in Myanmar
Source: FAOSTAT

1) Rice

Myanmar is well known as one of the largest rice consumer counties. According to Myanmar Agricultural Statistics 2011, per capita rice consumption (paddy equivalent) in Myanmar was 196 kg/year in 2011. However, according to Myanmar Rice Federation (MRF), consumption trend of rice

[4] Myanmar Agriculture at a glance 2014, Ministry of National Planning and Economic Development

particularly in urban area has decreased due to change in people's dietary habits.

Myanmar rice is characterized as relatively low quality with low price, and rice export had increased year by year; around 74%[5] went to West African countries including Ivory Coast, Guinea, Burkina Faso and Cameroon. However, in recent years, export to China has rapidly increased. According to Myanmar Rice Federation (MRF), around 60% of exported rice, 1.1 million tons out of 1.8 million tons, went to China in 2014-15 fiscal year, whereas around 75% of the rice, 0.9 million tons out of 1.2 million tons, was exported to China in 2103-14[6].

China has been the rice exporting country, but it is said that exported rice from China is mainly Japonica variety produced in Northern parts of the county while imported rice is *Indica* variety which is mainly produced in the Southern parts of China with decreasing trend[7]. However, trade condition of Myanmar rice, imposed by Chinese traders, had been not fair for Myanmar side due mainly to poor quarantine condition of products. To improve the situation, a protocol was entered into between the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) of China, and the Ministry of Agriculture and Irrigation of Myanmar[8]. According to the protocol, the conditions imposed to Myanmar side are as follows;

- ✓ Myanmar side shall carry out investigation on *Trogoderma granarium* events and *Crytolestes pusilloides* (Stee et Howe) in rice processing factories and install traps for the insects. The density of traps shall be 1 piece per 100m^2. The trapping result shall be checked and recorded every week, and reported to Chinese side.
- ✓ Myanmar side shall take protective measures to prevent rice from mildewing or being mixed with soil particles, plant residues, weed seeds and impurities. It is strictly prohibited to artificially add or mix rice with other grains or impurities.
- ✓ The packing bags/ boxes for export rice to China shall be marked “To the people’s republic of China” and all information that can identify rice type, processing factory, name of exporter, registration code and address of related enterprise in both English and Chinese.

2) Pulses, Beans, Oil Crops

As per domestic market on pulses and beans, Figure 2.3.2 shows that oversupply tendency of pulses and beans since 1984, and its surplus has been exported to India where hige deficit is found (see Figure 2.3.3). It means that the main market of pulses and beans is overseas. Especially, green gram and black gram are export-oriented commodity. However, not small amount of pulses and beans are consumed in Myanmar, especially chick pea, butter beans, grand nuts, and pigeon pea. Although grandnuts and sesames are used for edible oil, their demand shows decreasing trend since parm oil imported from Malaysia characterized with low quality and low price occupies large share in Myanmar.

The international demand of pulses, beans, and oils seeds produced in Myanmar is stable and high in the long run. However, Myanmar should tackle the problems of low quality of products and plant residuals. More specifically, Myanmar should satisfy with the standards of mycotoxin including

[5] During 2009 to 2012, average 74% of rice was export to West African countries, according to “Myanmar, Capitalizing on Rice Export Opportunities” February 28, 2014, The World Bank.
[6] Myanmar Business Today, June 12, 2015. When the JICA study team visited MRF on June 9, 2015, the figure that MRF staff informed was 0.8 million tons out of 1.3 million tons in total. Even though the accurate number was unknown, it seems true that around 60% of exported rice goes to China in recent years.
[7] Trend of Consumption and Production of Rice in China - A Sharp Increase of Japonica rice, July 2012, Japanese version, JC Institute.
[8] The protocol on Plant Inspection and Quarantine Requirements for Exporting Rice from Myanmar to China. The JICA Study Team obtained a draft protocol, but a copy of the original is under request to the Ministry.

aflatoxin for pulses, and plant residuals for sesame that they are very strict in developed countries such as Japan, Korea, Australia, Euro, and the USA. Total solutions covering entire value chain (especially, production and PH stage) is necessary with strengthening the system of plant quarantine.

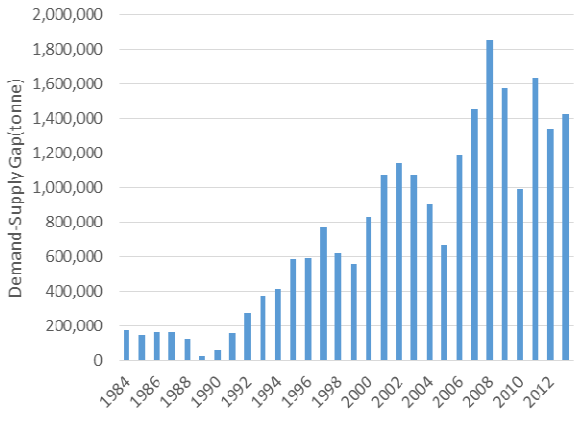


Figure 2.3.2 Domestic Supply-Demand Gap of Pulses in Myanmar
Source: FAOSTAT

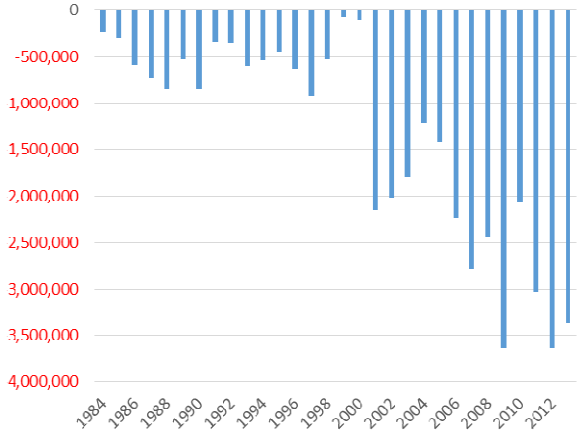


Figure 2.3.3 Domestic Supply-Demand Gap of Pulses in India
Source: FAOSTAT

3) Vegetables

The most important vegetable market is Myanmar itself, and domestic consumption of vegetables tripled in the last five decades (as seen in Figure 2.3.1). In the near future, not only vegetable consumption will increase more but also demand for new and safe vegetables are supposed to grow as the middle class will emerge. Aside from domestic consumption, according to MOC, 760 thousand tons of vegetables were exported in 2014 fiscal year, and 64% of total value of them came from watermelon, and 20% came from mask melon. Water melon produced in Myanmar has high demand, especially, in Chinese market.

Table 2.3.1 List of Exported Vegetables, Fruits & Flowers From Myanmar between 2001-2002 to 2014-2015

Sr	Description	2011-2012		2012-2013		2013-2014		2014-2015	
		Value (Mil. USD)	(%)	Value (Mil. USD)	(%)	Value (Mil. USD)	(%)	Value (Mil. USD)	(%)
1	Cabbage					0.0005	0%	0.01	0%
2	Watermelon	39.266	57%	47.269	63%	57.6	56%	68.927	64%
3	Muskmelon	10.799	16%	12.356	16%	19.341	19%	23.422	22%
4	Grape	0.031	0%	0.033	0%	0.032	0%	0.02	0%
5	Orange	0.682	1%	0.282	0%	0.394	0%	0.245	0%
6	Mango	13.459	20%			23.138	23%	13.5	12%
7	Apple*1	0.105	0%			13.229	13%	0.009	0%
8	Bitter Bean			0.029	0%	0.095	0%		
9	Pumpkin	0.056	0%	0.02	0%	0.076	0%	0.027	0%
10	Pineapple	0.494	1%	0.399	1%	0.193	0%	0.038	0%
11	Banana	3.319	5%	0.906	1%	0.924	1%	0.695	1%
12	Papaya					0.034	0%	0.008	0%
13	Lime	0.002	0%	0.02	0%	0.053	0%	0.053	0%
14	Tomato	0.017	0%						
15	Coconut	0.04	0%	0.074	0%	0.02	0%	0.477	0%
16	Avocado	0.006	0%	0.009	0%				
17	Plum	0.523	1%	0.832	1%	0.953	1%	0.817	1%
18	Wallnut							0.004	0%
Total		**68.799**	100%	**75.553**	100%	**102.7945**	100%	**108.252**	100%

Note: *1 means apple produced from China mountain. Source: Trade Promotion Department, Ministry of Commerce

On the other hand, promotion of commercial vegetables are one of the potential fields, which is

expected to grow. Some Japanese companies already started investment in the field of commercial export vegetables including primary processing as procurement cost is reasonable in this country. In these point of views, investment in establishing supply chains for fresh vegetables ha large potential.

2.3.2 Flow of Agricultural Products in Myanmar

Wholesale market surveys were conducted on June-July 2015 by JICA study team to identify the production sites, the main markets, and the exporting destinations by main crops (rice, pulse and beans, oil crops, vegetables and fruits). Followings are summery of these surveys (refer to Figure 2.3.4, Figure 2.3.5, Figure 2.3.6 and Figure 2.3.7).

1) Rice

The main production areas of rice is Ayeyarwady region, Bago region, and Sagaing region. For domestic transaction of rice, the product flows from these production areas to deficit areas including Chin State and Mandalay region. From Ayeyarwady region, some of oversupplies are exported to other countries including West Africa via Yangon port, while others are exported to China via Mandalay using water transportation. From Sagaing region, most of monsoon paddies are exported to China, but summer paddy, mainly Shwebo Saw San which is high grade variety, is consumed in Myanmar so they are distributed whole country. Also from Bago region, some of oversupplies are exported to other countries via Yangon port, while others are exported to China via Mandalay.

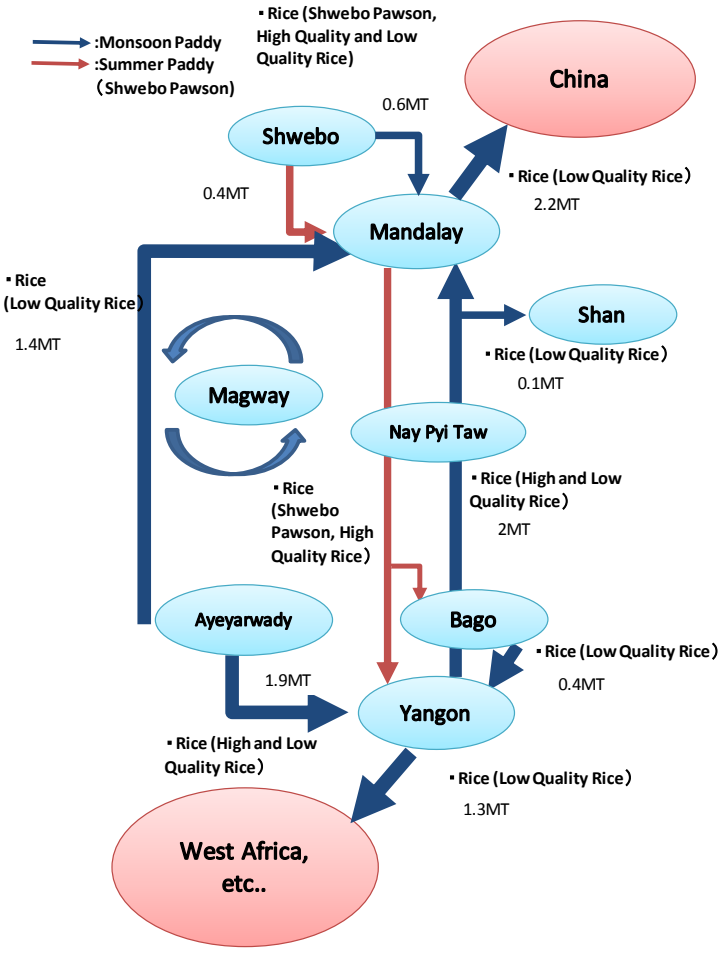


Figure 2.3.4 Rice Distribution in the Whole Country, Myanmar

Source: JICA Survey Team

The basic points of commodity flow are large cities including Yangon and Mandalay. On the other hand, for international rice transaction, there are various marketing routes including such international ports of Yangon and Pathein, trans-border route to China via Muse, that to India via Myawady and that to Bangladesh via Maung Daw, etc.

In general, plural dealers take part in rice marketing in Myanmar. In the case of rice for home consumption, farmers directly bring paddy to nearby Hullers etc, ask its milling by paying milling fee, or they once sell it to millers and later they repurchase it from them. As to surplus rice for sale, farmers often sell it to collectors or brokers in village track or township and these buyers are apt to mill their purchased rice at nearby medium or large scale rice millers. The milled rice is then sold to middlemen in local cities and it is traded in large cities including Yangon and Mandalay. Finally, it is sold to wholesalers in consuming areas and to exporters.

2) Pulses, Beans, Oil Crops

Pulses, beans, and oil crops are cultivated after monsoon paddy according to the typical cropping pattern in this country. Thus, paddy-producing region are also production site of these crops (Note that the dominant crop is black gram in delta region, while it is green gram and chick pea for CDZ and northern part of Myanmar). The distribution route is almost the same as paddy because production sites of these commodities are very similar (see Figure 2.3.5). However, the large amount of pulses, beans, and oil crops are exported to India via Yangon port. India is a gigantic importing country of pulses and beans, which is so-called "secondary staple food", since economic liberalization in 1991 when the share of primary industry in India started decreasing.

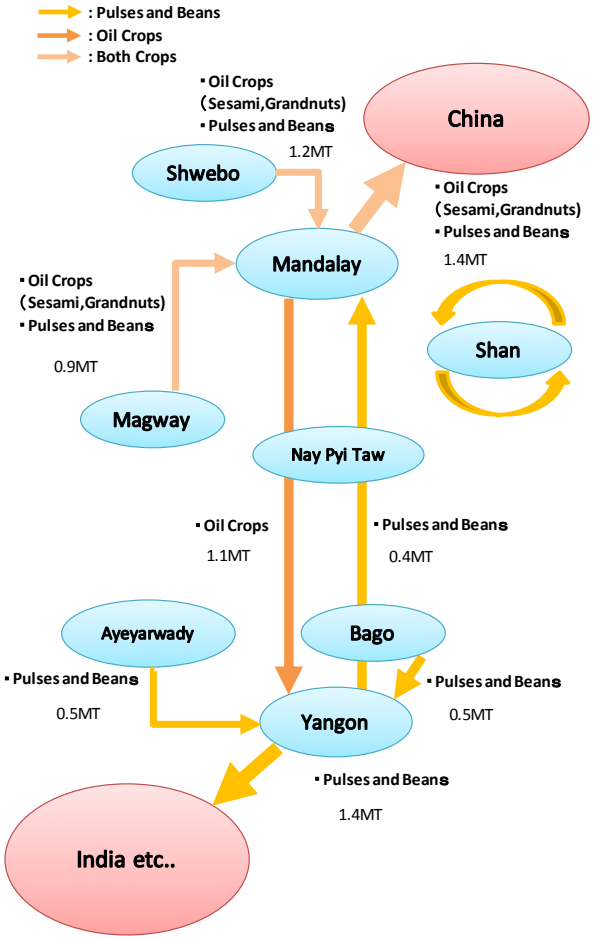


Figure 2.3.5 Pulses, Beans, Oil crops Distribution in the Whole Country, Myanmar

Source: JICA Survey Team

Basically, they are transacted in Crop Exchange Center (CEC) where Brokers, Millers, and Exporters are getting together to negotiate these commodities. The CEC is established in major cities including Yangon, Mandalay, Monywa (Sagaing), Myingyan (Mandalay), and Magway. The Broker, Miller and Traders Maha Kahtaintaw Association or The Chamber of Commerce operate the CEC to provide transaction place of oil seeds, pulses and beans, and cereals such as Maize to its members including brokers, millers, traders, and exporters. Usually, transaction at the CEC is conducted by showing a small amount of sample. If the negotiation is successfully concluded, middleman in production place (or seller) send product to buyers.

3) Vegetables

According to Settlement and Land Records Department (SLRD), major production areas of vegetables in terms of production volume are Sagaing (21%), Shan (17%), Ayeyarwady (16%), Bago (11%) and Magway (11%) in 2013-14, as shown in figure on the right. It should be noted that Shan state is very famous of highland vegetable production area; however due to population and farmland sizes, those areas other than Shan are also big vegetable production areas. Note

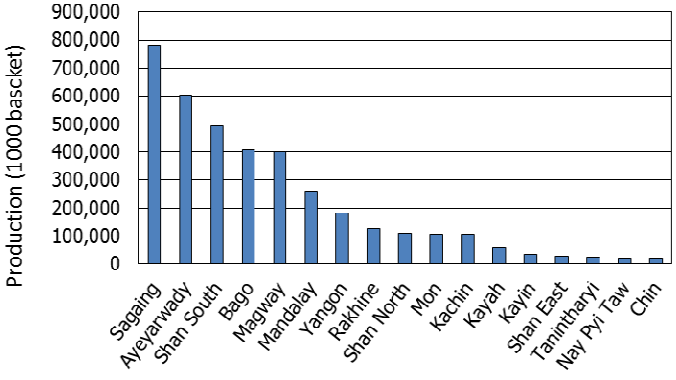


Figure 2.3.6 Vegetable Production in 2013-14

Source: Settlement and Land Records Department (SLRD), MOAI

that Shan is divided into three areas; Southern Shan, Northern Shan and Eastern Shan, and the Southern Shan is famous about highland vegetable production.

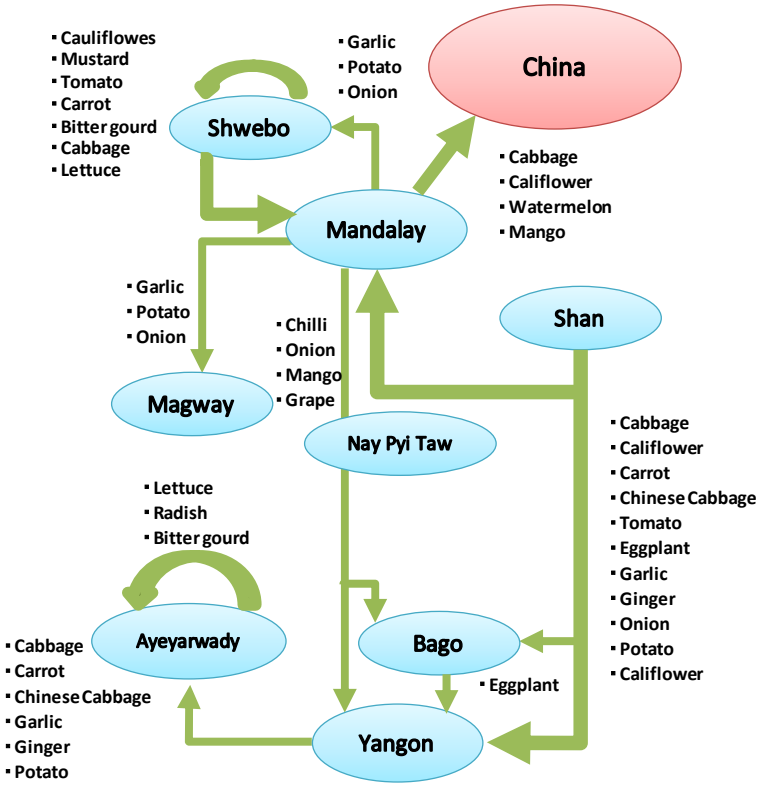


Figure 2.3.7 Vegetables Distribution in the Whole Country, Myanmar

Source: JICA Survey Team

Sagaing is one of major production area of vegetables, including cauliflower, mustard, tomato, carrot, bitter gourd, cabbage and lettuce, according to the statistics of SLRD in 2013-14. Sagaing and neaby regions which form the Central Dry Zone are also the largest production area of onion, chili, tomato , and watermelon. Particularly, quality of chilies from Monywa in Sagaing and Meiktila in Mandalay is higher than that from Shan, and are transacted with higher prices in and around Greater Mandalay area. According to wholesalers in Mandalay, quality of chilies from Shan state is poor due to higher moisture contents. According to wholesalers in Mandalay markets, major destinations of vegetables produced in Sagaing are within the region and surrounding Greater Mandalay area. A few products including tomato and onion are marketed to Nay Pyi Taw and Yangon.

Shan is a major production area of garlic and potatoes in Myanmar. Also, the highland vegetables, including cabbage, cauliflower, broccoli, chinese cabbage, asparagus and leafy vegetables, are marketed from Shan to major consumption areas in almost all regions such as Yangon, Mandalay, Nay Pyi Taw, Myingyan, Magway , and Pathein. As for tomatoes, even though Inle Lake is famous for the production, almost 70% of tomato in 2013-14 is produced in the CDZ. At the time of harvest season, tomato from Shan is dominant in major markets including Yangon and Mandalay. However, when tomato from CDZ flows into the markets, price of tomato from Inla Lake decreases sharply due to poor quality and taste.

Aungban wholesale market was developed as a way station of vegetable trading from Southern Shan to other regions. Even though Taunggyi is the third largest city in Myanmar, in terms of population, wholesale market has not been well developed due to constraints on geographical condition and limitation of area. Vegetables from Shan, mostly from Southern Shan, are once callected at Aungban wholesale market and are redistributed to broader market such as Thiri Marlar Market in Mandalay and Thiri Minglar Market in Yangon.

Ayeyarwady and Bago are also one of major production areas of lowland vegetables, and production volume of lettuce, radish and bitter gourd in 2013-14 are higher among regions and states in Myanmar. On one hand, however, as far as results of market surveys conducted by the JICA team show, vegetables from Ayeyarwady region could hardly be found in Thiri Minglar Market in Yangon. This fact may suggeste that most vegetables grown in Ayeyarwady delta are consumed inside and surrounding area since population of this region is quite high. On the other hand, lowland vegetables

from Bago are actively transacted in the wholesale market in Yangon, indicating that Bago is one of supply base of vegetables to the commercial capital of Yangon.

2.3.3 Distribution Hubs in Myanmar

1) Distribution Hub in Yangon

Yangon and Mandalay are two important distribution hubs of Myanmar. The principal distribution hub in Lower Myanmar is Yangon, while that in Upper Myanmar is Mandalay. In addition, Aungban wholesale market in Southern Shan shoulders important role for highland vegetable distribution to whole country.

For Yangon, nationwide distribution networks are connected from North, West and East. Viewing broadly, from North direction, pulses, beans and oil crops flows into Yangon from major production areas of CDZ, while vegetables, fruits and horticulture products are distributed from Shan and CDZ. From western side, agricultural products including rice, pulses and beans from mostly Ayeyarwady come in by both land and sea, while rice, pulses and beans, vegetables are from east and southeastern side of the country including Bago.

On the contrary, a part of rice coming from Ayeyarwady, Bago and surrounding areas goes from Yangon to Northern and South-eastern parts of Myanmar. From Yangon port, major agricultural commodities including pulses and beans, oil crops, rice, and some vegetables and fruits are exported by ship. Also, from Yangon Airport, some high value products including Sain Ta Lone Mango are exported to Singapore, Dubai, Hong Kong and Malaysia.

In Yangon, several large-scale markets exist, including Bogyoke Aung San Market, Mingala Market, Thiri Mingala Market, Bayintnaung Market, and Da Nyin Gone Market. Among them, wholesale markets for agricultural products are Bayintnaung Market and Thiri Mingalar Market. The former is located in Insein Township and is famous for wholesale transaction of pulses and beans, whereas the latter is the largest wholesale market for fresh products including vegetables, fruits and flowers.

Thiri Mingala Market is located western part of Yangon city, beside Yangon river. Since the market is located inner part of the city, traffic jam in the surrounding roads is almost regular situation and transport of fresh products meet difficulty. In addition, inside of market shed is congested and small van comes into the shed using narrow entranceway, resulting in worsening of sanitary conditions.

To overcome the situation, there is a plan to expand Da Nyin Gone Market and annex it to the largest wholesale market in Yangon. At present, Da Nyin Gone Market is a retail market for fresh products including vegetables and fruits, and is located in northwest direction of Yangon International Airport. Lot area of the current market is just 10 acre, but will be expanded to 85 acre after the improvement. According to YCDC officials, Talaad Thai wholesale market in Thailand is a model for the new Da Nyin Gone Market, and will be operated by a private sector under the PPP.

When the survey team visited the Da Nyin Gone market in June 2015, road condition was quite bad, and long line of traffic jam was observed at the entrance of market. However, the expansion plan includes road improvement, in addition to installation of colds storage. The first phase of construction was started in April 2015 and will be completed by 2016, followed by another phase of the implementation.

2) Distribution Hub in Mandalay

As for Mandalay, nationwide distribution networks are also connected from four cardinal points. The network includes the Yangon-Mandalay national highway, which is the main artery of surface transportation in the Myanmar. Mandalay-Muse road is the main export route to China by land,

whereas Mandalay-Tamu road connects Myanmar to India. Also, several routes from the central dry zone are connected to Mandalay mostly its western side. Through these road transportation networks, various types of agricultural commodities come in and go from Mandalay.

Mandalay also has several markets including Zegyo (Ze Cho) Market, Mingala Bazaar, Phayagyi Bazaar, Thiri Marlar Market, and 41 Vegetable Night Market. Among them, Thiri Marlar Market is a wholesale market for perishable products including fishes, vegetables, fruits and flowers, whereas 41 Vegetable Night Market is a retail market for vegetables and fruits. Thiri Marlar Market is a sort of wholesalers' cluster which has been historically established without any proper plan and design. There are no integrated market building including cold storage and sanitary facilities.

3) Distribution Hub at Production Area

Aungban wholesale market is an important local hub of highland vegetables distribution, and is located in the strategic point of agricultural marketing of Southern Shan. It is located in 50km away to west from Taunggyi, in the middle of Taunggyi-Meiktila road. From Meiktila, Mandalay is connected by national road in the North, whereas Yangon is located in the South. A Myanmar-China border town of Muse is also connected from Aungban via Nawngcho and Lashio.

Most highland vegetables produced in Southern Shan are once ferried to the Aungban wholesale market and distributed to almost whole regions in Myanmar. Therefore, marketing information at the Aungban is quite important for all traders dealing with highland vegetables. However, function of Aungban market is still poor comparing to the significance in the vegetable transaction in the nation. For example, Aungban wholesale market is also a naturally grown market where wholesalers have been historically accumulated without any proper plan. There is no integrated marketing function including market information system (dissemination of information on production and price trend), cold storage to keep freshness of produce and sanitary considerations.

2.3.4 Development Issues on Food Value Chain

There are several stakeholders over entire Food Value Chain including input producers, farmers, brokers, traders, buyers, processors, distributers, wholesalers, retailers, and consumers. To formulate intensive agricultural programs, it is essentially important to understand their rolls, their relationships, and problems they have faced. Figure 2.3.8 is an image of food value chain. The followings show development issues based on interviews we conducted. Following focus on some important crops: rice, pulses and beans, and vegetables (tomato):

1) Development Issue on Rice

Main stakeholders of rice are input-producers, farmers, distributers, traders, processors, wholesalers, and retailers, and processor often works as trader/wholesaler too. The total amount of individual trading is overwhelmingly larger than that of wholesale/retail market. Outflow of labors from production site is one of the main issues for farmers. In these days, farmer cannot hire enough agricultural labors. In Bago-east, for example, most of farmers can cultivate only either summer paddy or winter pulses because the period between summer paddy harvesting and winter pulses preparation is very short, and farm labors are insufficient. Another problem is absence of high quality seeds. Farmers sometimes use mixed-variety that causes the high percentage of broken rice.

According to Myanmar Rice Millers Association (MRMA), there are about 1,500 rice mills and 15,000 hullers in the country. Most of the rice mills operate with obsolete processing units, leading to quality and quantity losses of about 15-20 percent during milling[9]. However, investment for rice mills is not easy for marginal rice millers due to the large initial cost and the high interest rate of

[9] "Myanmar: Capitalizing on Rice Export Opportunities", the World Bank , February 2014

government/private bank.

Table 2.3.2 Food Value Chain Matrix for Rice

Stakeholders	Farmer	Distributer, Trader	Processor, Wholesaler	Retailer
Place	Production area	Production area-Consumer area	Production area-Trading area-Consumer area	Consumer area
Investments (Example)	Hand-Tractor	Storage/Warehous, Trucks	Rice Mill, Polisher, Storage , Drying Area	Warehouse
Outputs/	Paddy: -Sin Thu Kha 66bsk/Ac -Thi Htat Yin 110bsk/Ac		Rice/Broken rice: -Rice: 225bsk/day -Broken rice: 225bsk/day	
Margin	55% (Net Profit Ratio)	2-5%	41% (Net Profit Ratio in case of rice miller)	3-10%
Problems/ Challenges	1. Insufficient labor 2. Not-uniformed variety 3. Quality of paddy is low and unstable. 4. They have to sell their paddy just after harvesting because they lend money from traders/processors.	1. Heavy trucks cannot use the poor road. (Pathein - Yangon, Pathein - Pyai) 2. Marine transportation takes long times. (Pathein-Magway: 1-2 months) 3. Profit loss due to buyer's cheating.	1. Upgrading their facilities (Rice mills, Color sorter, Wet polisher etc..) 2. High interest rate of the government and commercial bank loan (about 12%). 3. Government electricity power is low.	1. Unstable price of rice. 2. Poor road condition near the market.

Note: “Investments", "Outputs", "Problems/Challenges" are based on market surveys conducted by JICA Study Team

Note: “Margin” is calculated by JICA study team, based on market surveys, but calculation of margin for rice miller is based on following study: http://www.ide.go.jp/English/Publish/Download/Vrf/pdf/471.pdf

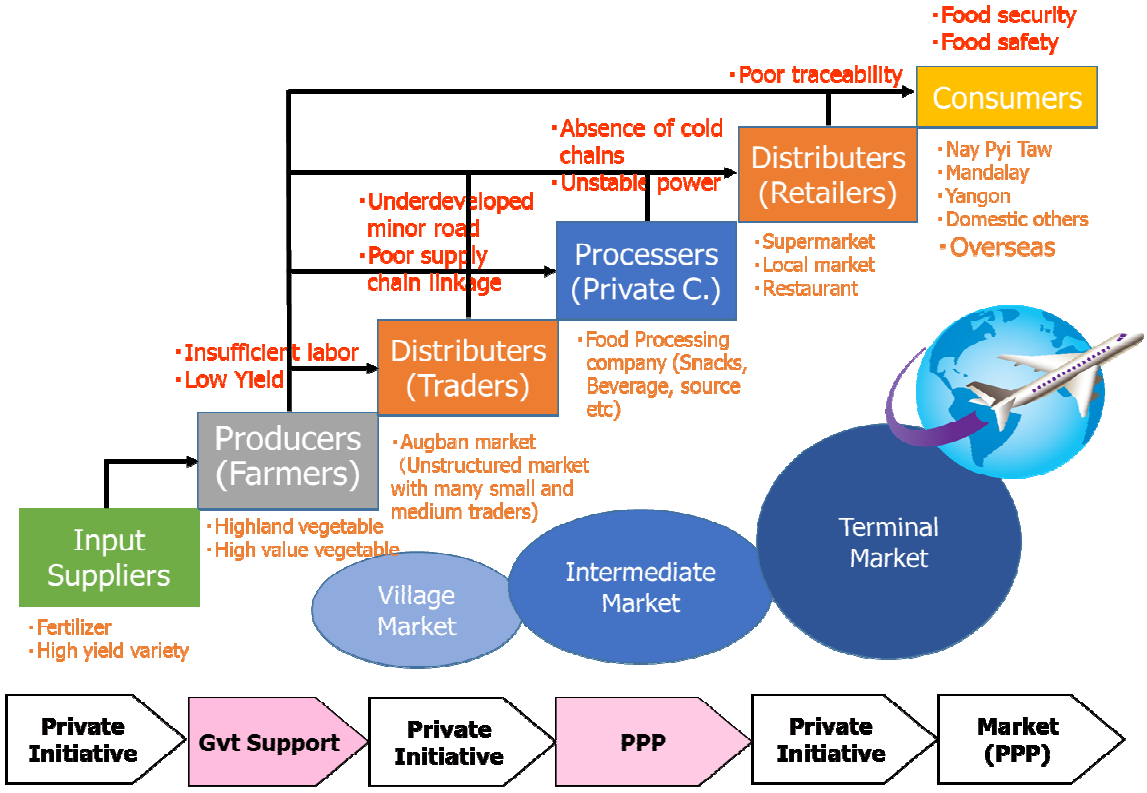


Figure 2.3.8 Food Value Chain And its Stakeholders

Source: JICA Survey Team

2) Development Issue on Pulses and Beans

Main stakeholders for pulses and beans are very similar to rice. They are transacted in Crop Exchange Center (CEC) where Brokers, Millers, and Exporters get together to negotiate these commodities. The CEC is established in major cities including Yangon, Mandalay, Monywa (Sagaing), Myingyan (Mandalay), and Magway. Pulses and beans are export oriented crops so needs for quality control is

very high (e.g. hygiene control, color sorter, and upgrading milling machines). Also, there is a need for market information about the border price (China and India).

Pulses and oil crops are planted as after-crop of paddy in Shwebo area, and these crops have also a problem on pre- and post-harvest handling at both on-farm level and off-farm level. According to DOA, recently sesame has been introduced in Shwebo area as a substitute crop of summer paddy. Sesame is directly connected to the world market, hence quality requirement of sesame is quite high. However, in general, many farm households produce the seeds by themselves, which result in degradation of seed quality. Also, mixing of different color grains and residual agro-chemicals remain issues in exporting sesame from Myanmar. Therefore, improvement of seed quality and pre-and post-harvest handling is required to enhance value chain of after-paddy crops.

Followings are requests from participants of an interview at Crop Exchange Center in Monyuwa (Maha Kahtina Association of Traders, Brokers & Industrialist) on 19 May 2015 about distributions of pulses and oilseeds in Sagaing:

- ✓ Spread:"Farmers should use high-quality varieties especially for Green Gram and Sesame. Seeds that farmer uses are degradating so update is necessary. In addition to this, it is better that some experts provide technical instructions for productivity increase. It is grateful if you will also provide instructions for agricultural chemical usage. Farmers face difficulty to get profit since procurement costs of agricultural chemicals become expensive."
- ✓ Mechanization: outflows of labors from rural area to urban area demand agricultural mechanization. Tractor and combine harvester are useful for farmer who produces chickpea or wheat. Small harvester is also needed if his cultivating lands are small, and his farm roads are narrow.
- ✓ Transportation: Diversifying the means of transportation is important for traders who exports pulses and oilseeds. Transportation on the road is currently prevalent but it costs very high so another options such as railway and water transportation can be useful. However, the water depth in Chidwin river becomes very shallow so distributers cannot count on it during dry season.
- ✓ Information: It is useful if daily information about international market including Chinese bordar (Muse), and Cambodia will be provided.

Table 2.3.3 Food Value Chain Matrix for Pulses and Beans

Stakeholders	Farmer	Distributer, Trader	Processor, Wholesaler	Retailer
Place	Production area	Production area -Consumer area	Production area-Trading area -Consumer area	Consumer
Investments (Example)	Hand-Tractor	Storage/Warehouse	Mill, Processing Area, Drying Area	Storage/Warehouse
Outputs/ (Example)	Green Gram: -Yezin-14: 18.26 bag/Ac		Broken Green Gram: -45,000 viss/day Broken Black Gram: -45,000 viss/day	
Margin	69% (Net Profit Ratio)	1-6%	1-3%	1-4%
Problems/ Challenges	1.Irrigation water is not enough so they cannot cultivate throughout the year.(MGW) 2.Low quality of pulses and beans.(ununiformed size and color, debris etc...)	1.Lack of information about the border prices. (China, India) 2.Quality of Pulses and Beans becomes bad during transportation in rainy season. 3.Heavy trucks cannot run (AYW-YGN). 4.Developping high value- added commodity (ex: peanuts butter)	1. Lacks of hygience control in processing. 2. Some oil mills cannot compete for the imported palm oils from Malaysia. 3. Upgrading machine (ready cargo, color sorter), and Instruction for these machines.	1. Market supply is not stable so they have to buy commodities just after harvesting.

Note: "Investments", "Outputs", "Problems/Challenges" are based on market surveys conducted by JICA Study Team
Note: "Margin" is calculated by JICA study team, based on market surveys.

3) Development Issues on Tomato Farmers in Inle Lake (Southern Shan)

Inle Lake is the second largest lake in Myanmar, located in Southern Shan. Its watershed area is 2,884km^2 and 4 streams including Nant Latt, Upper Belu, Ka Law, and Ye Pae are flow into the lake. The original Lake area was 271 km^2, but has decreased to 163.2km^2 in 2007, of which only 62.2km^2 remained as open water surface area[10]. The lake is also famous for tomato production in the floating bed. Tomato farmers in Inle Lake accumulate floating waterweed on the surface of water, and putting fertile soils from bottom of the lake on the floating bed to make floating plot for tomato production. The floating bed is fixed to the lake bottom by bamboo poles, which enable the bed to elevate as water level rise. The tomato farming is mostly conducted by Intha, an ethnic minority in Myanmar.

Income from the tomato production is unstable due to fluctuation of selling price, which in turn making farm household economy uncertain. According to a tomato farmer, farm gate price of tomato in May 2015 was around 5,000 to 6,000 Kyats/basket, which was below break-even sales price. In 2014, farm gate price of tomato in May was the highest, and was 50,000 to 60,000 Kyats/basket, indicating that the price of tomato in Inle Lake fluctuates between 10 times of price range.

One of main trigger for the crash is wrapping over of harvest time among tomato farmers in Inle Lake. Another reason is wrapping over of marketing with tomato from other areas particularly from the Central Dry Zone. According to the farmer, at least 8,000 Kyats/basket is necessary to generate profit from the tomato farming. The break-even sales price is also confirmed by the survey team through simple estimation as shown in Figure 2.3.9 in the right.

To enhance tomato value chain in Inle Lake, following challenges are identified through intensive discussions with a tomato farmer group and local collectors in Nyaung Shwe

- ✓ Promotion of sustainable farming in and around Inle Lake through watershed management in upstream areas.
- ✓ Promotion of eco-friendly farming through extension of farming technologies to reduce pecticide application
- ✓ Stabilization of tomato farming through production adjustment among farmers groups in Inle Lake.

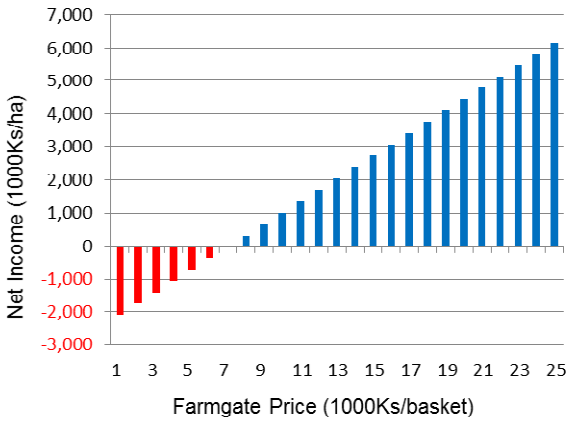


Figure 2.3.9 Break-even Sales Price of Tomato Production in Inle (as of May 2015)
Source: JICA Survey Team

- ✓ Income increase of farmers in Inle Lake through diversification of hydroponic technology.
- ✓ Stabilization of value chain stakeholders' income from tomato production and selling through cold chain development at production area.

2.4 Transportation and Electrification Availability and Forecast

To formulate intensive agriculture promotion program, one must consider the availability of transportation at present and also in future. To facilitate delivery and distribution of agriculture commodities, the existing road network, those condition, present volume of goods delivered, and also future plan shall be well taken into consideration. Basically, areas to promote intensive agriculture should have good access to a better road network, whereby able to facilitate the development of value

[10] "5 Year Action Plan for the Sustainability of Inle Lake and Environmental Conservation in Myanmar" Ministry of Environmental Conservation and Forestry, October 2014.

chain.

In addition, there is an area where pump irrigation schemes have densely been developed. It is the area stretching from downstream of Chindwin river to the confluence with Ayeyarwady river and also along the Ayeyarwady river from Mandalay to Bagan. Most of the power source is now diesel generator though they are connected to national grid. Due to frequent blackout, national grid power has rarely worked. If they were operated by national grid power continuously, the operation cost would be lowered by more than half. Therefore, to examine the possibility of promoting intensive agriculture in this area, present power availability and future plan should be examined.

2.4.1 Existing Transportation Network

Table 2.4.1 summarizes the road length in Myanmar as of 2012, which is managed by the Ministry of Construction, Ministry of Border Areas and others such as city development committees. Of the total length of 148,689.9 km, the majority is earth road with 76,884.6 km (52%), followed by bituminous road with 28,739.1 km (19%), gravel road with 26,320.4 km (18%), and so on. In terms of so-called trunk road, there are 45 north-south roads of about 9,100 km and 35 east-west roads of about 15,000 km. This give a total of 80 trunk roads with a total of 24,000 km. Major trunk roads are as follows (also see Figure 2.4.1):

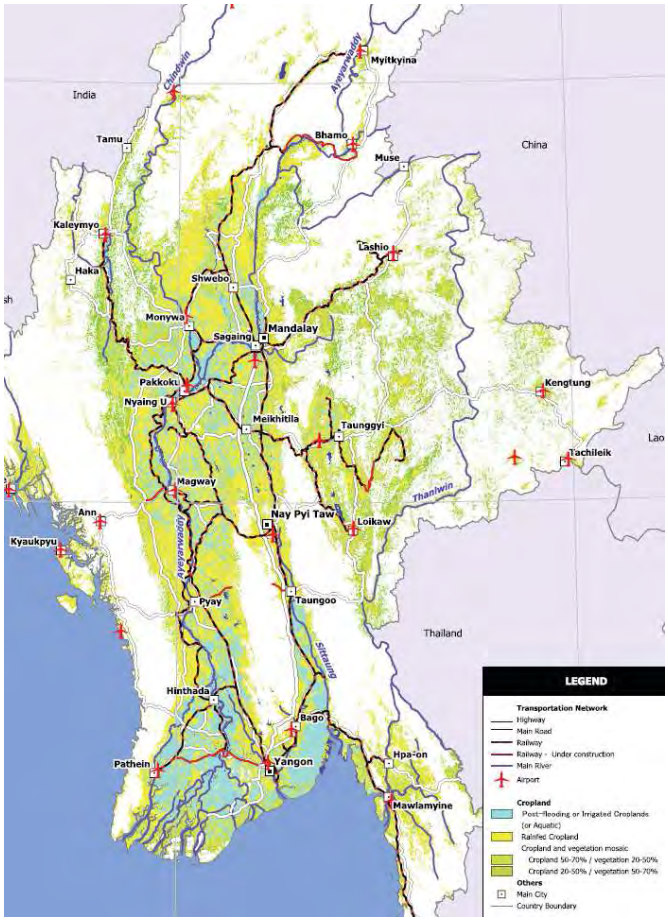


Figure 2.4.1 Road Network in Myanmar
Source: JICA Survey Team

1) Yangon – Mandalay New Highway; The road connects Yangon and Mandalay via Nay Pyi Taw. The construction between Yangon and Nay Pyi Taw was started in October 2005 and completed in March 2009 with a total length of 325 km. The construction from Nay Pyi Taw to Mandalay was commenced in 2007 and completed in 2010 with a total length of 262km, now total length of 587 km from Yangon to Mandalay. Pavement is concrete, so that tracks have not been allowed to run without permission. However, asphalt pavement started in between Yangon and Nay Pyi Taw, and therefore in future all the vehicles are expected to run.

2) Yangon – Mandalay Old Highway; The road passes through major cities in the central Myanmar such as Bago, Taungoo, Pyinmana, the capital Nay Pyi Taw and Meikhtila. This road is 695 km long.

3) Yangon – Pyay Road; This road runs west of the Bago Yoma range and has a length of 288 km. It was a best road among major trunk roads before the Yangon - Mandalay highway was opened; but it has been deteriorated and there are areas where road conditions are bumpy and traffic easily get congested in and around towns.

4) Pyay – Magway Road; This is actually a continuation of Yangon – Pyay road. It is running along the east bank of Ayeyarwady river and has a length of 202 km. From Magway, the road continues

to Bagan, passing through Yenanchaung, which is an oil drilling town in central Myanmar. Another road connects Bagan (from Kyaukpandaung) and Meikhtila, thus connecting the east and west corridors.

5) Mandalay – Lashio Road; This road starts from Mandalay and ends in Lashio, from which another road extends up to Muse, which is the border town with China. This road is the most important road in China - Myanmar border trade route. From Mandalay to Lashio, it is 262 km in length, and further 180km from Lashio to Muse.

6) Meikhtila – Taunggyi Road; This is an extension from Yangon – Mandalay Road. From Meikhtila, which is on the way from Yangon to Mandalay, the road extends to Taunggyi, the capital of Shan State. From Meikhtila to Taunggyi, it is 205 km in length.

Table 2.4.1 Summary of the Total Road Length by Responsible Organization

No	Department	Concrete Road (Km)	Bituminous Road (Km)	Gravel Road (Km)	Metalled Road (Km)	Earth Road (Km)	Donkey Road (Km)	Total (Km)
1	Ministry of Construction							
	Expressway & Highway	611.7	11733	2440.8	2700.3	1973.5	44.1	19503.2
	Regional & State Roads	49.7	5451.8	3299.6	2941.4	6497.1	1340	19579.5
	Sub-total	661.4	17184.8	5740.4	5641.7	8470.6	1384.1	39082.7
2	Ministry of Border Areas							
	Urban Road	6.6	4880.7	2215.5	660.8	3509	-	11272.6
	Village & Border Road	120.1	4073	17041.5	4976.7	55888.5	-	82099.9
	Sub-total	126.7	8953.7	19257	5637.5	59397.5	0	93372.5
3	Yangon City Dev. Committee	1239.7	1747.5	12.9	454.9	472.9	-	3928
4	Mandalay City Dev.Committee	10.8	573.4	119.7	-	309.8	-	1013.8
5	Nay Pyi Taw City D.Committee	246.1	129.3	43	734.9	1130.8	-	2284.1
6	Directorate of Military Engineers	393.4	61.8	605.3	166.4	6822.7	-	8049.5
7	Ministry of Electrical Power	48.3	88.5	542.1	-	280.2	-	959.2
	Sub-total	1938.3	2600.5	1323	1356.2	9016.4	0	16234.6
	Total	**2,726.4**	**2,8739**	**2,6320.4**	**12,635.4**	**76,884.5**	**1,384.1**	**148,689.8**

Source: Ministry of Construction (2012)

2.4.2 Future Forecast of Road Network Development

A JICA preparatory survey conducted future forecast of nation-wide transport and freight in Myanmar. The survey carried out simulations on passenger and cargo desire line in a target year of 2030. Following figures show the lines by a range of passenger/ cargo per day. From these simulations, it is obvious that the North-South corridor, Yangon to Mandalay via Nay Pyi Taw, is and will be the main trunk line, along which the largest population and freight are to move.

Based on the above simulation and also from nation- wide development point of view, the JICA survey recommended a transport spatial development framework as shown in Figure 2.4.4. According to the recommendation, there are 5 top priority roads which should be invested with higher priority; i.e., A) North – South Corridor (Yangon – Mandalay), B) East – West Corridor

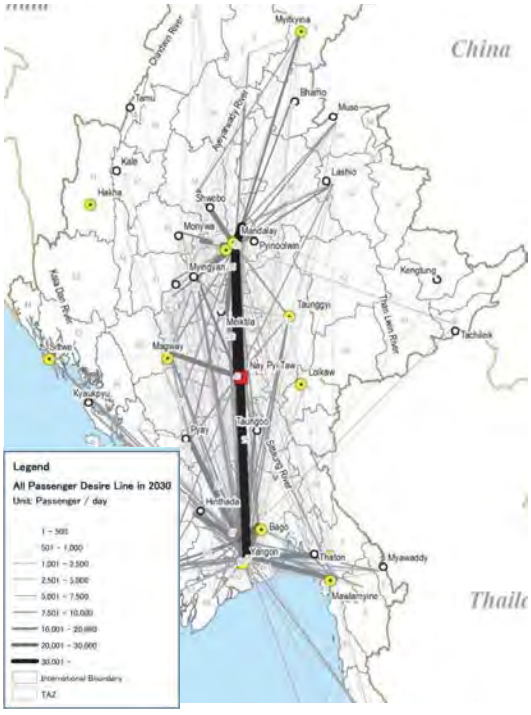


Figure 2.4.2 Simulation on Passenger Desire Line
Source: Preparatory Survey for National Transport Program in Myanmar (JICA)

(Yangon – Mawlamyine), C) Northern Corridor (Mandalay – Lasho – Muse - Yunnan), K/F) Western North – South corridor (Yangon – Pyay – Magway) and Main River corridor, and H) Ayeyarwady delta area network.

The implementation of the recommendation is of course dependent on the budget availability; however from the view point of nation-wide economic development, the recommendation should be followed as much as possible. Likewise, the desire lines simulated do not show the movement and its volume of agriculture commodities only, but at least it can suggest which area(s) should be given attention in promoting intensive agriculture as well as in facilitating value chain development. It can clearly be said that such areas located along the main North-South corridor should be given priority in promoting intensive agriculture, which needs good access to main road and cities where lots number of consumers reside. In addition, Ayeyarwady delta area could also be included as one of priority areas since it is not far from Yangon.

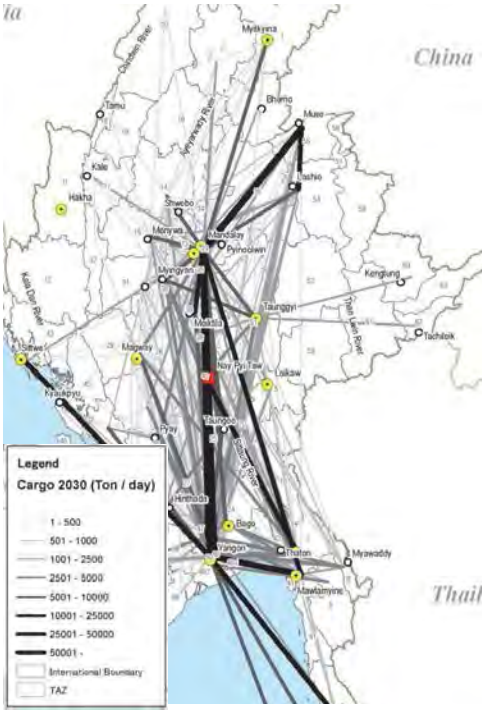


Figure 2.4.3 Simulation on Cargo Desire Line
Source: Preparatory Survey for National Transport Program in Myanmar (JICA)

Figure 2.4.4 Transport Spatial Development Frame
Source: Preparatory Survey for National Transport Program in Myanmar (JICA)

2.4.3 Availability of Electricity

Figure 2.4.5 shows the trend of electricity consumption over the years from 2006 to 2012. Note that potential demand must be more than that of the power consumption since there are lots of underlying demand, for which they have to depend on own generators or just cease using electricity. As shown in Figure 2.4.5, the power consumption has been around 4,000 – 5,000 GWh over years of 2006 – 2009, and after 2009 it has increased very much. The annual growth ratio

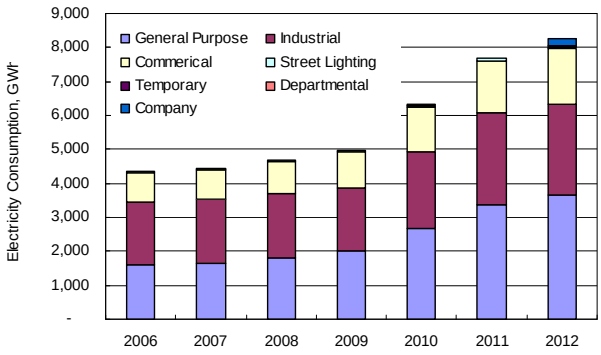


Figure 2.4.5 Trend of Electricity Consumption
Source: Preparatory Survey for National Electrification Plan (2014), JICA

marked as much as 26.5% in 2010, 21.9% in 2011, and 7.2% in 2012. This increase trend may have been explained by the open policy and economy implemented by the present government.

On the other hand, it is known that there has often been planned blackout and electricity outage almost over country. Table 2.4.2 summarizes the records of actual planned blackout by month as of year 2010 – 2012. As average, the blackout on basis of consumption was 9%, 8% and 11% in years of 2010, 2011, and 2012 respectively. It is also indicated that at least during the 3 years the situation had not been improved or rather got worsened.

Table 2.4.2 Planned Blackout for the 3 Years of 2010 - 2012

No	Month	FY 2010 Load Shed (Maximum)	on Consumption	FY 2011 Load Shed (Maximum)	on Consumption	FY 2012 Load Shed (Maximum)	on Consumption
1	April	230	16%	203	14%	211	14%
2	May	283	19%	254	17%	230	16%
3	June	184	13%	179	12%	100	7%
4	July	51	4%	125	9%	0	0%
5	August	84	6%	159	11%	0	0%
6	September	187	13%	27	2%	0	0%
7	October	0	0%	158	11%	0	0%
8	November	0	0%	0	0%	269	19%
9	December	0	0%	0	0%	175	12%
10	January	89	6%	0	0%	304	21%
11	February	153	11%	0	0%	325	22%
12	March	214	15%	286	20%	284	20%
	Average	**123**	**9%**	**116**	**8%**	**158**	**11%**

Source: Preparatory Survey for National Electrification Plan (2014), JICA

A JICA preparatory survey to formulate electricity development plan in Myanmar, conducted in 2014, carried out demand simulation up to 2030 in Myanmar as indicated the following figure. According to this simulation, the present level of 8,254 GWh of electricity consumption is expected to increase to 19,514 GWh even in low case and as much as 22,898 GWh in high case in year 2020, more than double than the present consumption level. In year 30, the consumption is expected to rise to 48,639 GWh and 77,730 GWh for low case and high case respectively, more than 5 folds.

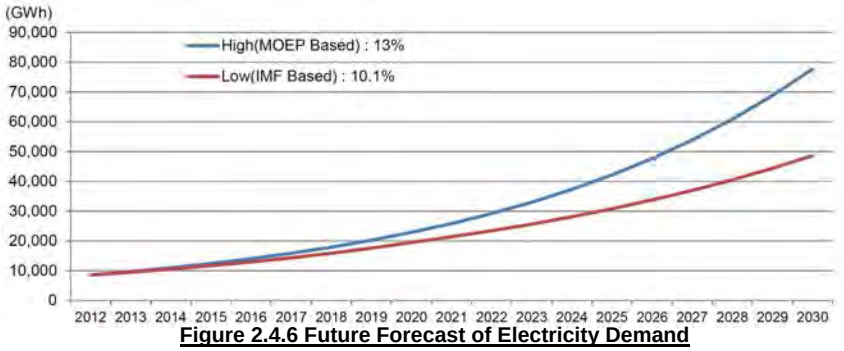


Figure 2.4.6 Future Forecast of Electricity Demand

Source: Preparatory Survey for National Electrification Plan (2014), JICA

In fact, to meet this big demand, there has to be a huge amount of investment as indicated below. The total development cost during the period from 2013 to 2020 is to be US$ 16.5 billion and as much as US$ 60.8 billion during the period from 2013 to 2030, including O&M cost, fuel cost, construction of transmission and sub-stations. These development cost is in fact huge, just beyond the financial capacity of Myanmar government, so that the initial investment has to be supported by donors and also PPP, promotion of IPP (independent power producer).

Table 2.4.3 Total Development Cost for Electrification in Myanmar

Particular	2013 – 2020, billion US$	2013 – 2030, billion US$	Remarks
Power Generation	13.8	55.2	
Power System	2.7	5.6	
Total	16.5	60.8	

Source: Preparatory Survey for National Electrification Plan (2014), JICA

Looking into the 2020 dry season scenario of block balance power supply-demand indicated in Figure 2.4.7, it is known that northern part of Myanmar is surplus in electricity. However, this electricity is planned to deliver to Yangon and its vicinity area where the electricity is needed the most. As in Figure 2.4.8, accordingly, the power line plan is also to be constructed mostly along north-south direction in order to convey the power from north to south of the country. Pump irrigation area is located at the circle-indicated location, where priority in terms of electricity distribution is not high.

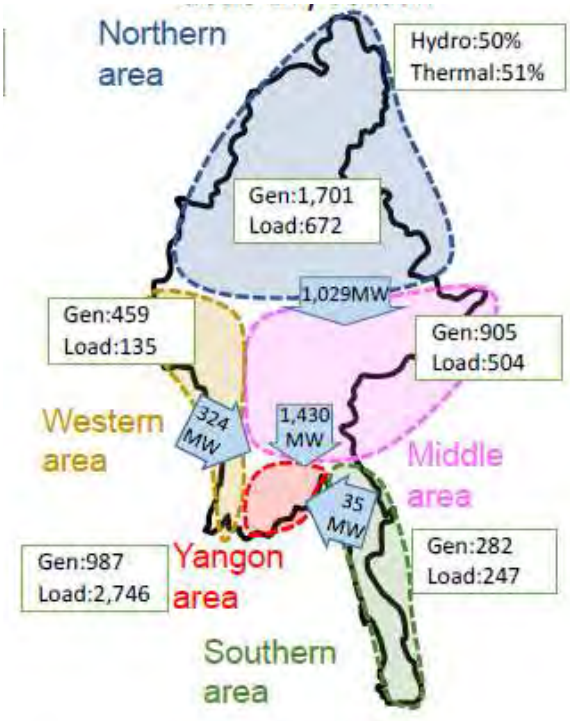


Figure 2.4.7 Power Block Balance of Demand-Supply (2020)
Source: Preparatory Survey for National Electrification Plan (2014), JICA

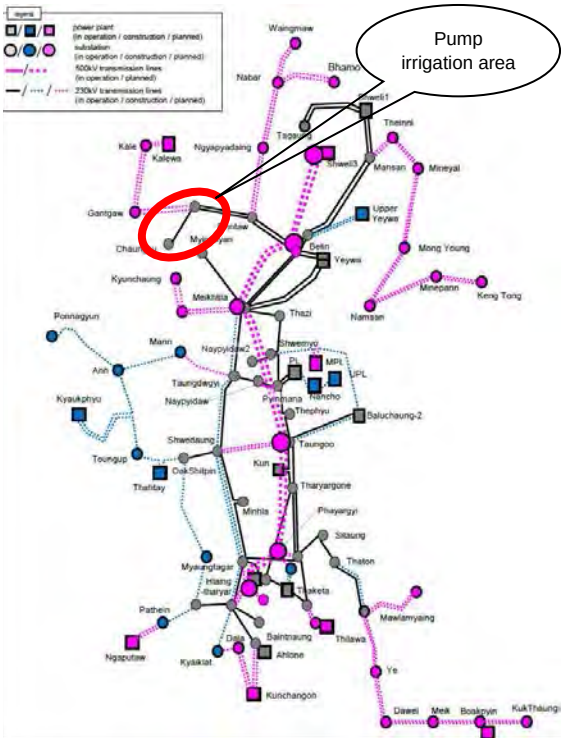


Figure 2.4.8 Future Plan of Distribution Line (2020)
Source: Preparatory Survey for National Electrification Plan (2014), JICA

CHAPTER 3 POTENTIAL AREA IDENTIFICATION

This chapter undertakes potential areas identification, starting with farm land delineation with a help of satellite data. Then, irrigation schemes, specifically irrigation dam reservoirs and intake sluices constructed by ID, are to be superimposed on the farm land map. This map can show us clusters of irrigation schemes which entail potential of promoting intensive agriculture. Further with a help of google map and SRTM (Space Shuttle Radar Topography Mission) 90m DEM (Digital Elevation Model), and ID irrigation scheme maps, current irrigation areas are to be identified as the first step of selecting priority areas.

3.1 Potential Area Identification

Preparatory data processing for the priority area selection starts with identifying the distribution of rain-fed croplands and irrigated croplands with reference to a satellite image. Then, irrigable area information (area, dam capacity, etc.) collected from ID and the related information like main traffic network will be plotted on a map showing the identified cropland distribution with GIS technique. Such plotting is carried out also for the data obtained from WRUD which are responsible for pump irrigation, while ID is responsible for gravity irrigation. The priority areas will be selected based on those maps.

3.1.1 Preparatory Data Processing for Priority-Area Selection

The ESA (European Space Agency) global land cover map (2009) is used in this Survey to grasp the distribution of croplands (upland crop field) and irrigated croplands in Myanmar. The map (ESA GlobCover 2009 land cover map) is a land cover map which was created by ESA based on the data collected in 2009 with the MERIS (Medium Resolution Imaging Spectrometer) sensor mounted on the ENVISAT satellite.

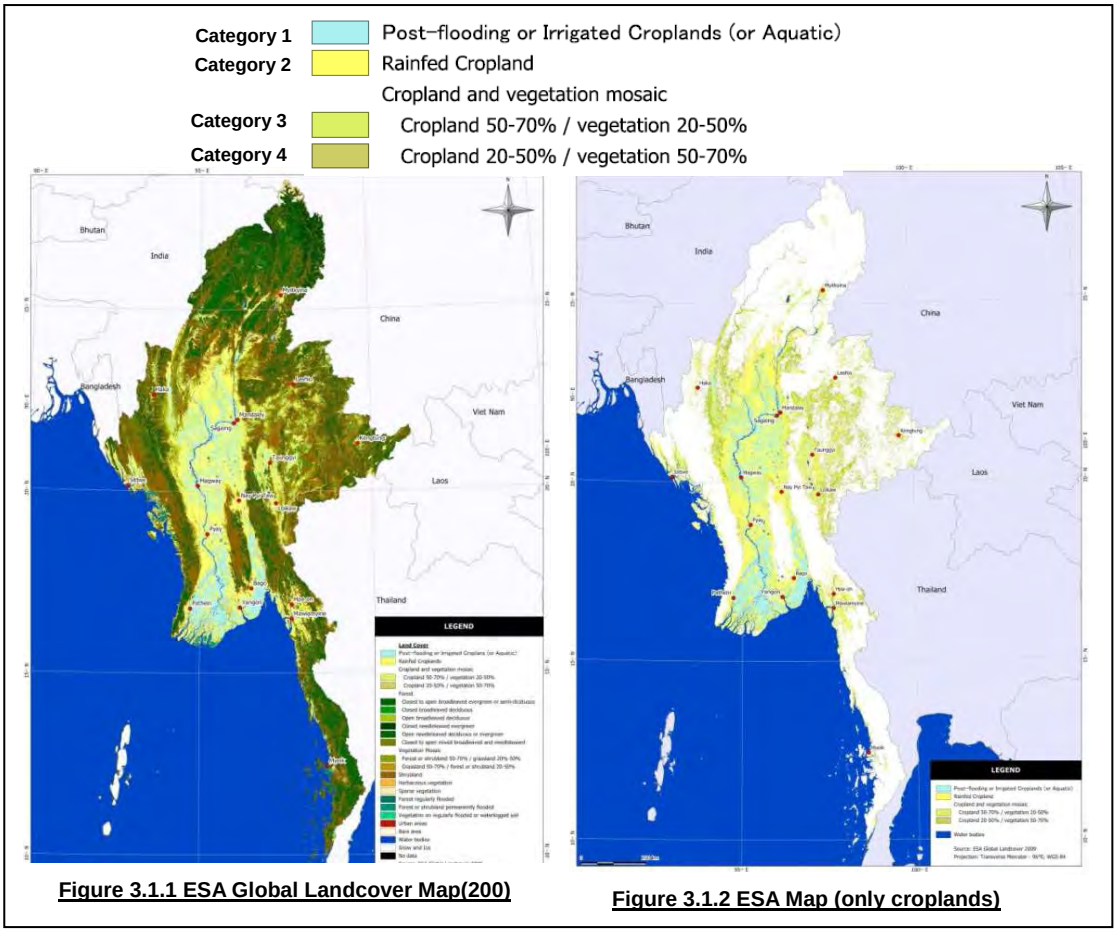


Figure 3.1.1 ESA Global Landcover Map(200)

Figure 3.1.2 ESA Map (only croplands)

Figure 3.1.1 shows the map for all land cover classifications and Figure 3.1.2 indicates that only for the croplands demarcated out of the Figure 3.1.1. Its spatial resolution is 300 m which is nearly equal to that of the World Atlas of Irrigated Agriculture for Sustainability Science (WAISS)[1]. The ESA global land cover map is provided as a raster data with processed land cover information. The croplands are classified into 4 categories as shown in the figure:

The ESA global land cover map (2009) is of a mosaic of data obtained in different times in 2009 and is completed without correction based on the verification which should be conducted at physical sites. According to the compatibility survey at selected points in the world, the fitting rate of land cover averages 67%. However, the rates of the category 1 and category 2 were judged better than the other ones, though they were sometimes found to be different.

Figure 3.1.3 Google Earth Natural Image

In Myanmar, considering the site condition in the area where we have worked so far and referring to the detailed satellite image of the Google Earth (see Figure 3.1.3), it is judged that the two categories most probably show the croplands and the category 1 (light blue color parts) mainly represents paddy fields. The category 2 (yellow color parts) originally shows the “rain-fed croplands”; however, it is possible to partly contain irrigated croplands.

The ESA color mosaic pattern of the land cover map is judged to well fit to those of the natural color image of the Google Earth shown in Figure 3.1.3, which must reflect the real land cover condition. Accordingly, it is considered that there could be no big technical error for the present preliminary purpose of the priority area selection as the cropland distribution on the land cover map is assumed to be the present cropland distribution in Myanmar.

3.1.2 Identification of Irrigation Schemes with Potential

Upon establishment of crop lands map based on ESA global land cover map, all the irrigation schemes developed by ID and WRUD have been plotted on the map. Note that data for ID constructed schemes are mostly available for those schemes constructed after 1988, before which dam reservoir type irrigation schemes had rarely been constructed by ID. As for the completed ID main source facilities (dam, weir, sluice gate), basic information and the exact geographical coordinates (318 points) have been obtained[2], and the locations were plotted.

In plotting the irrigation schemes developed by ID, two processing were undertaken; 1) circle with different color reflecting the size of irrigable area was plotted, and 2) circle with different color reflecting the ratio of reservoir capacity divided by irrigable area was plotted. An example is given in Figure 3.1.4 which shows the latter case for gravity irrigation developed by ID. The figure clearly shows there are number of irrigation reservoirs along both sides of the Ayeyarwady river and also

[1] WAIASS is a database which shows such information as water resources, irrigation scale/ dimension, agricultural production all related to irrigated lands. This WAIASS utilizes MODIS, Terra and Aqua satellite data, development by a team of Kobe University. Since this Survey needs to use raster data already processed into land utilization map, ESA global land cover map was employed instead of WAIASS database not covering Myanmar yet.

[2] In addition to the completed ones, 129 under-construction and planed facilities have also been collected for the names and approximate coordinates.

Sittaung river.

Since the color shown in Figure 3.1.4 indicates reservoir capacity against the present or planned irrigation area, the scheme with a warmer color near to orange (purple) possibly means that it has more excess water capacity in the reservoir as compared to its irrigable area. The irrigation scheme having such a source is marked as a preliminary priority area. These irrigation schemes are rather scattered over the country but somewhat concentrated in central part draining into Sittaung river.

Figure 3.1.5 shows the pump irrigation areas summarized by township. Note that the data for pump irrigation area is available only by the township level. The circle is plotted with different color, which means larger pump irrigable area in the township is given worm color (red or purple). With this figure, it is revealed that the areas of mid Ayeyarwady river between Mandalay and Nyaing-U and also downstream of Chindwin joining the main Ayeyarwady river have larger pump irrigation areas as compared to the other areas.

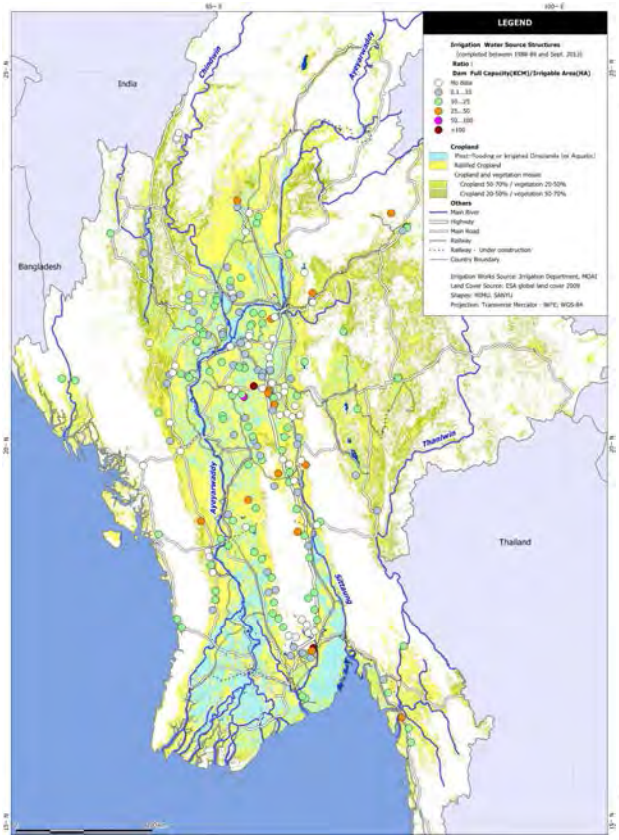


Figure 3.1.4 Location of Dam Irrigation Schemes and those Potential

Note: Data were collected from ID and plotted on the Map created based on ESA Global Landcover Map (2000)

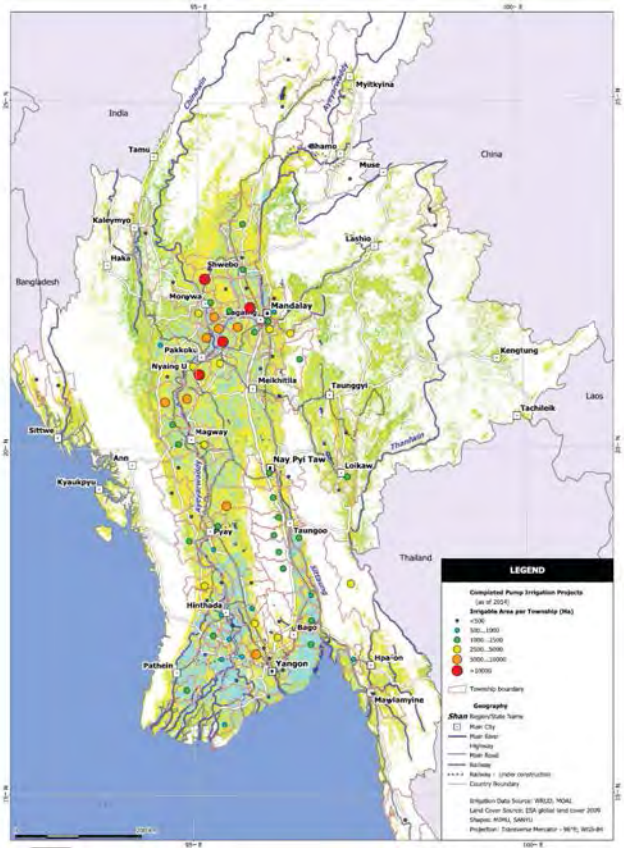


Figure 3.1.5 Location of Pump Irrigation Schemes and those Potential (by TS Llevel)

Note: Data were collected from WRUD and plotted on the Map created based on ESA Global Landcover Map (2000)

3.1.3 Identification of Potential Areas: 1st Screening

Following what has been discussed above, this Survey present total 9 priority areas as the first step. Figure 3.1.6 shows which areas should be selected as priority areas in order to promote intensive agriculture. As intensive agriculture needs established production infrastructure, e.g. irrigation and drainage facilities, as the base, following areas where clusters of irrigation schemes exit, are therefore recommended as 1st-screened priority areas; namely total 9.

Table 3.1.1 1st-Screened Priority Area (total 9 Areas)

No.	Area/ Location	Program Title
1	Shwebo	1-1 Intensive Irrigated Agriculture Promotion Sub-program in Shwebo Area
2	Mandalay	1-2 Intensive Agriculture Promotion Sub-program in Mandalay Area
3	Chindwin-Ayeyarwady	1-3 Intensive Irrigated Upland Field Crop Promotion Sub-program (Pump Irrigation)
4	Magway West	1-4 Intensive Irrigated Agriculture Promotion Sub-program in Magway West Area
5	Nay Pyi Taw	2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area
6	Shan South	3-1 High-value Agriculture Promotion Sub-program in Shan South Area
7	Bago South-East	4-1 Intensive Irrigated Agriculture Promotion Sub-program in Bago South-East Area
8	Bago South-West	4-2 Intensive Irrigated Agriculture Promotion Sub-program in Bago South-West Area
9	Ayeyarwady	5-1 Intensive Agriculture Promotion Sub-program in Ayeyarwady Delta Area

Note: No.5 '2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area' is corresponding to (Green Model City of ASEAN) concept presented by the Union Agriculture Minister.
Source: JICA Survey Team

Summery of the selected 9 areas is presented in Table 3.1.2. In fact, aside from the 9 priority areas identified above, there are such areas as western part of Meikhitila and the area around Pyay where a large number of irrigation schemes have been developed. However, the area near Meikhitila is now under study for ADB funding irrigation rehabilitation project. Likewise, the area near Pyay is to start rehabilitation of 4 irrigation schemes with a Yen Loan assistance. Therefore, these 2 areas, though there are clusters of irrigation facilities, were dropped from the 1st step priority area identification.

Of them, No.3 area '1-3 Intensive Irrigated Upland Field Crop Promotion Sub-program' is a cluster where there are number of pump irrigation schemes. The other areas are all gravity irrigation schemes. Shan South does not have reservoir in most cases and the schemes are merely river/ stream diversion with weirs. Ayeyarwady area does not reservoir either, and the first priority is to protect the production area from flood and inundation, followed by summer paddy production by gravity and pump irrigation.

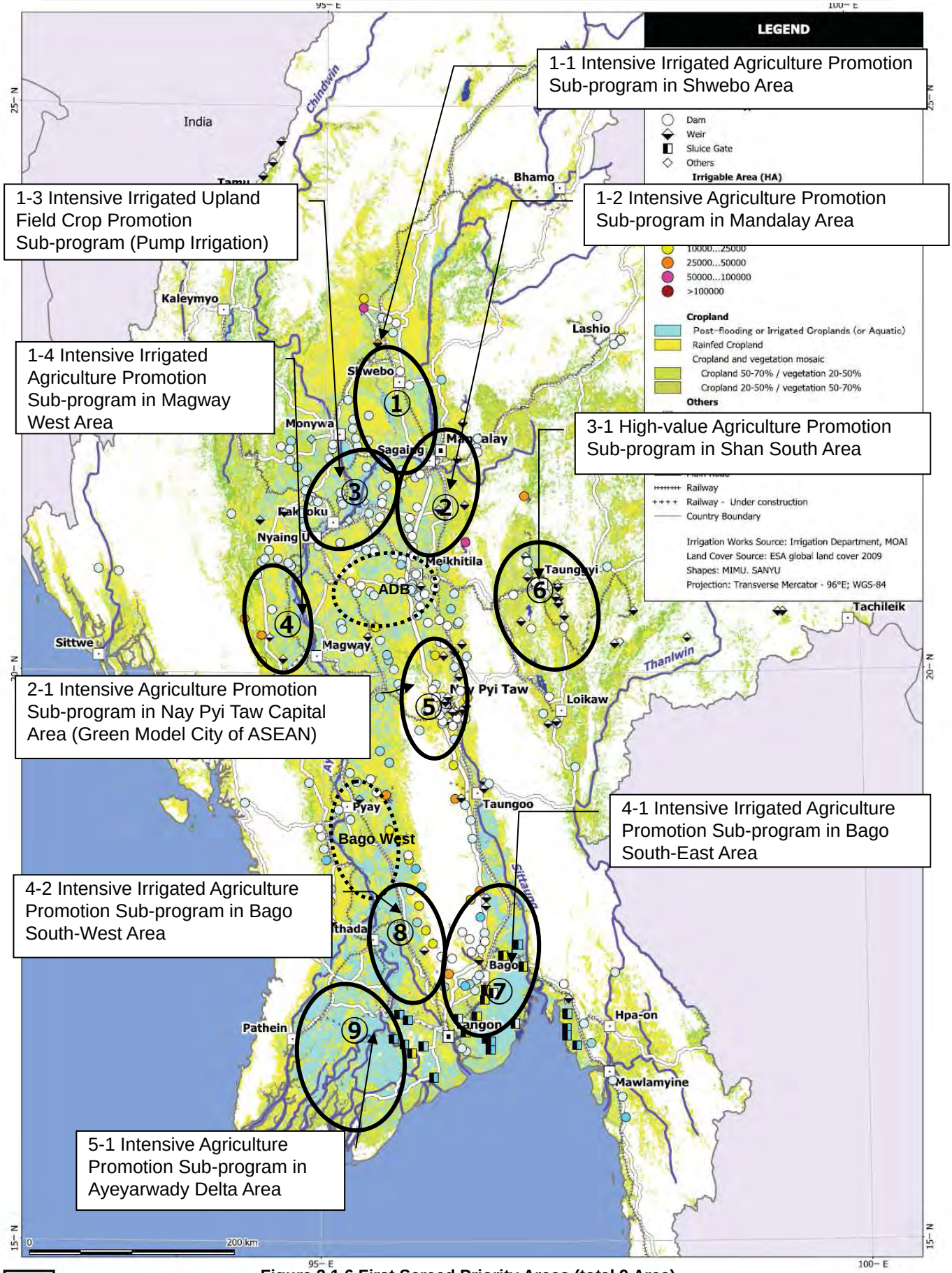


Figure 3.1.6 First Screed Priority Areas (total 9 Area)

Source: JICA Survey Team, based on ID and DOA Data

Table 3.1.2 Target Areas and the Proposed Priority Sub-programs by First Screening

Zone	Primary Topographic and Natural Condition	Challenges and Potential: Irrigation Facilities and Other Infrastructure	Challenges and Potential: Agricultural Production, Processing and Marketing	Priority Areas	Major Crops: Present	Major Crops: Potential	Serial No.	Proposed Sub-programs	Priority Components: Infra-structure	Production	Processing	Marketing
Central Dry Zone	・Annual rainfall: 700-1,000mm ・Relatively flat land ・Semi-dry or dry climate ・Irrigated paddy cultivation with some rain-fed paddy	・Rehabilitation/ upgrading of irrigation facilities and O&M improvement are required	・Sesame production pronouncedly fluctuates due to the weather change ・Mandalay holds a great potential for the large-scale market construction to be a market hub in the region	**1. Shwebo Old-Dynasty Irrigation Area**	Paddy, Beans	Vegetables (Onion)	(1)	**1-1 Intensive Irrigated Agriculture Promotion Sub-program in Shwebo Area**	●	◎	○	○
				2. Mandalay Area	Paddy, Mango, Watermelon.	Vegetables, Fruit processing, Export	(2)	**1-2 Intensive Agriculture Promotion Sub-program in Mandalay Area**	○	◎	●	●
				3. M/S Ayeyarwady and Chindwin Basin	Sesame, Pigeon Pea	Use of byproducts	(3)	**1-3 Intensive Irrigated Upland Field Crop Promotion Sub-program (Pump Irrigation)**	●	○	◎	○
				4. Magway West Area	Paddy, Beans	Vegetables (Onion)	(4)	**1-4 Intensive Irrigated Agriculture Promotion Sub-program in Magway West Area**	●	◎	○	○
Capital Area (CDZ)	・Stretching out in Sitttang valley area, and located in between Mandalay and Yangon	・Rehab/ upgrading of irrigation facilities and O&M improvement are required	・Adjacent to the major marketing route: north-south corridor ・Can be a good national demonstration site	**5. Sittaung River Basin**	Paddy, Beans, Vegetables	Vegetables, Primary processing, Export	(5)	**2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area (Green Model City of ASEAN)**	●	○	○	◎
Hilly and Mountainous Zone	・Annual rainfall: 1,000-2,000mm ・Highland vegetable production	・Large-scale irrigation difficult due to a lack of big water sources	・Preferable weather for highland high-value vegetables, fruits, flower ・Poor marketing channels	**6. Shan South Plateau**	Highland vegetables, Tree fruits, Flowers	Horticulture, High-end vegetables	(6)	**3-1 High-value Agriculture Promotion Sub-program in the Shan South Area**	◎	○	○	●
Central Dry Zone/ Delta Zone	・Annual rainfall: 1,500-2,500mm ・Leading to delta area	・Rehabilitation/ upgrading of irrigation facilities and O&M improvement are required	・Adjacent to Yangon, big marketing potential	**7. Bago South - East**	Paddy, Beans	Vegetables, Yield increment, and primary processing	(7)	**4-1 Intensive Irrigated Agriculture Promotion Sub-program in Bago South - East Area**	●	○	○	◎
				8. Bago South - West	Paddy, Beans	Vegetables	(8)	**4-2 Intensive Irrigated Agriculture Promotion Sub-program in Bago South – West Area**	●	○	○	◎
Delta and Coastal Zone	・Annual rainfall: 2,000-3,000mm ・Low-lying area with Ayeyarwady and Sittang deltas	・Irrigation and drainage facilities, and floodgates are degraded	・Navigable by the developed water transportation ・Delay in road and bridge construction, instead ・Poor drainage facilities	**9. Ayeyarwady Delta**	Paddy, Beans	Yield increment, and primary processing	(9)	**5-1 Intensive Agriculture Promotion Sub-program in Ayeyarwady Delta Area**	●	◎	○	○

This matrix is proposed by a first screening based on the secondary data available.

Note: Priority of the sub-programs/projects is shown by the symbols with the order: ● First Priority; ◎ Second Priority; and ○ Third Priority

3.1.4 Delineation of Irrigable Area by Priority Area

After the potential areas have been selected by the first screening, the river network, dam reservoirs and irrigable areas are delineated with Google Earth, ID prepared irrigation scheme maps, SRTM (Space Shuttle Radar Topography Mission) 90m DEM (Digital Elevation Model) and plotted on a cropland distribution map. This work is conducted for the 9 priority areas identified through the above first screening. The relationship among the river system, irrigation facility and irrigable area are shown clearly on the maps as in Figure 3.1.7 to Figure 3.1.14.

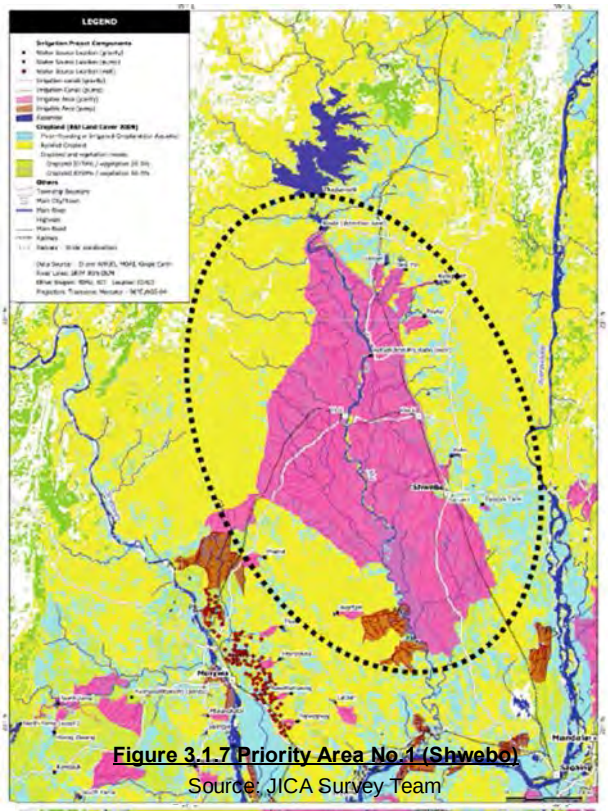


Figure 3.1.7 Priority Area No.1 (Shwebo)
Source: JICA Survey Team

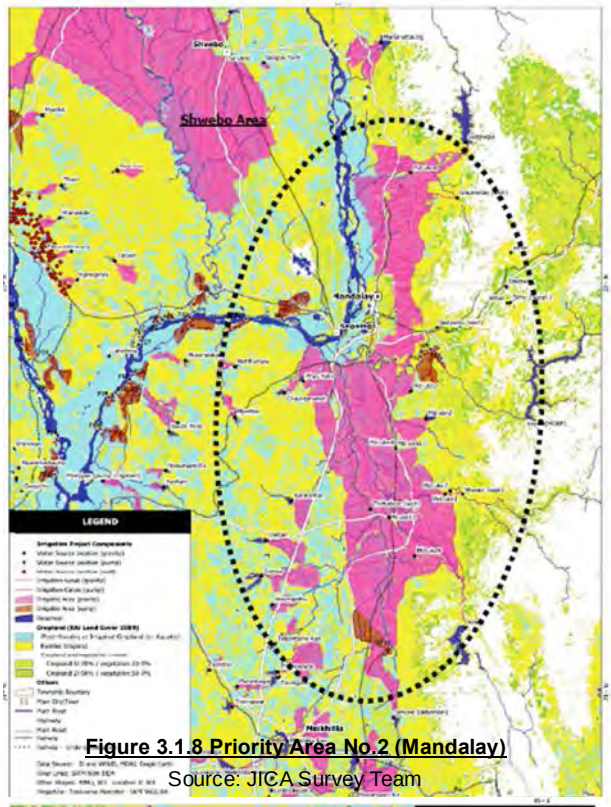


Figure 3.1.8 Priority Area No.2 (Mandalay)
Source: JICA Survey Team

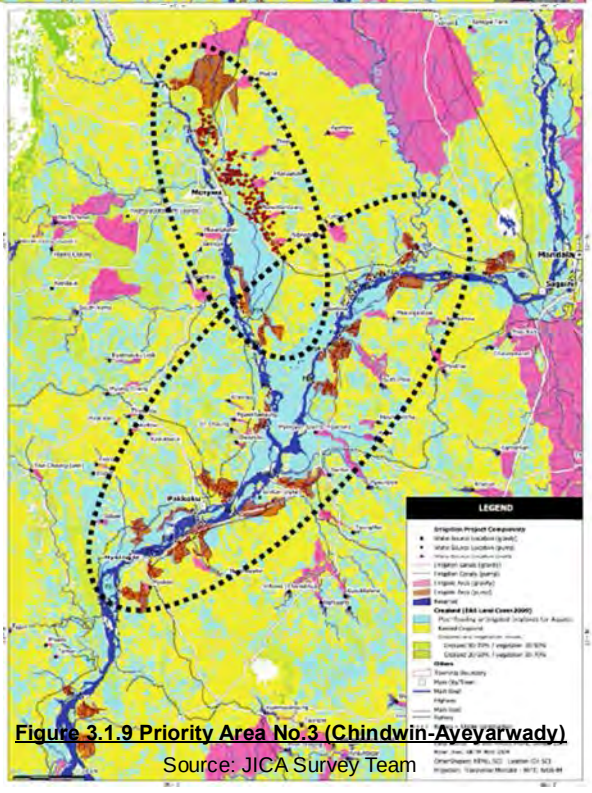


Figure 3.1.9 Priority Area No.3 (Chindwin-Ayeyarwady)
Source: JICA Survey Team

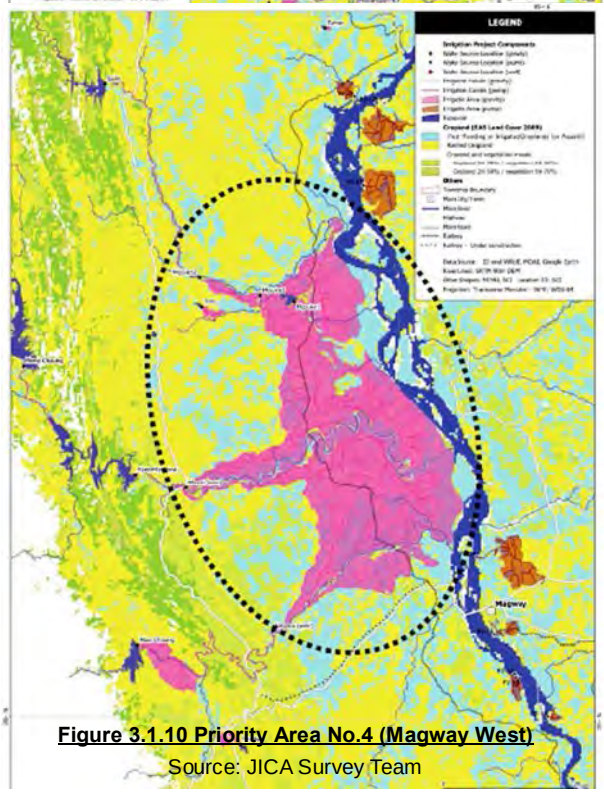


Figure 3.1.10 Priority Area No.4 (Magway West)
Source: JICA Survey Team

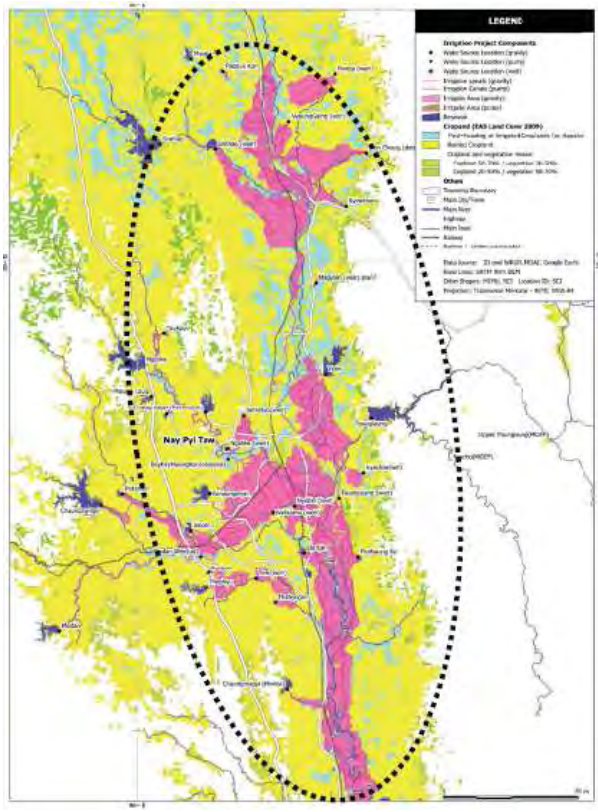


Figure 3.1.11 Priority Area No.5 (Nay Pyi Taw)

Source: JICA Survey Team

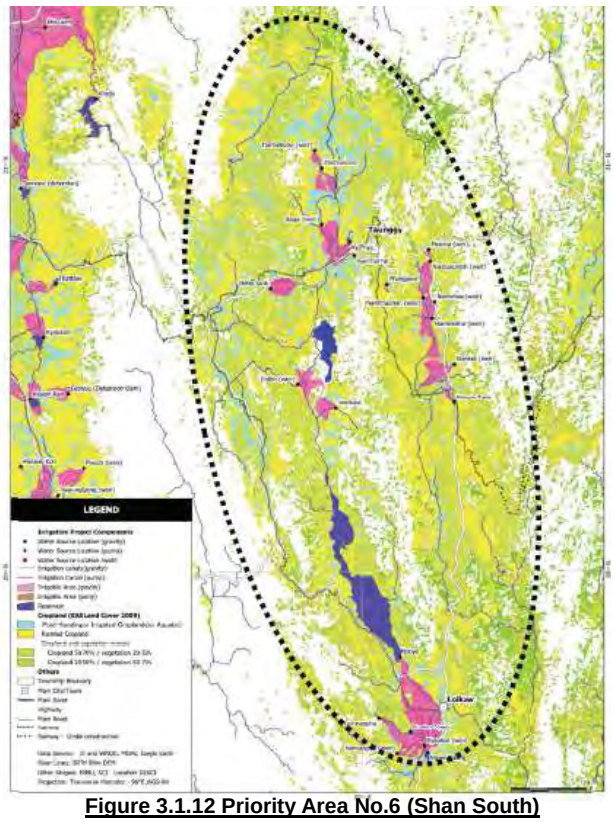


Figure 3.1.12 Priority Area No.6 (Shan South)

Source: JICA Survey Team

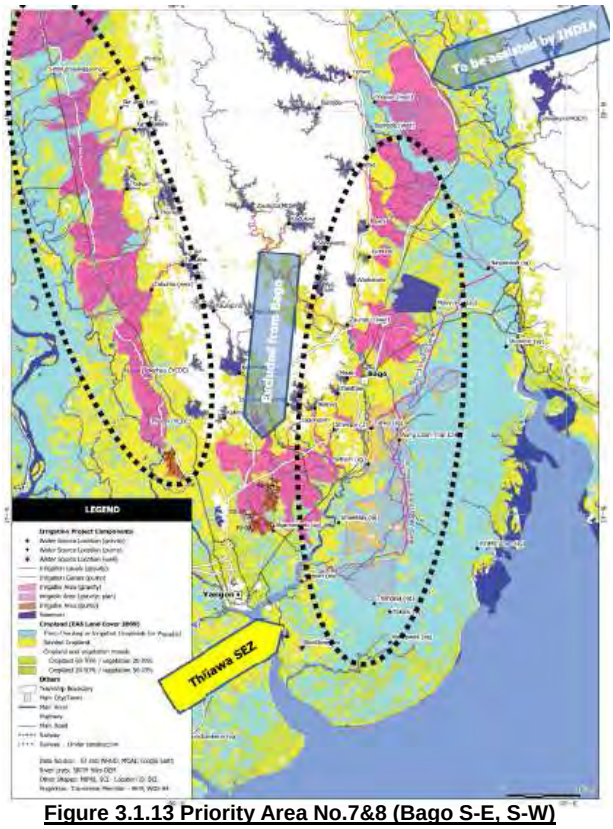


Figure 3.1.13 Priority Area No.7&8 (Bago S-E, S-W)

Source: JICA Survey Team

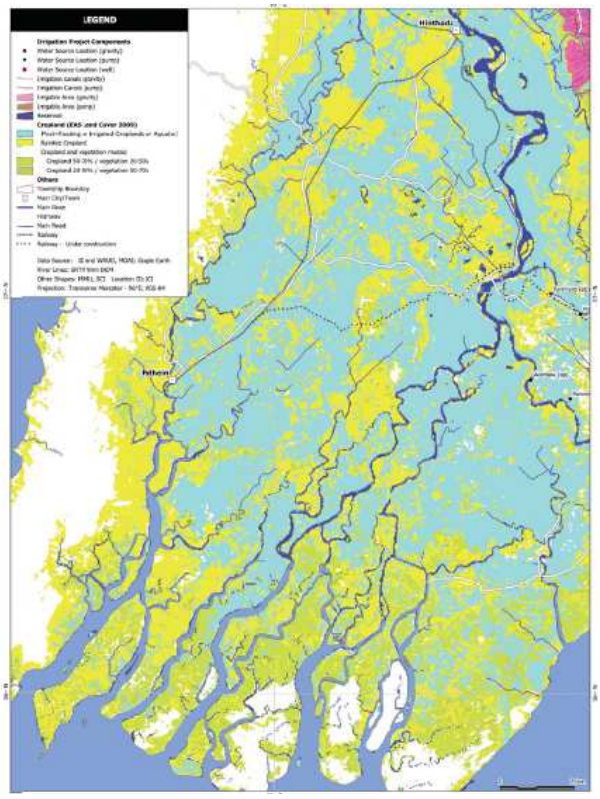


Figure 3.1.14 Priority Area No.9 (Ayeyarwady)

Source: JICA Survey Team

3.2 Agriculture in the Potential Areas

In the previous sub-chapter, a total of 9 areas have been identified as potential areas to promote intensive agriculture. All the 9 areas are equipped with irrigation facilities; whereby these areas have been developed as paddy production area since a long time ago. The major crops are monsoon paddy, which is supplementary irrigated, especially during ploughing and planting season as well as flowering period which need the bigger amount of water for paddy. Though this supplemental monsoon paddy irrigation had long been practiced, summer paddy irrigation was introduced in the mid-1990s to boost paddy production[1]. At present, the irrigation in Myanmar provides water mostly to monsoon and summer paddy only.

Aside from paddy irrigation in these forms, irrigation to other crops is quite limited at present. Though pulses have been cultivated during winter season right after monsoon paddy, they are in most cases grown with residual moisture, not requiring irrigation. In some cases, vegetables e.g. onion are cultivated with irrigation but not in a large scale, meaning they are not dependent on irrigation facilities constructed by the ID but on individual small scale irrigation.

However, in Magway, for example, sesame cultivation has started under irrigation instead of summer paddy. Though pulses are currently cultivated with residual moisture, if supplemental irrigation water is provided at least 1-2 time per cropping season, the yield will definitely increase. As people's lifestyle is improved, more vegetables are to be required. In future, therefore, there are opportunities that crops other than paddy are to be cultivated with a help of irrigation. With this in mind, following section discusses the characteristics of agriculture presently practiced in the selected 9 areas.

It is noted that since there is no data of crops production cultivated exclusively within the irrigation area, the following discussion refers to the crop data available at township level where selected irrigation schemes are located. Thus, crops that are not cultivated under irrigation, such as pulses, sesame, and vegetables, are also included in the data in addition to the monsoon paddy and summer paddy, which are grown with irrigation.

3.2.1 Shwebo Area

Shwebo irrigation scheme covers 7 townships: Shwebo, Khin-U, Wetlet, Kanbalu, Ye-U, Tabayin and Taze. Figure 3.2.1 and Figure 3.2.2 summarize sown area by crop in the 7 townships and the share of each crop, respectively. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area sharing as much as 39% of the total sown area, which is followed by groundnut (11%), sesame mostly cultivated during summer season (9%), pigeon pea cultivated only during monsoon season (8%), and green gram mostly cultivated during monsoon season (7%). As afore-mentioned, irrigation is provided only to the summer and monsoon paddy, while others are grown under rain-fed or with residual moisture.

The paddy varieties are Shwe Bo (55%) and Ayar Min (45%) for monsoon season and Shwe Sel Yin (50%) and the 747 variety (50%) for summer season. Shwe Bo is local and aromatic variety. The others are hybrid varieties. Shwe Bo needs longer growing period and has lower yield, but it can be sold at higher price because of its bland. The varieties for pulses are Yezin-3 for black gram, Yezin-14 for green gram, and Yezin-3, Yezin-6 and Yezin-8 for chick pea. These are provided by Yezin University.

Shwebo area is one of the best areas for cultivating paddy. Generally speaking, paddy plants make a larger number of tillers if the diurnal temperatures range is sufficiently big. In Shwebo area, during

[1] The first irrigation scheme which aimed at irrigating summer paddy is Tabhla irrigation scheme which was completed in 1995/06 with an irrigable area of 30,344 acre. This irrigation system is located within Bago region, about 60km north-west from Yangon city.

monsoon paddy tillering period (June to July), the highest temperature is almost 35 degrees C and the lowest temperature is almost 18 degrees C. It means that Shwebo area is suitable place for paddy cultivation in terms of tillering.

There are other crops such as chick pea, corn, cattle fodder, maize, sunflower, vegetables, sugarcane, and wheat. They are cultivated under rain-fed, in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. As compared to the other areas such as coastal and delta areas where there is much rainfall, there are much more varieties in the types of crops in this area. However, the share of these crops in the sown area is still limited; the total share of these minor crops is 21% only.

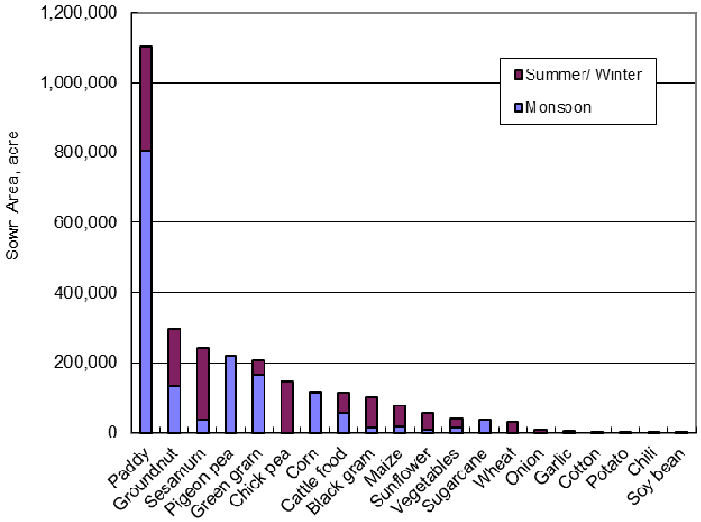


Figure 3.2.1 Sown Area in Shwebo by Crop (2013/14)

Source: SLRD, DOA

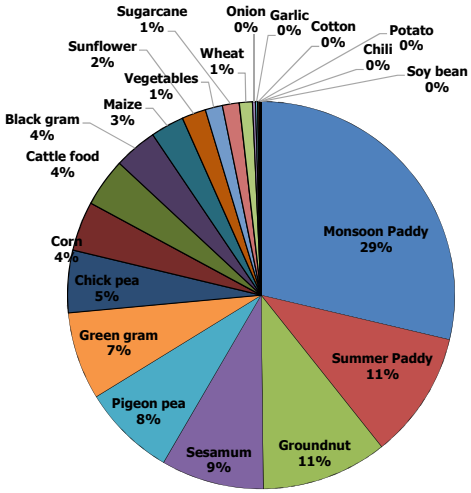


Figure 3.2.2 Share by Major Crop (2013/14)

Source: SLRD, DOA

Table 3.2.1 summarizes the yield and production of major crops: paddy, black gram, green gram, sesame and groundnut. As indicated, the yield of monsoon paddy is 85 basket/acre (4.39 ton/ha), while that of summer paddy reaches as much as 94 basket/acre (4.85 ton/ha); the latter is 11% higher. Black gram is mostly cultivated during winter season, and the average yield is 18 basket/acre (1.45 ton/ha). Green gram is mostly cultivated during monsoon season in upland fields, and the yield reaches 17 basket/acre (1.37 ton/ha).

Table 3.2.1 Yield and Production of Major Crops in Shwebo Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	85	67,913,946	94	28,319,798	88	96,233,744
	4.39	1,419,401	4.85	591,884	4.54	2,011,285
Black gram	17	250,800	19	1,617,004	18	1,867,804
	1.37	8,201	1.54	52,876	1.45	61,077
Green gram	16	2,697,369	18	775,615	17	3,472,984
	1.29	88,204	1.45	25,363	1.37	113,567
Sesame	12	441,133	17	3,070,269	16	3,511,402
	0.73	10,808	1.03	75,222	0.97	86,029
Groundnut	42	5,560,480	65	10,482,663	55	16,043,143
	1.18	63,389	1.83	119,502	1.55	182,892

Source: SLRD, DOA, Shwebo District

For oil crops, groundnut and sesame are the major ones cultivated in Shwebo area. Groundnut is cultivated during both of monsoon and summer seasons, providing bigger production in the summer. The yields are 42 basket/acre (1.18 ton/ha) in monsoon season and 65 basket/acre (1.83 ton/ha) in

summer season. Sesame is cultivated mostly during summer season, and the yield reaches 16 basket/acre (0.97 ton/ha). In recent years, sesame is considered as an alternative of summer paddy in this area.

Concerning the yield, both monsoon paddy, 85 basket/acre, and summer paddy, 94 basket/acre show medium level of the yield amongst the priority areas. Black gram shows a higher yield of 18 basket/acre and green gram, 17 basket/acre, shows an average level of the yield amongst the priority areas. Sesame's yield in this area is relatively higher as compared to those of other areas. The yield of monsoon groundnut is low; but that of winter season is high; after all, the yield of groundnut in this area, 65 basket/acre, is at medium level.

Rice is the most important agriculture commodity in Myanmar. Production of rice per population within the area is shown in Figure 3.2.3 based on such conditions: 1) post-harvest loss is counted at 20%, and 2) milling recovery is set at 55%. Overall rice production per population within the 7 townships of Shwebo area is calculated at 667 kg per person. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical yearbook (2006). With this figure, Shwebo area enjoys excess staple food within the area. Shwebo area has a potential of exporting rice to other regions e.g. Shan and Nay Pyi Taw.

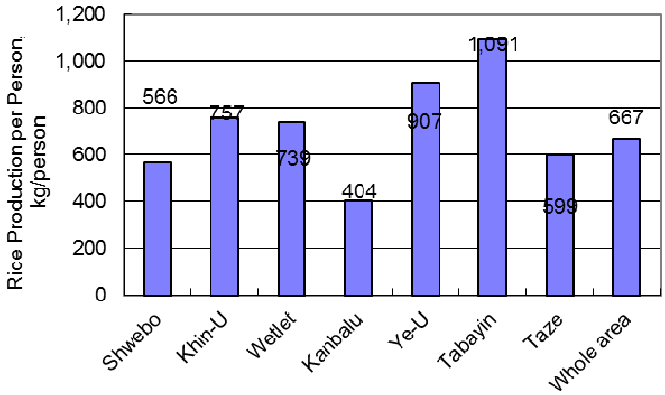


Figure 3.2.3 Rice Production per Person

Source; DOA (Shwebo), CSO Statistical Year Book (2006)

3.2.2 Mandalay Area

Mandalay irrigation scheme covers 5 townships: Patheingyi, Madaya, Kyaukse, Sintgaing, and Myittha. Figure 3.2.4 and Figure 3.2.5 summarize sown area by crop in the 5 townships and their share respectively. As illustrated well in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area sharing as high as 42 % of the total sown area, which is followed by sesame (16%), mostly cultivated during summer season, chick pea cultivated only during winter season (14%), and green gram cultivated during monsoon season (8%). Irrigation is provided only to the summer and monsoon paddy, while others are grown under rain-fed or otherwise with residual moisture.

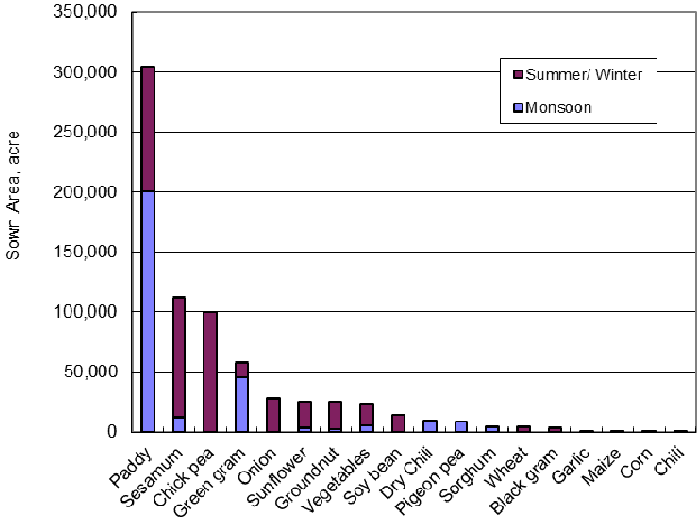


Figure 3.2.4 Sown Area in Mandalay by Crop (2013/14)

Source: SLRD, DOA

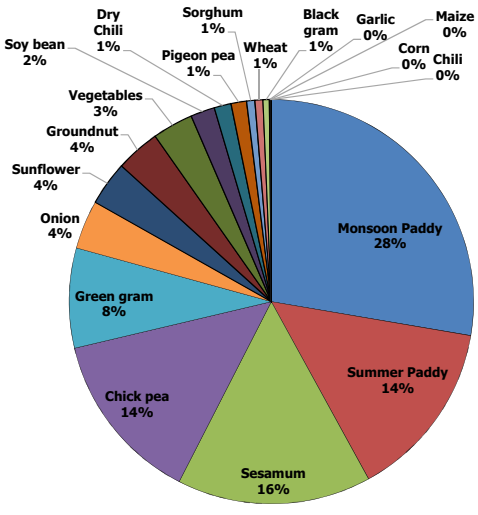


Figure 3.2.5 Share by Major Crop (2013/14)

Source: SLRD, DOA

The paddy varieties are Manaw Thu Kha (50%) and Ayar Min (50%) for monsoon season and Manaw Thu Kha (50%) and Shwe Thwe Yin (50%) for summer season. All of these are high yielding ones (HYV) developed by IRRI. The varieties for pulses are Yezin-2 for black gram, Yezin-11 (55%), and Yezin-14 (45%) for green gram, and V2 for chick pea. Yezin-2, Yezin-11 and Yezin-14 are developed by Yezin University.

There are other crops such as onion, sunflower, groundnut, vegetables, soybean, dry chili, pigeon pea, sorghum, and wheat, which are cultivated in addition to major crops mentioned above. They are cultivated under rain-fed in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. Though there are more varieties in the other crops as compared to such areas where there is much rainfall, e.g. coastal and delta area, the shares are small in the whole sown area, e.g. only 21 % even for the total of all these crops.

Table 3.2.2 summarizes yield and production only for the major crops: paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 93 basket/acre (4.80 ton/ha) while that of summer paddy reaches as high as 104 basket/acre (5.37 ton/ha); the latter is higher by 18%. Black gram is cultivated mostly during winter season, and the yield is 12 basket/acre (0.97 ton/ha). Green gram is cultivated mostly during monsoon season in upland fields, and the yield reaches 12 basket/acre (0.97 ton/ha).

For oil crops, as illustrated well in Figure 3.2.4 and Figure 3.2.5, sesame is the second major crop cultivated in Mandalay area. Sesame is cultivated mostly during summer season, which is partly supported by irrigation water. The yield of sesame reaches 11 basket/acre (0.67 ton/ha). The second major oil crop is sunflower, which is cultivated mostly during winter season and yield is 27 basket per acre (0.97 ton/ha). The third major oil crop is groundnut, which is cultivated mostly in winter season and yield reaches 57 basket per acre (1.61 ton/ha).

Table 3.2.2 Yield and Production of Major Crops in Mandalay Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	93	18,680,390	104	10,708,285	97	29,388,675
	4.80	390,420	5.37	223,803	5.01	614,223
Black gram	12	1,122	12	41,246	12	42,368
	0.97	37	0.97	1,349	0.97	1,385
Green gram	12	587,666	13	181,031	12	768,697
	0.97	19,217	1.05	5,920	0.97	25,136
Sesame	7	75,488	12	1,280,733	11	1,356,221
	0.42	1,849	0.73	31,378	0.67	33,227
Groundnut	41	111,273	61	1,480,806	57	1,592,079
	1.15	1,269	1.72	16,881	1.61	18,150

Source: SLRD, DOA, Mandalay Region

Concerning the yield, monsoon paddy, 93 basket/acre, and summer paddy, 104 basket/acre, show high level of yield in the priority areas. This is because farmers in Mandalay area cultivate high yield variety (HYV) recent years. Green gram's yield is only 12 basket/acre, but sown area is vanishingly small. Sesame's yields are relatively lower as compared to those of other areas in Central Dry Zone. The yield

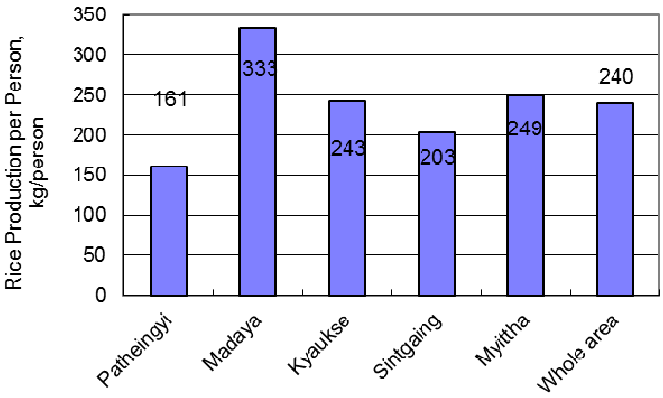


Figure 3.2.6 Rice Production per Person

Source; DOA (Mandalay), CSO Statistical Year Book (2006)

of groundnut in this area, 57 basket/acre, is middle level of the yield amongst the priority areas.

Production of rice per population within the area is estimated in Figure 3.2.6 based on such conditions that: 1) post-harvest loss is counted at 20%, and 2) milling recovery is set at 55%. Overall rice production per population within the 5 townships of Mandalay area is calculated at 240 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical yearbook (2006). With this figure, Mandalay area maintains enough staple food within the area.

3.2.3 Pump Irrigation Area

Pump irrigation scheme covers 3 townships: Sagaing, Wetlet and Budalin. Figure 3.2.7 and Figure 3.2.8 summarize sown area by crop in the 3 townships and the share respectively. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the bigger area, sharing as high as 18 % of the total sown area, which is followed by sesame (17%), sunflower (10%), chick pea cultivated during winter season only (9%), cattle food (9%), green gram cultivated mostly during monsoon season (7%) and pigeon pea cultivated only during winter season (7%). Pump irrigation provides water to the summer and monsoon crops; so in this area, not only paddy but also many kinds of crops can be cultivated as compared to other areas.

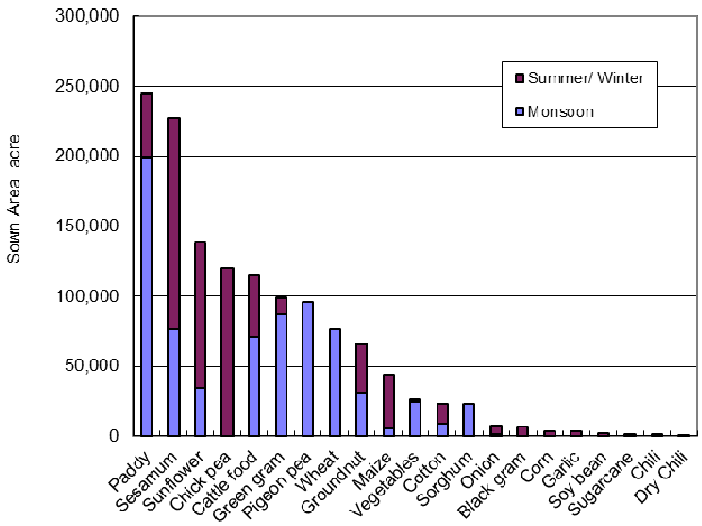


Figure 3.2.7 Sown Area in Pump Irrigation Area by Crop (2013/14)

Source: SLRD, DOA

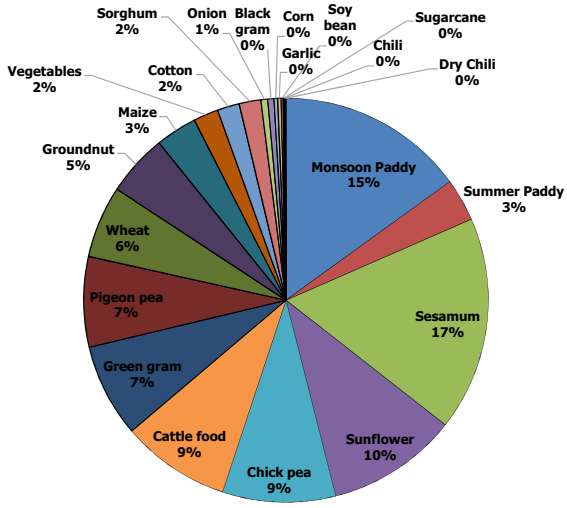


Figure 3.2.8 Share by Major Crop (2013/14)

Source: SLRD, DOA

The crop varieties are same as those of Shwebo area. The paddy varieties are Shwe Bo and Ayar Min for monsoon season and Shwe Sel Yin and 747 variety for summer season. Shwe Bo is local and aromatic variety. The others are hybrid varieties. Shwe Bo needs long growing period and has low yield, but it can sell at high price because of its bland. The varieties for pulses are Yezin-3 for black gram and Yezin-14 for green gram, Yezin-3, Yezin-6 and Yezin-8 for chick pea. Those are provided by Yezin University.

There are other crops such as wheat, groundnut, maize, vegetables, cotton, sorghum, onion, black gram, corn, garlic, which are cultivated in addition to the major crops mentioned above. They are cultivated using the water provided by pump irrigation. Pump irrigation makes it possible to cultivate many kinds of crops. There are much more varieties in the other crops as compared to such areas where there is much rainfall, e.g. coastal and delta area, and the share of all these crops is big in the whole sown area.

Table 3.2.3 summarizes yield and production only for major crops such as paddy, black gram, green

gram, sesame and groundnut. As indicated, monsoon paddy's yield is 83 baskets/acre (4.29 ton/ha) while that of summer paddy reaches as high as 90 basket/acre (4.65 ton/ha), the latter is higher by 11%. Black gram is cultivated during winter season only, and the yield is 16 basket/acre (1.29 ton/ha). Green gram is mostly cultivated during monsoon season in upland fields, and the yield reaches 16 basket/acre (1.29 ton/ha).

For oil crops, as shown in Figure 3.2.7 and Figure 3.2.8, sesame is the second major crop cultivated in Pump irrigation area. Sesame is cultivated mostly during summer season, which is supported by irrigation water. The yield of sesame reaches 12 basket/acre (0.73 ton/ha). The second major oil crop is sunflower, which is cultivated mostly during winter season and yield is 26 basket/acre (0.93 ton/ha). The third major oil crop is groundnut, which is cultivated mostly in winter season and yield reaches 57 basket/acre (1.61 ton/ha).

Table 3.2.3 Yield and Production of Major Crops in Pump Irrigation Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	83	16,955,468	90	4,254,390	84	21,209,858
	4.29	354,369	4.65	88,917	4.34	443,286
Black gram	0	0	16	99,201	16	99,201
	0	0	1.29	3,244	1.29	3,244
Green gram	16	1,423,753	16	202,327	16	1,626,080
	1.29	46,557	1.29	6,616	1.29	53,173
Sesame	8	578,324	15	2,174,058	12	2,752,382
	0.48	14,169	0.91	53,264	0.73	67,433
Groundnut	45	1,449,628	65	2,231,614	57	3,681,242
	1.27	16,526	1.83	25,440	1.61	41,966

Source: SLRD, DOA, Sagaing Region

Concerning the yield, both monsoon paddy, 83 basket/acre, and summer paddy, 90 basket/acre, of this area show medium level amongst the priority areas. Green gram's yield is 16 basket/acre, which indicates a standard level in the priority areas. Sesame's yields in this area are relatively higher than those of other areas especially during summer season, 15 basket/acre. The yield of groundnut, 57 basket/acre, shows middle level in the priority areas.

Production of rice per population within the area is estimated in Figure 3.2.9 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 3 townships of Pump Irrigation area is calculated 311 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical yearbook (2006). With this figure, pump irrigation area maintains enough staple food within the area.

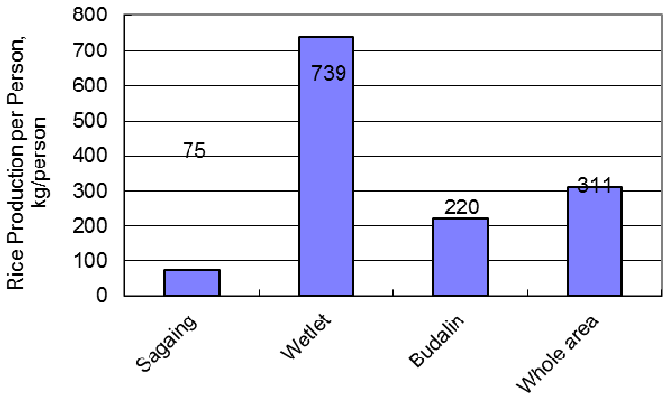


Figure 3.2.9 Rice Production per Person

Source; DOA (Sagaing), CSO Statistical Year Book (2006)

3.2.4 Magway West Area

Magway West irrigation scheme covers 3 townships: Minbu, Pwintbyu and Salin. Figure 3.2.10 and Figure 3.2.11 summarize sown area by crop in the 3 townships and the share respectively. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area, sharing

as high as 32 % of the total sown area, which is followed by sesame (17%), cultivated mostly during monsoon season, sunflower cultivated mostly during winter season (15%), green gram cultivated mostly only during monsoon season (12%) and chick pea cultivated only during winter season (10%). Irrigation is provided to the summer and monsoon paddy only as afore-mentioned while others are grown under rain-fed or otherwise with residual moisture.

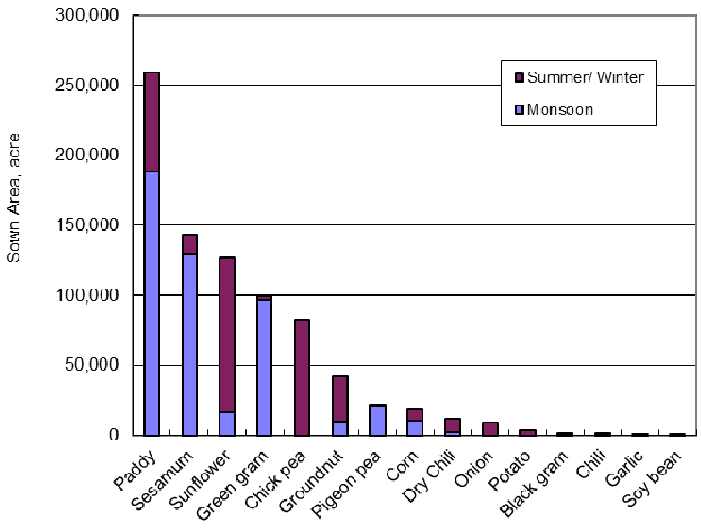


Figure 3.2.10 Sown Area in Magway West by Crop (2013/14)

Source: SLRD, DOA

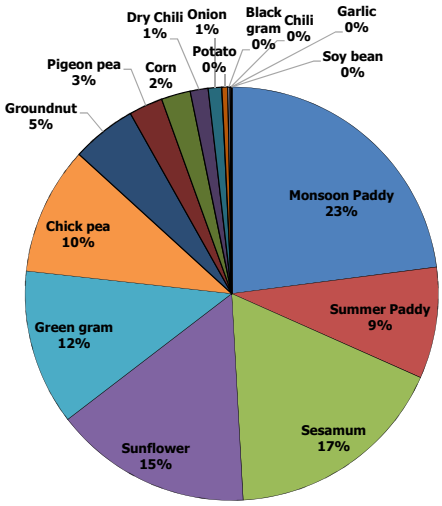


Figure 3.2.11 Share by Major Crop (2013/14)

Source: SLRD, DOA

The paddy varieties are Ayar Paday Thar (55%) and Manaw Thu Kha (45%) for monsoon season and Manaw Thu Kha for summer season. Manaw Thu Kha is the most popular in upper Myanmar and all of these are high yielding ones (HYV) originally developed by IRRI. The varieties for pulses are Min Hla Tun for black gram, Yezin-4, Yezin-5 for green gram and ICCV8820 for chick pea. Yezin-4, Yezin-5 and ICCV8820 are developed by Yezin University.

There are other crops such as groundnut, pigeon pea, corn, dry chili, onion, potato, black gram, chili, garlic, and soybean, cultivated in addition to major crops listed above. They are cultivated under rain-fed in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. Though there are much more varieties in the other crops as compared to such areas where there is much rainfall, e.g. coastal and delta area, the share of these crops is small in the whole sown area, e.g. only 13 % even with the total of all these crops.

Table 3.2.4 summarizes the yield and production only for the major crops: paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 96 basket/acre (4.96 ton/ha) while that of summer paddy reaches as high as 101 basket/acre (5.22 ton/ha), the latter is higher by 5%. Black gram is cultivated during winter season only, and the yield is recorded at 18 basket/acre (1.45 ton/ha). Green gram is cultivated mostly during monsoon season in upland fields, and the yield reaches 16 basket/acre (1.29 ton/ha).

For oil crops, as shown in Figure 3.2.10 and Figure 3.2.11, sesame is the second major crop cultivated in Magway West area. Sesame is cultivated mostly during monsoon season, which is grown under rain-fed water. The yields are 11 and 14 basket/acre (0.67 ton/ha and 0.85 ton/ha) respectively. The second major oil crop is sunflower, which is cultivated mostly during winter season and yield is 30 basket/acre (1.07 ton/ha). The third major oil crop is groundnut, which is cultivated mostly in winter season and yield reaches 67 basket/acre (1.89 ton/ha).

Table 3.2.4 Yield and Production of Major Crops in Magway West Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	96	17,933,426	101	7,190,747	97	25,124,173
	4.96	374,809	5.22	150,287	5.01	525,095
Black gram	0	0	18	26,931	18	26,931
	0	0	1.45	881	1.45	881
Green gram	16	1,579,308	19	52,806	16	1,632,114
	1.29	51,643	1.54	1,727	1.29	53,370
Sesame	11	1,396,279	14	183,172	13	1,579,451
	0.67	34,209	0.85	4,488	0.79	38,697
Groundnut	56	522,189	70	2,243,821	67	2,766,010
	1.58	5,953	1.97	25,580	1.89	31,533

Source: SLRD, DOA, Magway Region

Concerning the yield, monsoon paddy, 96 basket/acre, and summer paddy, 101 basket/acre, show high level of the yield amongst the priority areas. Black gram's yield in this area, 18 basket/acre, is relatively high as compared to the other priority areas. Green gram's yield, 16 basket/acre, show medium level of the yield amongst the priority areas. The yield of sesame, 13 basket/acre, is relatively higher as compared to those of the other areas. The yield of groundnut, 67 basket/acre shows the highest yield amongst the priority areas.

Production of rice per population within the area is shown in Figure 3.2.12 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 3 townships of Magway West area is calculated as 393 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical yearbook (2006). With this figure, Magway West area maintains enough staple food within the area.

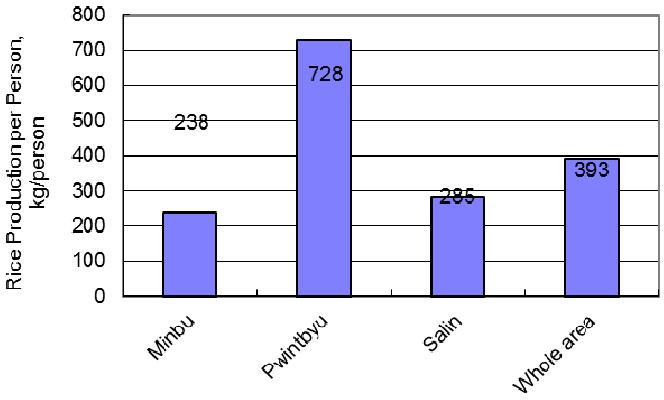


Figure 3.2.12 Rice Production per Person

Source; DOA (Magway), CSO Statistical Year Book (2006)

3.2.5 Nay Pyi Taw Area

Nay Pyi Taw irrigation scheme covers 7 townships: Tatkone, Zeyathiri, Ottarathiri, Pobbathiri, Pyinmana, Lewe and Zabuthiri. Figure 3.2.13 shows sown area by crop in the 8 townships of Nay Pyi Taw area and Figure 3.2.14 depicts the share of each crop. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area sharing as high as 34 % of the total sown area, which is followed by green gram (14%), cultivated mostly during monsoon season, sesame (13%), black gram cultivated only during winter season (13%) and groundnut (9%). Irrigation is provided to the summer and monsoon paddy only as afore-mentioned, while others are grown under rain-fed or otherwise with residual moisture.

The paddy varieties are Manaw Thu Kha for monsoon season and Shwe Thwe Yin for summer season, both of which are the most popular in upper Myanmar. Both varieties are high yielding ones (HYV) originally developed in IRRI. The varieties for pulses are LBG-17 for black gram, Yezin-9 for green gram and Yezin-4 for chick pea. LGB-17 is very popular variety in Myanmar. Yezin-9 and Yezin-4 is

provided by Yezin University.

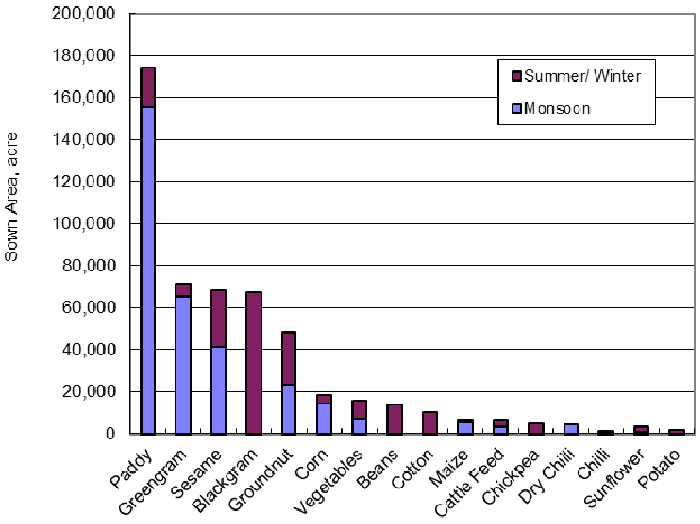


Figure 3.2.13 Sown Area in Nay Pyi Taw by Crop (2013/14)

Source: SLRD, DOA

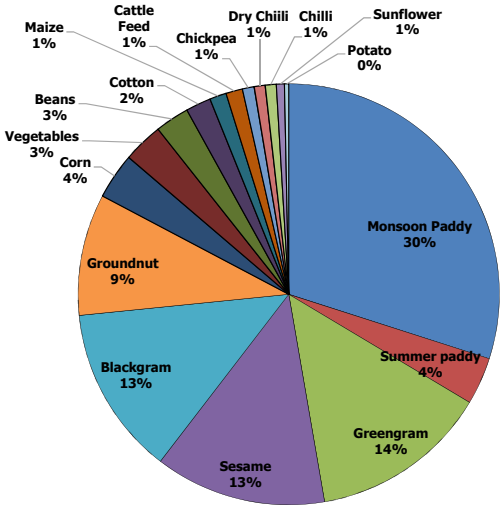


Figure 3.2.14 Share by Major Crop (2013/14)

Source: SLRD, DOA

There are other crops such as corns, vegetable, beans, cotton, maize, cattle feed, chick pea, dry chill, sunflower, and potato, which are cultivated in addition to above major crops. They are cultivated under rain-fed in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. Though there are much more varieties in the other crops as compared to such areas where there is much rainfall, e.g. coastal and delta area, the share of these crops is small in the whole sown area, e.g. only 17 % even for the total of all these crops.

Table 3.2.5 summarizes yield and production only for major crops such as paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 86 basket/acre (4.44 ton/ha) while that of summer paddy reaches as high as 101 basket/acre (5.22 ton/ha), the latter is 17% higher. Black gram is cultivated during winter season only, and the yield is recorded as 19 basket/acre (1.54 ton/ha). Green gram is mostly cultivated during monsoon season in upland fields, and the yield reaches 17 basket/acre (1.37 ton/ha).

Table 3.2.5 Yield and Production of Major Crops in Nay Pyi Taw Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	86	13,328,196	101	1,887,113	88	15,215,309
	4.44	278,559	5.22	39,441	4.54	318,000
Black gram	0	0	19	1,306,904	19	1,306,904
	0	0	1.54	42,736	1.54	42,736
Green gram	17	1,103,370	13	76,599	17	1,179,969
	1.37	36,080	1.05	2,505	1.37	38,585
Sesame	7	300,489	10	272,773	8	573,262
	0.42	7,362	0.61	6,683	0.48	14,045
Groundnut	49	1,133,191	53	1,349,634	51	2,482,825
	1.38	12,918	1.49	15,386	1.44	28,304

Source: SLRD, DOA, Nay Pyi Taw Region

For oil crops, sesame and groundnut are the major ones cultivated in Nay Pyi Taw area. Sesame is cultivated during both monsoon and summer season almost equally in terms of production, the latter of which is partly supported by irrigation water. The yields are 7 and 10 basket/acre (0.42 ton/ha and 0.61 ton/ha) respectively. Groundnut is also cultivated during both monsoon and summer season, providing a little bigger production in the summer. The yields are 49 basket/acre (1.38 ton/ha) and 53 basket/acre

(1.49 ton/ha) respectively by season.

Concerning the yield, monsoon paddy, 86 basket/acre, shows the medium level of the yield amongst the priority areas while that of summer paddy does higher range of the yield with its 101 basket/acre. Green gram's yield is only 13 basket/acre, which has some potential to increase with better farm management. Sesame's yields are relatively lower as compared to those of other areas despite the fact that this area is partly located in the Central Dry Zone. The yield of groundnut shows the same tendency with that of sesame. Especially, summer season's yield, 53 basket/acre, is not comparable to those of other areas located in the Central Dry Zone.

Rice is the most important agriculture commodity in Myanmar. Production of rice per population within the area is estimated in Figure 3.2.15 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 7 townships of Nay Pyi Taw area is calculated as 126 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical yearbook (2006). With this figure, it is revealed that Nay Pyi Taw area has staple food shortage within the area. Import of rice from other regions e.g. Sagaing and Bago can be an option to cope with the deficit aside from enhancing the paddy production by rehabilitating the irrigation schemes.

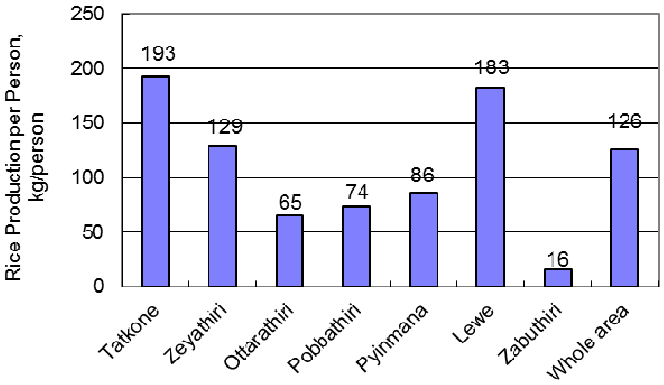


Figure 3.2.15 Rice Production per Person

Source; DOA (NPT), CSO Statistical Year Book (2006)

3.2.6 South Shan Area

South Shan irrigation scheme covers such 5 townships as Taunggyi, Hopong, Hsihseng, Kalaw and Lawksawk. Figure 3.2.16 and Figure 3.2.17 summarize sown area by crop in the 5 townships and the share respectively. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area sharing as high as 41 % of the total sown area, which is followed by corn (31%), cultivated mostly during monsoon season, pigeon pea cultivated during monsoon season only (10%). This area is characterized by a big share of corn compared to other priority areas.

The paddy variety found in this area is Shwe Yin Aye for both monsoon and summer season. It is high yielding one (HYV) originally developed by IRRI. The varieties for pulses are Yezin for black gram and Yezin-6 for green gram. They are developed by Yezin University. In terms of climate, South Shan is one of the best areas for cultivating crops. However, this area has too many hills as to cultivate paddy and pulses. So, people in this area choose to grow upland vegetables like cabbage, lettuce, and cauliflower.

There are other crops such as groundnut, potato, sunflower, garlic, chili, onion, sesame, chick pea, green gram, dry chili, and many kinds of vegetables cultivated in addition to the major crops. They are cultivated under rain-fed in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. Though there are much more varieties in the other crops as compared to such areas where there is much rainfall, e.g. coastal and delta area, the share of these crops is small in the whole sown area, e.g. only 18 % even for the total of all these crops.

Table 3.2.6 summarizes yield and production only for the major crops such as paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 71 basket/acre (3.67

ton/ha) while that of summer paddy reaches as high as 92 basket/acre (4.75 ton/ha), the latter is higher by 30%. Green gram is cultivated mostly during winter season in upland fields, and the yield reaches 13 basket/acre (1.05 ton/ha).

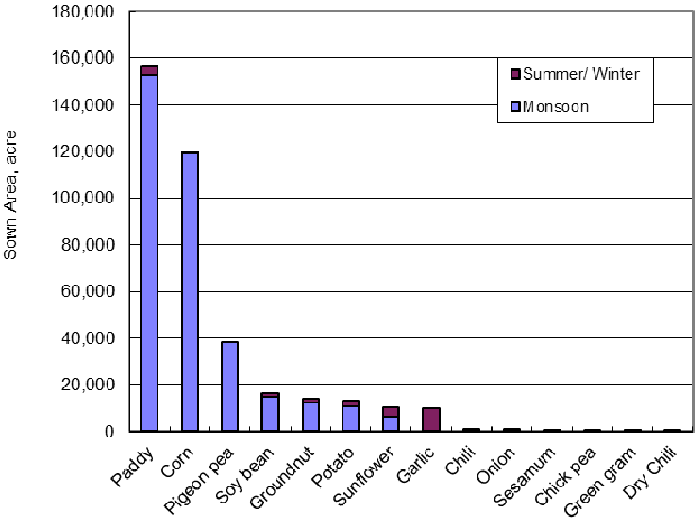


Figure 3.2.16 Sown Area in South Shan by Crop (2013/14)

Source: SLRD, DOA

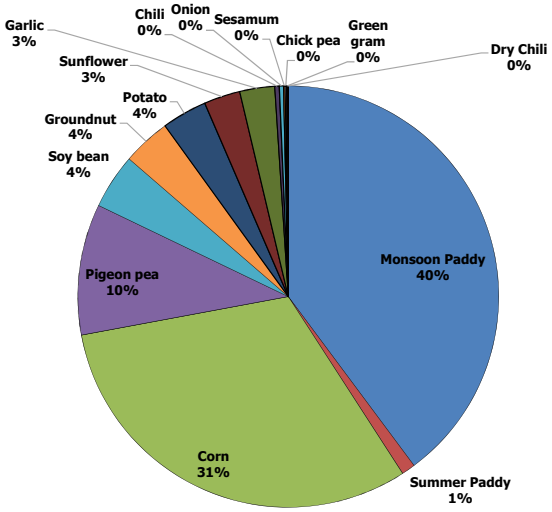


Figure 3.2.17 Share by Major Crop (2013/14)

Source: SLRD, DOA

* The data period of pulses and oil crops is 2012-2013

For oil crops, groundnut and sunflower are the major ones cultivated in South Shan area. Groundnut is cultivated mostly during monsoon season. The yield is 47 basket/acre (1.32 ton/ha). Sunflower is cultivated during both monsoon and summer season, providing a little bigger production in the monsoon. The yields are 30 and 33 basket/acre (1.07 ton/ha and 1.18 ton/ha) respectively. Sesame is cultivated only during monsoon season. The yields are 7 basket/acre (0.42 ton/ha).

Table 3.2.6 Yield and Production of Major Crops in South Shan Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	71	10,663,647	92	318,218	71	10,981,865
	3.67	222,870	4.75	6,651	3.67	229,521
Black gram	0	0	0	0	0	0
	0	0	0	0	0	0
Green gram	12	800	14	2,868	13	3,668
	0.97	26	1.13	94	1.05	120
Sesame	7	2,101	0	0	7	2,101
	0.42	51	0.00	0	0.42	51
Groundnut	47	575,770	49	91,999	47	667,769
	1.32	6,564	1.38	1,049	1.32	7,613

Source: SLRD, DOA, Shan State * As no data was available for the yield and production of sesame in Kalaw TS, the sesame's yield of South Shan area was calculated based only on the data from three other townships.

Concerning the yield, both monsoon paddy, 71 basket/acre, and summer paddy, 92 basket/acre, show low level of the yield as compared to the yields of these types of paddies in other priority areas. Green gram's yield is only 13 basket/acre, which may have some potential to increase with better farm management. Sesame's yields in this area are relatively lower as compared to those of other areas, which may have some potential to increase with better farm management. The yield of groundnut, only 47 basket/acre, shows low level of the yield as compared to the other areas.

Production of rice per population within the area is estimated in Figure 3.2.18 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 5 townships of South Shan area is calculated as 92 kg per

population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical yearbook (2006). With this figure, South Shan area is revealed that there is a staple food shortage within the area, especially Thaunggyi. Thaunggyi is the third biggest city of Myanmar and has a large population. As the demand of food is pronouncedly large, the importation of rice from other regions, e.g. Sagaing and Bago, is important for this area, in addition to the rehabilitation of irrigation system to secure more food within the area.

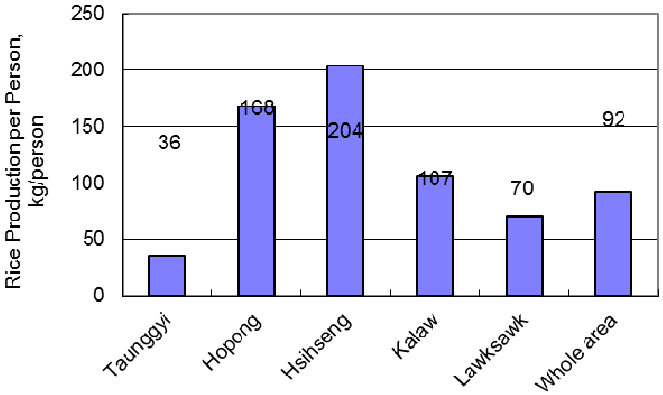


Figure 3.2.18 Rice Production per Person
Source; DOA (Shan), CSO Statistical Year Book (2006)

3.2.7 Bago South-East Area

Bago South-East irrigation scheme covers such 6 townships as Bago, Thanatpin, Kawa, Waw, Daik-U and [2]Kayan. Figure 3.2.19 and Figure 3.2.20 summarize sown area by crop in the 6 townships and the share respectively. As illustrated well in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area sharing as high as 61 % of the total sown area, which is followed by green gram (30%), cultivated during winter season only, black gram also cultivated only during winter season (7%). These 3 crops cover almost 98% of the total sown area.

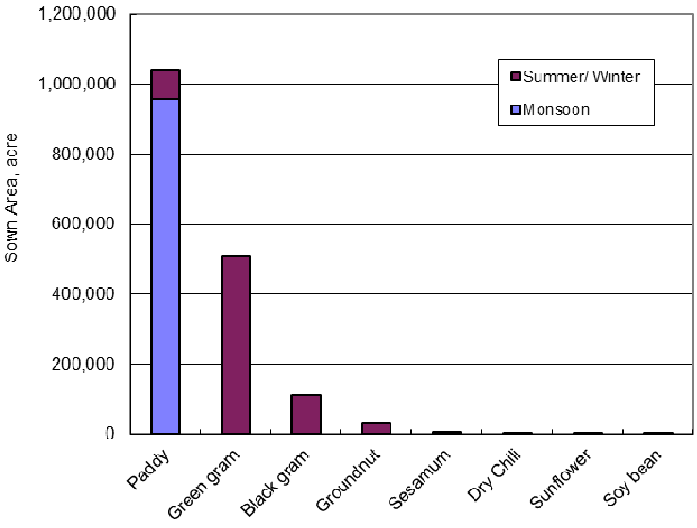


Figure 3.2.19 Sown Area in Bago South-East by Crop (2013/14)
Source: SLRD, DOA

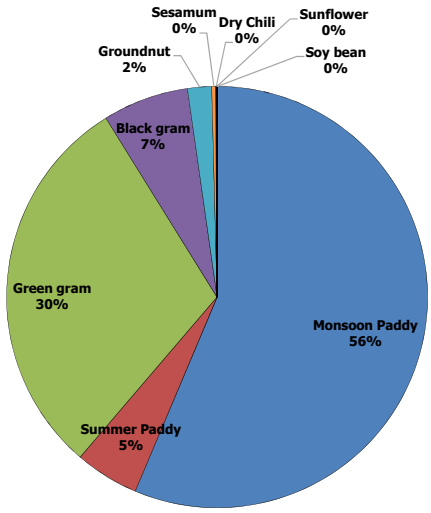


Figure 3.2.20 Share by Major Crop (2013/14)
Source: SLRD, DOA

The paddy varieties are Yadanar Toe (50%) and Sin Thu Kha (50%) for monsoon season and Yadanar Toe (60%) and Thai 90 days (40%) for summer season. All varieties are high yielding ones (HYV) originally developed in IRRI. Both Yadanar Toe and Shin Thu Kha are recommended by the Myanmar Farmers Association (MFA). The varieties for pulses are Yezin2, Yezin3 for black gram and Yezin11, and Yezin14 for green gram. All varieties of pulses are developed in Yezin University.

There are other crops such as groundnut, sesame, dry chili, sunflower, and soybean, cultivated in addition to the major crops mentioned above. They are cultivated under rain-fed in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. As there are a little varieties in the other crops as compared to such areas like Shwebo or Mandalay,

[2] Kayan TS is located in Yangon Region.

the shares are small in the whole sown area, e.g. only 9 % even for the total of all these crops.

Table 3.2.7 summarizes yield and production only for the major crops: paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 74 basket/acre (3.82 ton/ha) while that of summer paddy reaches as high as 81 basket/acre (4.18 ton/ha), the latter is higher by 9%. Black gram is cultivated during winter season only, and the yield is recorded as 17 basket/acre (1.37 ton/ha). Green gram is cultivated only during winter season in upland fields, and the yield reaches 20 basket/acre (1.62 ton/ha).

Table 3.2.7 Yield and Production of Major Crops in Bago South-East Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	74	70,844,113	81	6,909,656	74	77,753,769
	3.82	1,480,642	4.18	144,412	3.82	1,625,054
Black gram	0	0	17	2,060,053	17	2,060,053
	0	0	1.37	67,364	1.37	67,364
Green gram	0	0	20	10,067,703	20	10,067,703
	0	0	1.62	329,214	1.62	329,214
Sesame	0	0	9	52,027	9	52,027
	0	0	0.54	1,275	0.54	1,275
Groundnut	0	0	62	1,901,776	62	1,901,776
	0	0	1.75	21,680	1.75	21,680

Source: SLRD, DOA, Bago Region

Concerning the yield, both monsoon paddy, 74 basket/acre, and summer paddy, 81 basket/acre show low level of the yield as compared to the same ones in the other priority areas. Black gram's yield, 17 basket/acre, shows medium level of the yield amongst the priority areas. Green gram's yield, 13 basket/acre, is at the highest level of the yield amongst the priority areas. Sesame's yield, 9 basket/acre is at the lowest level of the yield amongst the priority areas. The yield of groundnut shows middle level of the yield amongst the other areas, 62 basket/acre.

Production of rice per population within the area is estimated in Figure 3.2.21 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 6 townships of Bago South-East area is calculated as 523 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical Yearbook (2006). With this figure, Bago South-East area is revealed that there is a large amount of staple food in the area. Bago South-East area has a potential of exporting rice to other regions e.g. Shan and Nay Pyi Taw.

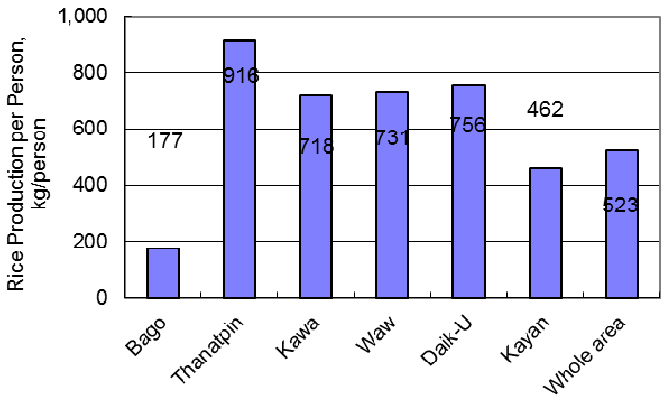


Figure 3.2.21 Rice Production per Person

Source; DOA (Bago), CSO Statistical Year Book (2006)

3.2.8 Bago South-Wes Area

Bago South-West irrigation scheme covers 7 townships: Thayarwady, Letpadan, Minhla, Okpho, Zigon, Monyo and Gyobingauk. Figures 3.2.22 and 3.2.23 summarize sown area by crop in the 7 townships and the share respectively. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area sharing as high as 54 % of the total sown area, followed by black gram

(39%) cultivated only during winter season. These 2 crops almost cover 93% of total sown area.

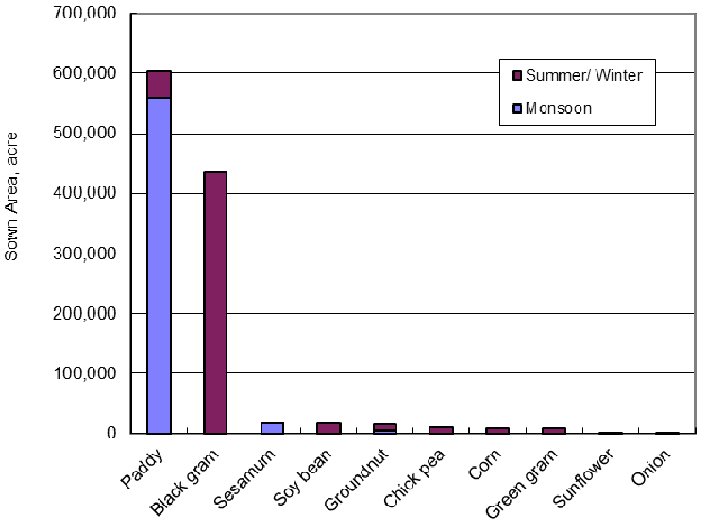


Figure 3.2.22 Sown Area in Bago South-West by Crop (2013/14)

Source: SLRD, DOA

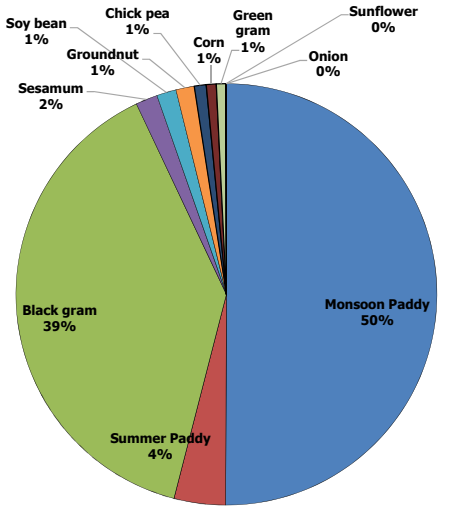


Figure 3.2.23 Share by Major Crop (2013/14)

Source: SLRD, DOA

The paddy varieties are Sin Thwe Latt (50%) and Ye Baw (50%) for monsoon season, and Sin Thwe Latt and Sin Thu Kha for summer season. Sin Thwe Latt and Sin Thu Kha varieties are high yielding ones (HYV) originally developed in IRRI, improved by Yezin University. Ye Baw is one of the varieties cultivated in Ye. The varieties for pulses are Yezin-2 for black gram and Yezin-14 for green gram. Both of varieties are developed in Yezin University.

There are other crops such as sesame, soybean, groundnut, chick pea, corn, green gram, sunflower, and onion, but they are limited. They are cultivated under rain-fed in case they are planted during rainy season or otherwise with residual moisture if they are grown during winter season. As there are a little varieties in the other crops as compared to such areas like Shwebo or Mandalay, the share of these crops is small in the whole sown area, e.g. only 7 % even for the total of all these crops.

Table 3.2.8 Yield and Production of Major Crops in Bago South-West Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	75	41,856,902	80	3,618,017	75	45,474,919
	3.87	874,809	4.13	75,617	3.87	950,426
Black gram	0	0	17	7,538,316	17	7,538,316
	0	0	1.37	246,503	1.37	246,503
Green gram	0	0	17	130,910	17	130,910
	0	0	1.37	4,281	1.37	4,281
Sesame	9	166,740	8	17,874	9	184,614
	0.54	4,085	0.48	438	0.54	4,523
Groundnut	50	211,611	53	657,384	62	868,995
	1.41	2,412	1.49	7,494	1.75	9,907

Source: SLRD, DOA, Bago Region

Table 3.2.8 summarizes the yield and production of major crops such as paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 75 basket/acre (3.87 ton/ha) while that of summer paddy reaches as high as 80 basket/acre (4.13 ton/ha), the latter is higher by 7%. Black gram is cultivated during winter season only, and the yield is recorded as 17 basket/acre (1.37 ton/ha). Green gram is also cultivated winter season only in upland fields, and the yield reaches 17 basket/acre (1.37 ton/ha).

Concerning the yield, both monsoon paddy, 75 basket/acre, and summer paddy, 80 basket/acre, of the

area show low level of the yield amongst the priority areas. Black gram's yield, 17 basket/acre, and green gram's yield, 17 basket/acre show medium level of the yield amongst the priority areas. Sesame's yield, 9 basket/acre is at the average level of the yield amongst the priority areas. The yield of groundnut shows relatively higher level of the yield amongst the priority areas, 62 basket/acre.

Production of rice per population within the area is estimated in Figure 3.2.24 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 7 townships of Bago South-West area is calculated as 470 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical Yearbook (2006). With this figure, Bago South-West area is revealed to have surplus staple food within the area. Bago South-West area has a potential of export rice to other regions e.g. Shan and Nay Pyi Taw.

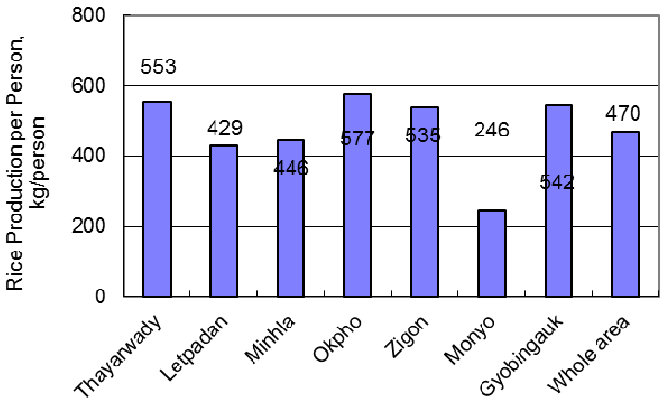


Figure 3.2.24 Rice Production per Person

Source; DAO (Bago), CSO Statistical Year Book (2006)

3.2.9 Ayeyarwady Area

Ayeyarwady area covers 3 townships: Wakema, Maubin and Kyaiklat. Figure 3.2.25 and Figure 3.2.26 summarize sown area by crop in the 3 townships and the share respectively. As illustrated in both figures, paddy, especially monsoon paddy, is cultivated in the biggest area, sharing as high as 75 % of the total sown area, which is followed by black gram (14%), cultivated only during monsoon season. These 2 crops almost cover 90% of total sown area.

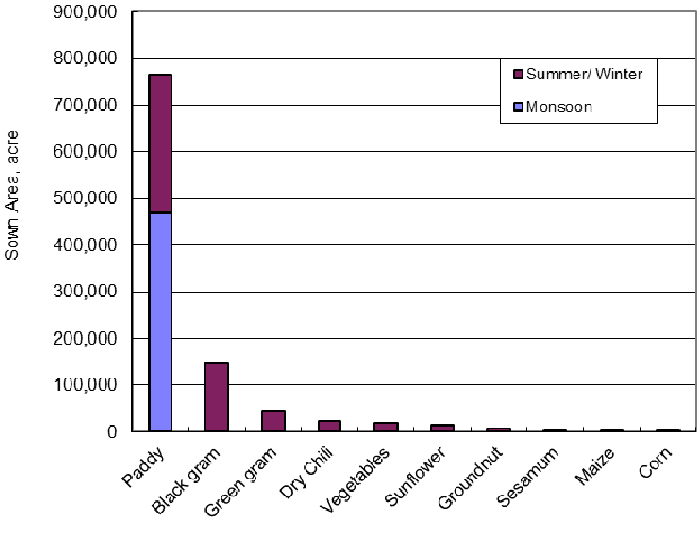


Figure 3.2.25 Sown Area in Ayeyarwady by Crop (2013/14)

Source: SLRD, DOA

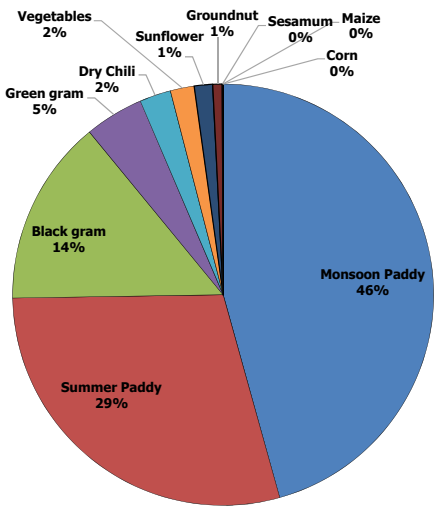


Figure 3.2.26 Share by Major Crop (2013/14)

Source: SLRD, DOA

The paddy varieties are Sin Thu Kha for monsoon season and Thi Htat Yin for summer season. Both varieties are high yielding ones (HYV) originally developed in IRRI. Some farmers in this area cultivate local variety like a kind of pawson in monsoon season. The varieties for pulses are Yezin-3 for black gram and Wakema Sein and Yezin-11 for green gram. Yezin-3 and Yezin-11 are developed in Yezin University.

Even though there are other crops such as green gram, dry chili, vegetables, sunflower, groundnut, sesame, and maize cultivated in addition to above major crops, they are significantly limited. They are cultivated with residual moisture during winter season. As there are a little varieties in the other crops as compared to such areas like Shwebo or Mandalay, the shares are small in the whole sown area, e.g. only 11 % even for the total of all these crops.

Table 3.2.9 Yield and Production of Major Crops in Ayeyarwady Area

Crop Name	Monsoon		Summer/Winter		Total	
	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (basket) (ton)	Yield (Basket/acre) (ton/ha)	Production (Basket) (ton)
Paddy	66	31,453,712	95	28,686,515	78	60,140,227
	3.41	657,383	4.91	599,548	4.03	1,256,931
Black gram	0	0	17	2,494,297	17	2,494,297
	0	0	1.37	81,564	1.37	81,564
Green gram	0	0	16	846,025	16	846,025
	0	0	1.29	27,665	1.29	27,665
Sesame	0	0	17	8,196	17	8,196
	0	0	1.03	201	1.03	201
Groundnut	44	261	52	417,006	52	417,267
	1.24	3	1.46	4,754	1.46	4,757

Source: SLRD, DOA, Ayeyarwady Region

Table 3.2.9 summarizes yield and production of major crops such as paddy, black gram, green gram, sesame and groundnut. As indicated, monsoon paddy's yield is 66 basket/acre (3.41 ton/ha) while that of summer paddy reaches as high as 95 basket/acre (4.91 ton/ha), the latter is higher by 44%. Black gram is cultivated during winter season only, and the yield is recorded as 17 basket/acre (1.37 ton/ha). Green gram is also cultivated during winter season only in upland fields, and the yield reaches 16 basket/acre (1.29 ton/ha).

Concerning the yield, monsoon paddy's yield, 66 basket/acre, shows the lowest level of the yield amongst the priority areas while summer paddy's yield, 95 basket/acre is at a high level amongst the priority areas. Black gram's yield, 17 basket/acre, and green gram's yield, 16 basket/acre show medium level of the yield amongst the priority areas. Sesame's yield, 17 basket/acre is at the highest level of the yield amongst the priority areas. But sesame's sown area is quite small; it should be treated as just as a reference. Groundnut shows a low level of the yield amongst the priority areas, 52 basket/acre.

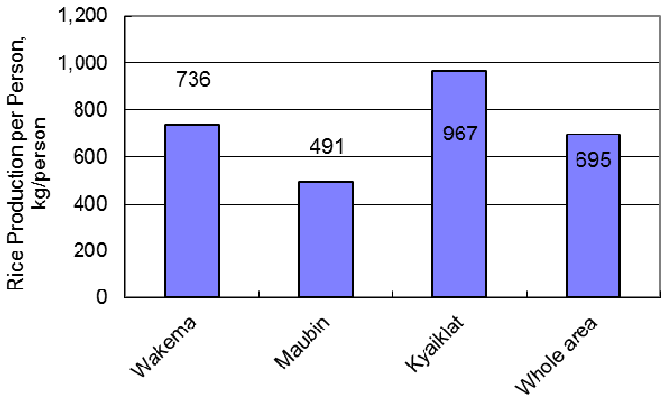


Figure 3.2.27 Rice Production per Person

Source; DOA (Ayeyarwady), CSO Statistical Year Book (2006)

Production of rice per population within the area is estimated in Figure 3.2.27 based on such conditions that: 1) post-harvest loss is counted as 20%, and 2) milling recovery is set as 55%. Overall rice production per population within the 3 townships of Ayeyarwady area is calculated as 695 kg per population. In Myanmar, a typical person is assumed to consume about 160 kg of milled rice per annum according to the CSO Statistical Yearbook (2006). This figure reveals that there are surplus of staple food in Ayeyarwady area. It means that Ayeyarwady area has a potential of exporting rice to other regions e.g. Shan, Nay Pyi Taw, and also foreign countries.

3.3 Irrigation Schemes for the Potential Areas

In the previous sub-chapter, total 9 areas identified as potential ones to promote intensive agriculture were discussed. All the 9 areas are equipped with irrigation schemes, whereby historically those areas have been developed as paddy production area.

3.3.1 Shwebo (Sagaing) Area

1) Kabo (of Thapanzeik Dam) Irrigation System

Kabo Weir construction across Mu River near Kabo Village was started in 1901, and completed in 1905. Thapanzeik Dam was built on Mu River located in Kyunhla Township, Sagaing Region. Thapanzeik dam was constructed in 1996-1997, and completed in 2001-2002. Another purpose of construction Thapanzeik dam is to generate 117.2 megawatt hydropower per year. Dead storage capacity is 95,800 ac-ft and effective storage can be used for irrigation is 2,784,200 ac-ft (3,433,753,860 m^3). The planned irrigable area of Thapanzeik Dam is about 566,270 acre and scrutinized area is 491,687 acre.

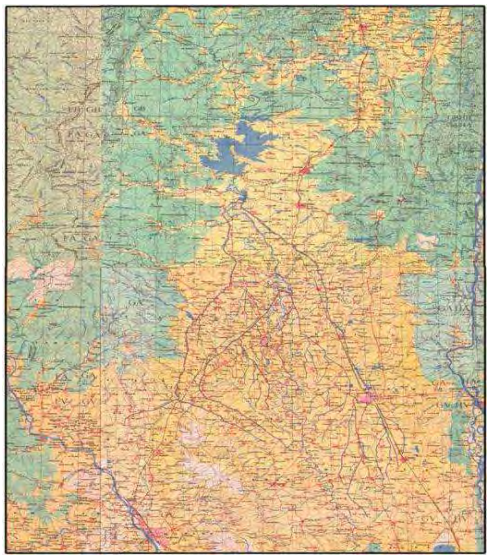


Figure 3.3.1 Kabo Weir Irrigation System
Source: Irrigation Department

Effective Storage Capacity	2,784,200 ac-ft
Length of Main Canal	172 Miles (275.2 Km)
Irrigable Area (Planned)	566,270 acres
Irrigable Area (Scrutinized)	491,687 acres
Construction Started	1996-1997
Construction Completed	2001-2002

3.3.2 Mandalay Area

1) Sedawgyi Weir (of Sedawgyi Dam) Irrigation System

Sedawgyi weir constructed on Chaungmagyi River and its canal system has been established since the Bagan-dynasty in 11th century. Sedawgyi Dam is located on the Chaungmagyi River about 2 miles away in the upstream part of Sedaw Weir in Madaya Township, Mandalay Region to get sufficient water for two times cultivation per annum. For this purpose, a storage dam comprising 4,120 ft length and 133 ft height composite dam across Chaungmagyi River just 2 miles upstream of the existing Sedaw Weir and related irrigation facilities, was constructed in 1976-1977.

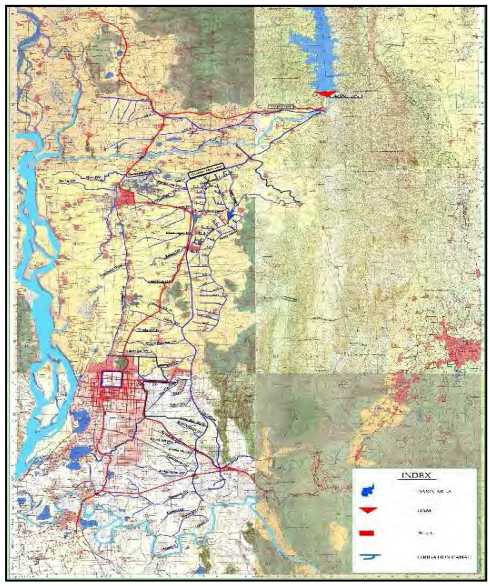


Figure 3.3.2 Sedawgyi Weir Irrigation System
Source: Irrigation Department

Secondary benefits has been derived from the generation of hydropower at the dam site 118.4 Gwh per annum, also it contributes to the increase in water supply to Mandalay City at the rate of 120 cusecs. The storage capacity of Sedawgyi Dam is 363,000 ac-ft with dead storage capacity is 84,000 ac-ft and effective capacity is 279,000 ac-ft/ 344,090,700 cubic meters. The dam can regulate the runoff of Chaungmagyi River as required, resulting in an increased acreage of about 32,000 acres from the existing acreage of 95,000 acres.

Location	Madaya Township, Mandalay Region
Effective Storage Capacity	279,000 ac-ft
Length of Main Canal	42 Miles (67.2 Km)
Length of Distributaries	102 Miles (163.2Km)
Irrigable Area (Planned)	127,000 acres (51,308 Ha)
Irrigable Area (Scrutinized)	96,097 acres (38,823 Ha)
Construction Started	1976-1977
Construction Completed	1986-1987

2) Zawgyi Dam Irrigation System

Zawgyi Irrigation System is located in Kyaukse, Singaing Township, Mandalay Region. Since the ancient Kingdom era, irrigated weirs such as Nga Pyaung, Thin Dwe, Minye and Zeedaw were established with many branch canals on the left and right embankment of Zawgyi River. For the long period of constructed irrigation facilities in Zawgyi irrigation system, the irrigable area decreased due to deterioration of structures, sedimentation in canal, and uncontrolled of natural water flow in Zawgyi River. Therefore, the need of storage dam in upstream part of Ngapyaung Weir becomes high for Irrigation Department.

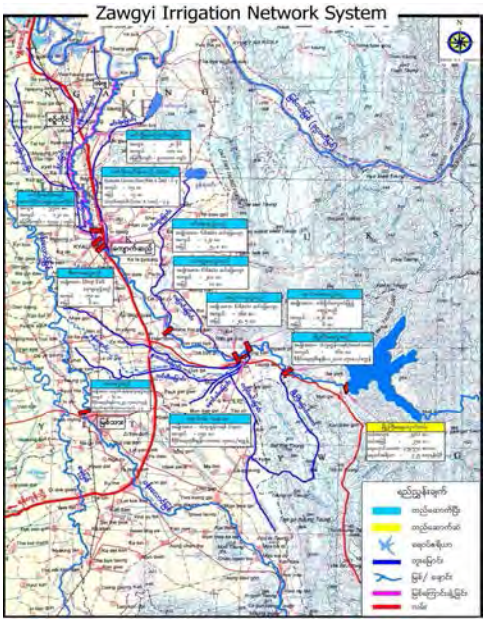


Figure 3.3.3 Zawgyi Dam Irrigation System
Source: Irrigation Department

Zawgyi Dam which is located in Yatsauk Township, Shan State was constructed in 1996, and completed in 1997. The storage capacity of Full Tank Level is 517,863 ac-ft, dead storage capacity of 33,616 ac-ft, and the effective storage capacity is 484,247 ac-ft (597,270,250 m^3). The planned irrigable area is 100,000 ac, and scrutinized area is 81,921 ac. Actual irrigable area is 78,800 acres in rainy season, and 30,000 acres for summer season.

Location	Kyaukse Township, Mandalay Region
Effective Storage Capacity	484,247 ac-ft (597,270,250 CUM)
Irrigable Area (Planned)	100,000 acres (40,400 Ha)
Irrigable Area (Scrutinized)	82,333 acres
Construction Started	1994-1995
Construction Completed	1997-1998

3) Kinda Dam Irrigation System

Kinda Irrigation System was implemented during ancient Myanmar King Era with a series of overflow typed weirs along Panlaung River such as Kinda, Nathlwe, Kyeeme and Htongyi. In dry season, irrigation water supply is not enough and in some years in rainy season, inundation problem occurs in low laying areas. In this instance, a storage dam for controlling the river flow needs to implement on the Panlaung River.

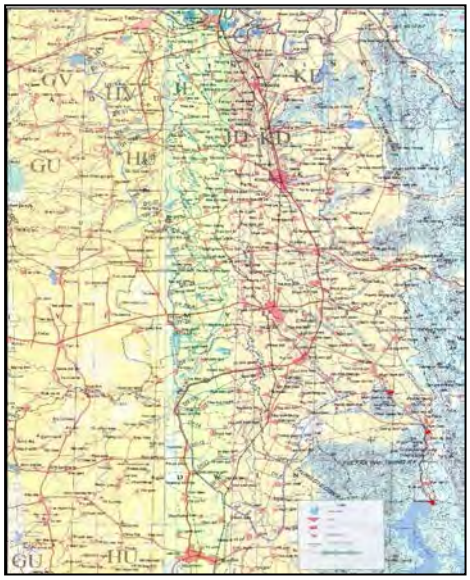


Figure 3.3.4 Kinda Dam Irrigation System
Source: Irrigation Department

Kinda Dam construction which is located at 9 miles away in upstream part of Kinda Weir in Myittha Township, Mandalay Region was started in 1979-1980 and completed in

1989-1990. Dam was built across Panlaung River. Storage capacity of full tank level is 873,500 ac-ft, dead storage capacity is 56,280 ac-ft, and effective storage capacity is 817,300 ac-ft (1,008,057,820 cubic meters).

Effective Capacity	817,300 ac-ft (1,008,057,820 CUM)
Length of Main Canal	78.8 miles (126.08 Km)
Length of Distributaries	420 miles (672 Km)
Irrigable Area (Planned)	201,500 acres (81,406 Ha)
Irrigable Area (Scrutinized)	147,274 acres (59,499 Ha)
Construction Started	1981-1982
Construction Completed	1989-1990

3.3.3 Chindwin-Ayeyarwady Area (pumping irrigation)

1) Tatywa Pumping Irrigation System

Tatywa River pumping project is located on the west bank of the Ayeyarwady River near Tatywa village, Wetlet Township, Sagaing Region. This project has implemented in 1995-1996. Targeted 16,548 acres farmlands were irrigated since 1999.

Cropping pattern includes paddy and other crops. By implementing this project, it will improve not only socio-economic status but also food sufficiency in central part of Myanmar. Moreover, it is expected to benefit regional green environment and increase income per capita.

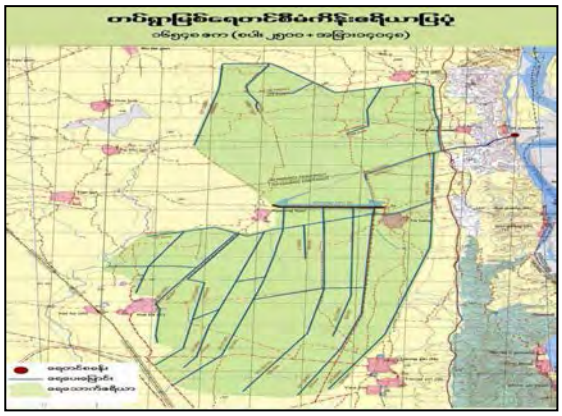


Figure 3.3.5 Tatywar Pumping Irrigation System

Source: WRUD

Water source	Ayeyarwady River
Type of pumping System	Pontoon Type
Pumping Head	110 ft
No of main pump station	1 Nos (Pump lift – 110')

2) Yebutalin Pumping Irrigation System

Yebutalin Water Pumping project is located on the riverbank of Chindwin River near Khochaung Village, Butalin Township, Sagaing Region. The project has started in 2005 so as to get irrigation facility to 40,000 acres of farmland in the Butalin Township by pumping from the Chindwin River.

Water Source	Chindwin River
Water Supply Area	40,000 ac (16,169 Ha)
Main Canal Length	2.93 miles (4.72 Km)
Secondary Canal	34.16 miles (54.89 Km)

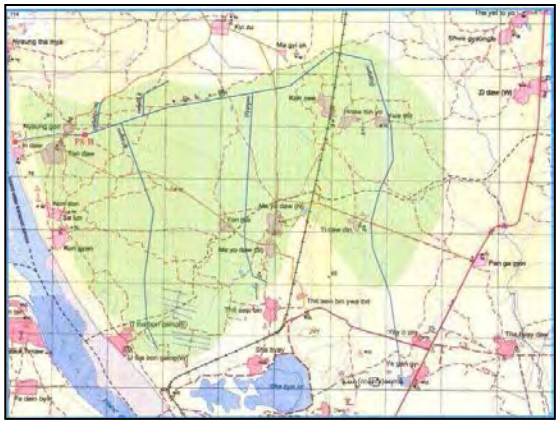


Figure 3.3.6 Yebutalin Pumping Irrigation System

Source: WRUD

3) Ayardaw (3) Pumping Irrigation System

Ayardaw (3) Water Pumping project is located on the western side of Mu River near Thalelbar Village, Ayartaw Township, Sagaing Region. The purpose of this project is to get irrigation water for 3,500 acres of paddy and 36,500 acres of other crops in eastern part of Mu River within Ayartaw and Myinmu Townships.

Water Resource	Mu River
Water Supply Area	40000 ac (16,169 Ha)
River Stage fluctuation	15 ft
Main Canal Length	23.1 miles (36.96 Km)
Distributaries Canal Length	53 Miles (85 Km)
Project Period	2003~2018

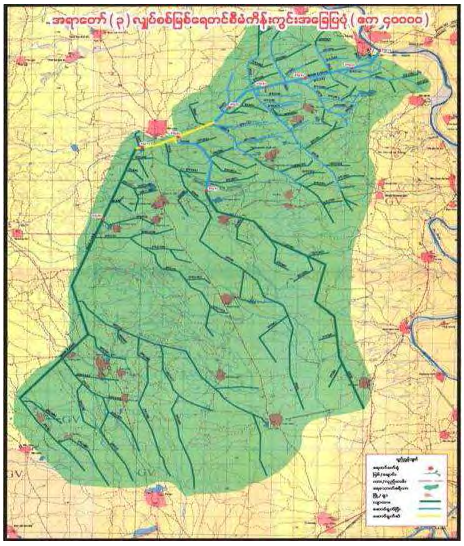


Figure 3.3.7 Ayardaw (3) Pumping Irrigation System

(Source: Irrigation Department)

3.3.4 Magway Area

1) Aingma Weir (of Mann Chaung Dam) Irrigation System

Construction of Aingma Weir was started in 1891 and completed in 1925 in order to provide water to the North and South Main Canals of Mann Chaung irrigation system, which was lately constructed with the purpose of promoting monsoon paddy and summer paddy cultivation in Minnbu and Pwint Phyu townships.

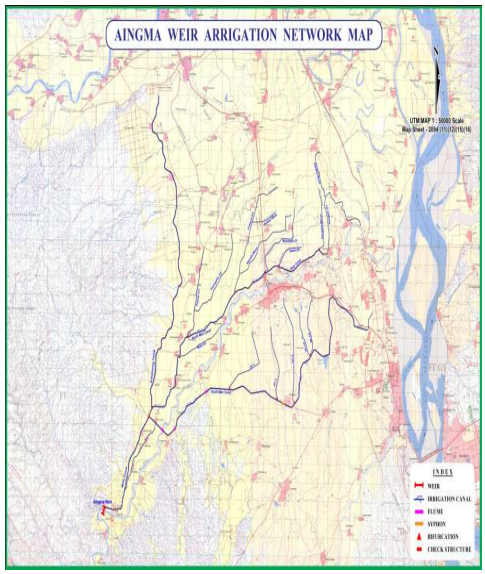


Figure 3.3.8 Aingma Weir Irrigation System

Source: Irrigation Department

About seventy years later, in 1995-1996 FY, a dam named Mann Chaung, located on the upstream of Aingma Weir, 4 miles away in west part of Ngaphe' Township, Minnbu District, Mangway Region was started construction. Dam Construction was completed in 1998 and water storing to the dam and diverted water to Aingma weir were also started in the same year.

Soil type of the most of the farmlands within this irrigation scheme is so loamy that summer sesame besides summer and monsoon paddy can be cultivated. Before, only monsoon paddy could be cultivated in the surrounding of above mentioned areas. But after the construction of dam, it became possible to cultivate not only monsoon paddy but also summer paddy as well.

Effective Storage Capacity	106,400 ac- ft (131,233,760 CUM)
Length of Main Canal	41.54 Miles (66.46 Km)
Length of Distributaries	69.89 Miles (111.82 Km)
Irrigable Area (Planned)	47,500 acres (19,230 Ha)
Irrigable Area (Scrutinized)	39,770 acres (16,100 Ha)
Construction Started	1995-1996
Construction Completed	1998-1999

2) Mezali Weir (of Mone Chaung Dam) Irrigation System

Construction of Mezali Weir was started in 1903, and completed in 1910. It was intended to provide irrigation water stream to farmlands in Minnbu, Pwintphyu and Salin townships through North and South Main Canal of Mone Chaung Dam irrigation scheme.

Figure 3.3.9 Mezali Weir Irrigation System
Source: Irrigation Department

Mone Chaung Dam is located in Saytoaktayar Township, Minnbu District, Mangway Division about 20 miles upstream of Mezali Weir. It was implemented in 1995 with the purpose of promoting the monsoon paddy and summer paddy through the Mezali Weir, and it was completed in 2004. Starting from 2004, water was stored in Mone Chaung Dam and diverted to Mezali reservoir

After dam construction, it became not only monsoon paddy, but also the summer paddy could be able to cultivate. Full storage capacity of Mone Chaung Dam is 674,400 ac-ft, dead storage capacity is 110,000 ac-ft and effective capacity is 564,400 ac-ft (696,130,960 cubic meters) respectively. Total irrigable area is 96,777 acres and the scrutinized area is 82,623 acres.

Location	Saytoaktayar Township, Minbu District, Magway Region
Effective Storage Capacity	564,400 ac-ft (696,130,960 CUM)
Length of Main Canal	53.8 miles (86.08 km)
Length of Distributaries	106.54miles (170.46 Km)
Irrigable Area (Planned)	96,777 acres
Irrigable Area (Scrutinized)	82,623 acres
Construction Started	1995-1996
Construction Completed	2004-2005

3) Linzin Weir (of Salin Dam) Irrigation System

Linzin Weir construction was started in 1927 and completed in 1934 to promote monsoon and summer paddy through the Linzin Reservoir. Salin Dam was constructed in the upstream part of Linzin Weir in Salin Township, Minbu District, Magway Division. It was implemented in 1998-1999 FY and completed in 2001-2002 FY. Starting from 2002, it was inbounded in Salin Dam and diverted to Linzin Weir. Before, farmers could only cultivate monsoon paddy by diverting naturally flowing water from Salin Chaung to farmlands in Pwintbyu and Salin Townships.

Figure 3.3.10 Linzin Weir Irrigation System
Source: Irrigation Department

After the construction of dam, water was stored well and the irrigation areas started receiving enough amount of irrigation water. Therefore, it became able to cultivate not only monsoon paddy but also summer paddy under Linzin weir irrigation system in Pwintbyu and Salin Townships, Magway Region.

Location	Salin Tsp, Minbu District, Magway Region

Effective Capacity	116,741 ac-ft (143,988,349 CUM)
Length of Main Canal	37.8 miles (60.48 Km)
Length of Distributaries	32.21 miles (51.53Km)
Irrigable Area (Planned)	36,092 acres (14,612 Ha)
Irrigable Area (Scrutinized)	34,332 acres (13,732 Ha)
Construction Started	1998-1999
Construction Completed	2001-2002

3.3.5 Nay Pyi Taw Area

1) Sinthe Dam Irrigation System

Regarding Sittaung River valley water resources Development Program Report prepared by UNDP, the necessary survey and investigation works for Sinthe Dam construction was carried out and implementation of the construction was also planned. Sinthe Dam was built across Sinthe creek in Tatkon Township, North-West part of Naypyitaw. Construction was started in 1996-1997 and completed in 1998-1999, with an estimated cost of 1,971 millions kyat.

Total storage capacity of the dam is 143,090 ac-ft and dead storage capacity is 17,303 ac-ft. Effective capacity is 125,787 ac-ft (155,145,686 cubic meters). Scrutinized irrigable area is 32,400 acres and it covers total planned irrigable area of the dam.

Figure 3.3.11 Sinthe Irrigation System Map
Source: Irrigation Department

Effective Capacity	125,787ac-ft (155,145,686 CUM)
Irrigable Area (Planned)	32,400 acres (13,089 Ha)
Irrigable Area (Scrutinized)	32,400 acres (13,089 Ha)
Estimated Cost of Project	1,971 Million Kyat
Construction Started	1996-1997
Construction Completed	1998-1999

2) Yezin Dam Irrigation System

Yezin Dam is about 40 years old and it was built across the Yezin creek near Yezin Village of Zayyarthiri Township, in North - East part of Naypyitaw. Dam construction was started in 1966-67 FY, and completed in 1975-1976 FY. Total storage capacity is 73,000 ac-ft, and dead storage capacity is 1,040 ac-ft. Scrutinized irrigable area of 15,850 acres can be irrigated by effective water storage capacity, 71,960 ac-ft (88,755,464 cubic meters), and it covers total planned irrigable area of the dam as designated.

Figure 3.3.12 Yezin Dam Irrigation System
Source: Irrigation Department

Effective Storage Capacity - 71,960ac-ft (88,755,464 CUM)

Irrigable Area (Planned)	15,850 acres (6,403 Ha)
Irrigable Area (Scrutinized)	15,850 acres (6,403 Ha)
Construction Started	1966-1967
Construction Completed	1975-1976

3) Paunglaung Dam Irrigation System

Paunglaung Multi-purpose Dam Project is also included as a part of Sittaung River Valley Water Resources Development report prepared by UNDP in 1964. Paunglaung dam was built across Paunglaung creek which is one of main tributaries of Sittaung River. Construction of Paunglaung Dam Multi Purposed Project was started in 2005-2006 and targeted to be fully completed in 2016-2017.

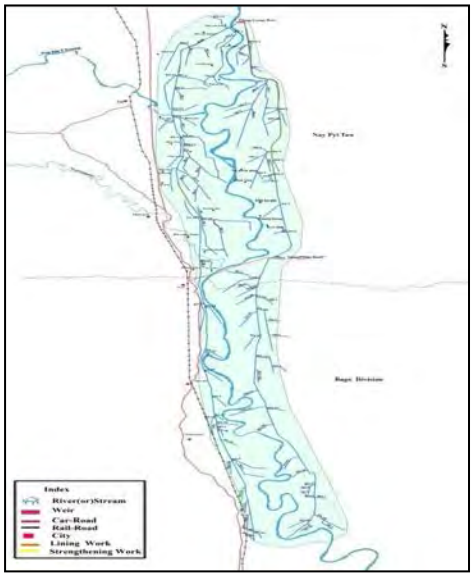


Figure 3.3.13 Paunglaung Dam Irrigation System
Source: Irrigation Department

Paunglaung Dam is located in Zayyarthiri Township and North-East part of Naypyitaw. Annual average rainfall of the project area is about 55 inches together with annual in-flow of 3,275,760 ac-ft. Total storage capacity is 549,420 ac-ft with dead storage capacity of 273,656 ac-ft and effective storage capacity is 275,764 ac-ft (340,127,318 cubic meter). The irrigable area of Paunglaung dam is 35,000 acres accompanying with 280 megawatt hydropower generating project.

ffective Capacity	275,764 ac-ft (340,127,318 CUM)
Irrigable Area (Planned)	35,000 acres (14,140 Ha)
Irrigable Area (Scrutinized)	35,000 acres (14,140 Ha)
Construction Started	2005-2006
Construction Completion	2016-2017

4) Ngalaik Dam Irrigation System

Ngalaik Dam construction was started in 1979-1980, and completed in 1984-1985. It's also one of the projects/activities formulate in Sittaung River Valley Water Resources Development Program report prepared by UNDP in 1964. Location of Ngalaik dam is near Kyueshin Village, Ottarathiri Township, about 16 miles away from Naypyitaw. Annual average rainfall of the project area is about 53 inches and average annual inflow of Ngalaik chaung is about 81,200 ac-ft.

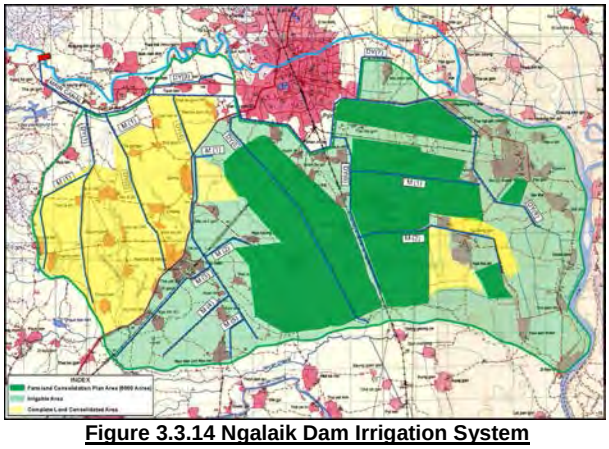


Figure 3.3.14 Ngalaik Dam Irrigation System
Source: Irrigation Department

For water storage capacity of Ngalaik dam, total storage is 75,000 ac-ft, dead storage is 12,950 ac-ft, and effective storage capacity is 62,050 ac-ft (76,532,470 cubic meters) respectively. Only 25,190 acres can be irrigated by water from Ngalaik Dam, because water stored by Ngalaik Dam is not only for agriculture sector but also for domestic water supply within Nay Pyi Taw at present.

Effective Capacity	62,050 ac-ft (76,532,470 CUM)
Irrigable Area (Planned)	25,190 acres (10,177 Ha)
Irrigable Area (Scrutinized)	25,190 acres (10,177 Ha)
Construction Started	1979-1980
Construction Completed	1984-1985

3.3.6 Shan Area

1) Taunggyi Area Irrigation Network

There are two major irrigation systems, Kyeephyu and Heho tanks for irrigation of agriculture within Taunggyi and its vicinity. Water storage capacity of Kyeephyu and Heho Tanks are; total storage 3,386 ac-ft, Dead Storage Capacity is 470 ac-ft and Effective Capacity is 2,917 ac-ft. Total Planned Area is 25,988 and Actual Area is 23,795.

2) Hopong Valley Irrigation Network

Hopong is located as a border area of four townships which are Taunggyi, Kyauktalonegyi, Hopong and Sesai Townships, Southern Shan State. There are small (9) water supply systems including weirs and feeders for agriculture sector within Hopong valley area. In Hopong Valley, paddy, potato,garlic etc., are being yearly cultivated in 23,795 acres. Experiencing inundation in almost 6,000 acres yearly is the main difficulty.

Figure 3.3.15 Taunggyi Area Irrigation Network

Figure 3.3.16 Hopong Valley Irrigation Network
Source: Irrigation Department

3) Nyaung Shwe Area Irrigation Network

Inlay Lake in Nyaung Shwe area is located at the southern-edge part of the Nyaung Shwe valley, also called Nant Latt valley and is a kind of Solution Lake which existed many years ago by melting of lime stones. To prevent siltation and sedimentation in Inlay Lake, diversion Weir and sedimentation trap dam are being constructed surrounding the lake. There are altogether 29 streams including the small streams, 17 from the east, and 11 from the west and 1 from the north flowing into Inlay Lake.

Figure 3.3.17 Nyaungshwe Valley Irrigation Network (Source: ID)

3.3.7 East Bago Area

1) Baingda Dam Irrigation System

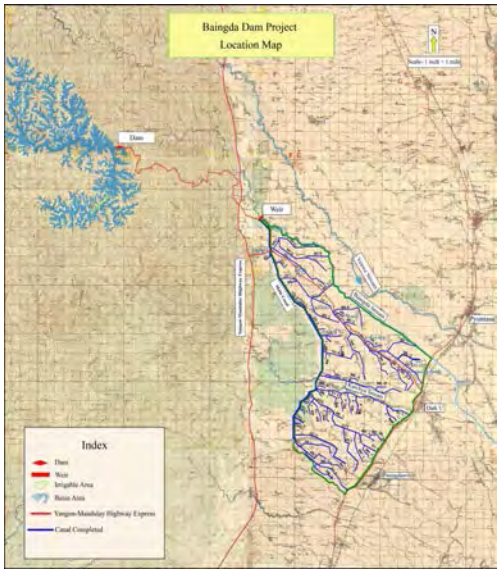


Figure 3.3.18 Baingda Dam Irrigation System
Source: Irrigation Department

Baingda Dam project is one of the projects to be implemented in Sittaung River basin. Baingda dam is located about 30 miles away in north-west part of Daik-U Township, Bago Region. According to a United Nations Development Program, the Irrigation Department in collaboration with Russian consultants has conducted investigation for the water resources development in Sittaung River Basin two times: the first study during 1963 to 1964; the second study during 1973 to 1976. Preliminary study for the Baingda Dam Project, which is one of the projects in Sittaung River Basin Development, was already described in the Yenwe - Pyontansar Plain Project reported in 1977. Developing Baingda project makes the Pyontansar Plain ease from flooding during monsoon seasons and assists in cultivation of summer crops. This project would irrigate 46,700 acres of land in Daik- U Township and saves the Pyontansar Plain to some extent from extreme floods during monsoon.

Effective Storage Capacity	317,800 ac-ft (1,051,183,651 CUM)
Length of Main Canal	15.52 Miles (24.83 Km)
Length of Distributaries	152.91 Miles (244.66 Km)
Irrigable Area (Planned)	46,700 acres (18,867 Ha)
Irrigable Area (Scrutinized)	24,745 acres (9,997 Ha)
Construction Started	(1999-2000) FY
Construction Completed	(2012-2013) FY

2) Warkadoak Dam

Figure 3.3.19 Wagadok Dam
Source: Irrigation Department

Warkadoak Dam was aimed and implemented to be green and lush the 30 miles of Eastern Yangon Division. Its aim is to support water to Moe Yunn Gyi Inn which makes the nearby 30 miles green and lush. It lets water flow into the Moe Yunn Gyi Inn, and then through the Moe Yunn Gyi Sluice, water is diverted to Bago-Sittaung Canal. From this canal, it can be able to drain water via Bagan-Nyaung Pin escape to Ohn Hne' Stream and can supply water along the Thanappin-Thone Khwa Road with canal system.

Effective Storage Capacity	31,400 ac-ft
Estimated Cost of Project	5,494 Million Kyat
Construction Started	2004- 2005
Construction Completed	2007- 2008

3) Zaungtu Weir Irrigation System

Zaungtu Weir is located near Bawnetgyi Village in Bago Township, Bago Region. The weir was constructed across the Bago River to divert the water for cultivation of summer crop. It was constructed in 1993-1994, and completed in 1996-1997. The planned irrigable area by Zaungtu weir is

32,454 acre and the final scrutiny area was about 28,350 acre.

Effective Storage Capacity	319,865 ac-ft
Irrigable Area (Planned)	32,454 acres
Irrigable Area (Scrutinized)	28,350 acres
Construction Started	1993-1994
Construction Completed	1995-1996

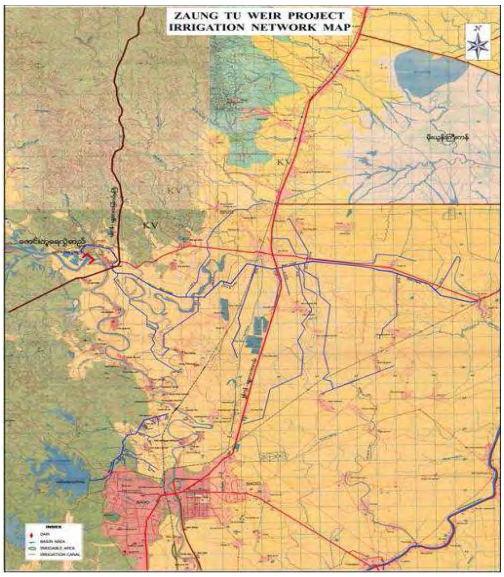


Figure 3.3.20 Zaungtu Weir Irrigation System
Source: Irrigation Department

4) Bago – Sittaung Canal

The construction of Bago – Sittaung Canal was started in 1873 and completed in 1878. The total length of canal is 37 miles 7 furlong (37.875 miles) with bed width 60 ft average The embankment that stretches out from 0/0 milestone at Tarwa Village to 8/4 milestone in Thanatpin Township is regarded as the one which protects from flooding. The related structures were constructed along with the canal, including two Navigation Lock Gates with the width of 30 ft at the mouths of the canal, Tarwa Lock Gate at the Bago River Site and Myitkyo Lock Gate at the Sittaung River Site. The four Escapes: Kyaikpadaing Escape, Bagan – Nyaungbin Escape, Minywa Escape and Abya – Shankaing Escape were also built to drain out the excess water. Myittkyo Feeder was also constructed to level up the surface of Sittaung River water when surface goes down in the summer season for being well navigable.

Type of Canal	Earthen Canal
Length of Canal	37.5 Miles (60 Km)
Beneficial Areas	44,998 acres(18,179 Ha)
Project Started	February, 2014
Project Completed	May, 2014

Figure 3.3.21 Bago – Sittaung Canal Irrigation System (Source: ID)

3.3.8 West Bago Area

1) Gamone Dam Irrigation System

Gamone dam was built across Gamone creek near Wine village, eastern part of Oakpho Township, Bago Division. Dam construction was started in (2000-2001) FY and completed in (2010-2011) FY. Full and dead storage capacity of Gamone dam are (62,000) ac-ft and (4,800) ac-ft respectively. Effective storage capacity is (57,200) ac-ft, (70,550,480 cubic meters). Planned irrigable area is (15,000) acres and scrutinized irrigated area is (12,000) acres. Total length of its distributaries canals is 69 miles, about 110 km. Estimated cost for dam construction stands at (3,173) million kyat.

Effective Storage Capacity	57,200 ac-ft

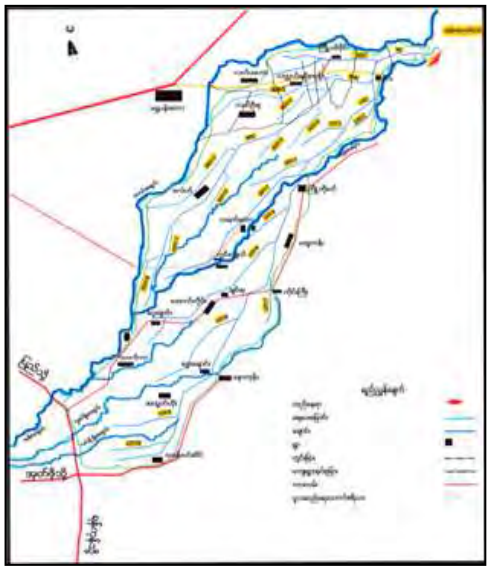


Figure 3.3.22 Gamone Dam Irrigation System
Source: Irrigation Department

Length of Distributaries	69 Miles(110 Km)
Irrigable Area (Planned)	15,000 acres
Irrigable Area (Scrutinized)	12,000 acres
Construction Started	2000-2001
Construction Completed	2010-2011

Figure 3.3.23 Min Hla Dam Irrigation System
Source: Irrigation Department

2) Minnhla Dam Irrigation System

Minn Hla Dam was built across Minnhla creek located near Seywar Village, Okapho Township, Bago Division. Under Minnhla dam irrigation system 3 Saddle Dams, 1 Conduit and 1 Spillway is included. A reservoir was constructed about 10 miles away in downstream of Minnhla dam, near Htampinkyaw village of Oakpho Township. Total storage capacity of Minnhla dam is 43,645 ac-ft and dead storage capacity is 3,291 ac-ft. Effective storage capacity is 40,354 ac-ft and planned irrigable area is 15,000 acres and scrutinized irrigated area is 11,725 acres. Total length of distributaries canals is 34 miles (54.4 km).

Effective Capacity	40,354 ac-ft
Length of Main Canal	20 Miles (32 Km)
Length of Distributaries	34 Miles (54.4 Km)
Irrigable Area (Planned)	15,000 acres (6,060 Ha)
Irrigable Area (Scrutinized)	11,725 acres (4,737 Ha)
Construction Started	2000-2001
Construction Completed	2003-2004

Figure 3.3.24 Sinkkuu Chaung Gaung Dam Irrigation System (Source: ID)

3) Sinkkuu Chaung Gaung Dam Irrigation System

It is constructed as 2 dams across the Sinkkuu and Chaung Gaung Streams, connected with drainage system and is a kind of Earthen Dam. It is situated near Kantharyar Village, 7 miles east to the Aye Mya Thar Yar Myothit, Oakpho Township, Bago Division. It can support 30 acres of irrigable area in the year 2014-2015. To support full amount of irrigable water for 800 ready implementation acres, it needs to construct Stone Pitching and Stone Lining at the rest drainage parts, Left and Right Main Canals.

Effective Storage Capacity	1,735 ac-ft
Length of Main Canal	1.44 Miles
Length of Distributaries	3.78Miles
Irrigable Area (Planned)	1,500 acres
Irrigable Area (Scrutinized)	810 acres
Construction Started	1989-1990
Construction Completed	1990-1991

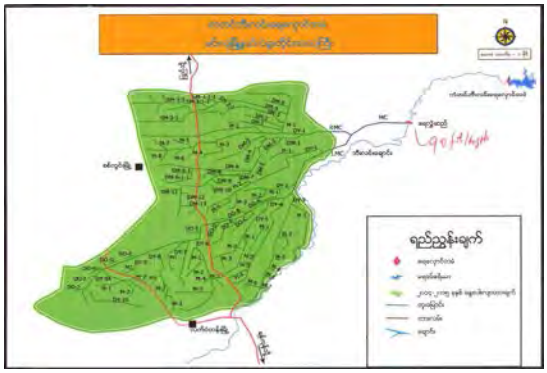


Figure 3.3.25 Kantin Beelin Dam Irrigation System
Source: Irrigation Department

4) Kantin Beelin Dam Irrigation System

Kantin Beelin Dam is located at 1 miles east to the Kywe' Ma Gine Village, Min Hla Township, Bago Division. It is intended to supply water to irrigation

area of 25,000 acres by constructing an earthen dam of 1,340,000 Dead Storage Capacity across the Beelin Stream. It could promote more farming areas if the Main Canal and Distributaries Canals had been made to meet the standards of canal section.

Effective Storage Capacity	126,400Ac-ft
Length of Main Canal	22.75 Miles
Length of Distributaries	132.92 Miles
Irrigable Area (Planned)	25,000 acres
Irrigable Area (Scrutinized)	26,374 acres
Construction Started	2000-2001
Construction Completed	2008-2009

5) The' Kaw Dam Irrigation System

The' Kaw Dam is situated 0.2 miles downstream from Hmyar Chaung Village, Lapantan Township, Bago Division. It intends to support water to 12,000 acres of irrigation area by the construction of dam with 35 square miles of catchment area. It could promote more farming areas if the Main Canal and Distributaries Canals had been made to meet with the standards of Canal Section and Water Structures had been repaired.

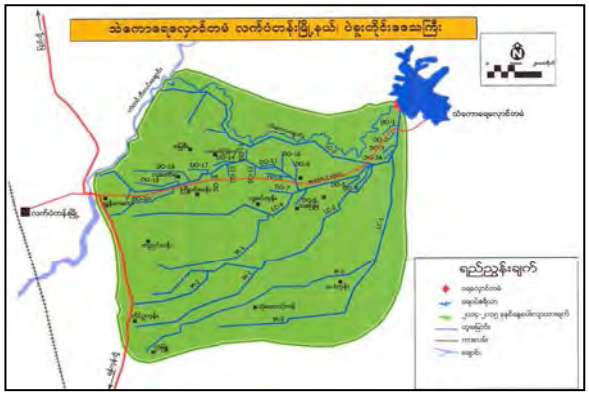


Figure 3.3.26 The' Kaw Dam Irrigation System

Source: Irrigation Department

Effective Storage Capacity	50,000 ac-ft
Length of Main Canal	8.07 Miles
Length of Distributaries	56.84Miles
Irrigable Area (Planned)	12,000 acres
Irrigable Area (Scrutinized)	9,372 acres
Construction Started	1999-2000
Construction Completed	2001-2002

6) Thoneze Dam Irrigation System

Thoneze Dam was located near Hle-kuu Village, Tharyarwaddy Township, Bago Region. Full storage capacity of the dam was 237,520 ac-ft with dead storage capacity was 8,800 ac-ft and effective capacity is 228,720 ac-ft. Total planned irrigable area is 50,000 acres and the scrutinized area was 42,003 acres.

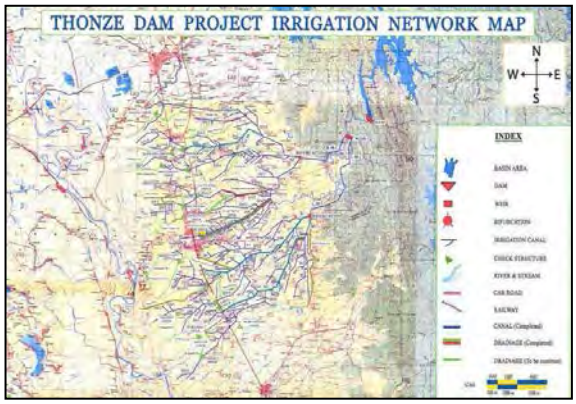


Figure 3.3.27 Thoneze Dam Irrigation System

Source: Irrigation Department

Effective Storage Capacity	228,720 ac-ft
Irrigable Area (Planned)	50,000 acres
Irrigable Area (Scrutinized)	42.003 acres
Construction Started	2000-2001
Construction Completed	2001-2002

7) Tabuu Hla Dam Irrigation System

Tabuu Hla Dam is located near Sam Ywar Village, Taikggyi Township, Yangon Division. Among all the dams and lakes within the Yangon Division, it has the biggest Storage Capacity, can store to Full Storage Capacity and can support irrigation water to 52,000 acres of summer paddy. Besides, there are

also enough farming areas around, it can promote summer paddy with systematic irrigated cultivation pattern.

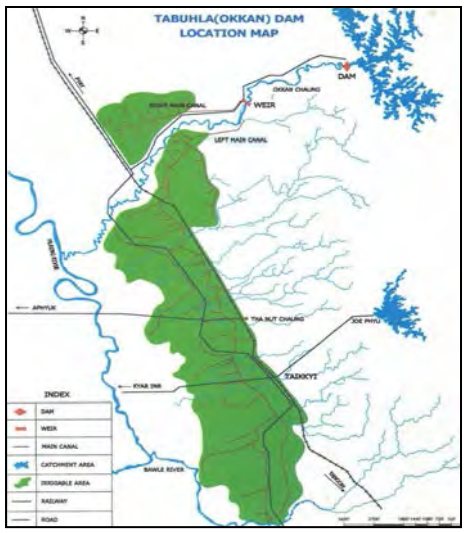


Figure 3.3.28 Tabuuhla Dam Irrigation System

Source: Irrigation Department

Okkan Stream, the inflow to the Tabuu Hla Dam, is winding and because of quicksand deposit in water spread areas of the reservoir, cannot carry out water discharge. According to fund difficulty, removing quicksand and flotsam cannot be fully carried out, yet.

Effective Storage Capacity	170,250 ac-ft
Length of Main Canal	30 Miles (48.56 Km)
Length of Distributaries	55 Miles (88 Km)
Irrigable Area (Planned)	52,000 acres
Irrigable Area (Scrutinized)	35,586 acres
Construction Started	1993-1994
Construction Completed	1995-1996

3.3.9 Ayeyarwady Area

1) Pilot Canal Irrigation System of Ngawun River

Ngawun River, one of the distributary of Ayeyarwady River, flow across the Thaboung Township, about 26 miles away from Pathein. Especially, Ngawun River mostly flooded, from July to October. In rainy season paddy land in Thabaung is inundated by river flood during the flood period of high discharge from Ngawun River.

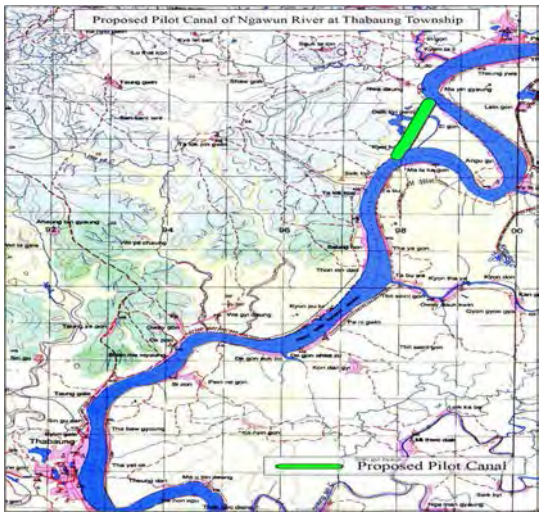


Figure 3.3.29 Pilot Canal Irrigation System

Source: Irrigation Department

Paddy Land in that area is not favourable to cultivate for pre-monsooon period because of the flood. Although paddy field can be cultivated beyond the post monsoon, it is very late for harvesting. On the other hand, paddy land has faced difficulty with water requirement. For the purpose of reduction and mitigation of flood damages, it is need to straighten by cutting the meander portion.

2) Kyaunggon Flood Plain Irrigation System

Kyaunggon flood Plain is located along the right side of Pathein – Yangon road between the Kangyidaung and Kyaunggon Township, Ayeyarwady Region. That area is suffering flooding every year by river water of Ngawun and Daka Rivesr during monsoon period.

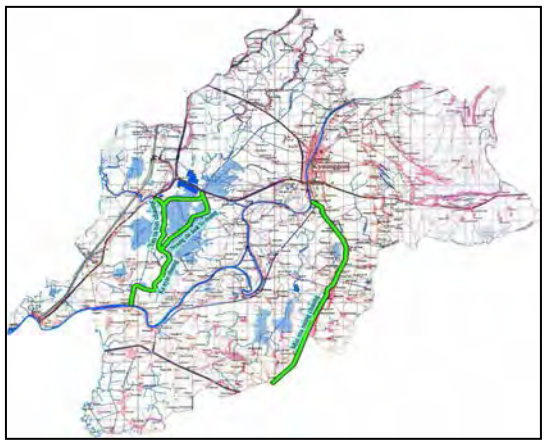


Figure 3.3.30 Kyaunggon Flood Plain Irrigation System (Source:ID)

Especially, Ngawun and Daka rivers flood mostly occur, from July to October and Paddy land in that area is inundated by river flood during period of high discharge from those rivers.

Total Nos of Drainage	4 Nos
Total Length of Drainage	39 Miles

3) Bitud-4 Polder Irrigation System

Bitud-4 polder is located about 97 miles far away from Pathein, in Labutta Township, Ayeyarwady Region. It was implemented as a part of the lower Myanmar Paddy Land Development Project, Phase (1), funded by World Bank in 1986.

After 30 year period, because of the lack of maintenance and also seriously damaged by Cyclone Nargis in 2008, all land developed systems such as sea water protection polders, dykes, drainages and sluices are in deteriorations, and consequently farmers in the polder frequently suffer from inundation under intensive rainfalls and causing damages of crops.

Upgrading and rehabilitation would be needed comprising with strengthening of embankment, dredging of drainage channel, upgrading of hydraulic channel, upgrading of hydraulic facilities and so on.

Length of Polder	43.00 Miles
No of Sluices	6 Nos
Number of gates	25 Nos
Total Length of Drainage	56.43 Miles
Protected Area	25,229 ac

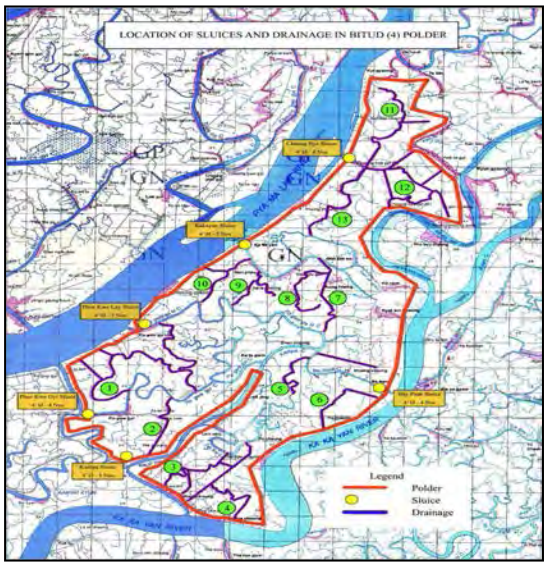


Figure 3.3.31 Bitud-4 Polder Irrigation System

Source: Irrigation Department

4) Shwelaung Polder Irrigation System

Shwelaung polder is located in Wakama Township, Ayeyarwady Region. It was implemented as a part of the lower Myanmar Paddy Land Development Project, Phase (1), funded by World Bank in 1986.

The delta has a lot of fertile land, a favorable weather condition and a sufficient rainfall for paddy production. The project was implemented in 1976-1990 by the assumption of low investment and quick out turn.

All round rehabilitation has to be needed, i.e. strengthen the earthen embankments, dredging and re-excavating drainage canals, upgrading existing hydraulic structures and establishing new facilities in accordance with the present geo-morphological features and anticipation of erratic rainfalls in the future.

Length of polder	57.00 Miles (91.2 Km)
Total Length of Drainage	104.95 Mile (168 Km)
Protected Area	48,648 Ac (19,696 Ha)
Completed Date	1986

Figure 3.3.32 Shwelaung Polder Irrigation System

Source: Irrigation Department

5) Kyun Nyo Gyi Island Irrigation System

Kyun Nyo Gyi Island is located between Zaung Ya Gyun River, Taung Ga Le River and Ngawun River, in Ngaputaw Township, Ayeyarwady Region. It is about 30 miles far from south of the Pathein, Ayeyarwady Region.

About 7,500 acres of paddy land within the Kyun Nyo Gyi Island is needed to protect by dykes from sea water intrusion after the rainy season. Also, sluices and drainages are required to deduce the inland water during the rainy season.

There are altogether 17 miles of dyke, 3 Nos of sluices and 23.82 Miles of Drainage are required for the proposed irrigation facilities which are necessary for the farmers in the island.

Length of Polder	17 Miles (27.2 Km)
Total Nos of Drainages	6 Nos
Number of Sluices	3 Nos
Total Length of Drainage	23.82 Miles
Protected Area	11,600 ac (4696 Ha)

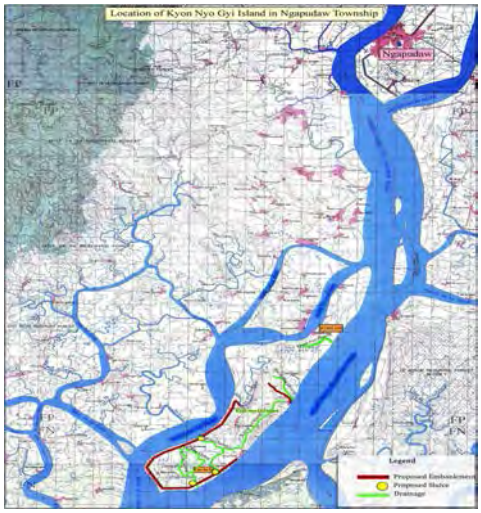


Figure 3.3.33 Kyunnyogyi Island Irrigation System (Source: Irrigation Department)

6) Tonegwa Polder Irrigation System

Thonegwa polder is located at South- East of Maubin Township and North of Kyaiklatt Township. The total cultivated area in Thonegwa polder is about 70,400 acres. Thonegwa polder is surrounded by tidal effected rivers of Toe River in the East and Kyaiklatt River in the west.

After completion of Paddy 2 Project, some part in polder faced with shortage of water for agriculture production. Thus, 10 Nos of Sluice Gates were constructed by Construction Circle 6 during 1993 to 1994. 30 Nos of irrigation and drainage channel with the length of 72.3 miles were excavated by paddy 2 Project.

Thonegwa polder is suitable for paddy cultivation except for the month of July and August when flood level is high in surrounded rivers. In rainy season, water level in polder is about 4' to 5' and it is difficult to drain out the water due to high flood level at surrounded river about 11' to 14'. For irrigation purpose, it can take the water through sluice gate from December to April.

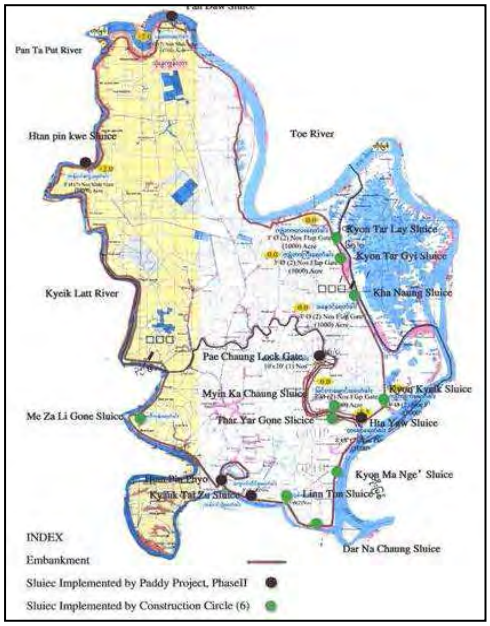


Figure 3.3.34 Tonegwa Polder Irrigation System
Source: Irrigation Department

CHAPTER 4 SCREENING AND THE PRIORITY AREA SELECTION

In this Chapter 4, selection of priority areas is discussed. In the selection, 9 areas shall be picked up through the 1st screening and then 6 areas be selected through examining the particulars of each area under the 2nd screening. Thereafter, 4 areas will be selected finally through taking into account the varieties of issues, development opportunities, possibility for development of food value chain and also the internal rate of returns to the investment to be made.

4.1 First Screening

All of the irrigation projects existing over the whole Myanmar are as shown in the Figures 3.1.4 and 3.1.5 (see Chapter 3). The figures were prepared through putting those water sources as developed/operated by ID and WRUD on the agricultural lands identified based on ESA Globe Cover 2009 land cover map provided by the European Space Agency. Then, based on these materials and referring to the IDôs project drawings/maps and Google earth, irrigation areas coupled with canal networks were identified as shown in Figure 4.1.1 (also see Figures 3.1.7 ï 3.1.14 in Chapter 3). Through reviewing/analyzing the figures as afore-mentioned, the followings can be confirmed:

1) Irrigation projects in Myanmar have been mainly planned and constructed with water sources from medium scale rivers flowing into Ayeyarwady river and Sittaung river. In the North, Shwebo irrigation area, the largest irrigation project (199,000 ha) in Myanmar, is developed along the Mu river, a tributary of Ayeyarwady. In the Bago river basin which extends from the north of Yangon to the south-east direction, there are some irrigation water sources built.

2) Ayeyarwady delta is famous for the massive rice farming. In the area, however, no gravity irrigation is found due to the extremely flat topography. There found no supplementary irrigation in monsoon season and instead pumping irrigation in dry season is popular, irrigating summer paddy by pumping the stored water in drainage canals.

3) Shan South State is famous for the production of highland vegetables at the upland farmlands in Myanmar. Mostly the production is practiced under rain-fed condition except those small scale irrigation areas constructed along Hopong gorge (moderate scale[1]) though there are some potentials for promoting intensive

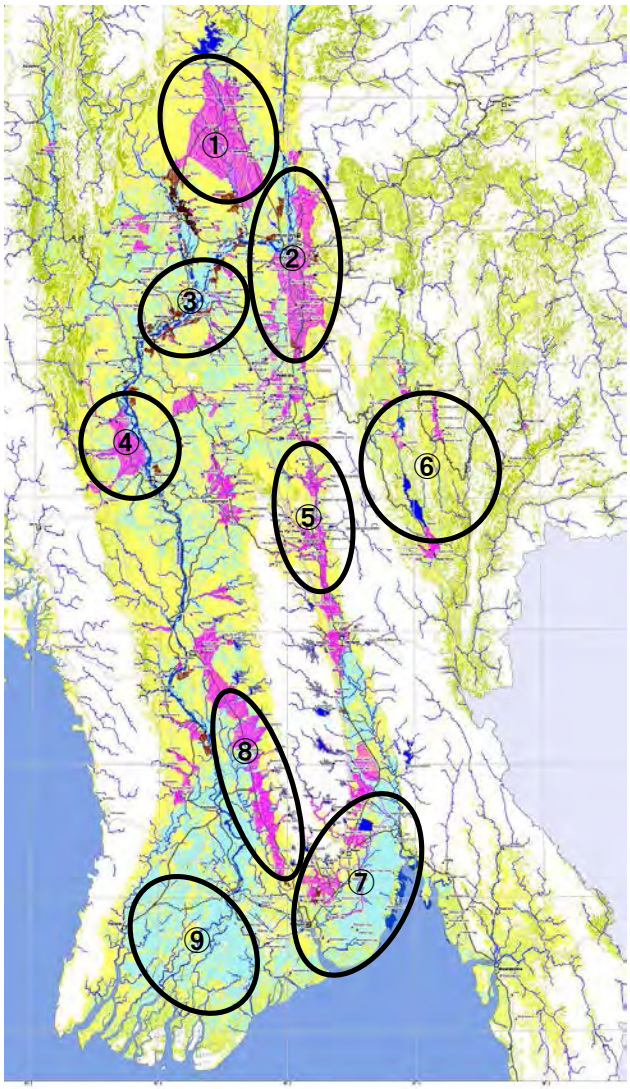


Figure 4.1.1 First Screened 9 Priority Areas

Source: JICA Survey Team

[1] 1. Located at the east of Taunggyi extending between the road connecting Hopong Town and Kayah. It is not a deep valley. Irrigation facilities by means of small scale intake weir are constructed and O&M is done by beneficiary farmers.

agriculture there too.

Based on these findings as mentioned above, 9 areas have been finally selected as 1st phase screening as shown in the Figure 4.1.1. Except the Ayeyarwady delta and Shan South State, there are large scale irrigation facilities existing in a cluster shape. In the western part of Bago near Pyay, there are 4 large scale irrigation facilities existing, for which project implementation by an Yen loan financing is on-going. Further, there found a number of irrigation areas in the central part and the northern part of Central Dry Zone for which project studies by ADB is undergoing.

4.2 Second Screening

4.2.1 Screening to 6 Areas

Under the 2nd phase screening, 6 areas are selected by setting aside such 3 areas as Pumping Irrigation areas, Shan South area and Bago South-West area. Major reasons for setting aside the said 3 areas are explained below:

1) **Pumping Irrigation areas:** Diesel generator is dominantly operated for pumping irrigation practices, which requires high energy costs. WRUD desires to convert the driving power to national grid electricity which requires lower operation cost; however, the prevailing electricity supply condition in Myanmar at present still remains in poor condition. Further, taking into consideration the policy to give higher priority for electricity supply to urban areas, especially Yangon area, and industrial estate, conversion of pumping energy from diesel to national grid electricity is considered as an option to be realized in future. It is yet noted that the production potential of high value added vegetables/fruits such as musk melon would be quite high in this area in view of the predominant sandy soils in the areas along the Ayeyarwady river.

2) **Shan South area:** In recent years, improvement for major roads have been progressed (Aungban-Kyaukse section is presently under construction)[2]. With this improvement, higher priorities should be given to vegetable production efficiency[3], improvement of preservation technique, plant quarantine technology and handling of residual agricultural chemicals. In fact, as is well known over Myanmar, Shan South area has huge potential of further producing upland vegetables, and then horticultures. To further enhance this potential, what is needed first could be a technical cooperation program together with private initiative promotion. On the other hand, there exists no medium-large scale irrigation facilities in Shan South area and the needs for rehabilitation projects are minimal, thus this area is set aside for further planning.

3) In Bago South-West area, there are 6 irrigation project areas situated one after another but the construction periods are comparatively new (rather old as 1995/06 for Tabuhla area near Yangon but the remaining were completed for construction in 2001/02-2010-11). Due to the budget limitation, irrigation canals are of earth canal and rehabilitation by concrete-lining are to be necessary in the sections where sandy soils are distinguished. Further, lengths of lining section both in upstream and downstream of hydraulic structures are found short, siltation being

[2] For the section Aungban-Meiktila, the work has been completed and the section Aungban-Kyaukse toward Mandalay is being underway as of July, 2015 to be completed in several months including the widening of the road width. After the completion, 4-ton truck transportation being the major transporting measure at present is expected to be replaced by 10-ton truck transportation.

[3] Productivity of vegetables in wet season is especially required. The City Mart, the largest marketing operator of fresh foods, procure most of the highland vegetables from Shan State and considers that extension of vegetable production techniques in wet season is the most important issue due to the significant loss in vegetable handling(As per the interview to the Fresh Food & Production Manager, City Mart). In the wholesale market in Nay Pyi Taw, loss ration of vegetables are quite substantial and in case of Chinese cabbage, a quarter to half are abandoned quite often (Based on the interview conducted on July 4, 2015).

significant and needs for bridge construction over the canal are high for improvement of living conditions. However, the rehabilitation cost is estimated at below a million US$ only per a project. These indicate lower priority as a loan project in view of the scale of investment and the fact the existing projects are rather newly constructed.

4.2.2 Development Directions for Each of 6 Areas

As the result of the 2nd screening, 6 areas of Shwebo, Mandalay, Magway West, Nay Pyi Taw, Bago South-East and Ayeyarwady have been selected. Specific features, issues and development opportunities of each area have been examined, based on which development directions for each area are proposed as follows:

1) Shwebo Area

Blessed with the most suited climate condition for rice farming, the area is the representative producing area for high value added rice (Shwebo Pawsan) in Myanmar. Therefore the development direction includes promotion of producing area and domestic demand for the Shwebo Pawsan through branding of the products and strengthening of value chain (introducing drying facilities with energy derived from paddy husk, improvement in rice milling technology, mechanization, storage facility and monitoring system for the residual chemicals). Moreover, with the advantage of location, 2 hours ride from Mandalay City which has the 2nd largest consumptive population in the country, promotion of suburban agriculture (vegetable production in dry season) by small scale farmers can be considered suitable.

2) Mandalay Area

Neighboring to Mandalay City, promotion of suburban agriculture (vegetable production in dry season) and development of value chain (improvement in farming techniques, improvement of post-harvest handling technologies, farm road construction, provision of cold chain, improvement in packaging technologies, plant quarantine and strengthening of residual chemicals monitoring) are considered.

Further, taking advantage of accumulation of varieties of agricultural products owing to location situated at the center of national level transportation network (MDY-YGN, MDY-Muse, MDY-Tamu and MDY-CDZ), the area can be promoted as the center of agricultural products distribution in Upper Myanmar region. This will lead the area to be developed as the center for promotion of food processing industries (including consolidation of required infrastructures, 1st stage processing for beans and promotion of packaging materials-related industries). In addition, it is necessary to develop/diversify varieties of transportation modes to meet the increased quantity and manner of transportation needs.

3) Magway West Area

As the supply center of beans and oilseeds through marketing to Mandalay nation-widely as well as globally, quality improvement and further strengthening of competitiveness in this Magway West area can be picked up. Moreover the area can be developed as the center for overall agricultural products marketing along the Ayeyarwady River including Magway-Pyi and Magway-Tawngyi.

4) Nay Pyi Taw Area

Taking the advantages as having abilities to attract customers being the capital of the nation and the favorable location situated at the middle between Yangon and Mandalay, demonstration and extension of advanced farming model (mechanization, upland irrigation, protected horticulture and organic farming, etc.) can be considered. Also, establishment of 6th sector industrialization model through

inviting food processing industries has to be implemented.

5) Bago South-East Area

Location advantage being the neighboring suburb to Yangon (potential to develop as the agricultural produces supply base to the largest consumption area in the country) and the long history as the center of rice production brought about the area with considerable accumulation of man-power, information and marketing expertise. Taking this point into account, through improvement of post-harvest handling technologies, rice quality improvement shall be targeted.

Those improvement measures include introducing drying facilities by using rice husk as the source of energy, provision of storage facilities, trap devices for specified insects eradication, fumigation facilities, improvement for quarantine system and quality standardization in rice milling, etc. Further, development plan includes production promotion for lowland vegetables (leaf vegetables and other perishables) focusing on supply to Yangon in dry season and protected horticulture for mushroom and others through introducing/extension of pumping irrigation, farm mechanization in upland cropping and upland crop irrigation etc.

6) Ayeyarwady delta Area

The delta area produces domestically popular Pawsan Hmwe (a flavor rice variety) and rice for exporting purpose (low quality and low price) and man-power, information and marketing expertise for rice are heavily accumulated in the area. While further extension of recommended seed variety and renovation of milling machines be promoted, farm mechanization and increase of yield per a unit area be attained together with the improvement in post-harvesting handling including drying, storing and milling. As for the domestic market, branding of Pawsan Hmwe shall be established and for exporting, production promotion be sought as coupled with the quality improvement.

4.3 Third Screening

As the final screening, examination shall be made for the selected areas on marketing aspects, possibility for crop diversification, water resources potential, needs for rehabilitation of the existing irrigation facilities and further on the internal rate of return to the investment to be made.

4.3.1 Marketing Aspects

Through interview survey at the wholesale markets, production areas and major consumption areas and destinations in case of exporting were identified on the major crops including rice, beans which are planted as 2nd crop after rice and oilseeds and vegetables and fruits. Survey results can be summarized as follows. (refer to Figure. 4.3.1):

1) Major production areas of rice are Ayeyarwady delta, Bago region and Sagaing region including Shwebo area. These 3 regions are significant overproduction area of rice. The overproduced rice is exported overseas through Yangon port in case of Ayeyarwady delta and the others are transported by ship to Mandalay by way of Ayeyarwady river and exported to China. From Sagaing, the monsoon season rice is mainly exported to China while the high quality dry season rice of Shwebo Paw San is distributed over nation-widely. The rice produced in Bago East is also exported through Yangon port while some are exported to China through Mandalay.

2) Beans are planted as the 2nd crop after monsoon season paddy indicating that the areas where monsoon season paddy planting is a major function as major bean production areas - black gram in delta area and green gram/chickpea are major in the central and north regions. Since the production areas of rice and beans are duplicated, marketing channels for beans are similar to the ones for rice. In terms of quantity, however, extremely massive quantity is exported to India

through Yangon port. In India, after the policy of free market economy implemented, GDP share by the 1st sector industry has been continuously lowered down and the country becomes a large importing nation of beans which are considered as the 2nd staple food for the nation.

3) Highland vegetables among a variety of vegetables are produced only in Shan State in Myanmar. The vegetables produced in Shan State are transported to the wholesale markets in Mandalay and Yangon and distributed nation-widely even to the western part of the country including Magway and Ayeyarwady delta area. In case of the longest distance transportation to Ayeyarwady, it takes from early afternoon leaving Shan to early next morning arriving at the wholesale market in Yangon and then hauled again from Yangon midnight and arriving at Pathein Town early morning. It means in total it took 2 days period.

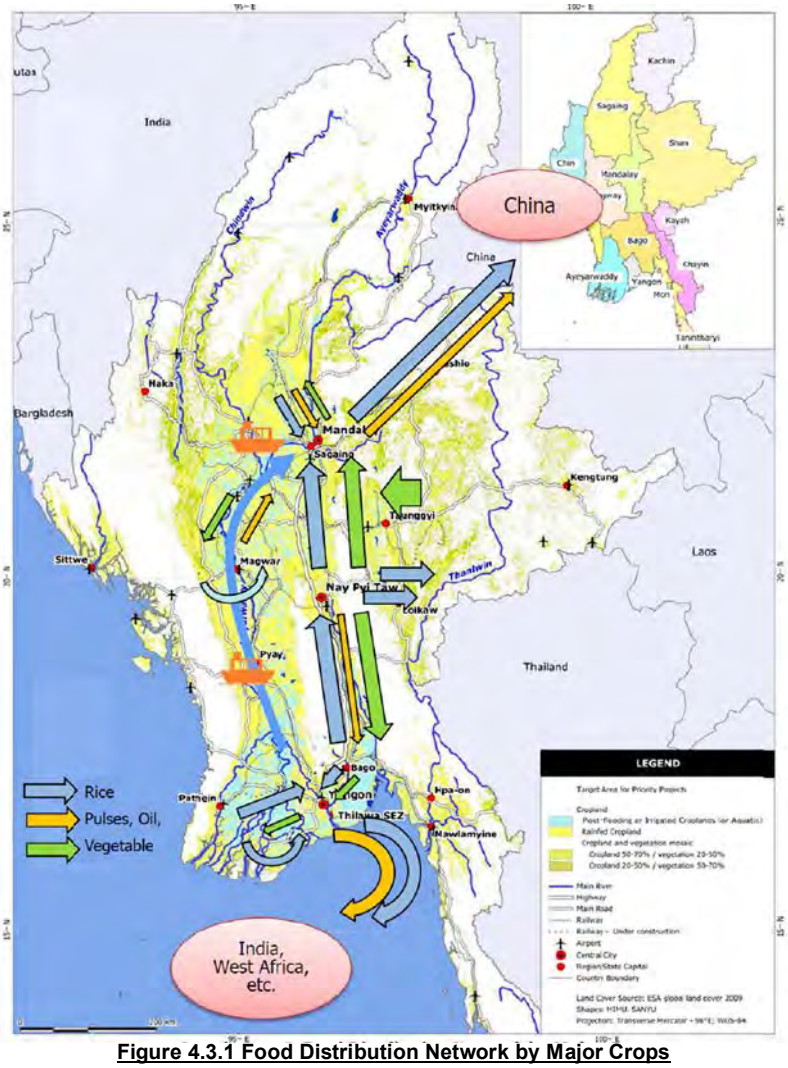


Figure 4.3.1 Food Distribution Network by Major Crops

Source: JICA Survey Team

From the above, it is known that the rice in a large quantity moves along the North-south corridor from Ayeyarwady to Yangon and Yangon to Mandalay, including move by navigation from Ayeyarwady to Mandalay. Oilseed products produced mainly in the central and northern areas also moves along the North-South corridor in between Mandalay and Yangon. Further, the vegetables produced in Shan are transported to Mandalay and Yangon, 2 major consumption areas in Myanmar, and then through the 2 marketing points the products are further distributed to the major cities in various localities nation-wide.

In summarizing the above, it is noted that major part of commodity transportation in Myanmar is supported by the North-South corridor between Mandalay and Yangon. The commodity transportation itself is mostly practiced by using the existing road network but the trucks carrying the fresh foods can use the new highway under the license system. At present, asphalt paving works are underway though intermittently for the Yangon-Nay Pyi Taw section of the road and the works are expected to be extended from Nay Pyi Taw to Mandalay in near future. When use of highway will be possible for the commodity transportation in future, the commodity marketing and needed transportation would be further promoted.

In case of commodity transportation in the western part of Myanmar, the condition is rather limited

due to the poor road conditions prevailing. The priority area in Magway area are located on the western side of Ayeyarwady river and placed in even poorer condition for transportation of commodities. At present, self-sufficiency is secured for rice, beans and oilseeds in the area and most of the produces are consumed within the area and it is deemed that the export quantity of excess beans and oilseeds via Mandalay is rather limited as compared with the other areas.

From the above, it can be said that in considering selection of priority areas for promotion of intensive agriculture with focusing on efficiency in marketing aspect, attentions should be paid on the particulars on easier connection with Mandalay and Yangon, 2 major export bases, easiness in accessing the North-South corridor located in between the 2 cities and also the availability of developed irrigation areas extending along the said corridor.

4.3.2 Yield Potential for Improvement

Yields per a unit area of major crops planted in the priority areas are as shown in the Table 4.3.1. In the priority areas, monsoon rice planting is major in the wet season (upland rice is major in Shan), and beans are planted as the 2nd crop. People of Myanmar enjoys the taste of oil and therefore a variety of oilseed crops as groundnut, sesame and sun flower etc., are planted widely. There is no crop data, limited only to the irrigation area and the data shown in the table below represent the crop data at township level. From the table, the followings can be grasped:

1) The yields per a unit area of rice are high in Mandalay and Magway areas. In case of the monsoon season paddy, it is 93 baskets (4.8 ton/ha) for the former and 96 baskets (5.0 ton/ha) for the latter. Further, in the case of dry season rice favored with better conditions, it reaches to 104 baskets (5.4 ton/ha) and 101 baskets (5.2 ton/ha) for the same, respectively. While, the unit yield of rice is low in Ayeyarwady and Bago areas due to the damages caused by inundation. Shwebo area is one of the representative rice production areas, but the unit yield there remains at the national average. This is derived from the fact that about 60 % of the rice planting in the area is shared by such native varieties of Shwebo Paw San and Ayar Min (Unit yield of 80-85 baskets/ha ï hearing from DOA). It is noted further that the climate condition in Shwebo area is very suitable for rice farming and there is high possibility to increase the unit yield significantly by means of introducing timely supply of irrigation water.

2) For the beans, 2nd crop after rice harvest, the unit yield is low at Mandalay as compared with the other areas. Planting of black gram covers mere 1 % only of the paddy planting area and considered negligible, but green gram and chick pea planting cover substantial area of 8% and 14%, respectively. In case of green gram, the unit yield is 18 baskets/acre in Shwebo, while it is only 13 baskets/acre in Mandalay. As for chickpea, the unit yield is 25 baskets/acre in Shwebo and it is 17 in Mandalay. Reasons behind the low yield in Mandalay are yet to be known at present, though it is assumed that farmersômotivation to plant 2nd crop is rather limited due to the location at suburban area which enables to secure income from side jobs. At any rate, however, it can be noted that the possibility to increase the unit yield of beans is quite high in Mandalay area.

Table 4.3.1 Yields of Major Crops in the Priority Areas, basket per acre

Site	Paddy		Black gram		Green gram		Chick pea	
	M	S/ W	M	S/ W	M	S/ W	M	S/ W
Shwebo	85	94	17	19	16	18		25
Mandalay	93	104	12	12	12	13		17
Pump Irrigation	83	90		16	16	17		21
Magway West	96	101		18	16	19		18
Nay Pyi Taw	86	101		19	17	13	0	18
South Shan	71	92			12	14		15
Bago South - East	74	81		17		20		

Bago South - West	75	80		17		17		16
Ayeyarwady	66	95		17		16		
Site	**Groundnut**		**Sesame**		**Sunflower**		**Onion**	
	M	**S/ W**	**M**	**S/ W**	**M**	**S/ W**	**M**	**S/ W**
Shwebo	42	65	12	17	24	26		4,278
Mandalay	41	61	7	12	26	28	2,550	2,335
Pump Irrigation	45	65	8	15	22	27	3,111	4,548
Magway West	56	70	11	14	27	31		5,327
Nay Pyi Taw	49	53	7	10	25	24	0	3,395
South Shan	47	49	6		30	33	1,410	2,186
Bago South - East	53	62	8	9		19	0	0
Bago South - West	50	53	9	8		12	0	3,374
Ayeyarwady	44	52		17		26		

Source: Regional DOA office, blank column means no crop is planted, M means monsoon while S/W means summer and/or winter.

4.3.3 Possibility for Crop Diversification

In Myanmar, construction of irrigation facilities has been initiated aiming at supplementary irrigation purpose for the monsoon paddy planting. It was rather recent that irrigation facilities for summer paddy planting were constructed under the former regime. The first project for this purpose is Tabuhla irrigation project (30,344 acre) located about 60 km north-west from Yangon. The project was completed in the year 1995/06 and in recent years, there found some areas producing sesame with irrigation supply in place of summer paddy planting (for example, irrigation area in Magway region).

In the former time, single cropping of monsoon paddy was predominant in Myanmar, however, starting from early 1990ôs, black gram was introduced in Ayeyarwady delta and green gram in central and north areas and the production of beans had been expanded to a large extent aiming at exporting the same to India. After the above, it was in the year of early 2000ôs that chickpea was introduced in the north (Shwebo and etc.). It indicates, in fact, that the 2nd crop after rice is covered by beans in almost all irrigation areas, but actually beans are cultivated by using the residual moisture in soils with having no irrigation supply.

Cultivation of beans requires minimal farm labor input without fertilizer application. Therefore, farmers in many cases cultivate only monsoon paddy and beans in winter season without summer paddy. This is the case when farmers have some allowance in their living and/or facing labor shortage and even if irrigation water for summer paddy is available. The background of the above, priority for summer paddy is lower than beans, can be attributed to the farmersô comment in general that summer paddy requires investment but the income is low due to the low price and less attractive than beans in terms of B/C ratio.

Under the circumstances as mentioned above, for further extension of summer paddy production, priorities shall be given to grade up the rice quality and efficiency of rice milling so as to enable increasing of rice price. On top of this, there is a possibility to increase rather easily the unit yield of beans with having proper 1-3 times irrigation water supply. Further to mention, there is a possibility to introduce beans and/or sesame and groundnut under irrigation condition in place of summer paddy cropping.

In introducing irrigation supply for the winter cropping, there is one problem to overcome. The standard design of irrigation facilities applied at present provides outlet structure for each of 50 acre as the minimum and/or 100 acre, and farmers themselves are responsible for establishing small ditches connecting with the outlet for their water distribution to their paddy fields. In the past, however, farmers cultivated only monsoon paddy and never constructed the farm ditches, and as the result, there is no other way but to rely on basin irrigation, farm-to-farm irrigation, for their winter season

cropping.

In case of basin irrigation for the other crops than paddy, irrigation will cause inundation on the field located nearby the canal and as the result no irrigation can be practiced for winter cropping so as to leave the cultivation of beans with the residual moisture in soils only. This indicates the need for providing farm ditch system before practicing irrigation water supply for summer non-paddy cropping and for winter cropping.

Other than the above, there is possible cropping of lowland vegetables such as egg plant, cucumber, gourd, onions and water melon etc.; but these are not suited for mass production under the basin irrigation condition which is the major means under gravity system irrigation. It may be necessary to apply other irrigation method through introducing deep furrow while utilizing the irrigation water from canals. For instance, furrow would be provided and furrow irrigation be practiced and/or cultivation can be possible by supplying water by man-power watering can. Toward the crop diversification to be developed in future, there considered several methods available.

Taking the above into consideration, the current cropping status in and around the priority areas is reviewed below. It is noted that in Myanmar only irrigation acreage data are available in the irrigation project area and therefore the cropping data are of each Township level. Accordingly, the cropping data indicate crops cultivated in each Township which includes both crops cultivated within the irrigation area and outside of the irrigation area yet within the same township.

The Figure 4.3.2 shows the shares of cultivation areas of each crop in the subject areas. From the figure, it can be confirmed that paddy cropping is the main followed by beans as the 2nd crop in all the areas except the case of pump irrigation area. In Ayeyarwady delta and Bago areas where rainfall is more than the other areas, the number of crops cultivated is much less.

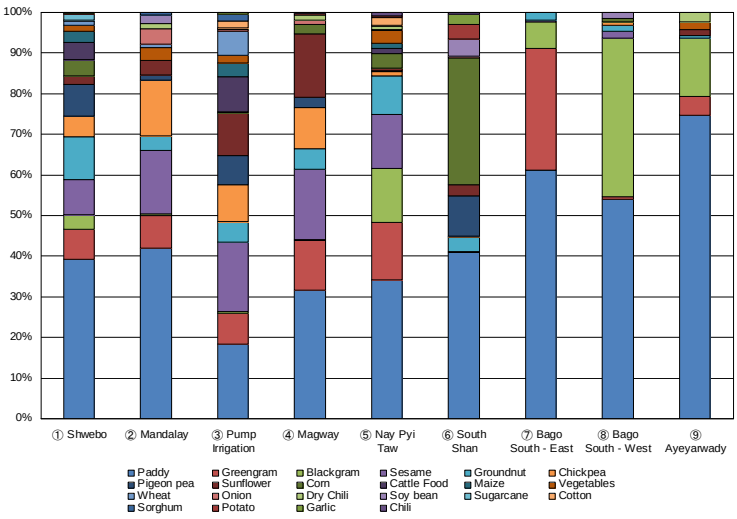


Figure 4.3.2 Share of Crops Sown by Priority Area
Source; Regional Department of Agriculture

On the other hand, in the central and north region areas like Mandalay and Shwebo where rainfall is less, the number of crops cultivated is much more in addition to the paddy and beans. In Magway, the number of crops cultivated is considerable but less than Shwebo and Mandalay. In view of the foregoing, it can be said that crop diversification can be achieved with less difficulty in the central-north regions where rainfall amount becomes less. This is particularly true in the suburban area of Mandalay, one of the largest consumption areas in the country.

4.3.4 Needs of Irrigation Facility Rehabilitation

The needs for rehabilitation of irrigation facilities (in Ayeyarwady, drainage improvement is main.) have been examined through hearing from the related Field Maintenance Division Offices of ID. Canal lining is the most needed rehabilitation work in most cases. Normally, the canals constructed by ID are of non-lining due to the lack of budget availed. As is the case, slope collapsing and siltation occurred often on the sections where soil embankment material is of sandy nature.

In addition, the needs for rehabilitation include additional lining for the upstream and downstream

canal stretches of hydraulic structures, providing bridges over canals which is useful for O&M purpose and improvement for the peopleôs living conditions and further improvement of intake facility attached to the dam structures, e.g., replacement of gate and sealing for water-tight sections.

When over-viewing the overall irrigation facilities, those old facilities in more need of rehabilitation works are in Shwebo, Mandalay and Magway West areas where intake weirs and canals were constructed during the colonial period. That is, the construction works were completed in the early 1900ôs (Kabo weir in Shwebo in 1905, for example) and thereafter reservoir dam was constructed in the upstream by ID[4].

As for Shwebo, Mandalay and Magway areas, the facilities have been operated comparatively in good condition with due O&M activities to date. However, about 100 years period has passed and the facilities are in need of improvement/rehabilitation works on the variety of hydraulic structures and lining works for the canal sections with sandy nature of embankment material. Table 4.3.2 summarizes the costs for rehabilitation works both for canal linings and hydraulic structures.

Table 4.3.2 Rehabilitation Cost and Unit Area Investment

Area/ Scheme	Project Name	Weir/Sluice	M. Canal	Dy Canal	Road	Others	Total	Beneficial Area	Total Cost per Unit Area	
		M.Kyat	M.Kyat	M.Kyat	M.Kyat	M.Kyat	M.Kyat	(acre)	Kyat/ ac	Kyat/ ha
Sagaing (Shwebo)	**Thapanseik**	**9**	**22,995**	**1,810**	**95**	**48**	**24,957**	**128,560**	**194,127**	**479,706**
	RMC (Ye-U)	0	22,995	1,164	85	10	24,254	104,915	231,10	**571,267**
	SMC (Shwebo)	9	0	646	10	38	703	23,645	29,719	**73,438**
Mandalay	**Mandalay**	**556**	**35,596**	**25,637**	**0**	**2,170**	**63,958**	**325,686**	196,380	**485,273**
	Sedawggyi	0	17,349	14,639	0	1,450	33,438	96,079	348,025	**860,000**
	Zawgyi	106	7,429	3,885	0	154	11,575	82,333	140,584	**347,397**
	Kinda	450	10,817	7,113	0	566	18,946	147,274	128,643	**317,888**
Chind.-Ayeyarwady						**25,717**	**25,717**	**56,548**	454,776	**1,123,791**
	Tatywa Pump					2,717	2,717	16,548	164,168	**405,673**
	Yebutalin Pump					23,000	23,000	40,000	575,000	**1,420,876**
Magway West		**612**	**8,782**	**8,124**	**1,794**	**6,629**	**25,940**	**156,725**	165,513	**408,998**
	Man	74	2,947	960	558	3,591	8,130	39,770	204,427	**505,157**
	Mone	318	3,687	6,549	1,056	2,716	14,325	82,623	173,383	**428,444**
	Salin	220	2,148	614	180	323	3,485	34,332	101,498	**250,810**
Nay Pyi Taw		**3,136**	**6,190**	**10,537**	**1,497**	**446**	**21,806**	**108,440**	201,087	**496,904**
	Sinthe	3,136	2,060	342	222	30	5,790	32,400	178,713	**441,616**
	Yezin	0	0	2,845	0	0	2,845	15,850	179,495	**443,549**
	Paunglaung	0	3,996	783	0	0	4,779	35,000	136,543	**337,409**
	Ngalaik	0	133	6,567	1,276	416	8,392	25,190	333,132	**823,199**
Shan South							**NA**	**39,906**		
	A.Hopong Valley						NA	23,795		
	B.Taunggyi Area						NA	9,584		
	C. Nyaungshwe						NA	6,527		
Bago South-East		**24,403**	**26,662**	**11,422**	**1,864**	**888**	**65,239**	**147,031**	443,711	**1,096,449**
	Baingda	103	1,090	2,476	960	383	5,011	24,745	202,504	**500,404**
	Kawliya						NA			
	Bawni						NA			
	Pyinbon (Not ID)						NA			
	Warkatoke (No area)						NA			
	Zaungtu	5,150	15,902	8,947	765	505	31,268	28,329	1,103,756	**2,727,479**
	Bago - Sittaung	750	8,024	0	0	0	8,774	28,957	303,001	**748,742**
	30 Miles Greening	18,400	1,647	0	140	0	20,186	65,000	310,554	**767,406**
Bago South-West							**NA**	**137,870**		
	Gamone						NA	12,000		
	Minhla						NA	11,725		

[4] For Thapanseik dam with the largest storage volume was completed in 2001/02; 3 dams in Mandalay in 1986/87-1997/98, and 3 dams in Magway in 1999/2000-2006-07.

	Sintkuchaunggaung						NA	810		
	Kantinbeelin						NA	26,374		
	Thekaw						NA	9,372		
	Thonese						NA	42,003		
	Tabuhla						NA	35,586		
						6,679	**7,131**	**85,477**	83,426	**206,153**
	Ngawun River (Thabaung TS)									
	Kyaunggone Flood Plain Drainage (39 miles)									
Ayeyarwady	Shwe Laung Polder	122				3,033	3,155	48,648	64,854	160,259
	Thonegwa									
	Bitut (4) Polder	330				476	806	25,229	31,947	**78,945**
	Kyun Nyo Gyi Island (Ngapudaw TS)					3,170	3,170	**11,600**	273,276	**675,289**

Source: ID Regional Maintenance Division, Construction Circle

Concerning the Shan South and Bago South-West areas, no costs are shown in the table as the project do not require large scale rehabilitation works. When looking into the rehabilitation cost for each area, it is estimated at 7 ï 65 billion kyats by area. When getting the unit cost per a unit area through dividing the overall rehabilitation cost by the beneficial irrigation area, it is about 206,000 kyats (Ayeyarwady) to 1.1 million kyats (Bago South-East, also Chindwin - Ayeyarwady). The areas of lower investment cost include Ayeyarwady where main works are drainage improvement and flood protection, followed by Nay Pyi Taw, Shwebo, Magway West, Mandalay and then Bago South-East in order, excluding pump irrigation area.

Under the rehabilitation project, the benefits to be obtained may vary depending on the increase of yield per a unit area and the extent of crop diversification for high value added crops. However, in normal case, benefits exceeding the opportunity cost can not be obtained if the investment cost could not stay at lower than $1,500-$2,000 per ha[5]. In view of this, the estimated cost of 206,000 ï 1,100,000 kyats per ha for the subject rehabilitation project is considered to be very low. This can be contributed to the manner of subject estimation including basic items for rehabilitation related with the irrigation facilities only and not including the costs for construction of farm road and bridges needed and also the costs for marketing facilities related. As is the case, there is a possibility that the estimated rehabilitation project cost may increase finally up to 1.5-2.0 times of the present estimation.

4.3.5 Potential of Expanding Irrigation Area

Irrigation scheme is generally categorized into two; 1) ones with dam reservoir which enables dry season irrigation aside from supplemental irrigation during rainy season, and 2) ones withdrawing water from river. The latter category is further divided into two; 1) pump irrigation scheme and 2) river water diversion scheme which can be seen in Shan South area. Irrigation schemes deployed in Chindwin ï Ayeyarwady rivers are pump schemes and those in Shan South and southern part of Bago South-East are diversion scheme. Irrigation schemes in Ayeyarwady area is complicated; primary purpose is flood protection and inundation reduction, and partly gravity irrigation and pump irrigation during most of the dry seasons.

This sub-chapter explores the potential of expanding irrigable area in two ways. One is that simple comparison between the dam reservoir storage and irrigable area is made. A ratio of dam storage over irrigable area would provide a sort of potential as per how much possibility we can still have in expanding irrigation area by comparison amongst the selected areas. Next way is to estimate how much summer paddy area could have been actually irrigated with the remaining dam reservoir volume at the beginning of dry season. This estimated maximum potential irrigable area is compared with the actual summer paddy area irrigated/ cultivated. The formula of estimating the maximum potential irrigable area is as follows:

[5] In case of Bago West Yen Loan project, investment cost is 15 Billion Yen for the beneficiary area of about 100,000 ha, indicating the unit cost per ha at 150,000 Yen.

Area1 which could have been irrigated with reservoir water at the beginning of dry season =
(STeff at the beginning of dry season ï 1 ac-ft x next yearôs Monsoon Irrigable Area (ac)) / 5 ac-ft
Area2 which could been expanded with the above water =
Area1 ï Summer Paddy Area which had been actually irrigated in the year.

Where:

1 ac-ft is the water requirement utilized for monsoon paddy preparation (note other monsoon paddy requirement is assumed to be provided by rainfall)

5 ac-ft is the water requirement utilized for summer paddy irrigation

An example of calculation is encoded in the following table, a case of Zawgyi irrigation system in Mandalay region. In this example, above Area1 and Area2 were estimated for the period of year 2007 ï 2013, from which one may see the possibility of expanding irrigation area with the water still available at the beginning of that dry season. The ratio between Area1 and the actually irrigated summer paddy area ranges from 0.06 to 3.95, giving an average of 1.69. Therefore, it can be assumed that if the water had been fully utilized for the period, the irrigable area for summer paddy could have been 1.69 times more as average over the period.

Table 4.3.3 Flow of Estimating Maximum Potential Irrigable Area of Summer Paddy

Year	Effect. Capacity (ac-ft)	Monsoon Paddy ac	Summer Paddy ac	C	Area1 D	Area2	D/B
	A	B	-	An - B(n+1)	C/5	-	
2007	413,264	79,833	32,340	334,466	66,893	34,553	2.07
2008	273,104	78,798	31,057	194,208	38,842	7,785	1.25
2009	73,139	78,896	17,291	5,140	1,028	-16,263	0.06[6]
2010	250,568	67,999	27,924	183,456	36,691	8,767	1.31
2011	481,991	67,112	21,004	414,753	82,951	61,947	3.95
2012	285,620	67,238	24,780	216,381	43,276	18,496	1.75
2013	173,572	69,239	18,895	112,445	22,489	3,594	1.19
2014	86,341	61,127	44,031				
Total		570,242	217,322	(38%)		118,879	1.69

Source: JICA Survey Team based on Dam Operation Data provided by ID Maintenance Office

The results are summarized in the following table. In terms of reservoir volume and irrigable area, the biggest value shows up in Shwebo area (5.66), followed by Magway West (5.02). Others are just below 4.0 such as 4.85 for Mandalay, 4.94 for Nay Pyi Taw , 4.82 for Bago South-East, and 4.89 for Bago South-West. It is observed that the values are not much different amongst the areas though Shwebo and Magway West, with more than 5.0 value, may present higher potential to expand the irrigable area.

In terms of D/B value, the ratio between the area which could have been irrigated with the remaining dam reservoir volume at the beginning of dry season and the area of what has actually been irrigated, 2 areas located in southern part of the country show very high value; e.g. 5.45 for Bago South-East and 5.83 for Bago South-West. These areas have big potential of expanding irrigable area; however, the farmers in the Bago South-West area are not much interested in cultivating summer paddy due mainly to the low profit according to interview results. In Bago South-East area, there could be expansion if the irrigable area were to extend over Yangon-Mandalay old road.

[6] According to the calculation, Area1 is only 1,028 acre while actually irrigated summer paddy area in the year 2009 is 17,291 acre which is far bigger than the potentially irrigable area. This may be that the monsoon paddy area of 78,896 acres may have not been provided with any land preparation water since the damôs reservoir volume available at the year 2009 was only 73,139 ac-ft.

On the other hand, looking at 3 areas deployed in northern and western part of the country, such as Shwebo, Mandalay and Magway West, the D/B values are not big but only just over 1.0. For example, Shwebo presents 1.20 and Mandalay area does only 1.05, and further Magway West provides only 1.01. These small values imply that the dams have been almost fully utilized, so that there is not much potential of further expanding the irrigable area. Especially, Magway Westôs D/B value is only 1.01, presenting minimal expansion possibility. Note that Nay Pyi Taw area provides 1.17 D/B value, this could be further increased upon inclusion of Paunglaung dam (in this estimation, not included).

Table 4.3.4 Potential of Expanding Irrigable Area by Reservoir Capacity and Available Water

Priority Area	Irrigable Area, ac	Reservoir V/ / I.A.*1	D/B (see above table)*2
Shwebo	(491,687) / 128,560	5.66	1.20
Mandalay	325,686	4.85	1.05
Chindwin ï Ayeyarwady (Pump)	56,548	NA (no dam)	NA (no dam)
Magway West	156,725	5.02	1.01
Nay Pyi Taw	108,440	4.94	1.17*3
Shan South	39,906	NA (no dam)	NA (no dam)
Bago South - East	176,7931	4.82	5.45 (Baingda only)
Bago South - West	137,870	4.89	5.83
Ayeyarwady	155,871	NA (no dam)	NA (no dam)

Note: *1: Reservoir volume divided by Irrigable Area (no dimension).
*2: D/B means potential of expanding summer paddy area based on the possible maximum irrigable area with the dam reservoir volume at the beginning of dry season and the area of what has been actually irrigated.
*3: excluding Paunglaung dam (reservoir capacity of 340 MCUM effective), if Paunglaung dam included, the D/B would be bigger.
Source: JICA Survey Team, calculated based on the data of dam operation and irrigated area provided by ID regional Maintenance Division.

4.3.6 Examination from Internal Rate of Returns

This section carries out project evaluation by examining a project economic feasibility in terms of benefit accrued against the investment, the project cost. To judge the feasibility, EIRR (Internal Rate of Return), B/C ratio and also NPV (Net Present Value) have been employed in most cases of exploring project viability. Here, what are employed to judge the viability are IRR and NPV without considering opportunity cost of capital as a preliminary step of examining which project(s) is more cost-effective in comparison across all the 2nd-screened 6 projects.

1) Conditions of Evaluation

A major component of the intensive agriculture promotion program is to rehabilitate irrigation facilities such as intake, diversion weir, canal, hydraulic structure including sluice gage, maintenance road, etc. Though there are other components to be included in the program, which are; agriculture extension, promotion of food value chain, establishment of whole sale market, etc., the basic component which will need the biggest investment is for the facilities related to irrigation. Therefore, at this stage, cost only for the irrigation rehabilitation and benefit expected only out of irrigation rehabilitation are taken into consideration. The following are the basic assumptions of the viability evaluation amongst the 2nd-screened projects:

1) Referring to other similar projects in the irrigation/agriculture sector, the economic life of the Project is in most cases designed at 30 years. It means that viability evaluation is encoded over a period of 30 years considering the initial investment and also operation and maintenance costs to be accrued. For the operation & maintenance cost, 1%, 2% and 3% of the initial investment cost is counted as the base case respectively for the priority areas excluding Bago South-East and Ayeyarwady, Bago South-East where dredging is frequently required for Bago-Sittaung canal and 30 miles canal, and Ayeyarwady delta where dredging is the most frequently needed.
2) Only above direct investment related to irrigation rehabilitation is counted as project cost, and

other costs are not considered at all in the following examination. Therefore, not only other program component costs such as agriculture extension and value chain improvement but other supportive costs, e.g., transfer costs such as tax and duties, price contingency (inflation) cost, physical contingency cost, consultancy cost, etc. are not considered either.

3) Prices employed in the evaluation refer to the prevalent market ones in early part of year 2015. It is noted that since the examination here is to see the viability in comparison of all those 2nd-screened 6 projects, conversion factors into economic value is not undertaken. Therefor, the discussion in this section centers on which projects would bear more benefit as compared to other remaining projects, not objectively judge the viability against opportunity cost of capital.

4) Scenario of the benefit accrued out of the project investment is presented in the following 4 stories as:

- ✓ Base 0: Yields of monsoon paddy and summer paddy are to increase to the mid point of between the current yields and practically expected ones[7], which have been achieved within the same areas given better water management and farm management (refer to Table 4.3.5). In this Base 0, no expansion of irrigable area is counted.

Table 4.3.5 Current Yield and Expected Yield by Area and by Variety

Area	Monsoon Paddy, bsk/ac		Summer Paddy, bsk/ac		Black gram, bsk/ac		Green gram, bsk/ac	
	Variety	Expected Yield	Variety	Expected Yield	Variety	Expected Yield	Variety	Expected Yield
Shwebo	Current	85.43	Current	93.88	Current	18.60	Current	18.26
	Shwe Bo(55%)	100.00	Shwe Sel Yin(50%)	115.00	Yezin-3	25.00	Yezin-14	25.00
	Ayar Min(45%)	100.00	747 variety(50%)	115.00				
Mandalay	Current	93.13	Current	104.10	Current	12.34	Current	12.88
	Manaw Thu Kha(50%)	100.00	Manaw Thu Kha(50%)	120.00	Yezin-2	20.00	Yezin-14 45%	20.00
	Ayar Min(50%)	110.00	Shwe Thwe Yin(50%)	120.00			Yezin-11 55%	20.00
Magway West	Current	95.83	Current	100.90	Current	18.18	Current	19.35
	Ayar Paday Thar(55%)	100.00	Manaw Thu Kha	120.00	Min Hla Tun	25.00	Yezin-5	20.00
	Manaw Thu Kha(45%)	100.00					Yezin-4	20.00
Nay Pyi Taw	Current	86.18	Current	101.31	Current	19.13	Current	13.37
	Manaw Thu Kha	100.00	Shwe Thwe Yin	120.00	LBG-17	19.00	Yezin-9	20.00
Bago S-East	Current	73.87	Current	81.47	Current	16.96	Current	19.88
	Yadanar Toe(50%)	100.00	Yadanar Toe(60%)	120.00	Yezin-2	20.00	Yezin-14 50%	25.00
	Sin Thu Kha(50%)	100.00	Thai 90 days(40%)	120.00	Yezin-3	23.00	Yezin-11 50%	25.00
Ayeyarwady	Current	66.01	Current	95.42	Current	16.58	Current	15.81
	Sin Thu Kha	80.00	Thi Htat Yin	110.00	Yezin-3	23.00	Wakema Sein 40%	20.00
							Yezin-11 30%	20.00

Source: JICA Survey Team

- ✓ Base 1: With rehabilitation and better reservoir operation, there should be extra irrigation water to be availed. With this, there is an opportunity of enlarging summer and/or winter crop cultivation. Note that since monsoon paddy is planted almost over the whole irrigable area, no expansion of monsoon paddy should be undertaken. In this Base 1, instead, pulses cultivation area and respective yields are to increase taking advantage of newly generated irrigation water. Expansion of pulses area is counted according to the water requirement of pulses, usually one-third of what paddy requires, and the newly generated irrigation water. Whereas, yield increase of pulses is assumed same as the case of paddy.
- ✓ Base 2: Based on the same assumption as the of Base 1 case, the newly generated irrigation water is now utilized in expanding summer paddy cultivation (see Table 4.3.6), equivalent to one-third area of what the pulses have been increased (note that irrigation requirement of summer paddy is usually 3 times more than that of pulses). In this case, yield increase is

[7] Expected yields have been assumed based on the data reported by regional DOA officers in charge of the irrigation area.

also counted as that of the Base 0 case; namely, yields of monsoon paddy and summer paddy including the expanded area are to increase to the mid point of between the current yields and practically expected ones.

Table 4.3.6 Increase in Summer Paddy Cultivation Area

Area	Potential S. P./ Actual S. P.	M. Paddy	S. Paddy	Ratio	Base 0 Case		Base 2 Case S.P. to Increase		Incre.[8]
		acre	acre	%	M.P. ac	S.P. ac	M.P. ac	S.P. ac	%
Shwebo	1.20	126,912	71,664	56	126,912	71,664	126,912	78,903	110%
Mandalay	1.05	256,692	142,688	56	256,692	142,688	256,692	159,680	112%
Magway West	1.01	145,088	89,550	62	145,088	89,550	145,088	92,487	103%
Nay Pyi Taw	1.17	68,261	24,705	36	68,261	24,705	68,261	38,076	154%
Bago South-East	NA	133,335	13,748	10	133,335	13,748	133,335	42,529	309%
Ayeyarwady	NA	68,300	17,552	26	68,300	17,552	68,300	19,055	109%

Note: Increased area for pulses are three times more than that of acre of S.P. to Increase.
Source: JICA Survey Team

- ✓ Base 3: A certain share of the summer paddy area is assumed to change to lowland vegetable areas. In fact, areas where there is much amount of rainfall have difficulty of diversifying the crops even during winter and summer season since soils in those areas are very often of clay or silt ones not conducive for vegetable cultivation. Therefore, different assumption in terms of diversification from summer paddy area to vegetable area has been undertaken; namely, 10% for Mandalay area, 7% each for Shwebo area and Nay Pyi Taw area, 5 % each for Magway and Bago South-East, and 3% for Ayeyarwady area, taking into account the vicinity level to populated areas as well.

2) Results of the Return Estimation

Figure 4.3.3 summarizes the IRRs estimated for the 6 areas by case, and Table 4.3.7 details the conditions for the estimation. Following can be observed:

1) At a glance is that Bago South-East shows the lowest returns for all the cases, namely only from 1.9% for the Base 0 in which only yield increase of monsoon and summer paddy was considered to 16.3% for the Base 3 where 5% of crop diversification was assumed to vegetables from summer paddy. This low returns are mainly due to the highest invest cost per acreage among the 6 priority areas, i.e., US$ 489 per acre.
2) Shwebo area and Ayeyarwady area show higher returns than others. In Shwebo area, summer paddy production can be increased by 22% thanks to the additional cultivation area based on the newly generated irrigation water and also the relatively higher yield increase expected in that area. Also, 7% of the crop diversification area has contributed to increase the rerun in the case of Base 3. On the other hand, the high returns in Ayeyarwady area are attributed to the lowest investment cost per acreage, US$ 104. Concrete works, e.g. canal lining, is not expected in Ayeyarwady area, and therefore the investment cost is relatively low as compared to other areas.
3) In comparing Mandalay and Magway West, the range of returns is somewhat similar. However, when looking at the Base 0, the return for Magway West is much higher than that of Mandalay area while for the rest of the cases of Base 1, Base 2 and Base 3, the returns are reversed. The returns for Mandalay area become higher than those of Magway West. This is because there is

[8] For Nay Pyi Taw area, monsoon paddy area was assumed at 80% of the planned one upon completion of the canal construction, say 28,000 acre against the planned 35,000 acre. For the summer paddy, half of the 28,000 acre was assumed as there is enough irrigation water in the reservoir. For the Bago South-East, Baingda dam and Zaungtu weir command areasôsummer paddy was assumed to increase up to double of current area though there is more water in the reservoir (this is because farmers may not prefer to engage in summer paddy cultivation as observed in Bago South-West due to low margin). For the Bago-Sittaung canal area and 30 miles canal area, half of the monsoon paddy area was assumed to cultivate summer paddy.

little water newly available in Magway West area, so that there is very limited potential to increase the cultivation area of summer paddy and also pulses. In addition, crop diversification in Magway West was assumed lower than that of Mandalay, say 5% vs. 10%, and accordingly return out of Base 3 for Magway West is not as high as that of Mandalay.

4) With respect to Nay Pyi Taw area, though the Base 0 shows the 2nd lowest return after Bago South-East, the increments for the cases of Base 1, Base 2 and Base 3 from the Base 0 are much higher than others. This is due mainly to the mid and downstream area of Paung Laung irrigation scheme. Pung Laung irrigation scheme is designed to irrigate a total paddy field of 35,000 acre during monsoon season while actually irrigated area for the last 5 years is only 4,106 acre. Till year 2013/14, approximately MUS$ 50 had been invested in Paung Laung irrigation scheme; however no budget allocation was made in the latest year of 2014/15, leaving unfinished parts along the main canal. Therefore, given an additional 4.8 billion Kyats, the Paung Laung irrigation scheme is expected to compete, benefiting huge monsoon paddy and summer paddy area. Base 0 considered yield increase only for the presently irrigated area while other cases took into consideration the to-be-newly irrigated area upon completion of the mid-downstream portion.

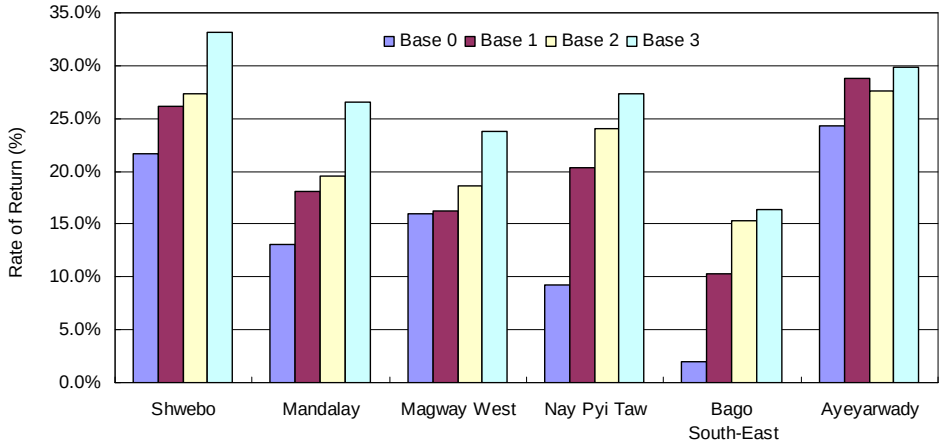


Figure 4.3.3 Comparison of Returns among the 6 Areas by Case

Source: JICA Survey Team

Table 4.3.7 Comparison of Returns among the 2nd-Screened 6 Priority Areas

Cases	Indices	Shwebo	Mandalay	Magway	Nay Pyi Taw	Bago South-east	Ayeyarwady
Base 0	IRR	21.7%	13.1%	15.9%	9.2%	1.9%	24.3%
	NPV	7.7	-5.2	1.1	-5.2	-30.1	3.1
Base 1	IRR	26.2%	18.1%	16.3%	20.3%	10.2%	28.7%
	NPV	13.4	8.9	1.5	5.4	-12.7	4.7
Base 2	IRR	27.4%	19.6%	18.7%	24.1%	15.4%	27.7%
	NPV	15.0	13.4	4.3	9.4	1.0	4.3
Base 3	IRR	33.1%	26.5%	23.8%	27.3%	16.3%	29.8%
	NPV	22.7	35.6	10.8	13.0	3.8	5.1

Title	Shwebo	Mandalay	Magway	Nay Pyi Taw	.Bago South-east	Ayeyarwady
Area Increase						
Monsoon Paddy						
Current(Ac)	126,912	256,692	145,088	44,368	133,335	68,300
Planned(Ac)	126,912	256,692	145,088	68,261	133,335	68,300
Increase(Ac)	0	0	0	23,893(*1)	0	0
Summer Paddy(Ac)						
Current(Ac)	71,664	142,688	89,550	24,705	13,748	17,552
Planned(Ac)	78,903	159,680	92,487	38,076	42,529	19,055
Increase(Ac)	7,239	16,992	2,937	13,371	28,781	1,503
Vegetable(Ac)						
Current(Ac)	0	0	0	0	0	0
Planned(Ac)	5,523	15,968	4,624	2,665	2,126	572
Diversification Ratio(%)	7.0%	10.0%	5.0%	7.0%	5.0%	3.0%

Production Increase						
Monsoon Paddy						
Current(bsk/ac)	85.4	93.1	95.8	86.2	74.9	66.0
Planned(bs/ac)	100.0	105.0	100.0	100.0	90.0	80.0
Percentage(%)	117	113	104	116	120	121
Summer Paddy						
Current(bsk/ac)	93.9	104.1	100.9	101.3	81.5	95.4
Planned(bsk/ac)	115.0	120.0	120.0	120.0	120.0	110.0
Percentage(%)	122	115	119	118	147	115
Pulses and Beans						
Current(bsk/ac)	18.3	12.9	19.4	13.4	19.9	16.6
Planned(bsk/ac)	25.0	20.0	20.0	20.0	25.0	23.0
Percentage(%)	137	155	103	150	126	139
Cost, MUS$	25.0	64.0	25.9	21.8	65.2	7.1
Cost per Acre, US$	197	249	179	319	489	104

Note: *1: Paung Laung Irrigation Scheme currently irrigates only 4,106 acre and after the completion of the canal construction, a total of 28,000 (designed 35,000 acre x 80%) acre is expected to irrigate, increasing an additional area of 23,893 acre.
Source: JICA Survey Team

From the view point of rerun against investment, it is recommended not to select Bago South-East area, since this area presents the lowest return, i.e. only 1.9% for the Base 0, and 10.2%, 15.4% and 16.3% for Base 1, Base 2, and Base 3 respectively. These returns are approximately 10% lower than those of other priority areas. Though Bago South-East area is located in the vicinity range of Yangon, the most populated city in Myanmar, whereby entailing possibility of promoting intensive agriculture, the lowest reruns hardly justify to take up this area as one of priority areas as far as economic return is concerned.

Comparing the Mandalay area and Magway West area, the increment in the latter area is very low due to little possibility of enlarging the irrigable area constrained by limited water source. Also, Magway West is located in remote area, making harder to promote intensive agriculture accompanied with value chain development. Alike, it is also recommended not to select Magway West area. Therefore, as far as return against investment is concerned, Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady areas are recommended.

3) Increase on Farmer Level

Net income increase is estimated for a 10 acre farmland and also for a typical average farmer household in each of the 2nd-screened 6 priority areas. Figure 4.3.4 shows expected net income per 10 acre farmland while Figure 4.3.5 illustrates net income as per a typical average farmer household. The result in the latter figure is very much dependent on the average size of the farmland that the typical farmer household owns.

Net profit per 10 acre farmland ranges approximately US$ 1,500 to as high as US$ 3,500. The lowest profit shows up in Bago South-East area and Ayeyarwady area, much lower than the profits of other 4 areas. Since the yield of monsoon paddy is not high in these areas, e.g. 75 baskets per acre and 66 baskets per acre for Bago South-East and Ayeyarwady respectively, the net profit results in lower level accordingly. As the increase of

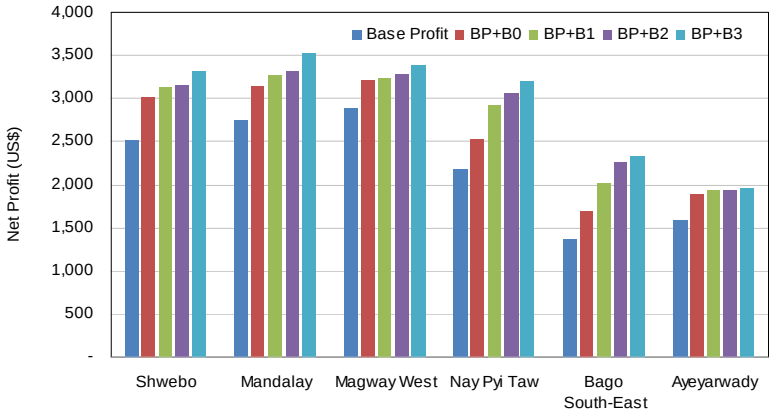


Figure 4.3.4 Net Profit per 10 Acre Farmland by Case and Area
Source: JICA Survey Team

summer paddy is difficult in Ayeyarwady area, unless otherwise farmers use engine-pump, smaller increase in summer paddy and pulses was assumed in Ayeyarwady area whereby almost no increase from Base 0 case towards Base 3 case.

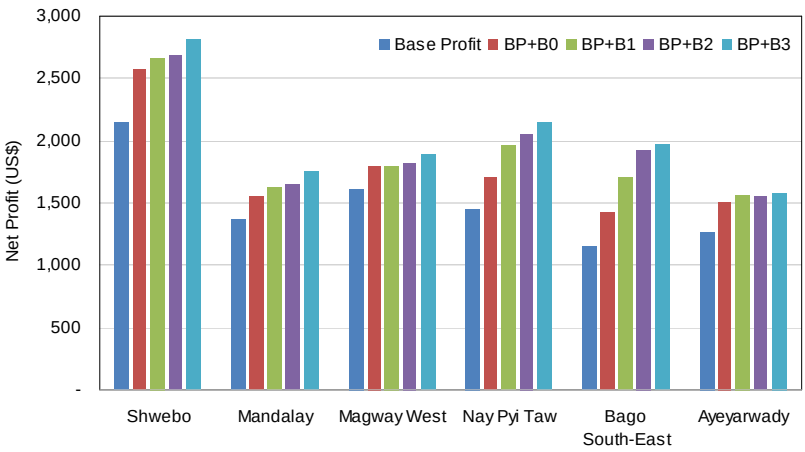


Figure 4.3.5 Net Profit per Typical Average Farmer Household
Source: JICA Survey Team

Net profit for the areas of Shwebo, Mandalay, and Magway West are almost comparable within the range of US$ 2,500 to US$ 3,500 depending on the area and case. Net profit of Nay Pyi Taw area is somewhat smaller than those of the afore-mentioned 3 areas. This is mainly due to lower yield of paddy in Nay Pyi Taw area. For example, yield of monsoon paddy in Nay Pyi Taw area is 86 baskets per acre while that of Mandalay is 95 baskets per acre.

With respect to net income per average farmer household, such acreage of farmland was applied as; 8.51 acre, 4.97 acre, 5.57 acre, 6.71 acre, 8.45 acre and 8.01 acre for Shwebo, Mandalay, Magway West, Nay Pyi Taw, Bago South-East, and Ayeyarwady respectively[9]. Since the farmland owned by farmers is the biggest in Shwebo area (8.51 acre), the net income in Shwebo area accordingly shows the highest income, ranging from about US$ 2,200 to about US$ 2,800. Bago South-East shows the second largest farmland per famer household (8.45 acre), so that the lower net profit illustrated in Figure 4.3.4 is inflated, comparable to other areas. Though Ayeyarwady areaôs net income has increased due to the third biggest farmland area (8.01 acre), it is still lower than the others especially given the assumption that summer paddy is not enlarged.

4.3.7 Examination from Poverty Ratio Viewpoint

UNDP conducted a survey on poverty profiling in Myanmar in the years 2010 and 2015, as titled Integrated Household Living Conditions Survey in Myanmar, 2009-2010, Poverty Profile, June 2011. The survey results are tabulated in Region-wise and State-wise and the results derived from 2005 and 2010 are compared as indicated below in Table 4.3.8.

The results show the conditions of each region areas related with the priority areas under the subject project. The poverty ratios are high in Ayeyarwady (33.9% in rural area) and in order the same is followed as Mandalay (31.6%), Shan South (31.2%), Magway (28.2%) and Bago East (20.1 %). When looking at the decreasing rate from 2005, Magway rural area shows the highest decrease of 15.7% from 43.9% in 2005 to 28.2% in 2010. On the other hand, in Ayeyarwady rural area , the poverty ratio increased up to 33.9% in 2010 from 30.3% in 2005.

In view of the above, showing the poverty ratio in rural areas, development assistances for Ayeyarwady (33.9%) should be given with higher priorities. It is noted that the poverty ratio in Mandalay is comparatively high at 31.6%. This is due probably to the higher ratio in the dry zone area where natural conditions are rather severe and the higher poverty ratio in this specific area causes

[9] Source: Report on Myanmar Census of Agriculture 2010 (SLRD): the average farmland per farmer household is at the level of region, since farmland figures and number of farmer households by irrigation scheme were not available. Also, data for Nay Pyi Taw was not available, and therefore average farmland area of Mandalay and Bago East was applied.

higher ratio in the Mandalay region as a whole. Therefore, it can be noted that the poverty ratio in the south of Mandalay city selected as one of the priority areas under the subject project may not be so high.

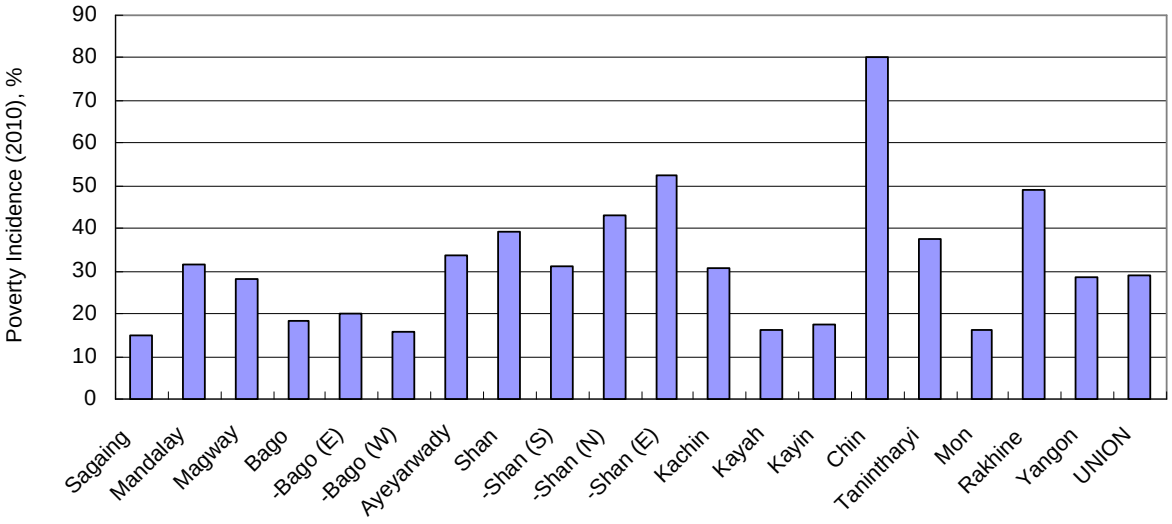


Figure 4.3.6 Poverty Ratio by Region and State in Myanmar (2020)

Source: UNDP Integrated Household Living Conditions Survey in Myanmar, 2009-2010, Poverty Profile, June 2011

Table 4.3.8 Poverty Ration by Region and State in Myanmar (2005, 2010)

State, Region and Union	Urban		Rural		Total	
	2005	2010	2005	2010	2005	2010
Sagaing	21.9	16.0	27.4	14.9	26.6	15.1
Mandalay	24.1	14.1	44.7	31.6	38.9	26.6
Magway	25.8	15.8	43.9	28.2	42.1	27.0
Bago	30.7	19.0	31.8	18.2	31.6	18.3
-Bago (E)	34.8	20.9	30.2	20.1	30.9	20.2
-Bago (W)	23.1	15.6	33.8	15.9	32.6	15.9
Ayeyarwady	24.4	23.1	30.3	33.9	29.3	32.2
Shan	31.0	14.1	50.5	39.2	46.1	33.1
-Shan (S)	26.1	8.3	44.5	31.2	40.2	25.2
-Shan (N)	34.7	16.3	55.0	43.1	50.6	37.4
-Shan (E)	37.1	28.6	56.0	52.3	51.8	46.4
Kachin	37.7	23.4	46.8	30.6	44.2	28.6
Kayah	26.1	2.3	38.2	16.3	33.6	11.4
Kayin	7.8	16.8	12.5	17.5	11.8	17.4
Chin	45.9	52.1	80.9	80.0	73.3	73.3
Tanintharyi	20.8	16.7	37.2	37.5	33.8	32.6
Mon	22.5	17.8	21.3	16.0	21.5	16.3
Rakhine	25.5	22.1	41.2	49.1	38.1	43.5
Yangon	14.4	11.9	17.4	28.7	15.1	16.1
UNION	21.5	15.7	35.8	29.2	32.1	25.6

Source: UNDP Integrated Household Living Conditions Survey in Myanmar, 2009-2010, Poverty Profile, June 2011

4.3.8 Concern with Polar Growth Strategy

ERIA (Economic Research institute for ASEAN and East Asia) made a model analysis (IDE Geographical Simulation Model: IDE-GSM) in its study on the economic development in Myanmar in terms of GDP growth rate for the whole nation level. Models analyzed include single polar (Yangon) type, double polar (Yangon and Mandalay) type and plural number of polar dispersed type where urban areas in rural areas assumed as polar to share development resources. For comparison, ERIA refers the single type with the Thailand model and the double type with Vietnam.

As per analysis result, Myanmar is recommended to apply the Vietnam model, double polar type of

Yangon-Mandalay so as to secure higher efficiency in GDP growth attaining for the whole nation level as well as eradication of poverty for the whole nation. With the double polar strategy adopted as recommended, the GDP share by Yangon will decrease from 55.1% to 43.1% in 2030 while the same by Mandalay will increase to 19.1% from 10.8% in the same year. As the result, the GDP of the whole nation is estimated to increase up to 154% in case of double polar strategy while the same remain at 149% in case of single polar strategy case.

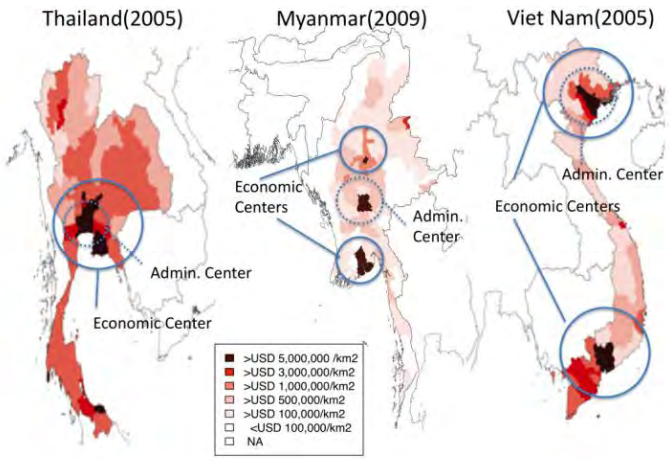


Figure 4.3.7 GDP Density of Myanmar, Thailand and Vietnam
Source: ERIA

In view of the above, it can be said that the development investment in Mandalay and surrounding areas will contribute to further increase of the GDP growth for the whole nation level in future. In the promotion of intensive agriculture too, if emphasis be placed in Mandalay and Shwebo areas and/or both areas together, the promotion project may significantly contribute to the said double polar strategy, resulting to bring about higher GDP growth rate for the whole nation level.

4.3.9 Relation with Myanmar Industry Development Vision

Japanese government presented Myanmar Industry Development Vision in July 2015 in order to facilitate industry development in Myanmar. The vision outlines the basic development concepts involved as; 1) attaining a balanced development with virtuous cycle between urban and rural areas, 2) 2) identification of specific industry sectors based on comparative advantages in accordance with the economic development stage, and 3) industrial development with paying due attention to human rights and social harmony. Among these, concerning the 1), it is considered important to encourage the growth in a way the urban and rural areas have mutually beneficial relation with each other at the same time.

In order to enable the mutually beneficial relation to be developed, it is important to increase the labor productivity in the agricultural sector which remains at lower level at present. By this, surplus labor force may be created in rural areas and it is necessary to comply with the massive labor demand for industrial development in urban areas. In other words, promotion of intensive agriculture coupled with farm mechanization will create surplus labor in rural areas and can comply with the demand from urban areas so as to materialize multiplier effect both for urban and rural areas economic growth.

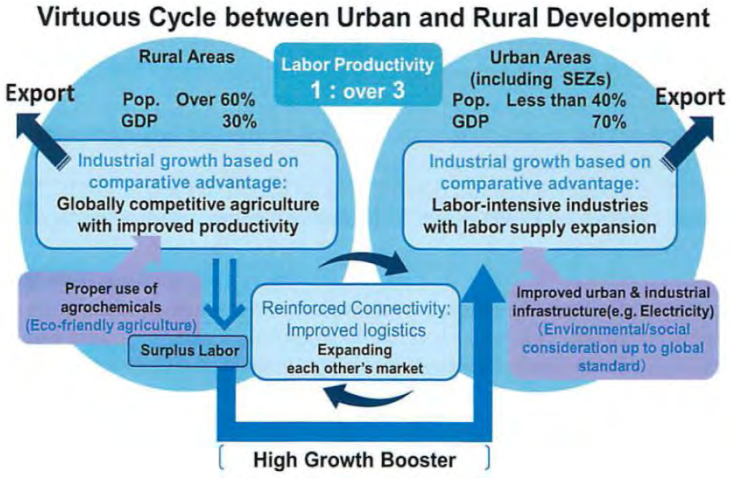


Figure 4.3.8 Balanced Development under Myanmar Industry Dev. Vision
Source: Myanmar Industry Development Vision

Those concepts involved in the Myanmar Industrial Development Vision are as illustrated in the Figure 4.3.8 and in case of agricultural sector in Myanmar not only the heightening of productivity but also improvement of production efficiency are necessary to be attained. Agricultural sector in Myanmar employs a number of hired-labor (of the overall expenditure by a typical farm household, the one for the hired-labor shares as much as 45%, 49% and 23% for the wet season paddy, summer paddy and beans, respectively) and these hired-labor is expected to be shifted to construction sector in future, causing a new problem issue of labor shortage in rural areas.

In addition, in Myanmar, more particularly in case of Burmese group, the tendency of declining birth rates has already taken place. From the population cohort of the national level too, the pattern is already of the bell contour shape. The population cohort obtained through farm family survey conducted at Bago West area in 2012, significant declining in younger generation is indicated. In view of the above, it can be said that there is a possibility to face a substantial labor shortage problem in rural areas in near future.

Therefor, farm mechanization issue has a high priority in the agricultural sector in Myanmar and also the on-farm development works which are necessary for promotion of farm mechanization shall be implemented in a greater area. For mechanization, the development used to be initiated at the suburban areas because of the repair requirements during the machine trouble and easiness to secure necessary spare-parts. As a background, it is noted that mechanization at suburban areas is required earlier than the other areas because of the population outflow from suburban areas to urban areas nearby.

In view of the foregoing as discussed about promotion of farm mechanization, it is deemed that the promotion shall be enhanced under the expansion program of intensive agriculture in the suburban areas aiming at effectively active extension of mechanized farming. For this concern, it is desirable to select Mandalay area, Nay Pyi Taw area, and Bago South-East area as the priority areas for promotion of intensive agriculture.

4.3.10 Final Screening to the Top 4 Priority Areas

Based on what has been discussed before, the final screening to select the top 4 priority areas is conducted in the following table. The table examines potential of promoting intensive agriculture for those areas by different indexes. The indexes are, as discussed in the previous sub-chapters, the possibility of promoting food value chain (FVC), yield increase, diversification of crops, rehabilitation need, possibility of expanding irrigable area based on water resources still available, and IRR. Aside from these indexes, reference is also made to such supplementary indexes as poverty ratio, contribution to 2-pole development strategy, and relevance to the Myanmar Industry Development Vision.

From the results in the table, the Team is to recommend 1) Shwebo, 2) Mandalay, 3) Nay Pyi Taw and 4) Ayeyarwady area as the top 4 priority areas with the following reason:

1) IRR can hardly justify to pick up Bago South-East area since the IRR is the lowest amongst 6 2nd-screened priority areas while Shwebo and Ayeyarwady provide highest return against the investment, which should be the candidate for the top priority area.

2) The prospective project aims at not only increasing production by means of rehabilitating irrigation infrastructure but also developing food value chain which should be supported by good access to markets. In the latter regards, Mandalay, Nay Pyi Taw and Bago South-East could be given higher priority while Magway is not the case as located in very remote area.

3) Magway West area has little potential of expanding irrigable area since the dry season agriculture, summer paddy cultivation, has been almost fully utilizing the dam reservoir. In addition, yields in

this area are already somewhat high due probably to the good topographic condition where there is rare inundation. Poverty ratio is not so high either as compared to the past. Taking all these in mind, Magway West can hardly be selected as one of the top 4 priority areas.

4) Ayeyarwady area's yields are lower than other areas, so that given drainage works there should be an opportunity of increasing the yields. Also, as afore-mentioned, low investment cost per unit area entails higher return, so that this area could be one of the topo 4 priority areas.

Table 4.3.9 Screening for selection of Top 4 Priority Areas by 2-level Indexes

Area	IRR	FVC	Yield	Div'n	Rehab. Need	Exp'n	Poverty	2-pole	MIDV
Shwebo	◎	○	○	○	◎	○	△	○	○
Mandalay	○	◎	○	◎	◎	△	○	◎	◎
Magway West	○	△	○	○	◎	△	○	○	○
Nay Pyi Taw	○	◎	◎	◎	△	○	○	○	○
Bago South - East	△	◎	◎	○	○	◎	△	△	◎
Ayeyarwady	◎	○	◎	△	○	○	◎	△	○
Following 3 areas already dropped by 2nd screening									
Chindwin – Ayeyarwady	-	△	◎	◎	○	△	○	○	△
Shan South	-	○	○	◎	△	△	○	△	○
Bago South - West	-	○	◎	△	△	◎	△	△	○

Note: FVC means the possibility of facilitating food value chain; Div'n means the possibility of crop diversification; Exp'n means the possibility of expanding irrigable area based on water availability; IRR is internal rate of return (no conversion factors are counted in this estimation); MIDV stands for Myanmar Industry Development Vision.
Source: JICA Survey Team

CHAPTER 5 DEVELOPMENT STRATEGY AND DIRECTION

Through the discussions made up to the former chapter, higher priority-given 4 areas have been selected. These include Shwebo area, Mandalay area, Nay Pyi Taw area and Ayeyarwady area. The first 3 areas are located along or neighboring with the North-South corridor, the largest economic corridor in Myanmar. For instance, the Shwebo area is located at North-North-West area connecting with the corridor and Mandalay is the northern terminal of the corridor. Nay Pyi Taw is located at the middle of the corridor stretching from Yangon to Mandalay. Ayeyarwady area is located in the delta but it is the center of largest rice production area in the country. Development strategies and components involved under these project areas are outlined in the following:

5.1 Directions for Development

For each of the 4 areas finally selected, major development-related items including the main crops, advantages and weak points, directions for production promotion and issues/needs are tabulated in the following tables:

Table 5.1.1 Summary of the Top Priority Area (1/2)

Index	1-1. Shwebo (Sagaing)	1-2. Mandalay
Main crops	Rice, sesame, green gram, chickpea, wheat, lowland vegetables (Cabbage, cauliflower, tomato, lettuce, mustard, turnip, water melon and melon etc)	Rice, beans, oilseeds, lowland vegetables (onion, chili, leaf vegetables, water melon, and melon etc.) and fruits as mango and etc.
Opportunities	✓ Representative production area in Myanmar for the high value added rice (Shwebo Pawsan) being favored with climate conditions most suited for rice production ✓ Easy access to Mandalay city, the 2nd largest consumer populated area (2 hours ride to Mandalay and possibility to develop suburban agriculture ✓ Monywa is a global basis marketing base for oilseeds and beans and the related man-power, information and marketing expertise are accumulated ✓ Possible to produce a variety of lowland vegetables by means of pump irrigation	✓ Located at the neighboring suburb of Mandalay, promotion of suburban agriculture seems possible ✓ As the center for nation-wide commodity transportation, a variety of agricultural produces are accumulated (MDY-YGN, MDY-Muse, MDY-Tamu and MDY-CDZ) ✓ Stabilized electricity supply (MDY city) ✓ CDZ with the center city of Mandalay functions as a global basis supply center of beans and oilseeds and related man-power, information and marketing expertise are accumulated
Weaknesses	✓ Unstable rainfall pattern, thin layer of topsoil and hard soil layer (CDZ) under the topsoil ✓ -utflow of labor to urban areas and overseas	✓ Unstable rainfall pattern and thin layer of topsoil and hard soil layer (CDZ) under the topsoil ✓ Outflow of labor force to urban areas and overseas
Directions for production promotion	✓ Branding of Shwebo Pawsan variety and further production promotion ✓ Quality improvement and high value adding for the crops to be exported to China and India ✓ Promotion of suburban agriculture (Vegetable production in dry season) and value chain development	✓ Development of marketing center for agricultural produces connecting Myanmar with China and India ✓ Quality improvement and high value adding for agricultural produces export-oriented to China and India ✓ Promotion of suburban agriculture (Vegetable production in dry season) and value chain development
Issues/needs	✓ Value chain strengthening for Shwebo Pawsan (Especially grading up of PH control techniques) ✓ Renovation of seeds (Sesame, green gram and rice), quality improvement through grading up of PH technology and strengthening of export competitiveness ✓ Grading up for information access at the boundary area (Muse) and international markets ✓ Promotion of farm mechanization for upland cropping (Tractor and small scale harvester) ✓ Production promotion for lowland vegetables	✓ Quality improvement and strengthening of export competitiveness through seed variety improvement as coupled with the PH control techniques (Beans, oilseeds and rice) ✓ Promotion of production of lowland vegetables (Leaf vegetable and other perishable ones) and protected horticulture (Strawberry etc.) for consumption by Mandalay city ✓ Development of cold chain connecting Mandalay city with the vegetable and fruits producing areas ✓ Promotion of food processing industry (Provision of infra-structure, 1st hand

Index	1-1. Shwebo (Sagaing)	1-2. Mandalay
	and protected horticulture by small scale farmers for consumption in Mandalay city (Pump irrigation, soil improvement and upland crop irrigation techniques) ✓ Development of cold chain connecting Mandalay with the producing areas (Mango for export and etc.)	preliminary processing of beans and encouragement for the packaging material-related industries) ✓ Diversification of transportation modes (Land, navigation and railway) and measures for cost saving in accordance with the quantity as well as form of agricultural produces to be handled ✓ Strengthening of bargaining power in boundary trading (Quality control and quarantine system reinforcement) ✓ Diversification of export markets (West Africa Region etc.)

Source: JICA Survey Team

Table 5.1.2 Summary of the Top Priority Area (2/2)

Index	2-1. Nay Pyi Taw	5-1. Ayeyarwady Delta
Main crops	Rice, green gram, lowland vegetables (Onion, leaf vegetables, water melon etc), and fruits (Mango)	Rice, black gram, green gram and fruits (Banana)
Opportunities	✓ -Power to attract customers as the nation's capital (Demonstration effect) ✓ ID Headquarter is in the capital and easier maintenance for the model project ✓ Favorable location at the middle of main economic corridor, YGN-MDY ✓ Stable electricity supply (Possibility for inviting food processing industries ✓ Easier access to receive assistances by public administration (Permits and licenses) ✓ More rainfall than central CDZ, free from natural hazard as compared with delta area and more sunshine and flat land than Shan highland	✓ Production area for domestically popular Pawsan Hmwe rice ✓ More rainfall than CDZ and more sunshine and flat land than Shan area ✓ Accumulation of related man-power, information and marketing expertise as central rice producing area ✓ Advantage as the neighboring suburban location to YGN
Weaknesses	✓ -Less number of consumers (Nay Pyi Taw city) ✓ Industries yet to be developed	✓ Too much rainfall, floods/poor drainage ✓ Sea water intrusion at the lower delta ✓ More costs for infra-structure construction due to the complicated topographic condition ✓ Outflow of labor force to urban area and overseas ✓ Value chain strengthening for higher price competitive power for rice (Low price rice with the quality higher than a certain level) ✓ Lowering of transportation cost through providing adequate road network suited to the topographic condition (Improvement of road and bridges)
Directions for production promotion	✓ -Demonstration and extension of advanced agricultural management model (Mechanization, upland crop irrigation, protected horticulture and organic farming etc) ✓ -Establishment of 6th sector industry model through inviting food processing industries ✓	✓ -Strengthening of rice export competitiveness through extension of recommended seeds, practicing of checkrows planting and renovation of milling machines (Drying facilities with rice husk as the energy source, trap device for specified insects, fumigation processing, quarantine system and standardization of milling quality) ✓ -Lowering of transportation cost of rice within the producing areas through providing farm road network (Central part of delta)
Issues/needs	✓ Promotion of lowland vegetables production through providing proper water management and drainage facilities ✓ Production promotion of lowland vegetables and protected horticulture by small scale farmers for consumption by Nay Pyi Taw city (Pump irrigation, soil improvement and upland crop irrigation) ✓ Assistances for organizing agricultural cooperatives and promotion of farm	✓ Improvement of basic infra-structures for rice producing areas through counter-measures for flooding and poor drainage capacity ✓ Increase of navigation transportation capacity at lower delta area (Port facilities at Pathein and other market handling facilities by river transportation, storage facilities capable for loading in bulk and introducing of shallow and light barges and etc.)

Index	2-1. Nay Pyi Taw	5-1. Ayeyarwady Delta
	mechanization ✓ Export promotion for processed food of lowland vegetables through establishment of adequate quarantine system ✓ Strengthening of agricultural produces marketing network and price competition power through providing infra-structures covering wider area	

Source: JICA Survey Team

5.2 Major Development Components for Shwebo, Mandalay, and Nay Pyi Taw Areas

There are 4 top priority areas selected; Shwebo, Mandalay, Nay Pyi Taw, and Ayeyarwady area. The intensive agriculture program to be formulated by the area should be of comprehensive plan composed of not only infrastructure improvement/ rehabilitation but also software components such as a mechanism of facilitating value chain development and also institutional arrangement required to sustainably operate and maintain major infrastructure.

Further looking at the major components to be put into implementation, ODA loan assistance would have to be required taking into consideration the size of the investment. To this regard, of the 4 areas selected, the first 3 areas can be planned by a sort of project loan approach while Ayeyarwady area to be by a sector loan approach. In fact, sector loan approach is still a part of project loan approach but the difference is that under sector loan approach not all the loan to-be-assisted sub-projects have been identified yet but only representative ones as lead example. It means that, under project loan approach, all the target investment must have specifically designated items at the loan appraisal stage.

In above sense, the first 3 areas such as Shwebo, Mandalay and Nay Pyi Taw can be designed under project loan approach as far as the components are concerned to the major ones requiring large scale investment. On the other hand, Ayeyarwady area needs to be implemented by a sector loan approach since identified rehabilitation works by ID are not such scale suitable for loan application unless otherwise other similar areas – polder area – are additionally taken up within the whole project of Ayeyarwady area.

Major development components regarding the first 3 areas are preliminary presented in this section while the components for Ayeyarwady area are to be discussed in the next section. The components envisaged in the first 3 areas are to be; rehabilitation of irrigation facilities, improvement/ rehabilitation of maintenance roads running alongside main irrigation canals, which also work as rural commuter road, facilities improvement or new establishment to promote value chain development, e.g. wholesale markets, cold storage, jetties in case of inland water transportation, and farm mechanization and also land consolidation.

In addition, private sector engaged in agriculture sector shall be facilitated to improve. One of the areas to improve is for rice milling machineries. Most of the milling machines are owned by individual private entities; but the machines are very much over-aged. In Sagaing region where Shwebo, rice production area, falls, the majority source of power for milling machines are steam, followed by electricity (refer to Table 5.3.1 in the next section). It means those milling machines were at first installed before the World War II. Consequently, milling recovery remains low, and improvement in this sector should be strongly initiated.

Aside from what was mentioned above, such technical assistances may be needed as; quality seed extension, crop diversification where natural conditions allow, water users association (WUA) establishment aiming at introducing irrigation management transfer from ID maintenance division to the established WUA at the level of distributary canals. To diversify crops, different types of irrigation method should also be demonstrated, e.g. sprinkler irritation and drop irrigation, which may be first

tried in Nay Pyi Taw.

Quality seeds dissemination is very much important from the view point of increasing white milled rice. If there are different varieties of grains in one lot of paddy, the milling recovery gets low due to the different size of the grain, leading to high rate of broken grain as well. Therefore, to improve the quality of white milled rice, milling machine alone can not achieve it but the quality of the seeds shall firstly be improved and uniformed. There is a Japanese technical assistance project, which has been disseminating improved seeds of rice. Outcome from this TA project should be referred to in the priority project areas too..

There is rarely functional water users association at present. All the irrigation facilities starting at dam reservoir down the distributary canals are currently operated and maintained by ID maintenance division. However, in order to increase the operation performance and also to relieve the government from the burden of operating and maintaining all the stretches of canals, irrigation management transfer should be prepared and progressively introduced over the national irrigation schemes managed by ID. To realize this IMT program, a technical assistance is to be required.

Based on the above discussions, following table summarizes the preliminary components and expected schemes to be undertaken by priority area (for Ayeyarwady area, refer to the next section): There are 8 – 10 components in each of the priority areas, and infrastructure improvement/ rehabilitation should be assisted by loan scheme while software components may better be assisted by technical assistance.

Table 5.2.1 Components in Shwebo Area and Assistance Schemes

Project Component	Schemes	Remarks
1. Rehabilitation of Irrigation	Loan (project type)	Only RMC and 3 Distributary Canals of SMC
		Though ID has identified only right main canal and 3 distributary canals of Shwebo main canal, other areas should also be considered for a loan assisted component.
2. Improvement of Rural Road	Loan (project type)	Included in above
3. Farm Mechanization	Loan (project component)	Demonstration basis only
4. Land Consolidation	Loan (project component)	About 10% of whole land
5. Mandalay Jetty Improvement	Loan (project component)	To facilitate transportation of rice, pulses
6. Renewal of Milling Machines	Two Step Loan	To utilize TSL already signed in June 2015.
7. Quality Seed Extension	Technical Assistance	
8. WUA Establishment and IMT	Technical Assistance	

Source: JICA Survey Team, Note: ITM means irrigation management transfer from ID to established water users associations at the level of distributary canal.

Table 5.2.2 Components in Mandalay Area and Assistance Schemes

Project Component	Schemes	Remarks
1. Rehabilitation of Irrigation	Loan (project type)	3 schemes of Sedawggyi, Zawgyi, Kinda
2. Improvement of Rural Road	Loan (project type)	Included in above
3. Farm Mechanization	Loan (project component)	Demonstration basis only
4. Land Consolidation	Loan (project component)	About 10% of whole irrigable area
5. Wholesale Market	Loan (project component)	To facilitate value chain in upper Myanmar
6. Cold Storage	Loan (project component)	To be attached to the wholesale market
7. Renewal of Milling Machines	Two Step Loan	To utilize TSL already signed in June 2015.
8. Quality Seed Extension	Technical Assistance	
9. Crop Diversification Extension	Technical Assistance	Including fruits (mango)
10. WUA Establishment and IMT	Technical Assistance	

Source: JICA Survey Team, Note: ITM means irrigation management transfer from ID to established water users associations at the level of distributary canal.

Table 5.2.3 Components in Nay Pyi Taw Area and Assistance Schemes

Project Component	Schemes	Remarks
1. Rehabilitation of Irrigation	Loan (project type)	4 schemes in Nay Pyi Taw area

Project Component	Schemes	Remarks
2. Improvement of East-West Road	Loan (project type)	Gravel to asphalt pavement (6.8 miles)
3. Farm Mechanization	Loan (project component)	Demonstration basis only
4. Land Consolidation	Loan (project component)	About 20% of whole irrigable area
5. Sprinkler and Drip Irrigation	Loan (project component)	Demonstration only, including crop diversification
6. Construction of View Point	Myanmar Government	At an eastern hill top
7. Quality/Hybrid Seed Extension	Technical Assistance	
8. WUA Establishment and IMT	Technical Assistance	

Source: JICA Survey Team, Note: ITM stand for irrigation management transfer from ID to established water users associations at the level of distributary canal.

5.3 Major Development Components for Ayeyarwady Area

In Ayeyarwady delta area, the yield of paddy per a unit area is low and the poverty ratio is high. This requires higher priority for development assistances for the area. Proposed project components by the ID Ayeyarwady include dredging of drainage canals within polders, gate installation for fresh water intake purpose at the upper-most part of the polder areas, rehabilitation and new installation of gates along the canals in the polder and improvement of polder dikes and etc.

In addition, due to poor road conditions prevailing as 223 miles long earthen road, proper pavement works have to be implemented. There is as long as 249 miles gravel paved road too. In view of promotion of marketing of produces in the area, existing wooden bridges with the 5 ton weight limit shall be newly replaced by a RC bridge.

With regard to farming practices in Ayeyarwady delta area, 45 days seedling is transplanted in the inundation areas. While in the semi-dry paddy fields in a little higher elevated location, direct sowing is practiced. This direct sowing is done by hands and called as broadcasting. Broadcasting requires less man-power for sowing in place of transplanting but causes difficulties as follows;

- ✓ In a same plot of paddy field, patched spots appear and causes occurrence of problems of diseases and insects.
- ✓ Moreover, planting in checkrows is not possible and no weeding can be done, resulting in many stumps remaining to cause further deterioration/degradation of seed varieties.

When degradation of seed varieties happen or if different varieties of paddy stay in a same plot of paddy field, naturally the harvested paddy become a mixture of different physical properties, causing lowering of milling recovery rate and significant post harvest losses. With this concern, it is noted that in Ayeyarwady delta area, some private companies are to introduce the most advanced large scale milling machines, but in many cases, the existing milling machines are those steam-engine-driven type which had been used to date from the time prior to the World War II.

Accordingly, the milling recovery rate is said to be very low. In view of the foregoing, in Ayeyarwady delta, it is necessary to extend the planting in checkrows and to grade up the post harvest handling technologies as milling and storage. As to the needed replacement of milling machines, availability of two step loan for which small-medium size companies can access is desirable (refer to “Financial Assistance for Small-Medium enterprises in Myanmar”, signed on June 30, 2015).

Table 5.3.1 Mill Numbers and Capacities in Myanmar

Region	Electricity		Steam		Husk(bio) Gas		Diesel		Total	
	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton
Ayeyarwady	57	1,485	278	8,856	137	3,014	115	2,299	587	15,654
Yangon	52	1,894	40	2,404	45	847	88	1,537	225	6,682
Bago	138	3,076	99	2,788	43	721	5	80	285	6,665
Mandalay	21	315							21	315

Region	Electricity		Steam		Husk(bio) Gas		Diesel		Total	
	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton	No. of Millers	Capacity, ton
Sagaing	51	1,326	77	1,716	19	371	16	329	163	3,742
Magway	NA		NA		NA		NA		NA	

Source: Ministry of Commerce (data for milling stations in Myanmar, March 2013)

Concerning the planting in checkrows, it is possible even in the case of direct sowing. For instance, there is a good example practiced in Mekong Delta, Vietnam. In this case, rice seeds are contained in a pipe with wheels and the seeds can be gradually sown from the openings (see photos). At least, it is necessary to extend the management techniques how to improve the farming practices including the following measures;

- ✓ -Introducing of uniform recommended seed in a plot,
- ✓ -Grading up the variety purity,
- ✓ -Extension of planting in checkrows by direct sowing, and
- ✓ -Removal of weed and stumps to attain quality improvement.

In addition to the above measures, improvement of milling qualities through renovation of milling machines will bring about raise up of international price of the exported rice and causes increase of farm gate price of rice in the area.

Left; Broad-casting of paddy seeds prevails in Ayeyarwady delta. Right; one of direct seeding which is practiced in Mekong Delta area with which seeds are sown in line so that weeding can be done, preventing cross pollination with native paddy. Source from IRRI HP

In Ayeyarwady delta, irrigation for dry season paddy is practiced by using pumping facilities, though the practices are minor or much less as compared with the case of Ganges plain in Bangladesh. As per the hearing, there are some difficulties in dry season irrigation like the shortage of water pumped from shallow well due to the clayey nature of soils. As is the case, the dry season paddy planting by pumping is limited only in the neighboring of canals. Another reason behind the limited extension of dry season paddy cultivation by pumping is in the energy cost. In other words, farmers hardly have motivations to expand the dry season paddy by pumping due to the higher fuel cost and at the same time low price of rice.

When quality improvement for rice could be achieved as discussed above, the rice price is expected to rise up at the same time. If rice price is up, there is possibility to expand the dry season paddy cropping by using pumps to be expanded further, though farmers have to bear the fuel costs. Under the circumstances, when the situation be matured, necessary assistances for farmers as provision of two step loan for purchasing of pumps would be desired.

In Ayeyarwady area, assistances are needed for provision of rehabilitation works for road networks including bridges. In the Ayeyarwady region, there exists as long as 1,679 miles long roads. Of this,

those under control by the government are 1,533 miles in total as classified into 4 grades as follows, and the first priority shall be given for the grade up of 1) Earthen Road to 2) Gravel Road status in parallel with the replacement of wooden bridges to RC bridges.

1) Earthen Road (223 miles),
2) Gravel Road (249 miles),
3) Macadam Road (36 miles), and
4) Paved Road (1,017 miles)

The irrigation/drainage projects planned with higher priorities by the ID Ayeyarwady Office are as shown in the following table. The total project cost was estimated at US$ 15-20 million by ID and judged to be rather small as a loan project. Note that this US$ 15-20 million is only for direct construction cost, on top of which such costs as management, design, market facilities, contingencies are to be required (to be elaborated during Phase 2 survey). As is the case, anyway, it may be appropriate to formulate the project as a sector loan project, as there are several others of similar natured polder areas in the Ayeyarwady delta.

Table 5.3.2 High Priority Given Projects in Ayeyarwady Delta as Proposed by ID Ayeyarwady

Proposed Project	Project Cost, Million Kyats	Remarks
1. Pilot Canal of Ngawun River (Thabaung TS)	200 (estimated by Team)	Diversion channel for flood releasing
2. Kyaunggone Flood Plain Drainage	7,927	Flood protection & drainage (39 miles)
3. Rehabilitation for Bitut (4) Polder (Laputta)	806	Sluice construction (9 Nos)
4. Shwe Laung Polder	3,155	Embankment, Sluice, Drainage
5. Kyun Nyo Gyi Island (Ngapudaw TS)	3,170	Sluice (28 Nos), Drainage (24 miles)
6. Thonegwa Polder	NA	Cost not available, probably
Total	15,258	

Source: ID Maintenance Division, Ayeyarwady Region

Since the disastrous damages caused by Cyclone Nargis in 2008, reinforcement of polder dike - heightening and widening of crest - works are given with the highest priority. For this, attention shall be paid on the requirement of new land acquisition, right of way, needed for embankment heightening and crest width widening, though rehabilitation only can be done within the already secured land plot. A grant aid project implemented in the past provided a set of heavy construction machines for the planned strengthening/reinforcement projects[1]. At present, ID is implementing the planned works by using the provided machines/equipment.

Based on the discussions as above, components of assistances needed for Ayeyarwady delta area as well as a variety of schemes can be tabulated in the following table. Priorities are given in order indicated as; 1) Extension of recommended seeds and planting in checkrows, 2) Renovation of milling machines, 3) Improvement of irrigation and drainage facilities, 4) Improvement of road (Earthen to Gravel), 5) Replacement of wooden bridge with RC bridge, 6) Jetty improvement at Pathein port to facilitate inland water transportation from Ayeyarwady, and 7) Expansion of dry season pumping irrigation.

Except the first two items, the priorities given for items 3, 4 and 5 are judged to be almost the same. In addition, there are inland water transportations of rice shipped from Pathein port to Mandalay port, and therefore to facilitate this transportation, the Pathein jetty should also be improved together with the one in Mandalay. The dry season pumping irrigation is expected to be expanded after the quality of rice has been improved and the price of rice has been hiked accordingly, being given with the lowest priority.

[1] The grant aid project provided 24 units of backhoe, 12 units of bulldozer, 2 units of roller, 2 units of mobile repair shop and 1 vibro-hammer with the total budget of 760 Million Yen.

Table 5.3.3 Components of Priority Projects in Ayeyarwady Delta and Assistance Schemes

Project Component	Schemes	Remarks
1. Quality Seed Ext'n, Line Planting Extension	Technical Assistance	To improve seed quality
2. Renewal of Milling Machines	Two Step Loan	To utilize TSL already signed in June 2015.
3. Improvement of Irrigation and Drainage, ID	Loan (sector lending)	Groups shall be identified
4. Rural Road Improvement (earthen to gravel)	Loan (project component)	Earthen road shall be improved to gravel
5. Wooden Bridge Replacement (5 ton to 20 ton)	Loan (project component)	5 ton wooden bridge be replaced by RC
6. Pathein Jetty Improvement	Loan (project component)	To facilitate loading/unloading agri. produces
7. Engine Pump Irrigation (private irrigation)	Two Step Loan	TSL Preparatory Survey Completed

Source: JICA Survey Team

5.4 Market and Value Chain Development

Previous section discussed major investment components by priority area. Aside from those components, there should be components to facilitate market and value chain development. Hardware to promote market and value chain are to be, for example, wholesale market, cold storage which may be attached to the wholesale market, jetty in case of inland water transaction, and also plant protection quarantine facilities. These facilities may be planned specifically relevant to each of the priority areas or otherwise in a strategic place covered by some of the priority areas simultaneously.

5.4.1 Challenges and Opportunities in Promoting Value Chain by Priority Area

As a first step of identifying components to promote market and value chain development, strategic positioning in terms of marketing and value chain is examined for such areas as Shwebo, Mandalay, Nay Pyi Taw, Ayeyarwady, and Shan South and Bago South-East area. The first 4 areas are the top 4 priority areas selected through aforementioned discussions, and the last 2 areas are not among the 4 areas but still they are worth planning spatial development of value chain.

1) Shwebo Area (Sagaing)

Shwebo is a production center of "Shwebo Pawsan", high value rice in the domestic market of Myanmar. Therefore, boosting regional economy through branding and increasing domestic demand of the famous product could be a development strategy in this area. However, rice production in this area has a challenge on post harvest handling in particular, and improvement of the post harvest including drying method, milling technology and storing facility is necessary.

On the other hand, pulses and oil crops are planted as after-crop of paddy in Shwebo area, and these crops have also a challenge on pre- and post-harvest handling at on-farm level and off-farm level. Recently sesame has been introduced in Shwebo area as a substitute crop of summer paddy. At present, many farm households produce the seeds by themselves, resulting in degradation of seed quality. Mixing of different color grains and residual agro-chemicals remain critical in exporting pulses and sesame. Improvement of seed quality and pre-and post-harvest handling is therefore required to enhance value chain of the after-paddy crops.

In addition, Shwebo area is located near Mandalay, Myanmar's second largest city in view of population and scale of economy. By taking the geographical advantage, it is recommended to increase farmer's income through promoting suburban agriculture particularly lowland vegetable production during dry season. Followings are development direction of intensive agriculture, in view of value chain enhancement, in Shwebo area;

- ✓ Value chain enhancement of high value rice variety, Shwebo Pawsan, through improvement of post harvest technology, including improvement of drying method, milling technology and storing facility,

- ✓ Value chain enhancement of pulses and oil crops through improving seed quality, improvement of on-farm management (proper application of pesticide), improvement of post-harvest handling (improvement of drying method), enhancement of inspection system of pulses and oil crops, and
- ✓ Value chain enhancement of vegetables and fruits targeting the growing demand in Mandalay, including promotion of market oriented vegetable production, farm mechanization of upland crops, pump irrigation for vegetable production during dry season, soil enrichment in hard-pan area.

2) Greater Mandalay Area

Greater Mandalay area is a surrounding area of Myanmar's second largest city of Mandalay, where nationwide distribution network is connected from four cardinal points. The network includes the Yangon-Mandalay national highway, which is the main artery of surface transportation in the Myanmar. Mandalay-Muse road is the main export route to China by land, whereas Mandalay-Tamu road connects Myanmar to India. Also, several routes from the Central Dry Zone are connected to Mandalay mostly from western side. Through these road transportation networks, various types of agricultural commodities come in and go from Mandalay.

As stated above, Mandalay is a transportation hub of upper Myanmar, and ideal development strategy of this area is to enhance its function through value chain development of various farming products, development of food processing industry, development of domestic and international wholesale market, and diversification of transportation mode based on form and volume of products.

In addition, by taking the geographical advantage, it is recommended to increase farmer's income through promoting suburban agriculture particularly perishable vegetable production during off season of paddy. Followings are development direction of Greater Mandalay area;

- ✓ Value chain enhancement of agricultural products from and into Mandalay through improving seed quality, pre- and post-harvest handling, reduction in transportation losses, value addition including primary processing,
- ✓ Enhancement of transport hub function, through diversification of transportation mode including land, water and air transportation, based on form and volume of agricultural products to decrease transportation costs and losses,
- ✓ Enhancement of transport hub function, through development of international wholesale market with cold chain facilities, enhancing quality control and quarantine inspection function, to enhance bargaining power of export products,
- ✓ Development of food processing industry including primary processing and packaging of crops for export to China, India and other ASEAN countries, and
- ✓ Promotion of suburban agriculture including perishable vegetable and fruits production.

3) Nay Pyi Taw Capital Area

Nay Pyi Taw is the capital city of Myanmar, and located in the middle of Yangon-Mandalay national highway. Therefore, it is expected to demonstrate a display effect of advanced farming technologies since many national and foreign people come and go, and pass through. In addition, stable electricity and water supply to the capital area is another advantage for developing showcase of advanced farming.

Therefore, by utilizing geological and political advantage, development strategy of this area is to promote advanced farming as a showcase to nationwide and international visitors. Development

directions of Nay Pyi Taw area relevant to value chain development are as follows;

- ✓ Promotion of display and extension of intensive production of lowland vegetables and fruits, through introduction of mechanized farming, upland irrigation method, horticulture development including green house farming, and organic farming,
- ✓ Promotion of mechanized rice farming with land consolidation, drainage system, proper water management including wet-and-dry irrigation, advanced rice production method such as hybrid rice cultivation, SRI (system of rice intensification), and modernized milling and storage facilities,
- ✓ Promotion of market oriented lowland vegetable production by small-scale farmers, including promotion of pump irrigation, farm mechanization with hand tractor, and upland crop irrigation, and
- ✓ Utilization of food industry including high-value and high-quality products for export purpose.

4) Ayeyarwady Delta Area

Ayeyarwady delta is a famous production area of rice, including Pawsan Hmwe for domestic market and Ematas for export purpose, and traditionally traders' cluster of rice value chain already exists in Pathein to Yangon. Therefore, development strategy of this area should be taken in both ways, 1) production increase, reduction in post harvest losses, branding and increasing domestic demand of Pawsan Hmwe, and 2) production increase and quality improvement for exporting rice.

The former includes promotion of mechanized rice production, increase of paddy yield through introduction of quality seeds, improvement of post harvest technologies - drying, milling and storing-, and marketing enhancement to domestic markets, whereas the latter will be promoted through introduction of quality seeds, proper on-farm management, pesticide control at storage facility, improvement of drying method, and enhancement of quarantine control, in addition to measures taken for the domestic rice production.

Ayeyarwady delta shows different features depending on geographical conditions, particularly between middle part and downstream part. In the middle parts, drainage improvement and road network improvement are serious issues to improve rice value chain, whereas improvement of water transportation can be an issue in the downstream parts. Followings are development direction of rice value chain developmnet in Ayeyarwady delta;

- ✓ Enhancement of production infrastructure of rice through flood control, drainage improvement, farm-to-market road improvement to reduce transportation cost in the middle parts,
- ✓ Enhancement of water transportation in the downstream parts through improvement of landing site, port facility especially in Pathein port, storage facility, light draft vessel,
- ✓ Enhancement of competitive power of rice production through improvement of post harvest technology; namely, enhancing drying facility using rice husk, improving storage facilities, installing traps for insects at rice processing factories, promoting fumigation, and enhancing quarantine system, and
- ✓ Promotion of lowland vegetable and horticulture crops targeting growing food demand in Yangon; namely, introduction of market oriented agricultural production, promotion of mechanization of lowland vegetable production, introduction of high value horticulture farming.

In addition, according to Myanmar Fruits, Flower and Vegetable Producer and Exporter Association, straw mushroom is suitable to grow in rice producing area since the mushroom can grow well in rice

straw beds with high moisture and temperature condition. In fact, straw mashroom and oyster mashroom are marketed from Ayeyarwady delta to Yangon city. Among them, straw mushroom is famous for one of three major mushrooms in the world, and has strong demand from hotels and restaurants since it is a must foodstuff of Chinese and Thai food. According to the association, its demand is highly growing but mostly imported due to low supply in domestic markets.

5) Bago South - East Area

Bago South – East area are located near Yangon where largest urban population reside in Myanmar. Therefore, supplying agricultural products from this Bago area to fill growing food demand of the urban population can be a growth strategy of this area. Traditionally, Bago South - East is a rice production area. However, quality of rice is still poor due to poor seeds, and poor post harvest handling. Therefore, measures to improve rice quality should be viewed as priority strategy in terms of rice value chain development.

Likewise, enhancement of supply chain of lowland vegetables, particularly those perishable products as leafy vegetables, targeting the growing food demand of hotels, restaurants and supermarkets in Yangon, is effective to increase farmers' income of this area. Straw mushroom is also suitable to grow in Bago area as the mushroom grows well in rice straw beds under high moisture and temperature condition.

In addition, construction of international airport is planned in Bago East area. By taking this opportunity, promotion of high value crop production for export purpose deserves consideration for boosting regional economy through regional economy to connect international market. In this regard, followings are development direction of value chain aspect in Bago South - East area;

- ✓ Enhancement of competitive power of rice production through improvement of post harvest technology: enhancing drying facility using rice husk, improving storing facilities, installing traps in rice processing factories, promoting fumigation, and enhancing quarantine system, and
- ✓ Promotion of lowland vegetable and garden crop targeting growing food demand of urban population: introduction of market oriented agricultural production, promotion of pump irrigation during dry season, promotion of mechanization of lowland vegetable production, introduction of upland irrigation technologies.
- ✓ Promotion of high value crop production for export: value chain establishment of high value crop production, including introduction of green house farming, development of cold chain, and enhancement of quarantine system at airport.

6) Shan South Area

In Southern Shan area, various types of farming including production of highland vegetables, fruits, horticulture, flower and fodder crops are possible, thanks to cool climate and moderate rich rainfall. On the other hand, mountainous topography, under-developed road network, deteriorated watershed -Inle lake watershed in particular-, and population drain to urban & overseas are drawbacks of this area. Based on the advantages and disadvantages, development strategy of the Shan South area may includes;

- ✓ Enhancement of value chain of highland vegetables, fruits and horticulture with introducing sprinkler irrigation, integrated pesticide management, green house farming, light culture for chrysanthemum production,
- ✓ Development of locally specialized products such as flowers, coffee, ripe tomatoes, tea, strawberry, medicinal plants, citrus, and their value-added products, and in addition establishment

of roadside station (government- or community-designated rest area found along roads and highways) to sell the locally specialized products,

- ✓ Promotion of environmentally friendly farming in Inle lake area, such as integrated watershed management, integrated pesticide management, diversification of hydroponic farming, production adjustment by tomato farmers to stabilize sales income from hydroponic farming,
- ✓ Reduction in transport cost through construction of farm-to-market road network, establishment of primary processing facilities for drying, freezing and cutting, improvement of packing method to reduce transportation losses, and
- ✓ Enhancement of inspection system of chemical residues at production area; namely, before the processing and packing.

5.4.2 Direction of Market and Value Chain Development

To improve market and value chain in Myanmar, especially relevant to the 4 top priority areas, its direction is examined from different angels such as 1) increase in transaction volume of agriculture products, 2) needs to Enhance competitive Power in agricultural distribution, 3) enhancement of central wholesale market in Yangon and Mandalay, and 4) enhancement of local wholesale market in a strategic location.

1) Increase in Transaction Volume of Agricultural Products

According to Yangon City Development Committee (YCDC), transaction volume at Thiri Mingalar wholesale market has been increasing. This phenomenon is quite expected due mainly to three reasons. The first reason is the increase in food demand in urban area. As Myanmar's economic grows, many population are flowing into urban areas from rural areas, since there are lots of employment opportunities in the urban areas. Increase in urban population means increase in foodstuff in Yangon.

The second reason is diversification of food consumption. According to MRF, in spite of increasing trend in nationwide, consumption trend of rice particularly in urban areas has decreased due to change in people's dietary habits. Instead, consumption of other foodstuff, including wheat products, meat, vegetables and fruits, has increased. For example, as FAO statistics indicates, consumption of vegetables has increased by triple during the recent half a century, which results in increase of transaction volume in wholesale markets including Thiri Mingalar Market.

The third reason is diversification of agri-products distribution particularly in Yangon and Mandalay. In recent year, number of retail stores including modern supermarkets such as City Mart, Ocean, Victoria, CAPITAL and Orange Supermarket, and other convenience store type retail shops such as 108 Shop, have increased particularly in Yangon. Also, as Myanmar's economy grows, number of hotels, shopping malls, restaurants and other catering industries has increased, resulting in growing demand for frequent and small delivery foodstuff to the commercial customers.

2) Needs to Enhance Competitive Power in Agricultural Distribution

In addition, a necessity to make Myanmar's marketing system more efficient will arise after ASEAN Economic Community (AEC) starts in 2015. Under the AEC, in principal, tariff will be removed from all of the imported commodities, and various types of agricultural products from Thailand, Vietnam, and other ASEAN countries may flow into domestic markets. It means that Myanmar's agriculture will be involved in competitive economic environment sooner or later. To prepare for the situation, it is necessary to make distribution system more efficient through proper alignment of markets, reduction in transport losses, and abbreviation or rationalization of distribution channels.

As domestic markets open to the world more, international demand for food quality and safety

measures increases more. For example, due to low quality and poor quarantine condition, trade condition of Myanmar rice imposed by Chinese traders had been unfair for Myanmar side. A protocol was entered into between AQSIQ of China and MOAI of Myanmar to improve that situation. Chemical residues in vegetables and fruits also cause challenges in international agro-products transaction, which in turn results in less competitive power of Myanmar's products. To overcome this situation, it is necessary to enhance quality inspection and quarantine inspection at strategic point of trading.

3) Enhancement of Central Wholesale Market in Yangon and Mandalay

Based on the above situation, it is necessary to enhance wholesale function of the Tow-Polar development areas; namely, Yangon area and Mandalay area. Followings are development direction for enhancing wholesale function in Yangon and Mandalay;

- ✓ To have well designed layout of market infrastructure in order to transact agricultural products efficiently taking into account expansion of trading space, separation between unloading/ uploading place and transaction space,
- ✓ To receive bulk commodities from production area, and redistribute in small volume to diversified commercial users and retailers,
- ✓ To installation public cold storage for wholesalers to enhance freshness-keeping,
- ✓ To enhance quality inspection and quarantine inspection before distributing foodstuff to retail markets, and
- ✓ To provide user friendly services including farm input supply, micro credit services, clean accommodation, and sanitary and phytosanitary facilities.

In Yangon, Thiri Mingala Market has shouldered wholesale function, but capacity of the market has reached near the limitation. In fact, since location of Thiri Mingala Market is considerably inside of the Yangon city, it is impossible to expand its market space. On the other hand, Da Nyin Gone Market is located relatively suburb of the city, and vacant area to expand its lot area is available.

YCDC made a plan to upgrade Da Nyin Gone Market from retail market to wholesale market, and implementation of the upgrading project has already started under a PPP arrangement. Therefore, it is not necessary to formulate new plan for wholesale market concerning Yangon city at moment. In future, though, it may be necessary to expand floor space of Thiri Mingala Market by vertical expansion, multi storied building market.

Figure 5.4.1 Location of 2 Markets in Yangon
Prepared on Google Map

On the other hand, wholesale market in Mandalay needs further improvement or construction at a new place, e.g. at a suburb area of Mandalay or near Mandalay international airport. Mandalay is a strategic point of distribution network in Upper Myanmar, in terms of both land and water transportation. To enhance wholesale function for land transportation, following are facilities to be developed or improved;

- ✓ Development of functional infrastructure for collecting/ assembling, drying, cleaning, grading, standardization, sanitary and phytosanitary (SPS) measures and quality inspection/ certification, labeling, packaging, ripening chambers, storing including cold keeping, retailing and wholesaling, value addition facilities,
- ✓ Improvement/ construction of common facilities including loading/ unloading and auctioning of the products, parking sheds, internal roads, garbage disposal arrangements, boundary wall, drinking water, sanitation arrangements, weighing and mechanical handling equipment etc., and
- ✓ Development of common space for direct marketing of agricultural commodities from producers to consumers/ processing units/bulk buyers, supply of production inputs, and other service facilities.

Cold storage in Mandalay is needed to establish cold chain between Mandalay and Yangon. Cold chain must be a chain of "cold", in other words, must be relay of products under low temperature continuously. Once the cold chain is interrupted and products are exposed under high temperature, products get damages easily. In Yangon city, several private firms have constructed cold storages to develop cold chain from production areas to their sales outlet. However, in Mandalay, cold chain including cold storage is still underdeveloped.

For example, Myanmar Golden Produce (MGP) is a private firm for exporting Sein Ta Lone mango, which needs low temperature transport to maintain high quality until foreign markets. However, the firm does not own cold storage and rents other firm's cold storage in Nay Pyi Taw at present. The firms' main procurement origins are surrounding areas of Mandalay including Sagaing, Kyaukse and Meiktila.

If the firm can use a cold storage in Mandalay, it does not need download and upload in Nay Pyi Taw, and can directly transport their products from Mandalay to Yangon, which keeps freshness and generates more profit to the firm. However, for most private firms, constructing own cold storage is quite high investment. In this regard, installation of public cold storage in wholesale market or nearby area is helpful for private firms to activate their transaction.

For water transportation, Mandalay is located midstream of Ayeyarwady river, which is historically the main artery of inland water transportation to downstream areas including Pakokku, Magway, and Yangon. Major transportation goods related to agriculture at Mandalay are rice (150,000 ton), beans (56,000 ton), fertilizer (18,000 ton) and vegetables (5,000 ton), and estimated cargo handling volume at Mandalay port is a total of 600,000 ton in 2013[2]. In this regard, Mandalay port is one of hub of inland water transport in Myanmar.

According to Maha Kahtina Association of Traders, Brokers & Industrialist, main constraint on inland water transport is the shallow water depth during dry season. According to a JICA's feasibility study on inland water transport facilities at Mandalay[3], water level difference between dry and rainy season is 8 m at Mandalay, and shallowest water depth between Mandalay and Yangon is only 1.5 m. In this study, necessity to establish modernized port facilities and machinery cargo handling and new O&M system were discussed. Development direction of Mandalay port will be followed by this feasibility analysis.

4) Enhancement of Local Wholesale Market in a Strategic Location

[2] "Brief Explanation for feasibility study on Inland Water Transport Facilities Improvement and Development Project", The Survey Program for the National Transport Development Plan (PPT Material), Oriental Consultants, March 2014. The volume of transported goods is estimated by the Survey team based on the PPT material.

[3] Same as above JICA study.

Function of the central wholesale markets is enhanced through connecting satellite markets including local wholesale markets at a strategic site and retail markets at consumption areas. For Yangon, at present, Thiri Mingala Market is connected to many retail markets including Da Nyin Gone Market. In near future, Da Nyin Gone Market will be upgraded to the central wholesale market, and will be connected to several retail markets within the city.

However, road condition of surrounding area of Da Nyin Gone Market is poor, and traffic jam is already observed chronically. If the road condition will not be improved dramatically, traffic jam in the surrounding areas of Da Nyin Gone Market becomes worse serious. This situation has already been seen at the Thiri Mingala Market, and same may take place in this Da Nyin Gone Market too. In this case, satellite wholesale market in outside of the Yangon city is needed.

For example, Bago city is ideal location to establish satellite wholesale market since it is located in Yangon-Mandalay and Yangon-Aungban roads, and has enough space for constructing wholesale markets without possibility of heavy traffic jam. Main function of Bago wholesale market could be transit of vegetables and fruits, in which bulk commodities uploaded by large tracks (e.g. 40feet container tracks) from production area will be downloaded to small tracks (e.g. 20 feet container tracks) and redistribute to diversified commercial users and retailers in Yangon city.

As for water transportation, improvement of Pathein port as a satellite is recommended. Pathein port is one of hubs of water transportation. However, the port does not have modern port facilities including landing pier with machinary and equipment, which may reduce transaction cost of rice trading in Ayeyarwardy region. Therefore, it is helpful for developing Pathein port as a hub of water transport in Myanmar.

5.4.3 Conceptual Development relating to Markets and Value Chain

Taking into above discussions, following market and value chain development is presented as a conceptual frame relevant to the top 4 priority areas (see Figure 5.4.2 and Table 5.4.1). As for wholesale market, one full functional wholesale market is recommended to construct in Mandalay area covering greater Mandalay, which has to be equipped with cold storage, and one satellite wholesale market in Bago suburban area which targets Yangon by connecting production areas and the biggest consumer area. Cold storage should also be installed at this satellite wholesale market.

Inland water uploading and unloading was identified as one of issues, for which jetties at Pathein in Ayeyarwady delta and at Mandalay port should be improved. With the improvement these jetties, water transportation between the 2 hubs; namely, Pathein and Mandalay, will be improved. The agriculture produces to be transported are mainly rice, pulses and oil crops such as sesame.

Aside from the wholesale market and jetty improvement, plant quarantine is also very important from the view point of safe food provision and crop/ food export. In this regard, a central quarantine center equipped with full set of laboratory equipment and devices should be established in Yangon. This center can be realized by upgrading the present plant protection function at a government laboratory in Yangon. In addition, one quarantine station should be established in Mandalay too, and further at each of export points, frontline quarantine stations should be established.

Table 5.4.1 Preliminary Market and Value Chain Improvement Facilities

Particulars	Quantity & Place	Remarks
Wholesale Market	1 x Mandalay 1 x Nay Pay Taw	at suburb of Mandalay city (new construction) Improvement of existing one
Satellite Wholesale Market	1 x Bago	To deliver to Yangon by smaller tracks
Cold Storage	1 x Mandalay 1 x Nay Pyi Taw 1 x Bago	To be attached to the wholesale market
Jetty Improvement	1 x Pathein (Ayeyarwady) 1 x Mandalay	To facilitate loading and unloading of agriculture produces transacted via Ayeyarwady river
Central Quarantine Center	At Yangon	Upgrading from existing one
Quarantine Center	At Mandalay	Newly established
Quarantine Station	At Muse, at Myawadi, and at Tamu	Newly established
Demonstration Farms	At Nay Pyi Taw	Advanced and modern agriculture demonstration

Note: Costs are all provisional and rough estimation. Source: JICA Survey Team

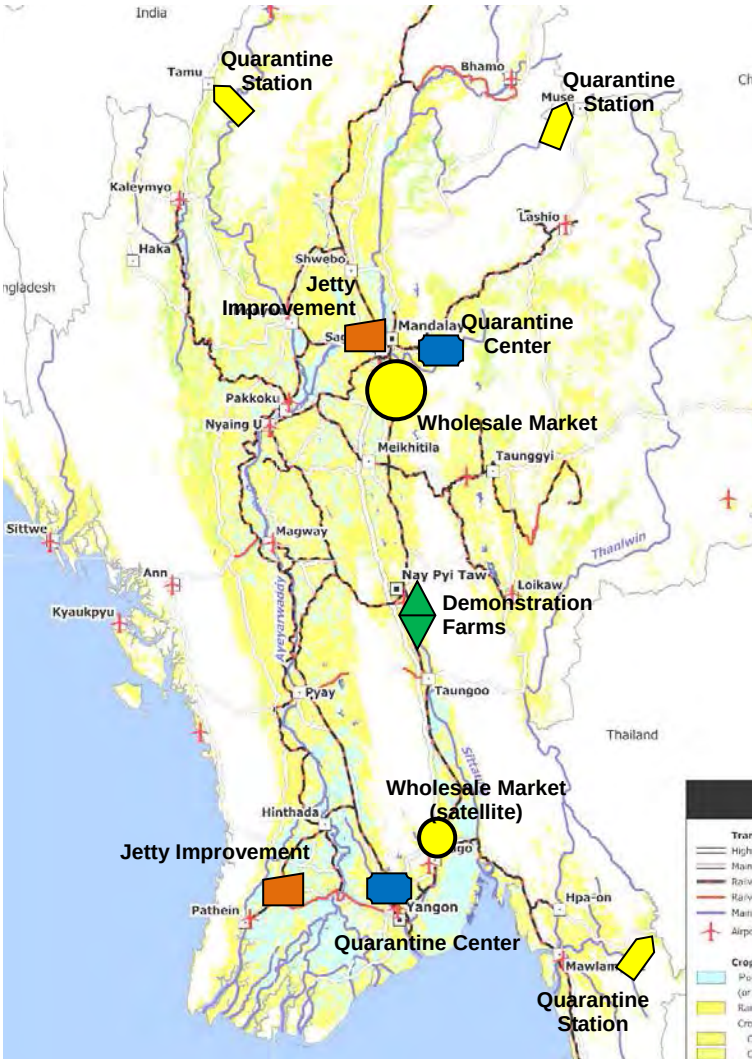


Figure 5.4.2 Development of Market and Value Chain

Source: JICA Survey Team

CHAPTER 6 CONCLUSION: SELECTION OF TOP PRIORITY AREAS

The major output from the Phase 1 survey is to identify the top 4 priority areas most suitable to promote intensive agriculture in Myanmar. To this end, this Phase 1 survey recommends such 4 areas as; 1) Shwebo area, 2) Mandalay area, 3) Nay Pyi Taw area and 4) Ayeyarwady area as the top priority areas, taking into account below;

1) Based on the satellite data (European Space Agency, global land cover map 2009), irrigation data provided by ID and WURD, and relevant field surveys conducted by the JICA Team, priority areas for promoting intensive agriculture have been examined. As intensive agriculture promotion needs established production infrastructure, e.g. irrigation and drainage facilities, as the base, following areas where there are clusters of irrigation schemes have been developed were recommended as the 1st-screened priority areas; namely total 9.

Table 6.1 1st-Screened Priority Area (Total 9 Areas)

No.	Area/ Location	Program Title
1	Shwebo	1-1 Intensive Irrigated Agriculture Promotion Sub-program in Shwebo Area
2	Mandalay	1-2 Intensive Agriculture Promotion Sub-program in Mandalay Area
3	Chindwin-Ayeyarwady	1-3 Intensive Irrigated Upland Field Crop Promotion Sub-program (Pump Irrigation)
4	Magway West	1-4 Intensive Irrigated Agriculture Promotion Sub-program in Magway West Area
5	Nay Pyi Taw	2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area
6	Shan South	3-1 High-value Agriculture Promotion Sub-program in Shan South Area
7	Bago South-East	4-1 Intensive Irrigated Agriculture Promotion Sub-program in Bago South-East Area
8	Bago South-West	4-2 Intensive Irrigated Agriculture Promotion Sub-program in Bago South-West Area
9	Ayeyarwady	5-1 Intensive Agriculture Promotion Sub-program in Ayeyarwady Delta Area

Note: No.5 '2-1 Intensive Agriculture Promotion Sub-program in Nay Pyi Taw Capital Area' is corresponding to (Green Model City of ASEAN) concept presented by the Union Agriculture Minister.
Source: JICA Survey Team

2) Out of the above 9 first-screened priority areas, such 3 areas were dropped by 2nd-screening as; 3) Chindwin-Ayeyarwady area, 6) Shan South area, 8) Bago South-West area. Chindwin - Ayeyarwady area was developed with pump irrigation schemes which still have difficulty of having on-time electricity due to shortage of power supply over the country, leading to less scheme sustainability; Shan South area has been developed with small scale irrigation, for which technical cooperation type assistance is more needed to improve farm management especially on the production of perishable vegetables; and irrigation schemes in Bago South-West area are relatively new, giving less priority on the rehabilitation of irrigation facilities.

3) Of the 6 second-screened areas of 1) Shwebo, 2) Mandalay, 4) Magway West, 5) Nay Pyi Taw, 8) Bago South-East, and 9) Ayeyarwady, those areas except for Magway West and Bago South-East were finally selected as the top 4 priority areas, which are to be undertaken for pre-feasibility study during the Phase 2 survey starting in August till December 2015. To select the final top 4 priority areas, the Team has examined several factors and development indexes such as potential of food value chain development, potential of further yield increase, potential of crop diversification, level of rehabilitation needs, potential of irrigation expansion, and return against the expected investment as the major ones, and further the poverty level, relevancy to 2-pole development strategy as well as to Myanmar Industry Development Vision.

4) Of the factors/indicators, IRR (internal rate of return) of Bago South-East is the lowest amongst the 2nd-screened 6 areas whereby there is a difficulty of selecting Bago South-East area as one of the final priority areas from the view point of economic justification though the area is endowed with transportation network and also located near Yangon, the biggest consumer area in Myanmar, leading to high potential of facilitating food value chain. A major reason of low return is attributed to the high investment cost of sea water prevention sluice gates to be required in lower

part – coastal part - of Bago South-East area.

5) Of the 5 priority areas, from which Bago South-East was dropped as above-mentioned, Magway West was further dropped. Magway West is located in a very remote area and agriculture commodities are more or less transacted within the region with some amount of pulses and oil crops for export. Given this situation, there is a difficulty pertinent to this area in promoting capital-based intensive agriculture. Though once the area was challenged by a high poverty ratio, the poverty ratio was very much improved, say from 43.9% in 2005 to 28.2% in 2010, the highest decrease of 15.7% among 2nd-screened 6 areas (considered as region). Though Magway may still need development assistance, the intervention should be of basic infrastructure establishment while the need of promoting intensive agriculture at this moment cannot be high, whereby dropped from the final selection.

Table 6.2 Screening for Selecting Top 4 Priority Areas by 2-level Indexes

Area	IRR	FVC	Yield	Div'n	Rehab. Need	Exp'n	Poverty	2-pole	MIDV
Shwebo	◎	○	○	○	◎	○	△	○	○
Mandalay	○	◎	○	◎	◎	△	○	◎	◎
Magway West	○	△	○	○	◎	△	○	○	○
Nay Pyi Taw	○	◎	◎	◎	△	○	○	○	○
Bago South - East	△	◎	◎	○	○	◎	△	△	◎
Ayeyarwady	◎	○	◎	△	○	○	◎	△	○
Following 3 areas already dropped by 2nd screening									
Chindwin – Ayeyarwady	–	△	◎	◎	○	△	○	○	△
Shan South	–	○	○	◎	△	△	○	△	○
Bago South - West	–	○	◎	△	△	◎	△	△	○

Note: IRR is internal rate of return (no conversion factors are counted in this estimation), FVC stands for possibility of facilitating food value chain; Div'n ; possibility of crop diversification; Exp'n; possibility of expanding irrigable area based on water availability; and MIDV stands for Myanmar Industry Development Vision.
Source: JICA Survey Team

PART II

Pre-feasibility Study on the Selected Areas

CHAPTER 1 DIRECTION AND STRATEGY SETTINGS

1.1 Top Four Priority Areas Selected

As a result of Phase-1 study, such top 4 priority areas have been selected as Shwebo (Sagaing region), Mandalay, Nay Pyi Taw and Ayeyarwady areas. Shwebo area is located in the upper Myanmar while the Ayeyarwady area in the southern part, the lowest part, of Myanmar. As is indicated by the name, Mandalay area extends around Mandalay city vicinity in its eastern side, and the Nay Pyi Taw area falls in and around the capital area. Following table shows general features of the top 4 priority areas:

Table 1.1.1 Top 4 Priority Areas Selected

Index	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Target Area	Shwebo District (Shwebo TS, Kin-U TS, Wetlet TS, Kandalu TS, Ye-U TS, Tabayan TS, Taze TS)	Mandalay City, Mandalay District (Patheingyi TS), Pyinoolwin District (Madaya TS), Kyaukse District (Kyaukse TS, Sintgaing TS, Myittha TS, Tada-U TS), Meiktila District (Wundwin TS)	Nay Pyi Taw City, Oke Ta Ra District (Tatkone TS, Zeyathiri TS, Ottarathiri TS, Pobbathiri TS),Det Khi Na District (Pyinmana TS, Lewe TS, Zabuthiri TS, Dekkhinathiri TS)	Myaungmya District (Wakema TS), Maubin District (Maubin TS), Pyapon Dostrict (Kyaiklat), Pathein District (Kangyidaunt TS, Thabaung TS, Ngapudaw TS, Kyaunggon TS), Labutta District (Labutta TS)
Socio-economic Feature	Major rice producing area in the upper Myanmar, Easy access to Mandalay city, An old capital of Shwebo	2nd largest city of Myanmar, One of poles of the Two-Polar Growth Strategy, center for nation-wide commodity transportation in the upper Myanmar	National Capital of Myanmar, in the middle of Yangon-Mandalay National Highway	Major rice producing area in the lower Myanmar, one of hubs of water transportation in the lower Myanmar
Topography	Low land area in the middle of Myanmar, right bank of Ayeyarwady river, suitable for paddy production	Low land area in the middle of Myanmar, located between Ayeyarwady river (west) and Shan Plateau (east)	Low land area in the middle of Myanmar, located between Bago Yoma (west) and Shan Plateau (east)	Low land area in Ayeyarwady delta, flood prone area during monsoon season, farmlands are segmented by rivers and creaks
Climate	Less rainfall area, Clear rainy and dry season, Summer (Mar ï Mid - May), Rain (Mid ï May - Oct), Winter (Nov - Dec)	Less rainfall area, Clear rainy and dry season, Summer (Mar ï Mid - May), Rain (Mid ï May - Oct), Winter (Nov - Dec)	Less rainfall area, Clear rainy and dry season, Summer (Mar ï Mid - May), Rain (Mid ï May - Oct), Winter (Nov - Dec)	Average annual rainfall is 2,000 - 3,000 mm, good for rice production, Rain season (Mid ï May ï Mid - Oct), Dry season (mid-Oct - Mid-May)
Major Crops	Rice, sesame, green gram, chickpea, wheat, lowland vegetables (Cabbage, cauliflower, tomato, lettuce, mustard, turnip, water melon, melon etc.)	Rice, beans, oilseeds, lowland vegetables (onion, chili, leaf vegetables, water melon, and melon etc.) and fruits as mango and etc.)	Rice, green gram, lowland vegetables (Onion, leaf vegetables, water melon etc.), and fruits (Mango)	Rice, black gram, green gram and fruits (Banana)
Irrigation Scheme	Kindat Irrigation Scheme, Kabo Irrigation Scheme (Thapanseik dam provides water)	Sedawgyi Irrigation Scheme, Zawgyi Irrigation Scheme, Kinda Irrigation Scheme	Sinthe Irrigation Scheme, Ngalike Irrigation Scheme, Yezin Irrigation Scheme, Paunglaung Irrigation Scheme	*Canal of Ngawun River (Thabaung TS) Kyaunggone Flood Plain Drainage (39 miles) Bitut (4) Polder (Laputta) Shwe Laung Polder Kyun Nyo Gyi Island (Ngapudaw TS) Thonegwa Polder

Note: * Since the implementation modality in Ayeyarwady delta is sector-approach, the schemes identified are examples as core project and on the course of the implementation, the areas will be additionally identified and added.
Source: from different documents provided by ID, DOA, DALMS, etc. and compiled by JICA Survey Team

1.2 Overall Direction Setting

1.2.1 Historical Implication over Agricultural Development

In theory, before industrialization, agriculture sector holds surplus labors in rural areas. Industrialization promotes labor shift from relatively low value-added industries including agriculture sector to high value-added industries such as manufacture industry and/or service sectors, resulting in economic growth, at least GDP base, of the nation. If the industrialization progress further, industry sector peels off labor forces from agriculture sector, and accordingly the surplus labor in the agriculture sector in turn reaches bottom. The bottom is so called ñLewis Turning Point[1]ò, after which the wages will increase due to tightening of demand and supply balance.

A theory of development economics indicates that labor shortage in rural area increases farming costs through wage increase, which results in increase in selling price of agricultural products. Increase in food prices in urban areas may seriously affect household economy of urban labors, and hence may incur social unrest provided that Engel's coefficient of the labors becomes too high. To avoid such situation, increase in wages of manufacturing workers is needed. However, the wage increase in industry sector causes weakening of competitive power of the sector in the world market, resulting in gear down of the industrialization process.

To mitigate rapid progress of the negative scenario of industrial development afore-mentioned, it is important to supply cheaper staple food constantly through increase in basic food production including rice, the staple food of Myanmar people. For this purpose, shifting from the labor intensive farming currently practiced in wider range of Myanmar to the capital intensive with labor saving agriculture is due necessary in this country. Shifting to the capital based intensive agriculture thus contributes to assuring the continuous provision of cheap and stable food, and thereby able to keep the progress of industrialization.

1.2.2 Agricultural Development in Myanmar Context

Myanmar is basically agricultural based country where agriculture sector absorb around 50% of labors and makes up around 30% of the national GDP. However, it is expected that the labor intensive industry sector will be accumulated particularly in Yangon and Mandalay, the poles of the two-pole growth strategy of the national economy, and industrialization will be rapidly progressed. It is said that one of advantages of the Myanmarôs industrialization is the cheap and abundant labor force in rural areas.

However, Myanmarôs population pyramid has already shifted from the stable type to the constructive type to a bell shape. In addition, labor force drain to urban areas and abroad is observed in rural areas due to lack of permanent working opportunities. As a result, labor shortage is becoming serious issue in rural areas, where labor intensive agriculture has been the dominant mode, resulting in competition with other industries including weaving industry, for example. It is expected that the tendency will accelerate hereafter. Therefore, it can be said that the above negative scenario cased by shortage of labor in agricultural sector is the coming risk in Myanmar economy. For this reason, increase in agricultural productivity to supply stable food to domestic markets is urgently needed.

On the other hand, ASEAN Economic Community (AEC) will start by the end of 2015, and, under that

[1] Named after economist W. Arthur Lewis, is term used in economic development to describe a point at which surplus rural labor reaches a financial zero. This in turn typically causes urban wages to rise dramatically. Upon reaching the Lewis turning point, a country or state usually experiences a labor shortage which leads to a rise in agricultural and unskilled industrial real wage. This usually continues until a labor surplus can be reached once again. Typically, reaching the Lewis turning point also causes an improvement in the wage bill and the functional distribution favoring labor. (Source: Wikipedia).

AEC, market integration among ASEAN countries will be accelerated. To survive in the competitive market, agriculture in Myanmar has to improve quality of products, adding value on agricultural products, and reduce transportation costs and losses, based on competitive advantages and markets needs. In this regard, role of private sector is quite important, and the government has to improve distribution infrastructure and, in cases processing infrastructure to support agribusiness of the private sector.

1.2.3 Overall Direction Setting

Promotion of intensive agriculture program comprises two major strategies, including ñincrease in agricultural productivityò and ñpromotion of agribusinessò. The former will be achieved through enhancement of production infrastructure, including irrigation structure rehabilitation/ improvement, land consolidation, and promotion of agricultural mechanization. Target areas for the enhancement of production infrastructure are those irrigable areas in lowland plains including Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady.

Whereas, the latter, promotion of agribusiness, will be materialized through improvement of distribution and processing infrastructure. The project components will be the improvement of farm-to-market roads mostly composed of canal inspection road under ID and rural road under the Department of Rural Development, jetty improvement with which river transportation will be enhanced especially between Ayeyarwady and Mandalay, credit accommodation to food processing facilities, improvement of post harvest facilities and enhancement of plant protection services.

The priority should be given to the both strategies of ñthe increase in agricultural productivityò as well as ñthe promotion of agribusinessò with the latter paying due consideration to private sectorôs participation. Though the priority is given to the both strategies, the speed of the impact appearance is different as may be illustrated in the figure right; namely, impact from the ñincrease in agricultural productivityò would accrue from the beginning at a relatively constant level while the impact from the ñpromotion of agribusinessò will progressively increase in line with the economic development as a whole country.

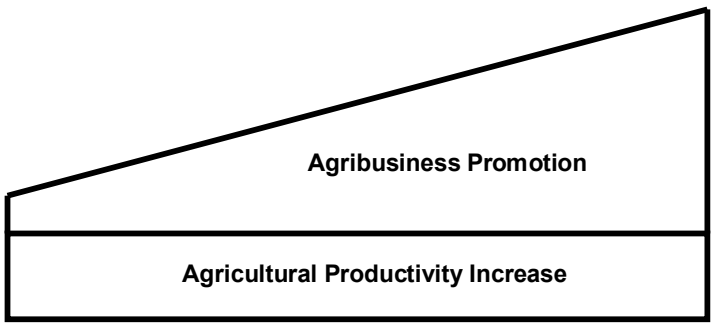


Figure 1.2.1 Conceptual Impact Appearance

1.2.4 Conformity to the 2nd Five Year Short Tem Plan

Ministry of Agriculture and Irrigation has already drafted a growth strategy and programs of agriculture sector for next 5 years, so called 2nd Five Year Short Term Plan 2016/17-2020/21 (see the vision and mission in the box). The plan stated numerical targets such as cultivated area, cropping intensity, average yield of paddy, and total irrigated area. To achieve the targets, the plan also indicated strategies which include hybridization, irrigation, mechanization, training and education, and privatization and industrialization. The program for intensive agriculture promotion (PIAP) will support the government policy by taking both approaches of infrastructure development and capacity development of supply chain stakeholders.

The infrastructure development contains irrigation rehabilitation, land consolidation to promote farm mechanization, and farm-to-market road improvement including bridge replacement/ upgrading. Whereas, supply chain enhancement of rice production, includes quality seed dissemination, demonstration of advanced farming technologies, support of private agribusiness through credit accommodation, distribution infrastructure improvement and food processing development.

Rice is the priority crop in the 2nd Five Year Short Term Plan, and Myanmar Rice Sector Development Strategy (MRSDS) is now reflected in the plan. According to a summery paper of the plan, development goal of the rice sector in 2030 is to materialize rice self-sufficiency for 100 million Myanmar people plus 4 million tons export through achieving 5.0 t/ha average yield. For this purpose, the plan introduces 11 strategic themes including intensive cultivation of improved varieties, utilization of farm mechanization, and mitigation and reduction of weakness of the rice value chain.

Vision
- To attain food and nutrition security,
- To create better income and development of socio-economic status of farmers, and
- To improve competitiveness of Myanmar agricultural products to international market.

Mission
- Creating profitable and sustainable market for farmers,
- Emerging seed industries to utilize high quality seeds appropriate to local condition,
- Adoption of good agricultural practices,
- Efficient and effective use of natural and chemical fertilizers and other inputs,
- Encouraging agro-based industries to produce value-added products,
- Reduction of transitional cost along the process from seedling to marketing, and
- Developing post-harvest technology.

Source: a PPT material, ñGrowth Strategy and Programs of Agriculture Sector in Five Years Plan for Development of Agribusinessò

The program component of PIAP meets directly to the MRSDSôs goal since intensive agriculture promotion focuses on production increase of rice through rehabilitation of irrigation shcemes, and also promoting of the efficiency of entire supply chain of rice, covering from farm inputs, production, processing, until selling in the markets. In addition, plant protection will also be improved under a program component of PIAP, which can facilitate the export of rice to the rice-consuming countries such as China, African countries, and Russia as well.

1.2.5 Relevancy to Myanmar Industrial Development Vision

Myanmar Industrial Development Vision was developed by Ministry of Economy, Trade and Industry of Japan in July 2015, aiming at providing a reference of industrial development direction and policy when Myanmar government prepares next Five Year Development Plan and other development plans/ policies. The vision contains past experiences of many countries, so that Myanmar government could attain leapfrogging development scenario.

For agriculture sector, the vision introduced a view that agriculture sector in Myanmar plays important role for employment and preservation of national land, but rooms for increasing productivity still remains a lot due to delay of mechanization and dissemination of modernized skills and know-how. In addition, establishment of quality management, improvement of distribution infrastructure, and development of food processing industry are the issues to be solved to develop the sector further. As a conclusion, the vision suggests to develop the agriculture sector as key industry through expansion of scale, export increase and high value-adding.

The vision includes a recommendation list which suggests priority measures to be taken by the Myanmar government for the industrial development. Following table shows the recommendation regarding realization for agriculture sector development potential, and corresponding component of the PIAP.

Table 1.2.1 Relevancies of Myanmar Industrial Development Vision and PIAP

Item		Recommendation (selected)	Component in the PIAP
Development of Food Value Chain	Rice, pulses, sesame	Support measures for productivity increase (farm mechanization, instruction for appropriate usage of fertilizers/ pesticides, dissemination and fosterage of quality seeds, irrigation and farmland improvement)	Enhancement of agri. machinery center, Supply chain enhancement of rice, irrigation rehabilitation, land consolidation
		Establishment of modernized distribution system	Farm-to-Market road (FMR) improvement, Jetty improvement, Rural market improvement, Function enhancement of wholesale market
		Establishment of mid and long term credit system of MADB	(Dissemination promotion of agriculture machineries by a loan scheme)
	Production increase of horticulture, value adding	Support measures for productivity increase (dissemination of quality seeds, formulation of production area through right crop for right land principle)	Value chain enhancement of vegetables & fruits, Demonstration and dissemination promotion of lowland vegetables
		Establishment of modernized distribution system (including enhancement of wholesale function)	FMR improvement, Jetty improvement, Rural market improvement, Function enhancement of wholesale market
		Promotion of organic farming (certification system)	Demonstration and dissemination promotion of lowland vegetables
	Expansion of processed food and development of food processing industry	Guidance for improvement of food processing technology	Food industry promotion
		Implementation of food inspection and chemical residuals	Enhancement of Plant Protection Function, Function enhancement of wholesale market

Source: Myanmar Industrial Development Plan, and JICA Survey Team

1.3 Development Direction and Strategy Setting by Priority Area

1.3.1 Shwebo Area

Shwebo Area is a rice producing area in the Upper Myanmar. Particularly, the area is a production center of ñShwebo Paw Sanò, which is a high value variety of monsoon paddy for domestic markets, and is possible for double cropping in irrigated area. To increase food supply to the rice shortage area in the CDZ and Mandalay in which accumulation of manufacturing industry is progressing, improvement of production infrastructure, including irrigation facility rehabilitation and land consolidation, is important to materialize stable supply of basic food such as rice.

In view of rice distribution, major drawbacks in the agro-products marketing are poor farm-to-market roads which often become unable to pass 2 to 3 days after rain due to poor surface condition, and jetties which have to rely on manual labors for up- and re-loading of cargoes due to delay of port modernization. Therefore, improvement of distribution infrastructure to reduce distribution costs is necessary, which can result in assurance of continuous supply of stable rice to urban labors.

In addition, by enhancing collaboration with stakeholders, quality improvement and intensification of agro-products supply chain as a whole should be promoted. This can be realized through dissemination of good quality seeds, appropriate dosages of fertilizers, proper/timely weeding, and improvement of post-harvest technologies including rice mill improvement. Rice mill should be improved since the

present milling ratio is very low, often said to be as low as less than 50% in many cases.

Based on the above brief discussion, Figure 1.3.1 now provides a comprehensive framework for intensive agriculture development, which shows issues that we need to tackle, program components in order to solve these issues, and effects and/or impacts to accrue from the components along with the supply chain starting from input, then production, processing, distribution and markets. Further, the components are broadly demarcated into two groups such as ones contributing to productivity increase and the rest for agri-business promotion.

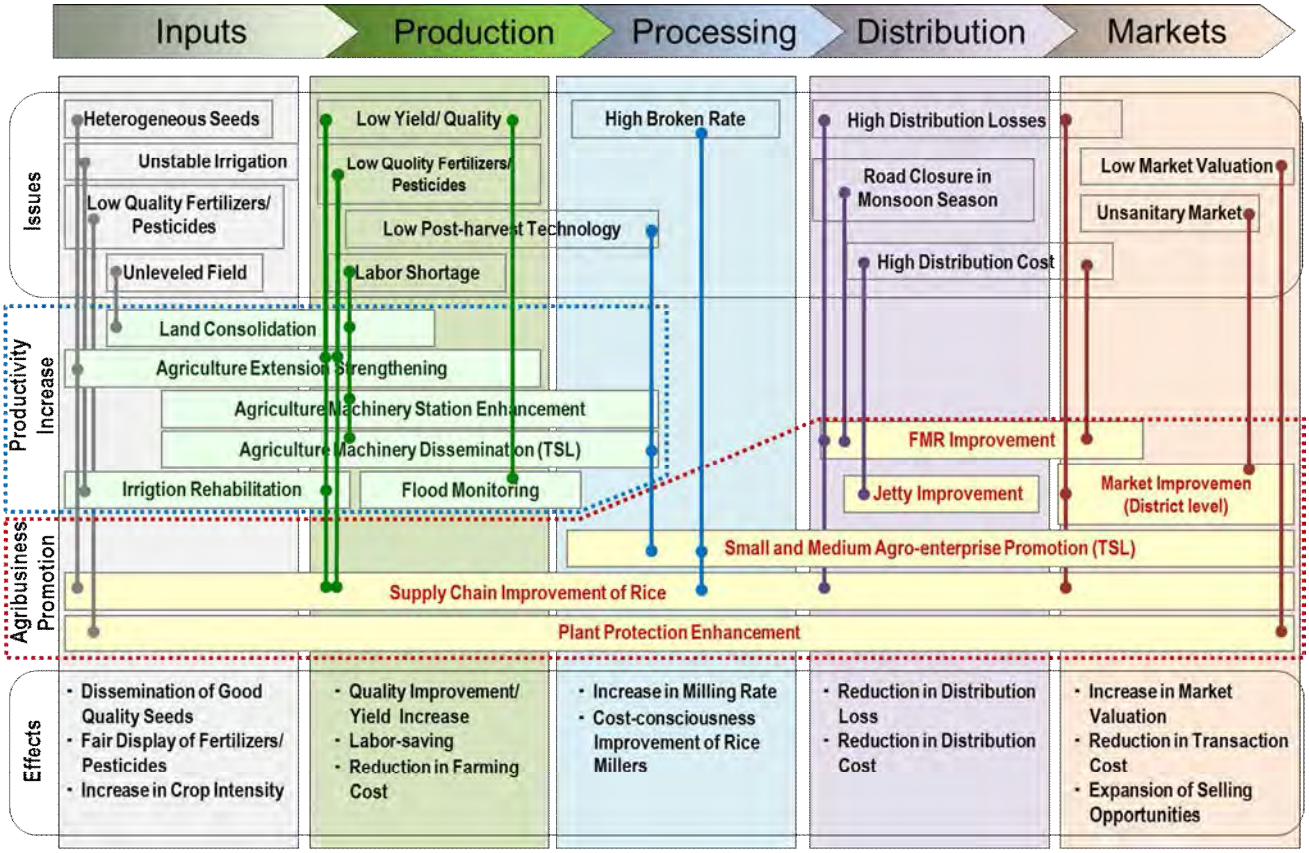


Figure 1.3.1 Issues-Projects-Effects in View of Supply Chain (Shwebo)

Source: JICA Survey Team

Identified program component in relation to issues in Shwebo Area is, as afore-mentioned, shown in the above Figure 1.3.1 along with the stages from input to the market. The components to increase agricultural productivity includes irrigation rehabilitation, land consolidation and enhancement of agricultural machinery center, whereas the components for promotion of agribusiness are farm-to-market road (FMR) and jetty improvement, rural market improvement, dissemination promotion of agricultural machinery, supply chain improvement of rice, and enhancement of plant protection function.

With above program implemented, the farmers in Shwebo area will further cultivate the high value local variety of Shwebo Paw San, a monsoon paddy. The variety used to be cultivated in around half of the area (Sagaing DOA office). However, after 2011 when the present government came into power, economy started improving and it is said in parallel with it certain share of the nation started preferring such high value rice (DOA headquarters). In 2014/15 season, the sown area of the Shwebo Paw San in Shwebo district had occupied as much as 80% of the cultivated area.

Contrary to the monsoon season, the Shwebo Paw San variety cannot be grown during summer season due to the property of short-day plant, for which short-daytime (longer night time) is required to

flower. Therefore, the farmers should cultivate common high yielding variety during summer season, primarily for the purse of export to China. To enable this switching of rice variety between monsoon and summer, water management is due required and rehabilitation of the irrigations systems will play a great role together with road improvement and land consolidation.

1.3.2 Mandalay Area

Mandalay is one of core area of economic growth in the Two-Polar Growth Model (Yangon and Mandalay), and strategically significant as trans-shipment station of agricultural products for domestic and international markets. Oil crops and pulses are brought about from the CDZ, while rice for export is brought in Mandalay from rice growing areas in the Lower Myanmar, and then shipped to the border area of Muse. Vegetables and fruits from Southern Shan are handled by traders and wholesalers in Mandalay and redistributed to final destination places in the Upper Myanmar.

To enhance function of the transshipment station of various farm products, promotion of food processing industries, enhancement of agro-products distribution and marketing, mechanization of river port, and enhancement of plant protection function should be promoted. Of them, further priority could be placed on; 1) food processing including rice, and 2) distribution and marketing of agro-products. For example, about 80 % of the shipped rice to China through Muse is said to be for processing, e.g. noodle, rice powder, etc. If such processing could be done in Mandalay area, value addition can be generated within Myanmar. Mandalay being the hub in Upper Myanmar, distribution function should be strengthened, which can also lead to the promotion of food processing.

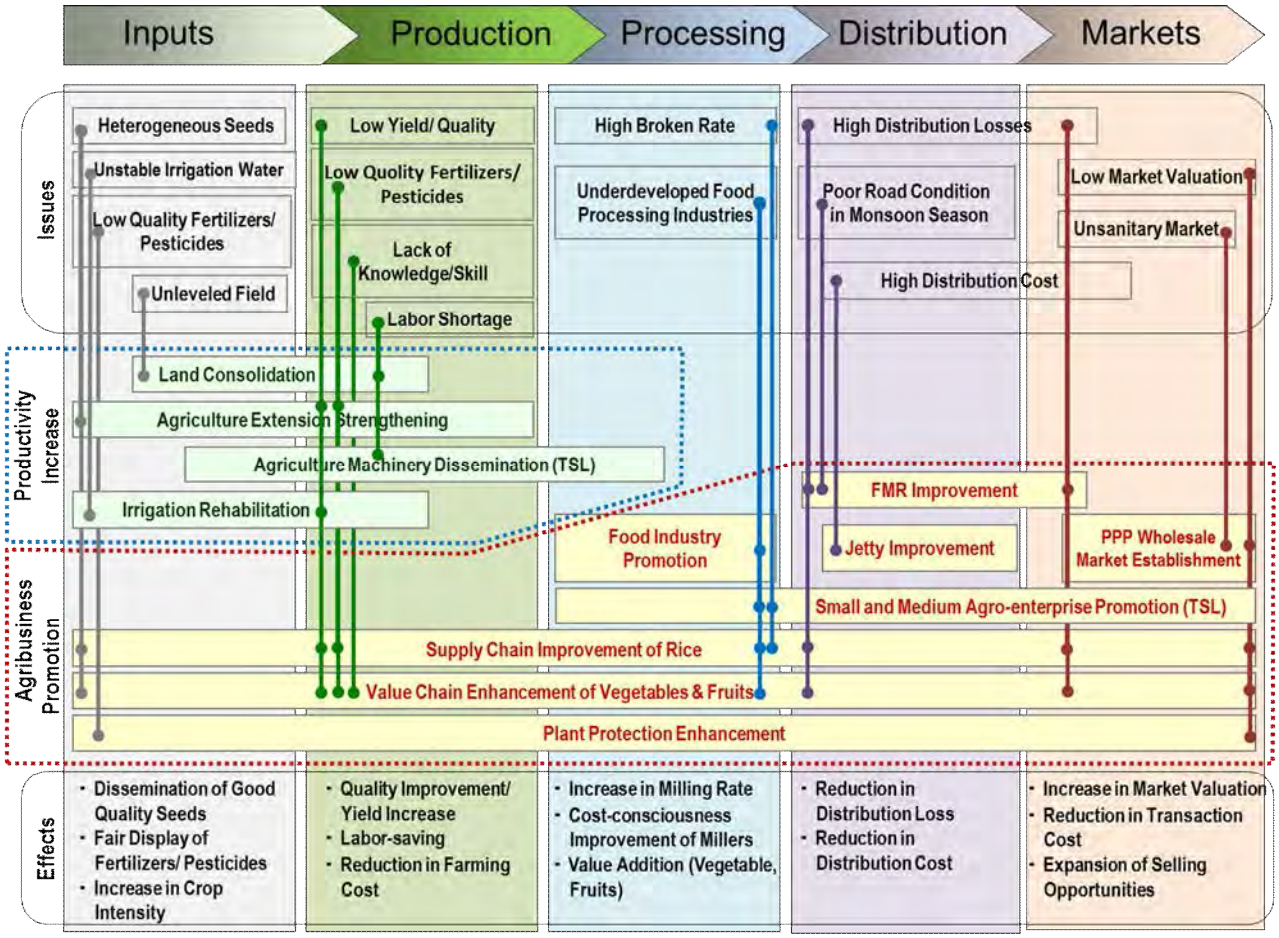


Figure 1.3.2 Issues-Projects-Effects in View of Supply Chain (Mandalay)

Source: JICA Survey Team

In outskirt areas of Mandalay city, double cropping is practiced in service areas of many irrigation

schemes, while vegetables and fruits production areas including Kyaukse and Pyin Oo Lwin are existent. It is possible to supply stable food from these areas through enhancement of production infrastructure and improvement of food supply chain. Since growth and accumulation of food processing industry is expected in Mandalay, it is necessary to take measures to avoid or at least prolong food price increase from labor shortage and farm cost increase.

Identified program component of Mandalay is shown in Figure 1.3.2 along with issues that have to be solved. The components to increase agricultural productivity includes irrigation rehabilitation and land consolidation, whereas the components for promotion of agribusiness are farm-to-market road (FMR) and jetty improvement, rural market improvement, enhancement of wholesale function, dissemination promotion of agricultural machinery, supply chain improvement of rice, value chain enhancement of vegetables and fruits, and enhancement of plant protection function.

1.3.3 Nay Pyi Taw Area

The capital Nay Pyi Taw is located between Mandalay and Yangon, which are two strategic areas of economic growth in the Two-Polar Growth Model. Therefore, Nay Pyi Taw has quite important political and economical role to facilitate and guide proportionate economic growth of the two poles. To disseminate innovative technologies and information to both domestic and international societies including ASEAN countries, Nay Pyi Taw's important role is primarily to demonstrate advanced agricultural technologies maintaining a harmonious balance with environment, as a Green Model City.

The ideal advanced technologies for demonstration purpose should be related to intensive agriculture promotion and value adding to agro-products, which may include water saving technologies including drip and sprinkler irrigation system, hydroponic farming system, green house farming, and organic farming applying effective microorganisms. In addition, it is important to demonstrate a model for improved supply chain of staple food product that includes the production infrastructure such as irrigation rehabilitation, and the distribution infrastructure including FMR improvement.

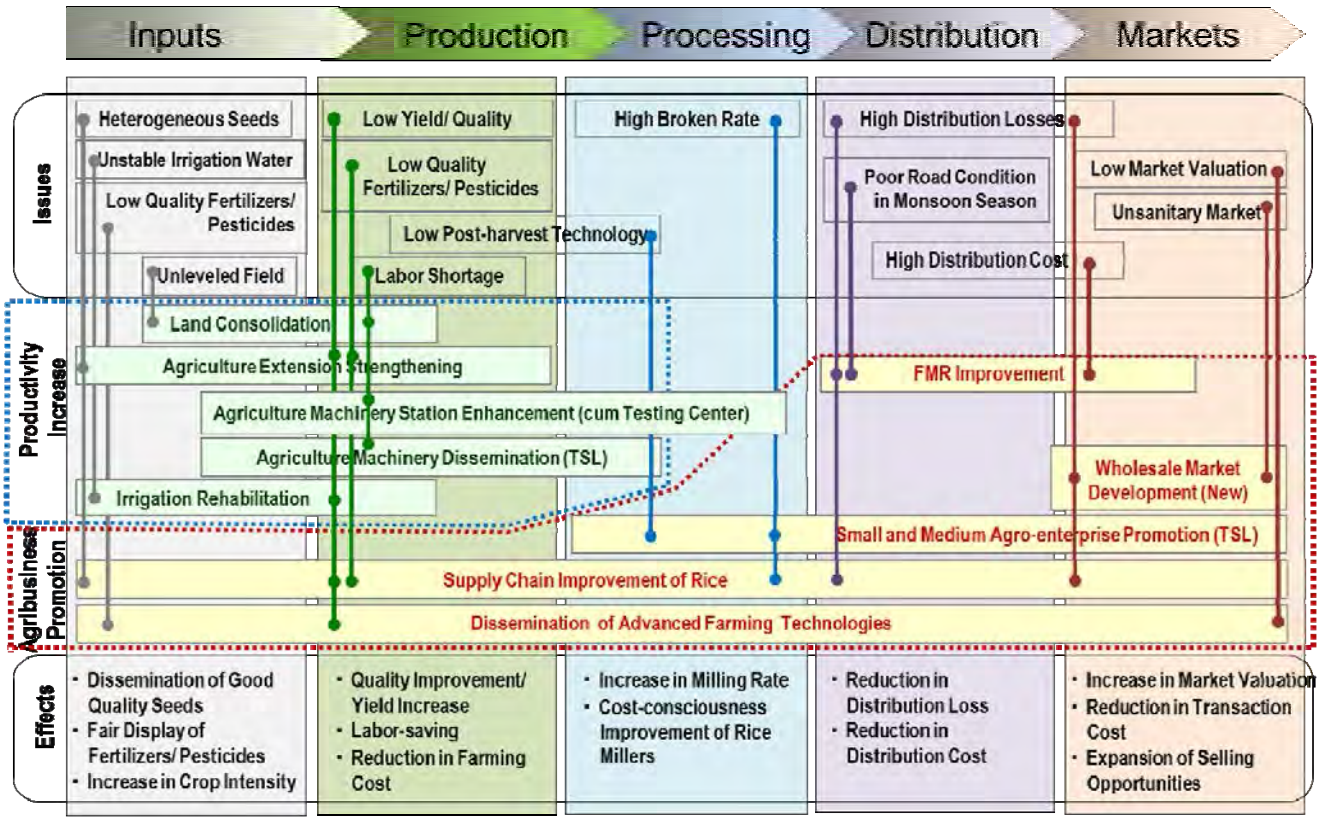


Figure 1.3.3 Issues-Projects-Effects in View of Supply Chain (Nay Pyi Taw)

Source: JICA Survey Team

Identified program component of Nay Pyi Taw Area is shown in Figure 1.3.3 along with the issues that we need to cope with. The components to increase agricultural productivity are land consolidation, agricultural extension strengthening, agricultural machinery dissemination, plant breeding enhancement and irrigation rehabilitation, whereas the components for promotion of agribusiness are FMR improvement, new wholesale market establishment, demonstration and dissemination promotion of lowland vegetables, and supply chain improvement of rice.

1.3.4 Ayeyarwady Area

Ayeyarwady Delta is internationally recognized rice producing area of Myanmar, and takes the substantial responsibility for the nationôs food security. However, function of protection dikes and drainage networks are deteriorating due to degradation and sedimentation, and functional enhancement of flood mitigation and drainage network is very much required. To sustain and enhance supply capacity of rice, it is important to increase productivity of rice through land consolidation and farm mechanization, in addition to the strengthening of flood protection dike and drainage.

On the other hand, villages in the delta area are segmented by unnumbered rivers and creeks, resulting in high cost and time consuming transportation of agricultural products. To mitigate the constraints on agro-products distribution, improvement of distribution infrastructure including upgrade of farm-to-market roads (FMRs), a part of the regional roads, bridges and river ports are required. Also, improvement of supply chain management such as dissemination of good quality seeds, appropriate use of fertilizers, and improvement of post harvest technologies, is necessary.

Identified program component of Ayeyarwady area is summarized in Figure 1.3.4. The components to increase agricultural productivity includes irrigation rehabilitation, land consolidation and enhancement of agricultural machinery center, whereas the components for promotion of agribusiness are FMR and jetty improvement, rural market improvement, dissemination promotion of agricultural machinery, supply chain improvement of rice, and enhancement of plant protection function.

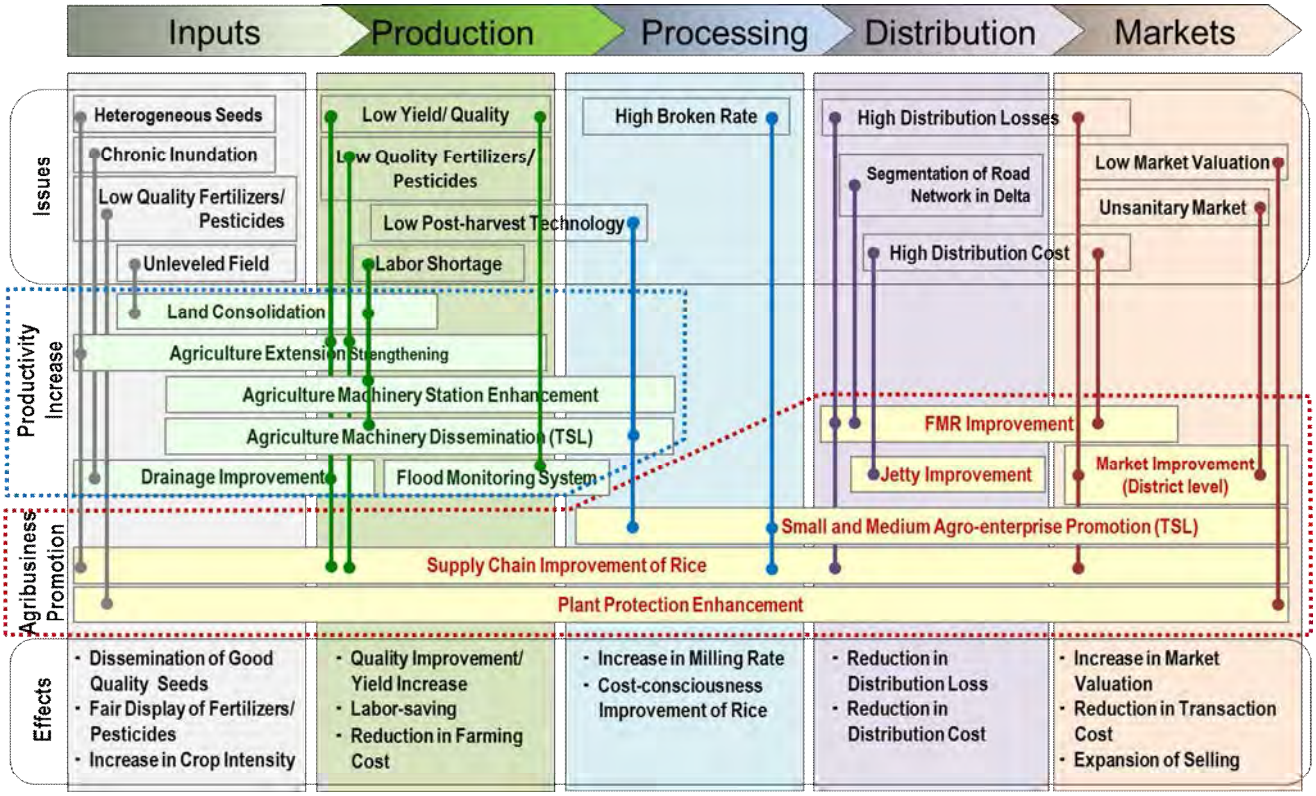


Figure 1.3.4 Issues-Projects-Effects in View of Supply Chain (Ayeyarwady)
Source: JICA Survey Team

1.4 Donor Involvement in Relevant Sectors

In the agriculture and rural development sector, there are donors who started projects implementation and are also undertaking planning. In the agriculture sector, major donors involved are the World Bank, ABD, IFAD, FAO, and India and China. Donor supported projects are summarized in the following table with the status; project preparation or already implementation, and main topics related to this survey are as follows:

1) The World Bank is to implement irrigation rehabilitation, and one of the target irrigation systems is Sinthe irrigation system in Nay Pyi Taw region. This JICA survey has also identified the Sinthe irrigation system as one of the target schemes for rehabilitation. The WB is to rehabilitate the left main canal, so that the JICA survey is to exclude the canal and concentrate on the rest of the canals, mainly right main canal.

2) The ADB is also to implement irrigation rehabilitation project in the Central Dry Zone area. The project is to rehabilitate total 5 irrigation systems, and 2 shcemes have been identified as core project under sector approach. The 2 schemes and other potential sites are not duplicated with the ones identified under JICA survey.

3) IFAD and Indian government are to carry out land consolidation component. IFAD is now implementing land consolidation, called land development, in Nay Pyi Taw area and the target coverage is as much as 10,000 acres including beneficiary area of Paung Laung system. Indian government will implement land consolidation over a total of 50,800 acres (20,000 ha) area. Of the land consolidation projects by the Indian government, following are to be implemented in the priority areas identified by this JICA survey;

✓ Nay Pyi Taw region land consolidation project: 12,500 acre

1) Ngalaik Irrigation system, Pyinmanar Township: 6,000 acre
2) Yezin Irrigation system, Pyinmanar Township: 5,000 acre
3) Sinthe irrigation system, Tatkone Township: 1,500 acre

✓ Mandalay region land consolidation project: 10,300 acre

2) Kinda irrigation system, Myittar TS: 1,800 ac and Windun TS: 2,000 acre
3) Zawgyi irrigation system, Kyaukse Township: 1,100 acre
4) Sedawgyi irrigation system, Mattaya Township: 5,400 acre

4) In Ayeyarwady region, IFAD is now preparing a project in Ayeyarwady delta area, and one of the components is Polder Infrastructure Rehabilitation, and Land Consolidation. Though the target areas have not been decided, there should be an attention not to duplicate with the identified polders under this JICA survey. Chinese government sent a mission to Ayeyarwady delta area 2 times in 2015, and is to finance strengthening/ construction of river banks. The target area is located in the upper most area of the delta, and it is not overlapped with the areas identified under this JICA survey.

Table 1.4.1 Donors' Activities in the Relevant Sector

Donors	Project and Contents	Cost & Schedule
WB	**Agricultural Development Support Project (appraised)** **Component and Cost:** 1) Irrigation and Drainage Management (US$78.4 million); 2) Farm Advisory and Technical Services (US$17.2 million); (3) Project Coordination and Management (US$4.4 million); and 5) Contingent Emergency Response (US$0 million). **Location:** Male Nattaung system(Mandalay region), North Yamar system (Sagaing region), Sinthe system (Nay Pyi Taw region), and Swa system (East Bago region)	100 MUS$ July 2015 to 30 July 2022 (7 years)

Donors	Project and Contents	Cost & Schedule
ADB	**Irrigated Agricultural Inclusive Development Project (under appraisal)** **Component:** Value Chain Development Composed of 1) improved seed supply, 2) extension of good agricultural practices, 3) agri-business support to post harvest, Cross-cutting Value Chain Development Support composed of 1) establishment and support to frontline centers, 2) support to improved input supply, 3) development of information system, 4) support to value chain development. **Location:** Central Dry Zone, and in irrigation component, 2 core projects have been identified as Chaungmagyi system (Mandalay region) and Natmauk system (Magway region), and total 5 irrigation systems are to be rehabilitated under sector approach.	50 MUS$ (Not fixed) 2017 to 2023 (7 years)
IFAD	**Fostering Agricultural Revitalization in Myanmar (under implementation)** **Component and Cost:** 1) Agricultural Infrastructure (11.8 MUS$), 2) Agricultural and Business Services (11.1 MU$), and 3) Project Coordination (2.7 MU$). The agricultural infrastructure component includes land development, e.g., land consolidation under a participatory approach. **Location:** Nay Pyi Taw region, the land development will be made over the first four years of implementation, and will cover 10,000 acres primarily in the upstream sections of three irrigation schemes (Paung Laung, Chaung Magyi, Madan).	28 MUS$ (18.7 MUS$ for IFAD loan) 2015 - 2020
IFAD	**Delta Agriculture Resilience Project (under planning)** **Location:** Ayeyarwaddy region **Component:** 1) Strategic investments composed of Polder Infrastructure Rehabilitation, and Land Development and Consolidation, and 2) Enabling Investment composed of Knowledge and Technology, Seed Production and Financial Services	30 MUS$ 2016/17 ï 7 years
India	**Land Consolidation Project (under appraisal)** **Location:** Nay Pyi Taw Region, Mandalay Region, Sagaing Region, Bago Region, Magway Region, Yangon Region, Kayin State, Mon State; 50,800 acres (20,000 ha) **Component Name:** Nay Pyi Taw Region land consolidation project 12,500 ac 1) Ngalaik Irrigation system, Pyinmanar Township 6,000 ac 2) Yezin Irrigation system, Pyinmanar Township 5,000 ac 3) Sinthe irrigation system, Tatkone Township 1,500 ac Mandalay Region land consolidation project 12,300 ac 1) Methilar (Chaung Gaunt) irrigation system, Methilar Township 2,000 ac 2) Kinda irrigation system, Myittar TS 1,800 ac and Windun TS 2,000 ac 3) Zawgyi irrigation system, Kyaukse Township 1,100 ac 4) Sedawgyi irrigation system, Mattaya Township 5,400 ac Total of the above 3 schemes: 10,300 acre Sagaing Region land consolidation project 6,500 ac 1) North yama (Extended) irrigation system , Yinmarbin Township 2,500 ac 2) North yama(left) irrigation system, Pale Township 4,000 ac Bago Region Land consolidation project 6,400 ac Magway Region land consolidation project 3,400 ac Kayin State land consolidation project 2,300 ac Yangon Division land consolidation project 6,100 ac Mon State land consolidation project 2,300 ac **Construction of Irrigation Network:** **Project Location:** Construction of Baidar Irrigation system (Bago East) and Khapaung irrigation system (Bago East), covering total 35,000 ac	64.874 MUS$ 2015/16 ï 2015/17 73.11 MUS$ 2015/16 ï 2017/18
China	**Flood Protection in Ayeyarwady Region (under preparation)** Details are not available as of October 2015. A Chinese mission visited Ayeyarwady delta area 2 times in 2015 to formulate a project for flood protection in upper stream of Ayeyarwady delta. As of November 2015, an amount of about 40 MUS$ is discussed in order to construct/ strengthen river embankment in upper area of the delta, reaching as long as 100 miles.	

Source: Project appraisal report, Aide Memoire, relevant documents of above project

CHAPTER 2 THE STATUS OF PRIORITY PROJECT AREA

Four areas were selected as priority area for promoting intensive agriculture program. Concerning the 4 priority areas, the JICA survey team visited relevant government organizations such as ID, DOA and other delegations of the national government, and local government including market authority. Also the team conducted interview survey to farmers, brokers, millers and traders to grasp current farming situation and commodity flow of agricultural products. In this chapter, the current condition of the priority areas are discussed based on those interviews and surveys:

2.1 Status of the Shwebo Priority Area

Current status of the Shwebo area is discussed below in terms of agriculture, irrigation, land consolidation, mechanization, and marketing or distribution infrastructure.

2.1.1 Agriculture in Shwebo Area

According to data provided by ID and DOA, paddy is cultivated during monsoon season almost over all the farmland (lowland) within the Shwebo irrigation area supplemented by irrigation, and summer paddy is planted at 56% of the area fully supported by irrigation. Pulses are planted at 31% area during winter season, and chick pea is the major pulse, followed by green gram. The pulse grows under residual moisture, not irrigated. The total crop intensity in this Shwebo area is therefore estimated at as high as 187%[1].

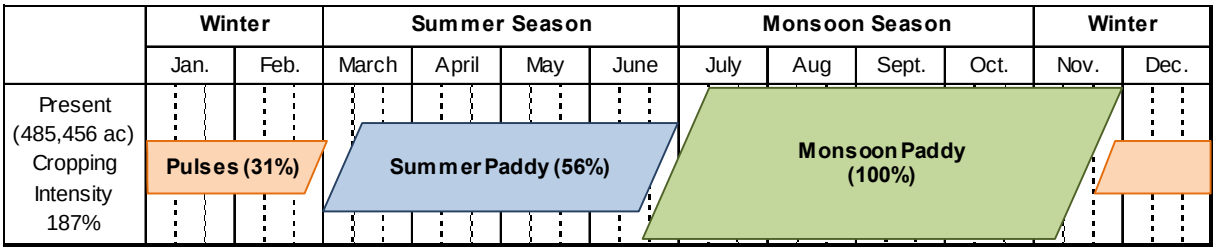


Figure 2.1.1 Present Cropping Pattern in Shwebo Area

Source: JICA Survey Team (2015)

JICA survey team conducted a crop yield survey in August ï October 2015, covering 121 samples. The result of the yield survey is summarized in the following table together with the yield data provided by DOA statistics. The survey asked farmers the yield in the last crop season (2014-15) and also for the average for the last, say, 4-5 years. The yield in average year is 63 basket/acre, 76 basket/acre, and 14 basket per acre for monsoon paddy, summer paddy, and chick pea respectively, while those provided by DOA show relatively higher yields[2].

Table 2.1.1 Yields Comparison between Yield Survey and DOA Statistics in Shwebo Area

Season	Crop	Yield Survey (N=121) 1/				DOA 2/ Statistics (2011-2014)
		2014-2015 (last season)		Average Year		
		No.	Yield	No.	Yield	
Monsoon	Paddy	121	61.8	121	62.7	87.9
Summer	Paddy	55	81.9 (3/)	54	81.5	93.8

[1] As famers cultivate paddy during monsoon season as far as possible, the intensity of monsoon paddy is practically counted at 100%. The cultivated area of summer paddy was provided by ID, based on which the intensity of summer paddy was estimated as a ratio comparing to the scrutinized irrigable area. The intensity of pulses was estimated by dividing total sown area of winter pulses in the target TSs by that of monsoon paddy, using 3 years average DOA statistical data (2011 ï 2014). Note that ID data does not provide any pulses cultivated area since irrigation water is not provided to the pulses.

[2] The reason why the DOA data show much higher range of the yield are; 1) possibility of inflating yield which might have been practiced during former regime, 2) difference in terms of the area surveyed by JICA team which covered only a sample area, and surveyed by DOA which basically covers all the areas.

Season	Crop	Yield Survey (N=121) 1/				DOA 2/ Statistics (2011-2014)
		2014-2015 (last season)		Average Year		
		No.	Yield	No.	Yield	
	Sesame	5	7.6	4	10.0	16.7
Winter	Chick pea	12	13.0	12	14.3	23.5
	Green gram	2	3.0	1	5.0	14.3

Note: 1/ The yield survey was conducted in 4 TSs located in mid and downstream of the Shwebo irrigation area, covering 121 farmer households.
Note: 2/ DOA data referred to those of 7 TSs where the Shwebo irrigation system extends.
Note: 3/ The irrigation system in Wetlet TS (located in downstream of the Shwebo irrigation area) was not fully functioning for the last 3-4 years, hence farmers have faced water shortage resulting in lower yield. The results of these TS were therefore omitted in this table. The sample no. removed for this TS is 29 out of the total 121 samples.
Source: Crop yield survey by JICA Survey Team (2015), DOA statistics (2011-14)

Following table shows the major rice variety in Shwebo area. Dominant variety of monsoon paddy is Shwebo Paw San, which is well known as high quality rice, hence quite popular variety in the domestic markets in Myanmar. Particularly, after the Cyclone Nargis hit Ayeyarwady area in 2008 where a Pay San variety used to be cultivated a lot, the quality of the paddy in Ayeyarwady delta is said to have decreased. Instead, the Shwebo Paw San has gained lots of popularity, and the demand has been increasing in Myanmar domestic market.

Table 2.1.2 Major Variety of Rice in Shwebo Area

Variety	Season	Growing period(days)	Yield (expected) (bsk/acre)	Selling price (kyat/bsk)	High Yield/Quality Variety
Shwebo Paw San(80%)	Monsoon	150	100	8,000 - 8,500	HQV
Ayar Min(20%)	Monsoon	145 -150	100	5,000	HQV
Shwe Thwe Yin(50%)	Summer	115	120	4,500 - 5,000	HYV
IR747(50%)	Summer	100	115	5,000	HYV

Source: DOA (2015), Note: HQV means high quality variety and HYV means high yield variety.

A household survey was conducted by the JICA team, covering 92 sample households in Shwebo irrigation area. All the 92 sampled farmers, as a matter of fact, have lowland (farmland for paddy) within the irrigation scheme, and of them 26 farmers have upland farm. For the lowland, average farmland area comes to 7.6 acres per farmer with 36 acre and 1 acre being the maximum and minimum respectively. Including the upland farms, the average farmland that a typical farmer owns is estimated at 8.5 acre (3.4 ha).

Table 2.1.3 Farmland Holdings in Shwebo Area

Items	Lowland	Upland	Others	Total / Average
No. of HH (N=92)	92	26	0	92
Total Area (Acre)	703.0	77.3	0.0	780.3
Maximum Area (Acre)	36.0	8.0	0.0	36.0
Minimum Area (Acre)	1.0	0.8	0.0	1.5
Average Area (Acre)	7.6	3.0	0.0	8.5 (3.4 ha)

Source: Household survey by JICA Survey Team (2015)

The farmers, as aforementioned, cultivate monsoon paddy, summer paddy, and pulses in the lowland (farmland in irrigation area). All the farmers cultivate monsoon paddy, while not all the farmers do summer paddy and winter pulses. In fact, summer paddy cultivation is totally dependent on the availability of irrigation water, whereby only the farmers who are provided irrigation water can cultivate the summer paddy. Pulses cultivation depends on the soil property, specifically moisture retention capacity, and the farmerôs interest. Figure 2.1.2 shows the cropping times; namely, 10% famers cultivate 3 crops, 76% farmers do 2 crops (monsoon paddy + summer paddy or monsoon paddy + pulses), and the rest, 14%, cultivate only one time crop, that is monsoon paddy.[3]

[3] Irrigation canals in Kanbalu TS of Shwebo area were under repairing during the survey period, and therefore

Agriculture related difficulties were also questioned to the sampled farmers. What came first is the water shortage of irrigation (52%), which indicates due needs of rehabilitation/ improvement of the irrigation facilities as well as sound operation and water management of the system. Lack of farm labors was ranked at second; namely, 39% of the sampled farmers replied it as their one of major problems in their farming. This shortage of farm labors has been worsening especially in recent years, caused by migration to urban areas and sometimes to foreign countries. Other issues are unstable rainfall (29%), high price of agricultural inputs (29%), bad/poor transportation road to market (26%), and low farm-gate prices of crops (22%).

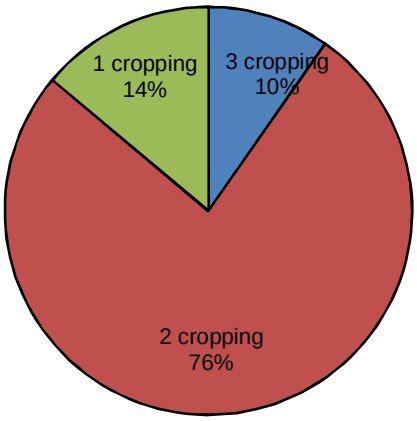


Figure 2.1.2 Rate of Cropping Pattern in Shwebo Area
Source: Household survey by JICA Survey Team (2015)

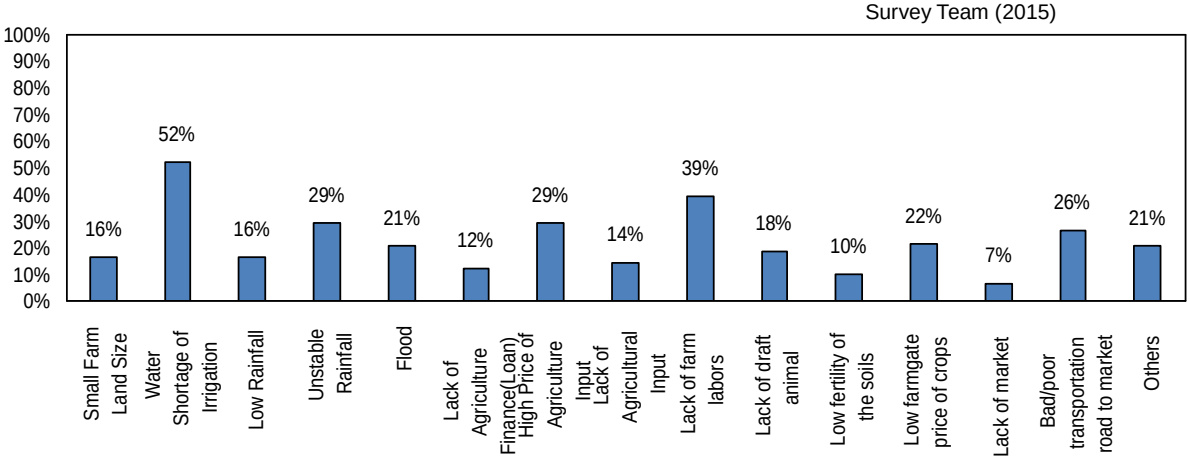


Figure 2.1.3 Severity of Agricultural Difficulty / Problem in Shwebo Area
Source: Questionnaire Household Survey, the Survey Team (2015)

2.1.2 Irrigation in Shwebo Area

Thapanzeik dam, one of the biggest dams in Myanmar, is the main water source for Shwebo irrigation area. It is located in the upstream of Mu River and it has 2,880,000 ac-ft of storage capacity with irrigable area of 566,270 acres. At the downstream of Thpanzeik dam, there are Kindat diversion dam and Kabo weir. Kindat diversion dam diverts MU river water into the irrigable area through Right Main Canal (RMC) with 55 miles length and Old Main Canal (OMC) with 50 miles length respectively. Kobo weir distributes river water to its irrigable area by Ye-U Main Canal (YMC) with 45 miles length and Shwebo Main Canal (SMC) with 27 miles length respectively.

Kabo Weir, YM.C and SMC were constructed in 1905 during the British colonial period. Those irrigation facilities have already passed 110 years after the completion of the facilities. Then, in 2001-2002, in order to save serious damage from flood during the monsoon period and to promote summer paddy cultivation, Thapanzeik dam together with Kindat diversion dam were constructed at 24 miles upstream of Kabo weir. Those irrigation facilities have in fact contributed a lot in realizing stable supplemental irrigation for monsoon paddy and increase of the irrigable area for summer paddy.

Irrigation facilities are composed of weir, main canal, intake structure, secondary canal, canal

the farmers in Kanbalu TS (20 samples out of 92 farmers) could not cultivate summer crops as in other years. The results of Kanbalu TS were therefore removed in this figure. For comparison, the cropping times of Kanbalu TS farmers surveyed (20 farmer households) were; no farmer (0%) do 3 cropping, 8 farmers (40%) do 2 cropping and 12 farmers (60%) do 1 time cropping.

inspection road and hydraulic structures such as gate, drop, etc. Most of the canals are earthen type except for the reaches to protect foundation of bridges and upstream and downstream of hydraulic structures. Irrigation facilities are operated and maintained by ID Monywa Maintenance office. ID staff officer in the Shwebo assistant director's office are responsible for SMC an LMC, while the staff in the Ye-U assistant director's office are responsible for RMC and YMC.

Most of the irrigation facilities are well-maintained by ID Maintenance office. However, deterioration of facilities has in cases caused scouring of canal bed and slopes, which resulted in difficulty of controlling appropriate water distribution even with gates. In addition, OMC has partly been damaged by the flood which took place in late July and early August 2015. Rehabilitation needs are highly recognized in this area with reference to the current conditions of deteriorated facilities and the aftermath of the flood.

Photo shows the un-lined canal which is located along OMC. The un-lined canal damages the inspection road and weakens the canal embankment.

At the downstream of a hydraulic structure in a DY canal in SMC, it is found that both sides of the embankment have been scoured by water flow. Protection for embankment is needed.

2.1.3 Land Consolidation in Shwebo Area

According to farmer interviews conducted by JICA survey team; without land consolidation growth and yield of paddy are quite uneven due to the unleveled field causing uneven depth of irrigation water. For example in Chipar village in Shwebo TS, yield of paddy is around 70% in shallow areas and only 60% in deep inundated areas as compared to that of average and well maintained filed. In addition, tractor and combine harvester cannot get into paddy field due to lack of path between paddy fields, and therefore under the current condition, the machineries can work only along roadside without land consolidation.

Given this condition, there is a high demand on implementation of land consolidation with farm-to-market road (FMR) development, and land leveling. In fact, Land consolidation has partially been implemented in Shwebo area, and the project cost per acre here is lower than that of other areas, e.g Nay Pyi Taw area. This is because the farmers in Shwebo area had to carry out land leveling and drainage improvement by themselves. The cost of land consolidation where farmers carried out those works was 0.35 to 0.4 million Kyats per acre, while that of Nay Pyi Taw is around 0.9 to 1 million Kyats per acre as of 2014.

Benefit of the land consolidation is quite obvious. A land consolidation was implemented in Min Gone village in Shwebo TS, and 200 acre in 2013 and 100 acre in 2014 were completed. Before the project, farmland was segregated and accordingly the average farm lot size was only 0.1 to 0.7 acre per household, and the lot became at least 1 acre per household after the project implementation. Cost of harvesting was about 60,000 to 70,000 Kyat/acre before the project, and is now 35,000 to 40,000 Kyat/acre since combine harvester can now enter the paddy fields.

In addition, according to farmer interviews, quality of paddy has increased by 100 to 200 Kyat/basket since harvesting method has changed from manual to combined harvester, which can reduce mixture with soils, stones, etc., and also lead to uniform drying. The standard farm gate price is usually 5,000 to 8,000 Kyats per basket depending on the variety, and this 100 to 200 Kyats equals to 2 ï 3 % hike. Weeds have also decreased due to appropriate water control at leveled fields. Following table shows major changes in farming in Min Gone village in Shwebo TS:

Table 2.1.4 Major Changes in Farming by Land Consolidation Project

Items		Before Project (2012-2013)	After Project (2014 -)
Yield (bsk/ac)	Shwebo Paw San	60	80-90
	Shwe Thwe Yin	100	135
	Chick Pea	10	15
	Green gram	-	18-20
	Sesame	-	12
Farm Gate price (Ks/bsk)	Shwebo Paw San	10,000	14,000
	Pale Thwe	4,500	5,500
	Shwe Thwe Yin	3,200	4,500-5,000 (6,000 if Chinaâs demand is high)
	Chick pea	18,000	-
Machinery	Plowing	Hand Tractor: 5 10 cows (Animal Draft 5)	Tractor: 3
	Harvesting	Thresher: 2	Combine Harvester: 4 (Kubota)
Total Input Cost (Ks/ac/season)		250,000	180,000 - 200,000
Planting/ Seedling		30 days seedling planting No seed bed 10 - 20 seedlings per hill	18-20 days seedling planting Making seed bed 2 seedlings per hill
Labor	Plowing	2ac/day 2,000～3,000 Ks/ac	10～15ac/day
	Planting/ Seedling	50 labor/8 - 10 ac	7 labor/ac
	Weeding	0 - 25 labor/ac	2 labor/ac (hand weeder)
	Harvesting and Threshing	10 labor/ac	23 ac/day
	Average Farm Labor	3,000 Ks/ac	5,000 - 7,000 Ks/labor
Fertilizers (bag) Urea : T-super : Compound : Potash	Shwebo Paw San	2:0:1:0	1:0:1:1
	Pale Thwe	―	2:1:1:1
	Shwe Thwe Yin	2:1:0.5:0	1.5:1:1:1

Note: Changes in the after-project is not sole result of the land consolidation project, but also including DOAâs technical support and influence of market demand.

2.1.4 Farm Mechanization

According to DOA, transplanting is practiced at a share of 90% for monsoon paddy and 40% for summer paddy, and rests are by broadcasting (partially by seeder). Around 5% of farmers own tractor, while as high as 75% of the farmers in Shwebo area own hand tractor. It is recorded that total 270 combined harvesters are owned by farmers and by private firms within the Shwebo district. However, animal draft is still dominant in some TSs, and progress of mechanization is quite different among TSs. Most of the farmers dry their paddy under sundry method, which often result in poor quality of rice, especially for the case of summer paddy which is harvested at the beginning of monsoon season.

JICA survey team conducted a household survey to 92 farmer households, and found none of the surveyed farmers have tractor, nor combined harvester yet. Owned machineries by the farmers at present were only hand tractor (39%) and thresher (9%), which are very low than what was reported by DOA above. This implies the farm mechanization speed varies very much by village, and some villages lug behind.

However, in any case, according to farmer interviews, farm labor wage has increased recently due to labor shortage, resulting in competition among employment sectors in villages. Labor shortage has

already started even in rural areas, and will become serious problem in future. Therefore farm mechanization for plowing, planting, harvesting will urgently be needed. Though the current level of farm mechanization is not high and varies by village very much, it is expected that the farm mechanization will take place and proceed in near future.

2.1.5 Agricultural Products Distribution in Shwebo Area

Shwebo Paw San is the main variety of monsoon paddy, and has a stable demand in the domestic markets, whereas markets of summer paddy are not stable and farmers tend to shift to pulses/beans or oil crop in this season. Also, DOA recommends shifting from summer paddy to legumes to avoid monoculture effect. Key locations in view of rice distribution in Shwebo area are Shwebo, Ye-U, Kandalu, and Wetlet, in which large scale rice mills are accumulated. Shwebo is the capital city of the Shwebo district, and is located within the command area of Kabo irrigation area.

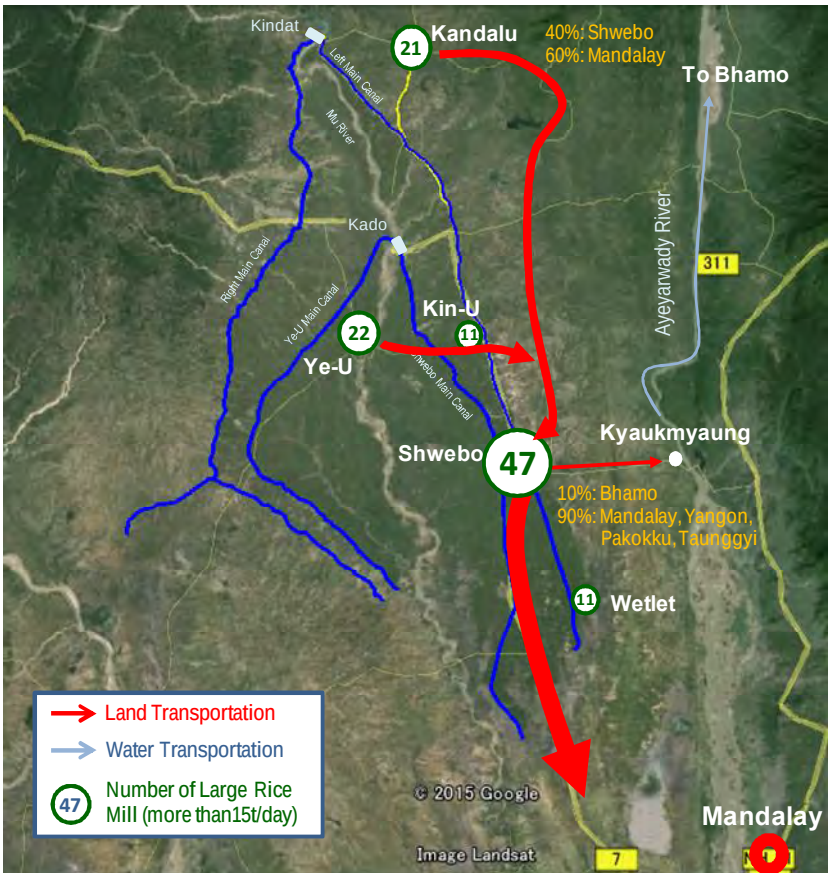


Figure 2.1.4 Distribution Route in Shwebo Area
Source: JICA Survey Team based on Interview to DOA Shwebo

According to DOA in Shwebo district, around 90% of rice milled in the district center is distributed by land to Mandalay, Yangon, Pakkokku and Taunggyi, while 10% of rice is transported to Kyaukmyaung Jetty and go upstream of Ayeyarwady River till Katha and Bhamo, a border trade port to China. For land transportation, most rice is carried by tracks, and only small volume of rice is transported by train.

Kandalu is located near the Left Main Canal of Kindat irrigation scheme (one of the 4 irrigation schemes in the Shwebo area), and 50 miles north from Shwebo town. Around 40% of rice is distributed to Shwebo, whereas remaining 60% is transported to Mandalay (interview to DOA). The land transportation is the major transportation mode of the area, and small volume of rice is transported by train. Whereas, Wetlet is located in south-eastern side of Shwebo, and most rice milled in the town is distributed to Mandalay, Yangon, Pakkokku and Taunggyi according to Shwebo DAO.

Monsoon paddy including Shwebo Paw San and Ayar Min is basically for domestic consumption, while summer paddy such as Shwe Ther Yin is mainly for export purpose to China. Shwebo Paw San growers has increased in recent years, and can be found in many paddy producing areas including Yangon, Magway, and Southern Shan. High quality rice produced in Shwebo area tends to be distributed to Yangon, while much of the 2nd grade rice is shipped to Southern Shan.

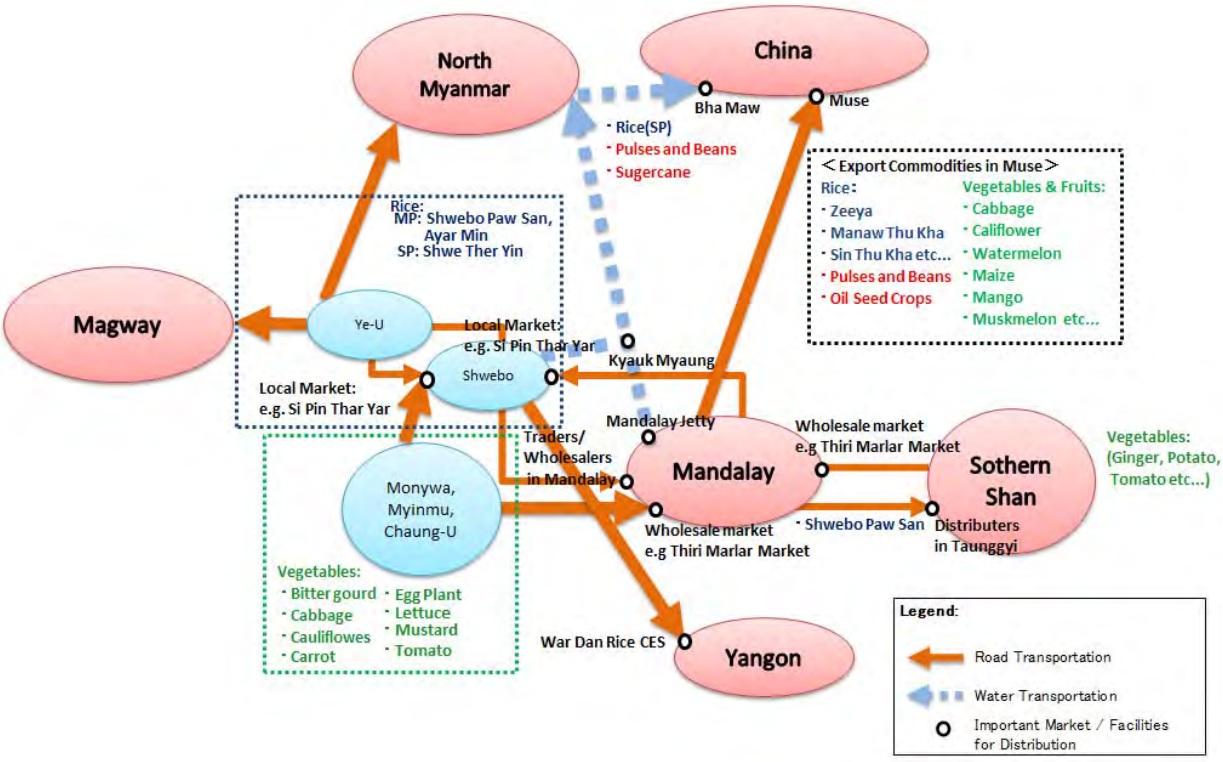


Figure 2.1.5 Distribution Mode for Rice and Vegetables in Shwebo and Mandalay Areas
Source: JICA Survey Team based on Interview to Relevant Stakeholders

Statistics of former Settlement and Land Record Department (SLRD), currently Department of Agricultural Land Management and Statistics (DALMS), indicated that Sagaing region is the third largest vegetable producing region, after Southern Shan and Ayeyarwady. However, according to DOA, most vegetable growers in the region are of small scale, and their products are basically distributed and consumed within the Sagaing region. There are some exceptional cases in suburb areas near Mandalay, including Monywa, Myinmu, and Chaung-U, where around 50% of vegetables, such as chou-fleur, cabbage, Chinese mustard and eggplant, are distributed to Mandalay.

2.1.6 Farm-to-Market Road (FMR)

Road condition in the Shwebo irrigation area is not so good especially during monsoon season. There is a village named Htan Kon in Kandalu TS located on right bank of the Left main canal of Kindat irrigation scheme, around 10 miles away from Kandalu center and 38 miles north from Shwebo center. The village has 11 large-scale (more than 15 ton/day) rice mills, and the mills and farmers use a maintenance road of the Left main canal for carrying their farm inputs, transporting farm products, buying daily necessities, schooling, and other purposes including emergency cases.

However, the maintenance road cannot be in service during and after heavy rainfall for 2 to 3 days due to poor surface condition of the road, which is totally an earthen road. According to a rice miller and farmers in Htan Kon village, duration of the road closure in monsoon season is around 30 days in 3 months. The period coincides with milling season of summer paddy in the village, and the milling work and rice distribution are often interrupted due to the road closure.

In addition, load limit of the maintenance road is 3 tons in the monsoon season, and traders and millers have to take an indirect road from Kandalu to Shwebo, which is about 70 miles distance. According to DOA, if the maintenance road could be upgraded to a paved road, 17 villages including Htan Kon village are benefited for not only farming activities and agricultural products transportation but also daily activities.

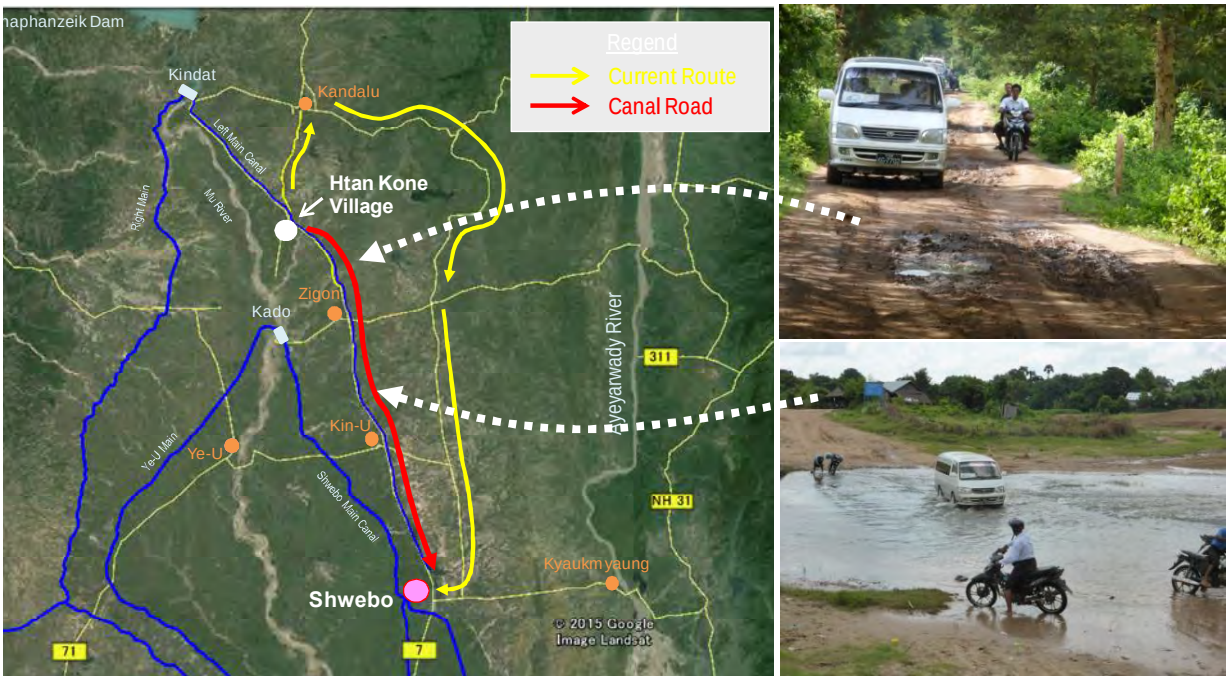


Figure 2.1.6 Typical Road Condition in Shwebo Area during Rainy Season

Source: JICA Survey Team based on field survey

Further, in Shwebo TS, several villages in the command area of Shwebo main canal suffer from poor road condition during monsoon season, since most maintenance roads are basically non-paved earthen roads. According to DOA officials in Shwebo district, among villages in the command area, Chi Par village, Aung Chan Thar village, Ngrsu Kone village and War Yone Kan village are affected by poor road conditions. These villages are in production areas of the famous rice variety in the domestic markets; namely, Shwebo Paw San. Road improvement is needed.

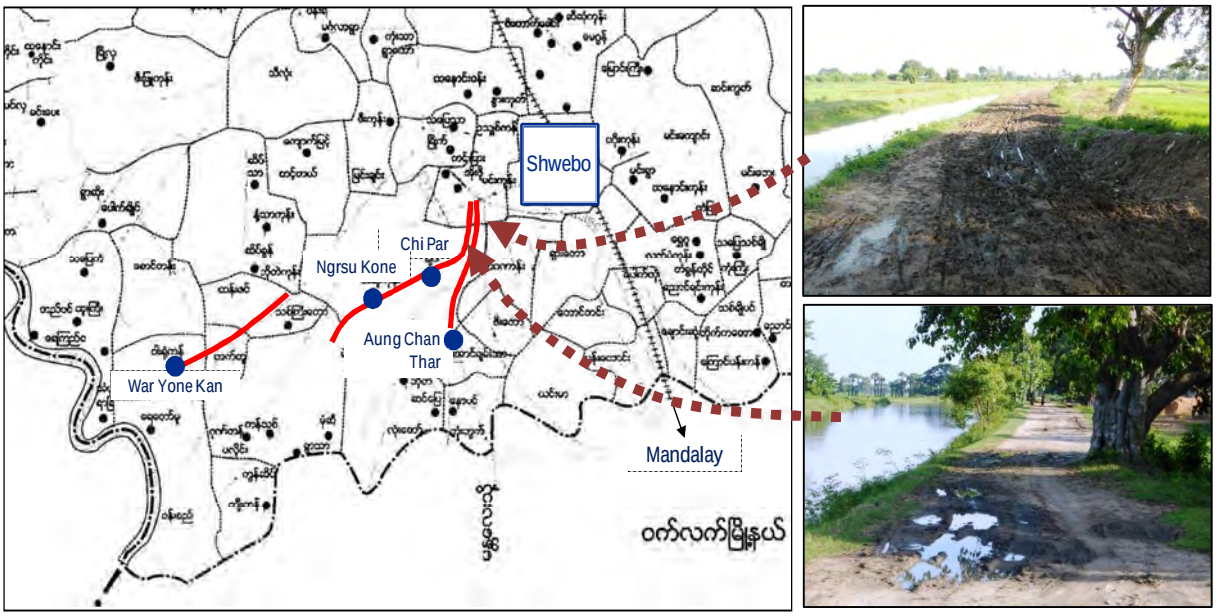


Figure 2.1.7 Typical Road Condition in Shwebo Area (Southern Part) during Rainy Season

Source: JICA Survey Team based on field survey

2.1.7 Jetty in Kyaukmyaung TS

Kyaukmyaung is a small town situated at right river bank of Ayeyarwady river, located at 27 km east from Shwebo center. The town is known as key point of water transportation in Shwebo district, and around 1.7 km of natural river bank is used for berth of ships and boats. Most cargo from

Kyaukmyaung TS carries farm products including rice, and the busiest season of the port is July to November when monsoon paddy, Ayar Min and Manaw Thu Kha for example, is distributed to domestic markets mostly located in northern parts of Myanmar. Summer paddy such as Shwe Thwe Yin and IR747 is shipped to China via Bhamo.

Even though floating jetty is observed in some locations, most parts of berth are natural river bank, and narrow wooden board is used for loading/ unloading of cargos and passengers. During monsoon period, water level goes higher and loading/ unloading works becomes potentially risky activities. In addition, since width of loading place is narrow in monsoon season, ships and boats have to wait for long time due to congestion of the port. In general, major advantage of water transportation is to make bulk transport possible with low cost. However, since loading/unloading works at jetty is done manually and all cargos are packed in hand-carry size, the works take too much time under the current condition. Thus, improvement of jetty with loading equipment is needed.

2.1.8 Local Market

During off-season of local vegetables, meaning except winter season, most vegetables transacted in Shwebo central market come from Southern Shan and Mandalay. Vegetables from Southern Shan, for which it usually takes 12 hours drive from Aungban to Shwebo, are estimated at around 70% of transaction volume at the market. Loading place of the long-distance truck is the open road located outside of the market place, and transporters have to carry vegetables for around 200 to 300m distance to inside of the market by using pushcart. However, sanitary condition of the loading place is quite poor since drainage is poor and residuals are scattered (see photo right up).

Photo up: loading place outside of the market:
Photo down: retailers very congested

On the other hand, inside of the market has concrete-paved and raised floors, and drainage condition even after heavy rains is rather good. However, outside of the market shed, where many small-scale retailers and farmers are selling their products under small parasols, is congested and aggravation of sanitary environment particularly during winter season is apprehend (see photo right down). In future, it is reasonably expected that more local farmers come to the market to sell their products so that they can make more money to educate their children for example. Therefore, it is necessary to improve market layout and sanitary environment. According to officials of the Shwebo market, they understand necessity to improve local markets, but they also hesitate to do the improvement since most retailers do not want to move to other places during rehabilitation/ renovation period.

2.2 Status of the Mandalay Priority Area

Mandalay area is selected as a priority area for promoting intensive agriculture program. In this section, current status of the Mandalay area is discussed in terms of agriculture, irrigation, land consolidation, mechanization, and marketing or distribution infrastructure, based on interviews to concerned offices such as ID, DOA, local government authorities, farmers, etc. Also, results of yield survey and household survey conducted by JICA survey team are presented:

2.2.1 Agriculture in Mandalay Area

Paddy is cultivated during monsoon season almost over all the farmland (lowland) within the Mandalay irrigation area supplemented by irrigation, and summer paddy is planted at 55% of the area fully supported by irrigation. Pulses are planted at 38% area during winter season, and chick pea is the most major pulse. The pulse grows under residual moisture, not irrigated. The total crop intensity in this Mandalay area is therefore estimated at as high as 193%[4].

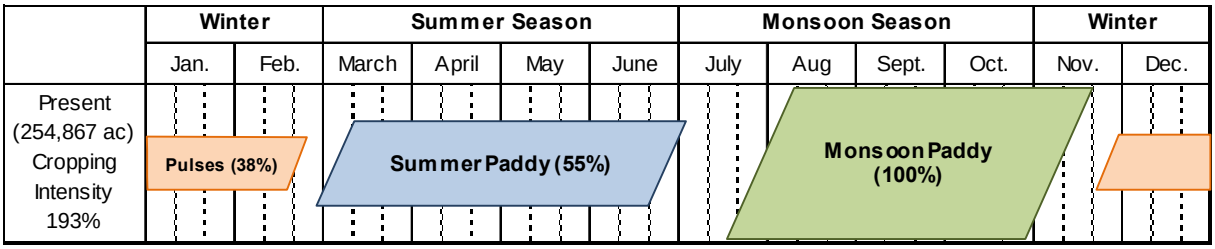


Figure 2.2.1 PresentCropping Pattern in Mandalay Area

Source: JICA Survey Team (2015)

Major varieties of monsoon paddy are Manaw Thu Kha and Ayar Min, whereas those of summer paddy are Manaw Thu Kha and Shwe Thwe Yin. Ayar Min is a high quality local variety, and the others, Manaw Thu Kha and hwe Thwe Yin, are high yield variety of paddy. The farmgate price of Ayar Min, local variety, is around 6,000 Kyats per basket while the others are 4,000 to 5,000 Kyats per basket, as is expected for local variety. Following table shows major variety of paddy in Mandalay Area.

Table 2.2.1 Major Variety of Rice in Mandalay Area

Variety	Season	Growing period (days)	Yield(expected.) (bsk/acre)	Selling Price (kyat/bsk)	High Yield/ Quality Variety
Ayar Min	Monsoon	150	110	6,000	HQV
Manaw Thu Kha	Monsoon	130 - 135	100	5,000	HYV
	Summer	150	120		
Shwe Thwe Yin	Summer	135	120	4,000	HYV

Source: DOA (2015)

Ayar Min is a long-term variety of paddy, that need transplanting if farmers try triple cropping in a year with Ayar Min. However, broadcasting is common in the area to reduce production cost of paddy. Also, if farmers want to grow Ayar Min, such conditions have to be taken into consideration as: 1) relay cropping with pulses (chickpea) at the time of harvesting Ayar Min, 2) make harvesting time shorten by using harvester, and 3) planting short-term variety (Shwe Thwe Yin) in summer season

JICA survey team conducted a crop yield survey during August ï October 2015, covering 115 samples. The result of the yield survey is summarized in the following table together with the yield data provided by DOA statistics. The survey asked farmers the yield in the last crop season (2014-15) and also for the average for the last, say, 4-5 years. The yield in average year is 74 basket/acre, 89 basket/acre, and 9 basket/acre for monsoon paddy, summer paddy, and chick pea respectively, while those provided by DOA show relatively higher yields[5].

[4] Since famers cultivate paddy during monsoon season as far as possible, the intensity of monsoon paddy is practically counted at 100%. The cultivated area of summer paddy was provided by ID, based on which the intensity of summer paddy was estimated as a ratio comparing to the scrutinized irrigable area. The intensity of pulses was estimated by dividing total sown area of winter pulses in the target TSs by that of monsoon paddy, using 3 years average DOA statistical data (2011 ï 2014). Note that ID data does not provide any pulses cultivated area since irrigation water is not provided to the pulses.

[5] The reason why the DOA data show much higher range of the yield are; 1) possibility of inflating yield which might have been practiced during former regime, 2) different areas surveyed between JICA survey which covered only a sample area, and DOA survey which basically covers all the areas.

Table 2.2.2 Yields Comparison between Yield Survey and DOA Statistics in Mandalay Area

Season	Crop	Yield Survey (N=115) 1/				DOA 2/ Statistics (2011-2014)
		2014-2015		Average		
		No.	Yield	No.	Yield	
Monsoon	Paddy	115	73.5	115	73.5	86.3
Summer	Paddy	55	88.3	55	88.6	98.7
	Sesame	61	14.8	61	15.2 (3/)	8.8
Winter	Chick pea	67	9.3	67	9.3 (4/)	16.5

Note: 1/ The yield survey was conducted in 3 TSs located in midstream of the Mandalay irrigation area, covering 115 farmer households.
Note: 2/ DOA data referred to those of 7 TSs where the Mandalay irrigation system extends.
Note: 3/ The yield for sesame provided by yield survey shows higher number than that by DOA. It may be because the village has been cultivating sesame since long time ago, whereby very experienced.
Note: 4/ A large number of farmers who cultivate chick pea usually practice 3 cropping in a year, and therefore the farmers may not be able to input enough agri-inputs and labors for chick pea cultivation. This may be the reason why chick pea in Mandalay irrigation area indicates lower yield.

A household survey was also conducted by the JICA team, covering 80 sample households in Mandalay irrigation area. All the 80 sampled farmers, as a matter of fact, have lowland (farmland for paddy) within the irrigation scheme, and of them 18 farmers have upland farm. For the lowland, average farmland area comes to 7.0 acres per farmer with 35 acre and 1 acre being the maximum and minimum respectively. Including the upland farms, the average farmland that a typical farmer owns is estimated at 8.7 acre (3.5 ha).

Table 2.2.3 Farmland Holdings in Mandalay Area

Items	Lowland	Upland	Others	Total / Average
No. of HH (N=80)	80	18	3	80
Total Area (Acre)	562.8	123.7	13.5	700.0
Maximum Area (Acre)	35.0	23.0	7.0	35.0
Minimum Area (Acre)	1.0	1.0	1.5	2.0
Average Area (Acre)	7.0	6.9	4.5	8.7 (3.5 ha)

Source: Household survey by JICA Survey Team (2015)

The farmers, as aforementioned, cultivate monsoon paddy, summer paddy, and pulses in the lowland (farmland in irrigation area). In Mandalay area, all the farmers do 2 or 3 times cropping in a year. All the farmers cultivate monsoon paddy, and they cultivate either summer paddy or winter pulses as the second crop. In fact, summer paddy cultivation is totally dependent on the availability of irrigation water, whereby the farmers who are provided irrigation water can cultivate the summer paddy. On the other hand, pulses can be grown under residual moisture, not irrigated. Figure 2.2.2 shows the cropping times; namely, 44% famers cultivate 3 crops, and the rest 56% farmers do 2 crops (monsoon paddy + summer paddy or monsoon paddy + pulses).

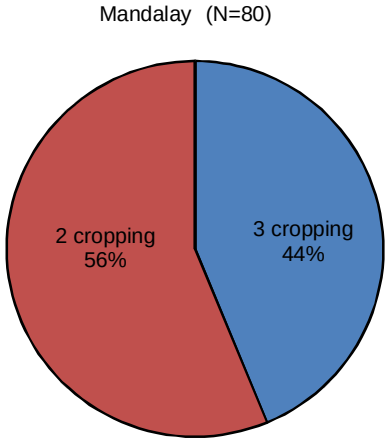


Figure 2.2.2 Percentage of Cropping Pattern in Mandalay Area
Source: Household survey by JICA Survey Team (2015)

Agriculture related difficulties were also questioned to the sampled farmers. What came first is the lack of the farm labors (53%), which indicates due needs of farm mechanization. High price of agriculture input was ranked at second; 38% of the sampled farmers replied it as their one of major problems in their farming. Other issues are water shortage of irrigation (31%), low rainfall (31%) and unstable rainfall (28%)

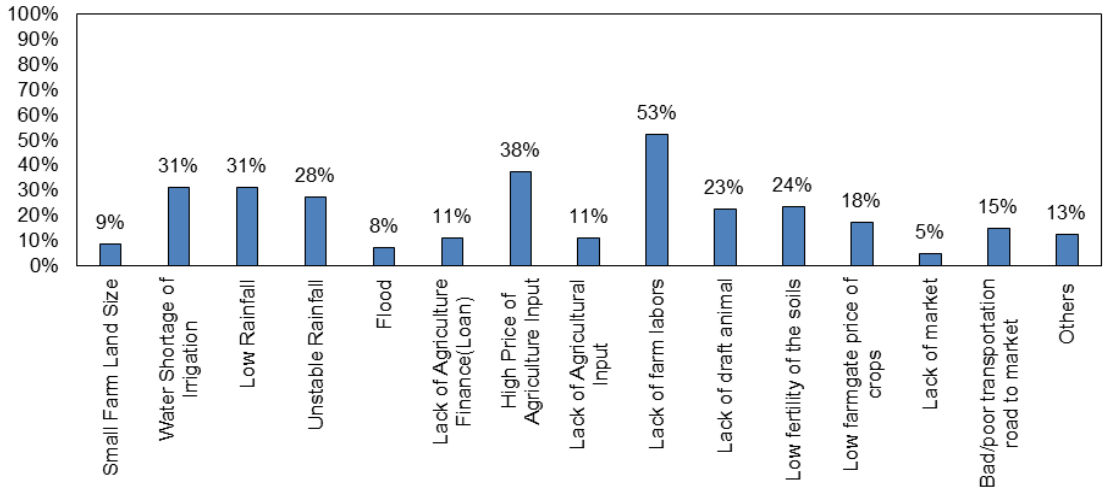


Figure 2.2.3 Severity of Agricultural Difficulty/Problem in Mandalay Area

Source: Household Survey, the Survey Team (2015)

2.2.2 Irrigation in Mandalay Area

There are three major irrigation systems in Mandalay area as follows: from north to south, 1) Sedawgyi irrigation system, 2) Zawgyi irrigation system and 3) Kinda irrigation system. Each irrigation system has own dam, and distributes the irrigation water by weirs and canals. All of these dams play a key role in Mandalay area for agricultural production and flood protection as well.

Sedawgyi dam is located on the Chaungmagyi river just two miles upstream of Sedaw weir in Madaya township. Sedaw weir and its canal system were constructed during the Pagan dynasty in the 11th century. The system has long been providing irrigation services to the beneficiary farmers, and then, in 1976-1977, for the purpose of establishment of two crop cultivation, Sedawgyi dam was constructed on Chaungmagyi river. The dam reservoir has realized 2 cropping of monsoon paddy and summer paddy.

In Zawgyi Irrigation system, the weirs for irrigation such as Nga Pyaung, Thin Dwe, Minya and Zeedaw were constructed in the ancient Kingdom era around 1891. These weirs were constructed along the Zawgyi river which catchment area belongs to Shan State. Many branch canals were constructed together with construction of weirs, and these branch canals have been providing irrigation service from the Zawgyi river to the command areas. After around 100 years have passed after the construction of said weirs, Zawgyi dam project started in 1994-95 and completed 1997-98. After construction of Zawgyi dam, approximately 30 % of total farmland became able to receive irrigation water for summer paddy and all the farmers able to get stable supplemental irrigation water during monsoon period.

Kinda irrigation system was implemented during ancient Myanmar King Period with a series of weirs along Panlaung river such as Kinda, Nathlwe, Kyeeme and Htongyi weirs. Even with these weirs installed, though, water supply during dry season had not met with the farmerôs requirement. In addition, in some years of rainy season, inundation problem has taken place in low land areas. With the background, a new dam was planned and the construction of Kinda dam started and completed in 1989-1990 to distribute irrigation water from Kinda weir to the command areas located in its left and right sides.

Above mentioned those three dams have an important role of distributing irrigation water for monsoon and dry period respectively. However, the irrigation systems have been deteriorated since more than 100 years have passed after the completion of the weirs and canal systems. Some gates have been operated by wooden stop logs in Zawgyi irrigation system and they have been operated manually, even

in the flooding period. These aged gates and manual operation make it difficult to control appropriate water distribution. Furthermore, in Kinda irrigation system, the canal capacity has been reduced by heavy sedimentation and this situation causes water shortage in downstream areas.

Photo shows the Zeedaw Weir which was constructed in 1890th. The gate leaf is wooden typed stop log, requiring up-grade to steel leaf.

At the Kinda Left Main Canal, the sedimentation reduces the capacity of canal and causes the water shortage. in the downstream command areas.

2.2.3 Agricultural Mechanization in Mandalay Area

In Mandalay area, farm mechanization has progressed and nowadays most farmers own hand tractors. Some farmers already started introducing combined harvester, and private firms provide lease services as well. It is said that the mechanization started accelerating since 2013, when foreign machinery manufacturers started business with their Burmese partners. In fact, recently, there are number of farm machinery sales agents operating along the main road of Mandalay city.

For example, Mandalay branch office of an agricultural machinery manufacturer of Japan has sold 300 tractors (60-70HP), 200 combined harvesters, 4 transplanting machines and 12 backhoes since its opening in 2013 to August 2015. Except the excavator, most buyers of these machineries are farmers while around 40% of the buyers for combined harvester are private firms who intend to provide machinery rental services.

The household survey, conducted by JICA team, explored the availability of farm machineries that the sampled 80 farmers have. Though none of the surveyed farmers have combined harvester yet, they have such machineries as tractor (6%), hand tractor (60%), thresher (6%), trawlagyi (9%) and water pump (3%) in Mandalay area.

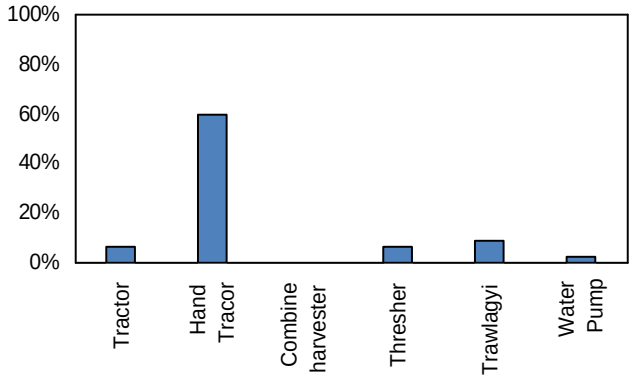


Figure 2.2.4 Agricultural Machineries Ownership in Mandalay
Source: Household Survey by the Survey Team (2015)

Concerning labor availability in the suburb of Mandalay, on the other hand, competition in the labor market has started between urban area and rural area. Labor shortage becomes serious nowadays in agriculture sector, resulting in difficulty of securing enough number of farm casual labors, making it difficult to follow the recommended cropping calendar by DOA in time. Therefore, promotion of farm mechanization is further needed especially in areas where labor shortage has become an acute issue.

2.2.4 Land Consolidation

Land consolidation is needed to increase agriculture production as well as to support farm mechanization. Irrigated areas in Mandalay area have suitable soil and climate condition to practice triple cropping, and many farmers prefer to grow Ayar Min, a long-term variety, due to high selling price as a monsoon paddy. In this condition, if farmers want to practice triple cropping including Ayar Min, the farmers have to minimize harvest time using agricultural machineries.

As above stated, demand for farm mechanization is high in Mandalay area; however, structure of farm land is not suitable for mechanized farm works at present. In addition, according to the farmer interview survey conducted by JICA survey team, some portions of farmlands are un-level and paddy yield in the unleveled farm lots is relatively low due to poor drainage condition. Therefore, land consolidation with land leveling is needed to make farming activities more efficient together with the farm mechanization.

2.2.5 Agricultural Products Distribution in Mandalay

Mandalay is the distribution hub of agricultural products including rice. Major distribution channel of rice to Mandalay is from the Lower Myanmar such as Ayeyarwady and Bago through water and land transportation. In addition, rice comes to Mandalay from Sagaing region where Shwebo priority area is located, and the transportation mode is exclusively through land. From the Lower Myanmar, most rice goes further to Muse for export purpose, and Mandalay is just a pass-through site.

From Sagaing region, monsoon paddy goes to Yangon since main market of the rice produced there is for domestic consumption, whereas summer paddy is exported to China via Mandalay and then Muse. According to representative from Muse Crop Exchange Center (CEC), Chinese traders prefer to import Zeeya, Manaw Thu Kha and Sin Thu Kha varieties, and major usage of them is for food processing including noodles, alcohol and snacks.

Vegetables transacted in Mandalay come from Southern Shan (Aungban and Inle) and surrounding areas such as Kyaukse, Pyin Oo Lwin, Monywa and Shwebo. Vegetables from Southern Shan are handled by traders mostly in Thiri Marlar market, and redistributed to regions and states in Upper Myanmar including Magway, Sagaing and Kachin. Among suburb areas, Kyaukse TS located at 45km south from Mandalay is one of primary production areas of vegetables[6]. From Shwebo, tomato, chou-fleur, radish and banana are marketed during March and May.

Kyaukse TS and Meiktila TS are primary production areas of fruits such as mango, banana, melon, papaya and water melon. Particularly, Kyaukse TS is famous for origin of Sein Ta Lone mango, also known as the diamond solitaire mango, the best quality mango in Myanmar. The production of Sein Ta Lone mango in Kyaukse TS started approximately 30 years ago, and the mongo is also grown in Sagaing region nowadays, imported from the Kyaukse TS.

Pyin Oo Lwin is famous production area of flowers including chrysanth, daisy and lilies. Pyin Oo Lwin is a part of Mandalay region, but climate condition is completely different from dry part of Mandalay. Pyin Oo Lwin is located in the eastern highland area of Mandalay where temperature is cool and rain is relatively abundant. Flowers, ornamental plants, medicinal plants, fruits and garden crops are possible to grow. According to Myanmar Fruits, Flowers, Vegetables Producers and Exporters Association (MFFVPEA), main markets of flowers from Pyin Oo Lwin are Mandalay and Yangon, and around 60% is for religious purpose and 40% is for glad occasion.

[6] Kyaukse is knows as production area of onion and turmeric in addition to mango, but other leaf y vegetable including cabbage and chou-fleur are also marketed to Mandalay city.

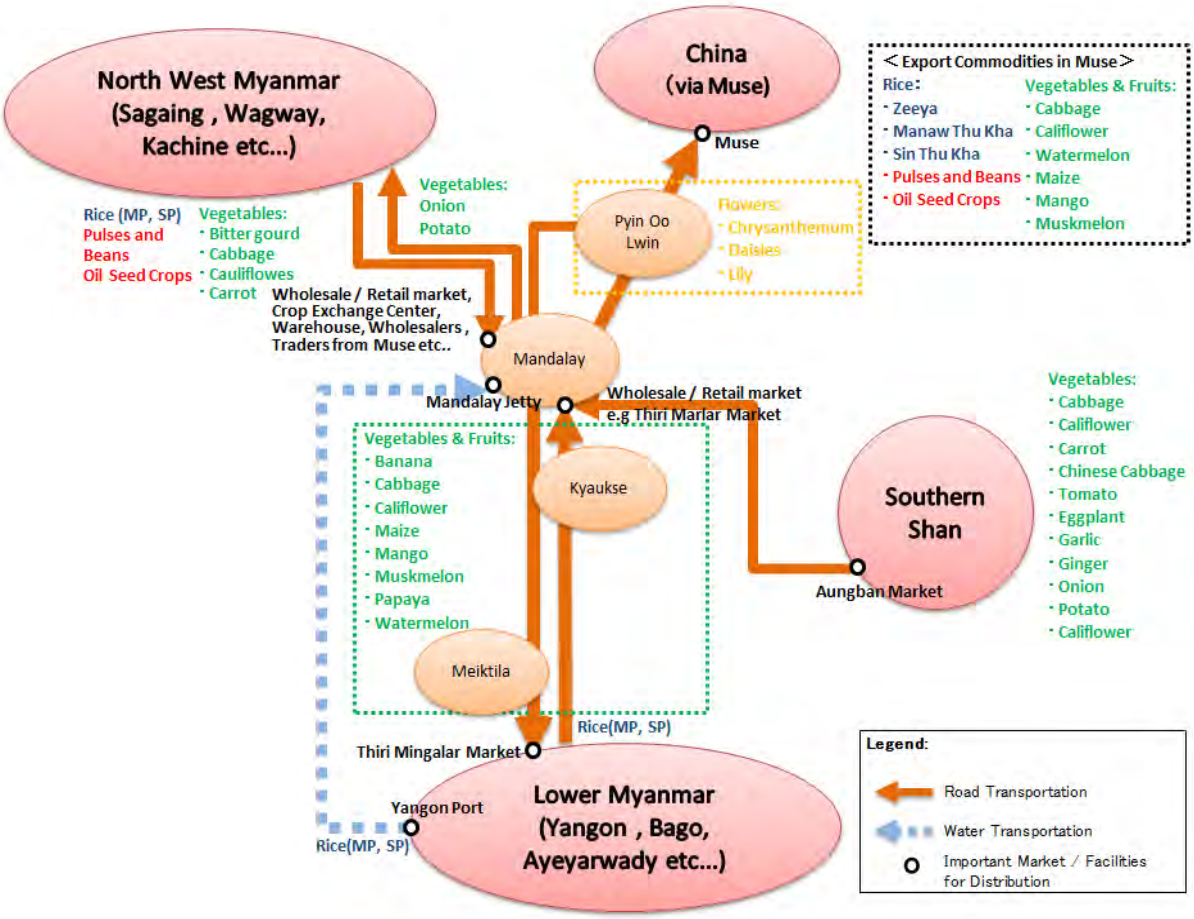


Figure 2.2.5 Distribution Mode for Rice, Vegetables and Fruits through Mandalay Ares

Source: JICA Survey Team based on Interview to Relevant Stakeholders

2.2.6 Food Processing

Myanmar Rice Industry Association (MRIA) is a lower organization of Myanmar Rice Federation (MRF). Most of them are rice mill owners. Main activities of MRIA are to provide good quality seeds to farmers and to promote improvement of rice milling technologies. According to MRIA, main issues on rice production in Mandalay are; 1) dissemination of good quality seeds to rice farmers, 2) seed management at field, 3) promotion of appropriate production management at field including introduction of GAP, 4) up-grading of milling equipment to reduce broken rate, and 5) provision of loan to traders and millers. However, in a practical sense, very few activities have been conducted in recent years.

In addition, post harvest handling at field has also problems. After harvesting monsoon paddy, farmers tend to leave the harvested paddy on the ground and rush to sow pulses since pulses grow on residual moisture originating in monsoon paddy cultivation. However, if rain falls on the stranded paddy, moisture contents become higher, resulting in poor quality of rice due to body cracking and changing color to yellow. Promotion of dryer and storage at production areas for appropriate post harvest management is needed according to several brokers and farmers interviewed.

Up-grading of rice milling equipment and improvement of rice mill management is also necessary to increase quality of rice. Most rice mills are very aged and dirty with spider webs and insects in cases. In some mills, naked fluorescent light is hanged up to light up separating process of normal rice and broken rice. If the light is broken, pieces of broken glass fall into the food products. In such regard, production process improvement is required in addition to up-grading of equipment and machineries.

According to Mandalay branch of MRIA, 80% of export rice to China is for processing purpose, while rest is for direct consumption in border areas. Most rice for reprocessing is of more than 25% broken rice. Also, around 80% of rice exported from Muse is transacted at Crop Exchange Center in Muse, and rest is directly traded between traders at boundary of Kachin State, for example. However, the border trade with China is unofficial transaction due to Chinese side circumstances. As of September 2015, 10 organizations have export permission to China, and all their products are shipped from Yangon port. Sea transportation takes more transportation costs and time consuming as compared with land transportation via Muse.

2.2.7 Farm-to-Market Road in Mandalay

Western part of Madaya TS which is located in left bank of Ayeyarwady river and around 25km north of Mandalay city, suffers annual flood in monsoon season particularly from August to September. During the season, most farm-to-market roads in the area are submerged under the flood water, and villagers have to use boat for carrying agricultural production and also for daily transportation.

Also some parts of canal maintenance roads of Sedawgyi, Zawgyi and Kinda irrigation scheme are under poor condition, and have caused difficulty in transportation of agricultural products in addition to daily transportation of villagers. It is expected that upgrading of maintenance roads from earthen or gravel to concrete or asphalt pavement would contribute to the reduction of transportation cost and transport loss of agriculture products.

2.2.8 Jetties in Mandalay

Jetties in Mandalay are located in left bank of Ayeyarwady river over 6 km. Port facilities including floating jetty are quite limited and most boats and ships stay close to natural river bank for loading/ unloading of cargoes and passengers. Just like other river ports in Myanmar, mechanization of port facility has not taken place and congestion is observed during peak season. In general, major advantage of water transportation is to make bulk transport possible with low cost. However, since loading/unloading works at jetty is done manually and all cargos are packed in hand-carry size, the works take too much time under the current condition.

Most parts of berth are natural river bank, and narrow wooden board is used for loading/unloading of cargos and passengers.

Tracks have to go into shallow waters where distance from natural river bank and berth of boats and ships is longer, resulting in congestion at loading place.

In addition, water level gap between monsoon season and summer season records as large as 8 m in Mandalay port. On one hand, during monsoon period, water level gets high, so the width of loading place becomes narrow, resulting in more congestion at loading places. Particularly, since Mandalay port is located near a trunk road, the loading activities often prevent smooth traffic flow in the road. On the other hand, during summer season, distance from natural river bank and berth of ships becomes longer and cargo tracks have to go close to the shallow waters. Therefore, it is needed to improve jetty

with concrete river bank, and introduce mechanization of loading equipment, modernization of port facilities, etc..

2.2.9 New Wholesale Market of Mandalay

Place where new Mandalay wholesale market is to be established, in a total 205 acres lot.

A new Mandalay wholesale market will be constructed 22 km south from Mandalay city and 12 km northeast direction from Mandalay International Airport. Operation body is Mandalay Green City Public Co., Ltd., and takes responsibility of fund-raising, building construction and operation of the market. The company will procure fund for construction and operation through market. The role of the regional government here is to supervise the market operation and provide land belonging to the government. According to a representative of the public company, as of early October 2015, master plan[7] of the wholesale market was drafted, and discussion with regional government will start at middle of October 2015. Land leveling was already started (see photo) and target year of the completion is set by year 2017.

According to the master plan, lot area of the new wholesale market extends over 205 acre (about 82 ha), and is divided in 4 sections as standard section, service section, wholesale section and retail section. Standard section includes office space, accommodation, training center and exhibition hall, whereas service section contains service apartment, restaurant, banks, exchange counter and rent-a-car service station. In addition, warehouse, value adding facility, cold storage and R&D facility will also be constructed in the service section. Main transaction place of commodities are wholesale and retail sections.

Beside wholesale section, auction center and on-stop service center are planned. The planned one-stop center enables traders to take necessary procedure for export within the one place. At present, traders and exporters have to obtain permissions through several government cumbersome and time-consuming procedures. According to the representative of the public company, DOA to provide plant protection and fumigation service is not included in the original one-stop service system; however, involvement of DOA may be needed for smooth export procedure of agricultural products.

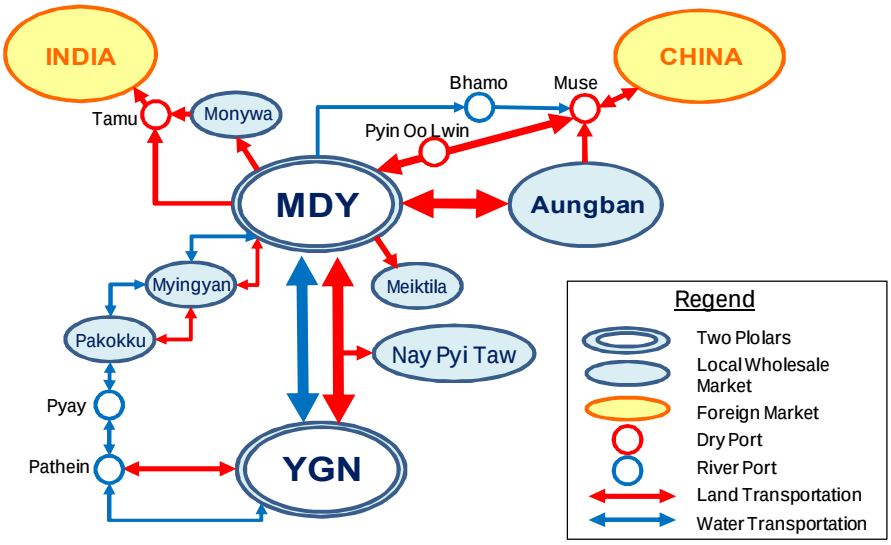


Figure 2.2.6 Regional Market Network in the Upper Myanmar

Source: JICA Survey Team based on Interviews

Yangon and Mandalay are positioned as the two bases of economic growth in Myanmar. The later is

[7] The JICA survey team could not obtain the whole master plan, but from what seen the plan so far, it is like a layout plan of the market.

therefore the core of regional distribution network in the uppor Myanmar, and connects several regional markets including Meiktila, Monywa, Myingyan, Pakokku and Aungban, as indicated by following figure. Rice from the lower Myanmar, and pulses and oil crops from CDZ are transported by land and water ways to Mandalay, whereas land transportation is sole way of vegetables and fruits from Southern Shan. From Mandalay, various products are redustributed to regional markets in the upper Myanmar, and exported to China via Muse and India via Tamu.

Mandalay thus plays a key role of agri-product distribution in the upper Myanmar. Therefore, planned new wholesale markets is strategically important as the collection and redistribution center of the agricutural commodities. As mentioned above, the new wholesale market will be established under PPP. According to the representative of the public company, they need financial support and operational support including market and distribution management through information technology, and quality management of export products.

2.2.10 Local Retail Market

In Mandalay, there are 44 retail markets which handle fresh vegetables and fruist, and major local markets are 41 Street Zay, Thiri Marlar, Sayar San, Mya Nandar and Bayar Gyi Zay. Among them, Thiri Marla Market has the largest wholesale function, at which many wholesalers and traders stand side by side in the same area. However, it is not a wholesale market in real terms, but a cluster of sellers and traders where they conduct daily transaction individually. Most local markets have more or less both wholesale and retail functions.

Among 44 retail markets, 41 Street Zay market is newly established market and sanitary condition is quite good. The retail section is raised by 50 cm from the ground, and side ditches are installed even inside of the retail section. However, most other markets need rehabilitation/ renovation to improve sanitary condition of retail section. Even in 41 Street Zay market, outside of the market shed is congested and sanitary condition becomes very worse during and after rainfall. The outside space of the shed is a common selling place for farmers and small retailers.

According to Mandalay City Development Committee (MCDC), as transaction volume of vegetables and fruits increase, all the markets need more space for retailers and farmers with better sanitary condition. Therefore, MCDC has a will to rehabilitate and/or renovate retail markets. However, most tenants do not show much interest of such rehabilitation/ renovation since they are afraid of losing selling places during the rehabilitation/ renovation of the markets. There should, therefore, be an alternate place where the tenants can continue the business even during the rehabilitation work.

Sanitary condition is secured in 41 Street Zay market. The floor is raised by 50cm concrete base.

Sanitary condition of outside of market shed in 41 Street Zay market becomes quite poor after rain.

2.3 Status of the Nay Pyi Taw Priority Area

Nay Pyi Taw area is selected as a priority area for promoting intensive agriculture program. In this section, current conditions of the priority area are discussed. For this purpose, the JICA survey team visited relevant government organizations such as ID, DOA and other delegations of the national government, and local government including market authority. Also the team conducted interview survey to farmers, brokers, millers and traders to grasp current farming situation and commodity flow of agricultural products.

2.3.1 Agriculture in Nay Pyi Taw Area

According to data provided by ID and DOA, paddy is cultivated during monsoon season in all the farmland (lowland) within the Nay Pyi Taw irrigation area. The monsoon paddy is partly rain-fed and supplemented by irrigation. Summer paddy is planted at 51% of the area fully supported by irrigation. Pulses are planted at 34% area during winter season, and black gram is the most major pulse. The pulse grows under residual moisture, not irrigated. The overall crop intensity in this Nay Pyi Taw area is therefore estimated at as high as 186%[8].

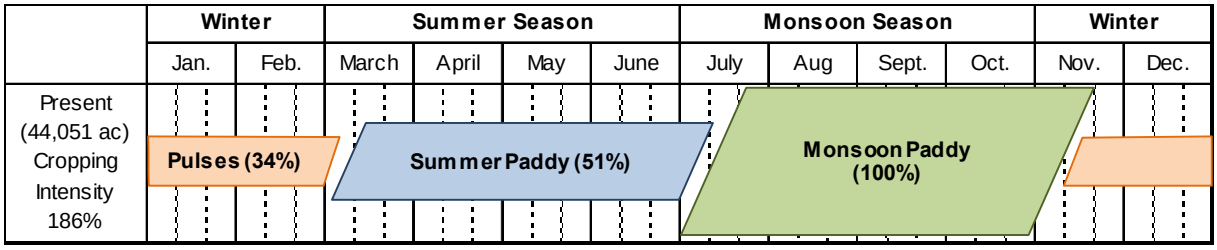


Figure 2.3.1 Present Cropping Pattern in Nay Pyi Taw Area

Source: JICA Survey Team (2015)

Major variety of rice in monsoon season is Manaw Thu Kha, which is a kind of Tmata, whereas that in summer season is Shwe Thwe Yin, a high yielding variety. Recently, some farmers grow Pale Thwe, a hybrid variety, under the contract farming with MAPCO. Hybrid varietyôs yield is expected at as high as over 200 basket per acre under proper management, almost double yield. Following table shows major varieties of rice in this area.

Table 2.3.1 Major Variety of Rice in Nay Pyi Taw Area

Variety	Season	Growing Period (days)	Yield(expected) (bsk/acre)	Selling Price (kyat/bsk)	High Yield/Quality Variety
Manaw Thu Kha	Monsoon	130 - 135	100	4,500	HYV
Shwe Thwe Yin	Summer	105 - 115	120	4,500	HYV
Pale Thwe	Summer	115	200 - 250	4,500	Hybrid

Source: DOA (2015)

JICA survey team conducted a crop yield survey in August ï October 2015, covering 89 samples. The result of the yield survey is summarized in the following table together with the yield data provided by DOA statistics. The survey asked farmers the yield in the last crop season (2014-15) and also for the average for the last, say, 4-5 years. The yield in average year is 73 basket/acre, 84 basket/acre, and 13 basket/acre for monsoon paddy, summer paddy, and black gram respectively, while those provided by

[8] As famers cultivate paddy during monsoon season as far as possible, the intensity of monsoon paddy is practically counted at 100%. The cultivated area of summer paddy was provided by ID, based on which the intensity of summer paddy was estimated as a ratio comparing to the scrutinized irrigable area. The intensity of pulses was estimated by dividing total sown area of winter pulses in the target TSs by that of monsoon paddy, using 3 years average DOA statistical data (2011 ï 2014). Note that ID data does not provide any pulses cultivated area since irrigation water is not provided to such crops.

DOA show relatively higher yields[9].

Table 2.3.2 Yields Comparison between Yield Survey and DOA Statistics in Nay Pyi Taw Area

Season	Crop	Yield Survey (N=89) 1/				DOA 2/ Statistics (2011-2014)
		2014-2015		Average		
		No.	Yield	No.	Yield	
Monsoon	Paddy	74	68.3	74	73.2	83.7
Summer	Paddy	34	114.4 (3/)	4	83.8	90.4
	Sesame	6	4.8	6	9.5	8.6
Winter	Black gram	29	11.3	29	12.6	19.4

Note: 1/ The yield survey was conducted in 3 TSs located in midstream of the Nay Pyi Taw irrigation area, covering 89 farmer households.
Note: 2/ DOA data referred to those of 9 TSs where the Nay Pyi Taw irrigation system extends, including Yedashe TS which located in Paunglaung Dam irrigated area in Bago Region.
Note: 3/ The yield for summer paddy provided by yield survey for last year shows higher number than that for average year. One reason of this may be that some farmers started introducing hybrid rice (the name is Pale Thwe; also known as high yield variety) in recent years.
Source: Crop yield survey by JICA Survey Team (2015), DOA statistics (2011-14)

A household survey was also conducted by the JICA team, covering 60 sample households in Nay Pyi Taw irrigation area. All the 60 sampled farmers, as a matter of fact, have lowland (farmland for paddy) within the irrigation scheme, and of them 29 farmers have upland farm. For the lowland, average farm size comes to 6.0 acres per farmer, with 40 acre and 1 acre being the maximum and minimum, respectively. Including the upland farms, the average farmland that a typical farmer owns is estimated at 9.2 acre (3.8 ha).

Table 2.3.3 Farmland Holdings in Nay Pyi Taw Area

Items	Lowland	Upland	Others	Total / Average
No. of HH (N=60)	60	29	1	60
Total Area (Acre)	358.5	196.3	3.0	557.8
Maximum Area (Acre)	40.0	60.0	3.0	68.0
Minimum Area (Acre)	1.0	1.0	3.0	1.0
Average Area (Acre)	6.0	6.8	3.0	9.2 (3.8 ha)

Source: Household survey by JICA Survey Team (2015)

The farmers cultivate monsoon paddy, summer paddy, and pulses in the lowland (farmland in irrigation area). All the farmers cultivate monsoon paddy, while not all the farmers do summer paddy and winter pulses. In fact, summer paddy cultivation is totally dependent on the availability of irrigation water, whereby only the farmers who are provided irrigation water can cultivate the summer paddy. Pulses cultivation depends on the soil property, specifically moisture retention capacity, and the farmer's interest. Figure 2.3.2 shows the cropping times; namely, 18% famers cultivate 3 crops, 67% farmers do 2 crops (monsoon paddy + summer paddy or monsoon paddy + pulses), and the rest, 15%, cultivate only one time crop, that is monsoon paddy.

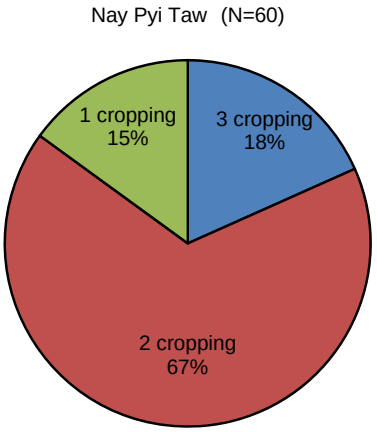


Figure 2.3.2 Percentage of Cropping Pattern in Nay Pyi Taw Area
Source: Household survey by JICA Survey Team (2015)

Agriculture related difficulties were also questioned to the sampled farmers. What came first are the lack of the farm labors and water shortage of irrigation (45%), which indicate due needs of farm mechanization and rehabilitation/ improvement of the

[9] The reason why the DOA data show much higher range of the yield are; 1) possibility of inflating yield which might have been practiced during former regime, 2) different areas surveyed between JICA survey which covered only a sample area, and DOA survey which basically covers all the areas.

irrigation facilities as well as efficient water management of the system. Low rainfall was ranked at third as 43% of the sampled farmers replied it as their one of major problems in their farming. Other issues are high price of agriculture input (30%), Lack of draft animal (30%) and unstable rainfall (25%).

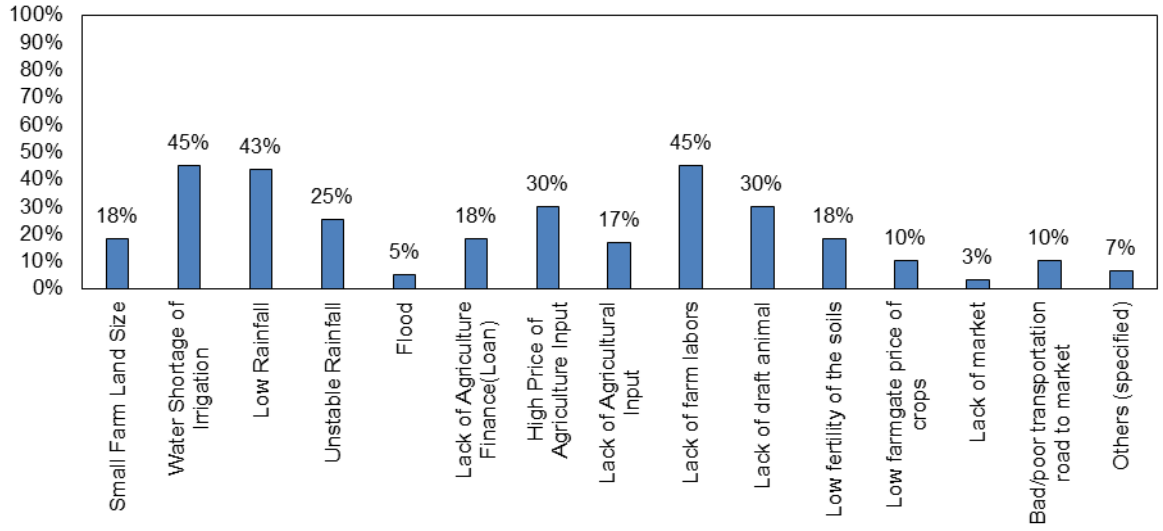


Figure 2.3.3 Severity of Agricultural Difficulty / Problem in Nay Pyi Taw Area
Source: Household survey by JICA Survey Team (2015)

2.3.2 Irrigation in Nay Pyi Taw Area

There are about twenty dams, large and small, in Nay Pyi Taw area. Selected irrigation systems for Intensive Agriculture Promotion Program are Yezin, Ngalaik, Sinthe and Paunglaung irrigation systems, and those are to contribute to agricultural production increase as well as expansion of irrigable area especially summer paddy with rehabilitation and/or upgrading work for each of the irrigation facilities. Each irrigation system has own dam located as follows; from north to south, Sinthe dam, Ngalike dam, Yezin dam and Paunlaung dam.

Sinthe dam is located at a northern part of Nay Pyi Taw. It has 143,090 ac-ft capacity and irrigate 32,400 acres. The dam has right main canal and left main canal with the length of 29 miles and 12 miles respectively. At the left main canal, the World Bank has a plan to rehabilitate the existing canal to lined-type canal in order to reduce the canal conveyance loss. To supplement the irrigation water of right main canal, ID proposes to put up Wegyi-Winpan rubber weir in a stream, called Sinthe Chaung, running in parallel with the canal. This is to provide supplemental irrigation water for monsoon cultivation (note that the river is seasonal, so summer paddy is not irrigated).

Yezin dam and Ngalaik dam are located almost central area of Nay Pyi Taw. Yezin dam is in north-east and Ngalaik dam in north-west from the central area respectively. Yezin dam has passed about 40 years since its completion. It irrigates 15,850 acres with 73,000 ac-ft storage capacity. Most part of the main canal and distributary canals have been changed to lined-type canal, in some parts including tertiary canals.

Ngalaik Dam has 75,000 ac-ft storage capacity and irrigates 25,190 acres. The dam construction was completed in 1986-1987, and 28 years have passed since the commissioning of the system. Ngalaik dam operation was changed in 2009/10 to provide domestic water. The cultivated area of summer paddy has therefore been reduced to around 3,000 acres for the sake of the allocation of domestic water. The dam has now important role in irrigation and domestic water supply, and the reduction of canal conveyance loss is a key for upgrading the aged irrigation system.

Paunglaug dam is located in an eastern side of central area. The construction started in 2005/06 and

will be finished in 2016/17 according to the schedule. The construction cost so far invested arrives at 43,000 million Kyats since the investigation stage, and hydraulic structures along the lower part of the main canals are yet to be completed, unable to irrigate 28,000 acre out of the planned 35,000 irrigable area. The current irrigable area is only about 6,000 acres and 4,000 acres for monsoon and summer paddy despite the 549,420 ac-ft dam storage capacity. Upon completion of the remaining works, Paunlaung dam will largely contribute to increasing the agricultural production in Nay Pyi Taw area.

Photo shows the example of upgraded canal by stone lining along a secondary canal of Yezin Irrigation System. The upgraded canal contributes to the reduction of water loss from the canal bank and bed.

Photo shows the Left Main Canal of Paunglaung irrigation system (right is Paunglaung river) Hydraulic structures in mid-lower parts of the canals have not yet been completed.

2.3.3 Land Consolidation in Nay Pyi Taw Area

Nay Pyi Taw with around 9,400 acres is the major region of implementing farmland consolidation projects in Myanmar. Land consolidation projects have been implemented by Myanmar government and also donor agencies. According to ID/ SLRD, based on experience of implementing previous land consolidation projects, a few farmers are still hesitating to consolidate their farmland due to reduction of a few parts of farmland by construction of farm roads and canals. However, most of the farmers living in the region need to consolidate their farmlands since they are very much aware with the advantages and benefits of mechanized farming by examining farmlands located around them which were already consolidated.

Applying advanced technologies in those consolidated farmlands are directly and closely supervised by the headquarters of Ministry of Agriculture and Irrigation with a concept of Nay Pyi Taw to be a model mechanized farming area of Myanmar since Nay Pyi Taw is the capital city of Myanmar. In fact, due to labor shortage, farmers also need to change their conventional farming into mechanized farming. According to farmer interviews conducted by the JICA survey team, not only increasing yield and quality with waste reduction but also price of farmland got higher after the completion of construction activities.

A land consolidation project site in Ayinlo village, Zabuthiri TS in Nay Pyi Taw

According to AMD, total farmland area consolidated till the end 2014/15 arrives at 9,424 acres (see table below) . On the other hand, based on the last five years records of Nay Pyi Taw regional DOA office, about 16,500 acres summer paddy and 81,000 acres monsoon paddy were cultivated in 4 major

irrigation schemes; Paung Laung, Sinthe, Yezin and Ngalaik. These acres are about 2 times and 9 times bigger respectively than the acres of the consolidated farmlands so far. Therefore, land consolidation project in the region is still in need to extend by the government and also by donor agencies.

Table 2.3.4 Consolidation Acreage for the Last 5 Years in Nay Pyi Taw Area

Township	LC Area (acre)	Fund Source	Remarks
Dekkhinathiri	3,589	Government	
Pyinmana	1,321	Government	
Lewe	700	Government	
Tatkon	686	Government	
Zeyarthiri	526	Government	
Pobbathiri	1,482	Government	
Ottarathiri	57	Government	
Zabuthiri	373	Government	
Zabuthiri	346	JICA	
Zabuthiri	345	KOICA	
Total	9,424		

Source: Agricultural Mechanization Department (2015)

2.3.4 Farm Mechanization

Starting from around 4-5 years ago, implementing most of activities relating to mechanized farming was done in Nay Pyi Taw area more and faster than other areas. This is because performing Nay Pyi Taw as a model city of mechanized farming to share advanced technologies is one of major components in transforming into mechanized farming in Myanmar. Therefore, most of farmers in Nay Pyi Taw area have already realized that time and man power can surely be saved in cultivating their farmlands by mechanized farming. This makes benefit on them avoiding labor shortage, which is the same problem of the farmers in other areas too.

According to interviews to AMD, budget allocation of the government for farm machination has increased. In addition, financially and technically collaborating with foreign agencies is also higher and increased than the past in the region to implement land consolidation, which is an important stage in transforming into mechanized farming. AMD has sold Myanmar-made hand tractors by installment in order to assist farmers to transform into mechanized farming; however private companies nowadays play a major role in disseminating machineries. Household survey, which covered 89 samples in 3 TSs, found that the ownership ratios of tractor, hand tractor, combined harvester, and thresher are 7%, 25%, 2%, 5% respectively.

There are 3 tractor stations within Nay Pyi Taw. There is at least one time training per year for the interested farmers to operate and maintain farm machineries, whose participants are usually 30 to 50 per time. AMD also assists farmers in land preparation and harvesting by machines by charging suitable fee; e.g., 15,000 Kyats for plowing, 7,500 Kyats for harrowing, 15,000 Kyats for rotary tilling and 40,000 Kyats for harvesting by combined harvester respectively per acre.

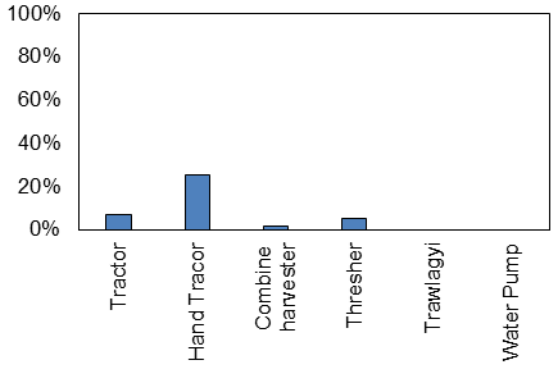


Figure 2.3.4 Agricultural Machineries Ownership Rate in Nay Pyi Taw Area
Source: Household Survey the Survey Team (2015)

2.3.5 Farm-to-Market Road (FMR) and Rice Distribution

Since Nay Pyi Taw is located between Yangon and Mandalay and most ministries are concentrated in

the area, many projects for basic infrastructure have been implemented. However, in the suburb of Nay Pyi Taw center, there are many locations that still have poor infrastructure. Of them, rural infrastructure of Paung Laung irrigation area is relatively worse, especially rural road and bridges. The irrigable area, 35,000 acre upon completion, lies north to south direction. Major crops produced in the Paung Lang irrigable area are monsoon paddy, summer paddy and pulses.

Paung Lang Irrigation area is characterized as the long and narrow form, and Paung Lang river runs through middle of the command area. Two canals, namely Right Main Canal and Left Main Canal, run both side of the river, and length of the canals are 29.35 mile and 29.72 miles respectively. Alongside the main canals, maintenance roads are provided and used for farming activities, products distribution and daily transport of villagers as well. Rice mills in the Paung Langôs service area are concentrated in Elar and Yeni, from which rice is distributed to Elar, Yeni, Thawatti and Pyinmana for mostly domestic consumption.

Road condition becomes worse during monsoon season since some parts of the maintenance roads are still earthen made, and time to time, ID has to fill soil on the roads to keep road condition better. According to ID, around 11 miles of maintenance road of the Left Main Canal is earthen road, whereas around 4 miles of the road is so called ñKankerò road, mixed with soil and gravel. At present, load limit of the maintenance roads is 2 tons. Following figure shows main roads that need improvement in the Paung Laung irrigation area.

Figure 2.3.5 Main Roads that need Improvement in the Paung Laung Irrigation Area

Source: JICA Survey Team based on Field Observation

Under the jurisdiction of Nay Pyi Taw, Paung Laung river has 6 bridges including Paung Laung weir. Out of the 6 bridges, 4 bridges are footbridges made by villagers, and vehicles cannot cross the river. Even motorbike cannot pass the bridges and motorbike transporters have to get down and push the bike till the other side of the river. Since large scale rice mills are located in Elar and Yeni, which are western side of Paung Laung River, villages located in eastern side of the river have to cross the footbridges for paddy milling.

According to DOA, more than 20 villages, including Thitchazeik, Aunglein, Okhpozaung, Kyauk-O and Gwethonbin, are located in the eastern side of river. Main economic activity of the villagers is farming, and paddy and pulses are grown in more than 10,000 acre of the irrigated land, whereas maize, soybean and sesame are produced in 2,000 acre of upland. Due to the poor bridge conditions, the farm and economic activities taking place in eastern side of the river are very much hindered.

For example, Elar-Yonbinzaung-Aungalein road connects Aungalein village to Elar TS with one of footbridges of Paung Laung river. The footbridge is made by wood with 85m length, and villagers constructed and maintain the bridge by themselves. The bridge is used for paddy distribution and daily transportation of mainly three villages, including Aungalein, Thitchazeik and Okhpozaung. Paddy and black gram are grown in total 2,000 acre of farmland in three villages. In left bank area of the river, two small-scale rice mills are operational for villagersô home consumption. However, commercially distributed paddy has to pass the footbridge so as to sell the paddy to rice millers in Elar TS.

According to villagers, around 70% to 90% of paddy is commercially distributed to Elar TS, whereas rests are consumed within their villages. Based on the interview result conducted by the JICA survey team in October 2015, at least around 2,923 ton/year of paddy, equivalent to 58,460 bags/year of paddy, are carried over the footbridge for commercial distribution. Transportation of paddy costs the farmers 300 Kyat/bag, and therefore total transportation cost carrying over the footbridge is estimated at 17.5 million Kyat/year.

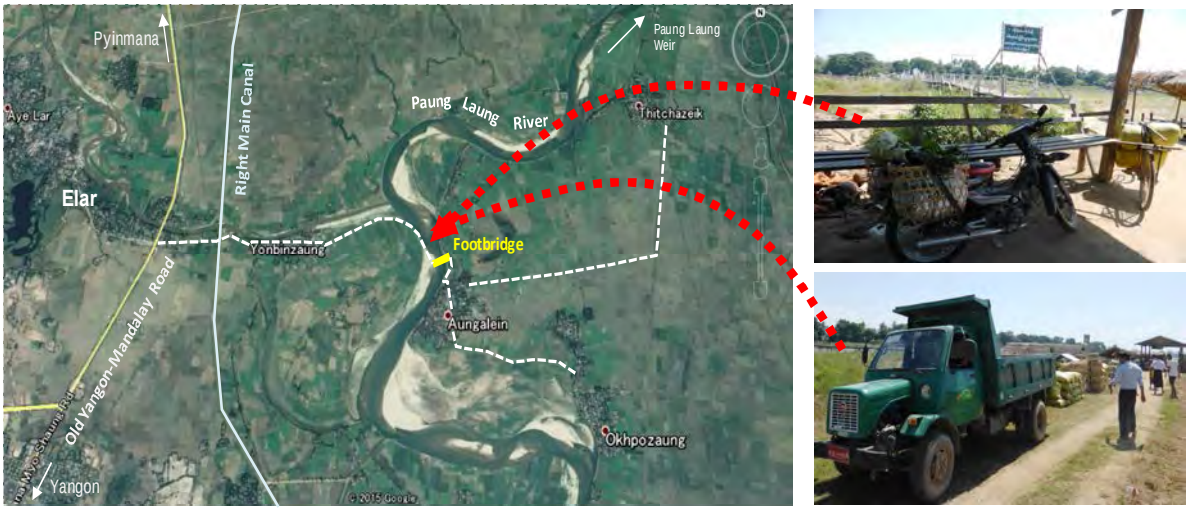


Figure 2.3.6 Location Map of Elar-Yonbinzaung-Aungalein Road

Source: JICA Survey team based on field observation

At the right bank of the footbridge, a simple collection point is constructed where trader with small track is waiting for loading products such as paddy bags. Usually, farmers ask motorbike transporter to carry paddy bags to the collection point and the charge of the transportation is 300 Kyat/bag. The motorbike transporter can carry only 2 to 3 bags in one time, and have to push this bike on the footbridge to pass. In addition, road condition from the footbridge until the old Yangon-Mandalay road is quite poor and average speed of 4-wheel drive is merely 10 km/hr. According to a DOA official, most roads in the Paung Laung command area are same condition. If FMRs with footbridges are

upgraded for vehicle transportation, transportation cost of paddy will dramatically decrease.

2.3.6 Market in Nay Pyi Taw

In Nay Pyi Taw, there are some markets which handle fresh vegetables and fruits, and major local markets are Aherrathukha, Lewe, Tha Pyay Kone and Myo Ma. During almost all season, most vegetables transacted in local markets in Nay Pyi Taw come from Southern Shan, and some come from around Nay Pyi Taw area like Tatkone TS located in northern part of Nay Pyi Taw. Vegetables traded in those markets are tomato, carrot, white mustard, cabbage, cauliflower, marrow, chili, kale, asparagus, gourd, okra, eggplant, cucumber, bitter gourd, pumpkin, lettuce, etc., while fruits are pineapple, pear apple, apple, Dragon fruit, orange, plum, peach, lychee, strawberry, etc. (see table below):

Table 2.3.5 Products Sold and the Source for Local Markets in Nay Pyi Taw

Source		Product
Aungban	Shan	Garlic, Onion, Potato, Ginger, Peanut, Tomato, Long bean, Carrot, White mustard, Cabbage, Cauliflower, Marrow, Chili, Kale, Djenkol bean, Asparagus, Chocho
Taungtha, Myingyan	Mandalay	
Taunggyi, Lashio, Hispaw, Kalaw	Shan	Pine apple, Pear apple, Apple, Dragon Fruit, Orange, Plum apple, Peach, Lychee, Strawberry, Chocho
Pyinoolwin	Mandalay	
Multiple Region	-	Check bean
Magway	Magway	Groundnut
Pyinmana, Lewe, Tatkone	Nay Pyi Taw	Taro, Maize, Gourd, Okra, Eggplant, Snake gourd, Kidney bean, Long bean, White carrot, Cabbage, Cauliflower, Cucumber, Bitter gourd, Pumpkin, Marrow, Fresh chili, Coccinea plant, Water grass, Roselle, Mustard, Lettuce, Budina, Coriander, Leek, Fermented bamboo shoot, Bamboo shoot, Dregea climber, Watermelon, Mango, Banana, Coconut, Papaya, Acacia, Penny wort, Custard apple,
Pyawbwe, Meiktila	Mandalay	
Taungdwingyi	Magway	
Mawlamyine	Mon	Mangosteen, Durian, Rambutan, Pomelo, Grapes
Taungoo	Bago	
Yamethin	Mandalay	Grapes

Source: NCDC (Nay Pyi Taw City Development Committee)

Aherrathukha market is one of the largest local markets in Nay Pyi Taw, accommodating about 300 tenants for fresh vegetables and fruits. This market was established as a wholesale market. However, it is not a wholesale market in real terms, but a cluster of retailers and traders where they conduct daily transaction individually. Most local markets in Nay Pyi Taw show more or less like this situations. In addition to the existing markets, there is a plan that a new Nay Pyi Taw wholesale market is to be constructed. This market plan is still in the conceptual phase, but the place has been arranged near the Nay Pyi Taw railway station.

Aherrathukha Market located in Pynmana where there are about 300 retailers.

One of the biggest problems of local markets in Nay Pyi Taw is the loss of products. JICA survey team conducted a market loss survey in October 2015, covering 50 tenants out of 300 tenants in Aherrathukha market. The result of the market loss survey is summarized in the following table[10]. As a

[10]The estimation method is explained as follows;
First, the 3 representative products (tomato, Chinese cabbage and cabbage) were identified by hearing of NCDC staff. Second, JICA survey team asked 50 tenants of the market if they handle these 3 representative products or not. When the tenant owner handles one of those representative products, (1) Amount of procurement, (2) Selling price, (3) Percentage of loss and (4) Production site were questioned additionally. Then, using the rate of 50 tenantsô loss of the representative products, total loss of the market was estimated by multiplying six (three hundred divided by fifty).

result of the market loss survey, the total market loss of the 3 representative products is estimated at about 203 ton/year. In other words, approximately 105 million Kyats is lost every year. If on-season is set at 3 months for the 3 representative products, the total market loss of the products reaches 2.3 ton/day during the season[11]. This loss is noticeable, thus storage should be considered.

Table 2.3.6 Total Loss Estimation of Vegetable of Local Market in Nay Pyi Taw

Representative Vegetable	Number of vegetable dealers in 50 tenants	Total tenants in the market	Estimated total number of vegetable dealers	Estimated average loss per tenant (viss/year)	Estimated average cost per tenant (1,000Ks/year)	Estimated total loss in the market (ton/year)	Estimated total loss in the market per year (1,000Ks/year)
Tomato	7	300	42	899	1,011	62	42,455
Chinese cabbage	3	300	18	1,985	1,793	58	32,273
Cabbage	3	300	18	2,831	1,697	83	30,547
					Total	203	105,275

Source: Market loss survey by JICA Survey Team (2015)

2.4 Status of the Ayeyarwady Priority Area

Ayeyarwady area is selected as a priority area for promoting intensive agriculture program. In this section, current condition of the priority area are discussed based on interviews to relevant governmental organizations such as ID, DOA, and other delegations of the national and local governments, including market authority, etc.

2.4.1 Agriculture in Ayeyarwady Priority Area

According to data provided by ID and DOA, paddy is cultivated during monsoon season almost all the farmland (lowland) within the Ayeyarwady area. In monsoon season irrigation is not required, but drainage and protection from flood are needed. Polder embankments and gates protect the farmland from the flood. Summer paddy is planted with a help of irrigation by gravity, tidal irrigation, and by pumps. For the core project area[12], an average of 54% of the area is planted with summer paddy. Pulses are planted at 36% area during winter season, and black gram is the most major pulse, followed by green gram. The total crop intensity in the core project areas is therefore estimated at as high as 176%[13].

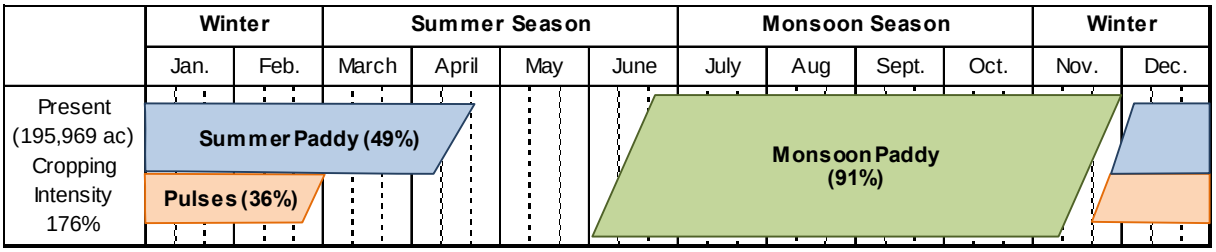


Figure 2.4.1 Present Cropping Pattern in Ayeyarwady Area

Source: JICA Survey Team (2015)

According to DOA, among total planting area of monsoon paddy in Ayeyarwady delta of 3.6 million

[11] According to a staff officer of Aherrathukha market, the total loss of vegetable in the market is reported at about 13 ton/day. Roughly compared to the result of a market loss survey, it may be considered within a possible range, taking into account the losses of other vegetables.

[12] Core project areas for polder are; Bitut (4) Polder (Laputta), Shwe Laung Polder (Wakema TS), Kyun Nyo Gyi Island (Ngapudaw TS), and Thonegwa polder (Maubin & Kyaiklatt TSs).

[13] As famers cultivate paddy during monsoon season as far as possible, the intensity of monsoon paddy is practically counted at 100%. The cultivated area of summer paddy was provided by ID, based on which the intensity of summer paddy was estimated as a ratio comparing to the scrutinized irrigable area. The intensity of pulses was estimated by dividing total sown area of winter pulses in the Ayeyarwady delta by that of monsoon paddy, using 3 years average DOA statistical data (2011 ï 2014).

acre, local variety of Paw San is planted in only 0.8 million acre, 22% of the total area, and the rests are planted with high yielding varieties of paddy, originally developed in IRRI. Paw San, one of the local high quality varieties, is transacted at the highest price among varieties in Myanmar, and is grown under fertile soil condition. Following table shows major varieties of rice in this area.

Table 2.4.1 Major Rice Variety in Ayeyarwady Area

Variety	Season	Growth period (days)	Yield (expected) (bsk/acre)	Selling price (kyat/bsk)	High Yield/Quality Variety
Manaw Thu Kha	Monsoon	135	120	4,200	HYV
Sin Thu Kha	Monsoon	130	120	4,200	HYV
Paw San	Monsoon	150 - 180	70	6,500	HQV
Thee Htet Yin	Summer	105 - 110	130	3,900	HYV

Source: DOA (2015)

Broadcasting is the common practice in this area, and farmers procure HYV seed mostly from DOA. In Ayeyarwady area, JICA's technical cooperation project for "Development of Participatory Multiplication and Distribution System for Quality Rice Seeds" has been implemented since 2011, and effects of quality seed multiplication through dissemination of related knowledge and skills are gradually expanded in the area.

A crop yield survey conducted in August – October 2015, covering 87 samples, shows the following yields together with the yield data provided by DOA statistics. The survey asked farmers the yield in the last crop season (2014-15) and also for the average for the last, say, 4-5 years. The yield in average year is 65 basket/acre, 88 basket/acre, and 10 basket/acre for monsoon paddy, summer paddy, and black gram respectively, while those provided by DOA show relatively higher yields[14].

Table 2.4.2 Yields Comparison between Yield Survey and DOA Statistics in Ayeyarwady Area

Season	Crop	Yield Survey (N=87) 1/				DOA 2/ Statistics (2011-2014), bsk/ac
		2014-2015		Average		
		No.	Yield, bsk/ac	No.	Yield, bsk/ac	
Monsoon	Paddy	87	63.6	87	65.3	66.1
Summer	Paddy	58	85.4	58	87.3	93.0
Winter	Black gram	7	7.7	7	9.9	12.9
	Green gram	6	10.0	6	9.7	16.0

Note: 1/ Yield survey was conducted in 3 TSs located in upper and downstream of the Ayeyarwady irrigation/drainage area, covering 87 farmer households.
Note: 2/ DOA data referred to Ayeyarwady regional total.
Source: Crop yield survey by JICA Survey Team (2015), DOA statistics (2011-14)

A household survey was also conducted by the JICA team, covering 64 sample households in Ayeyarwady irrigation/drainage area. All the 64 sampled farmers, as a matter of fact, have lowland (farmland for paddy) within the irrigation/drainage scheme, and of them only 1 farmer has upland farm. For the lowland, average farmland area is calculated at 17.5 acres per farmer with 100 acre and 2 acre being the maximum and minimum respectively. Including the upland farms, the average farmland that a typical farmer owns is estimated at 17.6 acre (7.1 ha), quite larger as compared with other priority areas.

Table 2.4.3 Farmland Holdings Rate in Ayeyarwady Area

Items	Lowland	Upland	Others	Total / Average
No. of HH (N=64)	64	1	0	64
Total Area (Acre)	1118.0	6.0	0.0	1124.0

[14] The reason why the DOA data show much higher range of the yield are; 1) possibility of inflating yield which might have been practiced during former regime, 2) different areas surveyed by JICA team which covered only a sample area, and surveyed by DOA which basically covers all the areas.

Items	Lowland	Upland	Others	Total / Average
Maximum Area (Acre)	100.0	6.0	0.0	100.0
Minimum Area (Acre)	2.0	6.0	0.0	2.0
Average Area (Acre)	17.5	6.0	0.0	17.6 (7.1 ha)

Source: Household survey by JICA Survey Team (2015)

The farmers of course cultivate monsoon paddy, and in addition summer paddy and pulses in many cases. All the farmers covered by household survey cultivate monsoon paddy, and 76% of the farmers, approximately one 3 in every 4 farmers additionally cultivate either summer paddy or pulses. In fact, summer paddy cultivation is totally dependent on the availability of irrigation water, whereby only the farmers who usually posses engine pumps an cultivate the summer paddy. Pulses cultivation depends on the soil residual moisture. Figure 2.4.2 shows the cropping times; namely, 16% famers cultivate 3 crops, 76% farmers do 2 crops (monsoon paddy + summer paddy or monsoon paddy + pulses), and the rest, 8%, cultivate only one time crop, that is monsoon paddy.

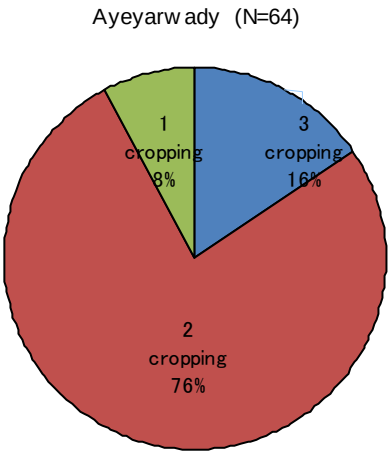


Figure 2.4.2 Percentage of Cropping Pattern in Ayeyarwady Area
Source: Household survey by JICA Survey Team (2015)

Agriculture related difficulties were also questioned to the sampled farmers. Lack of farm labors is ranked first (56%), which indicates due needs of farm mechanization. Flood was ranked at second; 23% of the sampled farmers replied it as their one of major problems in their farming. It implies that there is needs of rehabilitation/ improvement of the sluices and drainages facilities for the purpose of flood mitigation and protection. Other issues are water shortage of irrigation (19%), high price of agriculture input (19%), low fertility of the soils (17%) and low farm-gate price of crops (17%):

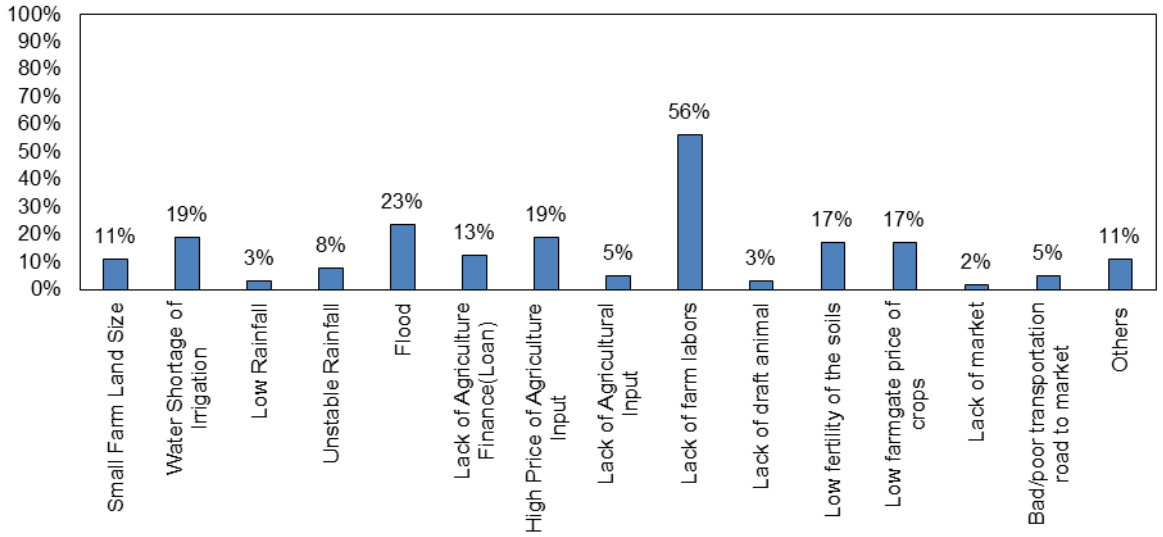


Figure 2.4.3 Severity of Agricultural Difficulty/Problem in Ayeyarwady Area
Source: Household survey by JICA Survey Team (2015)

2.4.2 Irrigation in Ayeyarwady Priority Area

Climate and landscape condition in Ayeyarwady is different from other priority areas, and this condition changes the concept of water utilization system. In monsoon period, there is no-need of supplemental irrigation water for paddy due to much amount of rainfall in the delta area. On the other hand, heavy rainfall in monsoon period causes serious inundation and flood damage. Therefore, in

Ayeyarwady area, drainage system is more important than irrigation system. Monsoon paddy cultivation can therefore be sustainably practiced in such areas where well-maintained drainage canal system and polder are existent.

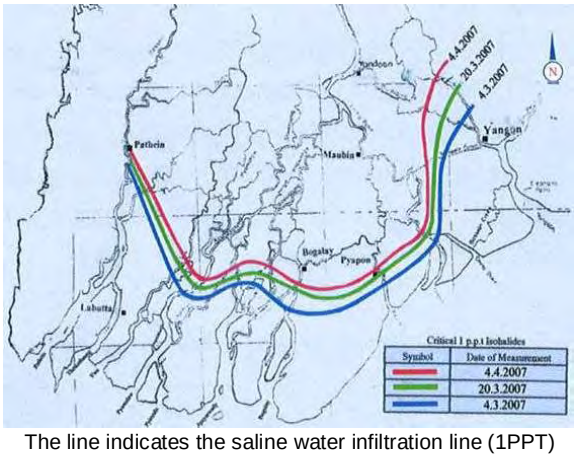
In Ayeyarwady area, the Paddy Land Development Project Phase I and II were implemented in the period of 1976-1988 by World Bank. The purpose of this project was to improve monsoon paddy cultivation by protecting the area from inundation and flood. It has improved a total area of 16,000 acres. Altogether, fifteen polders were constructed through this project. Such selected priority areas under this survey, Tonegwa Polder and Shwelaung Polder, were included in the phase I and II respectively. The production of rice has been increased by the project; however as time passes by, siltation in the drains has accumulated and facilities are also aged.

In Tonegwa Polder (70,400 acre) and Shwelaung Polder (48,648 acre), the cultivated area can obtain irrigation water during monsoon season, when the surrounded riverôs water level is raised by flood. In this period, water level in the polder rises to 4 to 5 feet above sea level (in case of Tonegwa), while the surrounded water level in the river rises up to as high as 11 to 14 feet. During this period, the water in the polder cannot be drained to the surrounded river by sluice gate. Rather, the polder and sluices work in protecting the inside area free from flood.

On the contrary, the water level of surrounded river decreases after the flood period, and now the inundated water inside the polder can be released to the river through drainage canal and sluice gate. In the post monsoon season, the farmers located nearby the drainage canals can get irrigation water through sluice gate during December to April by tidal irrigation method, when the water level of river is higher than the inside of farmlandôs elevation. Proper gate operation and good drainage system can contribute to the increasing of agricultural production.

Approximately 27 years have passed after the completion of World Bank funded project, and gates are aged and deteriorated and de-siltation and dredging have not been fully done due mainly to shortage of maintenance fund. In addition, polder embankments have settled in places, requiring re-shaping and strengthening. There are also damaged and weakened embankments due to the disaster, Nargis. Sedimentation in the drainage canals, and deteriorated sluice gates requiring rehabilitation have also been confirmed through site surveys. Rehabilitation of polder, embankment and sluice gates are needed in lower Ayeyarwady area.

Photo shows the sluice gate for preventing the saline infiltration through drainage canal. Some parts of gate are deteriorated and there is leakage through the gate.



The line indicates the saline water infiltration line (1PPT) in March and April, 2007. The need for polder is not only for flood protection but also prevention of saline infiltration (Outline of the Irrigation Department, ID).

2.4.3 Land Consolidation

Land consolidation pilot project is now on-going in 26 TSs in Ayeyarwady region. Last year, 100 acres

per TS was implemented and another 200 acre/TS will be carried out in 2015. According to DOA, under the pilot project, total 7,800 acres of farmland will be consolidated. However, the scale is still limited comparing to the needs of farmers. According to farmer interview survey in three TSs in the region conducted by JICA survey team in September 2015, farmers desire land consolidation with land leveling and farm-to-market road construction so as to promote farm mechanization.

2.4.4 Farm Mechanization

It is said that farm mechanization in the region started after the Cyclone Nargis hadt killed a lot of cows and water buffalo, and 75% of farmers own hand tractor while 3% of the farmers have tractor according to DOA regional office[15]. However, land holding size of farmers in Ayeyarwady area is relatively large. According to 2010 Census, average land holding size of Ayeyarwady region is 8.0 acre, whereas that of national average is estimated at 6.3 acre. Recently, population drain mostly to urban areas including abroad is taking place in a quick speed and therefore promotion of farm mechanization including tractor and combines harvester becomes urgent issue in this region.

2.4.5 Agricultural Products Distribution in Ayeyarwady

Ayeyarwady region is the largest rice growing area in Myanmar. Paddy is grown anywhere in the region and milled at *Huller* (small scale rice mill) in villages and at large scale rice mill in major towns. The largest town where many rice mills are assembled is Myaungmya, followed by Kangyidaunt, Kyaiklat, and Pathein, as indicated in the figure right. Most of the rice used to be transported by water ways in this region, but at present, some portions of rice are distributed by land transportation thanks to a government policy investing in network enhancement of land transportation.

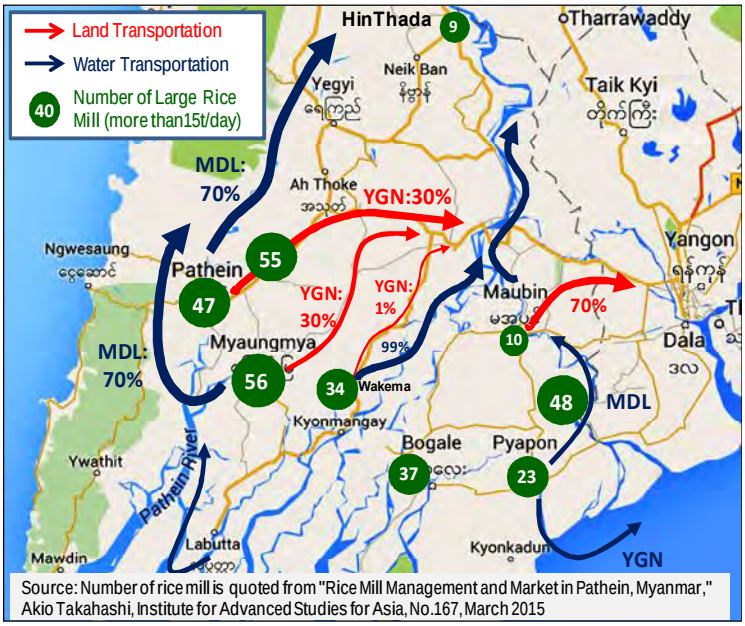
Figure 2.4.4 Locations of Large Rice Millers in Ayeyarwady Area

Source: JICA Survey Team based on Interviews

According to DOA officials, rice millers and traders in Ayeyarwady region contacted by JICA team, most of the rice is still transported by water ways in lower parts of the delta, whereas some millers and traders in middle parts of the region distribute rice by track (see figure below). For example, on one hand, most rice is still transported by river from Labuta. On the other hand, 70% of rice is shipped through Pathein river from mills in Pathein to the Upper Myanmar, while 30% of the rice is brought by tracks to Yangon. The tendency is more obvious in the eastern parts of the delta. From Maubin, the nearest district to Yangon, it is said that about 70% of rice is carried by land to Yangon, whereas only 30% of rice is transported by ship to the Upper Myanmar.

[15] According to the household survey conducted by JICA survey team, owned machineries by the farmers are tractor (2%), hand tractor (72%), combined harvester (5%), thresher (19%), trawlagyi (19%) and water pump (9%).

From these interview results, in the middle parts of the Ayeyarwady delta, transportation modes have been diversified according to the destinations. Rice to the Upper Myanmar is still carried by water ways, whereas that to Yangon has been shifted to land transport, particularly in eastern parts of the delta. However, the destinations are changed based on the demand of China, according to the millers and traders in this region. According to rice millers and traders of major towns in the region, main distribution ways of rice is summaries in the figure below:



Source: Number of rice mill is quoted from "Rice Mill Management and Market in Pathein, Myanmar," Akio Takahashi, Institute for Advanced Studies for Asia, No.167, March 2015

Figure 2.4.5 Transportation Modes of Rice from District Centers

Source: JICA Survey Team based on Interview to DOA Shwebo

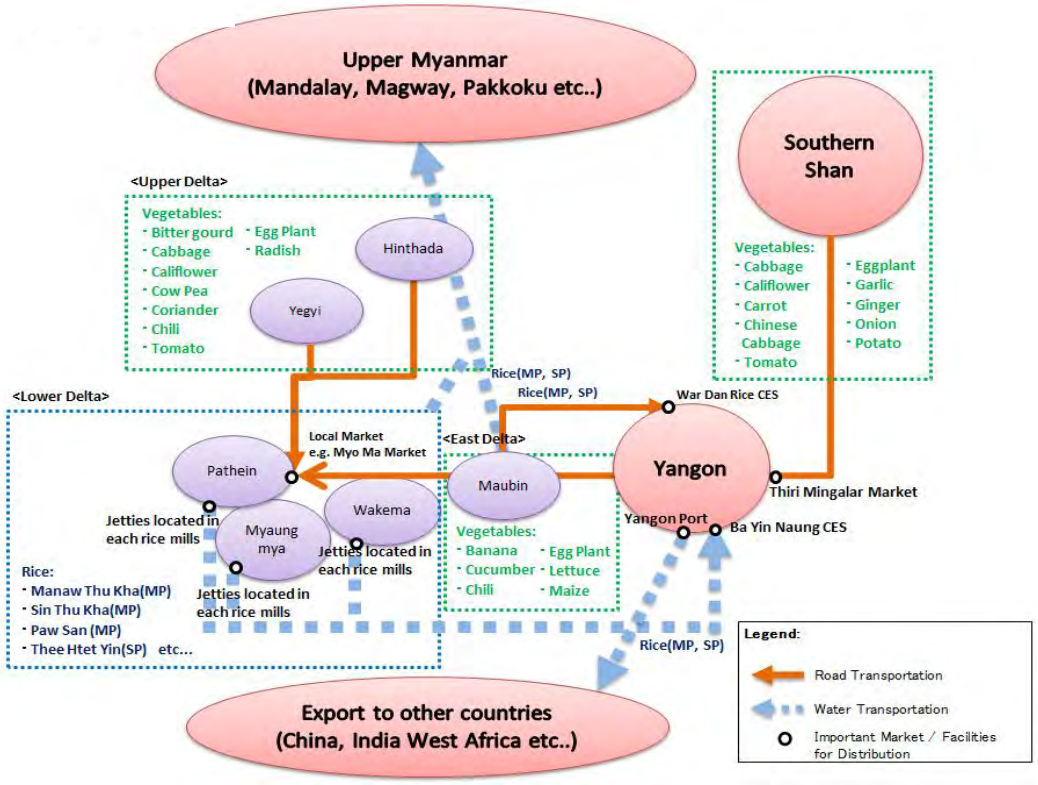


Figure 2.4.6 Distribution Route of Rice from Ayeyarwady Delta Area

Source: JICA Survey Team based on Interview to DOA Ayeyarwady

Ayeyarwady region is one of vegetable producing areas in Myanmar, same as Sagaing region. Main production areas in the region are Hintada and Yegyi, with a harvest season is from October to February next year. Major vegetables produced in the areas are chou-fleur, vabbage, tomato, cherry bean, eggplant, bitter gourd, radish, coriander and chilli. According to DOA, wholesale market for vegetables does not exist in Ayeyarwady region, and farmers sell vegetables to warehouse owners in Pathein, from which the products are redistributed to retail markets in the region, including Myo Mar Market.

Most vegetables produced in the region are consumed within the region, but in some TSs located near Yangon, vegetables are transported to the city and comsumed by the city dwellers. For example, from Maubin TS, cucumber, chilli, retus, banana and eggplant are distributed to Thri Miagalar market in Yangon during May and July and soled in many shops including super markets, whereas maize is shipped to Yangon during March, according to DOA regional officials.

2.4.6 Inundation in Kyaunggon Flood Plain

Pathein road is a main road running through middle part of Ayeyarwady delta with east-west direction, and connects 190 km distance between Yangon and Pathein. In Pathein, around 47 large scale rice mills (more than 15 ton rice production per day) are existent, and around 30% of milled rice is distributed to Yangon through the Pathein road, according to DOA regional office.

Kyaunggon flood plain is located in northeast direction from Pathein, and located within Kangyidaunt TS and Kyaunggon TS. Around 32km (20miles) distance of the Pathein road is under the Kyaunggon flood plain, and villages including Kangyidaunt, Begayet, Darka are suffering from flood annually during monsoon season. During the period from July to September, villagers evaluate to the Pathein road and construct simple houses along the narrow roadside. At the time the survey team visited the flood plain on the middle of September 2015, surrounding areas of Begyet was seriousely damaged and villagers evacuation houses were observed as in the pictures:

According to ID regional office, Ngawun river and Darka river run through the Kyaunggon flood plain from north-easst to south-west direction. Since sedimentation of both rivers is serious, they flow over during July to October, so paddy fields in the flood plain are submerged by flood water. Elevation of the flood plain is around 4 to 5m only, and is lower than that of northern neighboring areas, which elevation is recorded at around 7 to 9m. Faced with this bottle neck, ID has a plan to dredge three creeks including Tan ta bin chaung, Nyaung che dauk yo chaung and Ka nyin chaung; howver it has not yet been implemented.

Inundation area of Kyaunggon flood plain and evacuated houses alongside the Pathein ï Yangon road.

2.4.7 Road Condition

1) District and Region Wise

Ayeyarwady delta is basically a soft ground area, and most roads and bridges constructed more than 20 years ago cannot bear heavy transportation. Due to the fact, many traders in middle parts of the delta have been suffering from transportation restriction. If road netword in some strategic points in the delta area could be upgraded, transporattion cost of agricultural porduct distribution would be dramatically reduced.

Maubin: Land transportation of rice makes up around 70% in Maubin and rest is shipped by river. The shortest route for transporting rice to Yangon is the Maubin-Twantay-Yangon road. However, load limit of the road is only 2 tons, due to its low capacity. Particularly, the bridge near Twantay is considered as a bottleneck of the road network. Therefore, most traders in Maubin are forced to take the Maubin-Wadaw-Samalauk-Yangon way as indicated below. If the Maubin- Twantay-Yangon road is upgraded, transportation time and cost of millers and traders in Maubin could reduce to around a half of present condition.

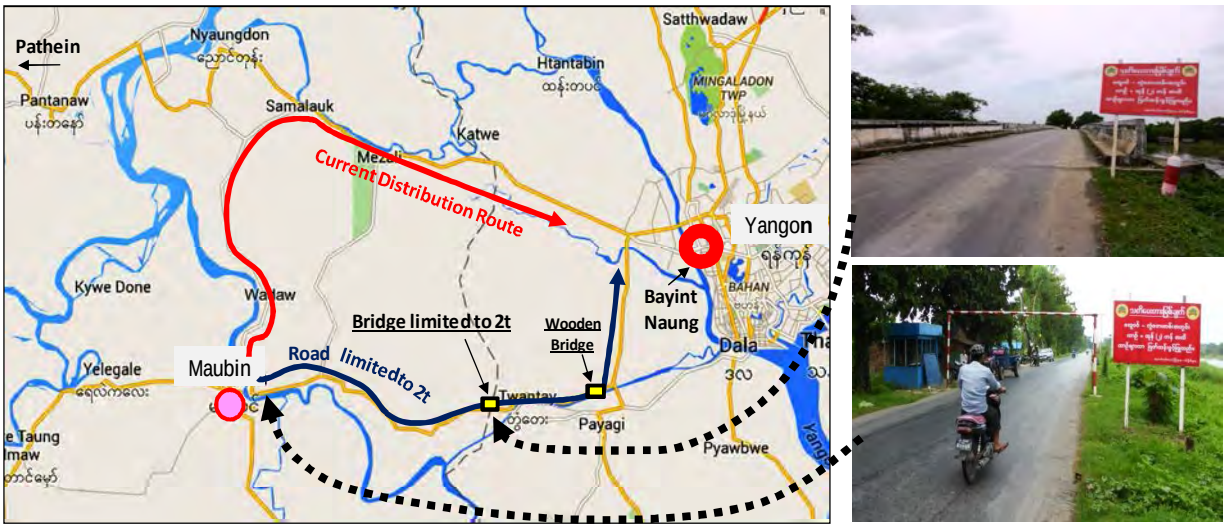


Figure 2.4.7 Distribution Route of Rice from Maubin to Yangon

Source: JICA Survey Team based on Interview to DOA Shwebo

Myaungmya: In Ayeyarwady delta, Myaungmya is the largest town in view of accumulation of large scale rice mills, as more than 50% of the 15 ton/day-class mills are located there. From Myaungmya, large volume of rice is distributed to Upper Myanmar (around 70%) and Yangon (around 30%), and transportation means of the former is by water way whereas that of the latter is land transportation. From Myaungmya to Yangon, there are three alternative ways as follows;

Table 2.4.4 Distance and Load Limit of the Three Alternative Route from Myaungmya to Yangon

	Route	Distance (mile)	Load Limit (ton)	
			Monsoon Season	Dry Season
R1	Myaungmya-Einme-Pantanaw-Yangon	110 mile	3 t	6 t
R2	Myaungmya-Einme-Kyaunggon-Pantanaw-Yangon	120 mile	5 t	10 t
R3	Myaungmya-Einme-Darka-Kyaunggon-Pantanaw-Yangon	150 mile	10 t	20 t

Source: Interview survey to rice millers and traders by JICA Survey Team

Weight limits for bridge in the R1 differs between monsoon and dry season, and that in monsoon season (June to December) is stricter due to poor road conditions. According to the rice millers contacted, common size of track is 10 t-carrying capacity in Myaungmya, and they have to take R2 in dry season even though R1 is the shortest way to Yangon. In monsoon season, millers and traders have to take R3 if they still use the 10 t-capacity tracks. Therefore, upgrading of bridges along Einme-Pantanaw road contributes to reducing the transportation cost of millers and traders in Myaungmya.

Figure 2.4.8 Distribution Route of Rice from Myaungmya to Yangon

Source: JICA Survey Team based on Interview to DOA Ayeyarwady

2) Farm to Market Road Improvement at Village Level

Owing to the road network expansion policy started in 1990s, the segmented situation in the delta area has been mitigated. However, a lot number of isolated villages still exist in the lower and the middle parts of the delta, where water transport of agricultural products and daily commodities is still dominant. Particularly in the middle-eastern part of the Ayeyarwady delta, road network improvement, including development of farm-to-market roads and bridges, significantly contributes to the improvement of rice distribution to Yangon, by reducing transit time dramatically

Maubin: On September 4, 2015, a farm-to-market road including Pan Tha Put bridge over the Pan Tha Put stream was completed, and since then, 8 villages including Kha Naung Htaw village enjoy benefit of the improved transportation by the road project. Population of Kha Naung Htaw village is around 1,400 and 200 households reside in the isolated village. Among them, 100 households are rice growers with 2,100 acres of monsoon paddy and 520 acres of summer paddy.

Figure 2.4.9 Location of Kha Naung Htaw Village In Maubin TS and the Bridge/Road Constructed

Source: JICA Survey Team based on Interview to DOA Shwebo

Before construction of the road, farmers had to transport their paddy to river bank of the Pan Tha Put stream by Trawllergy (hand tractor engine driven cart) or animal cart, then de-load/upload to a ferry, paying 100 Kyat/basket, and de-load/upload again at the other side of the river to deliver the paddy to the rice mills in Maubin center. After the road completed, farmers can carry their products directly to the rice mill by Troragy, or trader comes to village for paddy collection.

Still there are several villages isolated by stream in Maubin. According to a manager of ñWin Theingi Rice Millò in Maubin center, among her business partners, farmers in 5 villages including Ka Nu, Ka Nyin Wa, Ne Pa Say, Ohn Pin Su, and Phaung Yoe Seit,

Figure 2.4.10 Location of Isolated Villages in Maubin District

Source: DOA Regional and District Office

which are located at western side of Pan Tha Put stream, are forced to transport paddy by relay of land-river-land up to the rice mills in the Maubin center. If farm-to-market road with bridges were to be constructed near these villages, transportation cost of paddy could be reduced and distribution of paddy would be improved.

Myaungmya: Myaungmya district is located in the middle part of Ayeyarwady delta, and main towns of the district are Myaungmya, Einme and Wakema. According to DOA officials in Pathein, farmers in Nga Pyaw Taw village and Kun Chan Kone village, which are located in the south-eastern side of Myaungmya, have to cross a small river to transport paddy for milling. Numbers of household of both villages are around 200 each, and main income sources of them are rice production and fisheries. Also, Myin Kha Chaung village in northern part of Myaungmya district is in the same condition and is suffering from poor access to the rice mill. A small suspension bridge is only the way to cross the river at present.

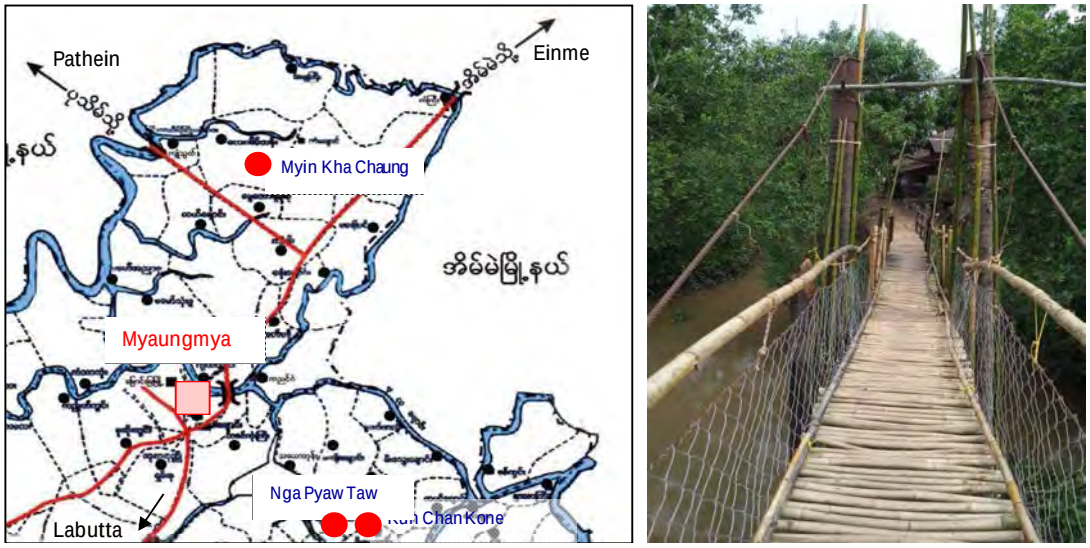


Figure 2.4.11 Location of Isolated Villages in Myauunmya District, and a Typical Bridge

Source: JICA Survey Team based on Interview to DOA Shwebo

2.4.8 Jetty in Pathein Port

Just like other river ports in Myanmar, mechanization of port facility has not taken place and congestion is observed during peak season. Loading and unloading of baggage and passengers are carried out using narrow wooden boards resulting in dangerous situation. In general, advantage of water transportation is its bulk transport at low cost, comparing to track transportation. For example, carrying capacity of long-distance ship for rice transportation is around 200 to 900 tons per vessel, while that of track is only 10 to 20 tons in average. However, since loading/ unloading works at jetty is done by manual and all cargos have to be packed in hand-carry size, the works take too much time under the current condition.

Therefore, improvement of jetty with concrete river bank, mechanization of loading equipment, modernization of port facilities is needed. For rice transportation by water way, fumigation service during shipping to the upper Myanmar is also effective to maintain quality of the export rice. For this purpose, collaboration with Plan Protection Division (PPD under DOA) in rice distribution from Pathein port is recommended.

2.4.9 Local Market in Pathein

Pathein market is located at southern part of Pagoda road, left bank of Ayeyarwady river, and selling place of perishable agricultural products occupies around 4 acres (1.5 ha). Same as other local markets

in Myanmar, the market has both function of wholesale and retail, and it is difficult to distinguish between them. However, most wholesalers have their warehouse outside the market shed.

Retail section of vegetables and fruits in the Pathein central market has concrete floor and wooden structure with tin roof. Drainage system was established inside of the market structure, and sanitary condition is relatively good. However, drainage canal runs through the middle part of the market, and plastic garbage and waste materials are accumulated in the canal resulting in poor sanitary environment of the market. It is necessary to improve sanitary condition of the market through relocation or realignment. In addition, retail section for farmers should be expanded, since such place is important for farmers to gain additional income from surplus vegetables and fruits, leading to crop diversification in the Ayeyarwady region.

Drainage running along almost center of the Pathein market, giving unsanitary environment to the market

CHAPTER 3 DEVELOPMENT PLAN AND COST REQUIRED

This chapter, based on the findings aforementioned and direction set forth, discuses development plan and the cost required at pre-feasibility level. The plan is a sort of program composed of different sub-programs, projects or program components. The plan is formulated by the priority area; however, similar sub-programs/ projects can be found across the priority areas. Therefore, what sub-programs should be put into implementation is presented by priority area first, and then the identified sub-programs are to be elaborated one by one:

3.1 Identification of the Program Components

Based on the direction set by priority area (refer to 1.3 Development Direction and Strategy Setting by Priority Area), following program components are proposed; namely, the components are firstly categorized into 2 groups of productivity increase and agri-business promotion, and then where a specific component is required in a priority area, it is noted:

Table 3.1.1 Program Components of the Priority Areas

Component	Shwebo	MDLY	NPT	AYWDY
I. Component for Productivity Increase				
1. Agriculture Extension Strengthening	○	○	○	○
2. Irrigation Rehabilitation	○	○	○	
3. Polder and Drainage Improvement				○
4. Land Consolidation	○	○	○	○
5. Agricultural Machinery Station Enhancement	○		○ (1/)	○
6. Agricultural Machinery Dissemination (TSL)	○	○	○	○
7. Flood Monitoring System Establishment	○			○
8. Plant Breeding Enhancement			○	
II. Component for Agribusiness Promotion				
9. Farm-to-Market Road (FMR) Improvement	○	○	○	○
10. Jetty Improvement	○	○		○
11. Market Improvement (District level)	○			○
12. PPP Wholesale Market Establishment (Mandalay)		○		
13. Wholesale Market Development (New)			○	
14. Small and Medium Agro-enterprise Promotion (TSL)	○	○	○	○
15. Supply Chain Improvement of Rice	○	○	○	○
16. Value Chain Enhancement of Vegetables & Fruits		○		
17. Food Processing Industry Promotion		○		
18. Dissemination of Advanced Farming Technologies			○	
19. Plant Protection and Quarantine Enhancement	○ (2/)	○		○ (3/)

Note: 1/ Agricultural machinery station in NPT should have a function of a machine testing center, which issues certificate for a properly and legally produced machine.
2/ Plant Protection and Quarantine center proposed for Shwebo is the same as the one proposed for Mandalay. Therefore, the center should be established in Mandalay city or its suburban area.
3/ Plant Protection and Quarantine center for Ayeyarwady should be established in Yangon, namely, an existent PPD's laboratory in Yangon should be renovated.
Note: MDLY means Mandalay, NPT is Nay Pyi Taw, and AYWDY stands for Ayeyarwady, and TSL is Two Step Loan
Source: JICA Survey Team,

As seen in the above table, program component required in all the 4 priority areas are; agriculture extension strengthening, land consolidation, farm-to-market road improvement, promotion of agricultural machineries, and supply chain improvement of rice. Irrigation rehabilitation, one of the major components in infrastructure development, is required in the 3 priority areas of Shwebo, Mandalay, and Nay Pyi Taw while Ayeyarwady area needs polder improvement composed of drainage improvement, or otherwise flood protection, with higher priority and then irrigation improvement.

There are sort of specific components which are required in a specific priority area. These are, for example, value chain enhancement of vegetables and fruits (No.16), and food industry promotion

(No.17). These 2 components are of priority only in Mandalay area since the area is vey close to the center of the upper Myanmar, Mandalay city. There are vegetable farmers and fruit farmers (especially mango), which need further improvement not only in production but also marketing. Food industry promotion could also be a potential development component in that city, providing job opportunities to the urban dwellers.

Plant breeding enhancement (No.8) is planned in Nay Pyi Taw area only. There is a breeding facility in Department of Agricultural Research. This facility was established in early 1990, which needs rehabilitation and upgrading. In addition, dissemination of advanced technologies (No.18) is also planned in Nay Pyi Taw area. There are lowland vegetable farmers, which need further improvement in the production, quality control, processing and marketing. Nay Pyi Taw is the capital of Myanmar, so that the demonstration effect is very high. There should be a demonstration and dissemination in Nay Pyi Taw area for advanced farm machineries used in upland fields, e.g. drip irrigation, sprinkler irrigation, etc.

3.2 Program Components

In total, 19 program components have been identified, and each priority area should have several components to promote intensive agriculture, depending on characteristics of the area, opportunities and potential endorsed to the area, etc. Following sections describe the contents of the development components:

3.2.1 Agriculture Extension Strengthening

1) Rationale

In the priority areas, crops cultivated are monsoon paddy, summer paddy, and pulses in winter, with some cases of sesame replacing summer paddy. In general, yield of these major crops are not high as compared to other ASEAN countries. Though one of the major potential program components is irrigation rehabilitation/ improvement, just infrastructure improvement hardly leads to the automatic improvement of the production. On the other hand, DOA has established extensive network of agriculture extension services down to township level. Roughly, there are around 10 ï 15 extension officers at the TS level, so that if they are well mobilized, extension service will contribute to the increase of the production.

2) Target Yield

This component is to be carried out in all the 4 priority areas. The major mode of the extension will be by demonstration farms organized, operated and maintained by township DOA offices. To set the target yields, this survey refers to a result of yield survey conducted by JICA team in August ï October 2015, covering total 412 sample households[1] in the 4 priority areas as present yield. Then, the target yields are set to be a mid point between the present yield and what were reported by regional DOA and TS DOA officers as practically expected yields in the respective area.

Table 3.2.1 Target Yield by Agriculture Extension Strengthening Component

Region	Crop	Present Basket/acre (ton/ha)	Target Basket/acre (ton/ha)	Practically Expected (ton/ha)	Increment
Shwebo	Monsoon Paddy	63 (3.3)	69.0 (3.6)	75 (3.9)	1.10
	Summer Paddy	82(4.2) (1/)	98.5 (5.1)	115 (5.9)	1.20
	Pulses(Chickpea)	14	17.0	20	1.21
	Sesame	10	12.5	15	1.25
Mandalay	Monsoon Paddy	74 (3.8)	89.5 (4.6)	105 (5.4)	1.21

[1] Note that the sample no. in Shwebo is 121, in Mandalay is 115, in Nay Pyi Taw is 89, and in Ayeyarwady is 87.

	Summer Paddy	89 (4.6)	104.5 (5.4)	120 (6.2)	1.17
	Pulses(Chickpea)	9	14.5	20	1.61
	Sesame	9	12.0	15	1.33
Nay Pyi Taw	Monsoon Paddy	73 (3.8)	86.5 (4.5)	100 (5.2)	1.18
	Summer Paddy	84 (4.3)	102.0 (5.3)	120 (6.2)	1.21
	Pulses(Black gram)	13	16.5	20	1.27
	Sesame	10	12.5	15	1.25
Ayeyarwady	Monsoon Paddy	65 (3.4)	72.5 (3.7)	80 (4.1)	1.12
	Summer Paddy	87 (4.5)	98.5 (5.1)	110 (5.7)	1.13
	Pulses(Black gram)	10	15.0	20	1.50
	Sesame	-	-	-	-

Note: numbers in parenthesis are in ton per hector unit.

Note: 1/: Irrigation system in Wetlet TS of Shwebo area were not fully functioning for the last 3-4 years, hence farmers have faced water shortage in summer resulting in lower yield of summer paddy. The results of Wetlet TS (29 samples) were therefore removed in this table.

Source: Present yields are by JICA yield survey, and practically expected yields are from regional and TS DOA officers.

3) Area Expansion with Irrigation Improvement

In addition to the target yields, there should be an expansion of irrigable areas and/or crop diversification with the rehabilitation of irrigation facilities. For the 3 priory areas of Shwebo, Mandalay and Nay Pyi Taw, the JICA team sets, for the purpose of project evaluation, the following 4 case cropping patterns:

1) Base 0α: yield increase for monsoon and summer paddy only,

2) Base 0: yield increase of the paddy for both monsoon and summer, and expansion of summer paddy area thanks to the reduced loss of irrigation water accrued from the rehabilitation,

3) Base 1: yield increase of the both paddy and expansion of pulses cultivation area with irrigation (no expansion of summer paddy is counted), and

4) Base 2: diversification of summer paddy to a potential alternative crop such as sesame, green gram, lowland vegetables, etc. with a ratio of 10% of the summer paddy to 3 times area of those alternative crops.

In the improved plans, Base 0α is set by the same as present case except for yield increasing. In the Base 0, cropping area of summer paddy will increase up to potential sown area with the rehabilitation of irrigation systems. In the Base 1, cropping area of winter pulses will increase by using the saved irrigation water instead of expanding summer paddy area. Therefore, cultivation area of summer paddy is not expanded, but yield increase only, in this Base 1, and instead pulses area is increased at a ratio of 3 times more than that of summer paddy expanded under Base 0. This is because pulses usually require one-third of the irrigation water of summer paddy.

In the Base 2, Base 1's 10% potential sown area of summer paddy will be replaced by alternative crops e.g. sesame, green gram, lowland vegetables, etc. which can grow under hot climate. Change to sesame has already taken place in an irrigation system in Magway region. Water requirement of sesame is approximately one-third of that of summer paddy, and therefore potential sown area of alternative crops is 3 times larger than that of summer paddy in terms of the same water use.

For Ayeyarwady area, the benefit appearance is different from the above 3 areas. In Ayeyarwady area, the major component is to rehabilitate polder system by mainly dredging and rehabilitation of sluice gates. These are all related to drainage improvement and flood mitigation by large, and to some extent to irrigation improvement of summer paddy. Therefore, above Base 0α case is only applied to the Ayeyarwady area.

Following figure and tables show the conceptual change of the cropping patterns and increase of the

cultivated area, as well as increase of the crop intensity. As summarized, the agricultural extension strengthening component will increase yield as aforementioned, and also contribute to expansion of the cultivation areas to such crop intensities of 220%, 224%, and 206% for Shwebo, Mandalay and Nay Pyi Taw area respectively with the irrigation rehabilitation component in case of Base 1:

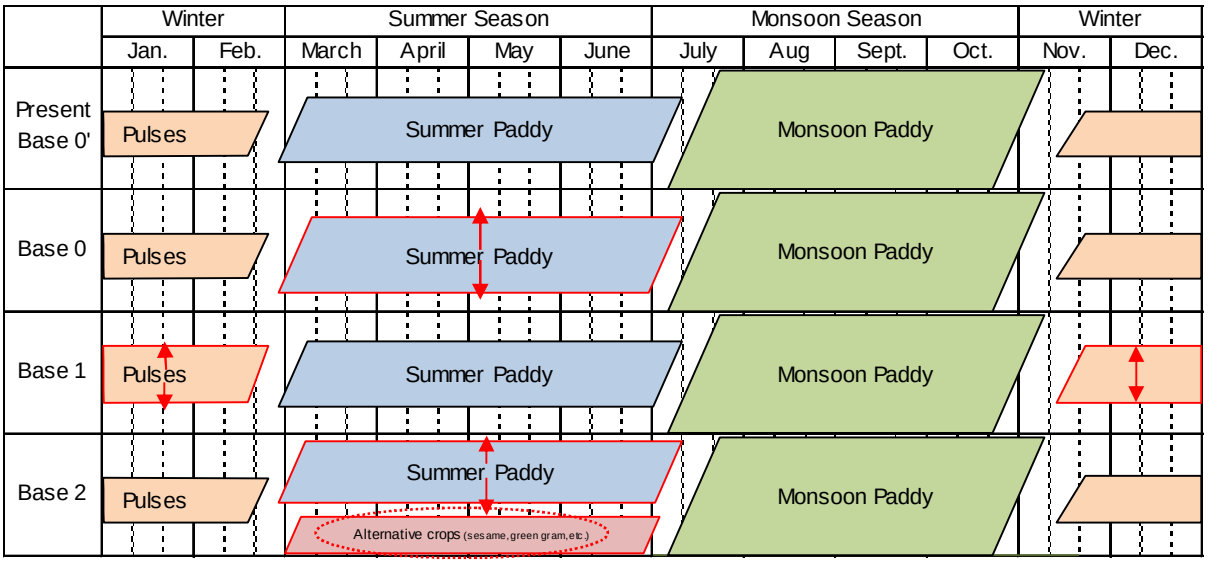


Figure 3.2.1 Representative Cropping Patterns with Agricultural Extension Strengthening

Source: JICA Survey Team

Table 3.2.2 Increase of Crop Intensity

Area	Crop	Crop Intensity	Crop Intensity Improved			
		Original	Base 0ô	Base 0	Base 1	Base 2
Shwebo	Monsoon Paddy	100%	100%	100%	100%	100%
	Summer Paddy	56%	56%	67%	56%	61%
	Pulses (Chick pea)	31%	31%	31%	64%	31%
	Sesame	0%	0%	0%	0%	20%
	Total	187%	187%	198%	220%	212%
Mandalay	Monsoon Paddy	100%	100%	100%	100%	100%
	Summer Paddy	55%	55%	65%	55%	58%
	Pulses (Chick pea)	38%	38%	38%	69%	38%
	Sesame	0%	0%	0%	0%	10%
	Total	193%	193%	203%	224%	207%
Nay Pyi Taw	Monsoon Paddy	100%	100%	100%	100%	100%
	Summer Paddy	51%	49%	57%	49%	51%
	Pulses (black gram)	34%	34%	34%	57%	34%
	Sesame	0%	0%	0%	0%	2%
	Total	186%	183%	191%	206%	188%
Ayeyarwady	Monsoon Paddy	91% (1/)	91%	100%		
	Summer Paddy	49%	49%	54% (2/)		
	Pulses (black gram)	36%	36%	36% (3/)		
	Total	176%	176%	190%		

Note: 1/: Since monsoon area within the protected area of a polder is not available, less 10% from the full cultivated area is assumed before the current area for monsoon paddy. 2/: 54% is the summer paddy ration against monsoon paddy area in the middle parts of delta (DOA). 3/: 36% is the pulse area against whole monsoon paddy area in the delta (DOA).
Source: JICA Survey Team,

Table 3.2.3 Cases in Relation to Agricultural Extension Strengthening

Case	Base 0' (only yield increase)		Base 0	Base 1	Original Pulses Area	Base 2	
	Monsoon Paddy	Summer Paddy	Summer P. Increase to:	Pulses Increment		Summer Paddy	Sesame
Unit	acre	acre	acre, 2/	acre, 3/	acre	acre	acre
Shwebo	485,456	274,086	327,181	+159,286	148,994	294,463	98,154
Mandalay	253,295	138,644	194,593	+167,850	96,282	175,134	58,378
Nay Pyi Taw	67,945	33,335	38,548	+15,640	15,047	34,693	11,564

Case	Base 0' (only yield increase)		Base 0	Base 1	Original Pulses Area	Base 2	
	Monsoon Paddy	Summer Paddy	Summer P. Increase to:	Pulses Increment		Summer Paddy	Sesame
	(44,051), 1/	(22,619), 1/					
Ayeyarwady	178,154	96,381	106,019 (MP 195,969)	-	64,135	-	-

Note: 1/: only the current irrigable area for Paung Laung is counted, and the above numbers include the newly to-be-irrigated areas for Paung Laung system with rehabilitation works. 2/: the areas are the total summer paddy area to be achieved with rehabilitation. 3/ the areas are only incremental ones with irrigation.

3) Activities of the Component

To achieve the expected yield of each crop as well as area expansion, dissemination of appropriate farming technology is needed. For this purpose, DOAôs extension service shall be enhanced as a program component. As a first step, DOA extension officers, especially TS level officers, should be given a series of trainings by agricultural experts, e.g. to be arranged under a loan assistance. Then, their agricultural extension service is rendered through demonstration activities at model farms. The demonstration farm is a place where recommended appropriate technologies of crop production are put on display in an orderly manner as a means for others to know, be aware, adopt, or disseminate such technologies.

The recommended appropriate technologies include quality management of certified seeds, which is very important and basic technology, weeding, application of farm machineries, and appropriate use of fertilizers and pesticides. The demonstration farms serve as a venue for;

- ✓ Providing technical assistance to farmer cooperators and DOA extension officers in designing and planning for the establishment and operation of appropriate farming systems;
- ✓ Conducting capacity building activities to train and assist farmer-cooperators in the preparation of management plans for the sustainable operation of their demonstration farms and in the provision of extension services to other farmers;
- ✓ Promoting the adoption or replication of recommended farming technologies, including seed management, machineries and input usage, by the farmer cooperators; and
- ✓ Facilitating linkages between the farmers and service providers.

Then, following activities are to be conducted with input provided by the project at the demonstration farms (see the following table):

- ✓ The Project conducts capacity development trainings to the participating DOA extension officers, and then establishes demonstration farms in each TS, and 10 or 15 acre of land for each demonstration farm is provided by farmer cooperators.
- ✓ The Project involves training of 30 farmer trainees, including 3 representatives from each village, at each demonstration farm.
- ✓ Input from the Project includes certified seeds of rice, appropriate fertilizers/ pesticides, fuel for farm machineries, vehicles and motorbike for extension workers.
- ✓ The certified seed is provided in collaboration with DOA, whereas farm machinery services are provided by AMDôs tractor service stations.

Table 3.2.4 Quantities of Input under Agricultural Extension Strengthening

Project Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady	Remark
Project Years	4	5	3	4	
No. of TSs	7	7	9	-	
Production Cost (1/)	Monsoon Paddy Summer Paddy Chick pea	Monsoon Paddy Summer Paddy Chick pea	Monsoon Paddy Summer Paddy Black gram	Monsoon Paddy Summer Paddy Black gram	Seed, Fertilizer, Pesticide etc.

Project Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady	Remark
Project Years	4	5	3	4	
No. of TSs	7	7	9	-	
Size of DF*	10	10	10	15 (2/)	
Total No. of DF	560	350	108	152	1 DF / 100 Farmers (3/)
Total No. of FS**	56	35	11	15	1 FS / 10 DFs
No. of Trainee	70	70	90	35	10 Trainees / 1 TS 24 days / 2 times / year
No. of Vehicle (Pickup)	4	4	3 (4/)	4	4 Pickup / 1 Project Area (5/)
No. of Motorbike	35	35	45	18	1 Motorbike / 2 Trainees (5/)
Extension Materials	1 LS				Brochure, Booklet, Poster, DVD, (6/)
International Staff	1	1	1	1	Agronomist/Agro-economist 1 Staff / 1 Project Area
Local Staff	5	3	2	3	Agronomist/Agro-economist (7/)
Supporting Staff	15	9	6	9	Agronomist (3 Supporting Staffs / 1 Local Staff)

* DF: demonstration farm ** FS: field school

Note: 1/: Production cost was set at one-and-a-half times as much as average input of each area, which comes from Household Survey by JICA Survey Team (2015). 2/: According to Household Survey, the farmers in Ayeyarwady own larger farmland than other areas, and therefore the size of DF in Ayeyarwady was set in larger size than that of other areas. 3/: The number of farmers in each project area was approximately estimated by the result of Household Survey. 4:/ The number of vehicles in Nay Pyi Taw was set one less than other areas, because the number of DF in Nay Pyi Taw is smaller than other areas. 5:/ Input of vehicles and motorbikes include the fuel cost. 6:/ The numbers of extension materials were set as follows; 1 brochure / 5 farmers, 1 booklet / 10 farmers, 1 poster / 50 farmers and 1 DVD /20 farmers approximately. 7/: The number of local staff was set under considering such as project years, number of DF and trainees compositely.

4) Summary of the Program Component

Project Name	No.1 Agricultural Extension Strengthening			
Project Purpose	To increase production volume and yield of crops through enhancement of agriculture extension services provided by DOA			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	○
Target Area	All the townships within the irrigation schemes (polders in Ayeyarwady area) of 4 priority areas			
Implementing Organization	DOA (MOAI)			
Support Organization	AMD, MRF (MRIA, MFA, etc.)			
Beneficiaries	Farmer cooperators, DOA extension officers			
Development Effect	Enhanced capacity for the DOA extension officers, Increase in production volume, Increase in yield of crops and cultivation are, Reduction in production cost			
ODA Scheme/ Cost	Project Loan		Shwebo	1120 million JPY
			Mandalay	918 million JPY
			Nay Pyi Taw	393 million JPY
			Ayeyarwady	582 million JPY
Duration of the Project	3 ï 5 years in combination with irrigation rehabilitation component			

Source: JICA Survey Team

3.2.2 Irrigation Rehabilitation (Shwebo, Mandalay, Nay Pyi Taw)

Irrigation system is one the major and essential infrastructure in attaining high productivity in agriculture. Upon commencement of the operation for the irrigation systems for the priority areas, ID has carried out maintenance for those schemes; however, due to shortage of budget allocation especially under the former regime, irrigation schemes have seriously been deteriorated year after year. Consequently, Irrigation Department can nowadays hardly operate the irrigation systems as planned and the farmers have been facing difficulties in obtaining irrigation water in time and in terms of quantity.

Under above situation, Irrigation Department needs to rehabilitate and in some cases upgrade aged

irrigation facilities to put back to the originally planned functional level, possibly bringing about ODA loan for the implementation of rehabilitation works as early as possible. Therefore, the objective of the component is to increase agriculture production through recovery of the area of the irrigated land by rehabilitating the irrigation systems. With the rehabilitation completed, it is expected to contribute to food security for the nation as well as for export.

2) Major Works under Irrigation Rehabilitation

To identify major works under rehabilitation, there should be a survey and design such as; identification of facilities which need rehabilitation, preliminary cost estimation, basic and detailed design, cost estimation and disbursement plan formulation, construction method and schedule planning, environmental examination, etc. Following table summarizes the rehabilitation items by priority area, based on the need assessment at site together with regional ID staff:

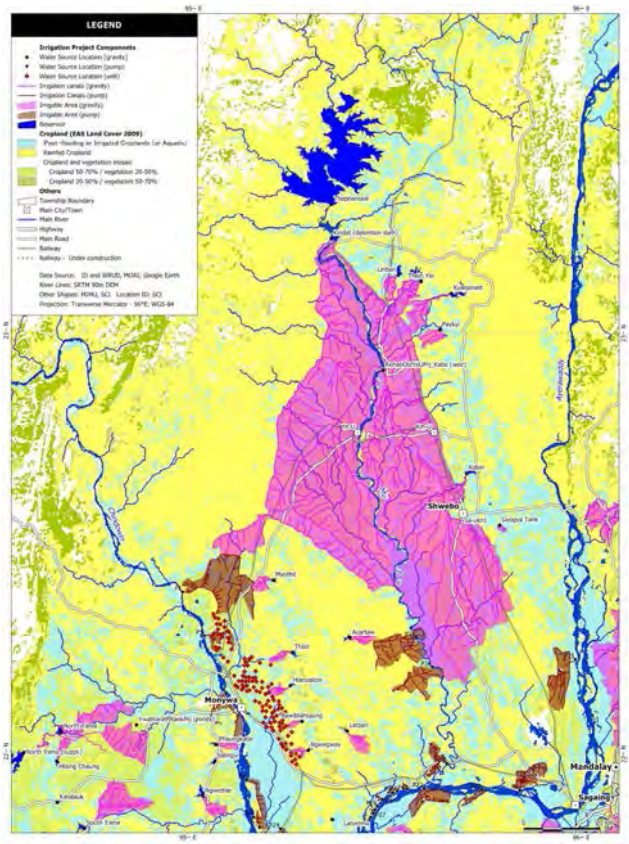


Figure 3.2.2 Priority Area of Shwebo
Source: Irrigation Department, JICA Survey Team

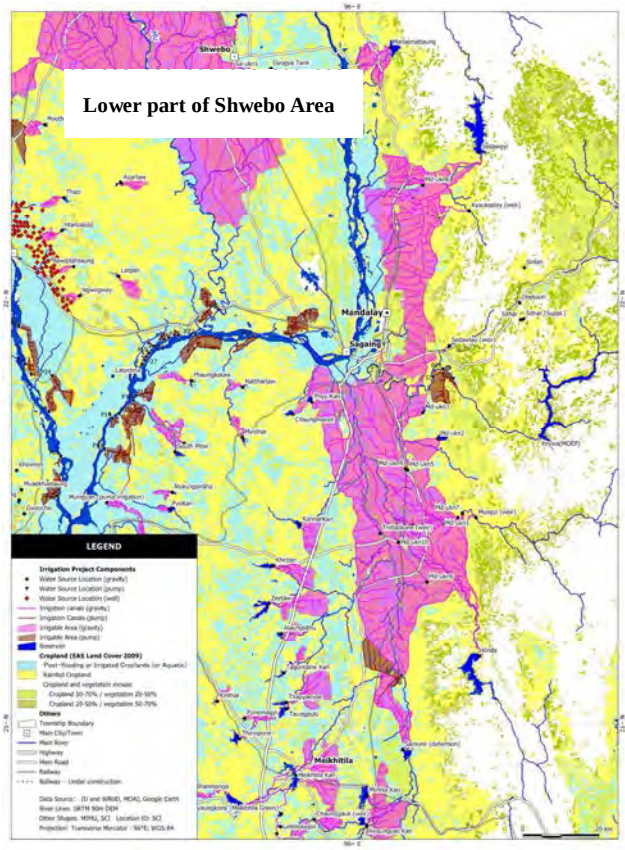


Figure 3.2.3 Priority Area of Mandalay
Source: Irrigation Department, JICA Survey Team

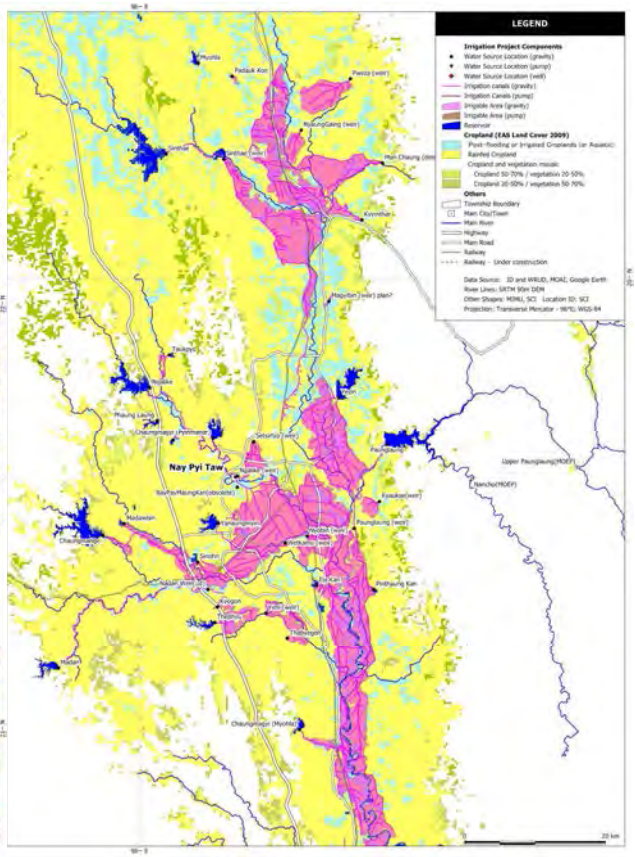


Figure 3.2.4 Priority Area of Nay Pyi Taw
Source: Irrigation Department, JICA Survey Team

Table 3.2.5 Major Rehabilitation Components by Priority Area

Region	Scheme	Irrigation System		Irrigation Facilities	Work Items
Shwebo	Shwebo Irrigation Scheme (Thapanseik Dam)	Kindat Head Works	Kindat Right Main Canal (MC) System	Head Works, Main Canal, Branch Canal	Repairing Spillway of Head Works, Repairing Gate System of Head Works, Canal Lining Work, Unsilting (Dredging) and Bank Raising Work, Repair of Canal Structure (Direct Outlet, Head Regulator, Drop etc.), Reconstruct of Canal Structure (Bridge, Spillway etc.), Upgrading of Canal Maintenance Road etc.
			Kindat Left MC (Old MC) System		
		Kabo Head Works	Kabo Right MC (Ye-U MC) System		
			Kabo Left MC (Shwebo MC) System		
Mandalay	Mandalay Irrigation Scheme	Sedawgyi Irrigation System (Sedawgyi Dam)		Head Works, Pump Station, Main Canal, Branch Canal, Reservoir (Water Tank)	Repairing Gate System of Head Works, Repairing Pump & Operation System, Canal Lining Work, Canal Slope Protection (Gabion) Work, Repair and Reconstruct of Canal Structure (Direct Outlet, Drainage Syphon, Bridge, Box Culvert etc.), Upgrading of Canal Maintenance Road, Unsilting (Dredging) of Reservoir etc.
		Zawgyi Irrigation System (Zawgyi Dam)			
		Kinda Irrigation System (Kinda Dam)			
Nay Pyi Taw	Nay Pyi Taw Irrigation Scheme	Sinthe Dam Irrigation System		Head Works, Main Canal, Branch Canal Drainage Canal	Repairing Gate System of Head Works, Canal Lining Work, Earth Work(Canal Embankment), Repair and Reconstruct of Canal Structure (Direct Outlet, Bridge, Drop etc.), Upgrading of Canal Maintenance Road, Unsilting (Dredging) of Drainage Canal etc.
		Yezin Dam Irrigation System			
		Paunglaung Dam Irrigation System			
		Ngalaik Dam Irrigation System			

Source: JICA survey team based on rehabilitation needs and quantity submitted by ID maintenance offices.

3) Current Irrigable Area and Potential Expansion

Current irrigation system serves monsoon paddy summer paddy. The system provides supplemental water to the monsoon paddy and the full requirement irrigation water for the summer paddy. During monsoon season, practically all the areas cultivates monsoon paddy while only the area provided with irrigation water can cultivate summer paddy. Note that though pulses and beans are cultivated during winter, they are not irrigated and grow under residual moisture.

Each irrigation system has scrutinized irrigable area provided by DALMS (former SLRD),within which irrigation water is provided as large area as possible during monsoon season while during summer season the irrigable area varies by year depending upon the water availability stored in dam at the beginning of dry season. Following table indicates scrutinized irrigable area by scheme, monsoon paddy area irrigated, summer paddy area irrigated, and those ratios against scrutinized area, and the ratio of the 2 seasons paddy:

Table 3.2.6 Irrigated Paddy Area and Potential to Increase Summer Paddy Cultivation Area

Project Area	Dam	Irrigable Area	Monsoon Paddy	Summer Paddy	M. Paddy	S. Paddy	Ratio	SP to Increase
		Scrutinized, acre	acre	acre	% ag/ Sc A	% ag/ Sc A	SP / MP	
Shwebo	**Thapanseik Dam**							
1.1	Kindat Right MC	104,915	98,785	54,354	94%	52%	55%	-
1.2	Kindat Left MC	65,105	64,034	34,080	98%	52%	53%	-
1.3	Kabo Right MC (Ye-U)	115,029	115,088	71,102	100%	62%	62%	-
1.4	Kabo Left MC (SMC)	206,638	207,550	114,550	100%	55%	55%	-
	Total	491,687	485,456	274,086	99%	56%	56%	1.194
Mandalay								
2.1	Sedawggyi	96,079	81,257	73,419	85%	76%	90%	0.501
2.2	Zawgyi	82,333	71,208	26,915	86%	33%	38%	1.998
2.3	Kinda	147,274	100,831	38,310	68%	26%	38%	1.679
	Total	325,686	253,295	138,644	78%	43%	55%	1.404

Project Area	Dam	Irrigable Area	Monsoon Paddy	Summer Paddy	M. Paddy	S. Paddy	Ratio	SP to Increase
		Scrutinized,	acre	acre	% ag/	% ag/	SP / MP	
Nay Pyi Taw								
3.1	Sinthe	32,400	12,730	6,890	39%	21%	54%	1.414
3.2	Yezin	15,850	9,710	5,231	61%	33%	54%	1.538
3.3	Paunglaung (35,000ac design)	35,000	4,106	3,284	12%	9%	80%	NA
	Paunglaung after completion		28,000	14,000	80%	40%	50%	NA
3.4	Ngalaik	25,190	17,506	7,213	69%	29%	41%	0.938
	Total	108,440	44,051	22,619	41%	21%	51%	1.270
	Total (Paunglaung aft completion)	108,440	67,945	33,335	63%	31%	49%	-

Source: JICA survey team, estimated based on data provided by ID Maintenance Divisions. Note: Monsoon paddy and summer paddy here mean that the area the irrigation system has irrigated actually. The figures are average based on for the last 14 to 15 years data, mostly 2000/01 to 2014/15.

As indicated above, for the Shwebo area, monsoon paddy irrigated covers almost all the scrutinized area and the summer paddy is cultivated with irrigation at 56% of that of scrutinized area. In case of Mandalay, monsoon paddy is planted at an area of about 78% of the scrutinized area and the summer paddy shares 43% of the scrutinized area. For Nay Pyi Taw, with the present condition where Paun Laung is not yet completed, monsoon paddy is cultivated at an area of 41% while that of summer paddy occupies 21%. With the Paung Laung scheme completed, the irrigated areas will increase to 63% and 31% respectively for monsoon and summer paddy, on condition that half of the monsoon paddy area is planted summer paddy.

At the right most column of above table, potential expansion of summer paddy area is indicated. The potential expansion was estimated by conducting dam operation simulation based on the last 15 years data of dam remaining water at the beginning of dry season, monsoon paddy area irrigated, summer paddy area irrigated, and ID standard water requirement of paddy. According to the simulation, the ratios of potential expansion of summer paddy area are; 19%, 40%, 27% for Shwebo, Mandalay and Nay Pyi Taw respectively. This expansion of summer paddy area is realized with the irrigation system rehabilitated.

4) Outline of the Component

Project Name	No.2 Irrigation Rehabilitation			
Project Purpose	To increase agriculture productivity through rehabilitation of aged irrigation facilities and establishment of nationalized water management.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	
Target Area	Shwebo area (491,687 acre), Mandalay area (325,686 acre) Nay Pyi Taw area (108,440 acre)			
Implementing Organization	ID (MOAI)			
Support Organization	DOA (agriculture extension)			
Beneficiaries	Farmers in the irrigation systems to be rehabilitated			
Development Effect	Increase of agricultural production of such crops as paddy, pulses and sesame, Rationalized water management associated with the improvement of irrigation facilities			
ODA Scheme/ cost	Project Loan		Shwebo	10.1 billion JPY
			Mandalay	15.4 billion JPY
			Nay Pyi Taw	4.0 billion JPY
Duration of the Project	4-6 years depending on the project size (first year for detail design while the remaining years are for rehabilitation works)			

Source: JICA Survey Team

3.2.3 Polder and Drainage Improvement (Ayeyarwady)

1) Rationale

In Ayeyarwady delta area, first priority is to protect farmland from inundation and flooding caused by

much rainfall reaching over 3,000 mm per annum and also by the rising river water during monsoon period. In fact, irrigation is not required in this season. The delta area has rather experienced increase of and volatile rainfall pattern, increase of river peak discharge, cyclone including Nargis, which occurred in 2008, and further increase of saline water intrusion along coastal areas associated with sea water rise, an effect of global warning and climate change.

Irrigation is practiced during summer season mostly in mid areas of the delta, and the irrigation method here is to depend on the change of river water level by tidal effect. When the river water goes high, sluice gates installed along a polder is opened and withdraw river water for irrigation purposes. It means most of the canals in this delta area work as drainage as well as delivering of irrigation water, discharging dual purposes.

In any of the above case, periodical dredging is very much needed; however, due to the shortage of maintenance budget, there are sedimentations in the drainage canal unable to drain excessive water. Silted canals can hardly deliver irrigation water during summer season either. Also, there are number of sluice gates already aged and they need replacement and/or rehabilitation. Further to the needs, embankment of the polders should also be strengthened where settled or eroded. To keep and improve the agricultural production, polder and drainage should be improved.

2) Primary Target Area within Ayeyarwady Delta

Ayeyarwady delta is broadly divided into 3 areas; 1) upstream area, 2) middle delta area, and 3) downstream or coastal area (see figure right). The major concern for the upstream area is flood as experienced in late July and early August 2015 while in the mid stream area the concern is prolonged inundation. In and along the downstream and coastal areas, the primary concern is saline water intrusion as well as inundation associated with monsoon rainfall and high tide. With respect to paddy production, monsoon paddy is extensively cultivated except for deep inundation areas where retarding cultivation is often practiced, for which paddy is planted after October or November with the receding of flood water.

Figure 3.2.5 Division of Ayeyarwady Delta
Source: JICA Survey Team (2015)

Summer paddy is more cultivated in middle delta area as summarized in the following table. This is because there are not many streams in the upstream area, and due to the relatively higher ground elevation, irrigation can only be practiced by a means of pump. On the other hand, tidal irrigation is practiced to large extent in the middle area, which may provide large potential of further increasing the paddy production. In the downstream areas, saline water intrusion hinders summer paddy cultivation in which relatively large investment is required to further promote agriculture production increase. Therefore, the Polder and Drainage improvement component will primarily target the middle part of delta.

Table 3.2.7 Monsoon Paddy and Summer Paddy Production in Ayeyarwady Delta

Area	Sown Area (acre)		Summer P. against Monsoon P.	Yield (bsk/ac)	
	Monsoon	Summer	Summer (%)	Monsoon	Summer
Whole Ayeyarwady	3,637,975	1,200,863	33.0%	66	93
Upstream (9TS)	838,609	87,870	10.5%	72	92
Middle (12TS)	**1,549,526**	**837,581**	**54.1%**	**69**	**93**
Downstream (5TS)	1,249,840	275,412	22.0%	59	93

Source: DOA Regional office, based on the last 5 years data (2010/11 to 2014/15)

ID maintenance division in Ayeyarwady delta has provided a list of polders, sluice gates and drainages which need rehabilitation. In fact, the data included facilities located in upstream and downstream areas; however, facilities proposed in upstream area were large scale in terms of unit beneficiary area, so that economic viability would not probably be attained. On the other hand, facilities proposed in downstream area are mostly polders which were damaged by cyclone Nargis, which means repairmen in essence whereby difficult to promote intensive agriculture production. Following table summarizes the target areas (polders and drainage):

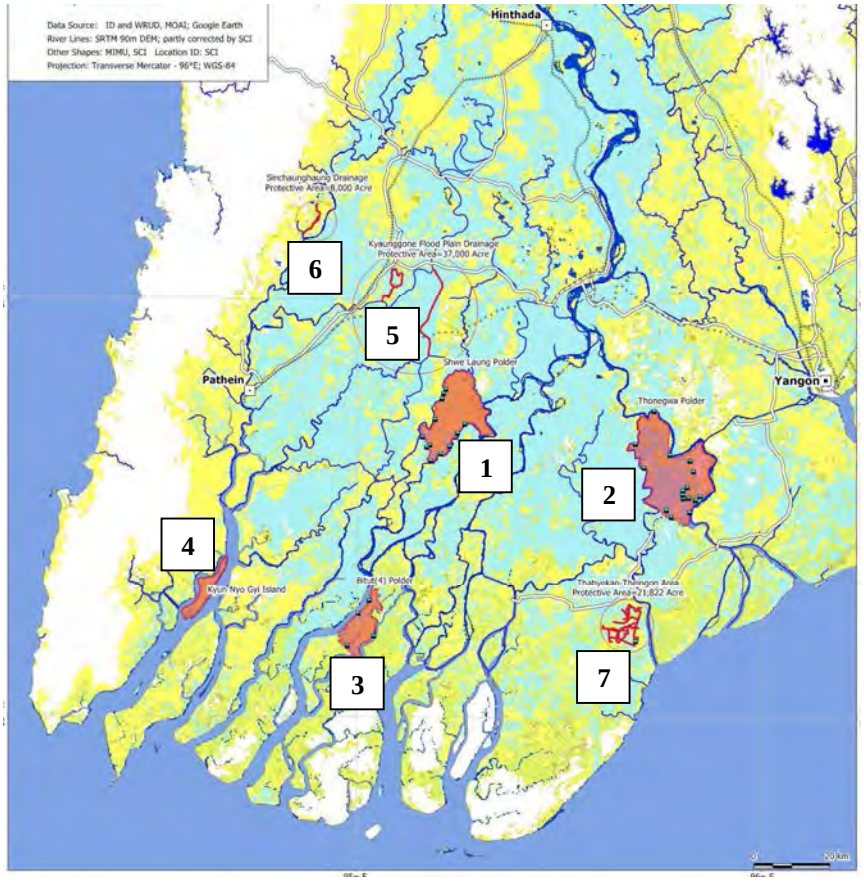


Figure 3.2.6 Target Areas in Ayeyarwady Delta

Source: ID and JICA survey Team

Table 3.2.8 Proposed Site for Polder and Drainage Improvement (Ayeyarwady)

Site Name	Work Item	Protective area (acre)	Monsoon Paddy, 1/ (acre)	Summer Paddy, 2/ (acre)
1. Shwe Laung Polder	Polder and Drainage Improvement	48,648	38,918	21,055
2. Thonegwa Polder		70,394	56,315	30,466
3. Bitud (4) Polder		25,229	20,183	10,919
4. Kyun Nyo Gyi Island		11,600	9,280	5,020
5. Kyaunggon Flood Plain	Drainage Improvement	37,000	29,600	16,014
6. Sinchaunghaung Drain		8,000	6,400	3,462
7. Thabyekan-Theingon Area		21,822	17,458	9,445
Total		222,693 (90,119.4 ha)	178,154 (72,095.4 ha)	96,381 (39,003 ha)

Note: 1/ monsoon paddy cultivated area is not available by ID, and therefore 80% of the protected area is counted as the beneficiary area of monsoon paddy. 2/ the area of summer paddy was assumed by applying 54.1% (average cultivation percentage of summer paddy against monsoon paddy in the middle part of delta) to the area of monsoon paddy.

Source: JICA survey team, based on the data provided by ID Maintenance Division, Ayeyarwady

3) Outline of the Component

Project Name	No.3 Polder and Drainage Improvement (Ayeyarwady)			
Project Purpose	To increase agriculture productivity through dredging and un-siltation of canals, rehabilitation of aged facilities, especially sluice gates, and strengthening of polder embankment			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
				○
Target Area	Ayeyarwady area (middle part of the delta)			
Implementing Organization	ID (MOAI)			
Support Organization	DOA (agriculture extension)			
Beneficiaries	Farmers in the polder systems to be rehabilitated			
Development Effect	Increase of production of monsoon paddy and summer paddy.			
ODA Scheme/ cost	Project Loan		Ayeyarwady	4.2 billion JPY
Duration of the Project	5 years			

Source: JICA Survey Team

3.2.4 Land Consolidation

1) Rationale

Farmland consolidation consists of several works such as enlargement and rearrangement of farmland plots, establishment of irrigation and drainage canals, and farm road construction. In Myanmar context, there are few tertiary level canals in an irrigation area. Irrigation for paddy is mostly carried out plot-to-plot irrigation, making it difficult to carry out proper water management. Further, without farm road, agriculture machineries can not proceed into his/her farm plot located behind the other farmersô plots. Thus, the present condition of the farmland hinders the promotion of farm mechanization, though it is urgently required facing the labor shortage in rural areas.

Farmland consolidation, as aforementioned, constructs farm road together with tertiary level irrigation canal as well as drainage canal, both of which should run in parallel with the farm road side by side. This arrangement facilitates the speed-up of farm mechanization and also rationalized water management, together leading to high productivity of farm produces. Land consolidation therefore primarily aims at ensuring high productivity for agriculture supported by effective mechanized farming and proper water management to meet intensive agricultural requirements.

Under farmland consolidation, furthermore, each farm plot will be once accumulated and re-plotted in a rectangular shape; this is why each of the beneficially farmers will have to reallocate their farmland upon mutual agreement among them. Reallocation works of farm plots are of very importance since farmland is the principal asset for every farmer; their farm plots have to be exchanged and sometimes combined towards achieving highly productive farmland as a whole. Thus, the reallocation plan should be carefully examined, wherein full consensus from all the beneficiaries should be obtained before the commencement of the construction works.

2) Major Works under Land Consolidation

Following flowchart shows the major work activities and the flow applied under a typical farmland consolidation project. To implement a farmland consolidation in Myanmar, ID (Irrigation Department), DALMS (former SLRD), AMD (Agriculture Mechanization Department) are the major implementers for construction of farm road together with irrigation and drainage canals, land leveling, and plot-reallocation respectively. Farmerôs organization should also be established prior to the commencement of physical construction, in order to agree the land re-allocation and also to surrender a part of farm land for the construction of farm road and canals (usually 6 ï 12%).

The land re-allocation and also the surrender[2] of a part of farm land are the critical issue in the land consolidation work. In fact, it takes in most cases more than half a year to settle these issues by and among the farmer members of the beneficiary area. The responsible organization in charge is DALMS, and the office facilitate the farmer origination to establish farm plot reallocation plan and its implementation, and also conduct the farmland area survey upon completion of consolidation works, and issue registration certificate for the use right of newly allocated farmland.

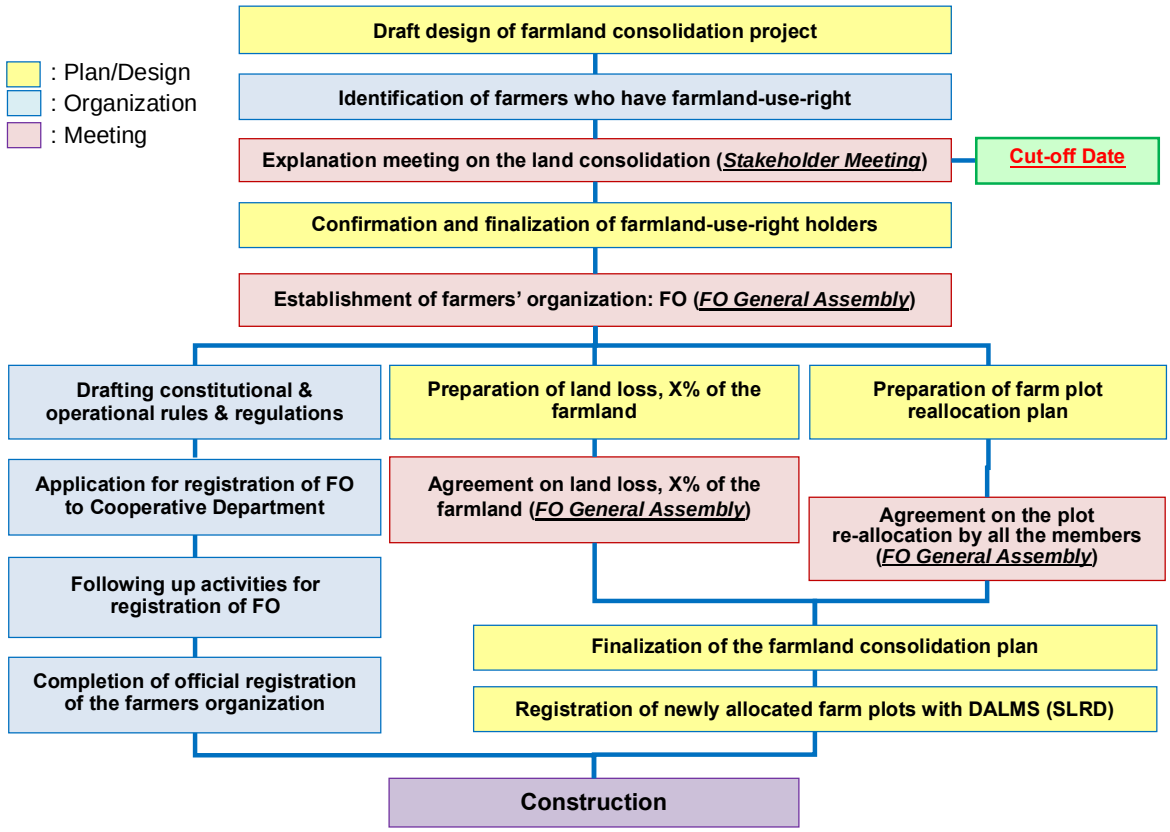


Figure 3.2.7 Implementation Flow of Land Consolidation Project

Source: Preparatory Survey for the Project of Rehabilitation of Irrigation Systems, JICA (2014)

3) Area to be Implemented

Land consolidation will be implemented in all the 4 priority areas as large scale pilot case. Land consolidation requires a unit investment cost ranging from 2,000,000 to 4,000,000 Kyats per hector (direct cost only). This unit investment cost seems not so big while the farm land area extends over huge irrigable area. Therefore, to implement the land consolidation covering all the irrigable area in the priority areas at once can hardly be done. Therefore, this component will implement land consolidation as pilot basis in easily accessible places from rural and canal maintenance roads.

Following table shows the planned consolidation area by priority area, ranging from 1,000 ha (2,500 acre) in case of Nay Pyi Taw to as large as 4,000 ha (about 10,000 acre) in case of Shwebo and

[2] With this surrendered farmlands, farm road and tertiary level irrigation canal and drainage are to be constructed. The ownerships of these facilities are not clear under the present law of Myanmar. In principle, such facilities should belong to the farmers organization legally established for the land consolidation area, and the organization should be in charge of the operation and maintenance of the facilities. However, in Myanmar at present, such legally established organization can not possess the land property or sole right of use, yet the government organizations, e.g. ID, is of opinion that the facilities should be maintained by the famer organization and ID should not enter such private property unless otherwise the organization requests such maintenance works. There should therefore be an urgent need to establish necessary law, with which the farmer organization legally established can/ should have such right of officially possessing the agriculture related infrastructure (or the sole right of use).

Ayeyarwady. The planed area is commensurate to approximately 2% of the whole irrigable area except Ayeyarwady where about 4% of the beneficial area is planned for the land consolidation taking into account the large extent of the farm land in the delta area, outside of the project area. It is also noted that INDIA will implement land consolidation in Mandalay and Nay Pyi Taw and IFAD in Nay Pyi Taw, starting from early 2016. IFAD is also planning to include land consolidation component in a project[3] to be started in 2016 in Ayeyarwady delta.

Table 3.2.9 Planned Quantities of Land Consolidation Area

Priority Area	Total Area, (acre)	Total Area, (ha)	LC Area, (ha)	LC Area (acre)	Ratio	INDIA (acre)	IFAD (acre)
Shwebo	491,687	198,976	4,000	9,900	2.0%	-	
Mandalay	325,686	131,799	3,000	7,400	2.3%	12,300	
Nay Pyi Taw	108,440	43,883	1,000	2,500	2.3%	12,500	10,000
Ayeyarwady	222,693	90,119	4,000	9,900	4.4%		under prepa n
Total	1,148,506	464,777	12,000	29,700	2.6%	24,800	10,000

Source: JICA Survey Team, for donor projects; from Planning and Works of ID (2015)

One pilot site of the land consolidation is set from 100 acre to 300 acre, 40 ha to 120 ha, approximately, based on similar pilot projects of land consolidation. Therefore, the numbers of sites where land consolidation is to be demonstrated are approximately 50, 40, 10 and 50 respectively for Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady. The land consolidation recommended here is to cover only 2 to 4 % of the whole farmlands in the area, so that to show the demonstration effect, the sites should be selected from such potential areas; 1) alongside main irrigation canals which always have maintenance road, presenting good access to the farmers, and 2) alongside rural roads running within the irrigable area. Of them, further, such roadsides, which can lead to towns where number of rice millers are located, should be given higher priority.

3) Outline of the Component

Project Name	No.4 Land Consolidation			
Project Purpose	To improve agriculture productivity and accelerate farm mechanization through land consolidation where farm road and irrigation and drainage canals are constructed together with re-shaping and allocation of farm plots			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	○
Target Area	Shwebo area, Mandalay area, Nay Pyi Taw area, and Ayeyarwady area 4,000, 3,000, 1,000, and 4,000 ha respectively. Note that one consolidation site is set from 40 to 120 ha each.			
Implementing Organization	ID (construction of farm road & canals), AMD (land leveling), DALMS (former SLRD, land reallocation and certificate issuance of new farm plot holding)			
Support Organization	DOA (agriculture extension), Cooperative Department (farmer organization establishment legally)			
Beneficiaries	Farmers			
Development Effect	Increase of agricultural produces such as paddy, pulses and sesame, Speed-up of farm mechanization, Rationalized water management associated with tertiary canal and drainage establishment.			
ODA Scheme/ cost	Project Loan	Shwebo (4,000 ha)	2.7 billion JPY	
		Mandalay (3,000 ha)	2.1 billion JPY	
		Nay Pyi Taw (1,000 ha)	0.7 billion JPY	
		Ayeyarwady (4,000)	2.7 billion JPY	
Duration of the Project	4-5 years in parallel with irrigation rehabilitation (polder and drainage improvement in Ayeyarwady area)			

Source: JICA Survey Team

[3] Delta Agricultural Resilience Project. As of October 2015, a concept document was prepared and the project is expected to start from October 2016.

3.2.5 Agricultural Machinery Station Enhancement (Shwebo, Nay Pyi Taw, Ayeyarwady)

1) Rationale

According to farmers in many places where agriculture activity and production are high, labor competition has already started among industries, for example weaving industry in Shwebo and urban construction moving for Yangon from Ayeyarwady. This shortage of farm labors results in wage increase of the farm labors. As is known already, population pyramid in Myanmar including rural population has also shifted to the constructive type, and labor shortage will be more serious in near future.

In addition, as industry sector grows more in urban areas, labor shortage in rural area becomes more serious. Shifting from the labor intensive agriculture to the capital intensive agriculture is needed through farm mechanization in each farming activities such as plowing, harrowing, planting and harvesting. AMD has installed Agricultural Mechanization Station in many townships of the country, and in the priority areas, most of the townships have been provided with the station as summarized in the following table:

Table 3.2.10 Agricultural Mechanization Stations in the TSs of Priority Areas

Agricultural Mechanization Station		Tractor			Combine
Region/State	Township	New	Old	Total	Harvester
Sagaing	Shwebo	10	8	18	9
	Wetlet	10	9	19	4
	YeU	10	9	19	10
	Kambalu	10	8	18	10
	Total	40	34	74	33
Mandalay	Patheingyi		9	9	7
	Madaya		9	9	13
	Kyaukse	10	4	14	
	Sintgaing		8	8	
	Myittha		33	33	11
	Tada-U		7	7	
	Wundwin	10	7	17	8
	Total	20	77	97	39
Nay Pyi Taw	Tatkone	15		15	5
	Pyinmana	25		25	
	Lewe	26		26	
	Total	66	0	66	5
Ayeyarwaddy	Myaungmya	10	13	23	10
	Wakema		10	10	5
	Mawlamyinegyun		7	7	2
	Pantanaw	10	3	13	5
	Nayungdon		10	10	5
	Pathein	10	5	15	9
	Kyaungon		10	10	7
	Kyaiklatt		5	5	8
	Total	30	63	93	51

Source: AMD (2015)

The component intends to promote farm mechanization further through demonstration of farm machineries at the above existing stations (no additional station is planned). The demonstration includes mainly such machineries used for paddy production, and in addition for pulses, so as to prepare farmland using tractor and different kind of attachments such as ridger, dozer and deep plow. In fact, 90 HP-tractor is very important in land consolidation work since this is used for land levelling. Therefor the 90-HP-tractor is provided more as compared with similar projects. Furthermore, rice trans-planter should also be provided as demonstration to encourage transplanting using nurseries

grown in seed bed.

This program component is planned to implement in Shwebo area, Nay Pyi Taw and Ayeyarwady areas where farm mechanization demonstration is highly needed. In fact, there are 3 stations already in Nay Pyi Taw, to which donors have contributed a lot. In this Nay Pyi Taw area, one of the existing station should be given a function of machineries testing center, so that Nay Pyi Taw is still selected for this component (for detail, refer to the following discussion).

In Mandalay area, there are number of sales agents operating in Mandalay city, so that farmers in Mandalay area can access those sales agent and also obtain some technical advices from the sales agent. On the other hand, Shwebo area is expected to accelerate the mechanization due to the large extent of the farm land, and in Ayeyarwady area cattle drafting has decreased since the Nargis disaster, which wiped away a large number of animals. The following table shows the quantities of input under this component.

Table 3.2.11 Quantities of Input under Agricultural Machinery Station Enhancement

Description	No.	Remark
Tractor (70HP, w/ rotary)	30	per each priority area
Tractor (90HP, w/ rotary)	25	
Combine Harvester	10	
Transplanter	2	
Attachment (ridger, dozer, deep plow, etc.)	1 Lump sum	
Spare Parts	1 Lump sum	

Source: JICA Survey Team

2) Need to establish a Machinery Testing Center (Nay Pyi Taw)

Purchasers of agricultural machineries such as hand tractors/ attachments, 4-wheel tractors/ attachments, combine harvesters, trowllergy and multi-purpose diesel engines very often face technological problems. Some imported brand-new machines cannot perform as shown in the specifications; e.g. less power output, low durability, poor water protection, high fuel consumption, and no guarantee by retailers/dealers. AMD is therefore requested to test performance of agricultural machineries and issue certificates to each model for the protection of purchasers from copycat products.

Especially, in order to ensure that the end-users of TSL, who intend to buy farm machineries with the loan approved, can be satisfied with machines they have purchased, it is recommended that the AMD strengthens the activities of AMD Quality Division by having and operating an Agricultural Machinery Testing Center. The activities of the Center are proposed as follows:

- ✓ Model Inspection: According to requests by dealers, manufactures and import merchants, AMD should conduct the following tests at least with the equipment shown the table further below:

Table 3.2.12 Contents of Model Inspection

Target Machinery / Check Items	Hand Tractor	4-Wheel Tractor	Combine Harvester	trowllergy	Diesel Engine
Structural Diagnose	Yes	Yes	Yes	Yes	Yes
Safety Check	Yes	Yes	Yes	Yes	No
Engine Exhaust Analysis & Fuel Consumption	Yes	Yes	Yes	Yes	Yes
PTO Shaft Output	Yes	Yes	No	No	Yes (crank shaft)
Traction Power	Yes	Yes	Yes	Yes	No
Hydraulic Lifting Power	No	Yes	Yes	No	No
Water/Dust Protection	Yes	Yes	Yes	No	No
Operational Diagnose	Yes (attachments)	Yes (attachments)	Yes (harvest test)	No	No

Source: JICA Survey Team referring to Agricultural Mechanization Research Institute, MAFF, Japan

Table 3.2.13 Equipment for Agricultural Machinery Testing Center

Item No.	Equipment Name	Major Technical Specifications	Quantity	Remarks
1	PTO Dynamometer with Joint & Necessary Materials	120kW	1	For PTO Output Test
2	Axle Dynamometer (for Left and Right Wheels) with Joint & Necessary Materials	170kW	1	For Engine Output Test at Final Gear Axles
3	Engine Dynamometer with Engine Table, Joint & Necessary Materials	120kW	1	For Engine Output Test at Crank Shaft
4	Cooling Tower with Water Pump and Plumbling Materials	500lit/min	1	For Cooling Dynamometers by shared usage
5	Dynamometer Car	30kN·m	1	For Traction Power Test
6	Truck Scale	15ton	1	For Structure Diaglose
7	Measurement and Tool Kits		1	For Water and Dust Protection and Other Tests

Source: JICA Survey Team

- ✓ Issue of Acceptable Certificate: AMD will inform testing results to the applicants and issue the acceptable certificate/ plates to each model, and the applicants can put the certificate plates on the machines.
- ✓ Share of Technical Information: AMD will inform acceptable models with testing results on a website. At the same time, AMD will provide information of acceptable models to MADB for TSL provision. MADB will utilize the technical information of agricultural machineries to evaluate credit cases.
- ✓ Legal System: AMD will prepare for an Agricultural Mechanization Act to support the efficient and sustainable dissemination of agricultural machineries.

3) Activities of the Component

The project is to enhance the existing farm mechanization station under AMD by providing new farm machineries and demonstration. In addition, a tractor station in Nay Pyi Taw should be given an additional task which is the role of machineries testing center with necessary equipment provided:

- ✓ Procurement of farm machineries for paddy as major one such as tractor, combined harvester, tillers, and also for pulses, beans, oil crop and vegetables to some extent,
- ✓ Demonstration of farm machineries through farmer field school approach,
- ✓ Improvement of maintenance skills for the various farm machineries,
- ✓ Accumulation and sharing of data for reduction in production cost through farm mechanization,
- ✓ Provision of machinery service to farmers, and
- ✓ Establishment of a machinery testing center in Nay Pyi Taw

3) Outline of the Project

Project Name	No.5 Agricultural Machinery Station Enhancement			
Project Purpose	To promotion of Farm Mechanization through demonstration of machineries at agricultural machinery station			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○		○(testing center)	○
Target Area	Agricultural Mechanization Station in Shwebo (Shwebo Station, Wetlet Station, Ye-u Station and Kamdalu Station) Agricultural Mechanization Station in Nay Pyi Taw area, to be equipped with a testing function. Agricultural Mechanization Station in Ayeyarwady middle part area (Wakema Station, Luputta Station, Maupin Station, Kyaungon Station, Kyiklatt Station			
Implementing Organization	AMD (MOAI)			

Project Name	No.5 Agricultural Machinery Station Enhancement		
Support Organization	MRF (MRIA, MFA, etc.), AMDB for TSL		
Beneficiaries	Farmers, AMD (AMD Quality Division), dealer, importer and manufacturers		
Development Effect	Reduction in production cost, On-time cultivation timing irrespective of farm labor shortage, Quality improvement of rice, pulses and oil crops.		
ODA Scheme/ cost	Project Loan	Shwebo/ Ayeyarwady	486 million JPY each
		Nay Pyi Taw	486 plus 362 (test center)=849 Milli. JPY
Duration of the Project	2 years		

Source: JICA Survey Team

3.2.6 Agricultural Machinery Dissemination (2 Step Loan)

1) Rationale

In Myanmar, there are two banks mainly targeting agricultural sector; Myanmar Agricultural Development Bank (MADB) and Global Treasure Bank (GTB; former ñMyanmar Livestock and Fisheries Bankò). GTB provides a short-term loan especially for fishery and livestock, and MADB provides two kinds of loan for farmer; ñTerm Loanò and ñSeasonal Loanò. The former is 1-3 years loan for equipment investment including procurement of farm machineries. The latter is annual loan for agricultural investment into, e.g., seeds, fertilizers, chemical pesticides and farm labor, limiting 100,000 Kyat/acre for paddy and 20,000 Kyat/acre for other crops. The loan products of MADB and GTB are shown in the follow table:

Table 3.2.14 Loan Products of MADB and GTB

Bank	MADB				GTB
Products	Seasonal Loan			Term Loan	Short-term Loan
	Monsoon (Apr-Aug)	Winter (Sept-Dec)	Pre-monsoon (Jan-Feb)		
Purpose	Working capital/ cultivation	Working capital/ cultivation	Working capital/ cultivation	Working capital, investment (farming machinery, etc.)	Working capital and/or investment
Eligible borrowers	1) The owners of land (cultivation right) certificate issued by the Land Record Department (LRD-MOAI). Illegal farmers who cultivate the "forestry area" are not allowed to apply for the MADB loan. 2) Farmers of rice, maize, pulse and beans, oilseed crops, cotton, jute, mustard, sugar cane, groundnut, sesame, etc. Vegetable, fruits, spice are not eligible. 3) In case of "Term Loan", the eligible farmer is a farmer who has agricultural land of more than 5 acre.				**Fishery**: License holder of Fisheries Department **Livestock**: Applicant's land needs to be registered at LRD-MOAI **Fishery and livestock**: Recommendation letter from Livestock & Fisheries Department of Ministry of Livestock &Fisheries.
Maturity	1 year or less	1 year or less	1 year or less	1 - 3 years	1 year or less

Source: Preparatory survey on two-step loan project for agriculture and rural development in the Republic of the Union of Myanmar: final report (JICA, 2014)

For agricultural machineries, according to interview survey to the farmers, they need loan program with long-term and low interest rate to procure farm machineries. Farm machineries include such as tractor and its attachments, combine harvester and irrigation pump. As mentioned above, population pyramid in Myanmar including rural areas has shifted to the constructive type, and labor shortage will be more serious in near future, the need of farm mechanization therefore will become higher especially in rural areas.

For agricultural input, on the other hand, according to a Household Survey conducted by JICA Survey Team (2015)[4], the farmers in the project areas invest an average amount of 170,442 Kyat/acre, 175,173 Kyat/acre, and 95,656 Kyat/acre for monsoon paddy, summer paddy, and winter pulses respectively.

[4] JICA Survey team conducted household survey in August - October 2015, covering total 296 sample households in the 4 project area. Note that the sample no. in Shwebo is 121, in Mandalay is 115, in Nay Pyi Taw is 89, and in Ayeyarwady is 87.

Some sampled farmers replied lack of agriculture finance as their one of major problems in their farming. In fact, one of the interviewed farmers reported that he needs at least 300,000-350,000 Kyat/acre for agricultural investment.

To promote farm mechanization and agricultural extension like GAP, it is necessary to provide access-friendly loan program for farmers, so that they can well prepare for their farming and also procure farm machineries coping with nowadays labor shortage.

In 2014, there was a preparatory survey on two-step loan for agriculture and rural development conducted by a JICA survey team. This survey intended to formulate a loan lending plan from JICA into two-step loan for Term Loan of MADB. In this survey report, the necessity of access-friendly loan program for farmers was also pointed out. The essential point of this survey is summarized in the box. The farmers need to access such loans to improve their farming activities.

Points identified under the Preparatory Survey (2014)

- ✓ Types of investments to be financed: purchasing of farming machinery, investments for agribusiness production (e.g. machinery, cultivation rights for farming land/land use rights & buildings).
- ✓ Maximum financing: - Farmers: MMK 50 million, Agribusinesses: MMK 500 million
- ✓ Approval authority for each sub-loan: Loan Department of MADB (in accordance with the practice applied by MADB in the case of its ñTerm Loanò)
- ✓ Interest rates: 8.5% per annum
- ✓ Maturity and grace period: The sub-loan maturity shall be 1 to 5 years, and the grace period shall not exceed 1 year.
- ✓ Repayment schedule: The principal and interest shall be repaid every 6 months.
- ✓ Collateral and guarantor: In principle, this condition shall comply with the relevant instructions of CBM, banksô general practices and MADBôs practice, but some relaxed conditions could be adopted in the TSL project.
- ✓ Documents required from loan applicants: Requirements for documents shall comply with the current practice of the PFI. For example, farmers who apply for a MADB loan are required to submit a land certificate issued by MOAI-LRD (Land Registration Department) to MADB.

Source: Preparatory survey on two-step loan project for agriculture and rural development in the Republic of the Union of Myanmar: final report (JICA, 2014)

2) Activities of the Project (MADB)

Two-step loan is applied to develop access-friendly loan service program for the farmers who face labor shortage and to increase farm productivity. Major activities are as follows:

- ✓ Development of loan program based on usersôneeds,
- ✓ Establishment of formality and eligibility check system,
- ✓ Establishment of overall evaluation by; 1) Financial Analysis, 2) Non-financial Analysis, and 3) Project evaluation,
- ✓ Assisting loan applicants in building the farmersôbusiness plan,
- ✓ Speed up of approval and loan procedure, and
- ✓ Development of human resources for bank staff, and extension services.

3) Summary of the Program Component

Project Name	No.6 Agricultural Machineries Dissemination (Two Step Loan)			
Project Purpose	To promotion farm mechanization through provision of loan program, with which farmers purchase farm machineries in addition to prepare for farm input.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	○
Target Area	All the townships within the irrigation schemes (polders in Ayeyarwady area) of 4 priority areas			
Implementing Organization	Myanmar Agriculture Development Bank (MADB)			
Support Organization	Union of Myanmar Federation of Chambers of Commerce & Industry(UMFCCI), Ministry of Agriculture and Irrigation(MOAI)			
Beneficiaries	Farmers who intend to purchase farm machineries			
Development Effect	On-time farm preparation with the farm machineries, Reduction in farming time, Reduction in costs, Reduction in post-harvest losses			

ODA Scheme/ cost	Two-Step Loan	Project Cost	Total 5 billion JPY
Duration of the Project	5 years		

Source: JICA Survey Team

3.2.7 Flood Monitoring System Establishment (Shwebo, Ayeyarwady)

1) Rationale

In late July and early August 2015, serious flood had occurred in Myanmar. The flood hit 12 of Myanmarôs 14 states and regions. Shwebo Area in Sagaing was also affected by the flood, which came from the north-east side of mountainous area to the south-west direction. Old Main Canal (OMC) located at Kanbalu and Khin-U townships was especially affected, and some reaches of the irrigation canal were damaged and bleached. Figure 3.2.8 shows the OMC (dotted red line), which was partly affected and damaged by the flood. Also, flood took place in Ayeyarwady delta area, especially in its upstream areas due to swollen river water.

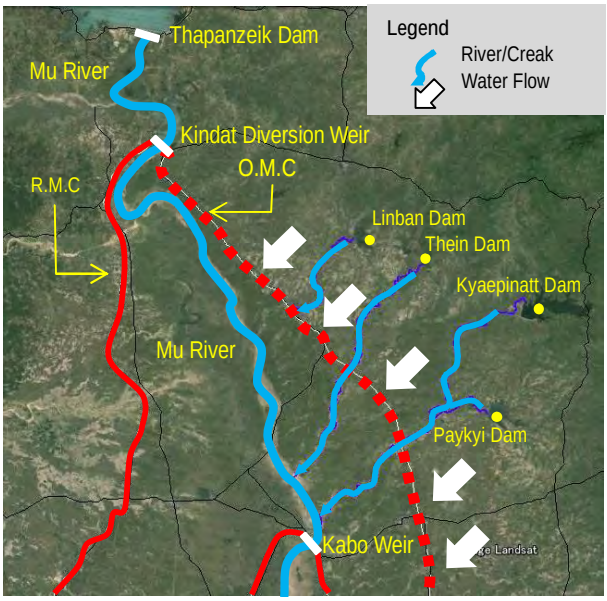


Figure 3.2.8 Damaged by Flood in Shwebo

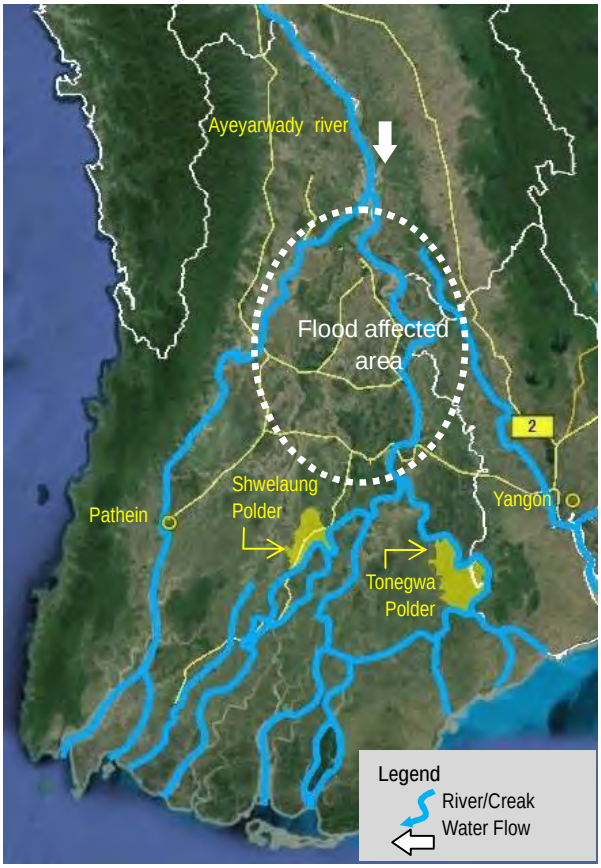


Figure 3.2.9 River System in Ayeyarwady Delta

The current monitoring system only measures the rainfall and water level at the dam site by ID. There are no rain gauge and water level stations in the catchment area. Even at the dam site monitoring, these data have been monitored and recorded manually by ID staff at each of the dam sites, and have been recorded by ID Maintenance office in charge. However, in such areas where the access road condition is not good during monsoon period due to muddy road, the data cannot be easily collected on-time. These monitored data are always shared after the heavy monsoon period has finished.

One of the reasons for flood damage occurred seriously in remote areas is the lack of hydro-meteorological monitoring station for rain gauge and water levelôs data by real-time aiming for reference of dam operation and flood alert in advance. In addition, no operational rule for dam during or prior to flood period has not ben established, which could support the staff in charge of dam operation based on forecasting of the flood condition. This lack of operation rule may be another reason, by which flood damage becomes larger.

Under these situations, there is an urgent need to install a flood monitoring system such as rain gauge, water level station, data transmitting system, and recording and analyzing system. There is also a need of establishing a flood forecasting and alert system, which can inform the population in rural areas in advance. In addition, installation of water level stations along main canals with associated monitoring system could contribute to equal and appropriate water distribution in irrigated area not only during the monsoon period but also during summer period.

2) Improvement Works and Activities

The purpose of this component is to install a hydro-meteorological and flood monitoring system in Shwebo and Ayeyarwady area. Current condition to monitor rainfall and water level is almost same as other areas, just monitored at the dam site by ID staff in charge. Introducing an automated monitoring system contributes to collecting on-time rainfall and flood information, and also contributes to an appropriate water management during dry season.

The monitoring system consists of rain gauge in the catchment area of dam site, rain gauge and water level station at the dam site, and water level stations along the main canal. CCTV (Closed-circuit Television) for dam site should be installed to monitor the dam condition visually. All the collected data should be transferred by telecommunication network through mobile phone. Note that a part of dam catchment areas may not be covered by telecommunication network yet, and in this case extension of the network should also be implemented.

In addition, Myanmar has experienced flood disaster so far several times. It is very important not only to install hydro-meteorological equipment but also establish a network which delivers flood warning alert for the purpose of evacuating rural people in advance. In current situation during flood period, ID is responsible for monitoring rainfall at dam site, river water level and polder embankment condition in Ayeyarwady delta at certain places.

Department of Meteorology and Hydrology (DMH) is, on the other hand, in charge of monitoring water levels of major rivers, forecasting flood and delivering alerting on flood in advance. Local administrations such as regional and township offices carry out direct communication with the rural people. There is a need of establishing a network and mechanism to deliver flood alert information well in advance to the rural population starting from ID and DMH, and then through local administration.

3) Outline of the Component

Project Name		No.7 Flood Monitoring System Establishment			
Project Purpose		To upgrade the current monitoring system for flood management / irrigation water management through installation of hydro-meteorological system			
Priority Area		Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
		○			○
Implementing Organization		ID (Maintenance, and Hydrological Branch)			
Beneficiaries		Farmers and villagers who are affected by flood			
Development Effect		Reduction of flood damage Reduction of maintenance cost for repapering			
System Component (Number of Installation)	Item	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	Rain Gauge (Catchment Area: (C.A.))	(6)			
	Water Level (C.A. / Dam / Canal)	6 / 4 / 42			- / - 50
	CCTV	2			
	Tele-Communication	1 LS			1 LS
ODA Scheme/ cost		Project Loan		Shwebo/ Ayeyarwady	150 Million JPY

Project Name	No.7 Flood Monitoring System Establishment
Duration of the Project	2 years

Source: JICA Survey Team

3.2.8 Plant Breeding Enhancement (Nay Pyi Taw)

1) Rationale

Agricultural export of Myanmar has not yet exploited its large potential. For the major export product, i.e., Indica rice, the export volume was only 1.0 million ton in 2013, with export market limited to China and West Africa. Vegetable, fruit, flower exports are also expected but not yet materialized due mainly to usage of low quality seed, low cultivation technique, and inadequate post harvest processing. Although whole process in value chain should be upgraded, the development of high value added variety is especially important as it is the starting point of the value chain.

Nowadays, Myanmar is on the pass of economic development, and it is important to promote the production of products which will be demanded more in accordance with its economic development. In addition to what was mentioned above, in order to respond to the domestic demand, plant breeding is required to create new varieties suited to consumer preference and environment in Myanmar while ensuring high productivity.

However, GOM faces difficulties in allocating resources in plant breeding and ends up with adopting the varieties developed by international research institutes, such as International Rice Research Institute by testing the suitability of the variety to the environment of Myanmar. Even though Myanmar has variety of plant gene resources, and GOM keeps these resources in the Seed Bank, supported by the Government of Japan in late 1980s (July 1987 for EN) for plant breeding purpose, the resources are not fully utilized. Thus, an investment in plant breeding sector should be made in order to revive and enhance plant breeding activities in Myanmar.

2) Activities of the Component

This component is to improve plant breeding capacity of the Department of Agricultural Research (DAR) located in Yezin of Nay Pyi Taw by renovating plant breeding facilities and provision of related equipment. In fact, Government of Japan assisted establishment of seed bank in the DAR in late 1980s and also provided a technical cooperation project to enhance breeding capacity of the DAR officers from 1997 to 2002. This component further enhances the breeding capacity of the DAR, and whereby contributing to the increase in agricultural productivity in Myanmar. Following activities are planned under this component:

2.1) Facilities Construction/ Renovation

There are 5 sections such as; 1) Administration, Training and Research Laboratory section, 2) Information section, 3) Seed Bank, 4) DAR divisionsô section, 5) Net House, and 6) Accommodation. These buildings were constructed under a Japanese grant aid project in late 1980s, EN agreed in July 1987, and they have been deteriorated over 20 years of service. Renovation, rehabilitation, and necessary new construction are planned.

2.2) Equipment

A varieties of equipment should be procured to be employed in such sections as; 1) Introduction laboratory, 2) Evaluation laboratory, 3) Preservation laboratory, 4) Isolation laboratory, 5) Seed Bank center, 6) Information center, 7) Training center, 8) Divisionôs annex, 9) Storage, and 10) Administration section. Equipment provided by the above grant aid project are still well maintained and operated to an extent, so that evaluation of the present equipment shall firstly be done and according to the replacement needs and also renewal needs, a set of equipment should be provided.

3) Outline of the Component

Project Name	No.8 Plant Breeding Enhancement			
Project Purpose	To improve plant breeding capacity of the Department of Agricultural Research (DAR) located in Yezin of Nay Pyi Taw by renovating plant breeding facilities and provision of related equipment.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
			○	
Implementing Organization	Department of Agricultural Research, MOAI			
Support Organization	DOA (in charge of extension)			
Beneficiaries	DAR researchers engaged in plant breeding, and also Myanmar farmers			
Development Effect	Identification of plant varieties suitable in Myanmar environment Release of plant varieties suitable in Myanmar environment			
ODA Scheme/ cost	Grant Aid		Nay Pyi Taw (DAR)	2,006 Million JPY
Duration of the Project	2 years			

Source: JICA Survey Team

3.2.9 Farm-to-Market Road (FMR) Improvement

1) Rationale

After production in the farmland, the produces have to be delivered to the farmers house yard, or in some cases traders come to the farmland to buy from the farmers. There are 2 major kinds of roads which serve as farm-to-market (or to village) road; namely, 1) canal maintenance road belonging to ID, and 2) rural road under the responsibility of Department of Rural Development (DRD). In almost all the cases, such roads from farmlands to the villages, nearest trading centers, milling factories, etc. are not concrete or asphalt paved. Most of the rural roads, including canal maintenance roads, are of earthen, kankar (mixture with gravel), and to some extent gravel.

Above situation hinders smooth transportation of agricultural produces, especially during monsoon season. In cases, roads are closed during heavy rainfall as exampled within Shwebo irrigation system. In this case, farmers and traders have to take a detour, spending more time. Current poor road condition also incurs post-harvest loss, needs more fuel in using track and trawllergy (hand-tractor engine driven cart) for transportation. To promote intensive agriculture from the farmland up to the market, the current road should be improved, and the improved road also facilitates the development of rural economy.

2) Roads to Improve

Roads to be improved are categorized as follows by priority area; 1) canal maintenance roads under ID and rural roads under DRD in case of Shwebo, Mandalay, and Nay Pyi Taw area, and 2) rural roads under DRD and parts of regional roads (highways) under Highway Department in case of Ayeyarwady area. The roads to be selected are primarily those ones which lead to specific townships where lots number of rice milling stations and trading centers mainly for paddy are located, and also those ones which connect district centers for rural economy promotion.

The JICA survey team has identified most of the specific roads to improve for the case of canal maintenance road, and regional highway (in case of Ayeyarwady). However, identification of specific rural roads to improve is very difficult though some sections were done according to field surveys by the team. Therefore, for the purpose of quantification of the improvement of rural roads, approximately 20%[5] of the rural roads existent in the irrigable area are planned to improve to one-step

[5] Note that in Ayeyarwady area, 10% was planned instead of 20% due to too large extent network with the project areas (polders and drainages) being scattered.

improved mode, e.g. from earthen to kankar, from kankar to gravel, and from grave to paved one. Wooden bridges are also improved to RCC type at a ratio of 20 % of the existent wooden bridges.

Following table summarizes the roads which need improvement/ upgrading. As aforementioned, canal maintenance roads for the improvement are those ones which lead the farm produces to township/ district centers where number of rice millers and trading places are located. On the other hand, the sections of regional roads in Ayeyarwady area were identified as follows:

1) From Maubin area, most traders are forced to take the Maubin-Wadaw-Samalauk-Yangon way. If the Maubin- Twantay-Yangon road is upgraded, transportation time and cost of millers and traders in Maubin could reduce to around a half of present condition taking into account the distance between the 2 routes. Volume of rice distributed through Maubin-Wadaw-Samalauk-Yangon way is at least 17,325 tons per year[6], and project benefit of the road improvement is estimated at 25,988,000 Kyats per annum. The current weight limitation of a bridge near Twantay is considered as a bottleneck of the road network, only 2 tons. This road and bridge should be improved (see A).

2) Similar situation is happened in Myaungmya area, in where most millers and traders have to carry rice through Myaungmya-Einme-Kyaunggon-Pantanaw-Yangon way. Though the shortest way to Yangon is Myaungmya-Einme-Pantanaw-Yangon road, they have to take the indirect road due to weight limitation, 3 tons in monsoon season and 6 tons in summer season. Volume of rice distributed from Myaungmya to Yangon is estimated at 24,300t per year, and project benefit of the road improvement is at least 27,459,000 Kyats per annum (see B)

3) Aside from the above 3 routes, there should be improvement of regional road running from west to east in mid-stream of the delta. At present, major road between Pathein, the regional capital, and the Yangon is only Yangon-Nyaugdon-Pathein road running somewhat upstream part of the delta. Therefore, there should be east-west road down to the southern area from the major road. There is a road connecting west-east in the mid-stream of the delta. However, there is a gravel section, which shall be upgraded to asphalt paved road (see C).

Table 3.2.15 Roads to be Improved

Priority Area	Existing Condition of Road Pavement & Bridge Type		Improvement of Road Pavement & Bridge Type	Remark
Shwebo	Canal Maintenance Road	Kanker	Asphalt Road: L = 80 mile	Heavy traffic section
		Kanker	Gravel Road: L = 60 mile	
	Rural Road (DRD)	Gravel	Asphalt Road: L = 40 mile	
		Earthen	Gravel Road: L = 60 mile	
	Bridges (DRD)	Wooden	RCC Bridge: 5 units	
Mandalay	Canal Maintenance Road	Kanker	Asphalt Road: L = 60 mile	
		Kanker	Gravel Road: L = 40 mile	
		Earthen	Kanker Road: L = 63 mile	
	Rural Road (DRD)	Gravel	Asphalt Road: L = 35 mile	
		Earthen	Gravel Road: L = 70 mile	
	Bridges (DRD)	Wooden	RCC Bridge: 35 units	
Nay Pyi Taw	Canal Maintenance Road	Kanker	Asphalt Road: L = 20 mile	Heavy traffic section
		Kanker	Gravel Road: L = 1 mile	Proposed by ID
	Rural Road (DRD)	Gravel	Asphalt Road: L = 20 mile	
		Earthen	Gravel Road: L = 40 mile	
	Bridges (DRD)	Wooden	RCC Bridge: 15 units	
Ayeyarwady	Rural Road (DRD)	Gravel	Concrete Road: L = 40 mile	Construction record
		Earthen	Gravel Road: L = 100 mile	
	Bridges (DRD)	Wooden	RCC Bridge: 25 units	
	Regional Road	Asphalt	Widening (Asphalt Rd): L = 7 mile (A)	Heavy traffic section

[6] Based on the number of large scale rice millers, total transaction of paddy per annum was estimated, and with the share of paddy transported by road, the annual transaction amount was obtained. With this amount and the transportation charge per mile, the benefit was estimated.

	(Ministry of Construction)	Gravel	Asphalt Road: L = 22 mile (B)	
		Gravel	Asphalt Road: L = 9 mile (C)	
	Bridges (ditto)	Wooden	RCC Bridge: 8 units	

Source: JICA Team based on data provided by ID, Department of Rural Development, and Highway Department (Ayeyarwady)

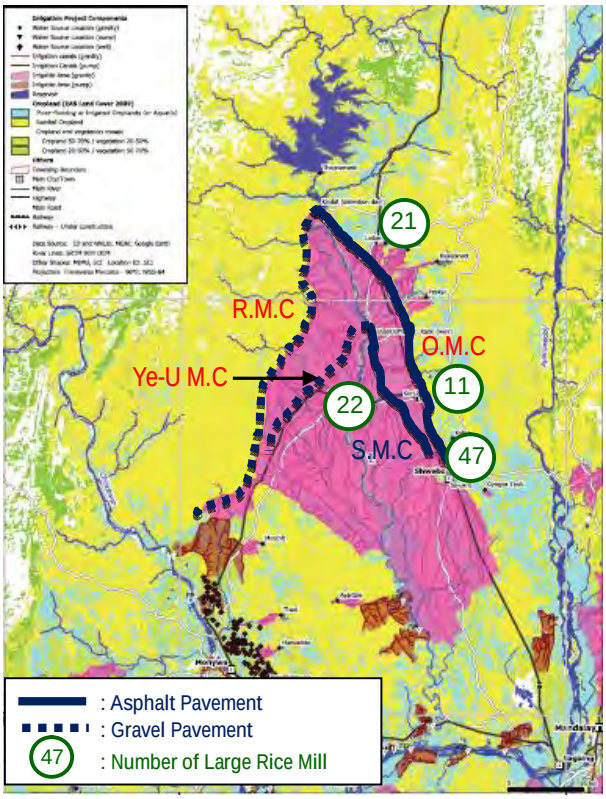


Figure 3.2.10 Road Improvement (Shwebo)

Source: JICA Survey Team

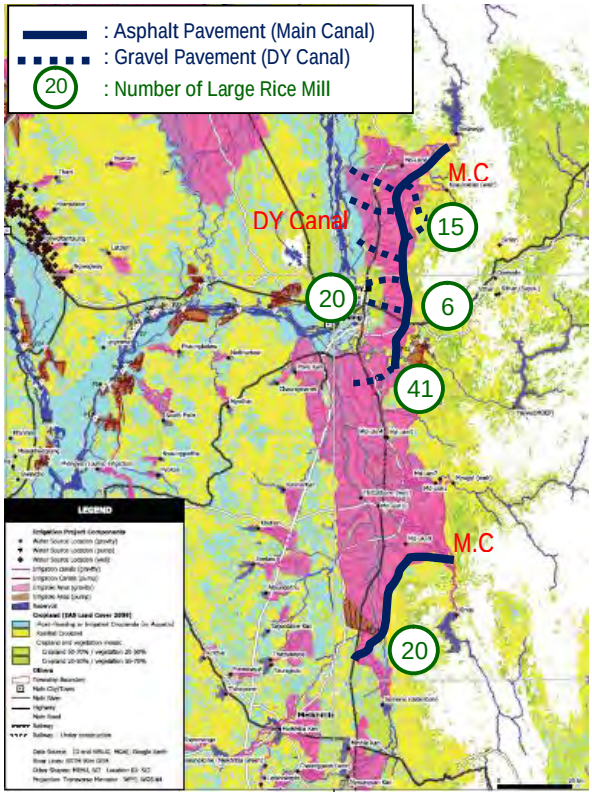


Figure 3.2.11 Road Improvement (Mandalay)

Source: JICA Survey Team

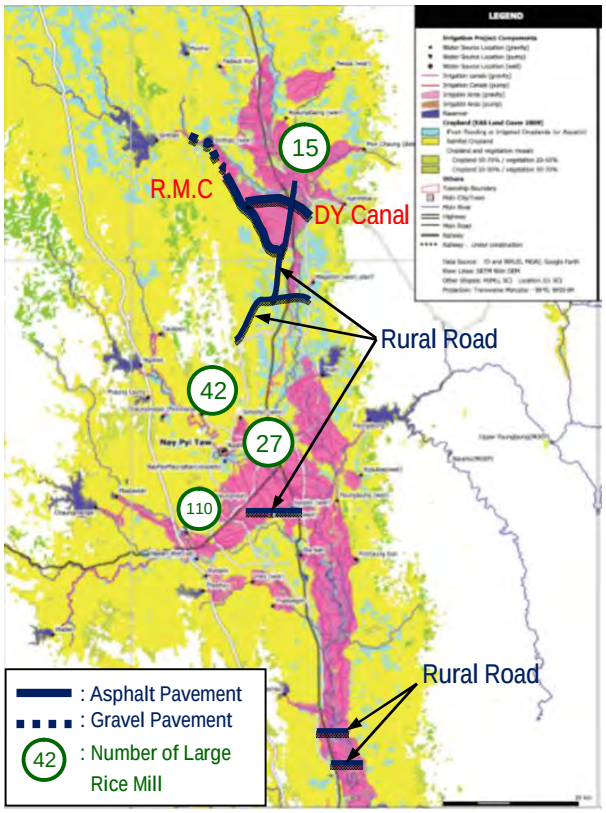


Figure 3.2.12 Road Improvement (Nay Pyi Taw)

Source: JICA Survey Team

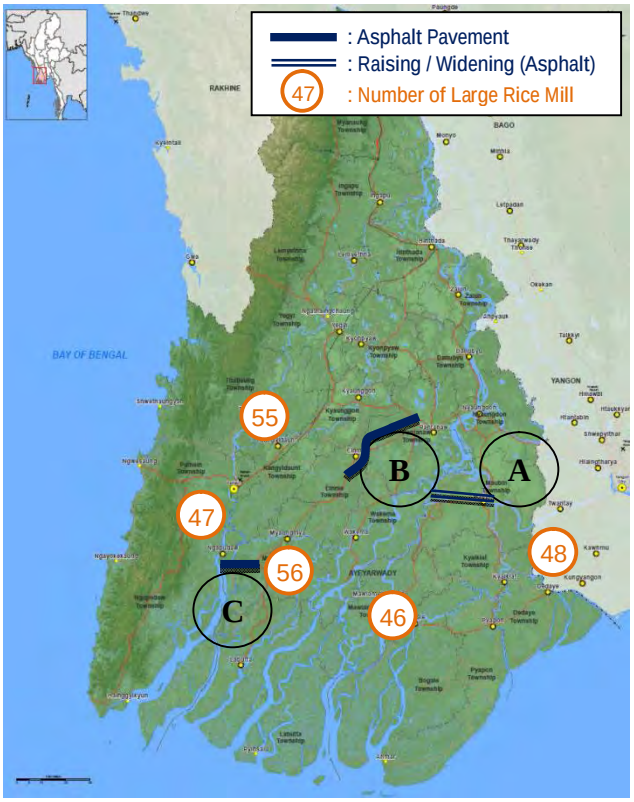


Figure 3.2.13 Road Improvement (Ayeyarwady)

Source: JICA Survey Team

3) Outline of the Component

Project Name	No.9 Farm-to-Market Road (FMR) Improvement			
Project Purpose	To reduce distribution loss and distribution cost, and to prevent closure in monsoon season			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	○
Target Area	All the townships within the irrigation schemes (polders in Ayeyarwady area) of 4 priority areas			
Implementing Organization	ID (canal maintenance road), DRD (rural road), Highway Department (Ayeyarwady regional road)			
Support Organization	Concerned TS and district generation administration offices, Ayeyarwady regional government			
Beneficiaries	Farmers, traders, and common people			
Development Effect	Reduction in transportation cost and time, Reduction of post harvest loss, Activation of rural economy			
ODA Scheme/ cost	Project Loan		Shwebo	3.3 billion JPY
			Mandalay	3.6 billion JPY
			Nay Pyi Taw	1.6 billion JPY
			Ayeyarwady	3.6 billion JPY
Duration of the Project	4 ï 5 years in parallel with rehabilitation of irrigation systems and polders/ drainage (in case of Ayeyarwady)			

Source: JICA Survey Team

3.2.10 Jetty Improvement (Shwebo, Mandalay, Ayeyarwady)

1) Rationale

Jetty improvement is planned at 3 locations of Kyaukmyaung TS (Shwebo District), Mandalay port and Pathein port (Ayeyarwady region). In general, major advantage of water transportation is to make bulk transport possible with low cost. However, since loading and unloading at most of the jetty sites is done by manual and all cargos are packed in hand-carry size, the works take too much time under the current condition. Also, even though floating jetty is observed in some locations, most parts of berth are natural river bank, including Mandalayôs ones, and narrow wooden board is used for loading/ unloading of cargos and passengers. During monsoon period, water level goes higher and loading/ unloading works becomes potentially risky. Improvement of jetty with loading equipment is therefore needed.

2) Mandalay Case

Of the 3 jetties proposed, Mandalay port is the biggest one. Mandalay is located at midstream of Ayeyarwady river, which is historically the main artery of inland water transportation to downstream areas including Pakokku, Magway, and Yangon. Major transportation goods related to agriculture at Mandalay are rice (150,000 ton), beans (56,000 ton), fertilizer (18,000 ton) and vegetables (5,000 ton), and estimated cargo handling volume at Mandalay port reached as much as a total amount of 600,000 ton in 2013[7]. In this regard, Mandalay port is one of hub of inland water transport in Myanmar.

According to Maha Kahtina Association of Traders, Brokers & Industrialist, main constraint on inland water transport is the shallow water depth during dry season. According to a JICAôs feasibility study on inland water transport facilities at Mandalay[8], water level difference between dry and rain season

[7] The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar, Feasibility Study on Inland Water Transport Facilities Improvement and Development Projectò, P5-8 - 5-9, Final Report, September 2014, JICA, Oriental Consultants Co., Ltd., International Development Center of Japan, ALMEC Corporation..

[8] Same as above source

reaches as high as 8 m at Mandalay, and shallowest water depth between Mandalay and Yangon marks only 1.5 m. In this study, necessity to develop modernized port facilities and machinery cargo handling and new O&M system were discussed. Development direction of Mandalay port should be followed by this feasibility analysis.

3) Modernization of Jetties

The points to modernize and up-grade jetty facilities are as follows;

- ✓ Design of jetty will be based on the easy-approach by boat (refer to the figure as example),
- ✓ Pavement/ reinforce-concreted floor between truck/ warehouse and jetty are to be established in order to keep easy-approach to boats and to have dust/ dirt guard,
- ✓ Shade and/ or warehouse for temporary storage for proper storage used in case of trouble not getting boat etc., and
- ✓ Mechanization of loading and unloading works through introducing forklift and crane will be introduced to have quick movement and to reduce manpower.

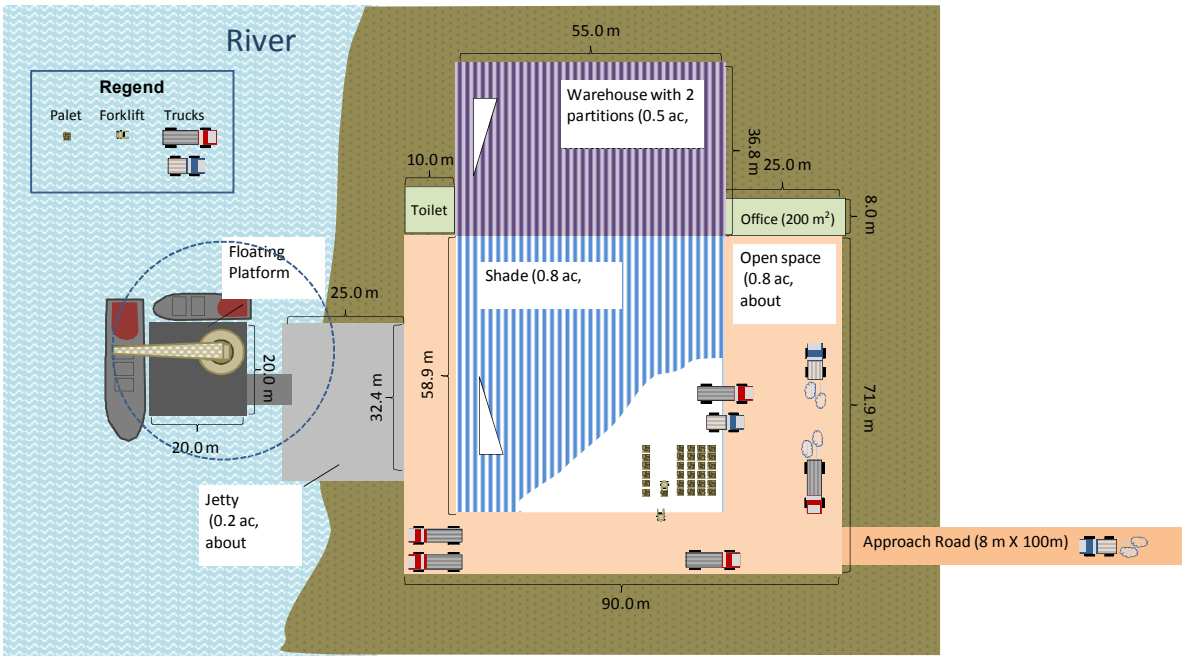


Figure 3.2.14 An Example of Improved Jetty Facilities

Source: JICA Survey Team

4) Summary of the Program Component

Project Name	No.10 Jetty Improvement			
Project Purpose	To reduce distribution cost of water transportation through river port mechanization			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○		○
Target Area	Kyaukmyaung TS, Shwebo district Mandalay port Pathein port (Ayeyarwady region)			
Implementing Organization	Inland Water Transport Department (IWTD), Ministry of Transport			
Support Organization	Shwebo City Development Committee (in case of Kyaukmyaung TS port) Mandalay City Development Committee (in case of Mandalay port) Pathein City Development Committee (in case of Pathein port, Ayeyarwady)			
Beneficiaries	Traders, Transporters			
Development Effect	Reduction in waiting time, Reduction in loading/unloading time, Increase in labor safety,			

	Reduction in transportation cost		
ODA Scheme/ cost	Project Loan	Shwebo	378 million JPY
		Mandalay	515 million JPY
		Pathein	447 million JPY
Duration of the Project	2 years		

Source: JICA Survey Team

3.2.11 Local Market Improvement (District Level: Shwebo, Ayeyarwady)

1) Rationale

In most local markets, sanitary environment particularly during monsoon season is poor due to insufficient drainage system. In addition, retail section including vegetables and fruits section becomes congested at the time of peak season of locally produced vegetables and fruits marketed. Therefore, it is necessary to improve local markets (district level) to provide enough space for daily transaction and to secure sanitary environment. For farmers, market at district level is still an important opportunity to gain cash income from their products, and promotion of direct selling by farmers at the market place could contribute to income generation and also diversification of farming activities.

In many cases, loading and unloading areas for large scale tracks are arranged at roadside area and sanitary condition is quite bad due to scattered wastes and garbage, especially when it rains. Also, retail of vegetables and fruits in the outside of market shed is often congested, and sanitary environment is worsened during peak season particularly in winter season. Vegetables and fruits are produced a lot in this season locally, which are an important income source for small holder farmers. Improvement of loading areas and retail section for small scale farmers is necessary to keep market place under good sanitary environment.

2) Activities of the Project

Upgrading of local (district level) markets take into consideration users needs including farmers, retailers, wholesalers and consumers, and followings are ideal viewpoints for the upgrading of the local market facilities:

- ✓ Realign the market facilities to make sure of efficient transaction and traffic line,
- ✓ Equip modernized market facilities including warehouse, low temperature storage, sanitary facilities, orderly parking facilities (note that low temperature is a cold storage, but a heat-preventive storage warehouse),
- ✓ Improve sanitary environment through installing washing place, drain facilities, waste disposal and treatment facility,
- ✓ Provide service facilities to meet consumersôdiversified needs such as primary processing facility, canteen, multipurpose room, etc., and
- ✓ Arrange welfare provisions including cheap and clean lodging house, bank, and transporting services.

3) Outline of the Project

Project Name	No.11 Market Improvement (District level)			
Project Purpose	To reduce transaction losses, improve sanitary condition of district market, and enhance accessibility of farmers to retail section for income increase			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○			○
Target Area	Shwebo District (Shwebo town) Pathein town (Ayeyarwady)			

Project Name	No.11 Market Improvement (District level)		
Implementing Organization	Shwebo City Development Committee (SCDC) Pathein City Development Committee (PCDC)		
Support Organization	MOC, MOAI		
Beneficiaries	Retailers (including farmers), Wholesalers, and Consumers,		
Development Effect	Improve sanitary condition of the market, Reduction in distribution losses, Reduction in waiting time, and Reduction in transaction time		
ODA Scheme/ cost	Project Loan	Shwebo	78 million JPY
		Ayeyarwady	361 million JPY
Duration of the Project	1 year (for construction)		

Source: JICA Survey Team

3.2.12 PPP Wholesale Market Establishment (Mandalay)

1) Background/ Development Needs

In Mandalay, nationwide distribution networks are connected from four cardinal points. The network includes the Yangon-Mandalay national highway, which is the main artery of surface transportation in the Myanmar. Mandalay-Muse road is the main export route to China by land, whereas Mandalay-Tamu road connects Myanmar with India. Also, several routes from the central dry zone are connected to Mandalay in its mostly western side. Through these road transportation networks, various types of agricultural commodities come in and go from Mandalay.

Under the above condition, several markets including Zegyo (Ze Cho) Market, Mingala Bazaar, Phayagyi Bazaar, Thiri Marlar Market, and 41 Vegetable Night Market have been established in Mandalay city. Among them, Thiri Marlar Market is a wholesale market for perishable products including fishes, vegetables, fruits and flowers, whereas 41 Vegetable Night Market is a retail market for vegetables and fruits. However, most markets have been historically formulated without any proper plan and design. There are no integrated market building including orderly transaction place, cold storage and sanitary facilities, and efficient market environment such as wide approach roads.

Under above situation, a new wholesale market is very much required and will be constructed in a suburb of Mandalay city, and as of October 2015 it is under planning stage with PPP approach. According to Mandalay Green City Public Co., Ltd., which takes the responsibility on fund-raising, building construction and operation of the market, as of early October, muster plan of the wholesale market was drafted, and discussion with regional government has started from middle of October. Land leveling for the market yard was already started and target year of the completion is set by year 2017. For this purpose, the company will procure fund by issuing, for example, bond, share/stock for the construction, and the operation is to be made through income from the market.

2) Activities of the Project

Under this project, there are mainly 3 sub-components; namely, 1) provision of fund for the construction and 2) plant protection and quarantine enhancement with PPD, and 3) technical advices on effective market operation including linkage establishment with local markets by a means of IT, auction system, one-stop export establishment, etc.

Since there is already a private company in charge of procurement of the necessary fund, construction and also operation, the project does not constructed the wholesale market but provide fund and/or function of plant protection and quarantine. A potential source of the financial support could be ñoverseas investment and loanò scheme. The scheme aims at promoting economic development of developing countries through providing loan to development projects implemented by private sector. Aside from the loan provision, the main activities for the project are stated as follows;

- ✓ Promote dialogue between the government sector and the private sector to enhance ñone stop

service functionò of the wholesale market. At present, plant protection and quarantine function is not included in the service planned by the company. Collaboration with Plant Protection Division (PPD) is effective to promote export of fruits such as mango through examination of fruit flies by supporting vapor heat treatment service for example.

- ✓ Enhance plant protection function of PPD of MOAI, through providing technical assistance and necessary equipment and facilities. Note that PPD has established a new office near the wholesale market but necessary equipment are not installed due to lack of budget as of October 2015.
- ✓ Provide technical advice on effective market operation including establishment of IT network to enhance relation between the new wholesale market and regional wholesale markets, and auction system of perishable products when necessary. This advice can be made by dispatching international experts who have knowledge in the field. With arrangement, for example, display panel in the wholesale market will show prices of each products transacted in the market, and the information will be linked to other regional markets and crop exchange centers (for rice and beans) for effective transaction among traders and exporters. Prices of major commodity in international markets should also be available through the IT network.

3) Outline of the Project

Project Name	No.12 PPP Wholesale Market Establishment			
Project Purpose	To enhance the market function including plant protection and quarantine for one-stop export purpose for the New Mandalay Wholesale Market			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
		○		
Target Area	Mandalay			
Implementing Organization	Private Sector, PPD (MOAI)			
Support Organization	Mandalay City Development Committee (MCDC)			
Beneficiaries	Wholesalers, Exporters, Consumers, and Retailers			
Development Effect	Export promotion of agricultural products, Increase in transaction amount of vegetables and fruits, Reduction in distribution losses, Reduction in waiting time, and Reduction in transaction time			
ODA Scheme/ cost	Overseas Investment and Loan		7.5 billion JPY (according to the company) for construction	
Duration of the Project	3 years			

Source: JICA Survey Team

3.2.13 Wholesale Market Development (New: Nay Pyi Taw)

1) Rationale

In Nay Pyi Taw, there are 37 markets in 8 TS including 12 in Zabu Thiri TS, 6 in Oattara Thiri TS, 6 in Pyinmanar TS, 6 in Lewe TS, 4 in Pobba Thiri TS, 3 in Tatkon TS, and 1 in Dekhina Thiri TS. Out of 37 markets, 11 markets have wholesale function. Among them, Nay Pyi Taw Myo Ma Zay, which was established in 2006, is the largest market with 1,695 tenant capacity in 101 acre of market compound. Nay Pyi Taw City Development Committee (NCDC) manages these markets, but self-supporting accounting system is not yet established in the markets.

However, most markets are small-scale and centralized wholesale market is needed to materialize efficient transaction of agricultural products. Through development of new wholesale market in Nay Pyi Taw, development of cold chain, improvement of sanitary environment, reduction in distribution losses of perishable products and promotion of direct selling of farm products will be promoted. The new wholesale market shall have following functions:

- ✓ Well designed layout of market infrastructure to transact agricultural products efficiently

including expansion of trading space, separation between loading/uploading place and transaction space, and expansion of approach road without congestion in public roads.

- ✓ Receive bulk commodities from production areas, and redistribute in small volume to diversified commercial users, retailers in Nay Pyi Taw and surrounding districts.
- ✓ Installation of public cold storage for wholesalers and retailers to enhance freshness-keeping of perishable products. In addition, it is necessary to enhance quality inspection and sanitary inspection before distributing retail markets.
- ✓ Provision of user friendly services including farm input supply, micro credit services, clean accommodation, and sanitary and phytosanitary facilities.

2) Outputs and Activities of the Project

New wholesale market in Nay Pyi Taw should take into consideration the users needs including farmers, retailers, wholesalers and consumers, and followings are ideal viewpoints for the market facilities:

- ✓ Proper arrangement of market facilities to make sure of efficient transaction and traffic line (see diagram below for an ideal example of the layout),
- ✓ Equip modernized market facilities including warehouse, low temperature storage, sanitary facilities, orderly parking facilities, and service facilities to meet consumersô diversified needs (primary processing facility, canteen, multipurpose room),
- ✓ Improved sanitary environment (washing place, drain facilities, waste disposal and treatment facility), and
- ✓ Welfare provisions including cheap and clean lodging house, bank, and transporting services

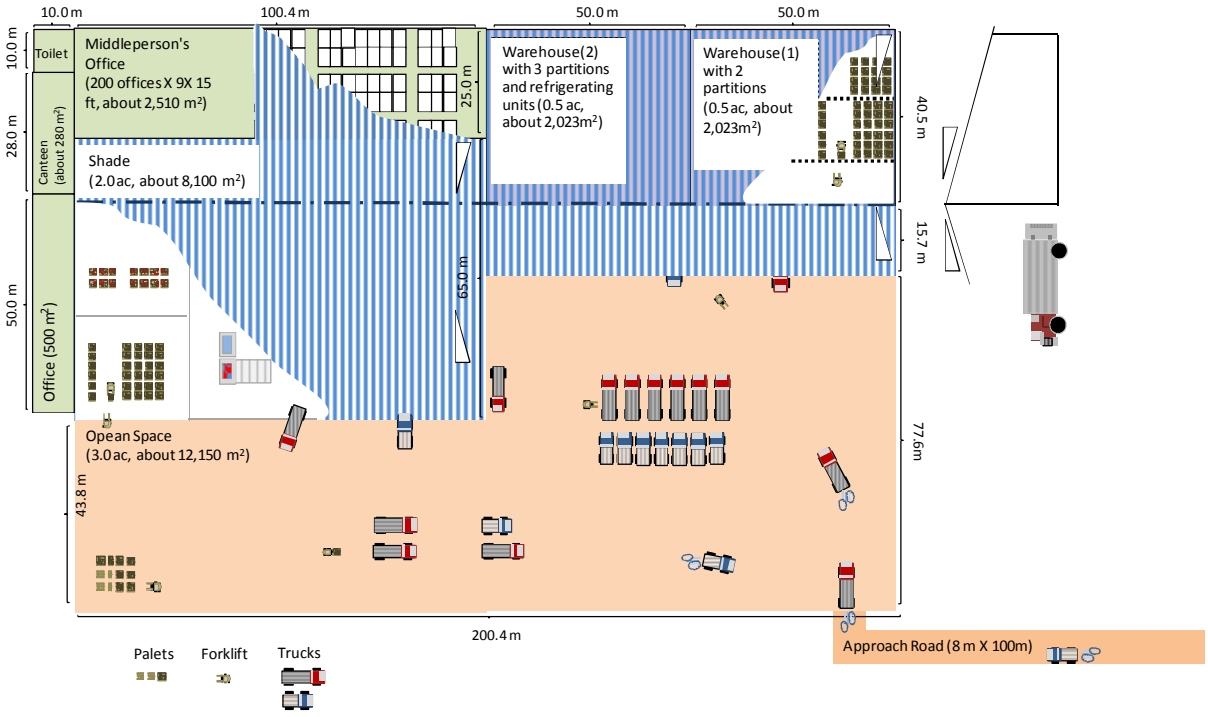


Figure 3.2.15 Layout Plan of New Wholesale Market

Source: JICA Survey Team

4) Summery of the Program Component

Project Name	No.13 Wholesale Market Development (New)			
Project Purpose	To enhance wholesale function Nay Pyi Taw to materialize effective transaction of agricultural products.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
			○	
Target Area	Nay Pyi Taw			
Implementing Organization	Nay Pyi Taw City Development Committee (or private sector under PPT)			
Support Organization	MOAI			
Beneficiaries	Consumers, Retailers (including farmers), Wholesalers			
Development Effect	Reduction in distribution losses, Reduction in waiting time, Reduction in transaction time, Export promotion of agricultural products, Increase in sanitary condition,			
ODA Scheme	Project Loan		788 million JPY	
Duration of the Project	3 years			

Source: JICA Survey Team

3.2.14 Small and Medium Agro-enterprise Promotion (2 Step Loan)

1) Rationale

According to interview survey to brokers, traders, rice millers and processors, they need more accessible loan to procure equipments such as dryers, warehouses, rice milling machines and processing machines. Particularly, many rice millers still use aged equipment and renewal is needed to improve quality of white rice[9]. If brokers, traders, rice millers and processors could get better quality equipments by using a loan program, post-harvest and processing losses of produces will reduce.

In Myanmar, brokers, traders, rice millers and processors are defined as small and medium enterprises (SMEs), and they are therefore supposed to borrow money from not MADB (Myanmar Agricultural Development Bank) but Small and Medium Industrial Development Bank (SMIDB; former ñMyanmar Industrial Development Bankò). Especially for the rice production areas such as Shwebo and Ayeyarwady areas, there should be huge needs of an accesible loan from rice millers to upgrade the milion machines and also from brokers and traders in order to, for example, construct a warehouse.

It had been pointed out that there were some problems such as complex bank procedures, high interest rate[10], restriction on the length of loans[11] and tight collateral requirement[12] with official and private banks in Myanmar. This situation has made it difficult to manage company or management unit especially for SMEs. SMIDB was therefore established by an order of the government, providing ñSME loansò with comparatively low interest rate and long lending term. Comparison between comercial loans and SME loan could be seen in following table:

Table 3.2.16 Comparison between Commercial Loans and SME Loan

Particulars	Commercial loans	SME loan by SMIDB
Interest Rate	13.0%	8.5%
Lending limit/recipient	None (single lending limit by regulation = 20% of capital)	500 million kyat
Maximum Term	1 year	3 years
Funding support	None Minimum deposit rate 8%	GOM* ordered MEB** to lend to SMIDB at 8.25% (Loan/deposit < 80% apply) (Collateral required)

[9] In Kandalu TS located in Shwebo area, where 21 large scale rice millers and 78 medium and small scale rice millers are operated, all rice millers do not have color sorting system, and they have to entrust rice millers in Shwebo TS with color sorting process at a cost of 600 kyat/bag.
[10] Generally, current lending interest rate of private banks is about 13% per year.
[11] Maximum lending term of banks is averagely only 1 year.
[12] In Myanmar, collateral requirement of loan is needed, as a matter of principle, immovable collateral.

Particulars	Commercial loans	SME loan by SMIDB
Fund size	Loan balance of all banks as of 2012.3 was 3.1 trillion kyat, (Annual increase in 2011-2012 was 1.2 trillion kyat)	Currently 10 billion kyat (Limit is 30 billion kyat)
Eligibility criteria	Not applicable	None
Additional procedure		Recommendation by SME Development Center
Bank selection rule		Not clear
Participating bank		SMIDB
Use of funds	No restriction	
Collateral	Based on banking regulation and bank's policy	

* Goverment of Myanmar **Myanmar Economic Bank
Source: Preparatory survey on Two-Step Loan Project for Small and Medium Enterprises Development in the Republic of the Union of Myanmar: final report (JICA, 2014)

In 2014, there was a preparatory survey on two-step loan for small and medium enterprises development conducted by a JICA Survey Team[13]. This survey intended to formulate a loan lending plan from JICA into two-step loan for SMIDB. In this survey report, the necessity of access-friendly loan program for SMEs was pointed out. In June 2015, based on this survey, Japanese government signed an agreement document with the Myanmar government on Yen-loan Project for the Development of Finance for Small and Medium–sized Enterprises[14].

This loan program should be utilized under the Small and Medium Agro-enterprise Promotion (2 Step Loan). However, even if this Yen-loan project has been carried out, the total loan amount for SMEs is not enough yet. SMEs in Myanmar were reported as many number as 127,000 companies[15], and therefore only a part of those could access and invest this loan project money. To promote agricultural products processing and improvement of value chain, it is necessary to provide more amount of access-friendly loan for the SMEs especially for rice millers, and to an extent brokers, traders and processors in terms of intensive agriculture promotion.

2) Activities of the Project (SMIDB)

- ✓ Development of loan program based on users' needs and/or expansion of the current two step loan program,
- ✓ Establishment of formality and eligibility check system,
- ✓ Establishment of overall evaluation by (1) Financial Analysis, (2) Non-financial Analysis, and (3) Project evaluation,
- ✓ Assisting loan applicants in building their business plan,
- ✓ Speed up of approval and loan procedure, and
- ✓ Development of human resources for sub-borrowers services and extension services

3) Summary of the Program Component

Project Name	No.14 Small and Medium Agro-enterprise Promotion (TSL)			
Project Purpose	Promotion of agricultural products processing and improvement of value chain through provision of loan program			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	○
Target Area	All the townships within the irrigation schemes (polders in Ayeyarwady area) of 4 priority			

[13] Preparatory survey on Two-Step Loan Project for Small and Medium Enterprises Development in the Republic of the Union of Myanmar: final report (JICA, 2014)
[14] http://www.jica.go.jp/press/2015/20150630_02.html (Accessed 26 November 2015)
[15] Preparatory survey on Two-Step Loan Project for Small and Medium Enterprises Development in the Republic of the Union of Myanmar: final report (JICA, 2014)

Project Name	No.14 Small and Medium Agro-enterprise Promotion (TSL)	
	areas	
Implementing Organization	Small and Medium Industrial Development Bank (SMIDB)	
Support Organization	Union of Myanmar Federation of Chambers of Commerce & Industry(UMFCCI), Ministry of Industry (MOI)	
Beneficiaries	Small and Medium Agro-Enterprise (e.g., Brokers, Trader, Rice Millers, Processors)	
Development Effect	Reduction in post-harvest losses, Reduction in processing losses, Quality Improvement of products	
ODA Scheme	Two-Step Loan	Total 5 billion JPY
Duration of the Project	5 years	

Source: JICA Survey Team

3.2.15 Supply Chain Improvement of Rice

1) Rationale

Labor shortage becomes serious issue in rural areas in Myanmar, where labor intensive agriculture has been dominant. Labor shortage increases farming costs through wage increase, which results in increase in food prices. In urban areas, increase in food prices may seriously affect household economy of urban labors, To mitigate this situation, it is important to supply cheaper staple food constantly through promoting capital intensive and labor saving agriculture in Myanmar.

The intensive agriculture program contains improvement of production infrastructure such as irrigation rehabilitation, land consolidation and FMR improvement. To maximize effects of the each component, supply chain improvement of rice, as a soft component of the intensive agriculture promotion program, is significantly important. Primary objective of the supply chain improvement is to improve productivity of rice, and output of the component includes 1) establishment and enhancement of supply chain stakeholders, 2) quality improvement in rice production, and 3) quality improvement in rice distribution/ processing.

2) Outputs and Activities of the Project

Output 1: Establishment of partnership among stakeholders

In Myanmar, collaboration among stakeholders in rice supply chain is still weak. To improve productivity of rice, establishment and enhancement of effective linkage among supply chain stakeholders including private sector and public sector is necessary. Direct beneficiaries of the project are rice growers, brokers, rice millers, traders and exporters, whereas support organizations include MOAI (DOA, AMD, PPD and ID), MRF (MRIA, MFA, etc.), MFSPEA, and Myanmar-Japan Center.

MRF is a representative organization of rice producing farmers and rice agents, and members of MRF consist of rice farmers, post-harvest treating agents, marketing agents, sales agents, export agents, etc. MRFôs objectives of the establishment include development and strengthening of rice supply chain, and its activities range from input supply of seed, fertilizers, and pesticides to rice exports. Thus, as a representative of rice industry covering the whole rice supply chain, MRF is an appropriate organization to promote collaboration among stakeholders.

Also, MOAI is a government organization that can support productivity improvement of rice supply chain. DOA can provide certified seeds and promote appropriate use of fertilizers and pesticides, whereas AMD can support farm mechanization. Myanmar-Japan Center is a business development service (BDS) organization and can provide several trainings for human development including KAIZEN. Followings are activities of the Output 1.

Activity: 1-1. Identification of target stakeholders

1-2. Need assessment of the target stakeholders

1-3. Promotion of dialogue among the stakeholders

Output 2: Productivity improvement in rice production

Heterogeneous grain is one of main cause of low milling rate of rice. Original caustic factor of this quality deterioration may stem from poor cultivation management at paddy parcel level, resulting in intra-varietal cross pollination leading to higher rate of mixing with variable grain sizes (length). At milling stage, unhooked grain inevitably remains in the milled rice unless the adjustment of roller slit at rice milling to closer to short/ round grain. However, this adjustment tends to break longer grain, thus leading to higher rate of milling loss.

To improve the condition, promotion of introducing certified seed and proper seed management at field is necessary. For this purpose, collaboration with DOA and seed producer farmers will be promoted and strengthened. In this connection, collaboration with JICAôs technical cooperation project for ñDevelopment of Participatory Multiplication and Distribution System for Quality Rice Seedsò is also effective.

Appropriate use of fertilizers and pesticides reduce input cost of paddy production. According to DOA, farmers tend to overuse fertilizers and pesticides due to unclear instruction of imported products, poor quality of imported products, and spillage of fertilizers caused by the plot-to-plot irrigation. In fact, imported products often do not have Myanmar version instruction (nor English instruction). Especially, un-proper use of pesticide is hazardous to human.

To promote appropriate use of fertilizers and pesticides, technical training should be administered to the farmers by DOA officers in collaboration with private sector, including Myanmar Fertilizer, Seed and Pesticide Entrepreneurs Association (MFSPEA). Introduction of combined harvester is also effective to improve quality of harvested paddy, and collaboration with AMD should be promoted for post-harvest management purpose. Followings are activities of the Output 2.

Activity: 2-1. Promotion of introducing certified seeds

2-2. Promotion of appropriate use of fertilizers and pesticides

2-3. Improvement of post-harvest management of farmers

Output 3: Productivity improvement in rice distribution and processing

Nurturing business mind in traders and millers is necessary step to reduce loss in the rice supply chain. Myanmar-Japan Center is an ideal business development service provider to support efficiency improvement of processing and distribution process, through introducing Japanese administrative and quality control methods such as 5S and kaizen.

The 5S, taking acronym of "Sort", "Straighten", "Shine", "Standardise", and "Sustain", is a systematic form of visual management that is not just simply about cleanliness or organization, but is a framework that emphasizes the use of a specific mindset and tools to create efficiency and value.[16] Also, "visualization" or "transparency" of cost structure is one of kaizen practices, and is effective way to identify waste or losses. Through 5S and kaizen, rice milling and distribution can improve efficiency.

For export rice, fumigation is one of important issue to improve quality of rice, and collaboration with PPD is considered important for this purpose. Followings are activities of the Output 3.

Activity: 3-1. Nurturing business mind in traders and millers

3-2. Promotion of kaizen in the milling and distribution process

[16] http://www.creativesafetysupply.com/content/education-research/5S/index.html

3-3. Improvement of rice quality for export

3) Outline of the Project

Project Name	No.15 Supply Chain Improvement of Rice			
Project Purpose	To improve productivity and quolity of rice through improving efficiency of rice supply chain.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○	○	○	○
Target Area	All the townships within the irrigation schemes (polders in Ayeyarwady area) of 4 priority areas			
Implementing Organization	MOAI (DOA, AMD, PPD)			
Support Organization	MRF (MRIA, MFA, etc.), MFSPEA, Myanmar-Japan Center			
Beneficiaries	Farmers, Brokers, Millers, Traders, Exporters, MRF			
Development Effect	Quality improvement of rice, Reduction in production cost, Reduction in distribution loss, Reduction in transaction cost			
ODA Scheme/ Cost	Technical Cooperation Project		784 million JPY / Area	
Duration of the Project	5 years			

Source: JICA Survey Team

3.2.16 Value Chain Enhancement of Vegetables and Fruits (Mandalay)

1) Background/ Development Needs

Rice production has received sufficient degree of support from the government particurarly in lowland area where climate condition is suitable for paddy production endorsed with monsoon rainfall and irrigation water during summer. However, in comparison with the paddy production, vegetable and fruist production could hardly receive enough support from the government. As a result, productivity of vegetables and fruits production is still low, and quality is not the exception either, and therefore there are lots of issues to tackle.

Major problems on the vegetable and fruits production includes low quaility of seeds, poor production skills of farmers, inactive extension activities, and high losses in post-harvest and distribution process. Labor shortage is also a recent issue for vegetable growers since their farming is basically of labor intensive.

2) Outputs and Activities of the Project

Primal objective of the value chain development of vegetables and fruits is to improve productivity of the production. Then, outputs of the project includes; 1) establishment and enhancement of value chain stakeholders, 2) quality improvement in vegetables and fruits production, and 3) quality improvement in vegetables and fruits distribution/processing. Activities for each output are as follows:

Output 1: Establishment of partnership among stakeholders

Activity: 1-1. Identification of target stakeholders

1-2. Need assessment of the target stakeholders

1-3. Promotion of dialogue among the stakeholders

Output 2: Productivity improvement in vegetables and fruits production

Activity: 2-1. Promotion of introducing quality seeds through collaboration with Doe Kwin Farm. Doe Kwin Farm is a laboratory cum training facility of DOA in Pyin Oo Lwin, and produces quality seeds of vegetables under contract with East West Seed Company.

2-2. Improvement of soil condition through dissemination of compost production, effective microorganisms, vermin-culture and IPM for organic farming through collaboration with

Doe Kwin Farm.

2-3. Promotion of appropriate use of fertilizers and pesticides for commercial production of selected vegetables and fruits.

2-4. Promotion of irrigated upland farming through introduction of small scale pump irrigation, sprinkler irrigation, and hydroponic methodology, in collaboration with DOA.

2-5. Demonstration of mechanized farming in collaboration with AMD.

2-5. Improvement of post-harvest management of farmers.

Output 3: Improvement in vegetables and fruits distribution and processing

Activity: 3-1. Nurturing business mind of traders and processors through visualization of cost structure of vegetable and fruits distribution.

3-2. Improvement of distribution method through collaboration with package industry.

3-3. Identification of stable buyers through market matching and promoting contract farming.

3-4. Improvement of quality of fruits for export through collaboration with PPD.

3) Outline of the Project

Project Name	No.16 Value Chain Enhancement of Vegetables and Fruits			
Project Purpose	To Improve productivity and quolity of vegetables and fruits through enhancement of the value chain.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
		○		
Target Area	Mandalay region (including Pyin Oo Lwin), Shan State			
Implementing Organization	MOAI (DOA, AMD, and PPD), Mandalay Fruit, Flower, Vegetable Producers and Exporters Association（MFFVPEA）			
Support Organization	UMFCCI, Doe Kwin Farm (DOA in Pyin Oo Lwin), Vegetable and Fruits Research Development Center (Yangon)			
Beneficiaries	Farmers, Brokers, Processors, Traders, Exporters, MFFVPEA			
Development Effect	Quality Improvement of vegetables and fruits, Reduction in production cost, Reduction in distribution Loss, Reduction in transaction Cost			
ODA Scheme/ Cost	Technical Cooperation Project		605 million JPY	
Duration of the Project	5 years			

Source: JICA Survey Team

3.2.17 Food Processing Industry Promotion (Mandalay)

1) Rationale

At present, most agriculture products from Myanmar are exported without processing despite the fact that, for example, around 80% of rice exported to China via Muse is used for processing purpose including rice noodle, alcohol and snacks in there. Also turmeric without processing is exported to China and Bangladesh, where the raw material is processed and re-exported to Japan and Pakistan for final consumption.

Food industry is one of the promising industry in Myanmar. At present, most manufacturing activities are agro-based, which shares as much as 63% of registered industries. However, in actual situation, the industry is still infant level in terms of technologies and market share. To promote economic development of Myanmar, it is important to develop food industry sector through value addition to agricultural products, development of food processing technologies. In this regard, development of entrepreneurs are quite important including agriculture development and industry development.

At present, Postharvest Technology Training Centre (PTTC) under DOA in Mandalay provides

training for agiculture processing, whereas Post-Harvest Technology Application Center (PTAC) in Yangon under MOC provides technical services to industrial customers. Since Mandalay has high potential to develop food industry, the PTTC is the main target of the proposed project to upgrade its function to the food processing technology provider. At a latter stage, then, such center in Yangon is also envisioned to function as food industry promotion center.

The project is divided into two stages. First stage is to provide technical cooperation to the government offices and processors/ entrepreneurs, and the technical cooperation includes development of processed product, componential analysis for quality certificate, development of business plan, cultivation of market and contract farming with farmers. Second stage is a loan provision stage to entrepreneurs so that they can start investment of their business.

2) Outputs and Activities of the Project

Technical cooperation scheme is applied to develop service program of the Food Processing Technology center, and to provide services to establish processing technology for starting business.

Output 1: Establishment of Food Processing Technology Center

Activity: 1-1. Construction of Food Processing Technology Center by renovating PTTC

1-2. Procurement of food processing equipment

1-3. Establishment of management system of the Food Processing Technology Center

Output 2: Establishment of partnership among stakeholders

Activity: 2-1. Identification of target stakeholders

2-2. Need assessment of the target stakeholders

2-3. Establishment of partnership among stakeholders

Output 3: Development of service program of the Food Processing Technology Center

Activity: 3-1. Development of service menu of the Food Processing Technology Center

3-2. Development of training method and training materials

Output 4: Provision of service to Entrepreneurs

Activity: 4-1. Provision of service to Entrepreneurs by administering a series of training

4-2. Monitoring and feed backing of project activities

3) Outline of the Project

Project Name	No.17 Food Processing Industry Promotion			
Project Purpose	To promote food processing businesses through dissemination of relevant technologies at a center (to be established in Postharvest Technology Training Centre, Mandalay)			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
		○		
Target Area	Mandalay City			
Implementing Organization	Postharvest Technology Training Centre (PTTC)			
Support Organization	Mandalay Fruit, Flower, Vegetable Producers and Exporters Association (MFFVPEA) Myanmar Food Processors and Exporters Association (MFPEA) MCDC, UMFCCI, Myanmar-Japan Center Small and Medium-sized Industrial Development Bank (SMIDB)			
Beneficiaries	Entrepreneurs, Farmers, Processors, Traders			
Development Effect	Value adding to raw products, Creation of employment opportunity			
ODA Scheme/ Cost	Technical Cooperation Project		822 million JPY	
Duration of the Project	5 years			

Source: JICA Survey Team

3.2.18 Dissemination of Advanced Farming Technologies (Nay Pyi Taw)

1) Rationale

Nay Pyi Taw is the national capital of Myanmar with full of greens, and located in the middle of Yangon-Mandalay national highway. Therefore, it is expected a display effect of advanced farming technologies since many domestic and foreign people come and go, and pass through. In addition, stable electricity and water supply to the capital area is another advantage for developing showcase of advanced farming. Therefore, by utilizing geological and political advantage, development strategy of this area is to promote advanced farming as a showcase to nationwide and international visitors.

Main target of the crops is basically lowland vegetable and fruits though paddy is also considered to be one of the targets. Vegetables produced in this area are pumpkin, okra, asparagus, chili, onion, potato, taro, egg plant, sweet corn, water melon, etc. These vegetables can be cultivated with high quality with irrigation during dry season. Irrigation should be for upland crops such as drip irrigation and sprinkler irrigation, not basin irrigation for paddy. As an advanced technologies, upland farm machineries should also be demonstrated, which are quite rare at this stage of Myanmar.

In fact there is one Japanese investor which established contract farming and is to process taro. The company provides the farmers with net for shading and protection from rainfall, know-how of making compost manure, soil improvement by adding the compost manure and lime, etc. According to the company, stable availability of electricity and reasonable labor force are the opportunity of promoting lowland vegetables with the processing.

2) Activities of the Project

Activities of the project are as follows:

- ✓ Establishment of demonstration centers in the strategic locations.
- ✓ Identification of advanced technology for demonstration purpose base on farmersô needs and taking into account future prospects. Then, develop demonstration method with preparing demonstration materials.
- ✓ Promotion of display and extension of intensive production of lowland vegetables and fruits, through introduction of mechanized farming, upland irrigation method, horticulture development including green house farming, tunnel cultivation, hydroponics, vermin-culture and organic farming.
- ✓ Promotion of market oriented lowland vegetable production by small-scale farmers, including promotion of pump irrigation, farm mechanization with hand tractor, sprinkler irrigation.
- ✓ Promotion of mechanized rice farming with land consolidation, drainage system, proper water management including wet-and-dry irrigation, advanced rice production method and modernized milling and storing facilities.

Advanced technologies are to be demonstrated under the Project such as tunnel cultivation (left photo), sprinkler irrigation (center), and introduction of upland farm machineries (right). In addition to these, .organic farming, compost making, hydroponics, vermin-culture can also be tried.

3) Outline of the Project

Project Name	No.18 Dissemination of Advanced Farming Technologies			
Project Purpose	To increase farm income through promotion of lowland vegetable production by advanced farming technologies.			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
			○	
Target Area	Nay Pyi Taw (including Tatkon TS and Lewe TS)			
Implementing Organization	DOA			
Support Organization	Yezin Agriculture University, ID, AMD			
Beneficiaries	Upland farmers, Vegetable growers			
Development Effect	Increase in vegetable production, Quality improvement of vegetables, Crop diversification			
ODA Scheme/ Cost	Technical Cooperation Project		574 million JPY	
Duration of the Project	5 years			

Source: JICA Survey Team

3.2.19 Plant Protection and Quarantine Enhancement (Shwebo, Mandalay, Ayeyarwady)

1) Rationale

There are concerns about residual pesticides in agricultural products among DOA staff, farm products traders and agricultural processing companies. Even though there is no statistical data of pesticide application amount, excessive herbicides seem to be applied according to some interview results. One DOA staff in Magway pointed out that insufficient post-harvest treatment and shortage of proper warehouses have resulted in residual aflatoxin[17] in chili and groundnuts. The Government of Myanmar has a plan to increase rice export from current one million tons to four millions tons in the future, and accordingly it is an urgent issue to secure safety of agricultural products.

For the sake of agricultural products safety enhancement, proper pesticide registration, chemical analysis of residual pesticide in agricultural products are essential. Moreover, inspection certificates clarifying that no residual pesticide in products should be issued. However, there are no detailed regulations under the current laws, and any monitoring system to check residual pesticide in products yet to be established. In addition, governmental organizations that cover this field do not have enough functions, equipment and techniques due to shortage of human resource and financial resource.

Plant Protection Division (PPD) under DOA is suitable organization as the inspector for residual pesticides in agricultural products for plant protection and quarantine. For the purpose of promotion of plant protection and quarantine in Myanmar, capacity development of PPD personnel is necessary. Strengthening of the monitoring system for residual pesticides for export expansion has to be implemented. In order to establish plant protection and quarantine mechanism, necessary equipment for analysis and technical trainings for the staff are needed under a soft component.

2) Activities

The proposed component intends to enhance functions of PPD for strengthening plant protection and quarantine. An existing laboratory of PPD in Yangon will be upgraded, while one laboratory will be newly constructed in Mandalay. They are expected to be core laboratories and they will be provided with some advanced pesticide analysis equipment such as a liquid chromatograph-mass spectrometer. On the other hand, 43 offices of PPD at district level will be provided with simple equipment such as stereoscopic microscopes with camera for pest control of agricultural products. It is also planned to organize trainings[18] for the PPD staff to analyze by means of new equipment.

[17] It is mycotoxins that are produced by the fungi species *Aspergillus flavus* and *Aspergillus parasiticus*.
[18] Under Japanese grand aid scheme, there is always soft component, which provides trainings for government

There is a laboratory called National Edible Oil Quality Control Laboratory in Yangon, which is under DOA. This laboratory is equipped with specialized equipment such as gas chromatographer with auto sampler (total 3 numbers), spectrophotometer (2 numbers), and general equipment. If there were well coordinated function with this laboratory, or otherwise if the laboratory were merged with PPD, the PPD will have certain specialized equipment. The laboratory and the PPD are both under DOA, so that the DOA should think of such arrangement in order further to enhance plant protection and quarantine functions in Myanmar. In such case, procurement of equipment could also be minimized.

Given that pesticide registration procedure is not clear, proper registration of pesticides should be established based on the results of effective tests. Certificate describing that no banned pesticide is detected in the agricultural products should be issued for traders to promote export. Proper monitoring system to check residual pesticides in agricultural products should also be established. Furthermore, it is possible to control quality of agricultural products by post-harvest treatment such as fumigation and steaming. It is expected that these integrated attempts can contribute to the enhancement of plant protection and quarantine. Summary of issues and proposed activities are as shown below:

Table 3.2.17 Issues and Proposed Activities for Enhancement of Plant Protection and Quarantine

Output	Issues	Proposed Activities
Strengthening of PPD for pesticide control	✓ Lack of equipment to analyze residual agro-chemicals in agricultural products	✓ Installation of analysis equipment in Yangon, Mandalay and district offices of PPD (e.g. high-performance liquid chromatograph-mass spectrometer etc.) ✓ Examination of collaborating with National Edible Oil Quality Control laboratory ✓ Technical trainings of PPD staff for chemical analysis and pest control as a soft component
Enhancement of pesticide control	✓ Unclear pesticides registration system ✓ Concern of residual pesticide in agricultural products, which suppress export of the products	✓ Establishment of proper pesticide registration system ✓ Certificate issuance that no banned pesticide is detected in the agricultural products ✓ Technical trainings of PPD staff for above matters
Enhancement of quality control	✓ Insufficient post-harvest treatment for quality control of agricultural products	✓ Demonstration of fumigation and steaming techniques by PPD as post-harvest treatment to control the agricultural products quality

3) Outline of the Project

Project Name	No.19 Plant Protection and Quarantine Enhancement			
Project Purpose	To enhance the functions of plant protection and quarantine of MOAI			
Priority Area	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	○			○
Target Area	Yangon laboratory Mandalay laboratory Major laboratory/ district stations/ border stations at 43 Districts			
Implementing Organization	MOAI (PPD)			
Support Organization	Regional DOA office and District DOA office			
Beneficiaries	PPD officers, Traders and Exporters			
Development Effect	Quality improvement of products, Reduction of residual pesticide in agricultural products, Export promotion and capacity development of PPD			
ODA Scheme/ Cost	Grant Aid	Shwebo / Mandalay / Ayeyarwady	1,459 million JPY / place	
Duration of the Project	2 years			

Source: JICA Survey Team

officersôcapacity development.

3.3 Program Implementation Schedule

In this sub-chapter, program implementation schedule is presented by priority area. Total period of the implementation is defined by, in general, the biggest component in the priority area in terms of work volume, though technical cooperation project which aims at capacity building may need longer period of implementation period.

In this pre-feasibility level planning, the longest implementation period is set at 6-year for the cases of undertaking large amount of infrastructure rehabilitation/ construction,; namely, rehabilitation of irrigation systems according to past experiences in the country. On one hand, shortest period of implementation is set at only 1-year in case of dealing with small scale construction. For the technical cooperation projects, 5-year implementation period is proposed as practiced in many cases:

3.3.1 Program Implementation Schedule in Shwebo Area

Total implementation period is set at 5 years taking into account the construction volume of irrigation rehabilitation, the biggest part of the program in terms of investment, and also the duration which needs to develop capacity under technical cooperation projects. Of the 5-year period, small scale components are to be completed within 1 ï 2 year; for example, 1-year implementation can be applied to óAgricultural Machinery Station Enhancementô, Flood Monitoring System Establishmentô, while 2-year implementation could be enough to complete Jetty, Market Improvement (district level), and Plant Protection and Quarantine Enhancement.

Table 3.3.1 Implementation Schedule for Shwebo Priority Area

I.	Component for Productivity Increase	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	Remarks
1	Agriculture Extension Strengthening							
2	Irrigation Rehabilitation							
4	Land Consolidation							
5	Agricultural Machinery Station Enhancement							
6	Agricultural Machinery Dissemination (TSL)							extension to need
7	Flood Monitoring System Establishment							
II.	Component for Agribusiness Promotion							
9	Farm-to-Market Road (FMR) Improvement							
10	Jetty Improvement							
11	Market Improvement (District level)							
14	Small and Medium Agro-enterprise Promotion (TSL)							extension to need
15	Supply Chain Improvement of Rice							extension to need
19	Plant Protection and Quarantine Enhancement							

Source: JICA Survey Team

It is also noted that extension, or 2nd phase, may be required in order to further produce impact for Agricultural Machinery Dissemination (TSL) and Small and Medium Agro-enterprise Promotion (also, TSL) For example, taking into account the loan amount relevant to the latter TSL already agreed, the outreach would not be enough to cover needy farmers in the priority area. The TSL should be extended and up-scaled. Supply Chain Improvement of Rice may also need 2nd phase since there are lots number of stakeholders in the chain.

3.3.2 Program Implementation Schedule in Mandalay Area

Total implementation period in Mandalay area is set at 6 years taking into account the biggest construction volume of irrigation rehabilitation, and also the duration which needs to develop capacity under technical cooperation projects. Agricultural Extension, Land Consolidation and Farm-to-Market road improvement are also implemented over this 6-year period. Of the 6-year period, small scale components are to be completed within 2 ï 3 years; for example, 2-year implementation can be applied to óJetty Improvementô and óPlant Protection and Quarantine Enhancementô. For the PPP

whole sale market establishment, 3-year implementation is proposed with reference to the relatively large scale of the market.

Table 3.3.2 Implementation Schedule for Mandalay Priority Area

I.	Component for Productivity Increase	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	Remarks
1	Agriculture Extension Strengthening							
2	Irrigation Rehabilitation							
4	Land Consolidation							
6	Agricultural Machinery Dissemination (TSL)							extension to need
II.	Component for Agribusiness Promotion							
9	Farm-to-Market Road (FMR) Improvement							
10	Jetty Improvement							
12	PPP Wholesale Market Establishment (Mandalay)							
14	Small and Medium Agro-enterprise Promotion (TSL)							extension to need
15	Supply Chain Improvement of Rice							extension to need
16	Value Chain Enhancement of Vegetables & Fruits							
17	Food Processing Industry Promotion							
19	Plant Protection and Quarantine Enhancement							

Source: JICA Survey Team

3.3.3 Program Implementation Schedule in Nay Pyi Taw Area

Total implementation period in Nay Pyi Taw area is set at 4 years, the shortest period, taking into account the relatively smaller construction volume of irrigation rehabilitation. However, Two Step Loan components and technical cooperation projects, Supply Chain Improvement of Rice and Dissemination of Advanced Farming Technologies should be implemented over 5-year period. New wholesale market and the Plant Breeding Enhancement are planned to be implemented over 2 years taking into account the size of the activities.

Table 3.3.3 Implementation Schedule for Nay Pyi Taw Priority Area

I.	Component for Productivity Increase	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	Remarks
1	Agriculture Extension Strengthening							
2	Irrigation Rehabilitation							
4	Land Consolidation							
5	Agricultural Machinery Station Enhancement cum Machine Testing Center							incldng Machine Testing Center
6	Agricultural Machinery Dissemination (TSL)							extension to need
8	Plant Breeding Enhancement							
II.	Component for Agribusiness Promotion							
9	Farm-to-Market Road (FMR) Improvement							
13	Wholesale Market Development (New)							
14	Small and Medium Agro-enterprise Promotion (TSL)							extension to need
15	Supply Chain Improvement of Rice							extension to need
18	Dissemination of Advanced Farming Technologies							

Source: JICA Survey Team

3.3.4 Program Implementation Schedule in Ayeyarwady Area

Total implementation period for Ayeyarwady area is set at 5 years taking into account the construction volume of polder and drainage rehabilitation, the biggest part of the program in terms of investment, and also the duration which needs to develop capacity under technical cooperation projects. Of the 5-year period, small scale components are to be completed within 1 ï 2 years; for example, 1-year implementation can be applied to óAgricultural Machinery Station Enhancementô, Flood Monitoring System Establishmentô, while 2-year implementation could be enough to complete Jetty, Market Improvement (district level), and Plant Protection and Quarantine Enhancement components.

Table 3.3.4 Implementation Schedule for Ayeyarwady Priority Area

I.	Component for Productivity Increase	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	Remarks
1	Agriculture Extension Strengthening							
3	Polder and Drainage Improvement							
4	Land Consolidation							
5	Agricultural Machinery Station Enhancement							
6	Agricultural Machinery Dissemination (TSL)							extension to need
7	Flood Monitoring System Establishment							
II.	Component for Agribusiness Promotion							
9	Farm-to-Market Road (FMR) Improvement							
10	Jetty Improvement							
11	Market Improvement (District level)							
14	Small and Medium Agro-enterprise Promotion (TSL)							extension to need
15	Supply Chain Improvement of Rice							extension to need
19	Plant Protection and Quarantine Enhancement							

Source: JICA Survey Team

3.4 Program Cost Required

3.4.1 Basis of Cost Estimation

In the previous chapter, a series of program components have been identified and the pre-feasibility level plans have been formulated composed of rationale, purpose, activities and outputs, identification of responsible organization in implementation, etc. This sub-chapter stipulates preliminary cost estimation by component, and the manner of the estimation is summarized below:

- ✓ No.1 Agriculture Extension Strengthening: Major costs are establishment of demonstration farm including input supply, farmer field school, training for the regional/TS DOA extension officers, dissemination materials such as brochures, booklets, DVD, banners, etc. and a set of extension lead team composed of international and national experts, support staff, and procurement of logistics including vehicles and motor bikes. The DOA extension officers are in charge of frontline extension to the famers upon trainings completed by the lead team.
- ✓ No.2 Irrigation Rehabilitation: Major costs are rehabilitation of the aged facilities of hydraulic structures and canal lining, and in some cases rehabilitation of diversion weirs (headworks). The cost was referred to those ones ID regional maintenance office gave to the JICA survey team, on which the team has carried out some modifications examining those facilities across all the irrigation systems in order to keep almost same level of rehabilitation/ improvement amongst the systems. Note that improvement of canal maintenance road (inspection road) is not counted here but in the category of Farm-to-Market Road (FMR) improvement.
- ✓ No.3 Polder and Drainage Improvement; Major costs are rehabilitation and/or replacement of aged sluice gates, dredging, and enforcement of polders. The cost was referred to those ones ID Ayeyarwady maintenance office gave to the JICA survey team, on which the team has made some adjustment with reference to prevalent unit prices in the region. Note that improvement of roads are not included in this component but in the category of Farm-to-Market Road (FMR) improvement.
- ✓ No.4 Land Consolidation: Major costs are for construction of farm road, tertiary level irrigation and drainage canals which run alongside the road, land leveling and re-allocation, demarcation of plot and making ridges, etc. There are number of land consolidation projects already implemented including a JICA pilot project implemented in 2013, and the base cost refers to those actually expensed in the previous projects. Note that facilitation of farmers takes time and this is managed by the relevant government officers (mainly DALMS) under recurrent budge thereby not included in the project cost.

- ✓ No.5 Agricultural Machinery Station Enhancement: There are already agricultural machinery stations in all the priority areas. They are basically established at an extent of township level. In fact, there are townships where there is not yet such station. However, in this case, the neighboring station(s) usually takes care of the township area not having such station. Therefore, major costs under this component are provision of farm machineries such as tractor, combine-harvester, rice-planter, etc. In case of Nay Pyi Taw, a machine testing center is also established attached to a biggest Machinery Station.
- ✓ No.6 Agriculture Machinery Dissemination (TSL): This component aims at assisting famers who need to buy agricultural machineries such as tiller, hand-tractor, tractor, combine-harvester, thresher, etc. by a means of access-friendly loan provision. There was a JICA preparatory study to formulate a plan to provide this sort of two-step loan to MADB. The cost for this component is set same as the loan amount recommend in the study.
- ✓ No.7 Flood Monitoring System Establishment: Major costs are equipment of measuring rainfall and water level and its data transmitting system from the stations to the ID regional office and the headquarters. The cost refers to the ones prevalent in commercial market and it includes installation cost as well.
- ✓ No.8 Plant Breeding Enhancement: Major costs are composed of 2 items such as; 1) building renovation/ rehabilitation, and 2) equipment procurement. In fact, the present plant breeding facilities were once established under a Japanese grant aid project in late 1980s. The items and costs estimated here refer to those ones implemented under the grant aid project. Note that since necessary work items should be examined by assessing the condition of existing facilities, the costs here are only indicative.
- ✓ No.9 Farm-to-Market (FMR) Improvement: There are 3 categories of road to be improved under this component; 1) canal maintenance road under ID, 2) rural road under the responsibility of Department of Rural Development, and 3) regional road under Highway Department which is undertaken only in Ayeyarwady region. The cost estimation is made on basis of quantities preliminary estimated and relevant unit prices applied in the current road works.
- ✓ No.10 Jetty Improvement: The construction cost of jetty is very much dependent on the size, and therefore a standard size of jetty per place is prepared and based on the major work item, e.g. concrete work volume, the cost is preliminary estimated including indirect cost by a certain percentage to the direct cost. It means that the cost here is very first-hand and preliminary only.
- ✓ No.11 Market Improvement (District Level): A typical yard area is prepared and the cost estimation is based on the major work, which is the raised concrete floor and superstructure of the market. With reference to the unit price of concrete floor, the cost is estimated taking into account the associated facilities and in-direct construction cost by a lump-sum percentage. It is therefore the cost here is very first-hand and preliminary only.
- ✓ No.12 PPP Wholesale Market Establishment (Mandalay): The conceptual plan formulated by the in-charge private company indicates a very preliminary complex building including not only the market place with cold storage but also other amenities such as restaurants, banking, hotel and apartment. They have not carried out detail planning and cost estimation either. There is only an indicative amount that is US$ 50 to 100 million. It is therefor that this cost estimation refers to just the mid amount, namely 75 million US$.
- ✓ No.13 Wholesale Market Establishment (New in Nay Pyi Taw): Nay Pyi Taw city development committee has a very preliminary plan to establish this new wholesale market near Nay Pyi Taw station. Since the plan is of still conceptual idea only, the cost estimation here is to prepare for a standard yard area for a wholesale market, about 2 times bigger than the existing ones, based on

which only major direct construction cost, e.g. concrete work, is calculated and together with in-direct cost as certain percentage the total cost is estimated. It is therefore the cost here is very first-hand and preliminary only.

- ✓ No.14 Small and Medium Agro-enterprise Promotion (TSL): This component aims at assisting small to medium Myanmar agro-enterprises, e.g. rice millers, who need to establish or expand their businesses, by a means of access-friendly loan provision. There is already a two-step loan program which started in October 2015. JICA has provided an amount of 5 billion JPY loan to three banks including Small and Medium Industry Development Bank (SMIDB). Though the places that the enterprises can access are Yangon, Mandalay, and Pathein only as of 2015, the cost of this component is set same as the loan amount.
- ✓ No.15 Supply Chain Improvement of Rice: This component is proposed to implement by a technical cooperation project. Therefore the major cost will be dispatch of the experts, procurement of facilities, support staff, logistics of field operation, and trainings. With reference to previous experiences of similar technical cooperation projects, the cost for this component is preliminary estimated.
- ✓ No.16 Value Chain Enhancement of Vegetables and Fruits; Being same as No.15 component, it is planned to implement this component by a technical cooperation project. Therefore with reference to previous experiences of similar technical cooperation projects, the cost for this component is preliminary estimated taking into account expert assignment, procurement of facilities and equipment, a series of trainings, etc.
- ✓ No.17 Food Processing Industry Promotion; Being same as above No.15 and No.16, it is planned to implement this component by a technical cooperation project. Therefore with reference to previous experiences of similar technical cooperation projects, the cost for this component is preliminary estimated taking into account expert assignment, procurement of facilities and equipment, a series of trainings, etc. Note that procurement of facilities would occupy bigger part of the operation cost since demonstration of food processing needs a series of machineries and equipment.
- ✓ No.18 Dissemination of Advanced Agricultural Technologies; Being same as above No.15 to No.17, it is planned to implement this component by a technical cooperation project. Therefore with reference to previous experiences of similar technical cooperation projects, the cost for this component is preliminary estimated taking into account expert assignment, procurement of equipment and materials for demonstration activities, logistics for field operation, and a series of trainings, etc.
- ✓ No.19 Plant Protection and Quarantine Enhancement; this component is to strengthen the capacity of Plant Protection division by providing necessary equipment and a series of trainings. Therefore, the cost estimation is based on the quantities and unit prices of major equipment to be provided, those installation, and trainings.

In estimating the costs of the above No.1 (Extension), No.2 (Irrigation), No.3 (Polder), No.4 (Land Consolidation) and No.9 (FMR Improvement), an Excel macro based cost estimation kit, provided by JICA headquarters, was employed. This is because these components are of certain scale and therefore could be better implemented by an assistance of ODA loan. In estimating the cost of these components, following pre-conditions were set:

(1) Exchange Rate: 1) US$ 1 = ¥ 120.4, 2) US$ 1 = Kyat 1,030.9, 3) Kyat 1 = ¥ 0.117

(2) Price Escalation Rate: 1) Foreign Currency Portion: 1.8%, 2) Local Currency Portion: 5.1%

(3) Physical Contingency: 1) Construction: 5.0%, 2) Consultant: 5.0%

(4) Rate of Tax: 1)VAT: 5.0%, 2) Import Tax: 7.5%

(5) Rate of Administration Cost: 10.0%

(6) Rate of Interest During Construction: 1) Construction: 0.01%, 2) Consultant: 0.01%

For other components than above potential ODA loan assisted ones, price contingency and physical contingency were only counted in addition to the project cost (direct cost) and consultancy/ expert fees. The contingencies were set at 5% and 5% for the price and physical ones respectively with reference to the contingencies applied in the cost estimation of above potential loan assisted components. Note that interest during project implementation and administration were not counted in this stage.

3.4.2 Program Cost Estimation

Following tables summarize the program cost by area and by component. Total program cost required ranges, by priority area, from 185 billion Kyats (Nay Pyi Taw) to as much as 374 billion Kyats (Mandalay). It is noted that the cost includes a nation wide component such as Agricultural Machinery Dissemination (No.6) and Small and Medium Agro-enterpriser Promotion (No.14), both of which are planned to implement by Two Step Loan scheme with a preliminary loan amount of 5 billion JPY each (43 billion Kyats).

There are components which can better be implemented by an ODA project loan assistance. The components are possibly; 1) Agriculture Extension Strengthening (No.1), 2) Irrigation Rehabilitation (No.2), 3) Polder and Drainage Improvement (No.3), 4) Land Consolidation (No.4), 5) Agricultural Machinery Station Enhancement (No.5), 6) Flood Monitoring System Establishment (No.7), 7) Farm-to-Market Road (FMR) Improvement (No.9), 8) Jetty Improvement (No.10), 9) Market Improvement (District level, No.11), and 10) Nay Pyi Taw Wholesale Market Development (No.13). The total cost for those potential project loan components ranges from 71 billion Kyats (Nay Pyi Taw), 106 billion Kyats (Ayeyarwady), 156 billion Kyats (Shwebo), to 193 billion Kyats (Mandalay).

There are market related components; one is to rehabilitate and renovate district level market. This component can be included in the above project loan components. New wholesale market in Nay Pyi Taw is also planned and this component could be constructed by the same project loan. The cost required for the district level wholesale market is estimated at around 670 million Kyats per place; one in Shwebo area and total 5 in Ayeyarwady area. There is a plan to establish large scale wholesale market in Mandalay area. This is to be implemented by PPP, and the cost is tentatively counted at 64 billion Kyats according to an interview to the company in charge.

There are program components which should be implemented by a technical cooperation type project. They area 1) Supply Chain Improvement of Rice (No.15), 2) Value Chain Enhancement of Vegetables & Fruits (No.16), 3) Food Processing Industry Promotion (No.17), and 4) Dissemination of Advanced Farming Technologies (No.18). The cost is mainly composed of; 1) assignment of the experts, 2) trainings, 3) equipment provision, and 4) logistics and operations. The cost ranges from 5 billion Kyats (Dissemination of Advanced Farming Technologies) to 7 billion Kyats (Food Processing Industry Promotion).

Plant Breeding Enhancement (No.8) and Plant Protection and Quarantine Enhancement (No.19) may be implemented by a grant aid as these components do not generate direct profit but are required as a basis of enhancing production for the former component and also for the latter to protect the consumersô health from hazardous agro-chemicals and also for expert promotion. The costs are composed mainly of rehabilitation and renovation of buildings and laboratories, procurement of necessary equipment and a series of trainings. The costs for the components are estimated at around 17 billion Kyats and 12 billion Kyats respectively for Plant Breeding Enhancement (No.8) and Plant Protection and Quarantine Enhancement (No.19).

Table 3.4.1 Summary of Program Cost (Shwebo)

Component	Currecy	Project Cost	Price Escalation	Physical Contingency	Consulting Service / Expert	Interest during Construction	Administration Cost	Compensation Fee	Total	Remark
I. Component for Productivity Increase										
1. Agriculture Extension Strengthening	(million MMK)	4,615	1,113	414	2,557	2	870	0	9,572	
	(million JPY)	540	130	48	299	0	102	0	1,120	
2. Irrigation Rehabilitation	(million MMK)	59,593	11,030	3,735	4,083	21	7,844	0	86,306	
	(million JPY)	6,972	1,290	437	478	2	918	0	10,098	
4. Land Consolidation	(million MMK)	15,200	2,834	968	1,330	5	2,033	0	22,371	
	(million JPY)	1,778	332	113	156	1	238	0	2,617	
5. Agricultural Machinery Station Enhancement	(million MMK)	3,615	181	181	181	0	0	0	4,157	
	(million JPY)	423	21	21	21	0	0	0	486	
6. Agricultural Machinery Dissemination (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
7. Flood Monitoring System Establishment	(million MMK)	1,111	56	56	56	0	0	0	1,278	
	(million JPY)	130	7	7	7	0	0	0	150	
II. Component for Agribusiness Promotion										
9. Farm-to-Market Road (FMR) Improvement	(million MMK)	19,000	3,610	1,236	2,108	7	2,595	0	28,556	
	(million JPY)	2,223	422	145	247	1	304	0	3,341	
10. Jetty Improvement	(million MMK)	2,810	140	140	140	0	0	0	3,231	
	(million JPY)	329	16	16	16	0	0	0	378	
11. Market Improvement (District level), 1 unit	(million MMK)	604	18	30	18	0	0	0	670	
	(million JPY)	71	2	4	2	0	0	0	78	
14. Small and Medium Agro-enterprise Promotion (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
15. Supply Chain Improvement of Rice	(million MMK)	2,438	305	305	3,655	0	0	0	6,702	
	(million JPY)	285	36	36	428	0	0	0	784	
19. Plant Protection and Quarantine Enhancement	(million MMK)	10,567	528	528	845	0	0	0	12,469	
	(million JPY)	1,236	62	62	99	0	0	0	1,459	
Grand Total (million MMK)								**Grand Total**	**260,782**	**million MMK**
Grand Total (million JPY)									**30,511**	**million JPY**
Total (1+2+4+5+7+9+10+11, potential project loan components), million MMK					**Total for potential project loan components**				**156,141**	**million MMK**
Total (1+2+4+5+7+9+10+11, potential project loan components), million JPY									**18,268**	**million JPY**

Source: JICA Survey Team (2015)

Table 3.4.2 Summary of Program Cost (Mandalay)

Component	Currecy	Project Cost	Price Escalation	Physical Contingency	Consulting Service / Expert	Interest during Construction	Administration Cost	Compensation Fee	Total	Remark
I. Component for Productivity Increase										
1. Agriculture Extension Strengthening	(million MMK)	3,504	980	340	2,309	2	713	0	7,849	
	(million JPY)	410	115	40	270	0	83	0	918	
2. Irrigation Rehabilitation	(million MMK)	90,313	18,608	5,710	5,270	38	11,990	0	131,928	
	(million JPY)	10,567	2,177	668	617	4	1,403	0	15,436	
4. Land Consolidation	(million MMK)	11,400	2,442	773	1,609	5	1,622	0	17,851	
	(million JPY)	1,334	286	90	188	1	190	0	2,089	
6. Agricultural Machinery Dissemination (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
II. Component for Agribusiness Promotion										
9. Farm-to-Market Road (FMR) Improvement	(million MMK)	20,043	4,300	1,344	2,542	9	2,823	0	31,062	
	(million JPY)	2,345	503	157	297	1	330	0	3,634	
10. Jetty Improvement	(million MMK)	3,829	191	191	191	0	0	0	4,404	
	(million JPY)	448	22	22	22	0	0	0	515	
12. PPP Wholesale Market Establishment (Mandalay)	(million MMK)								64,103	
	(million JPY)								7,500	
14. Small and Medium Agro-enterprise Promotion (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
15. Supply Chain Improvement of Rice	(million MMK)	2,438	305	305	3,655	0	0	0	6,702	
	(million JPY)	285	36	36	428	0	0	0	784	
16. Value Chain Enhancement of Vegetables & Fruits	(million MMK)	1,759	235	235	2,945	0	0	0	5,174	
	(million JPY)	206	28	28	345	0	0	0	605	
17. Food Processing Industry Promotion	(million MMK)	3,035	320	320	3,355	0	0	0	7,029	
	(million JPY)	355	37	37	393	0	0	0	822	
19. Plant Protection and Quarantine Enhancement	(million MMK)	10,567	528	528	845	0	0	0	12,469	
	(million JPY)	1,236	62	62	99	0	0	0	1,459	
Grand Total (million MMK)								**Total**	**374,039**	**million MMK**
Grand Total (million JPY)									**43,763**	**million JPY**
Total (1+2+4+9+10, potential project loan components), million MMK					**Total for potential project loan components**				**193,092**	**million MMK**
Total (1+2+4+9+10, potential project loan components), million JPY									**22,592**	**million JPY**

Source: JICA Survey Team (2015)

Table 3.4.3 Summary of Program Cost (Nay Pyi Taw)

Component	Currecy	Project Cost	Price Escalation	Physical Contingency	Consulting Service / Expert	Interest during Construction	Administration Cost	Compensation Fee	Total	Remark
I. Component for Productivity Increase										
1. Agriculture Extension Strengthening	(million MMK)	1,453	333	145	1,120	1	305	0	3,356	
	(million JPY)	170	39	17	131	0	36	0	393	
2. Irrigation Rehabilitation	(million MMK)	22,607	3,796	1,454	2,682	7	3,054	0	33,599	
	(million JPY)	2,645	444	170	314	1	357	0	3,931	
4. Land Consolidation	(million MMK)	3,800	651	255	652	1	536	0	5,895	
	(million JPY)	445	76	30	76	0	63	0	690	
5. Agricultural Machinery Station Enhancement (cum Machine Testing Center)	(million MMK)	6,307	315	315	315	0	0	0	7,253	incl. Machine test center
	(million JPY)	738	37	37	37	0	0	0	849	
6. Agricultural Machinery Dissemination (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
8. Plant Breeding Enhancement	(million MMK)	13,212	661	661	2,612	0	0	0	17,145	
	(million JPY)	1,546	77	77	306	0	0	0	2,006	
II. Component for Agribusiness Promotion										
9. Farm-to-Market Road (FMR) Improvement	(million MMK)	9,262	1,557	600	1,175	3	1,259	0	13,855	
	(million JPY)	1,084	182	70	137	0	147	0	1,621	
13. Wholesale Market Development (New)	(million MMK)	5,854	293	293	293	0	0	0	6,732	
	(million JPY)	685	34	34	34	0	0	0	788	
14. Small and Medium Agro-enterprise Promotion (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
15. Supply Chain Improvement of Rice	(million MMK)	2,438	305	305	3,655	0	0	0	6,702	
	(million JPY)	285	36	36	428	0	0	0	784	
18. Dissemination of Advanced Farming Technologies	(million MMK)	1,779	223	223	2,684	0	0	0	4,910	
	(million JPY)	208	26	26	314	0	0	0	574	
Grand Total (million MMK)								**Total**	**184,918**	**million MMK**
Grand Total (million JPY)									**21,635**	**million JPY**
Total (1+2+4+5+9+13, potential project loan components), million MMK					**Total for potential project loan components**				**70,691**	**million MMK**
Total (1+2+4+5+9+13, potential project loan components), million JPY									**8,271**	**million JPY**

Source: JICA Survey Team (2015)

Table 3.4.4 Summary of Program Cost (Ayeyarwady)

Component	Currecy	Project Cost	Price Escalation	Physical Contingency	Consulting Service / Expert	Interest during Construction	Administration Cost	Compensation Fee	Total	Remark
I. Component for Productivity Increase										
1. Agriculture Extension Strengthening	(million MMK)	1,880	553	215	1,870	1	452	0	4,971	
	(million JPY)	220	65	25	219	0	53	0	582	
3. Polder and Drainage Improvement	(million MMK)	23,650	3,697	1,542	3,486	9	3,237	0	35,621	
	(million JPY)	2,767	432	180	408	1	379	0	4,168	
4. Land Consolidation	(million MMK)	15,200	2,850	979	1,533	5	2,056	0	22,623	
	(million JPY)	1,778	333	115	179	1	241	0	2,647	
5. Agricultural Machinery Station Enhancement	(million MMK)	3,615	181	181	181	0	0	0	4,157	
	(million JPY)	423	21	21	21	0	0	0	486	
6. Agricultural Machinery Dissemination (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
7. Flood Monitoring System Establishment	(million MMK)	1,111	56	56	56	0	0	0	1,278	
	(million JPY)	130	7	7	7	0	0	0	150	
II. Component for Agribusiness Promotion										
9. Farm-to-Market Road (FMR) Improvement	(million MMK)	20,993	3,891	1,320	1,515	7	2,773	6	30,505	
	(million JPY)	2,456	455.25	154.47	177.29	0.86	324.38	1	3,569	
10. Jetty Improvement	(million MMK)	3,319	166	166	166	0	0	0	3,817	
	(million JPY)	388	19	19	19	0	0	0	447	
11. Market Improvement (District level), 5 unit	(million MMK)	3,019	18	30	18	0	0	0	3,085	
	(million JPY)	353	2	4	2	0	0	0	361	
14. Small and Medium Agro-enterprise Promotion (TSL)	(million MMK)								42,735	
	(million JPY)								5,000	
15. Supply Chain Improvement of Rice	(million MMK)	2,438	305	305	3,655	0	0	0	6,702	
	(million JPY)	285	36	36	428	0	0	0	784	
19. Plant Protection and Quarantine Enhancement	(million MMK)	10,567	528	528	845	0	0	0	12,469	
	(million JPY)	1,236	62	62	99	0	0	0	1,459	
Grand Total (million MMK)								**Total**	**210,697**	**million MMK**
Grand Total (million JPY)									**24,652**	**million JPY**
Total (1+3+4+5+7+9+10+11, potential project loan components), million MMK					**Total for potential project loan components**				**106,057**	**million MMK**
Total (1+3+4+5+7+9+10+11, potential project loan components), million JPY									**12,409**	**million JPY**

Source: JICA Survey Team (2015)

CHAPTER 4 PROJECT EVALUATION

Economic evaluation is carried out in this Chapter 4 in order to determine the economic viability of the program components. In order to examine the proposed program components in terms economic viability, internal rate of return (EIRR) in economic terms is employed in most cases. However, it is noted that financial basis viability is examined in case of market and rice miller since they should be basically operated by an private entity. In addition, farm budget analysis is also conducted in order to know how much benefit a typical farmer can obtain out of the implementation of components. Analysis results are summarized below (detailed calculation results are attached in Appendices-V):

4.1 Basic Assumptions

The proposed components in the intensive agriculture promotion program include both production increase oriented components and value chain promotion oriented ones. The main components of this program are; 1) agricultural extension strengthening, 2) rehabilitation of irrigation systems, 3) land consolidation, and 4) farm-to-market road rehabilitation in terms of scale of the investment. Although there are other components to be included in the program, some of them are not suited for quantitative evaluation. Above all, the main four components occupy more than 90% of total costs. In this respect, only these four major programs will be undertake for the project economic analysis[1]. Note that agricultural extension strengthening is counted together with irrigation rehabilitation, so that 3 cases analysis is to be made for the major 4 components. The followings are the basic assumption of the economic evaluation:

1) Referring to other similar projects in the irrigation/agriculture sector, the economic life of the project related to agriculture production is designed at 30 years. It means that economic evaluations are encoded over these periods considering the initial investments and also operation and maintenance costs to be accrued.
2) Project cost and benefit are calculated in Myanmar currency Kyat (Ks.).
3) For the operation & maintenance cost, following percentages of total costs are applied,

Operation and Maintenance cost	Irrigation Rehabilitation	Land Consolidation	Road Rehabilitation
	2.0 % [2]	1.0 %	2.0 %

4) In the evaluation, the foreign exchange rate of 1 Kyats = 0.117 JPY is applied as of October 2015.
5) The opportunity cost of capital in Myanmar is not established yet; however, a range of 12% to 15% can be applied as a reference opportunity cost of capital with reference to practices that the World Bank, ADB, and JICA have done so far in the sector of irrigation/agriculture

[1] For the economic evaluation of jetty rehabilitation, refer to ñThe Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar, Feasibility Study on Inland Water Transport Facilities Improvement Development Projectò, 2014.
For showcase components such as ñAgricultural Mechanization Centerò and ñDissemination of Advanced Agricultural Technologiesò, they are intended to encourage farmers to introduce more modernized agricultural methods. It is difficult to estimate their-own quantitative benefits. Thus, economic evaluation for these components are not taken. The program also includes ñFlood Monitoring System Establishmentò, which is not undertaken for economic analysis either since the objective of the component is not directly related to the goal. Similarly, ñPlant Protection and Quarantine Enhancementò is not undertaken as the main objective of this component is to establish an inspection system of import/export agricultural commodities, not to directly promote intensive agriculture.

[2] According to Maintenance Division, Irrigation Department, the current annual maintenance cost is about 29,883 Kyat/ac, at most. In comparing this, the survey finds that two percentage of total cost seems large enough.

development in the world. In this economic evaluation, EIRR should therefore be at least more than 12% and targeted at 15% or more, or otherwise the investment cannot be justified.

6) Transfer costs such as tax and duties are eliminated from the economic cost. Also, price contingency (inflation) cost is not counted in the economic evaluation while physical contingency is counted in the evaluation.

7) Conversion factors are applied to estimate economic costs/prices, or border prices from the financial market ones. Note that conversion factors are not standardized in Myanmar, so that a SCF which was employed in ñFeasibility Study on the Yangon ï Mandalay Rail Improvement Projectò is applied in this economic evaluation3.

Table 4.1.1 Applied Conversion Factors

Particulars	Factor	Remarks
Standard Conversion Factor (SCF)	0.880	SCF which is employed in ñFeasibility Study on the Yangon ï Mandalay Rail Improvement Projectò
Skilled Labor	1.000	Assumed placed under competitive market
Unskilled Labor/ Family Labor	0.600	Assumed with reference to rural unemployment

4.2 Cases for Project Evaluation

The project evaluation is conducted for three cases with the major four components; namely, 1) agricultural extension strengthening + irrigation rehabilitation, 2) land consolidation, and 3) farm to market road rehabilitation. The following sections summarize the evaluation cases by each component:

4.2.1 Cases for Agricultural Extension Strengthening + Irrigation Rehabilitation

Table 4.2.1 shows the cases to examine the project economic viability for irrigation rehabilitation together with agricultural extension strengthening. In total, 4 cases (Base 0ôï Base 2) are undertaken as follows;

Base 0ô It considers only yield increase of monsoon and summer paddy with the project investment. It is assumed that yields will increase up to the mid points of between the current yields and practically expected ones. Practically expected yields have been set from the data reported by regional DOA officers in charge of the extension area of the target irrigation systems.

Base 0: with rehabilitation and better reservoir operation, there should be an extra irrigation water to be availed. Thanks to this, there is an opportunity of enlarging summer paddy cultivation. In Base 0, we consider not only yield increase, but also area expansion of summer paddy based on the water availability. Note that since monsoon paddy is planted almost over the whole irrigable areas, no expansion of monsoon paddy should be undertaken.

Base 1: The newly generated irrigation water is now utilized in expanding winter pulses (chick pea and black gram). The area expansion of pulses is supposed to be three times larger than that of summer paddy estimated in above Base 0. This is because irrigation requirement of summer paddy is usually three times more than that of pulses.

Base2: It is based on the same assumption as at Base 0 case, but now, we assume that 10% of the summer paddy area is diversified to sesame. It is also assumed that the area expansion of sesame is three times larger than the original summer paddy area to be changed to the sesame from the same

[3] According to ñ*The Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar, Feasibility Study on Inland Water Transport Facilities Improvement and Development Project, Final Report*ò, examples of SCF in the surrounding countries are 0.88 in India, 0.86 in Cambodia and 0.87 in Vietnam, which are close to 0.88.

reason above.

Table 4.2.1 Cases for Irrigation Rehabilitation with Agricultural Extension Strengthening

Case	Monsoon Paddy	Summer Paddy	Pulses / Sesame	Remarks
Base 0ô	Yield increase*1	Yield increase*1	Yield not changed	O&M Cost:2%
	Area not changed	Area not changed	Area not changed	
Base 0	Same as Base 0ô	Yield increase	Same as Base 0ô	O&M Cost:2%
		Area increase		
Base 1	Same as Base 0ô	Same as Base 0ô	Yield increase*1	O&M Cost:2%
			Area increase	
Base 2	Same as Base 0ô	Yield increase	Yield increase*1	O&M Cost:2%
		10% less than Base 0	Area increase	

Note; *1 Yields increase to the mid points of between the current yields and practically expected ones. Practically expected yields have been assumed based on the data reported by regional DOA officers in charge of the irrigation area.

Note; *2 Paung Laung Irrigation Scheme in Nay Pyi Taw area currently irrigates only 4,106 acre and after the completion of the canal construction, a total of 28,000 (designed 35,000 acre × 80%) acre is expected to irrigate, increasing an additional area of 23,893 acre.

Source: JICA Survey Team

4.2.2 Cases for Land Consolidation

Land consolidation is supposed to accelerate farm mechanization, which should reduce labor costs, while farmers have to pay additional fuel charges and rental cost of machineries. To show this numerically, farming costs per acre are calculated in each working schedules by with/without land consolidation. Then, we compare the total farming costs between with/without land consolidation in each of the representative crops i.e. monsoon paddy, summer paddy, and black gram.

In addition to above, this economic evaluation also considers yield increases of monsoon paddy, summer paddy, and winter pulses. According to interviews, many farmers experienced the increases upon introduction of land consolidation[4]. The degree of yield increases are based on the questionnaire survey result interviewed to model farmers in Nay Pyi Taw[5] as in the following table. With these assumptions, only a typical case is undertaken for the economic evaluation of land consolidation component. The case takes into account the farmerôs cost increase/ reduction and yield increase between before and after the land consolidation.

Table 4.2.2 Cases for Land Consolidation

Case	Monsoon Paddy	Summer Paddy	Winter Pulses	Remarks
Base0	Labor cost reduced, but machinery cost increased Yield increases by 18%*1	Labor cost reduced, but machinery cost increased Yield increases by 19%*1	Labor cost reduced, but machinery cost increased Yield increases by 17%*1	O&M Cost:1%

Note: *1 Yield increases are based on ñPreparatory Survey for the Project for Rehabilitation of Irrigation Systemsò, 2014

4.2.3 Case for Road Rehabilitation

The benefit of road rehabilitation is estimated by calculating how much transportation cost is reduced with improvement of road conditions. The total transportation cost is composed of fuel costs, loading/ unloading cost, and personnel traveling costs. With the road rehabilitation, loading capacity improvement, transportation speed improvement, and reduction of fuel charges are expected.

[4] According to JICA Study Team (2014): ñP*reparatory Survey for the Project for Rehabilitation of Irrigation Systems", Final Report*, yield increases were observed after land consolidation. It is estimated that various factors such as land leveling, effective water management, and good drainage management have increased the yields.

[5] JICA Study Team (2014): ñ*Preparatory Survey for the Project for Rehabilitation of Irrigation Systems*ò, Final Report

Considering these factors, the JICA team has calculated the difference of total transportation costs between with/without the roads rehabilitation[6]. To collect basic information, the team has conducted a field survey in Pauk Myaing village, Nay Pyi Taw.

Table 4.2.3 Cases for Road Rehabilitation

Case	Monsoon Paddy	Summer Paddy	Remarks
Base0	Farm to market transportation cost such as fuel costs, loading/unloading cost, and traveling personnel costs reduced.	Farm to market transportation cost such as fuel costs, loading/unloading cost, and traveling personnel costs reduced.	O&M Cost:2%

Source: JICA Survey Team (2015)

4.3 Economic Term of Project Cost and Benefit

In this sub-chapter, economic costs and benefits are estimated based on the financial ones and conversion factors. Table 4.3.1 summarizes the financial and economic total costs by program components. Then, the following 4.3.2 summarizes the economic term of project benefits:

4.3.1 Economic Term of Project Cost

Table 4.3.1 summarizes the financial and economic total cost by main program component and by priority area. Since there are several components in each of the priority areas, here, we only indicate the total financial costs and their converted economic costs in each of the program components (For more detail, refer to Appendix V):

Table 4.3.1 Financial and Economic Cost by Main Project Components, million Kyat

Area	Component	Financial Cost			Economic Cost		
		FC	LC	Total	FC	LC	Total
Shwebo	Irrigation Rehabilitation	31,919.5	54,365.5	86,285.1	30,137.4	39,655.1	69,792.5
	Agricultural Extension	3,990.9	5,579.2	9,570.1	3,863.4	4,466.3	8,329.7
	Land Consolidation	8,460.3	13,905.1	22,365.4	8,021.7	10,150.1	18,171.8
	Canal Maintenance Road Rehabilitation	5,962.4	10,081.6	16,044.1	5,648.3	7,303.0	12,951.3
	Rural Road Rehabilitation	4,756.1	7,748.8	12,504.9	4,529.0	5,632.0	10,161.0
	Total	**55,089.3**	**91,680.3**	**146,769.6**	**52,199.9**	**67,206.4**	**119,406.3**
Mandalay	Irrigation Rehabilitation	47,897.7	83,992.1	131,889.8	44,820.3	60,027.7	104,848.0
	Agricultural Extension	3,465.8	4,380.6	7,846.4	3,373.7	3,474.5	6,848.2
	Land Consolidation	6,974.0	10,871.5	17,845.5	6,632.0	7,826.1	14,458.0
	Canal Maintenance Road Rehabilitation	4,960.7	7,961.5	12,922.1	4,715.3	5,699.4	10,414.7
	Rural Road Rehabilitation	6,719.8	11,410.7	18,130.6	6,334.8	8,122.0	14,456.8
	Total	**70,018.0**	**118,616.4**	**188,634.4**	**65,876.0**	**85,149.7**	**151,025.7**
Nay Pyi Taw	Irrigation Rehabilitation	13,001.8	20,591.2	33,592.9	12,457.6	15,388.1	27,845.7
	Agricultural Extension	1,595.8	1,759.5	3,355.3	1,579.7	1,429.0	3,008.6
	Land Consolidation	2,407.6	3,486.0	5,893.6	2,327.2	2,609.5	4,936.8
	Canal Maintenance Road Rehabilitation	1,765.4	2,500.4	4,265.9	1,714.2	1,862.0	3,576.1
	Rural and Regional Road Rehabilitation	3,596.7	5,989.8	9,586.5	3,426.8	4,410.8	7,837.6
	Total	**22,367.3**	**34,326.9**	**56,694.2**	**21,505.5**	**25,699.4**	**47,204.9**
Ayeyarwady	Irrigation Rehabilitation	15,163.2	20,448.5	35,611.7	13,929.2	16,071.0	30,000.2
	Agricultural Extension	2,323.5	2,646.3	4,969.7	2,306.4	2,164.5	4,470.9
	Land Consolidation	8,714.5	13,903.0	22,617.5	8,288.6	10,148.1	18,436.7
	Rural and Regional Road Rehabilitation	11,126.4	19,371.1	30,497.6	10,492.8	13,987.3	24,480.0
	Total	**37,327.6**	**56,368.9**	**93,696.5**	**35,017.0**	**42,370.9**	**77,387.8**

Note: Tax and land acquisition cost are excluded from the economic cost since they are transfer payment.
Source: JICA Survey Team

To accomplish the yield increases, not only irrigation rehabilitation but also agricultural extension

[6] Note that, in this evaluation, the benefit of bridge construction projects is not taken into account because there are too many to specify the benefits of each construction. Alternatively, we estimated the numerical impact of bridge construction/rehabilitation as a case study.

services are important. The JICA team therefore assumes that the yield increases and area expansions could be accomplished after irrigation rehabilitation and technical assistance are to be conducted. In other words, the economic evaluation is performed with the total cost of these two components; irrigation rehabilitation and agricultural extension.

4.3.2 Economic Term of Project Benefit

Table 4.3.2 summarizes farm-gate prices and net profit ratio in financial and economic terms. Since there are many cases, only the total financial and economic benefits are indicated in the table below (for detail, refer to the Appendix V):

Table 4.3.2 Economic Term of Farm-gate Price and Net Profit Ratio

Title	1.Sagaing	2.Mandalay	3.Nay Pyi Taw	4.Ayeyarwady
Farmgate Price (Financial)				
Monsoon Paddy (kyat/bsk)	7,327	6,078	4,826	5,253
Summer Paddy (kyat/bsk)	4,562	5,602	5,313	4,195
Pulses (kyat/bsk)	11,786	23,926	27,938	27,295
Sesame (kyat/bsk)	23,630	47,952	36,167	N.A
Farmgate Price (Economic)				
Monsoon Paddy (kyat/bsk)	6,448	5,349	4,247	4,623
Summer Paddy (kyat/bsk)	4,015	4,930	4,675	3,692
Pulses (kyat/bsk)	10,372	21,055	24,585	24,020
Sesame (kyat/bsk)	20,794	42,198	31,827	N.A
Net Profit Ratio (Financial)				
Monsoon Paddy (%)	61.2	55.6	52.5	60.3
Summer Paddy (%)	57.7	57.9	58.9	59.2
Pulses (%)	65.4	72.9	69.3	77.5
Sesame (%)	63.7	68.8	71.1	N.A
Net Profit Ratio (Economic)				
Monsoon Paddy (%)	58.0	52.0	48.6	57.1
Summer Paddy (%)	54.9	55.1	56.2	56.5
Pulses (%)	56.4	65.8	63.9	73.6
Sesame (%)	57.4	63.4	66.1	N.A

Note1: Farm-gate price was averaged within the farmer households surveyed under this JICA Survey.
Note2: Net profit ratio was calculated by JICA Survey Team based on the household survey results conducted by JICA team
Source: JICA Survey Team

Table 4.3.3 summarizes the annual financial and economic benefit of land consolidation. To calculate the annual economic benefit, farm-gate prices and farming costs (e.g. labor costs, input costs, and rental cost of machineries) are converted to economic prices by using conversion factors.

Table 4.3.3 Financial and Economic Benefit of Land Consolidation

Title	1.Sagaing	2.Mandalay	3.Nay Pyi Taw	4.Ayeyarwady
Total Financial Gross Profit Increase , million Kyat				
Monsoon Paddy	1,569.7	1,151.7	299.8	1,461.4
Summer Paddy	979.4	849.8	255.0	1,131.0
Chick Pea	74.0	361.5	54.9	440.0
Total	**2,623.2**	**2,363.0**	**609.7**	**3,032.4**
Total Economic Gross Profit Increase , million Kyat				
Monsoon Paddy	1,381.4	1,013.5	263.8	1,286.1
Summer Paddy	861.8	747.9	224.4	995.4
Chick Pea	65.2	318.1	48.3	387.2
Total	**2,308.4**	**2,079.5**	**536.6**	**2,668.8**
Total Financial Cost Reduction, million Kyat				
Monsoon Paddy	1,584.0	1,188.0	396.0	1,980.0
Summer Paddy	1,121.7	727.3	242.4	1,325.4
Chick Pea	160.1	634.5	55.4	584.9
Total	**2,865.8**	**2,549.9**	**693.8**	**3,890.3**

Title	1.Sagaing	2.Mandalay	3.Nay Pyi Taw	4.Ayeyarwady
Total Economic Cost Reduction, million Kyat				
Monsoon Paddy	78.1	58.6	19.5	97.7
Summer Paddy	107.0	69.4	23.1	126.4
Chick Pea	83.7	331.7	29.0	305.8
Total	**268.8**	**459.7**	**71.6**	**529.9**
Annual Benefit (Financial)[7]	**5,489.0**	**4,912.8**	**1,303.6**	**6,922.7**
Annual Benefit (Economic)	**2,577.2**	**2,539.2**	**608.2**	**3,198.6**

Note1: Financial farming cost per acre was calculated by JICA Survey Team, based on the result of the questionnaire survey conducted at Lat Pan Kha Hla village, Nay Pyi Taw.

Note2: To see the detail calculation, refer to Appendices V., Source: JICA Survey Team

Table 4.3.4 summarizes the basic condition of road rehabilitation. The major vehicles used in rural roads are animal cart, trawllergy (hand-tractor engine driven cart), and small & medium truck. According to a survey conducted by JICA team, the shares of transportation volume by these main vehicles are approximately 10%, 20%, and 70%, respectively. The current condition of the target rural roads is earthen road, and some of them will be rehabilitated to asphalt road, while others will be to gravel road. Basic conditions set under this economic analysis are shown below:

Table 4.3.4 Basic Conditions of Road Rehabilitation

Type of Vehicles	Fuel Charges		Personnel Charges		Speed (km/hr)	Load capacity (basket)
	Financial	**Economic**	**Financial**	**Economic**		
	Unit Cost (Kyats/km)	Unit Cost (Kyats/km)	Cost per hour	Cost per hour		
Animal Cart (Earthen)	0.0	0.0	4,000	2,400	10.0	30
Animal Cart (Gravel)	0.0	0.0	4,000	2,400	10.0	30
Animal Cart (Asphalt)	0.0	0.0	4,000	2,400	10.0	30
Trawllergy (Earthen)	1250.0	1100.0	4,000	2,400	10.0	50
Trawllergy (Gravel)	1041.7	916.7	4,000	2,400	13.5	65
Trawllergy (Asphalt)	833.3	733.3	4,000	2,400	17.0	80
Small and Medium Truck (Earthen)	625.0	550.0	4,000	2,400	10.0	100
Small and Medium Truck (Gravel)	520.9	458.3	4,000	2,400	16.0	125
Small and Medium Truck (Asphalt)	416.7	366.7	4,000	2,400	22.0	150

Note: Based on the interview at Pauk Myaing village, Nay Pyi Taw on November 2015. This village is located beside Thar Wutti-Pauk Mying- Sittaung Road. The length is about 5.6 km, and the width is 12 feet. The current condition depends on this yearøs situation (2015), and planned condition is based on villagerøs experience for similar asphalt roads. As for gravel road, we assume that unit cost of fuel charge, traveling speed, and loading capacity are set at the midpoint between earthen and asphalt road.

Since there are many target rural roads, it is hard to estimate total benefit in each of the rehabilitation schemes. Alternatively, the JICA team estimated unit benefits by pavement types (i.e. asphalt and gravel), as is summarized in the following table. Then, the total annual benefit is calculated as the product of unit benefit and the length of rehabilitation.

In Ayeyarwady area and Nay Pyi Taw area, the rehabilitation component has included regional roads. Since these regional roads are of center of distribution in the area, people living here must be benefitted from these road every day. It means that the impact for regional economy may not be limited only to the farmers. However, focusing on the project objective, only benefits for agricultural

[7] The JICA team supposed that, without land consolidation, the farming method that farmers in the beneficial area have introduced is ñlabor-intensiveò, and largely depend on hired labors. Also we suppose, these hired labors will be replaced to machinery after land consolidation. The assumption seems reasonable because we found that the labor shortage becomes serious every year in many villages. However, our calculation found that, after converting to economic prices and costs, the total farming cost per acre with land consolidation becomes higher than the case without land consolidation (Note that the conversion factor for unskilled labor is 0.6 and SCF is 0.88). It may imply that the current wages of agricultural labors are small enough that farmers feel machinery usage is relatively expensive. In spite of this, the team considers that the importance of land consolidation still exists, because the wages of agricultural labor has been continuously increasing.

commodities are taken into account in this economic evaluation of road:

Table 4.3.5 Summary of Financial and Economic Benefit of Road Rehabilitation

	Particulars	Financial	Economic
1)	Total length of the model road (km):	5.6	5.6
2)	Total Benefit of the model road, Asphalt Pavement (Million Kyat/5.6km):	142.5	91.6
3)	Total Benefit of the model road, Gravel Pavement (Million Kyat/5.6km):	87.5	56.2
4)	Benefit per mile, Asphalt Pavement (Million Kyat/mile):	40.71	26.17
5)	Benefit per mile, Gravel Pavement (Million Kyat/mile):	25.00	16.06

Source: JICA Survey Team

4.4 Project Economic Evaluation

4.4.1 Economic Project Benefits

Table 4.4.1 shows the quantified economic project benefits. These benefits, however, will not be fully realized immediately after the irrigation rehabilitation. Table 4.4.2 summarizes the degree of effect realization by year and by program component. The benefit of irrigation rehabilitation will accrue with the implementation of agricultural extension component step by step.

We assume that, to achieve the planned yields, it will take several years as 0% in first year after the construction completion (assumed to the year of extension preparation), 0% in 2nd year after the construction completion (assumed to be the extension commencement but not yet farmers apply), 10% in 3rd year after the completion, 30% in 4th years after the completion, 60% in 5th years after the completion, and 100% in 6th year and onwards after the completion. Note that the 1st year indicated in Table 4.4.2 is for detail design, so that the construction is to start from the 2nd year, consuming total 5 years to complete.

On the other hand, the degree of effect realization for land consolidation and farm road rehabilitation are assumed to accrue one year later after the construction has been completed. Note that construction is progressed step by step over a 5-year period, accordingly benefit in entire project area is generated step by step.

Table 4.4.1 Economic Project Benefits by Priority Area

Project Component	Case	Explanation	Quantified Annual Benefit (Million Kyat)			
			Shwebo	Mandalay	Nay Pyi Taw	Ayeyar wady
Irrigation Rehabilitation + Agricultural Extension	Base 0ô	Effective water management that increased yield per acre.	20,858	16,758	9,433 (2,295)	5,303
	Base 0	Effective water management that increased yield per acre. Additional water supply that increased summer paddy cropping acreage.	32,386	32,641	10,831 (3,930)	10,175
	Base 1	Effective water management that increased yield per acre. Additional water supply that increased pulses cropping acreage.	36,699	50,479	13,487 (7,040)	-
	Base 2	On the top of base0, 10 percent of summer paddy acreage is replaced to sesame	39,929	45,872	13,438 (5,783)	-
Land Consolidation	Base 0	Introducing machinery on farming that reduce farming cost per acre.	2,583	2,539	608	2,558
		Land leveling, proper water management, proper drain management that increases yield per acre.				
Road Rehabilitation	Base 0	Road pavement that reduces transportation cost such as personnel expense as well as fuel charges.	5,067	5,258	1,705	3,647

Note: Reference case without Paung Laung irrigation scheme is shown in parenthesis

Source: JICA Survey Team (for detail, refer to Appendix V)

Table 4.4.2 Economic Project Benefits by Year

Item	1st (DD) *1	2nd Yr *2	3rd Yr *2	4th Yr *3	5th Yr	6th Yr	7th Yr
Irrigation Rehabilitation	0.0%	0.0%	0.0%	2.0%	8.0%	20.0%	40.0%
Land Consolidation	0.0%	0.0%	28.0%	46.0%	64.0%	82.0%	100.0%
Farm Road Rehabilitation	0.0%	0.0%	28.0%	46.0%	64.0%	82.0%	100.0%
Item	8th Yr	9th Yr	10th Yr	11th Yr	12th Yr	13th Yr	14th Yr
Irrigation Rehabilitation	60.0%	78.0%	92.0%	100.0%	100.0%	100.0%	100.0%
Land Consolidation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Farm Road Rehabilitation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: *1: 1st year is for detail design, so that the construction is to start from the 2nd year covering 5 years.
*2: 2nd year for the project is the commencement of construction and it is the preparation year for extension service strengthening. In 3rd year, the extension is to start, yet the farmers have not applied such technologies extended, and accordingly the benefit is still 0%.
*3: in 4th year, benefit for extension is assumed to be 10% while the covered area by the project is assumed to be 20% (construction is assumed to take 5 years, so that one-year completion is assumed to be 20%). Therefore the benefit in the 4th year is assumed to be 2% (10% x 20%).

Source: JICA Survey Team

4.4.2 Economic Internal Rate of Return (EIRR) and Net Present Value (NPV)

EIRR and NPV are calculated by priority areas, and the results are summarized in Table 4.4.3. Regarding irrigation rehabilitation including agricultural extension strengthening, the largest project component, Shwebo shows more than 15% opportunity cost ratio even only with yield increase (Base 0õ). This region has the largest irrigable area, while cost per acre is the smallest. Moreover, the farm gate price of monsoon paddy is the highest because ñShwebo Pawsanò variety is well-known as a bland rice variety in Myanmar. Therefore, this area should have largest potential in investment:

Table 4.4.3 Economic Internal Rate of Return (%) and Net Present Value (million Kyats)

Case	Shwebo		Mandalay		Nay Pyi Taw		Ayeyarwady	
	IRR	NPV	IRR	NPV	IRR	NPV	IRR	NPV
Irrigation Rehabilitation								
Base0õ*1	15.1%	496	8.4%	-31,697	16.9% (4.5%)	3,162 (-9,028)	8.7%	-9,457
Base0*1	21.3%	29,092	16.3%	7,540	18.8% (10.1%)	6,629 (-4,974)	16.4%-	2,628
Base1*1	23.2%	39,791	22.5%	51,700	22.1% (17.3%)	13,216 (2,741)	-	-
Base2*1	24.6%	47,803	21.1%	40,297	22.0% (14.7%)	13,096 (-376)	-	-
Land Consolidation								
Base0*2	12.9%	779	16.6%	3,141	10.8%	-277	12.5%	464.1
Road Rehabilitation								
Base0*2	20.5%	9,366	19.7%	9,060	12.9%	466	12.9%	956

*1: NPV is calculated at 15% discount ratio., *2: NPV is calculated at 12% discount ratio (Unit: Million Kyat).
Note: Reference case without Paung Laung irrigation scheme is shown in parenthesis
Source: JICA Survey Team, refer to Appendices-V

In Nay Pyi Taw, the mid and downstream area of Paung Laung irrigation scheme is designed to irrigate a total paddy field of 35,000 acre during monsoon season while actually irrigated area for the last 5 year is only 4,106 acre. Till year 2013/14, approximately MUS$ 50 had been invested in Paung Laung irrigation scheme; however, no budget allocation was made in the latest year of 2014/15, leaving unfinished parts along the main canal.

Therefore, given an additional 4.8 billion Kyats, the Paung Laung irrigation scheme is expected to complete, benefitting the huge monsoon paddy and summer paddy area. Considering this sunk costs, we assume that the new beneficial area will be generated after Paung Laung irrigation scheme

completion. As a result, Nay Pyi Taw shows more than 15% opportunity cost ratio in all base cases.

On the other hand, the Team also calculated IRR and NPV ignoring Paung Laung irrigation scheme. The reference case is summarized in the parenthesis in above table The results show that EIRR could not exceed 15% opportunity cost ratio even for the case summer paddy area increase was taken into account (Base 0).

For land consolidation, Nay Pyi Taw shows less return than 12% opportunity cost ratio. In Nay Pyi Taw, the planting ratio of summer paddy and pulses are relatively low (for example, as compared to Ayeyarwady, 33.3 percent versus 42.2 percent for summer paddy, also, 60.0 percent versus 65.6 percent for black gram), and farm-gate price of monsoon paddy is the lowest among 4 priority area. Therefore, the land consolidation in Nay Pyi Taw area resulted in lower rerun of the investment.

As for other priority areas, they show more than 12% opportunity cost ratio with Mandalay achieving more than the 15%. In Mandalay, not small number of farmers have already introduced three-cropping pattern which causes the very high cropping ratio of pulses (e.g. chick pea). In addition to this, current yields and also farm-gate prices of monsoon and summer paddy have recorded high as compared to other areas. In addition, introducing farm machinery in this area is relatively high. These facts also indicate that land consolidation is demanded high in Mandalay area in order to introduce agricultural machineries.

Lastly, road rehabilitation component exceeded 12% opportunity cost ratio in all the 4 priority areas; however, only Shwebo and Mandalay showed more than 15%. This difference may come from unit cost of gravel roads. In Nay Pyi Taw and Ayeyarwady, the cost of gravels is considerably high as compared to other priority areas, approximately more than 4-5 times higher than those of other areas, since the availability of gravel in these areas are relatively low.

In fact, the road rehabilitation component in the areas of Nay Pyi Taw and Ayeyarwady include regional roads, which could benefit not only farming but also regional economies. Despite the estimated benefit focusing only on agricultural commodities, IRR has marked more than 12%, i.e. 12.9% in Nay Pyi Taw, and 12.9% in Ayeyarwady. Therefore, with further investigation considering other regional transportations such as non-agricultural commodities, the return would be higher enough.

4.5 Financial Evaluation for Wholesale Market and Rice Miller

In this sub-chapter, the Team will discuss financial variability of such components as; Market Improvement (district level) by renovation and rice miller improvement to be assisted under Small & Medium Agro-enterprises Promotion (by 2 step loan). These components should have financial variability as a business entity, so that the activities can financially be sustainable:

4.5.1 Financial Evaluation of Local Wholesale Market Rehabilitation

Financial evaluation of local wholesale Market Improvement (rehabilitation/ renovation) is conducted on one model market: Aherrathukha market, Pyinmanar township, Nay Pyi Taw. The market was opened in May 2008, and the total area of this market occupies an area of about 47 acre. This market has 100 stalls for wholesale warehouse, 16 stalls for restaurants, as many as 1,080 stalls for grocery/vegetables, and 120 stalls for meat/fish.

According to the following table, the current incomes and expenditures for the market operation are almost balanced. The current annual total income is about 110.2 million Kyats, while the total expenditure is 111.8 million Kyats. Among annual total income sources, stall tax, stall registration fees, and stall rental fees collectively occupy about 72.9 Million Kyats. It shows that incomes from tenants are the most important sources for the market.

Table 4.5.1 Current Income Sources in Aherrathukha Market

No.	Income Source	Month	Year
1	Renter Name Changing Fees	30,000	360,000
2	Stall Tax	3,175,150	38,101,800
3	Stall Registration Fees	160,100	1,921,200
4	Stall Rental Fees	2,743,300	32,919,600
5	Entrance fees for Motor and Security License Fees	806,667	9,680,004
6	Public Toilet and Bathroom License	2,244,950	26,939,400
7	Surcharge	27,840	334,080
	Total	**9,188,007**	**110,256,084**

Source: Nay Pyi Taw City Development Committee

Table 4.5.2 Current Expenditures in Aherrathukha Market

No.	Expenditure	Month	Year
1	Salary	889,962	10,679,544
2	Allowance	390,000	3,680,000
3	Charges for Work	4,383,200	52,598,400
4	Fuel, Lubricant	2,199,100	26,389,200
5	Seal, Tele and communication	17,000	204,000
6	Electric City and Power	1,005,884	12,070,608
7	Properties	403,300	4,839,600
8	Maintenance Fees and Repair Charges (Other)	30,417	369,004
	Total	**9,318,863**	**111,826,356**

Source: Nay Pyi Taw City Development Committee

The current hygiene condition in Aherrathukha market is not enough to keep the freshness of vegetables. For example, the ground of this market is not paved, and drainage systems need to be upgraded. Under the current condition, a pile of wastes is generated every day, especially tomato, cabbage, and Chinese cabbage. These vegetables get smaller and smaller after peeling the damaged parts, while others are completely wasted especially during monsoon season.

Estimated daily total losses of fresh vegetables in Aherrathukha market is estimated at around 13 ton/day, according to Nay Pyi Taw City Development Committee. If the market loss will be mitigated, the procurement cost for tenants should also be reduced. In other words, even if the tenant fee would increase in order to avail of the fund for the rehabilitation of the market facilities, the net profit for the tenants would keep unchanged or even increased provided that the reduction of the loss could compensate it enough. In this respect, financial evaluation is performed under three basic cases:

1) Base 0: the market loss will be reduced by 10 % (1.3 ton/day)
2) Base 1: the market loss will be reduced by 20 % (2.6 ton/day)
3) Base 2: the market loss will be reduced by 30 % (3.9 ton/day)

To calculate cost reduction, the market loss have to be converted in monetary basis. However, in Aherrathukha market, various kinds of vegetables are distributed such as tomato, cabbage, Chinese cabbage, garlic, onion, potato, ginger, taro and so on. For the purpose of simplicity, an averaged vegetable price is applied based only on three ñrepresentative vegetablesò; namely, tomato, cabbage, and Chinese cabbage. The calculation is summarized in Table 4.6.3. The estimated annual procurement cost reduction in the whole market is about 166.3 million Kyats with 10% reduction, 332.6 million Kyats with 20%, and 498.9 million Kyat with 30% loss reduction respectively.

Table 4.5.3 Estimation of Loss Prevention with Market Rehabilitation

Title	Base 0	Base 1	Base 2
1) Current total amount of loss per day (t/day)	13.0	13.0	13.0
2) Percentage of loss reduction (%)	10%	20%	30%
3) Planned total amount of loss per day (t/day)	11.7	10.4	9.1
4) Estimated Total loss reduction (t/day)	1.3	2.6	3.9
5) Average financial price of major vegetables (kyat/kg)	457	457	457

Title	Base 0	Base 1	Base 2
6) Estimated procurement cost reduction per day (million kyat/day)	0.59	1.19	1.78
7) Estimated procurement cost reduction (million kyat/year)	166.3	332.6	498.9
8) 7) ×0.3 (Million kyat/year)	49.9	99.8	149.7
9) 7) ×0.5 (Million kyat/year)	83.2	166.3	249.5
10) 7) x0.7 (Million kyat/year)	116.4	232.8	349.2

Source: JICA Survey Team

For the market operation, the reduction of the loss can create an opportunity of imposing additional tax to the tenants. Given the total reduction of the loss, in turn equal to the reduction of procurement cost, the Team considers following three cases;

Case 1: Additional tax fee is equivalent to 30% of the total reduction of loss cost (See ñ8)ò).

Case 2: Additional tax fee is equivalent to 50% of the total reduction of loss cost (See ñ9)ò).

Case 3: Additional tax fee is equivalent to 70% of the total reduction of loss cost (See ñ10)ò).

The planned income in Aherrathukha market is the sum of current income (110.2 million Kyats) and additional tax fee summarized in the above table, 8) to 10). The basic conditions of this financial evaluation are as follows;

1) By referring to similar project[8], the project life is set at 20 years.
2) Capital investment is set at 670 million Kyats with the rehabilitation/ improvement such as raised concrete floor by 30 cm, steel poles super structure.
3) Current operation and management (O&M) cost is 111.8 million Kyats (see Table 4.5.2), and incremental operation and management fee is assumed to be 1.0% of the total capital investment, 6.7 million Kyats, and accordingly the total planned O&M cost is set at 118.5 million Kyats per annum.
4) The current interest ratio in private banks is around 13%[9,] and therefore 15% is selected as discount ratio in this financial viability analysis.
5) Half of the annual benefit is assumed to generate at the first year of project period as the construction is to complete within 6 months. From the second year, full-annual benefit is counted.

Financial viability results area summarized in Table 4.5.4. The positive net present value implies that the tax fee increase is large enough to recover the initial investment within 20 years under 15% discount ratio. In Case 1, only Base 2 shows more than 15%. In Case 2, Base 1 and Base 2 exceed 15% opportunity cost ratio. Finally, in Case 3, all of the three base cases (Base 0 ï Base 2) exceed the cut-off ratio.

Table 4.5.4 Result of Financial Evaluation for Wholesale Market Improvement

Cases	Case 1: 30% cost reduction becomes additional tax fee			Case 2: 50% cost reduction becomes additional tax fee			Case 2: 70% cost reduction becomes additional tax fee		
	IRR	NPV	Tax Income Change	IRR	NPV	Tax Income Change	IRR	NPV	Tax Income Change
Base 0, (10%)	2.0%	-344.0	145%	9.4%	-164.8	175%	15.5%	14.5	206%
Base 1, (20%)	12.5%	-75.1	190%	23.8%	283.4	251%	34.2%	641.9	311%
Base 2, (30%)	21.1%	193.8	236%	36.8%	731.6	326%	52.1%	1,269.4	417%

Note: NPV is calculated with 15% discount ratio, Source: JICA Survey Team

[8] ñThe study on distribution mechanism reform through development of wholesale market (improving of post-harvest handling and market facilities in Indonesia) (Agriculture), Final Report, January 2012, JICA Study Team (2012)

[9] ñPreparatory Survey on Two-Step Loan Project for Small and Medium Enterprises Development in the Republic of the Union of Myanmarò., JICA Study Team (2014)

The result finds that there is a trade-off between additional payment for tenants and the wholesaleôs return. If the market imposes tax charges more, the IRR will increase, while on the other hand too much tax increase would invite objections from the tenants. Perhaps, more than 200% of tax income change (increase by 100%) will bring about the objection to the market improvement. According to Base 0 ï Case 2 (the market loss reduction is by 10%, and 70% of cost reduction becomes tenant taxes), IRR is more than 15% showing this project is financially viable, and cost reduction for the tenants can compensate enough for the tax increment. However, still, planned tax fee is 2.06 times (206%) larger than that of the current level.

In contrast to this, Base 1ï Case 1 (the market loss reduction is by 20%, and 30% of cost reduction becomes tenant taxes), the planned tax fee is about 1.9 times (190%) larger than that of the current tax fee that may be accepted by the tenants. In this case, however, the IRR is only 12.5%, less than the market interest, which means this investment is not financially viable. It means that the capital investment can not be returned out of the hiked tenant tax fee under this Base 1 ï Case 1.

From these point of views, it may be concluded that there is a difficulty to execute the rehabilitation/ improvement by the wholesale marketôs own efforts. At least, some parts of the initial investment should be supported or subsidized by the Government or donors. Otherwise, the tax should be hiked more than 2 times, and in this case the tenants may not agree on the rehabilitation/ improvement of the market.

4.5.2 Small and Medium Agro-enterprise Promotion (by TSL)

In this sub-chapter, financial validity of a 2-step loan support project, rice mill improvement, will be examined. Rice mill upgrading/ rehabilitation should be covered by private initiatives, probably with an assistance of accessible loan. Many rice mills in Myanmar are very old, and need to be rehabilitated. According to statistics, current milling ratio is around 50% in whole Myanmar (DOA). Poor quality of rice mills cause huge amount of broken rice. Therefore, rehabilitation of rice mill is essentially important to produce higher quality of rice.

In Myanmar, there are a dozens of small and medium rice mills within one township. Small rice mills tend to be located near villages. They do not procure paddies from famers, but only take service charges for the milling on behalf of farmers. Medium and large rice mills are often located in the main cities, or suitable places for distribution connecting with main roads. For this loan support project, the targeted rice miller is the medium and large scale rice millers with capacity of around 15 ton/day.

The Team collected budget data from rice millers in Nay Pyi Taw area as a sample case. Using these information, initial investment, operation and maintenance fee, gross profits are estimated as follows:

1) Initial investment: Investments in the loan support project include a set of facilities which are necessary for upgrading the rice mills. For example, one rice miller the Team interviewed in needs a loan for rehabilitating the following facilities: engine, mill, separator, polisher, whitening machine, de-stoner, and sizing machine:

Table 4.5.5 Set of Investments for Upgrading Rice Mill

Facilities	Country	Costs
Engine (Electricity)	China	25.0 Million Kyats
Mill	China	6.3 Million Kyats
Separator	China	7.3 Million Kyats
Polisher	China	8.5 Million Kyats
Whitening Machine	China	9.0 Million Kyats
De-stoner	China	3.5 Million Kyats
Sizing Machine	China	3.5 Million Kyats
Total		63.1 Million Kyats

Source: JICA Survey Team, based on interviews for rice millers, December 2015.

The total investment comes to 63.1 million Kyats in the above case. On top of that, considering other investments such as tax fee, small equipment costs, etc., the total investment is now assumed at 84.0 million Kyats, also by adding 5 percent as physical contingencies.

2) Operation and maintenance cost (O&M cost): O&M cost is composed of energy cost (electricity, stream, diesel, and gasifier), minor maintenance fee, and large maintenance fee (replacing rollers, for example). The annual operation and maintenance fee is about 11.5 million Kyats, or 14.4% of total cost in the above example. Therefore, the O&M cost is set at 15% of the total investment cost.

3) Annual profit: For the rice millers, there are two times of busy season in a year, namely, harvesting season of monsoon paddy (February - March) and summer paddy (October - December). The Team collected monthly budgets data for a typical rice miller with 15 tons capacity. The budget is calculated by busy season and by non-busy season, and the annual profit is the sum of monthly profit. The gross profit is the total of rice selling, broken rice selling, husk selling, and service charges. To calculate the net income, input cost is deducted from the gross profit. Input cost is composed of procurement costs of monsoon and summer paddy, and labor costs.

According to the Table 4.5.6 below, the gross profit is about 119.2 million Kyat/month in busy season, and it is 28.4 million Kyat/month in non-busy season. On the other hand, the input cost is about 114.1 Kyat/month in peak season, while it is 26.1 million Kyat/month in non-busy season. Then, the monthly net income comes to 5.1 million Kyat in busy season, and 2.2 million Kyat in non-busy season. Based on the monthly net profits, total annual profit is estimated at around 43.9 million Kyats.

Table 4.5.6 Rice Miller's Budget on Busy Month, and on Normal Month

Title	On Busy Month (February ï March, October - December)				On Normal Month (Other months)			
	Unit	Quantity	Price per unit (Ks)	Value (Kyat)	Unit	Quantity	Price per unit (Ks)	Value (Kyat)
Paddy Purchase	Bsk	18,000	5,800	104,400,000	bsk	3,300	7,000	23,100,000
Staff and Labor	man/month	20	150,000	3,000,000	month	12	150,000	1,800,000
Transportation(farm-mill)	Ks/bsk	18,000	100	1,800,000	Ks/bsk	3,300	100	330,000
Transportation(mill-retail)	Ks/bag	5,400	900	4,860,000	Ks/bag	990	900	891,000
(1) Input Cost				114,060,000				26,121,000
Electricity	Ks/month	1	650,000	650,000	Ks/month	1	150,000	150,000
Maintenance (Small)	time	1	60,000	60,000	time	1	60,000	60,000
Maintenance (Large)	year	1	7,500,000	625,000	year	1	7,500,000	625,000
(2) Operation and Maintenance Cost				1,335,000				835,000
(3) Total Cost				115,395,000				26,956,000
Rice sale	Bag	3,960	22,000	87,120,000	Bag	726	30,000	21,780,000
Broken Rice Sale (Large)	Bag	720	17,000	12,240,000	Bag	132	17,000	2,244,000
Broken Rice Sale (Medium)	Bag	360	16,000	5,760,000	Bag	66	16,000	1,056,000
Broken Rice Sale (Small)	Bag	360	15,500	5,580,000	Bag	66	15,500	1,023,000
Rice Bran Sale (Smooth)	lb	90,000	90	8,100,000	lb	16,500	90	1,485,000
Fees	bsk	500	700	350,000	bsk	1,100	700	770,000
(4) Gross Profit				119,150,000				28,358,000
(5) Net Income (4) - (1)				5,090,000				2,237,000
(6) Net Profit (4) - (3)				3,755,000				1,402,000
(7) Net Profit Ratio (6)/(4)				**3.2%**				**4.9%**

Source: JICA Survey Team

For financial evaluation, basic conditions are set as followed:

1) The project life is set at 7 years; namely, the initial investment cost has to be recovered within 7 years, at least. Otherwise, the project should be regarded as unfeasible from the view point of

private business entity.

2) The current interest ratio in private banks is basically around 13%[10], and therefore at least 15% of internal rate of return should be needed in order to keep financial viability.

3) All the initial costs will be paid at the first year of the project period. Also, all of the benefit will take place from the next year of the investment.

Following table summarizes the financial analysis results; the internal rate of return (IRR) is 29.4%, and net present value (NPV) is 30.2 million Kyats. The result shows that this loan support project is very much viable with 7-year project life. As a reference, the Team also calculates IRR and NPV with 5- year project life. The result shows that IRR is 18.2% and NPV is 4.8 million Kyats. Considering the 13% interest rate of private bank loan, it can be said that the loan project is still viable even for the case of 5-year project life.

Table 4.5.7 Financial Cash Flow, IRR, and the NPV of Rice Mill Upgrading, FIRR 29.4%, Million Kyats

Year	Construction Cost	O & M Cost	Total Cost	Benefit	Net Benefit	Discount Rate	Present Value
1	84.0	0.0	84.0	0.0	-84.0	1.15	-73.0
2	0.0	12.6	12.6	44.0	31.4	1.32	23.7
3	0.0	12.6	12.6	44.0	31.4	1.52	20.6
4	0.0	12.6	12.6	44.0	31.4	1.75	17.9
5	0.0	12.6	12.6	44.0	31.4	2.01	15.6
6	0.0	12.6	12.6	44.0	31.4	2.31	13.6
7	0.0	12.6	12.6	44.0	31.4	2.66	11.8
Total	84.00	75.60	159.60	263.77	104.17	12.73	30.16

Source: JICA Survey Team

4.6 Farm Budget Analysis: Income Increases per Farmer Household with Project

To explore the change with project at the level of farmer households, we should establish a model farmerôs farm budget. To know the model farm budget, a typical average farmerôs agricultural income is referred to. In the project economic analysis as discussed before, current net agricultural benefit and the benefit with project have been estimated at the regional level, and the present and with-project benefits can further be calculated. The farm budget evaluation is performed by project component, and accordingly the farm budget analysis should also be done by component.

4.6.1 Farm Budget Analysis in Case of Irrigation Rehabilitation (+ Extension Services)

The upper part of Table.4.6.1 summarizes the net benefits without-and with-projects, which are shown by priority area. As for the number of farmer households, there is no reliable data available. However, the Team conducted household survey in August - September 2015, covering 296 households, and therefore the survey has explored the size of farmlands of the sampled farm households. Dividing the irrigable areas by the average farmland area, we can estimate the number of farmers (see the mid part of Table 4.6.1).

Using the result of household survey, we estimated the total net profit per household. The current (without) net benefit is calculated as the sum of the total net profit of monsoon paddy, summer paddy, pulses (chickpea or black gram), and sesame. On the other hand, with the estimated number of farmers by priority area, a typical average farmerôs incremental benefit can now be calculated by dividing the net benefits increase with the number of farmers. By adding this net benefit increase to the current net benefit that we already introduced, the net income with project per household is estimated.

[10] JICA (2014): ñPreparatory Survey on Two-Step Loan Project for Small and Medium Enterprises Development in the Republic of the Union of Myanmarò.

The results are summarized in the bottom part of Table 4.6.1. As shown, a typical average farmer in Ayeyarwady, at present, namely without project, shows the largest net income with 5.2 million Kyats, and in Nay Pyi Taw, at present, shows the lowest with 2.2 million Kyats. After the project, the net income of ówith- projectô would increase up to 6.0 million Kyats in Ayeyarwady, and it is 3.1 million Kyat in Nay Pyi Taw in Base 0. By percentage, these are equivalent to 15% and 41% of increases respectively. The percentage of increase becomes more if we consider crop diversification (Base 1-Base 2). These results represent a great impact on the beneficiary farmers:

Table 4.6.1 Farmer's Budget with/without Extension-Services & Irrigation Rehabilitation

Particular	Shwebo	Mandalay	Nay Pyi Taw	Nay Pyi Taw (Reference Case)	Ayeyarwady
Net Benefit with Project (Kyats)					
Base 0'	20,857,964,750	16,757,698,550	9,433,440,762	2,295,372,398	5,302,763,944
Base 0	32,386,113,800	32,640,664,760	10,831,190,962	3,929,584,098	10,174,685,016
Base 1	36,699,244,814	50,478,797,010	13,486,573,032	7,039,736,528	-
Base 2	39,929,241,242	45,872,388,502	13,438,155,343	5,783,301,985	-
Net Irrigable Area (acre)	491,687	325,686	108,440	73,440	222,693
Average Farmland Area (acre/FHH)	8.5	8.7	9.2	9.2	17.6
No. of FHHs	57,846	37,435	11,787	7,983	12,653
Net Income without Project (Kyats/FHH)	3,051,121	3,529,298	2,210,873	2,210,873	5,277,884
Net Income with Project (Kyats/FHH)					
Base 0'	3,411,699	3,976,946	3,011,198	2,498,405	5,696,975
Base 0	3,610,989	4,401,227	3,129,782	2,703,117	6,082,016
Base 1	3,685,551	4,877,736	3,355,063	3,092,714	-
Base 2	3,741,389	4,754,686	3,350,955	2,935,325	-
Ratio b/t with & without Project, (%)					
Base 0'	**111.8**	**112.7**	**136.2**	**113.0**	**107.9**
Base 0	**118.3**	**124.7**	**141.6**	**122.3**	**115.2**
Base 1	**120.8**	**138.2**	**151.8**	**139.9**	**-**
Base 2	**122.6**	**134.7**	**151.6**	**132.8**	**-**

Source: JICA Survey Team, Note: Reference case in Nay Pyi Taw means that Paung Laung irrigation scheme is excluded.

4.6.2 Farm Budget Analysis in Case of Land Consolidation

Table 4.6.2 summarizes the net profit with/without project, gross profit, and costs for land consolidation. The process of calculation is almost the same as that of irrigation rehabilitation, but this time, the net benefit per household is divided into two, namely gross profit per household and cost per household. Since we applied only one model case to all the priority areas, cost per acre without project is fixed at 737,100 Kyats. The farm-gate prices and average farmland area that we have applied are exactly the same as those of irrigation rehabilitation. Then, the derived gross profit per household is also the same as those of irrigation rehabilitation.

Without project, net benefit per farmer household is calculated at 1.1 ï 2.4 million Kyat. The estimated gross profit increase per household is, by percentage, around 5 ï 6 %. Also, the estimated cost reduction per household is around 9 ï 12%. In total, the estimated net profit increase is around 30 ï 57 %. These results show that even if farmers would have lost their farmlands by around 8% for public utilization (e.g. construction of farm roads, tertiary irrigation and drainage canals), they can get much more profits than before the project. In addition, labor cost reduction means that the beneficial self-employed farmers can get additional time, which could be an opportunity of getting other income sources including non-agricultural activities.

Table 4.6.2 Farmer's Budget with/without Land Consolidation

Particular	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Net Benefit with Project (Kyats)	5,496,348,075	4,912,818,650	1,303,574,332	5,538,162,038
Total Financial Gross Profit Increase (Kyats)	2,630,566,085	2,362,964,900	609,742,122	2,425,944,030
Total Financial Cost Reduction (Kyats)	2,865,781,990	2,549,853,750	693,832,210	3,112,218,008

Particular	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Targeted Area (acre)	40,000	30,000	10,000	40,000
Targeted Area after land consolidation (acre), 8% reduction	36,800	27,600	9,200	36,800
Average Farmland Area (acre/FHH)	8.5	8.7	9.2	17.6
Average Farmland Area after land consolidation (acre/FHH)	7.8	8.0	8.5	16.2
No. of FHHs	4,706	3,448	1,087	2,273
Net Benefit with Project per farmer (Kyats/FHH)	1,167,945	1,424,831	1,199,240	2,436,499
Total Financial Gross Profit Increase per FHH (Kyats)	558,981	685,315	560,940	1,067,287
Total Financial Cost Reduction per FHH (Kyats)	608,963	739,517	638,300	1,369,212
Without Projects				
Net Benefit per ac (Kyat/acre)	263,589	426,584	424,684	242,260
Gross Profit per ac (Kyat/acre)	1,000,689	1,163,684	1,161,784	979,360
Cost per ac (Kyat/acre)	737,100	737,100	737,100	737,100
Net Profit per FHH (Kyats/FHH)	2,240,507	3,711,281	3,907,093	4,263,777
Gross Profit per FHH (Kyat/FHH)	8,505,857	10,124,051	10,688,413	17,236,736
Cost per FHH (Kyat/FHH)	6,265,350	6,412,770	6,781,319	12,972,959
With Projects				
Net Profit per FHH (Kyats/FHH)	3,408,452	5,136,113	5,106,334	6,700,276
Gross Profit per FHH (Kyat/FHH)	9,064,838	10,809,365	11,249,353	18,304,023
Cost per FHH (Kyat/FHH)	5,656,386	5,673,253	6,143,019	11,603,747
Ratio b/t with & without Project				
Net Benefit (%)	**152.1%**	**138.4%**	**130.7%**	**157.1%**
Gross Profit (%)	**106.6%**	**106.8%**	**105.2%**	**106.2%**
Cost (%)	**90.3%**	**88.5%**	**90.6%**	**89.4%**

Source: JICA Survey Team

4.6.3 Farm Budget Sensitivity against Labor Wage Increase

One of the critical issues in Myanmar agriculture is the shortage of farm labors or otherwise increase of the farm labor wage. In fact, farm labor wage shares as much as about 70% of total farming cost. To cope with this labor wage increase, production efficiency should be increased by, e.g. implementing the components proposed in Chapter 3 Development Plan and Cost Required. In this section, a sensitivity analysis is conducted, in which how much the increase of labor wage can be absorbed by the generated benefits out of the project (components). Here, the benefits considered are 1) Irrigation Rehabilitation (Polder and Drainage Improvement in case of Ayeyarwady) together with Agricultural Extension Strengthening, and 2) Land Consolidation.

Table 4.6.3 summarizes the simulation results, and Figures 4.6.1 & 4.6.2 show, as an example, the comparison of gross profit, farming cost affected by labor wage increase, and net profit considering both irrigation and land consolidation benefits under different range of labor wage increase. As seen in the table, irrigation benefit (plus agricultural extension strengthening) could absorb labor wage increase by a range of 8% to 19% as in the upper part of table, while the benefit out of land consolidation could do by 40% to as much as 54% as in the middle part of table depending on the area.

It is noted that since land consolidation is expected to introduce farm mechanization, alternatively reducing wage labors, the impact of absorbing wage increase by land consolidation project is much larger than those of irrigation benefit. Then, summated benefit, as indicated in the lower part of the table, could absorb 57% to 87% of labor wage increase in total. Note that all these calculation is on a constant basis, in which no inflation is considered.

Table 4.6.3 Threshold of Wage Increase to Keep the Baseline Net Profit

Case	Area	Net Profit, Kyats per FHH (Baseline, without land consolidation)	Threshold of wage increase	Total Cost Increase under threshold
1. Irrigation Rehabilitation plus Agricultural Extension Strengthening	Shwebo	2,240,507	12% increase	8.4%
	Mandalay	3,711,281	19% increase	13.3%
	Nay Pyi Taw, 1/	3,907,093	10% increase	7.0%
	Ayeyarwady	4,263,777	8% increase	5.6%

Case	Area	Net Profit, Kyats per FHH (Baseline, without land consolidation)	Threshold of wage increase	Total Cost Increase under threshold
2. Land Consolidation	Shwebo	2,240,507	44% increase	8.9%
	Mandalay	3,711,281	54% increase	10.5%
	Nay Pyi Taw	3,907,093	40% increase	8.0%
	Ayeyarwady	4,263,777	44% increase	7.7%
Total of above 1 & 2	Shwebo	2,240,507	65% increase	17.8%
	Mandalay	3,711,281	87% increase	23.9%
	Nay Pyi Taw	3,907,093	57% increase	15.4%
	Ayeyarwady	4,263,777	60% increase	14.4%

Note: 1/ In case of Nay Pyi Taw area, the newly development area of Paung Laung was excluded and therefore only the existing irrigation areas were counted.

Source: JICA Survey Team

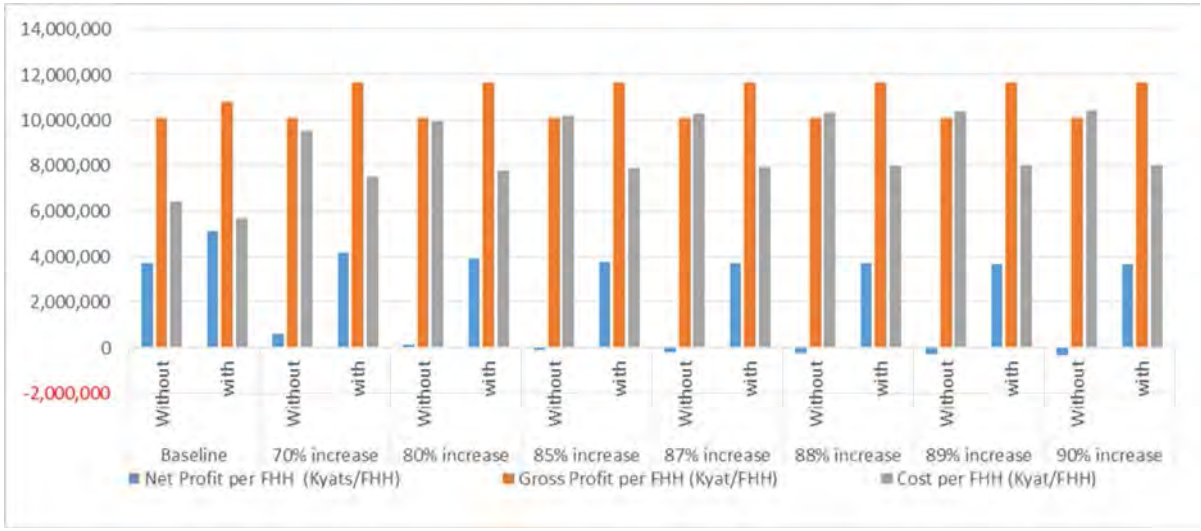


Figure 4.6.1 Farm Budget Simulation under Different Range of Farm Labor Wage Increase (Mandalay)

Source: JICA Survey Team

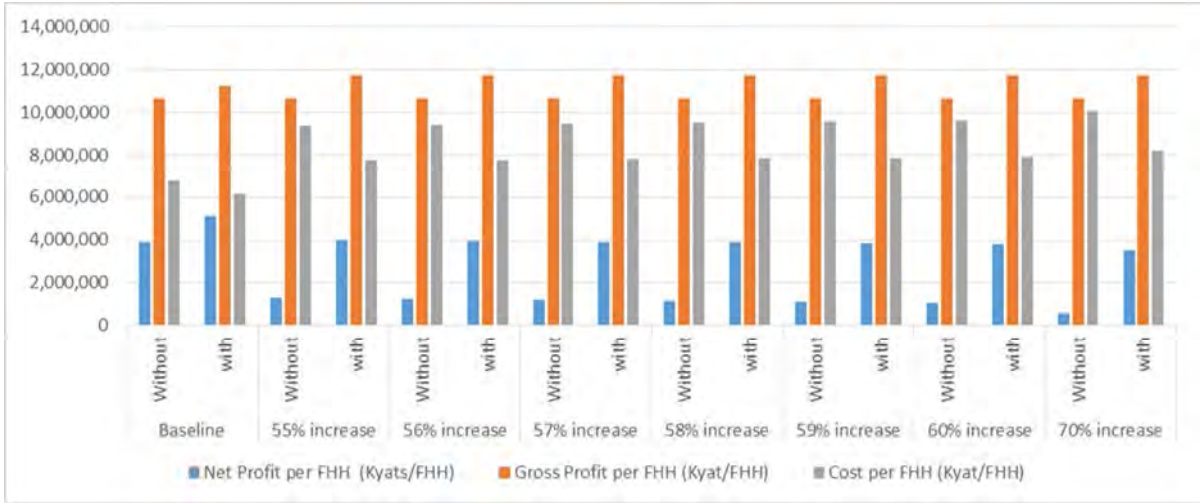


Figure 4.6.2 Farm Budget Simulation under Different Range of Farm Labor Wage Increase (Nay Pyi Taw)

Source: JICA Survey Team

4.7 Effect of Food Value Chain Establishment

In this section, an analysis will be extended to examine the benefit of value chain improvement. The team will calculate the net profits in each stakeholders (i.e. farmers, brokers, rice miller, distributers, processors, and retailers). By summing up them, the total benefit of entire value chain will be

estimated. This analysis focuses on monsoon paddy, which is the most major agricultural production in Myanmar.

The flow of monsoon paddy distribution is as follows: starting from farmers, the paddy is distributed to a rice miller located near to the villages, in most cases, via brokers. After milling, rice and broken rice are sold to retailers who do the business in a large city, Mandalay, Yangon, for example, through distributers. Then, retailers sell the while rice to consumers.

Currently, not large number of rice processors such as making flour, snack, noodle, alcohol, etc., is operational in Myanmar, so that processing is mainly conducted in foreign countries, e.g. China. If this country can connect its value chain from production to processing within the domestic market, it may produce an addition values. From this point of view, this analysis also considers the benefit to accrue out of food processing. Figure 4.7.1 shows the flow of value chain that we mentioned:

The analysis is standardized in one model rice miller whose milling capacity is around 15 tons/day[11], and annual procurement is about 63,900 baskets of paddy. From 63,900 baskets of paddy, about 19,170 bags of rice and broken rice are produced. Dividing 63,900 basket of paddy by the average acre (6.3 acre) and average yield (74 baskets)[12] in case of Mandalay priority area, the Team estimates the number of farmer households relevant to this rice mill is 137 under the case if all of the produced paddy is delivered to the rice mill. Following are the proposed benefits from the relevant program components:

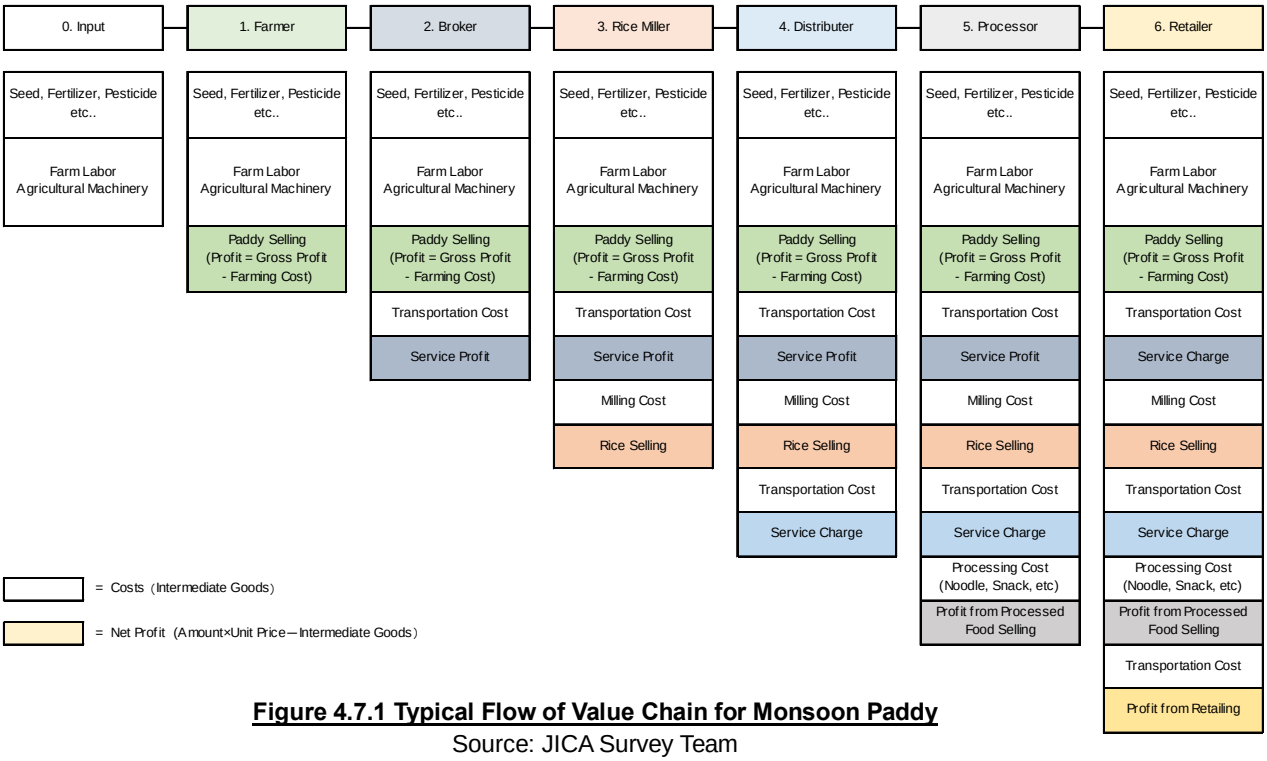


Figure 4.7.1 Typical Flow of Value Chain for Monsoon Paddy

Source: JICA Survey Team

1) Farmers (example in Mandalay): increase in production of monsoon paddy by 21% (before: 74 baskets, after: 89.5 baskets), reduction in farming costs per acre by 8.8% (before: 215,000 Kyats/ac, after: 196,000 Kyats/ac). Note that 21 % originates from irrigation rehabilitation and the 8.8% reduction comes from land consolidation.

[11] In Myanmar, millers whose capacity is 15 tons/day or more are categorized in large scale, and this category is expected to grow in near future, this analysis took the 15 tons/day miller as the model case.

12 The average acreage and yield are based on the result of Household survey carried out by the JICA Survey team (October 2015).

2) Brokers: reduction in transportation cost by 35.4% (before: 553.9 Kyats/5.2 mile, after: 357.8 Kyats/5.2 mile). Note that 35.4% reduction comes thanks to the improvement of road from earthen to asphalt paved one.

3) Rice millers: increase in milling efficiency by 5 % point (before: 50 % milling ratio, after: 55% milling ratio) according to experiences for those who renovated the milling machines recently, and

4) Processors: starting new operation (before: no net profit, after: 132.1 million Kyat/year with handling 24,731 bags of rice into noodle). Note that this production is promoted in domestic market (not target export).

5) Retailers (loss): Lost their business opportunity due to rationalizing the supply chain. It is exampled that retailers used to have 7.7 million Kyats with transportation of 19,170 bags of rice to China through Muse before the project while after the project, cannot get profit).

After the intervention, farmerôs production will increase by 21%, and the dealing amount for rice miller will also increase (before: 63,900 baskets, after: 77,284 baskets). From 77,284 baskets of paddy, the produced rice and broken rice is now 24,731 bags (before: 19,170 bags). Therefore, farmerôs production increase would create additional business opportunities for the rice miller. Needless to say, not only gross profit but also the total operation cost will also increase. To obtain the net profit with project, the gross profit with 55% milling ratio and total cost are merely scaled up using the ratio of procurement amount before/after.

By scaling up the net profits for brokers/ distributers/ retailers with the same way, their net profits with the project intervention are obtained. The net profit of each stakeholder is calculated as follows;

1) Farmers: gross profit and total cost per farm household (FHH) is referred to the results household survey the Team conducted[13]. The net profit of farmers is the product of net profit per FHH and the number of FHH (namely, 137).

2) Brokers: According to the interview we conducted in Mandalay. The brokerôs cost is transportation cost from village to rice mill. The transportation cost is 100 Kyats/basket, while service charge is 200 Kyats/basket (net profit is 100 Kyats/basket). With the project, the transportation cost will decrease by 35.4%, then the transportation cost after project is 64.6 Kyats/basket, and net profit is 135.4 Kyats/basket.

3) The total net profit of brokers is counted as the product of unit net profit (100 Kyats/basket) and distribution amount (before: 63,900 baskets, after: 77,284 baskets).The net profit of brokers without project is 6.39 million Kyats, while it is 10.5 million Kyats with project (135.4 Kyats/basket x 77,284 baskets).

4) Rice Millers: rice millerôs budget is shown in section 4.5 (see Table 4.5.6). Calculating from this data, the procurement of monsoon paddy per 6 months is about 63,900 baskets (54,000 in peak 3 months, and 9,900 basket in normal 3 months). Without project, the procurement cost of monsoon paddy per 6 months is 382.5 million Kyats, other operation cost (energy, maintenance, and labor costs) is estimated at 20.9 million Kyats, and thus the gross profit arrives at 442.5 million Kyats.

   From 100 baskets of paddy, currently 22 bags of white rice is produced (around 50% milling ratio), but the Team assumes that the milling efficiency will be improved up to 24 bags of while rice after the program. In that case, the gross profit per 6 months will increase (before: 442.5 million Kyats per half-year, after: 472.2 million Kyats per half-year).

[13] According to the ng price of rice miller, the farm-gate price is modified to 5,800 Kyats/basket

Finally, considering the production increase of farmers, cost and gross profit will also increase by 21%, then the procurement cost is now estimated at 462.6 million Kyats, and other operation costs are estimated at 25.3 million Kyats, leading to a gross profit of 571.1 million Kyats.

5) Distributer: According to the interview the team conducted in Mandalay, the distributerôs cost is mainly the transportation cost of rice and broken rice from rice mill to retailers/processors. The transportation cost is 400 Kyats/bag, while service charge is 900 Kyats/bag (net profit is therefore 500 Kyats/bag). The distribution between rice mill ï retailers/processors are mostly through main roads, which the project dose not undertake. The total net profit of distributers is therefor only from the increase of dealing amount, composed of the unit net profit (500 Kyats/bag) and distribution amount (before: 19,170 bags, after: 24,731 bags).The net profit of brokers without program is thus 9.6 million Kyats, while it is 12.4 million Kyats with program.

6) Processor: Based on the interview for a rice noodle processor, the Team roughly estimates that the net profit ratio is about 11.9%. Using this parameter, and procured amount (24,731 bags of rice), and selling price of noodle (1,050 Kyats/viss), we estimates that the net profit comes to about 132.1 million Kyats.

7) Retailers: Almost the same way as distributers, but the transportation cost is now 1,600 Kyats/bag (suppose Mandalay ï China transportation), and service charge is 2,000 Kyats/bag (net profit is therefore 400 Kyats/bag). The net profit of retailers without program is 7.7 million Kyats, while it is NIL with program as we mentioned before.

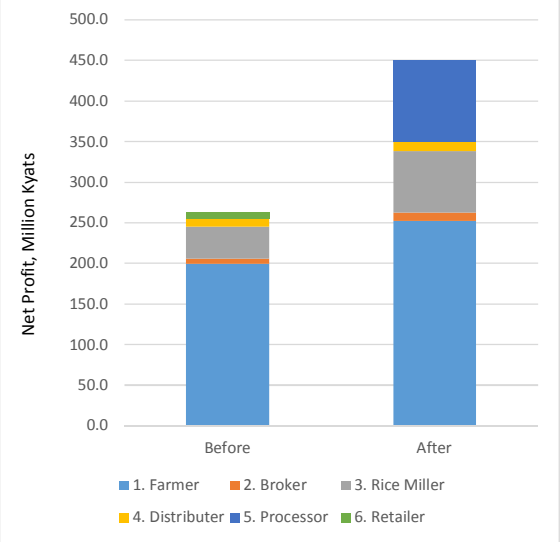


Figure. 4.7.2 Net Profit Increase after Intervention

Source: JICA Survey Team

Figure 4.7.2 and Table 4.7.1 show how the intervention will change the net profits in each stakeholders. In addition, Table 4.7.2 shows the gross profit, total costs, and net profits in each stage of value chain. The total net benefit without project is 261.0 million Kyats, while it is 488.6 million Kyats with project. The difference is 277.6 million-Kyat, which is equivalent to 87% in increase.

Table 4.7.1 Change After Intervention, million Kyats

Stakeholder	Before	After	% of Increase
1. Farmer	199.8	252.4	26.3%
2. Broker	6.4	10.5	63.8%
3. Rice Miller	39.1	75.6	93.3%
4. Distributer	9.6	11.6	20.9%
5. Processor	0.0	101.6	N.A
6. Retailer	7.7	0.0	N.A
Total	262.5	451.6	

Source: JICA Survey Team

Comparing before/after the program intervention, farmers can get additional 52.2 million Kyats net profits (26.4% increase), while it is 4.1 million Kyats (63.8 % increase) for brokers, 44.1 million Kyats (112.7 % increase) for rice millers, 2.8 million Kyats (29.0%) increase for distributers. The simulation finds that there is a great difference despite the only five percent change of milling ratio bringing large net profit increase for rice miller.

This simulation also shows that supporting processing companies may create large additional values since 132.1 million Kyats (48%) out of total increment of 277.6 million Kyats is attributed to the newly generated value addition for food processors.

Table 4.7.2 Production Cost, Gross Profit, and Net Profit after Program Interventions

Actor	Cost and Profit		Project Intervention	Change		
				+/-	Before	After
1. Farmer	Production Cost	Input			71.4	86.4
		Labor and Machinery	Reduction in farming costs	-	100.3	110.6
		Total			171.7	197.0
	Gross Profit	Paddy	Increase in production	+	370.0	447.5
	Net Profit				198.3	250.5
2. Broker	Transportation Cost	Transportation	Reduction in transportation cost	-	6.4	5.0
		Total			6.4	5.0
	Gross Profit	Service			12.8	15.5
	Net Profit				6.4	10.5
3. Rice Miller	Milling Cost	Procurement			382.5	462.6
		Other Operation Cost			20.9	25.3
		Total			403.4	487.9
	Gross Profit	Rice, Broken Rice	Increase in milling efficiency	+	442.5	571.1
	Net Profit				39.1	83.2
4. Distributer	Transportation Cost	Transportation			7.7	9.9
		Total			7.7	9.9
	Gross Profit	Service			17.3	22.3
	Net Profit				9.6	12.4
5. Processor	Processing Cost	Processing	Starting new operation	+	0.0	977.3
		Total			0.0	977.3
	Gross Profit	Processed Foods	Starting new operation	+	0.0	1,109.4
	Net Profit				0.0	132.1
6. Retailer	Retailing Cost	Transportation	Loss of business opportunity	-	30.7	0.0
		Total			30.7	0.0
	Gross Profit	Service	Loss of business opportunity	-	38.3	0.0
	Net Profit				7.7	0.0

Source: JICA Survey Team, refer to Appendix-Ⅴ for more detail.

4.8 Rice Supply to Urban and Industry Workers

Irrigation rehabilitation, also polder and drainage improvement in Ayeyarwady, with agricultural extension strengthening will increase paddy production. In fact, Myanmar aims at becoming an industrialized country in its Myanmar Comprehensive Development Plan 2011-2030. To realize this vision, the agriculture sector should supply modest price of staple food, that is rice, or otherwise the industry sector should increase the wage for the workers, which in turn results in the loss of competitive power in the international markets under the current condition where expenditure on staple food for the workers occupies much share.

To provide an insight how much impact the irrigation rehabilitation could generate in view of supplying staple food, rice, to the urban dwellers and industry sector workers, following estimation was made: Table 4.8.1 calculates paddy production in the 4 priority areas under without-project and with-project condition. According to the estimation, under present condition, total 1,340 million kg and 947 million kg of paddy are produced by the 4 priority areas altogether. These production will increase to 1,567 milling kg and 1,379 million kg of paddy under with-project condition.

Then, the table 4.8.2 estimates how many population the rice produced can support the urban dwellers, after subtracting the self consumed rice by the famer family members. Here, assumptions were made as such; 1) a typical person consumes 150 kg of rice per annum and 2) milling rate was set at 0.55 (55%), and also lowland farm holdings for paddy cultivation and the average family members were obtained from a household survey conducted by JICA team in 2015 covering total 296 samples.

Table 4.8.2 shows that the priority areas even with the current condition can support 3.7 million, 2.2 million, 0.36 million and 1.5 million population for Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady respectively in terms of supplying rice to the non-agricultural urban dwellers and industry sector

workers. With-project, the priority areas now supports such populations as 5.1 million, 3.3 million 0.77 million and 1.8 million with the surplus rice produced.

Looking into the balance between before-project and after-project, the increments are 1.3 million, 1.1 million, 0.41 million and 0.31 million population. Thus, it is found that the priority areas, even under present condition, play a very important role in supplying staple food to the non-agricultural population, and this role will be further strengthened by the irrigation rehabilitation.

Table 4.8.1 Paddy Production Estimation by 4 Priority Area with Irrigation Rehabilitation

Particulars	Original (current)		With-project	
Paddy area, acre	Monsoon, ac	Summer, ac	Monsoon, ac	Summer, ac
Shwebo	485,456	274,086	485,456	327,181
Mandalay	253,295	138,644	253,295	194,593
Nay Pyi Taw	44,051	22,619	67,945	38,548
Ayeyarwady	178,154	96,381	178,154	96,381
Paddy Yield, basket/acre	Monsoon, bsk/ac	Summer, bsk/ac	Monsoon, bsk/ac	Summer, bsk/ac
Shwebo	63.0	82.0	69.0	98.5
Mandalay	74.0	89.0	89.5	104.5
Nay Pyi Taw	73.0	84.0	86.5	102.0
Ayeyarwady	65.0	87.0	72.5	98.5
Paddy Production, basket	Monsoon, bsk	Summer, bsk	Monsoon, bsk	Summer, bsk
Shwebo	30,583,746	22,475,052	33,496,484	32,227,353
Mandalay	18,743,827	12,339,277	22,669,899	20,335,012
Nay Pyi Taw	3,215,749	1,900,017	5,877,239	3,931,920
Ayeyarwady	11,580,010	8,385,147	12,916,165	9,493,529
Paddy Production, kg	Monsoon, kg	Summer, kg	Monsoon, kg	Summer, kg
Shwebo	639,200,291	469,728,587	700,076,510	673,551,678
Mandalay	391,745,988	257,890,889	473,800,891	425,001,751
Nay Pyi Taw	67,209,157	39,710,348	122,834,293	82,177,136
Ayeyarwady	242,022,209	175,249,572	269,947,849	198,414,746
Total	1,340,177,646	942,579,397	1,566,659,542	1,379,145,311

Source: JICA Survey Team

Table 4.8.2 Population Supported by Surplus Rice Produced by 4 Priority Areas

Particulars	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Lowland farm holdings per farmer, acre	7.6	7.0	6.0	17.5
No. of FHHs in the monsoon paddy area	63,876	36,185	7,342	10,180
Average family members, person	5.0	5.2	5.0	4.3
Population in the monsoon paddy area	319,379	188,162	36,709	43,775
Rice needed for the farm population, ton	47,907	28,224	5,506	6,566
Rice production (monsoon, original), ton	351,560	215,460	36,965	133,112
Rice production (summer, original), ton	258,351	141,840	21,841	96,387
Rice production total (original), ton	609,911	357,300	58,806	229,499
Rice production (monsoon, w-project), ton	385,042	260,590	67,559	148,471
Rice production (summer, w-project), ton	370,453	233,751	45,197	109,128
Rice production total (w-project), ton	755,496	494,341	112,756	257,599
Increase by with-project, ton	145,585	137,041	53,951	28,100
Rice surplus (original), ton	562,004	329,076	53,299	222,933
Rice surplus (w-project), ton	707,589	466,117	107,250	251,033
Population to consume the surplus (original)	3,746,693	2,193,840	355,329	1,486,222
Population to consume the surplus (w-project)	5,054,205	3,329,408	766,070	1,793,094
Increase in population for the surplus by project	1,307,511	1,135,568	410,742	306,873

Source: JICA Survey Team

4.9 Proposed Indicators for Project Operation and Effects

Several numbers of indicators should be established in order to measure and evaluate the project impacts by comparing before- and after-project. Following indicators are preliminary taken into account and proposed for the major components, which could be better assisted by loan, such as 1) irrigation rehabilitation, 2) land consolidation, and 3) farm-to-market road (FMR) improvement:

Table 4.9.1 Indicators Preliminary Proposed for Major Components

Item	Irrigation Rehabilitation (No.2/4)	Land Consolidation (No.4)	FMR Road Improvement (No.8)
Area	Cultivated area by crops (operation indicator),	No change in area cultivated	No change in area cultivated
Yield	Yield of major crops per unit area (effect indicator),	Yield of major crops per unit area (effect indicator),	No change in yield
Production	Production volume of major crops (effect indicator)	Production volume of major crops (effect indicator),	No change in production volume
Farm Income	Farm net income per typical farm household	Farm net income per typical farm household	No change in income
Farming cost reduction	Not considered	Farming Cost per unit area (efficient indicator)	No change in farming cost
Vehicle	Not considered	Not considered	Vehicle operation cost saving (effect indicator)

Source: JICA Survey Team

4.9.1 Proposed Indicators for Irrigation Rehabilitation

Monsoon paddy is cultivated throughout the priority areas while summer paddy is limited where irrigation water is available in dry season. Pulses are currently cultivated under residual moisture during winter season, and with irrigation water provided there is a high potential of increasing the yield. There is not much potential for monsoon paddy increase of cultivated area while summer paddy and pulses have much potential of area increase by the irrigation rehabilitation. With reference to what was discussed in Chapter 3 ó Development Planô, cultivated areas for the last 3 years (2012 ï 2014) represent the current situation, and therefore the proposed base values of the indicators are shown in Table 4.9.2. In addition, the indicators 3 years after the project completion are also presented in Table 4.9.3 (refer to 4.4.1 Economic Project Benefits):

Table 4.9.2 Proposed Base Indicators on Cultivated Area by Crops (Unit: acre)

Priority Area	Monsoon Paddy	Summer Paddy	Pulses
Shwebo	485,456	274,086	148,994
Mandalay	253,295	138,644	96,282
Nay Pyi Taw	44,051 (67,945)	22,619 (33,335)	15,047
Ayeyarwady	178,154	96,381	43,028

Source: ID, the Survey Team (2015) Note: Figures in parenthesis includes the planned area of Paung Laung system.

Table 4.9.3 Indicators on Cultivated Area by Crops, for 3 Years After Project Completion (Unit: acre)

Item		Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Monsoon Paddy	Base 0'	485,456	253,295	44,051 (69,857)	178,154
	Base 0	485,456	253,295	44,051 (69,857)	179,579
	Base 1	485,456	253,295	44,051 (69,857)	-
	Base 2	485,456	253,295	44,051 (69,857)	-
Summer Paddy	Base 0'	274,086	138,644	22,619 (34,192)	96,381
	Base 0	278,334	143,120	23,107 (34,609)	97,152
	Base 1	274,086	138,644	22,619 (34,192)	-
	Base 2	275,716	141,563	22,877 (34,301)	-
Pulses	Base 0'	148,994	96,282	15,047 (15,047)	43,028
	Base 0	148,994	96,282	15,047 (15,047)	43,028

Item		Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
	Base 1	161,737	109,710	16,511 (16,298)	-
	Base 2	156,846	100,952	15,736 (15,972)	-

Source: JICA Survey Team

A field study has identified significant gaps of yields of major crops in the priority areas and it means there is potential to increase yield from the current situation. Improvement of crop yield cannot be achieved by improvement of irrigation system alone; it requires human developments such as training for farmers and knowledge sharing by farmers. Therefore, agriculture extension service strengthening is one of the components which should be implemented together with irrigation rehabilitation. Proposed base yield indicators and also the yield indicators 3 years after project completion are as follows:

Table 4.9.4 Proposed Base Indicators on Yield of Major Crops (Unit: Basket/ acre)

Priority Area	Monsoon Paddy	Summer Paddy	Pulses
Shwebo	63	82	14 (chick pea)
Mandalay	74	89	9 (chick pea)
Nay Pyi Taw	73	84	13 (Black gram)
Ayeyarwady	65	87	10 (Black gram)

Source: Department of Agriculture, the Survey Team (2013)

Table 4.9.5 Indicators on Yield of Major Crops, for 3 Years After Project Completion (Unit: Basket/ acre)

Priority Area	Monsoon Paddy	Summer Paddy	Pulses
Shwebo	63.5	83.3	14.2 (chick pea)
Mandalay	75.2	90.2	9.4 (chick pea)
Nay Pyi Taw	74.1	85.4	13.3 (Black gram)
Ayeyarwady	65.6	87.9	10.4 (Black gram)

Source: JICA Survey Team

The major 3 crops in the priority areas are expected to increase the production after project implementation. Crop production coupled with cultivated area increase will directly contribute to raising the farm income and food production. Currently, Myanmar can produce enough food for self-consumption for rice and pulses, so that the increase of crop production will contribute to the development of food-processing sector and also to the export sector rather than domestic consumption. Proposed base data as well as the data 3 years after the project completion for this indicator are shown below:

Table 4.9.6 Proposed Base Indicators on Production Volume of Major Crops (Unit: Basket)

Priority Area	Monsoon Paddy	Summer Paddy	Pulses
Shwebo	30,583,728	22,475,052	2,085,916
Mandalay	18,743,830	12,339,316	866,538
Nay Pyi Taw	3,215,723 (4,959,985)	1,899,996 (2,800,140)	195,611
Ayeyarwady	11,580,010	8,385,156	430,280

Source: Department of Agriculture, the Survey Team (2015), , Note: Figures in parenthesis includes the planned area of Paung Laung system.

Table 4.9.7 Indicators on Production Volume of Major Crops, for 3 Years After Project Completion (Unit: Basket)

Item		Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Monsoon Paddy	Base 0'	30,816,765	19,057,916	3,263,298 (5,174,971)	11,686,876
	Base 0	30,816,765	19,057,916	3,263,298 (5,174,971)	11,780,371
	Base 1	30,816,765	19,057,916	3,263,298 (5,174,971)	-
Summer Paddy	Base 0'	22,836,846	12,511,235	1,932,567(2,921,388)	8,473,826
	Base 0	23,190,756	12,915,142	1,974,255(2,957,020)	8,541,617
	Base 1	22,836,846	12,511,235	1,932,567(2,921,388)	-

Item		Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Pulses	Base 0'	2,121,675	908,902	199,824 (199,824)	447,491
	Base 0	2,121,675	908,902	199,824 (199,824)	447,491
	Base 1	2,303,133	1,035,662	219,263 (216,440)	-

Source: JICA Survey Team

Based on the production increase, farm net income is also expected to increase. A household survey, conducted by JICA survey team, explored the household faming economy by examining the faming cost, production, area harvested, farm gate price, gross profit, and net profit. Following table summarizes the present farm net income for typical farmers who possess the average farmland area, which are the base parameter in terms of farm income. In addition, Table 4.9.9 shows the farm net income to be expected 3 years after the project completion:

Table 4.9.8 Proposed Base Indicators on Farm Net Income (Unit: Kyats)

Particular	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Net Irrigable Area (acre)	491,687	325,686	108,440	222,693
Average Farmland Area (acre/FHH)	8.5	8.7	9.2	17.6
No. of FHHs	57,846	37,435	11,787	12,653
Net Income without Project (Kyats/FHH)	3,051,121	3,529,298	2,210,873	5,277,884

Source: JICA Survey Team

Table 4.9.9 Indicators on Farm Net Income, for 3 Years After Project Completion (Unit: Kyats)

Particular	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
Net Income with Project (Kyats/FHH) , Base0ô	3,079,967	3,576,248	2,274,899	5,311,411
Net Income with Project (Kyats/FHH) , Base0	3,095,910	3,610,190	2,284,385	5,342,214
Net Income with Project (Kyats/FHH) , Base1	3,101,875	3,648,311	2,302,408	-

Source: JICA Survey Team

4.9.2 Proposed Indicators for Land Consolidation

Myanmar government has already started model land consolidation project. International organizations have also supported land consolidation projects. The most important expected impact of land consolidation is the reduction in farming cost. In Myanmar, wages for agricultural labors show an increasing trend due to labor shortages, and accordingly faming cost with manual labors becomes expensive compared to mechanized farming in near future. Land consolidation is expected to promote mechanization in agriculture since it enables machineries to enter farmlands easily, and also, farmers will be able to use machineries effectively thanks to land leveling.

For agricultural machinery promotion, land consolidation may not be sufficient, for example, farmerôs income, knowledge of machinery, locations of farmlands are also important factors to be introduced farm mechanization. In this respect, agricultural machinery extension program is also included in the program components. Using the household survey data conducted by JICA survey team, cost of labor and outsourcing (including machine rental fee) was explored. Following tables show the proposed base data which is the current farming cost and also the farming cost 3 years after the project completion:

Table 4.9.10 Proposed Base Indicators on Labor and Outsourcing Cost per Farmer (Unit: Kyats)

Priority Area	Monsoon Paddy	Summer Paddy	Pulses
Shwebo	116,505	91,345	38,625
Mandalay	116,584	126,641	43,724
Nay Pyi Taw	105,642	103,217	76,048
Ayeyarwady	81,142	57,552	48,295

Source: JICA Survey Team

Table 4.9.11 Indicators on Labor & Outsource Cost per Farmer, for 3 Years After Project Completion (Unit: Kyats)

Priority Area	Monsoon Paddy	Summer Paddy	Pulses
Shwebo	111,381	87,469	36,494
Mandalay	111,457	121,268	41,312
Nay Pyi Taw	100,996	98,838	71,852
Ayeyarwady	77,574	55,110	45,630

Source: JICA Survey Team

According to a JICA Study Team (2014)[14], increase in production is also observed on major three crops (monsoon paddy, summer paddy, and winter pulses). Production increase and farming cost reduction immediately mean the net income increase of farmers. The proposed base data and also data 3 years after project completion on yield, production volume, and net income are the same as irrigation rehabilitation (See Tables 4.9.4 – 4.9.9).

4.9.3 Proposed Indicators for FMR Improvement

Transportation plays important roles in farming and deliver/ distribution activities. There are three major transportation methods in the priority areas; one is transportation by labor, second is transportation by bull-cart, and third one is transportation by tolloergyi, a cart with a hand-tractor engine. Nowadays, track and vehicles are also used to transport the agricultural produces to, e.g., township where rice mills area located. Especially, during rainy season earthen roads become muddy and sometimes swampy in some of the roads in the priority areas, hindering local transport a lot.

To cope with above situation, farmers and traders have to spend a lot of time or take a detour, spending more time thereby fuel cost. If roads are upgraded, farmers will use trolloergyi and vehicles as close as possible to their farmland, and the farmers and traders can also be benefitted for transporting the paddy to milling stations. Therefore the transportation cost for harvested produces and also farm input can be reduced, making in turn the net profit to hike. Following tables summarizes the base indicators and such indicators, for 3 years after project completion on the cost saving for the road improvement:

Table 4.9.12 Proposed Base Indicators of Transportation Cost Saving by Road Upgrading (Kyat/mile)

Type of Pavement	Cost per basket of monsoon paddy (Kyats/basket/mile)		
	Animal Cart	Trawllergy	Small and Medium Truck
Earthen Pavement	72.5	122.3	96.0

Source: JICA Survey Team[15]

Table 4.9.13 Indicators of Transportation Cost Saving by Road Upgrading, for 3 Years After Project Completion (Kyat/mile)

Type of Pavement	Cost per basket of monsoon paddy (Kyats/basket/mile)		
	Animal Cart	Trawllergy	Small and Medium Truck
Earthen - Gravel Pavement	72.5	116.6	92.4
Earthen - Asphalt Pavement	72.5	113.2	90.0

Source: JICA Survey Team[16]

[14] JICA Study Team (2014): "Preparatory Survey for the Project for Rehabilitation of Irrigation Systems", Final Report

[15] The proposed indicators are calculated by JICA Survey Team. The current total transportation cost in each vehicle is already derived to estimate EIRR. Dividing the current total transportation cost by transportation amount, the current transportation cost per basket is calculated. The calculation of total cost is based on per 5.2 mile, and accordingly it was converted to per mile.

[16] The proposed indicators are calculated by JICA Survey Team. The current total transportation cost in each vehicles is already derived to estimate EIRR. Dividing the current total transportation cost by transportation amount, the current transportation cost per basket is calculated. The calculation of total cost is based on per 5.2 mile, and accordingly it was converted to per mile.

CHAPTER 5 IMPLEMENTATION ARRANGEMENT

This chapter discusses necessary implementation arrangement for the program. In fact, since the program is composed of different components, what is discussed first is the prioritization amongst the components/sub-programs, and implementation scheme with the potential fund source, e.g. government budget, ODA loan, grant aid and technical cooperation project (TCP), collaboration with other donorsô project, etc. Then, especially for the components which should be assisted by ODA loan, implementation arrangement is elaborated:

5.1 Program Components with Priority and Cost by Priority

5.1.1 Program Components and those Priority

A total 19 components/ sub-program have been identified in order to promote intensive agriculture in the priority areas. Each of the priority areas should implement a package, or combination, of the components depending upon the potentials and constraints that each of the areas has. Following tables summarize the components/ sub-programs that each of the priority areas should implement with 3 levels of priority; namely, A, B, and C. Priority level óAô means its implementation should be urgently needed with the highest priority; óBô needs the implementation with higher priority while the óCô means the components should still be implemented with priority. As indicated in the tables;

1) In Shwebo area; components given priority óAô are; 1. Agriculture Extension Strengthening, 6. Agricultural Machinery Dissemination (TSL), 14. Small & Medium Agro-enterprise Promotion, 15. Supply Chain Improvement of Rice. The yield for paddy in this area is still low, so that the extension services should be strengthened. To cope with the labor shortage associated with Mandalay urban area, farm mechanization should be accelerated together with the rice milling improvement since this area is very famous for its high value local variety of Paw San. To further promote this high value variety of rice, whole supply chain for the rice should be improved. In addition, road running along Old Main Canal should be paved since it is often closed during and after heavy rainfall.

2) In Mandalay area, rank óAô is given to such components as; 2. Irrigation Rehabilitation, 12. PPP Wholesale Market Establishment, 17. Food Processing Industry Promotion, 19. Plant Protection and Quarantine Enhancement. The irrigation systems identified in this area is very aged and need high level of rehabilitation. Since Mandalay is the hub of Upper Myanmar, there should be a very high potential of promoting value-added industry, e.g., food processing[1]. Lots of agro-produces, including vegetables and fruits, are coming to Mandalay from Pin Oo Lin, Southern Shan, etc., so that the wholesale market should be established at an earliest time. To support export of rice, pulses, and tropical fruits/ vegetables from Mandalay, the function of plant protection and quarantine should be strengthened in Mandalay.

3) On Nay Pyi Taw area, priority óAô should be given to such components of; 1. Agriculture Extension Strengthening, 8. Plant Breeding Enhancement, 14. Small & Medium Agro-enterprise Promotion, and 18. Advanced Farming Technologies. Though the Nay Pyi Taw has been given number of donor and government supports, the yields still have potential of nearing to the practically achievable ones. Extension services should therefor be strengthened. In addition, Nay Pyi Taw is the capital of country, with which this area should demonstrate and disseminate advanced farming technologies including lowland vegetables and fruits. Small & Medium Agro-enterprise can also be smoothly promoted since this Nay Pyi Taw area has the most stable

[1] In fact, about 80% of the rice exported to China via Muse is for processing (interview to DOA Mandalay regional office), e.g. noodle and rice flour. This fact entails a high potential of promoting relevant industry in Mandalay.

power supply in Myanmar, which is due needed to promote agro-related industry such as milling machine renovation, food processing, etc. Further, the downstream of the Paung Laung irrigation system should be completed at an earliest date.

4) In Ayeyarwady area, priority óAô should be given to the components of; 1. Agriculture Extension Strengthening, 6. Agricultural Machinery Dissemination (TSL), 9. Farm-to-Market Road (FMR) Improvement, and 14. Small & Medium Agro-enterprise Promotion. In Ayeyarwady area, paddy yield is still low and quality seeds[2] are not enough distributed. Extension services including quality seeds promotion should be strengthened. In this connection, rice milling machines have to be upgraded in order to improve the rice quality. Since farmland area owned by each of the farmers is the biggest in the country and given the fact that there is an acute labor shortage, farm mechanization should be urgently accelerated. Further, taking into account the present condition of roads which are often affected by flood, inundation and heavy rainfall, road improvement will have to be done, especially such roads leading to townships where lots number of rice millers are operating.

5) Concerning irrigation rehabilitation which in most cases needs the biggest investment, the top priority should be given to the ones in Mandalay area among the 4 priority areas. The irrigation systems in Mandalay area had been firstly constructed in old dynasty era, more than 100 years ago. There are aged hydraulic facilities which need rehabilitation and renovation, and also there are canal reaches which need concrete lining. Aside from the ones in Mandalay, the mid to downstream of the Paung Laung irrigation system in Nay Pyi Taw should be completed as soon as possible. With an estimated amount of 6.2 billion Kyats, the system will start operation, enabling irrigation over a large area of 28,000 acres for monsoon paddy.

6) Components with óCô in Shwebo and Ayeyarwady areas are; 7. Flood Monitoring System Establishment, 10. Jetty Improvement, and 11. Market Improvement (district level). Flood monitoring system should be established at a national level in collaboration with Department of Meteorology and Hydrology (DMH). It should start with nationwide review and it may take some time. Transportation mode for paddy and pulses has been shifted gradually from river-ships to tracks, so that the jetty improvement may be second to the improvement of road network. Market improvement is in fact needed, as the vegetable losses are at present very high. However, this improvement for the district level markets may be done by the local government authority step by step.

7) Land consolidation is very much required in all the priority areas since the consolidation can accelerate farm mechanization, which in turn can well cope with labor shortage. It is therefore that the land consolidation should primarily be given at least rank óBô priority. Donors have contributed to the land consolidation including JICA, and as of 2015 IFAD and Indian loan are to conduct an extensive land consolidation project in Nay Pyi Taw (IFAD & India) and Mandalay (India). Therefore, land consolidation in the 2 priority areas of Mandalay and Nay Pyi Taw are ranked at óCô.

8) A component related to vegetable and fruit promotion in Mandalay area, that is ó16. Value Chain Enhancement of Vegetables & Fruitsô, is given óCô priority. Since the government priority is placed on rice, top priority is accordingly given to rice. Present loss associated with vegetables and fruits distribution is very large, and therefore improvement along supply/ value chain should be implemented. However, this component can be undertaken at a later stage, so that the óCô

[2] Paddy is by its nature susceptible to cross-pollination with similar paddy-like weeds, resulting in degradation of the quality easily. Since Ayeyarwady is a wet land, such weeds which can cross-pollinate with paddy are often found. In this situation, quality seeds promotion and distribution are highly required.

priority is given.

Table 5.1.1 Shwebo Program Components and the Priorities

Component: Shwebo	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	A	Yield is still low as compared to the potential.
2. Irrigation Rehabilitation	B	Irrigation facilities are fairly maintained.
4. Land Consolidation	B	Need to implement step by step with mechanization.
5. Agricultural Machinery Station Enhancement	B	Some available from private farmers/ companies.
6. Agricultural Machinery Dissemination (TSL)	A	Mechanization be progressed due to labor shortage.
7. Flood Monitoring System Establishment	C	Flood takes place, but not disastrous.
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	B (A)	Fairly maintained except Old MC inspection road Old Main Canal maintenance road be paved.
10. Jetty Improvement	C	Major mode of transportation is by road.
11. Market Improvement (District level)	C	Major distribution of rice to Mandalay, then Muse.
14. Small & Medium Agro-enterprise Promotion	A	Aged rice milling machines be renovated.
15. Supply Chain Improvement of Rice	A	Both high value rice and for export being produced.
19. Plant Protection and Quarantine Enhanced	B	Mandalay be given the highest priority.

Note: MC means Main Canal. Source: JICA Survey Team

Table 5.1.2 Mandalay Program Components and the Priorities

Component: Mandalay	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	B	Yields are fairly high already, but still need.
2. Irrigation Rehabilitation	A	Facilities are vey aged, and need rehabilitation.
4. Land Consolidation	C	Indian Loan is to cover 10,300 acres within the area.
6. Agricultural Machinery Dissemination (TSL)	B	Very needed but fairly accessible to Mandalay agents.
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	B	Overall condition is fairly passable.
10. Jetty Improvement	B	Need very much but better by another whole set of prj.
12 PPP Wholesale Market Establishment	A	Due needed as the Mandalay being the center of UM.
14. Small & Medium Agro-enterprise Promotion	B	Needed as rice milling machines are aged.
15. Supply Chain Improvement of Rice	B	Needed including marketing & processing.
16. Value Chain Enhanced of Vegetables & Fruits	C	Needed but not in urgent.
17. Food Processing Industry Promotion	A	Mandalay being center of UM, this should be promoted.
19. Plant Protection and Quarantine Enhanced	A	Need one central PP laboratory in Upper Myanmar.

Note: UM means Upper Myanmar. Source: JICA Survey Team

Table 5.1.3 Nay Pyi Taw Program Components and the Priorities

Component: Nay Pyi Taw	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	A	NPT being the capital, be strengthened.
2. Irrigation Rehabilitation	B (A)	Government & donors have contributed fairly. However, Paung Laung be completed at soonest time.
4. Land Consolidation	C	IFAD and Indian Loan to contribute total 22,500 acre.
5. Agricultural Machinery Station Enhancement	B	Has a functions of machinery Testing Center
6. Agricultural Machinery Dissemination (TSL)	B	Needed and under progressing fairly.
8. Plant Breeding Enhancement	A	Needed in DAR HQs
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	B (A)	Except a part of Paung Laung area, fairly passable. Rural roads in Paung Laung area be paved.
13. Wholesale Market Development (New)	C	Current markets operated well, though need improvemd
14. Small & Medium Agro-enterprise Promotion	A	Can well promote thanks to the stable power supply
15. Supply Chain Improvement of Rice	B	Fairly needed.
18. Advanced Farming Technologies	A	NPT being the capital, demonstration be the highest.

Source: JICA Survey Team

Table 5.1.4 Ayeyarwady Program Components and the Priorities

Component: Ayeyarwady	Rank	Remarks
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	A	Paddy quality be improved from seed to harvest.
3. Polder and Drainage Improvement	B	Fairly managed and maintained by ID.
4. Land Consolidation	B	Needed since there area lots of areas.
5. Agricultural Machinery Station Enhancemî	B	Needed due to labor and animal shortage.
6. Agricultural Machinery Dissemination (TSL)	A	Needed due to labor and animal shortage.
7. Flood Monitoring System Establishment	C	Chinese government to support.
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	A	Needed very much due to poor road and bridges.
10. Jetty Improvement	C	Needed but at latter stage accepted.
11. Market Improvement (District level)	C	Major rice distribution to Mandalay and Yangon.
14. Small & Medium Agro-enterprise Promotion	A	Needed much to renovate aged rice milling machines.
15. Supply Chain Improvement of Rice	B	Rice being produced largest, needed in this area.
19. Plant Protection and Quarantine Enhancemî	B	Need to improve PPD in Yangon.

Source: JICA Survey Team

5.1.2 Component Cost by Priority

Based on the 3-level categorization of the component priority, A, B and C, the program costs are also summarized by such categorized group. Following table indicates the costs categorized into 3 groups. It is noted that 2-Step loan is excluded from the summation of the cost in the table as the loan is implemented over wide coverage of the country, and accordingly it can not be categorized into a specific priority area. Likewise, whole sale markets planned with PPP scheme are excluded, which are the wholesale market in Mandalay and another one in Nay Pyi Taw area. This is because the wholesale markets can be implemented by a private initiative, so that the markets should be differentiated from the ones initiated by the government with donor assistances.

Table 5.1.5 Cost Categorized According to the 3-level Priority

Priority Area	Priority Level	Cost of Components (million Kyats)			Cost of Components (million JPY)		
Shwebo Area	A	24,270			2,840		
	B	145,863	(A+B)	(A+B+C)	17,066	(A+B)	(A+B+C)
	C	5,179	170,133	175,312	606	19,906	20,511
Mandalay Area	A	151,426			17,717		
	B	50,015	(A+B)	(A+B+C)	5,852	(A+B)	(A+B+C)
	C	23,025	201,441	224,466	2,694	23,569	26,263
Nay Pyi Taw Area	A	37,841			4,427		
	B	48,980	(A+B)	(A+B+C)	5,731	(A+B)	(A+B+C)
	C	5,895	86,820	92,715	690	10,158	10,848
Ayeyarwady Area	A	35,476			4,151		
	B	81,572	(A+B)	(A+B+C)	9,544	(A+B)	(A+B+C)
	C	8,180	117,047	125,228	957	13,695	14,652

Note 1: Cost of the 2-Step Loan schemes; namely, 6. Agricultural Machinery Dissemination and 14. Small & Medium Agro-enterprise Promotion, are excluded.

Note 2: In addition, Cost of Wholesale Market Construction (12. PPP Wholesale Market Establishment in Mandalay and 13. Wholesale Market Development (New) in Nay Pyi Taw) are also excluded.

Note 3: Further, there are components, only parts of which are categorized in ó Aô but the rest are still in ó Bô, such as farm-to-market roads in Shwebo and Nay Pyi Taw area and irrigation scheme (Paung Laung scheme) in Nay Pyi Taw area. In these cases, the costs are divided into the groups, A or B, according to the detail cost categorization.

Costs summarized in óAô category are; 2.84 billion JPY (24 billion Kyats), 17.7 billion JPY (151 billion Kyats), 4.4 billion JPY (38 billion Kyats) and 4.2 billion JPY (35 billion Kyats) for Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady respectively. As indicated, the cost of A category for Mandalay area is quite high, and this is because the rehabilitation of the 3 irrigation systems, which

occupies the largest cost, is placed under this category-A. Irrigation systems in other areas (drainage in Ayeyarwady area) are in fact under the category-B.

When the cost covers not only category-A but also category-B, it is now 19.9 billion JPY (170 billion Kyats) , 23.6 JPY (201 billion Kyats), 10.1 billion JPY (86.8 billion Kyats), and 13.7 JPY (117 billion Kyats) for Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady respectively. On the other hand, costs only for category-C are in a rage of 600 to 900[3] million JPY except for Mandalay whose cost of category-C comes to 2.7 billion. Land consolidation[4] component in Mandalay falls in the category-C, so that the C categoryôs cost in this Mandalay area becomes large.

5.2 Program Components and Potential Implementation Scheme

There are total 19 components, and a set of combination of them needs to be implemented in order to promote intensive agriculture in the priority areas, depending upon the characteristics of those areas. To implement those components, relevant government offices should undertake the responsibility as well as the leading roles, to which donors could contribute with a series of schemes including loan provision. Following table shows indicative schemes in cases that; 1) ODA scheme(s) is to be applied, and 2) schemes other than ODA are to be applied:

Table 5.2.1 Program Components and Potential Implementation Scheme

Component	Potential ODA Scheme	Other than ODA
I. Component for Productivity Increase		
1. Agriculture Extension Strengthening	Loan (Project)	MOAI (DOA)
2. Irrigation Rehabilitation	Loan (Project)	MOAI (ID)
3. Polder and Drainage Improvement	Loan (Project)	MOAI (ID)
4. Land Consolidation	Loan (Project)	MOAI (ID/ AMD)
5. Agricultural Machinery Station Enhancement	Loan (Project)	MOAI (AMD)
6. Agricultural Machinery Dissemination (TSL)	Loan (TSL), 1/	Commercial banks, Sales agents
7. Flood Monitoring System Establishment	Loan (Project)	MOAI (ID)
8. Plant Breeding Enhancement	Grant Aid	MOAI (DAR)
II. Component for Agribusiness Promotion		
9. Farm-to-Market Road (FMR) Improvement	Loan (Project)	DRD, Highway Department
10. Jetty Improvement	Loan (Project)	Local Government
11. Market Improvement (District level)	Loan (Project)	Local Government
12. PPP Wholesale Market Establishment (Mandalay)	Loan (OIL), 2/	Private Company (PPP)
13. Wholesale Market Development (Nay Pyi Taw)	Loan (OIL)	Private Company (PPP)
14. Small & Medium Agro-enterprise Promotion (TSL)	Loan (TSL), 1/	Commercial banks
15. Supply Chain Improvement of Rice	TCP, 3/	MOAI (DOA), MOC
16. Value Chain Enhancement of Vegetables & Fruits	TCP	MOAI (DOA), MOC
17. Food Processing Industry Promotion	TCP	MOAI (DOA), MOC
18. Dissemination of Advanced Farming Technologies	TCP	MOAI (DOA)
19. Plant Protection and Quarantine Enhancement	Grant Aid	MOAI (DOA)

Note: 1/ TSL means Two Step Loan, 2/ this loan could be provided by ñOverseas Investment and Loanò scheme. The scheme aims at promoting economic development of developing countries through providing loan to development projects implemented by private sector. 3/ TCP means technical cooperation project, one of JICAôs technical cooperation schemes.

[3] In Ayeyarwady, the scale of Jetty is larger than that of Shwebo, and also number of markets to be improved at district level is 5 while the market which needs improvement in Shwebo is only one. Therefor, though the category-C components are more or less similar for Shwebo and Ayeyarwady, the total cost is different; the cost for Ayeyarwady is larger than that of Shwebo.

[4] In Mandalay are, Indian loan is to carry out 10,300 acres of land consolidation in the 3 irrigation schemes, same as those identified under this Survey, so that the land consolidation under this JICA Survey is ranked at óCô. However, since Indian loan is to provide loan only and the implementation procedure is same as what the ID/AMD have been doing so far, there should be another donorôs involvement, e.g. JICA, to demonstrate participatory based land consolidation procedure as piloted under a JICA pilot land consolidation conducted in Nay Pyi Taw area in 2014.

5.2.1 Potential ODA Implementation Schemes

ODA schemes in the above table are composed of; 1) Loan provision, 2) Technical Cooperation Project (of JICA), and 3) Grant Aid. Loan schemes could support the implementation of above components No.1 to No.14 except for No.8, taking into account the size of investment and also the potential to implement as a component of loan supported activities. Components from No.15 to No.18 can be supported by a technical cooperation scheme, providing technical transfer, equipment, trainings, etc. The remaining components of No.8 Plant Breeding Enhancement and No.19 Plant Protection and Quarantine Enhancement could be supported by a grant aid scheme inclusive of capacity development.

The loan schemes are further categorized into three types; 1) project type loan, 2) Overseas Investment and Loan, and 2) two step loan. Project type loan is a common scheme, same as the one being implemented in Bago West area under Irrigation Department, MOAI. The project type loan presented here, however, has to cover several components; namely, not only irrigation component under ID but also agricultural extension under DOA, machinery station under AMD, and some components under other ministries, e.g. road improvement under Department of Rural Development, Ministry of Livestock, Fisheries and Rural Development, etc.

Overseas Investment and Loan (OIL) scheme aims at promoting economic development of developing countries through providing loan to development projects implemented by private sector. A wholesale market in Mandalay is planned to implement under PPP, and a private company is already in charge. However, the plan is still a concept level and the fund is to be procured through market. The OIL may well support the implementation as per the need. There is a plan of establishing a new wholesale market in Nay Pyi Taw as well. The land to establish has already been identified near Nay Pyi Taw station (a government owned land), and there is a plan to proceed with PPP. In this plan, the OIL scheme may be incorporated as well.

Two Step Loan is expected to support such 2 components as; 1) No.6 Agricultural Machinery Dissemination, and 2) No.14 Small & Medium Agro-enterprise Promotion. The latter component could be supported by an already available scheme of Small & Medium Enterprises Promotion loan, started in 2015, while a preparatory survey was done for a two step loan program which can support farmers to be covered under the former component. This two step loan, targeting farmers, should also start. In both cases, however, the loan amount agreed/ planned is 5 billion JPY, and this amount should be up-scaled to cover needy large number of farmers, rice millers, traders, etc.

5.2.2 Potential Implementation Schemes Other Than ODA

Other schemes than ODA to implement the identified components/ sub-programs are to be the government development and/or recurrent activities. Government of Myanmar has implemented number of projects to date, and these activities should be continued and enhanced with some re-alignment in terms of man-power and budget in line with the above components identified to promote intensive agriculture. Also, local government authorities such as city development committee and/or district development committee can be in charge of the improvement of jetty and market, assisted by the central government.

Aside from the components which can be pursued by government, there are possibilities of bringing about private initiatives in the following components:

1) Under 6. Agricultural Machinery Dissemination, not only private commercial banks but also sales agents themselves could be engaged in the mechanization promotion. With the current arrangement in Myanmar, farmers can submit their farmland use-right as collateral to borrow money from commercial banks for the purpose of purchasing farm machineries, with the interest of 13% in most cases. Further there is a case that sales agents for farm machineries provide

installment arrangement. For example, an agent in Mandalay provides an installment sale, in which a farmer has to pay 40% at the time he/she purchases a machine, and the rest 60% shall be paid over 2 years by 4 install payments (once in every half year) with an interest of 11%[5]. If this kind of private installment arrangement is extended to farmers, there will be more farmers to buy farm machineries.

2) In establishing wholesale market, PPP arrangement could be initiated. In fact, there is already an example; namely, the wholesale market to be constructed in Mandalay. The government has provided the land, at which a private company is to construct a wholesale market together with service facilities such as lodging, restaurants and even one-stop facilities for export. The private company is to collect construction fund from market, e.g., through issuing bond and/or stocks, and will be in charge of operating and maintaining the market. This arrangement could also be made in establishing the new wholesale market in Nay Pyi Taw since the land has already been arranged.

5.3 Areas to Share and Collaborate with Donors

There are donors, e.g. the World Bank, ADB, IFAD, Indian government, etc. which are working in the agricultural development sector. Of them, the target areas by the World Bank, IFAD and Indian government are partly overlapped with the priority areas identified under this Survey. These overlapped areas are summarized with the components that the 3 donors are to undertake:

Table 5.3.1 JICA Proposed Priority Areas, and Respective Donors Involvement

Priority Area	Other Donors	Component by Other Donor(s)	JICA
1. Shwebo	No	-	
2. Mandalay	Indian Government	Land consolidation is carried out in 3 irrigation systems of Sedawgyi, Zawgyi and Kinda, totaling 10,300 acre. The 3 systems are same as the ones identified by JICA survey.	7,4000 acre (3,000 ha) land consolidation
3. Nay Pyi Taw	Indian Government	Land consolidation is conducted in 3 irrigation schemes of Ngalaik (6,000 ac), Yezin (5,000 ac) and Sinthe (1,500 ac), totaling 12,500 acre.	1) 2,500 acre (1,000 ha) land consolidation 2) Advanced farming technologies dissemination
	IFAD	1) Land consolidation is implemented in total 10,000 acre, part of which is to be carried out in Paung Laung irrigable area, one of priority areas identified by JICA survey. 2) Under Agricultural and Business Services, Knowledge Centers will be established which provide varieties of technologies and knowledge including agricultural extension.	
	The World Bank	Left main canal of Sinthe irrigation system will be rehabilitated, one of irrigation systems identified by JICA survey.	Irrigation rehabilitation including Sinthe system
4. Ayeyarwady	IFAD (under planning)	To carry out polder rehabilitation, land consolidation, and seed production with an expected amount of 30 MUS$. Possibly prioritizing lower parts of the delta under the Delta Resilience Project.	4,000 ha (9,900 acre) land consolidation, drainage improvement

Source: Reports of and interviews to the relevant donor projects

Land consolidation is recommended to implement in all the priority areas in case of JICA while Indian government will carry out the consolidation works in Mandalay and Nay Pyi Taw. IFAD will also be implementing land consolidation in Nay Pyi Taw area. The proposed procedure by IFAD is more or

[5] In this private installment arrangement, the farmers have to submit the certificate of farmland use right as collateral. As of December 2015, no defaulters are reported.

less same as what JICA tried and proposed under the Preparatory Survey for the Project for Rehabilitation of Irrigation Systems, under which a pilot land consolidation was conducted. Therefore, land consolidation in Nay Pyi Taw proposed by JICA could be superseded by IFAD or the scale can be kept small, e.g. 2,500 acre as proposed in this Survey.

The procedure of the land consolidation by Indian government loan is not clear as of November 2015; however, it is said that the Indian government is to provide loan with which ID/AMD will proceed the consolidation works. Therefore, the level of participation of the beneficiaries may not be the same as what JICA pilot land consolidation had done, nor to the IFAD funded project. Therefore, the land consolidation proposed in Mandalay by this JICA Survey still should have a certain scale; that is 7,400 acres (3,000 ha) proposed.

One of the components of IFAD funded project in Nay Pyi Taw is to enhance Agricultural and Business Services, under which a center called Knowledge Center, will be established to conduct various trainings, and disseminate new knowledge and technologies, whereas, this JICA Survey proposes Agricultural Extension Strengthening and also Dissemination of Advanced Farming Technologies. The JICA proposed ones basically target establishment of new technologies at DOA experimental farms, and then disseminate to farmers. In the course of the dissemination, the Knowledge Center can be utilized as a venue of extension.

The World Bank is to rehabilitate left main canal of Sinthe irrigation system in Nay Pyi Taw area, which is also one of the target irrigation systems proposed under this JICA Survey (as of February 2016, project management unit of the WB funded project is being established, and fund is to start flowing from April, 2016). In order to avoid the overlapping, the left main canal was excluded from the component formulation of JICA Survey, hence only right main canal and below thereof are to be undertaken for the rehabilitation and upgrading of the facilities.

In Ayeyarwady delta, IFAD is now formulating a project, called Delta Agriculture Resilience Project, composed of 1) Strategic investments including Polder Infrastructure Rehabilitation, and Land Development and Consolidation, and 2) Enabling Investment including Knowledge and Technology, Seed Production and Financial Services (30 MUS$ envisaged). JICA Survey also identified such priority components in Ayeyarwady area as polder strengthening, drainage improvement, land consolidation, agricultural extension strengthening including quality seed production, etc. These components may be overlapped; however since the delta extends over huge area, such overlap will be welcomed as far as the areas to be implemented are not in the same place.

5.4 Implementation Arrangement

5.4.1 Executing Organization

Following table shows the implementing agencies by component, and also demarcates all these components into 2 groups; 1) project loan components which are better implemented as one-package, and 2) components which can be implemented by its own as standalone component. It means that the components under ôProject Loan Componentsôin the table below are expected to implement under one package of a project loan while the components under ôStandalone Componentô can be better implemented by its own as standalone project in terms of financial and operation management.

The components in the former group are mainly infrastructure improvement including Jetty and market and also agriculture extension. Standalone type components are, on the other hand, tow step loan component, PPP market construction, technical cooperation projects, and grant aid component. It is noted that though implementation of several components under a project loan could contribute to accelerating intensive agriculture promotion, project management mechanism should be well established.

Table 5.4.1 Program Components and the Relevant Implementation Agencies

Component	Potential ODA Scheme	Implementing Agency
Project Loan Component		
1. Agriculture Extension Strengthening	Loan	Department of Agriculture (DOA)
2. Irrigation Rehabilitation	Loan	Irrigation Department (ID)
3. Polder and Drainage Improvement	Loan	Irrigation Department (ID)
4. Land Consolidation	Loan	Irrigation Department (ID) Agricultural Mechanization Depâ (AMD)
5. Agricultural Machinery Station Enhancement	Loan	AMD
7. Flood Monitoring System Establishment	Loan	ID
9. Farm-to-Market Road (FMR) Improvement	Loan	ID (canal maintenance road) Depart. of Rural Development (rural road) Highway Department (regional road)
10. Jetty Improvement	Loan	Inland Water Transport Department
11. Market Improvement (District level)	Loan	Local Gvt (development committee)
Standalone Component		
6. Agricultural Machinery Dissemination (TSL)	TS Loan	Myanmar Agricultural Development Bank
8. Plant Breeding Enhancement	Grant Aid	DAR
12. PPP Wholesale Market Establishment (Mandalay)	Loan (OIL)	PPP (Private company)
13. Wholesale Market Development (Nay Pyi Taw)	Loan (OIL)	PPP (Private company, or NPT CDC)
14. Small & Medium Agro-enterprise Promotion (TSL)	TS Loan	Small & Medium Industry Developâ Bank
15. Supply Chain Improvement of Rice	TCP	DOA
16. Value Chain Enhancement of Vegetables & Fruits	TCP	DOA
17. Food Processing Industry Promotion	TCP	DOA (Post harvest Tech. Training C.)
18. Dissemination of Advanced Farming Technologies	TCP	DOA
19. Plant Protection and Quarantine Enhancement	Grant Aid	Plant Protection Division, DOA

Note: TS Loan means Two Step Loan, OIL means Oversees Investment and Loan, TCP means Technical Cooperation Project (of JICA), NPT means Nay Pyi Taw, CDC means City Development Committee. Source: JICA Survey Team

5.4.2 Implementation Arrangement of Project Loan Components

To implement various components in a priority area by a project loan needs to establish well workable management structure. Though there is a regional government and the program is to be implemented at regional level, the regional government is a political establishment without technical offices. It implies that the regional government would have a difficulty of implementing program components by their own staff.

The lead executing organization for the overall implementation should, therefore, be the MOAI through its Department of Planning (DOP). The DOP should oversee the implementation of program components and provide administrative support to the Project Management Offices (PMOs). The program operation and management should be the responsibility of DOP from the central to the field level through its PMOs. The PMOs are composed of the Central Project Management Office (CPMO) at the DOP Central Office, and the Regional Project Management Office (RPMO), well supported by a team of consultants.

There is a pitfall, however, in the implantation basic structure. Department of Planning (DOP) does not

Staffing of DOP:

There are 7 divisions such as; 1) Farmland Management, Crop Production Division, 2) Water Resources, Farmland Development and Financial Division, 3) Research and Training Division, 4) Admin & Finance Division, 5) International Relation Division, 6) ASIA and Local Coordination Division, 7) Investments, Trading and Agricultural Market Evaluation Division.

There are total 311 officers as of November 2015 in the DOP such as:

Director General:	1
Deputy DG:	1
Director:	7
Deputy Director:	17
Assistant Director:	30 (in charge of district)
Staff officer:	55 (in charge of TS)
Staff:	200 (subordinates)
Total	311

have enough technical and management officers in overseeing all the project components (see box right). Therefor, relevant departments under MOAI should second their technical and management officers to the PMO. The participating departments under MOAI are Department of Agriculture (DOA), Agricultural Mechanization Department (AMD), Irrigation Department (ID). The seconded technical and management officers from the various departments should form the PMO together with a team of consultants.

Further to these organizations under MOAI, there are other participating agencies from different ministries, which are Department of Rural Development (DRD) under Ministry of Livestock, Fisheries and Rural Development (rural road), Highway Department (HD) under Ministry of Construction (in charge of regional road in Ayeyarwady), Inland Water Transport Department (IWTD) under Ministry of Transport (Jetty construction), and local government authorities, e.g. city development committee, in charge of market construction and operation (see figure below):

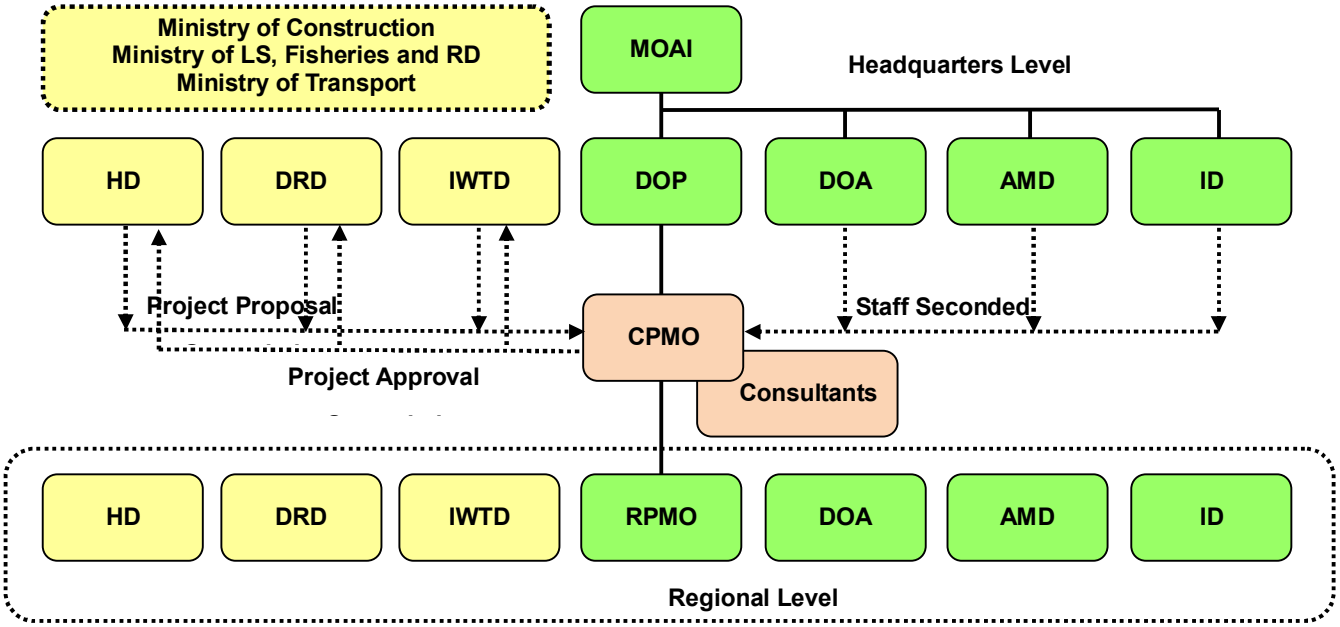


Figure 5.4.1 Implementation Structure for the Program Components (Proposed)

Source: JICA Survey Team

5.4.3 Roles and Responsibilities

MOAI is responsible for the overall project supervision, management and coordination being the lead executing agency. The main units in MOAI directly involved in the implementation of the loan assisted project, including financial management, monitoring and evaluation, should be the Department of Planning (DOP) and the PMOs - the CPMO at the central level and RPMO at the regional level.

1) Department of Planning (DOP), MOAI

The DOP, headed by the Director General, serves as the coordinating arm of the loan assisted project. It provides administrative support to the PMOs both for central and regional levels. Specifically, the DOP shall be responsible in providing the following services:

- ✓ Provide administrative assistance and resource complementation;
- ✓ Coordinate staff detail and resource complementation;
- ✓ Overall financial management programming and disbursement; and
- ✓ Monitoring and evaluation.

2) Central Project Management Office (CPMO)

The central project management office (CPMO) organized at the MOAI central office under the supervision of the DOP is responsible for the detail design for infrastructure, checking and approval on detail designs to be conducted by relevant organizations other than CPMO-Consultant, procurement of contractors/suppliers, tendering when required, supervision of construction component, management, and coordination and monitoring of the day-to-day implementation of the Project. Its responsibilities include the following:

- ✓ Review, consolidate and finalize the Project Investment Program (confirmed shortlist of sub-components/ projects and indicative budgetary requirements);
- ✓ Secure clearances/ endorsements from the DOP on all matters pertaining to the government counterpart funding, loan proceeds, recruitment of key personal, staffing and, if any, compensation package and other relevant administrative and financial matters;
- ✓ Submit regular reports on their respective program of activities;
- ✓ Submit physical and financial status/ accomplishments to the MOAI permanent secretary through the DOP;
- ✓ Prepare and approve detailed design, cost, schedule and implementation with assistance of the Consultants;
- ✓ Coordinate with implementing agencies and oversight entities;
- ✓ Coordinate monitoring, evaluation and feed-backing;
- ✓ Conduct project planning and assessment workshops; and
- ✓ Conduct site validation on the proposed sub-components/ projects.

One of the difficulties associated with the CPMO is the staffing to establish. The CPMO is supervised and controlled by DOP, which shall provide most of the staff of PMO. However, DOP does not have abundant work force at their central and regional offices, and therefore key staff of the CPMO should be seconded by the participating organizations such as ID, AMD, DOA, and also the offices from other ministries.

3) Regional Project Management Office (RPMO)

The RPMOs organized at the regional level are responsible mainly in coordinating project activities in the project area under their jurisdiction. Their roles and responsibilities include the following:

- ✓ Assist in the preparation of sub-components/ project, as necessary, in coordination with the concerned local government offices (for jetty and market;
- ✓ Monitor implementation of sub-components/ projects;
- ✓ Ensure that sustainability mechanisms of sub-components/ projects are in place; and
- ✓ Monitor the financial cash flow on the construction work at the regional level.

4) Consultant Team (PIAP Consultants)

The Consultant Team provides technical assistance to MOAI/DOP and the collaborating and participating agencies for the smooth and effective implementation of the Project. Its scope of services covers the provision of; 1) assistance to over-all project management, 2) technical detail design for infrastructure, 3) bid document preparation, 4) assistance to procurement of contractors, suppliers, 5) technical assistance to the implementation of the Projectôs components (infrastructure, agriculture, transportation, market), and 6) training of the Project staff. The Consultant team works under the supervision and control of the CPMO.

5) Department of Rural Development (DRD), Ministry of Livestock, Fisheries, and Rural Development

The DRD is one of the participating executing agencies for the rural road component. It directly manages and implements construction and rehabilitation works related to the rural roads and bridges. It undertakes rural road and bridge rehabilitation work in close coordination with the CPMO/ Consultants. The functions of the DRD under the Project include:

- ✓ Prepare the annual Work and Financial Plan for the rural road and bridge improvement components;
- ✓ Review and endorse sub-components/ project proposals for rural road and bridges to DOP-CPMO;
- ✓ Review and endorse the cost estimates and Programs of Work (POW) prepared by the regional DRD office;
- ✓ Monitor and prepare reports on the overall physical and financial status of the rural road and bridge improvement component; and submit to the CPMO/ Consultant through the DRD headquarters; and
- ✓ Conduct detailed field surveys for the detail design in coordination with RPMO (regional office);
- ✓ Prepare the design of the road profiles and location of structures (regional office);
- ✓ Prepare the detail design, cost estimates and program of work for rural road and bridges (regional office);
- ✓ Manage and supervise the construction works on a day-to-day basis with the assistance of the CPMO/ Consultant (regional office);
- ✓ Inspection and commissioning of works together with the RPMO, DRD-headquarters, CPMO/ Consultant (regional office);

6) Highway Department, Ministry of Construction

The Highway Department is one of the participating executing agencies for the road and bridge improvement component under their jurisdiction in Ayeyarwady delta. There are road sections which need rehabilitation and improvement under the Highway Department, placed under national highway, and work as a part of very important regional artery. The Department undertakes the road and bridge rehabilitation work in close coordination with the CPMO/ Consultants. The functions of the Department are same as those aforementioned in the Department of Rural Development.

7) Inland Water Transport Department (IWTD), Ministry of Transport

The IWTD Department is one of the participating executing agencies for the construction of Jetty component in Pathein of Ayeyarwady, Shwebo and Mandalay. There are existing jetties in these 3 locations, and they should be improved and expanded with modernized equipment such as crane, fork-lift, warehouse, pontoon, etc. The Department undertakes the necessary rehabilitation work in close coordination with the CPMO/ Consultants. The functions of the Department are same as those aforementioned in the Department of Rural Development.

8) Local/ Municipal Government (Market Improvement, and Construction)

The local/ municipal government, specifically development committee in charge of the local/ municipal area is one of the participating executing agencies for the renovation/ construction of wholesale market. There are existing local wholesale markets in all the district centers and most of them are dilapidated and not in good sanitary conditions. They should be renovated and improved and, in cases, expanded with raised floor, warehouse, etc. The local/municipal offices undertakes the

necessary renovation work in close coordination with the CPMO/ Consultants. The functions of the Department are same as those aforementioned in the Department of Rural Development.

5.5 Consultant and Expert Assignment

To lead the project implementation smoothly, technical assistances should be arranged involving international and national consultants/experts. Those consultants/experts shall work closely with and under the supervision of Project Management Office in case of loan assisted components. In case of technical cooperation projects, Japanese experts should closely work with the counterpart personnel assigned by the relevant departments, supported by national experts.

5.5.1 Consultancy Services

To carry out a loan project, consultants should be employed mainly for the 2 works such as; 1) detail design and also tender documents preparation, and 2) progress management including the supervision of construction works. In most cases, detail design and the tender documents preparation shall be carried out under a Task Concept for the consultants while the management/ supervision is to be under an Assistant Concept to the project owner. Especially, as the loan envisaged under this JICA Survey is to cover various components and also the DOP overseeing the PMO does not have enough officers, a team of consultants and/or sets of consultants should be employed, and assigned to the PMO.

Consultants will be composed of both international experts and national experts, who are to undertake 1) necessary surveys, 2) detail design 3) quantification of works, 4) cost estimation, 5) preparation of tender documents as required, which are all undertaken during the detail design stage, and 6) progress management/ supervision of works during the construction period. In case that construction is done by direct force account, the consultants have to be in charge of monitoring and endorsing the expenses made by the implementing departments, which are then disbursed by the Loan.

Table 5.5.1 shows consultants to be required with major components which could be financed by a loan, which are composed of international and national consultants. International consultants are to be assigned only in key tasks while national consultants will have to be assigned in all the works required. National consultants are therefore to be assigned approximately 2 times to 5 times more than those of international consultants.

In terms of consultant/ expert fee share, it ranges 5 % to as much as 12 % depending on the work nature except for Agriculture Extension Strengthening (No.1). Since the Agriculture Extension Strengthening conduct a series of trainings together with demonstration, the fee for the consultant/ expert will share much, say one-third to as much as half of total cost of the components. Consultant fee for Irrigation Rehabilitation (No.2) shares relatively smaller amount. This is because the rehabilitation is technically not much difficult and also the size of the construction cost is the largest, and thereby the consultant share becomes smaller. Note that consultant fee of ôPolder and Drainage Improvement (No.3 in Ayeyarwady)ô shares 12% and this is because the detail design will have to be carried out not just in the first year but over 4 years.

Table 5.5.1 Consultant and Expert Person-Month Expected for Major Loan Assisted Components

Program Components	Professional/Expert		Project Cost (M JPY)		Rate
	International	National	Total (1)	Consulting (2)	(2) / (1)
Shwebo Area					
1. Agriculture Extension Strengthening	24	220	1,018	359	35 %
2. Irrigation Rehabilitation	75	275	9,180	550	6 %
4. Land Consolidation	25	99	2,379	178	7 %
8. Farm-to-Market Road (FMR) Improvement	32	198	3,037	286	9 %
Mandalay Area					
1. Agriculture Extension Strengthening	30	165	835	326	39 %
2. Irrigation Rehabilitation	94	374	14,033	717	5 %

Program Components	Professional/Expert		Project Cost (M JPY)		Rate
	International	National	Total (1)	Consulting (2)	(2) / (1)
4. Land Consolidation	30	121	1,899	218	11 %
8. Farm-to-Market Road (FMR) Improvement	38	242	3,304	349	11 %
May Pyi Taw Area					
1. Agriculture Extension Strengthening	18	66	357	153	43 %
2. Irrigation Rehabilitation	49	176	3,574	357	10 %
4. Land Consolidation	13	44	627	86	14 %
8. Farm-to-Market Road (FMR) Improvement	22	88	1,474	156	11 %
Ayeyarwady Area					
1. Agriculture Extension Strengthening	24	132	529	260	49 %
3. Polder and Drainage Improvement	81	132	3,789	465	12 %
4. Land Consolidation	33	88	2,406	205	9 %
8. Farm-to-Market Road (FMR) Improvement	24	132	3,863	204	5 %

Source: JICA Survey Team

5.5.2 Technical Assistances from JICA

Aside from the deployment of consultants under the implementation of loan assisted components, dispatches of a set of experts are required in implementing different types of technical cooperation projects. Table 5.5.2 summarizes the indicative input of technical experts by each of the recommended technical cooperation projects. A typical technical cooperation project may need 4 ï 6 long term experts who are to work during the project implementation period, usually 4 ï 6 years.

Table 5.5.2 Expert Required for Technical Cooperation Project

Program Components	Professional / Expert		Project Cost (M JPY)		Rate
	Expert	National	Total (1)	Expert (2)	(2) / (1)
14. Supply Chain Improvement of Rice	155	220	784	428	55 %
15. Value Chain Enhanô of Veg. & Fruits	125	165	605	345	57 %
16. Food Processing Industry Promotion	145	165	822	393	48 %
17. Disseminatôn of Advanced Farming Tech.	116	132	574	314	55 %

Source: JICA Survey Team

5.6 Construction Modality for ODA Loan Components

In Myanmar, direct force account implementation is still common specially in case of construction of irrigation schemes including dams. However, there are already private company participations in such areas of road construction and building construction. There are general contractors engaged in civil construction works including road construction. However, as a matter of fact, many contractors in Myanmar are at the same time developers, who invest in procuring the land and constructing private buildings, e.g. apartment, on it and sell it to the market. Therefore, in general, it can be said that constructors engaged in building construction are already much available in Myanmar while the ones engaged in civil works are yet to be many, especially in the works related to hydraulic structures.

The JICA team has conducted a interview survey to registered general contractors based in Yangon. Frist, the team contacted Myanmar Engineering Society and picked up 11 biggest contractors. Though the team tried to contact all the 11 biggest companies, only 4 companies accepted the teamôs interview. Fortunately, the 4 interviewed companies are well known in Myanmar and 3 out of the 4 are said to be within the top 5 civil contractors in Myanmar. Following table summarizes the sizes of the 4 companies as;

- ✓ In terms of workforce, it ranges from 300 to about 1000, while the construction machineries they have are bulldozer, excavator, wheel/road loader, concrete batching plant, etc. the number of owned machines are; less than 10 for bulldozer, 5 to 111 for excavator, 14 to 39 for dump truck, and so on.

✓ For the works experienced, 2 companies have been engaged in irrigation related works which was also confirmed in ID. In fact, ID has made contract-out to these companies, and Company C has undertaken at least 4 number of works whose contract amounts were more than 1 billion Kyats.

Table 5.6.1 Information of Civil Contractors in Myanmar

Name of Company		A Company	B Company	C Company	D Company
1. General Information					
Location of Head Office		Yangon	Yangon	Yangon	Yangon
Capital Fund (million kyat)		20,000	50	30	-
Number of Employee		380	908	300	418
Annual Total Sales (million kyat)		4,150	27,494	-	-
2. Number of Construction Equipment					
Bulldozer		5	7	4	6
Excavator (Backhoe)		5	11	111	8
Dump Track		30	14	39	30
Wheel / Road Loader		4	6	2	10
Batching Plant		1	-	-	8
Hydraulic Pile Machine		2	-	-	-
Others		5	10	36	11
3. Experience of Construction (for the last 10 years)					
Irrigation related (Dam, Canal etc.)	> 1,000 million kyat	-	-	> 4	-
	1,000 million kyat <	-	-	> 8	> 6
Others (Building, Port etc.)	> 1,000 million kyat	> 14	> 20	-	-
	1,000 million kyat <	-	> 20	-	-

Source: Interview to the private construction companies

Table 5.6.2 Machinery Owned by Irrigation Department

Item	Under Operation	Under Repair	Out of Order	total
Excavator	316	72	101	489
Bulldoze (CII)	224	40	79	343
Roller	17	2	12	31
Dump Track	295	70	24	389

Source: ID Mechanical Division

On the other hand, above Table 5.6.2 shows the machineries that the ID owns as of 2014. As is well shown, the machines ID owns are much more than those the private companies own. For example, ID has 316 operational excavators while the company C has only 111 excavators though it is the largest number among the 4 private companies. On top of that, ID owns 224 operational bulldozers and the 4 private companies have only less than 10 dozers. Therefore, it is recommended that the rehabilitation of irrigation system should better be managed by IDôs direct force account work.

In case of road rehabilitation and improvement, there are already private companies who have experienced such works. In addition, Department of Rural Development, in charge of rural road, does not have enough equipment and machineries for road improvement, and in this case contractors should be engaged in the work. If the road requiring rehabilitation/improvement is divided into sections, even local contractors operating in district capital and/or township capital could participate in case of gravel paved and concrete paved roads. Therefor, road improvement should primarily engage private civil contractors.

Taking into account above mentioned examination, following table indicates the construction modality; namely, direct force account implementation can only be applied in irrigation rehabilitation and land consolidation work. Other works should engage civil contractors, either local or nation wide operator depending upon the size of the works:

Table 5.6.3 Construction Modality for Civil and Hydraulic Works

Work	Potential Implementer	Remarks
Irrigation facilities	Irrigation Department (ID)	Direct force account
Land consolidation	ID, and Agri.l Mechanization Depart. (AMD)	Direct force account
Road (rural)	Civil Contractor	Local contractor accepted
Road (regional)	Civil Contractor	PQ is required
Jetty	Civil Contractor	PQ is required
Wholesale Market	Civil Contractor	PQ is required

Source: JICA Survey Team, PQ is Pre-qualification which identifies suitable contractors, per size of the work.

5.7 Operation and Maintenance of the Project

There are components/ sub-programs in the proposed program, which can be supported by a project type loan as package. Following table provides the project implementers and the entity in charge of operation and maintenance of those components. In most cases, the project implementers are same as those entities in charge of operation and maintenance except for Land Consolidation and Jetty Construction.

Table 5.7.1 Responsibility of Construction and O&M for Project Loan Components

Project Type Loan Component	Implementer	In Charge of O&M
1. Agriculture Extension Strengthening	DOA	DOA
2. Irrigation Rehabilitation	ID	ID
3. Polder and Drainage Improvement	ID	ID
4. Land Consolidation	ID/ AMD	Farmers
5. Agricultural Machinery Station Enhancement	AMD	AMD
7. Flood Monitoring System Establishment	ID	ID
9. Farm-to-Market Road (FMR) Improvement	ID, DRD, HD	ID, DRD, HD
10. Jetty Improvement	IWTD	Local Gvt (Dev. Committee)
11. Market Improvement (District level)	Local Gvt	Local Gvt (Dev. Committee)

Note: DRD means Department of Rural Development in charge of rural roads, HD is Highway Department in charge of regional road in Ayeyarwady, IWTD means Inland Water Transportation Department in charge of construction of jetty but the operation is managed by local government, e.g. city development committee.

For the Land Consolidation, the present arrangement is that ID constructs farm road together with tertiary level irrigation canal and drainage running alongside the farm road while AMD carries out farm leveling, farm plot demarcation by putting up a small ridge, etc. Then, the maintenance of the farm roads and tertiary level canals are said to be by the farmers or the farmer organization established. However, there is no clear law specifying who should and can be the owner of the facilities and whereby who should be in charge of the maintenance.

In principle, the farmer organization established should own the facilities, farm road and tertiary level canals; however the present law does not have any provision with which such organization can possess such properties. In anyway, the O&M of the facilities should be made by the farmers or the organization and relevant law(s) should be established in near future. In case that there is a large scale repair or rehabilitation which go beyond the capacity of the farmers/ organization, they shall request ID and/or AMD to support the required works.

Jettyôs construction is to be carried out Inland Water Transport Department under the Ministry of Transport. Then, upon completion of the facilities, the jetty is transferred to the local authority, i.e., city development committee in most cases. The committee in charge collects tax as service fee, and with the service fee, the committee carries out necessary maintenance works. Therefore, the level of the service fee should be so set that the collected fee can manage the maintenance. For large scale rehabilitation/ renovation, the committee should request the department for its assistance.

Of the components in the above table, 2. Irrigation Rehabilitation and 8. Farm-to-Market Road (FMR)

Improvement are one of the major ones which need large investment and thereby certain amount of maintenance. Following discussions focus on the 2 components in terms of maintenance.

5.7.1 Operation and Maintenance of Irrigation Systems

The current operation and maintenance cost for the concerned irrigation schemes is not available, and therefore example of Bago West area is referred, and also based on the ID overall recurrent budget, an indicative maintenance cost which can actually be spent is examined. Table 5.7.2 shows the maintenance cost for the 4 irrigation schemes in Bago West area; North Nawin, South Nawin, Wegyi and Taung Nyo. From this table, for the last 5 years of 2008 to 2012, an average of about 6,000 Kyats/ha (2,400 Kyats/acre) was spent.

It is noted that the maintenance cost spent in 2008 was only 1,980 Kyats/ha which is less than one-third of what had been spend after the year 2008. In fact, this is a trend over almost all the irrigation shcemes in Myanmar. The maintenance cost actually spent was very minimal up to 2000s, and from late 2000s, it has increased.

Table 5.7.2 Actual O&M Cost Spent on Bago West Irrigation Schemes (NN, SN, Wegyi and Taung Nyo)

Total of Bago West Office	Budget spent for maintenance, Kyats	Irrigable Area (ha)	Unit Price (kyat/ha)	Unit Price (kyat/acre)
2008 (actually spent)	138,617,839	70,021	1,980	801
2009 (actually spent)	494,339,646	70,021	7,060	2,857
2010 (actually spent)	448,344,432	86,382	5,190	2,100
2011 (actually spent)	648,436,745	86,382	7,507	3,038
2012 (actually spent)	690,374,955	86,382	7,992	3,234
Average	**484,022,723**		**5,946**	**2,406**

Source: Bago West Maintenance Division

Table 5.7.3 shows the annual budget allocated to Irrigation Department since year 2000. As is well illustrated, the recurrent budget, wherein maintenance cost is allocated, was somewhat minimal up to mid-2000s, and then started increasing very much. As an example, recurrent budget before year 2004/05 was less than 10 billion Kyats, and that in 2013/14 was increased to about 98 billion Kyats, more than 10 times increase over the 10 years.

Table 5.7.3 Actual Recurrent Cost Allocated to Irrigation Department

Year	Annual Budget of ID (Million Kyats)			Irrigable and Flood Protection Area (ha '000)		
	Recurrent	Capital	Total	Irrigable	Flood Protection	Total
2000 - 2001	3,169	9,474	12,643	1,008	1,447	2,456
2001 - 2002	4,000	9,025	13,025	1,061	1,452	2,513
2002 - 2003	4,138	13,914	18,052	1,113	1,399	2,513
2003 - 2004	8,171	18,380	26,552	1,182	1,399	2,582
2004 - 2005	5,849	24,017	29,866	1,193	1,473	2,666
2005 - 2006	11,673	44,427	56,100	1,201	1,474	2,675
2006 - 2007	20,016	57,443	77,459	1,324	1,474	2,798
2007 - 2008	25,040	70,730	95,770	1,333	1,491	2,824
2008 - 2009	27,193	139,311	166,504	1,332	1,491	2,823
2009 - 2010	32,640	88,334	120,973	1,381	1,484	2,865
2010 - 2011	59,697	97,390	157,087	1,309	1,484	2,793
2011 - 2012	77,531	28,677	106,208	1,372	1,487	2,860
2012 - 2013	92,776	95,425	188,201	1,315	1,483	2,798
2013 - 2014	98,025	298,626	396,651	1,398	1,496	2,894

Source: Irrigation Department

With the recurrent cost actually allocated, an available maintenance cost is estimated in the following table by subtracting assumed personal expenses and management cost from the allocated total recurrent cost. According to this estimation, an available budget for maintenance is calculated at about 13,000 - 14,000 Kyats per hector for the latest 2 years of 2012/13 to 2013/14. However, when looking

into the estimated available maintenance cost before 2009/10, it had been negative which means there must have not been available maintenance budget.

Table 5.7.4 Estimated Available Maintenance Cost for Whole Irrigation Systems

Year	Annual Budget of ID (Recurrent) (MK)				Irrigable and Flood Protection Area (ha '000)			Available Maintenance Cost	
	Personnel Expense (1)	Mgt Cost (2)	Maint. Cost (3)	Total	Irrigable	Flood Protection	Total (4)	(3)/(4) (kyat/ha)	(kyat/acre)
2007 - 2008	42,520	8,504	-25,985	25,040	1,333	1,491	2,824	-9,202	-3,724
2008 - 2009	43,388	8,678	-24,873	27,193	1,332	1,491	2,823	-8,811	-3,566
2009 - 2010	44,274	8,855	-20,489	32,640	1,381	1,484	2,865	-7,151	-2,894
2010 - 2011	45,177	9,035	5,485	59,697	1,309	1,484	2,793	**1,964**	795
2011 - 2012	46,099	9,220	22,212	77,531	1,372	1,487	2,860	**7,767**	3,143
2012 - 2013	47,040	9,408	36,328	92,776	1,315	1,483	2,798	**12,983**	5,254
2013 - 2014	48,000	9,600	40,425	98,025	1,398	1,496	2,894	**13,968**	5,653

Source: JICA Survey Team based on Date from Irrigation Department

Looking at the current conditions of the irrigation schemes in the priority areas, the level of allocated budget for O&M could be said not enough, at least the previously allocated budgets for O&M was not enough at all, having created the present deteriorated conditions. Therefore, in the economic analysis, 2% of the capital investment was entered as the necessary O&M cost. The amounts of the O&M entered in the economic analysis are indicated in the following Table 5.7.5, ranging from 7,700 Kyats/ha to 21,000 Kyats/ha.

This range of O&M cost is more than the recent O&M cost for the Bago West and also comparable to the latest allocated budget as indicated in above Table 5.7.4. Since EIRR shows economic justification in the implementation of the irrigation rehabilitation, the government should allocate such level of O&M budget, or should keep the latest level of recurrent budget.

Table 5.7.5 Proposed O&M Cost for Irrigation Systems in Priority Areas (employed in Economic Analysis)

Irrigable Area	Budget spent for maintenance, Kyats	Irrigable / Protected Area (ha)	Unit Price (kyat/ha)	Unit Price (kyat/acre)
Sagaing	1,562,000,000	198,976	7,850	3,177
Mandalay	2,233,900,000	131,807	16,948	6,859
Nay Pyi Taw	617,100,000	29,720	20,764	8,403
Ayeyarwady	689,400,000	90,119	7,650	3,096
Average			**13,303**	**5,383**

Source: JICA Survey Team

As of now, the irrigation service fee that the beneficiary farmers are supposed to pay is very minimal; 1,950 Kyats per acre (4,800 Kyats/ha) only. This level of irrigation service fee is very minimal as compared to other countriesôpractice. In most of the counties, a range of 3% to 5%, and in some cases as much as 10%, against gross profit of the agriculture produces with irrigation has been applied as irrigation service fee in case of gravity irrigation system. With this range of irrigation service fee, following table explores expected irrigation service fee to be collected with rehabilitation:

Table 5.7.6 Proposed Irrigation Service Fee Collected After Rehabilitation

Item		1. Sagaing	2. Mandalay	3. Nay Pyi Taw	4. Ayeyarwady
Planned Yield (basket per ac)	Monsoon Paddy	69	89.5	86.5	72.5
	Summer Paddy	98.5	104.5	102	98.5
Farm-gate Price (Kyat per bsk)	Monsoon Paddy	7,327	6,078	4,826	5,253
	Summer Paddy	4,562	5,602	5,313	4,195
Irrigation Service Fee, Kyats/ acre					
Monsoon Paddy	3%	15,167	16,319	12,523	11,425
	6%	30,334	32,639	25,047	22,851
	9%	45,501	48,958	37,570	34,276

Item		1. Sagaing	2. Mandalay	3. Nay Pyi Taw	4. Ayeyarwady
Summer Paddy	3%	13,481	17,562	16,258	12,396
	6%	26,961	35,125	32,516	24,792
	9%	40,442	52,687	48,773	37,189
Monsoon Paddy Area, acre		485,456	253,295	67,945	178,154
Summer Paddy Area, acre		274,086	138,644	33,335	96,381
Weighted Fee (3% & 6%), Kyats/ ac		19,423	22,972	19,104	16,118
Weighted Fee (3% & 6%), Kyats/ ha		**47,996**	**56,765**	**47,207**	**39,829**

Source: JICA Survey Team

Upper part of the above table indicates expected yields after rehabilitation and also prevalent farm-gate prices of monsoon paddy and summer paddy. The mid part of the table presents irrigation service fee estimated based on 3%, 6% and 9 % of the gross farm gate prices. Then, 3% and 6% are applied as irrigation service fee for monsoon paddy and summer paddy respectively, as practiced in other countries[6]. The weighted irrigation service fees out of monsoon and summer paddy are therefore estimated at 39,839 Kyats to 56,765 Kyats per hector as indicated in the bottom row of the above table.

The recent actual maintenance cost in Bago West area is 7,000 to 8,000 Kyats/ha while available maintenance cost estimated based on IDôs recurrent budget is around 13,000 to 14,000 Kyats/ha in latest years. As compared to these recent trend of maintenance costs, the range of above estimated irrigation service fees, based on 3 % to 6 % of gross farm gate prices, is quite enough since the level is from 39,000 to as much as 57,000 Kyats/ha. Therefore, it is recommended that ID should raise the irrigation service fee with reference to other countriesô practice in order to cover necessary operation and maintenance cost, and above estimation shows there is enough room to raise.

5.7.2 Maintenance of Farm-to-Market Roads (FMR)

Road proposed here are categorized into three; 1) canal maintenance/ inspection roads running alongside the main canals of irrigation schemes, 2) rural roads under the Department of Rural Development, and 3) regional highway in Ayeyarwady area which is under the Highway Department, Ministry of Construction. The maintenance of canal inspection roads is undertaken by ID as a part of recurrent O&M activities afore-mentioned. Following explore the maintenance of rural roads and regional highway in Ayeyarwady:

1) Rural Roads under Department of Rural Development (DRD)

Since DRD is a new organization established in year 2012, actually allocated and spent O&M costs for rural roads are not well organized and in many cases not allocated as a matter of fact. In cases, maintenance is counted as new investment to upgrade and/or rehabilitate the current poor roads. Therefore, this Survey indicates the level of maintenance cost, with which the DRD should start allocating necessary maintenance cost.

Following Table 5.7.7 calculates necessary maintenance cost per mile in case of gravel road, the most common mode of road under DRD, with the detail BOQ, and concrete road, asphalt paved road. The standard width of the roads is set at 12 feet, and the maintenance is to replenish the gravel with compaction, remove and replace the concrete, and replace the asphalt coat respectively. The required maintenance costs are, respectively, 23 million, 80 million and 64 million Kyats per mile.

[6] As irrigation for monsoon paddy is mostly supplemental to the rainfall, the range of irrigation service fee for this monsoon paddy is set lower than that of summer paddy which is completely dependent on irrigation.

Table 5.7.7 Proposed O&M Cost for DRD Road

Item	Unit	Quantity	Unit Price (kyat)	Cost (Kyat)
(1) Machinery: Road Roller				
Diesel (H.S.D.)	gal	161.242	3,156	508,880
Engine Oil	gal	3.225	15,200	49,020
Gear Oil	gal	3.225	15,200	49,020
Grease	lb	3.225	3,000	9,675
(2) Material				
Chipping Stone	sud	422.7	50,000	21,134,237
Miscellaneous	set	1		514,168
(3) Labor				
Labor Chief	day	10.50	7,000	73,500
Operator (Machine Driver)	day	10.50	7,000	73,500
Labor	day	147.00	4,000	588,000
Total (Gravel, 12 feet)	**Per mile**			**23,000,000**
Total (Concrete, 12 feet)	**Per mile**			**80,000,000**
Total (Asphalt, 12 feet)	**Per mile**			**64,000,000**

Source: JICA Survey Team based on unit cost provided by Irrigation Department

2) Regional Roads in Ayeyarwady, under Highway Department (HD)

There are many cases in Myanmar, in which private companies are in charge of asphalt pavement, and operation and maintenance of parts of national highways and regional highways. Private companies are contracted by the Ministry of Construction, and they put up a toll gate, collect fee and carry out the initial asphalt pavement and maintenance. In Ayeyarwady region, there are 3 sections, which are now operated and maintained by private companies covering about 6% of the Ayeyarwady total length of national/ regional highways as;

- ✓ Parts within Yangon-Pathein Road: 62 miles (4 section, 4 toll gates)
- ✓ Whole Pathein- Ngwesaung Road: 29 miles
- ✓ Whole Maubin- Sarmalauk Road: 21 miles

Table 5.7.8 National and Regional Roads and Private O&M Sections in Ayeyarwady Region

Road managed by Private Company		Total National/ Regional Road (b)	(a) / (b)
Name	Length (a)		
Yangon-Pathein Road (4 sections)	62 mile	1,765 mile	3.5%
Pathein- Ngwesaung Road	29 mile		1.6%
Maubin- Sarmalauk Road	21 mile		1.2%
Total	112 mile		6.3%

Source: Highway Department, Ministry of Construction

Toll gate fee varies by route and usually is set by 4 classes as less than 1 ton, 1 to 3 tons, 3 to 10 tons and more than 10 tons. Following table estimates the toll gate fee collected annually based on the number of traffic according to interviews to the toll gates. Further, with an assumption of allocation ratios amongst such expenditures as personal (40%), asphalt pavement which is needed as initial investment (20%), maintenance cost (30%) and others (10%), the maintenance costs which can actually be spent are obtained.

Table 5.7.9 Estimated Toll Fee Collected and Available Budget for Maintenance, Million Kyats

Name of Road	Fee per vehicle (Kyats)	Toll Gate Fee (Annual)	Expenditure			
			Personal Expense	Asphalt Pavement	Maintenance Cost	Others (Miscellaneous)
Yangon-Pathein Rd (Section(1) - (4))	350 - 400	1,296 (100%)	518.4 (40%)	259.2 (20%)	388.8 (30%)	129.6 (10%)
Pathein- Ngwesaung	2,000 ï	864	345.6	172.8	259.2	86.4

Name of Road	Fee per vehicle (Kyats)	Toll Gate Fee (Annual)	Expenditure			
			Personal Expense	Asphalt Pavement	Maintenance Cost	Others (Miscellaneous)
Road	3,000	(100%)	(40%)	(20%)	(30%)	(10%)
Maubin- Sarmalauk Road	500 ï 1,500	480 (100%)	192.0 (40%)	96.0 (20%)	144.0 (30%)	48.0 (10%)

Source: Private Companies in charge of Toll Gates (2015)

On the other hand, it is estimated that the actually required maintenance cost per mile comes to around 95 million Kyats/mile[7] based on the required works (see table below). Dividing the above estimated maintenance cost, which are set aside for maintenance, by the estimated required maintenance cost of 95 million Kyats/mile, the possible lengths for the maintenance are as follows; namely, with the current collected fee, they can maintain approximately 7 ï 9 % of the road per annum;

- ✓ Yangon-Pathein Road: 4.1 mile (7% of total length)
- ✓ Pathein- Ngwesaung Road: 2.7 mile (9% of total length)
- ✓ Maubin- Sarmalauk Road: 1.5 mile 21 mile (7% of total length)

Table 5.7.10 Standard Cost Required for Asphalt Pavement Maintenance per Mile

Item	Unit	Quantity	Unit Price (kyat)	Cost (kyat)
Hot Bitumen Prime Coat with Coarse Sands				
(1) Machinery: Steam Roller (Asphalt Finisher)				
Diesel (H.S.D.)	gal	473.57	3,156	1,494,587
Engine Oil	gal	9.48	15,200	144,096
Gear Oil	gal	9.48	15,000	142,200
Grease	lb	14.21	3,000	42,630
(2) Material				
Sand	sud	2,700.00	29,737	80,289,900
Bitumen	ton	9.60	600,000	5,760,000
Timber (Scant / Jungle Wood)	ton	5.70	470,000	2,679,000
Miscellaneous		1		3,841,587
(3) Labor				
Labor Chief	day	18.00	7,000	126,000
Labor	day	120.00	4,000	480,000
Total				**95,000,000**

Source: JICA Survey Team based on unit basis cost estimation.

The length that the private company can maintain per annum, about 7 ï 9 % of the total length, could be enough in order to maintain smooth traffic. It means that the present level of toll fee could be reasonable able to manage the required maintenance works. Therefore, if the rehabilitated/improved road sections are to be placed under private companyôs management, it could be properly operated and maintained with the current level of toll fee[8]. The proposed improved sections will have enough number of traffic since they are due needed in transporting agricultural produces. Therefore, the private company to be in charge of O&M of the rehabilitated road could financially manage the maintenance.

[7] Standard cost in case of width 18 feet asphalt with hot bitumen prime coat, including coarse sand placed beneath.

[8] From the table above, the level of toll fee could around 350 ï 400 Kyats per vehicle on the Yangon - Pathein road while the other sections may need at least 500 to 1,000 Kyats per vehicle (as in the case of Maubin-Sarmalauk Road), and at maximum it could be a range of 2,000 ï 3,000 Kyats per vehicle (as in the case of Pathein- Ngwesaung Road)

CHAPTER 6 ENVIRONMENTAL AND SOCIAL CONSIDERATION

This chapter explores impacts on the environmental and social issues, which may be caused by the components of the intensive agriculture promotion program. It starts with confirmation of regulatory settings in Myanmar concerning environmental examination, and discusses areas/issues to be affected by the project implementation by component of the program, the impacts including both negative and positive ones, and then mitigation measures are to be examined.

6.1 Legislative and Institutional Framework of Environmental Consideration in Myanmar

6.1.1 Environmental Impact Assessment

The Ministry of Environmental Conservation and Forestry (MOECAF) is responsible for forestry, logging, implementing national environmental policy, strategy, framework, planning and action plan for the integration of environmental consideration. Under the Ministry, the Environmental Conservation Department is responsible for environmental conservation in Myanmar and it has around 100 official personnel in total. Under this department, there are four Divisions, and Division of Natural Resource Conservation and Environmental Impact Assessment (EIA) is in charge of EIA in Myanmar.

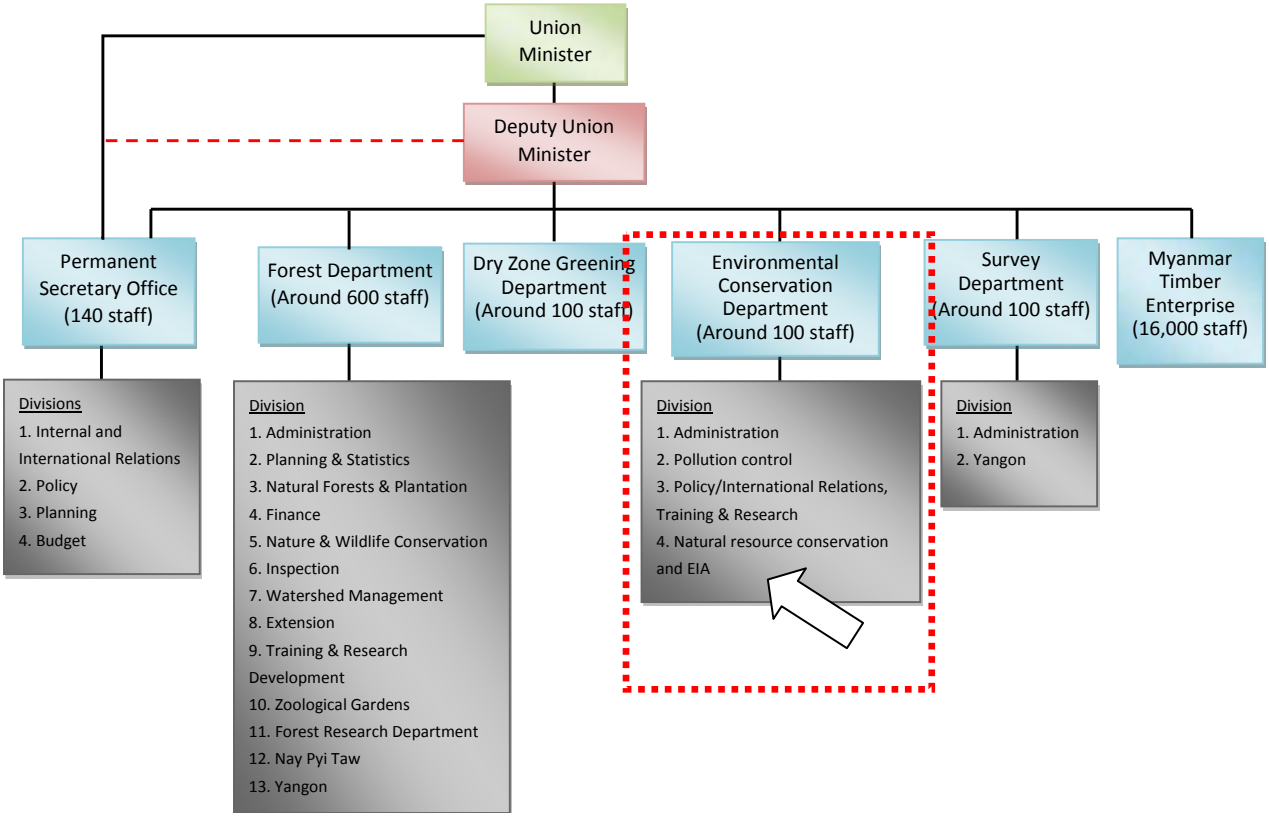


Figure 6.1.1 Organization Chart of the Ministry of Environmental Conservation and Forestry

(Source: hearing from the Environmental and Conservation Department staff as of November 2015)

In Myanmar, the draft environmental impact assessment (EIA) Guideline was formulated in 2015 and, the Draft EIA Guideline is under process for approval by the parliament as of November 2015. In line with the procedure, a project proponent is supposed to prepare for EIA report in case that the project is to cause a significant environmental impact, and submits it to the Department of Environmental Conservation.

The Department, then, invites some technical experts from various ministries to formulate a Report Review Body (RRB) on the project, and the RRB will review the report and make some comments on the IEE/EIA report. Based on the RRB's comments, MOECAF make decision for approval on the

IEE/EIA report, and finally Environmental Conservation Committee (ECC), which is placed over the MOECAF, chaired by the Minister of MOECAF, issues an Environmental Compliance Certificate.

On the other hand, there are no rules/regulations for involuntary resettlement. In such case, General Administrative Department (GAD) under the Ministry of Home Affairs is requested to be involved in the negotiation with the affected persons/ households. The roles and responsibilities of organizations concerning environmental and social consideration in Myanmar are as follows:

Table 6.1.1 Roles and Responsibility by each Organization for EIA/IEE

Name of organization	Roles and Responsibilities
Proponent	Assignment of specialist for EIA and IEE report preparation, supervision of EIA report preparation, organizing and conduct of public consultation
Environmental experts	IEE and EIA report preparation
Environmental Conservation Committee (ECC)	ECC is responsible for final approval on IEE and EIA reports at national level and issues Environmental Compliance Certificates for proposed projects. The committee consists of various official personnel from various ministries and it is a permanent organization chaired by the Minister of MOECAF. ECC makes decision whether any appeal/objection to the proposed project is acceptable or not.
EIA Report Review Body (RRB)	RRB is responsible for preparation of comments on IEE and EIA report in terms of technical view. RRB consists of technical experts concerned to the proposed projects.
Department of Environmental Conservation	The Department formulates RRB by inviting technical experts on project basis. It receives IEE/EIA report from the proponents and submits them to RRB.
Ministry of Environmental Conservation and Forestry (MOECAF)	Making decision of approval on IEE and EIA report based on the RRBôs comments and recommendation. Making recommendation to the project proponent at which level public consultation is needed.
General Administrative Department (GAD) under the Ministry of Home Affair	If the proposed projects cause involuntary resettlement and land acquisition, GAD is involved for setting of compensation rate for affected structures and smooth consultation with the project affected persons.

Source: Ministry of Environmental Conservation and Forestry (MOECAF)

Any projects are categorized into three, namely, 1) projects which require EIA, 2) projects which require Initial Environmental Examination (IEE) and 3) projects which do not require EIA or IEE. Projects requiring EIA are the ones which could cause negative impacts on environment and society, or ones whose environmental impacts cannot be identified, or ones that continuous monitoring is needed. Projects which need IEE are the ones that have potential of negative impacts, however, less than those of projects which need EIA. List of projects which require EIA and IEE, and procedures for EIA an IEE are attached in the Guideline (see Appendix-VI).

Concerning irrigation, EIA is needed for projects covering 5,000 ha and above area, while IEE is necessary for projects with 100 ha to 5,000 ha development area. There is no mention for rehabilitation in existing facilities in the list; however, according to the Division of Policy/International Relations, Training and Research under the Environmental Conservation Department, rehabilitation works require only Environmental Management Plan (EMP). On the other hand, if any projects target upgrading or expansion of existing facilities, they require IEE or EIA report depending on the scale of the projects.

With respect to road and bridge construction/ improvement, to be planned under Farm-to-Market road improvement, in case of a category of ópupgrading roads (upgrading and expanding roads till it can use any seasons)ô, it is stated that roads above 50km need to undertake IEE while EIA may be required more than that depending upon the impact. In case of new construction or expansion, a road with 50 ï 100 km length has to undergo IEE while more that the 100 km the EIA may be decided depending upon the impact. For bridges in case of upgrading, a bridge less than 300m does not require any, but

IEE in case of more than that 300 m.

There are two main stages for EIA process, namely, 1) Scoping, and 2) Environmental study and EIA report preparation. Public consultation shall be organized for both stages and the project proponent shall submit the scoping report and an EIA report to the department. If any objection to the proposed project comes out, it is possible for anyone to issue an appeal letter to the ECC. Necessary contents to be filled in an EIA report are stipulated in the draft environmental guideline and they are as follows:

1) Summary
2) Preface (presentation of project proponent and experts of environment, social issues and health)
3) Policies, laws and organizational framework
4) Alternatives
5) Natural and social conditions in and around project area
6) Impacts and countermeasures at each project implementation stage (pre-construction, construction, operation and so on)
7) Integrated impacts assessment
8) Environmental management plan and cost
9) Public consultation and information disclosure

Necessary contents to be described in an IEE report are stipulated in the draft environmental guideline. They are as follows:

1) Project description
2) Profile of project proponent and profile of experts of environment, social issues and health
3) Policies, laws and organizational framework
4) Maps and description illustrating physical, biological, social, socio-economic and cultural status around the project area
5) Description of geological impact by maps, photos, images, GIS photos and satellite photos, and negative environmental impacts
6) Response by letter from project proponent to comments gained at the public consultations
7) Mitigation measures
8) Environmental management plan and cost

In Article 123 and 124 of the Draft Environmental Guideline, there is a description of Strategic Environmental Assessment (SEA); however, there is no clear description about programs which require SEA, procedure of SEA report preparation, contents of SEA report and so on in the guideline. Specific SEA procedure is still under the preparation as of November 2015, according to an officer of the Environmental Conservation Department.

6.1.2 Involuntary Resettlement and Land Acquisition

There are no laws/regulations concerning involuntary resettlement in Myanmar. If some projects result in involuntary resettlement, the project proponents shall provide compensation to the affected persons. However, there are no unified standards for compensation rates or support to be provided for recovery of living standard of the affected persons, and accordingly they are decided case by case. Moreover, it is not needed to prepare a Resettlement Action Plan (RAP) in Myanmar. Therefore, as mentioned before, General Administration Department (GAD) plays a role of negotiator/coordinator between proposed project side and the affected persons to fix the compensation rates for the structures to be

resettled.

Farmland Law enacted in March 2012 provides a private use right over farmland that includes the right to sell, exchange, inherit, donate, lease and pawn the land. The law covers conditions, under which farmers can retain use-rights, the stateôs power to rescind such rights, the process of settling land-related disputes. In fact, the Land Acquisition Act (1894) is still effective concerning compulsory land acquisition. The Act permits the government to acquire land for public purposes and describes necessity of compensation for current land users. The Act stipulates that compensation rate for land acquisition is decided on the market value of the land at the date of notification of land acquisition, and the court shall award a sum of 15 percent top up on such market value, considering that it is a compulsory acquisition.

On the other hand, compensation for loss/reduction of farmland due to land consolidation project is not stipulated in any laws, and no compensation has been provided to the affected farmers so far. It is based on the concept that land consolidation is profitable for farmers in the long run, as far as the benefit is bigger than loss, and the farmers do not have to shoulder the project cost for land consolidation. Recently, number of land consolidation has increased for promotion of agricultural modernization in Myanmar. At the ground level, it is said that land loss percentage due to a land consolidation project ranges within 5-10% of total farmland area, and there is no documented regulation (hearing from DALMS staff, 2015).

6.1.3 Gap Analysis

It is needed for any JICA projects to implement environmental and social examination based on the JICA Guidelines for Environmental and Social Considerations (2010, referred to as ñJICA Guidelinesò). The JICA Guidelines and the Draft EIA guideline in Myanmar are compared, and gaps between them are analyzed. Following table shows the result of gap analysis. If some projects are implemented under the support of JICA, some efforts to compensate the gaps have to be proposed.

Table 6.1.2 Gap Analysis between the Draft Environment Guideline in Myanmar and JICA Guidelines

Items	JICA Guidelines (with reference to WB OP4)	Draft EIA Guideline in Myanmar	GAP
Language of the EIA report	EIA Reports must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them.	EIA report shall be prepared in either of Burma and English. Summary of EIA report shall be prepared in Burma language.(Article 51 and 62)	Local people cannot understand full-EIA report if it is prepared in English.
Consultation with local stakeholders and information disclosure	Project proponents shall consult with local stakeholders through means that induce broad public participation to a reasonable extent, in order to take into consideration the environmental and social factors in a way that is most suitable to local situations, and in order to reach an appropriate consensus. EIA Reports are required to be made available to the local residents of the country in which the project is to be implemented. The EIA Reports are required to be available at all times for perusal by project stakeholders such as local residents and copying must be permitted;	It is needed to organize public consultations at two stages: 1) Scoping and 2) before submission of EIA report to the environmental conservation department. Public consultation to present an EIA report shall be organized. In advance, it is needed to announce the public consultation to the public by signboards, notice boards, local media and social organizations (Article 50 and 61).	None
Monitoring of environmental impact	Monitoring is done in order to confirm that project proponents etc. are undertaking environmental and social considerations for projects.	Proponent shall implement monitoring during all phases of the project regarding adverse impacts in compliance with regulation/rules, EMP and so on. (Article 106)	None

Items	JICA Guidelines (with reference to WB OP4)	Draft EIA Guideline in Myanmar	GAP
Avoidance and minimization of involuntary resettlement and land acquisition	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL) When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	In particular, there is no regulation. However, on the social norms, involuntary resettlement should be avoided as much as possible.	None
Restore of living standard and income opportunities	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	There is no mention for restoration of living standards.	In Myanmar, such concept is not established.
Compensation at full replacement cost	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	The amount of compensation would be paid at the market price plus an addition of 15%, where the land acquisition is required by a public project (Article 23 of the Land Acquisition Act)	Concept of full replacement cost has not been introduced.
Assistance and compensation prior to resettlement and land acquisition	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	There is no mention, however, after year 2011, compensation is made in place prior to the resettlement and land acquisition (e.g. Myitta Dam Project under ID, 2014).	None
RAP preparation	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	There is no provision.	In Myanmar, preparation of RAP is not required.
Consultation for RAP	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	There is no mention since RAP preparation is not needed, however, it is possible to hold a public hearing to explain necessity of resettlement and land acquisition and to present compensation policy, given that Article 50 and 61 stipulate organizing of public hearing. .	None
Language for consultation on RAP	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	There is no provision. However, local language is used for such consultation.	None
Participation of affected people for RAP preparation and monitoring	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	No mention	No participation in RAP preparation in Myanmar
Grievance handling system	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	No mention, however, it is possible to issue an appeal/objection letter to the ECC.	No grievance handling system
Identification of affected persons at initial stage and cut-off date	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to	No mention	Concept of cut-off date is not established in Myanmar.

Items	JICA Guidelines (with reference to WB OP4)	Draft EIA Guideline in Myanmar	GAP
	prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)		
Eligibility of persons for compensation	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Those who do not have official land usufruct are not entitled for compensation.	In Myanmar, affected persons who do not have right usufruct, they are not eligible for compensation.
Land for land compensation	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Cash compensation is done generally.	Land for land compensation is not common in Myanmar.
Support for transitional period	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	There is no description, however, there are some cases that supports for livelihood restoration were provided, e.g., rice was provided by the Government of Myanmar for transitional period (Myitta Dam Project under ID, 2014).	None
Attention to vulnerable people	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	No mention	In Myanmar, no consideration is paid to vulnerable people.

Source: JICA Survey Team

6.2 Development Option Identification by Strategic Environmental Assessment

6.2.1 Development Option

For the purpose of promotion of intensive agriculture in Myanmar, four priority areas, namely, Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady were identified. To meet the development objective, there should be paths, which are called development options for those areas. In examining the development options, major means of intervention are integrated into three items. These are 1) structural measure such as infrastructure development (not big-scale new constructions, though), 2) non-structural measure such as enhancement of value chain, and 3) combination of structural measures and non-structural measures. In addition to those three measures, case of no project is also considered. Option 0 is for no project, Option 1 is for structural measure, Options 2 is for non-structural measure, and the Option 3 includes both Option 1 and Option 2 as shown in Table 6.2.1.

Table 6.2.1 Development Options

Means of intervention	Option 0	Option 1	Option 2	Option3
Structural measure (construction and rehabilitation of facilities)	-	○	-	○
Non-structural measures (promotion of agribusiness and establishment of value chain)	-	-	○	○

Source: JICA Survey Team

6.2.2 Examination of Alternatives

As shown in the following table, Option 0, 1, 2 and 3 are examined in terms of environmental negative impacts, positive impacts and cost. Option 1 includes some structural measures, and therefore, issues regarding air pollution, waste and so on can take place during the construction. However, these

impacts are tentative, and not irreversible. In addition, since construction of facilities is included in Option 1, there is a possibility that land acquisition could take place. In case of Option 2, it is effective for intensive agriculture promotion through value chain enhancement and so on, which will not cause environmental impacts, yet the effectiveness may be limited. Therefore, it is recommended to select Option 3, which includes both structural and non-structural measures, to bring about synergy effect.

Table 6.2.2 Expected Environmental Impacts by the Proposed Options

Item	Option 0	Option 1: Structural measure	Option 2: Non-structural measure	Option 3: Combination of Option 1 and Option 2
Environmental negative impacts				
Pollution (air pollution, water pollution, noise/vibration and waste)	-	X	-	X
Natural environment (protected area)	-	To be confirmed	-	To be confirmed
Social environment (resettlement and land acquisition)	-	X	-	X
Positive impacts				
Crop production increase by stable irrigation water supply and land consolidation	-	+	-	+
Crop distribution system improvement by road rehabilitation	-	+	-	+
Quality improvement and competitiveness strengthening by value chain establish	-	-	+	+
Cost	None	High	Medium	Very high
Selection	-	-	-	Selected

X: Negative impact is expected. +: Positive impact is expected.

- : Either positive or negligible negative impact is expected

6.3 Protected Area and the Priority Areas

According to Protection of Wildlife and Conservation of Natural Area Law (1994), total 43 areas have been registered as protected areas in Myanmar. Viewing 4 priority areas from this perspective, Shwebo area, Nay Pyi Taw area and Ayeyarwady area are located with a good distance from those protected areas. Though Mandalay area is located near Minwuntaung Wildlife Sanctuary (No 25), it is just opposite shore of Ayeyarwady River. Therefor none of the priority areas is directly concerned with such protected areas. Basic information and location of those areas are shown in following table and figure:

Table 6.3.1 Specifications of Prospected Area in Myanmar

ID	Site Name	National Designation	Status	Establishment Year	Area(km^2)
1	Alaungdaw Kathapa	National Park	Designate	1989	1597.62
2	Bawditataung	Nature Reserve	Proposed	2008	72.52
3	Bumhpabum	Wildlife Sanctuary	Designated	2004	1854.43
4	Chatthin	Wildlife Sanctuary	Designated	1941	269.36
5	Hlawga	Wildlife Park	Designated	1989	6.24
6	Hponkanrazi	Wildlife Sanctuary	Designated	2003	2703.95
7	Htamanthi	Wildlife Sanctuary	Designated	1974	2150.73
8	Hukaung Valley	Wildlife Sanctuary	Designated	2004	6371.37
9	Hukaung Valley (Extension)	Wildlife Sanctuary	Designated	2004	15431.16
10	Indawgyi Lake	Wildlife Sanctuary	Designated	2004	814.99
11	Inlay Lake	Wildlife Sanctuary	Designated	1985	641.9
12	Kahilu	Wildlife Sanctuary	Designated	1928	160.56
13	Kelatha	Wildlife Sanctuary	Designated	1942	23.93
14	Khakaborazi	National Park	Designated	1998	3812.46
15	Kyaikhtiyoe	Wildlife Sanctuary	Designated	2001	156.23

ID	Site Name	National Designation	Status	Establishment Year	Area(km^2)
16	Kyauk-Pan-Taung	Wildlife Sanctuary	Proposed	2001	132.61
17	Lampi Island Marine	National Park	Designated	1996	204.84
18	Lawkananda	Wildlife Sanctuary	Designated	1995	0.47
19	Lenya	National Park	Proposed	2002	1761.19
20	Lenya (Extension)	National Park	Proposed	2004	1398.59
21	Loimwe	Protected Area	Designated	1996	42.84
22	Maharmyaing	Wildlife Sanctuary	Proposed	2002	1180.39
23	Mainmahla Kyun	Wildlife Sanctuary	Designated	1993	136.69
24	Minsontaung	Wildlife Sanctuary	Designated	2001	22.6
25	Minwuntaung	Wildlife Sanctuary	Designated	1972	205.88
26	Moscos Island	Wildlife Sanctuary	Designated	1927	49.19
27	Moyingyi Wetland	Wildlife Sanctuary	Designated	1988	103.6
28	Mulayit	Wildlife Sanctuary	Designated	1936	138.54
29	Natma Taung	National Park	Proposed	1997	722.61
30	Panlaung-Pyadalin Cave	Wildlife Sanctuary	Designated	2002	333.8
31	Parasar (Par Sar)	Protected Area	Designated	1996	77.02
32	Pidaung	Wildlife Sanctuary	Designated	1918	122.08
33	Popa	Mountain Park	Designated	1989	128.54
34	Pyin-O-Lwin	Bird Sanctuary	Designated	1918	127.25
35	Rakhine Yoma Elephant Range	Wildlife Reserve	Designated	2002	1755.7
36	Shinpinkyetthauk	Wildlife Sanctuary	Proposed	2006	71.9
37	Shwesettaw	Wildlife Sanctuary	Designated	1940	552.7
38	Shwe-U-Daung	Wildlife Sanctuary	Designated	1918	325.95
39	Tanintharyi	National Park	Proposed	2002	2071.81
40	Tanintharyi	Nature Reserve	Designated	2005	1699.99
41	Taunggyi	Bird Sanctuary	Designated	1930	16.06
42	Thamihla Kyun	Wildlife Sanctuary	Designated	1970	0.88
43	Wenthtikan	Bird Sanctuary	Designated	1939	4.4

Source: Ministry of Environmental Conservation and Forestry

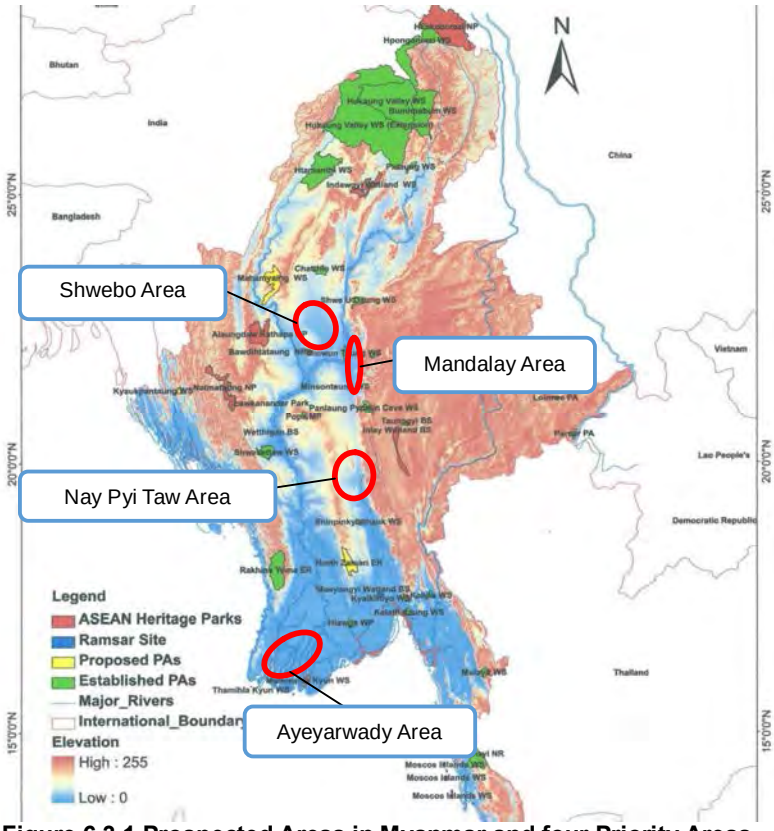


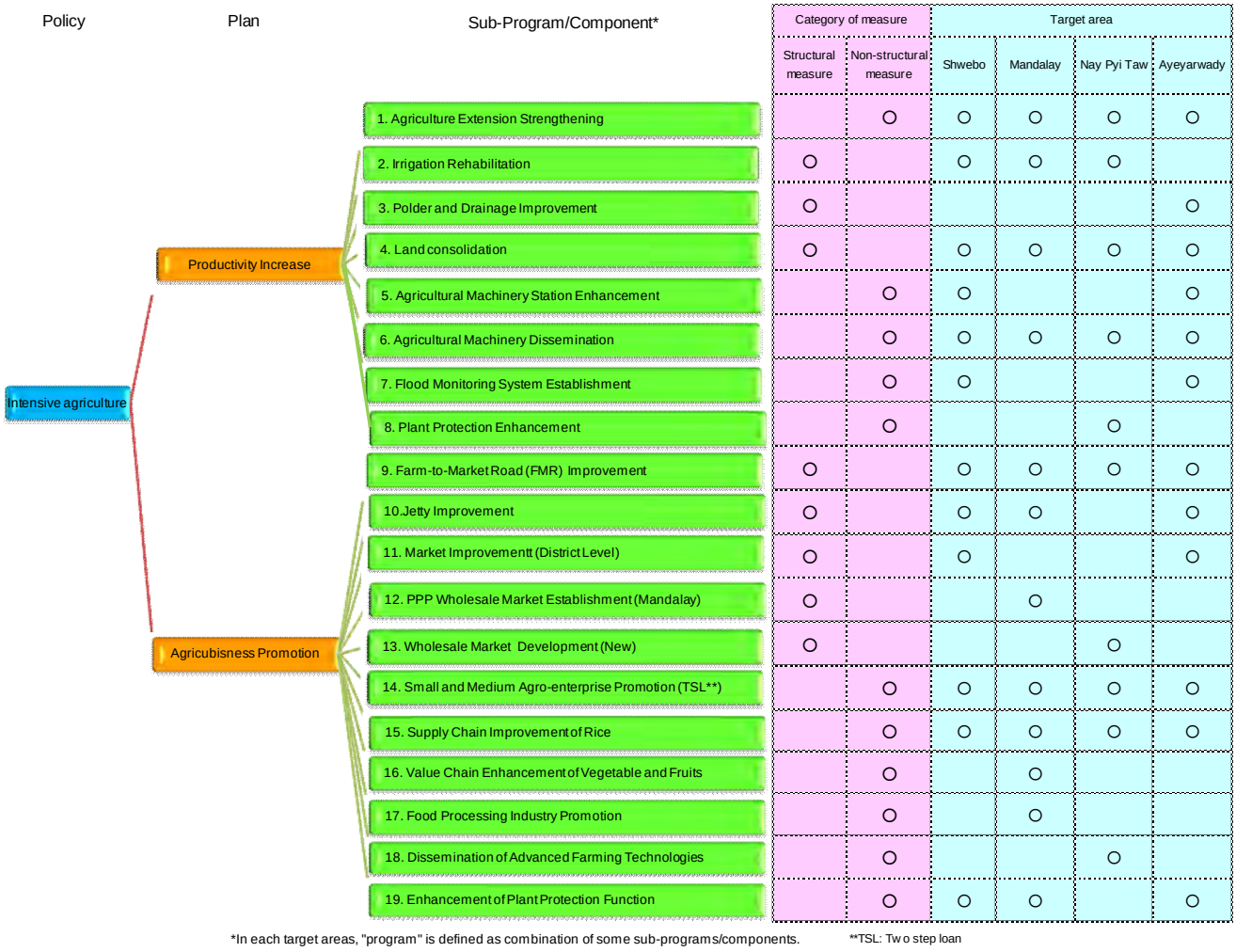
Figure 6.3.1 Prospected Areas in Myanmar and four Priority Areas

Source: Ministry of Environmental Conservation and Forestry

6.4 Environmental and Social Consideration for Programs in the Priority Area

6.4.1 Proposed Programs

Proposed program at each of the priority areas consists of plural sub-program/components such as agriculture extension strengthening, jetty improvement, land consolidation and so on. A matrix illustrating the programs to achieve the objectives, namely, intensive agriculture, by the priority area is as shown in next page:



Sub-Program/Component*	Category of measure		Target area			
	Structural measure	Non-structural measure	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady
1. Agriculture Extension Strengthening		○	○	○	○	○
2. Irrigation Rehabilitation	○		○	○	○	
3. Polder and Drainage Improvement	○					○
4. Land consolidation	○		○	○	○	○
5. Agricultural Machinery Station Enhancement		○	○			○
6. Agricultural Machinery Dissemination		○	○	○	○	○
7. Flood Monitoring System Establishment		○	○			○
8. Plant Protection Enhancement		○			○	
9. Farm-to-Market Road (FMR) Improvement	○		○	○	○	○
10.Jetty Improvement	○		○	○		○
11. Market Improvementt (District Level)	○		○			○
12. PPP Wholesale Market Establishment (Mandalay)	○			○		
13. Wholesale Market Development (New)	○				○	
14. Small and Medium Agro-enterprise Promotion (TSL**)		○	○	○	○	○
15. Supply Chain Improvement of Rice		○	○	○	○	○
16. Value Chain Enhancement of Vegetable and Fruits		○		○		
17. Food Processing Industry Promotion		○		○		
18. Dissemination of Advanced Farming Technologies		○			○	
19. Enhancement of Plant Protection Function		○	○	○		○

*In each target areas, "program" is defined as combination of some sub-programs/components. **TSL: Two step loan

Figure 6.4.1 Relationship between Program Components and Categories

Source: JICA Survey Team

6.4.2 Scoping for the Proposed Components

As shown in the following tables, the expected adverse impacts by component/sub-program are examined. This sub-chapter focuses on the scoping results for major structural measures, namely, ñIrrigation rehabilitationò, ñLand consolidationò and ñFarm-to-market road improvementò. Scoping results for other components/sub-programs are attached in Appendix-VI.

Table 6.4.1 Scoping for "Irrigation Rehabilitation"

Environmental Parameters	Evaluation		Reason
	Construction period	Operation period	
1. Air Pollution	B-	D	**Construction period:** With regard to rehabilitation works, heavy machinery and trucks are supposed to emit exhaust gas, and a little serious degree of air pollution would take place. In addition, dust is generated when vehicles pass.

Environmental Parameters	Evaluation		Reason
	Construction period	Operation period	
			Operation period: Once offered for use, no air pollution arises.
2. Water Pollution	B^-	D	**Construction period:** Accompanying with rehabilitation works, turbid water may occur in the canals. **Operation period:** Once offered for use, no water pollution arises.
3. Waste	B^-	D	**Construction period:** Wastes and scraps (mostly excavated soils and bricks of existing canal) are expected. **Operation period:** Once offered for use, no waste is generated.
4. Soil Contamination/ Salinization	D	D	**Construction period:** Oil leakage from construction vehicles is expected, however, the extent is negligible. **Operation period:** Once offered for use, no soil contamination is generated
5. Noise and Vibration	B^-	D	**Construction period:** Transport of materials by heavy machinery and trucks takes place toward the construction sites. Though serious noise/vibrations are not generated from these activities, consideration should be paid when the heavy machinery and trucks pass through the living quarters. **Operation period:** Once offered for use, no noise/ vibration are expected.
6. Ground Subsidence	D	D	Since no groundwater lifting is planned in the Component, no land subsidence will be caused.
7. Offensive Odor	D	D	Since the Component deals with irrigation water supply, no cause of odor is resulted from the construction work and operation period either.
8. Bottom Sediment	D	D	Since the Component has the objective of irrigation water supply, no erosion of river bottom is resulted from the work, and operation period either.
9. Protected Area	D	D	There is no protected area in and around the sites except Mandalay (see Table 6.3.1 and Figure 6.3.1). However, the Component will cover existing structure, and any construction works within the protected areas will not be done.
10. Ground Water	D	D	Use of ground water is not planned.
11. Hydrological Situation	D	D	No hydrological situation for existing rivers and drainages will be changed by the Component.
12. Topography and Geographical Features	D	D	Since this Component deals with rehabilitation of existing facilities, no topographical and geographical change by the works will be caused, whereby no impact is expected.
13. Involuntary Resettlement	D	D	Since the Component deals with rehabilitation of existing facilities, no resettlement by the works will take place, whereby no impact is expected on the resettlement.
14. Land Acquisition	D	D	Since it is rehabilitation of existing irrigation facilities, no impact is expected.
15. Cultural Heritage	D	D	There is no cultural heritage in and around the sites.
16. Landscape	D	D	Since the Component covers rehabilitation works for the existing facilities, no change of landscape is expected.
17. The Poor, Indigenous and Ethnic People	D	D	It is confirmed that there are no ethnic minority peoples residential areas in the priority areas according to the ID and DOA official personnel concerned.
18. Livelihood	B^-	B^+	**Construction period:** Due to the rehabilitation works, farmers cannot use irrigation facilities, which will result in suspension of crop production. **Operation period:** Due to rehabilitation of irrigation facilities, productivity will be improved, which results in improvement of living standard.
19. Local Economy	D	B^+	Since farmers can access to the stable irrigation water, local economy will be activated.
20. Existing Social	B^-	B^+	**Construction period:** Due to rehabilitation of existing irrigation facilities, farmers

Environmental Parameters	Evaluation		Reason
	Construction period	Operation period	
Infrastructures and Services			cannot use the facilities. There is a possibility that they are requested to suspend cultivation during the construction period. **Operation period:** Existing irrigation facilities are improved, which results in stable farming..
21. Misdistribution of Benefit and Damage	D	D	No biased distribution of benefits and suffering takes place from the Component.
22. Social Institutions	D	D	No negative impact on social institutions is expected.
23. Water Usage or Water Rights and Rights of Common	D	D	No impact or change on water use right is anticipated.
24. Gender	D	D	No gender issue is caused by the Component.
25. Children Rights	D	D	Children's rights are not spoiled by the Component.
26. Hazards (Risk), Infectious Diseases such as HIV/AIDS	D	D	**Construction period:** Labors for rehabilitation works will be hired from local people, therefore, risk of HIV infection is very low. **Operation period:** No impact is expected.
27. Accidents	B-	D	**Construction period:** Potential risk of accidents would be arisen from the Component such as possibility of traffic accidents by vehicles of the construction work. **Operation period:** No accident is expected during the operation period.
28. Global Warming	D	D	No global warming by the Component is anticipated.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 6.4.2 Scoping for "Land Consolidation"

Environmental Parameters	Evaluation		Reason
	Construction period	Operation period	
1. Air Pollution	B-	D	**Construction period:** With regard to rehabilitation works, heavy machinery and trucks are supposed to emit exhaust gas. In addition, dust is generated when vehicles pass, which results in air pollution. **Operation period:** Once offered for use, no air pollution arises.
2. Water Pollution	D	D	Land consolidation works will not cause water pollution.
3. Waste	B-	D	**Construction period:** Soil waste is generated by the land consolidation works to some extent. **Operation period:** Once offered for use, no waste is generated.
4. Soil Contamination/ Salinization	D	D	**Construction period:** Oil leakage from construction vehicles is expected, however, the extent is negligible. **Operation period:** Once offered for use, no soil contamination is generated.
5. Noise and Vibration	B-	D	**Construction period:** Transport of materials by heavy machinery and trucks takes place toward the construction sites. Though serious noise / vibration are not generated from these activities, consideration should be needed to pay when the heavy machinery and trucks pass through the living quarters. **Operation period :** Once offered for use, no noise/ vibration is emitted.
6. Ground Subsidence	D	D	Since no groundwater lifting is planned in the Component, no land subsidence takes place.
7. Offensive Odor	D	D	No cause of odor is resulted from the construction work

Environmental Parameters	Evaluation		Reason
	Construction period	Operation period	
			and operation period either.
8. Bottom Sediment	D	D	No erosion of river bottom is resulted from the work, and operation period either.
9. Protected Area	D	D	The Component will cover only existing farmlands, which will not result in damage to the protected area.
10. Ground Water	D	D	Use of ground water is not planned.
11. Hydrological Situation	D	D	No hydrological situation for existing rivers and drainages will be changed by the Component.
12. Topography and Geographical Features	D	D	Since this Component deals with rehabilitation of existing farmlands, no topographical and geographical change by the works will be caused.
13. Involuntary Resettlement	D	D	Since the Component deals with rehabilitation of existing farmlands, no resettlement by the works will take place.
14. Land Acquisition	B^-	B^-/B^+	**Construction period:** Due to land consolidation, farmers cannot use their farmland during construction period. **Operation period:** After the component completion, parts of farmland will be reduced, however, values of the farmlands are increased and crop productivities are improved.
15. Cultural Heritage	D	D	There is no cultural heritage in and around site.
16. Landscape	D	D	Since the Component covers rehabilitation works for the existing facilities, no change of landscape is resulted from the work.
17. The Poor, Indigenous and Ethnic People	D	D	It is confirmed that there are no ethnic minority peopleôs residential areas in the priority areas according to the ID and DOA official personnel concerned.
18. Livelihood	B^-	B^+	**Construction period:** During land consolidation works, farmers cannot cultivate their farmlands. **Operation period:** Due to land consolidation, efficiency of farming and crop productivity will be improved, which will result in improvement of living standard.
19. Local Economy	D	B^+	Since effective farming is promoted and farmers can share the farm-roads and canals within farmlands, local economy will be activated.
20. Existing Social Infrastructures and Services	D	D	No negative impact on existing social infrastructure and services is expected.
21. Misdistribution of Benefit and Damage	D	D	The farmers will lose their lands at equal percentage for land consolidation, therefore, misdistribution of benefit and damage will not be caused. The farmers in and around the project can access to farm road equitably.
22. Social Institutions	D	D	No negative impact on social institutions is expected.
23. Water Usage or Water Rights and Rights of Common	D	B^+	After land consolidation, the farmers can access to canal easier and more efficiently than before.
24. Gender	D	D	No gender issue is caused by the Component.
25. Children Rights	D	D	Childrenôs rights are not spoiled by the Component.
26. Hazards (Risk), Infectious Diseases such as HIV/AIDS	D	D	**Construction period:** Potential risk of infectious diseases, such as TB and HIV/AIDS, may arise since there will be big number of labors coming together to the construction sites. **Operation period:** No impact is expected.
27. Accidents	B^-	D	**Construction period:** Potential risk of accidents would arise from the Component such as possibility of traffic accidents by vehicles of the construction work. **Operation period:** No accident is expected during the operation period.
28. Global Warming	D	D	No global warming by the Component is anticipated.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

Table 6.4.3 Scoping for "Farm-to-Market-Road Improvement"

Environmental Parameters	Evaluation		Reason
	Construction period	Operation period	
1. Air Pollution	B-	D	**Construction period:** With regard to rehabilitation works, heavy machinery and trucks are supposed to emit exhaust gas. In addition, dust is generated when vehicles pass, which results in air pollution. This situation will be caused during only construction period. **Operation period :** After the construction works are completed, air pollution will not be caused.
2. Water Pollution	B-	D	**Construction period:** When bridges within farm road are rehabilitated, mud water can be caused, however, it is temporary during construction stage. **Operation period :** No water pollution can be caused.
3. Waste	B-	D	**Construction period:** Wastes and scraps (mostly excavated soils, reinforcing steel and concrete blocks of existing canal) are generated to some extent. **Operation period :** During operation stage, no waste is generated.
4. Soil Contamination/ Salinization	D	D	**Construction period:** Oil leakage from construction vehicles is expected, however, the extent is negligible. **Operation period :** After the construction works are completed, no soil contamination is generated
5. Noise and Vibration	B-	D	**Construction period:** Transport of materials by heavy machinery and trucks takes place toward the construction sites. Though serious noise / vibration are not generated from these activities, consideration should be needed to pay when the heavy machinery and trucks pass through the living quarters. **Operation period :** Once offered for use, no noise/ vibration are expected.
6. Ground Subsidence	D	D	Since no groundwater lifting is planned in the Component, no land subsidence takes place.
7. Offensive Odor	D	D	No cause of odor is resulted from the construction work and operation period either.
8. Bottom Sediment	D	D	No erosion of river bottom is resulted from the works.
9. Protected Area	D	D	There is no protected area in and around the sites except Mandalay (see Table 6.3.1 and Figure 6.3.1). Even in Mandalay, the Component will cover existing structure, and any construction works within the protected areas are planned.
10. Ground Water	D	D	Use of ground water is not planned.
11. Hydrological Situation	D	D	No hydrological situation for existing rivers and drainages will be changed by the Component.
12. Topography and Geographical Features	D	D	Since this Component deals with rehabilitation of existing facilities, no topographical and geographical change by the works will be caused.
13. Involuntary Resettlement	D	D	Since the Component deals with rehabilitation of existing facilities, no resettlement by the works will take place.
14. Land Acquisition	D	D	No new road construction or road expansion is planned, and land acquisition is not necessary.
15. Cultural Heritage	D	D	There is no cultural heritage in and around the sites.
16. Landscape	D	D	Since the Component covers rehabilitation works for the existing facilities, no change of landscape is resulted from the work.
17. The Poor, Indigenous and Ethnic People	D	D	It is confirmed that there are no ethnic minority peoples residential areas in the priority areas according to the ID

Environmental Parameters	Evaluation		Reason
			and DOA official personnel concerned.
18. Livelihood	D	B^+	Easy access to market can improve livelihood in the target areas.
19. Local Economy	D	B^+	Due to improvement of accessibility to market, improvement of local economy is expected.
20. Existing Social Infrastructures and Services	B^-	D	**Construction period:** Due to rehabilitation of existing road, half of lane is closed, and inconvenient situation will be caused. **Operation period:** No negative impact is anticipated.
21. Misdistribution of Benefit and Damage	D	D	The farmers in and around the project can access to farm road equitably and no biased distribution of benefits and suffering takes place from the Component.
22. Social Institutions	D	D	No negative impact on social institutions is expected.
23. Water Usage or Water Rights and Rights of Common	D	D	No impact on water use is anticipated.
24. Gender	D	D	No gender issue is caused by the Component.
25. Children Rights	D	D	Children's rights are not spoiled by the Component.
26. Hazards (Risk), Infectious Diseases such as HIV/AIDS	B^-	D	**Construction period:** Potential risk of infectious diseases, such as TB and HIV/AIDS, may arise, since there will be big number of labors coming together to the construction sites. **Operation period:** No impact is expected.
27. Accidents	B^-	D	**Construction period:** Potential risk of accidents would be caused by the Component such as possibility of traffic accidents by vehicles of the construction work. **Operation period:** No accident is expected during the operation period.
28. Global Warming	D	D	No global warming by the Component is anticipated.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

In addition to those three components, there are some other components which may cause land acquisition, namely, "Wholesale market development" in Nay Pyi Taw, "Market improvement at district level", and "Polder and drainage improvement" in Ayeyarwady. As for the latter component, polder embankment may need to be strengthened, though this was not proposed by ID Ayeyarwady Maintenance office. In case of embankment strengthening, additional land right beside the bank toe may be needed; however an additional 20ft land from the toe is owned by ID, so that land acquisition will not be expected even in case of embankment strengthening.

Wholesale market in Nay Pyi Taw is planned to establish in a government owned land, so that land acquisition is not expected. With respect to "Market improvement at district level", its functions have to be transferred to other places during the renovation, which will result in inconvenient situations for the market users. Aside from these, for other components, especially, non-structural measures, serious negative impacts are not anticipated. Following table shows summary of the expected environmental negative impacts for each proposed component/sub-program:

Table 6.4.4 Summary of the Expected Impacts by Component/Sub-program

No.	Component/Sub-program	Expected Negative Impacts
1.	Agriculture Extension Strengthening	The component conducts agricultural extension services by demonstrating good and modern practices in order to increase farm production, and the activities are not structure-related. Therefore, no negative impacts are expected.
2.	Irrigation Rehabilitation	Pollution during the construction period is expected, it is temporary and relatively small scale, though. Moreover, during construction stage, farmers cannot use

No.	Component/Sub-program	Expected Negative Impacts
		the existing irrigation facilities and they will be requested to suspend farming during the construction.
3.	Polder and Drainage Improvement (Ayeyarwady region only)	Major works are dredging and un-silting for drainages in polder areas, which do not cause noticeable negative impact. In addition, polder embankment may need to be strengthened, and in this case expansion of bank-toe is expected. However, still, this can be managed within the ID owned land.
4.	Land consolidation	Due to land consolidation, the farmers will lose their parts of farmlands, however, benefits from the land consolidation can compensate for the farmland loss. It is important to secure at least half year for consultation to reach to consensus with the farmers.
5.	Agricultural Machinery Station Enhancement	The Component will install new agricultural machines to the existing machinery stations; hence no negative impacts are expected.
6.	Agricultural Machinery Dissemination (Two Step Loan)	The Component will promote to use new agricultural machines targeting farmers, therefore, no adverse effects is anticipated.
7.	Flood Monitoring System Establishment	Since it will establish a flood monitoring system, no negative impact is anticipated.
8.	Plant Breeding Enhancement	This Component will rehabilitate and renovate buildings and laboratories, and replace/ install new equipment for plant breeding and provide technical training for the DAR staff, and it will not cause any negative impacts.
9.	Farm-to-Market Road (FMR) Improvement	Pollution during the construction period for road improvement is expected, it is temporary and relatively small scale, though. In addition, only half lane can be used during the construction, which will result in inconvenience for the users.
10.	Jetty Improvement (Shwebo, Mandalay, Ayeyarwady)	Since there are several jetties in a reach of the river bank, it is possible to use other sites of jetties during the construction period. In other words, jetty improvement will not cause inconvenient situations for the users very much.
11.	Market Improvement (District level) (targeting existing ones to improve)	During renovation of the existing market facilities, it is needed to transfer the market functions to other areas temporarily. City Development Committees are requested to arrange/provide their lands for alternative sites during the construction period. In addition, market function transfer will cause some complaint from the users, it is needed to obtain consensus with the sellers prior to the construction works.
12.	PPP Wholesale Market Establishment (Mandalay)	The construction of the new market had been already planned and land for the market has been already secured. The Component will construct wholesale market and install some equipment at the already secured land, and therefore, the Component will not cause negative impacts.
13.	Wholesale Market Development (Nay Pyi Taw, new construction)	It is planned to establish a new wholesale market in the governmental area, and therefore, it is not needed to acquire the land. Some impacts such as air pollution during the construction period are expected, however, it is temporary.
14.	Small and Medium Agro-enterprise Promotion (Two Step Loan)	Since the Component will not take structural measures, no negative impact is anticipated.
15.	Supply Chain Improvement of Rice	Since the Component aims at improving the supply chain through non-structural measure, no negative impact is anticipated.
16.	Value Chain Enhancement of Vegetables & Fruits	Since it is not structural measure, no negative impact is anticipated.
17.	Food Processing Industry Promotion	The Component will deal with technical improvement of food packaging, sanitation, value-added products and so on, together with equipment procurement, no negative impact is anticipated.
18.	Dissemination of Advanced Farming Technologies	Since the Component aims at technical improvement of farmers in a modern agriculture, no adverse effect is anticipated.
19.	Plant Protection Enhancement	This Component will install new equipment for PPD and provide technical training for the PDD staff, and it will not cause any negative impacts.

Source: JICA Survey Team

6.5 Land Consolidation Practices by International Donors

Donors have started or have plans to implement land consolidation projects in Myanmar. International

Fund for Agricultural Development (IFAD) has already started the Fostering Agricultural Revitalization in Myanmar (FARM), which includes land consolidation. Final Project Design Report (IFAD, 2013) describes the planned procedure. JICA had implemented a land consolidation project as pilot in Nay Pyi Taw from 2013 to 2014, and a Guidelines based on the lessons learnt have been compiled. Moreover, World Bank (WB) has a plan to implement ñMyanmar Agricultural Development Support Projectò, which includes land consolidation. The Government of India has a plan to loan for land consolidation, covering the biggest area of 50,800 acres (20,000 ha).

1) IFAD

IFAD has started FARM project, aiming at: 1) improvement of the equity of irrigation water distribution; 2) opportunity creation for crop diversification; and, 3) improvement of field access (for machinery and transport). One of project components is agricultural infrastructure. In this component, IFAD has a plan to implement land consolidation targeting 10,000 acre in total in Paung Laung, Chaung Magyi and Medan in Nay Pyi Taw within three years. Consultation between IFAD and the farmers concerned has been started, and construction works will be commenced in December 2015. IFAD applied participatory approach for the land consolidation and had a series of meetings with the farmers prior to the construction. According to ID staff concerned, at least half year should be secured for the process. Based on the consensus with the farmers, they prepared a land consolidation plan and map.

The farmers in the land consolidation area by FARM will lose around 7% of their farm lands equally. Given that benefit of the project can recover the land loss, no compensation will be provided to the famers. This condition should be explained to the farmers in advance, and it is now on-going as of December 2015. If there are some farmers who object to the land consolidation, their lands will be excluded from the consolidation. At each 50 acre block, the farmers are requested to select one representative, at each 500 acre block, these representatives gather to establish a Project Implementation Committee. The committee members play a role as coordinator between the farmers and the Project. IFAD will facilitate the committees to register as a Water User Group (WUG). At the governmental level, under the MOAI, the Participatory Land Use Project Team is established, consisting of ID, DOA, AMD, DALMS, and local authorities (township).

2) JICA

Under ñThe Preparatory Survey for the Project for Rehabilitation of Irrigation Systemsò, funded by JICA, a pilot project had been implemented from April 2013 to May 2014 in Nay Pyi Taw, and the pilot project covered an area of 338 acre (137 ha) with 138 farmers. Based on the lessons learnt, JICA has compiled ñGuidelines for Land Consolidation in Myanmarò. The Guidelines cover issues of paddy field consolidation in agricultural land consolidation, specifying survey works, planning and designing works, implementation procedure and methods, etc., which are necessary for the land consolidation project. It is noted that an agricultural cooperative has been established for sustainable maintenance of the facilities constructed by the project, since a cooperative has legal status.

To implement the farmland consolidation pilot project, ID, SLRD[1] (as of 2014), AMD and DOA, which are under the MOAI, and GAO (General Administration Office), CD (Cooperative Department) and also the Management Committee of Farmers Organization concerned were involved as the project implementer, facilitator to establish farmer organization, the office in charge of registering the farmer organization, the office in registering farmland-use-right, etc. The relationship among the organizations with the farmer organization at the center, and major responsibilities by each organization are shown in Figure 6.5.1

[1] SLRD, which covered land consolidation and land recording, has been reorganized into DALMS in October 2015.

Figure 6.5.1 Implementation Structure of Land Consolidation Project

Source: Guidelines for Land Consolidation in Myanmar (JICA, 2014)

Figure 6.5.2 shows the flow of the major activities to be applied for a typical farmland consolidation project proposed by the JICA guidelines. As aforementioned, major activities pertaining to the beneficiary farmers are to be conducted and tackled by the farmer themselves, meaning by the farmer organization established fairly before the commencement of physical construction. There should be at least four times general assembly, or general stakeholder meetings, where all the concerned farmers together with government officials are to attend prior to the commencement of the construction.

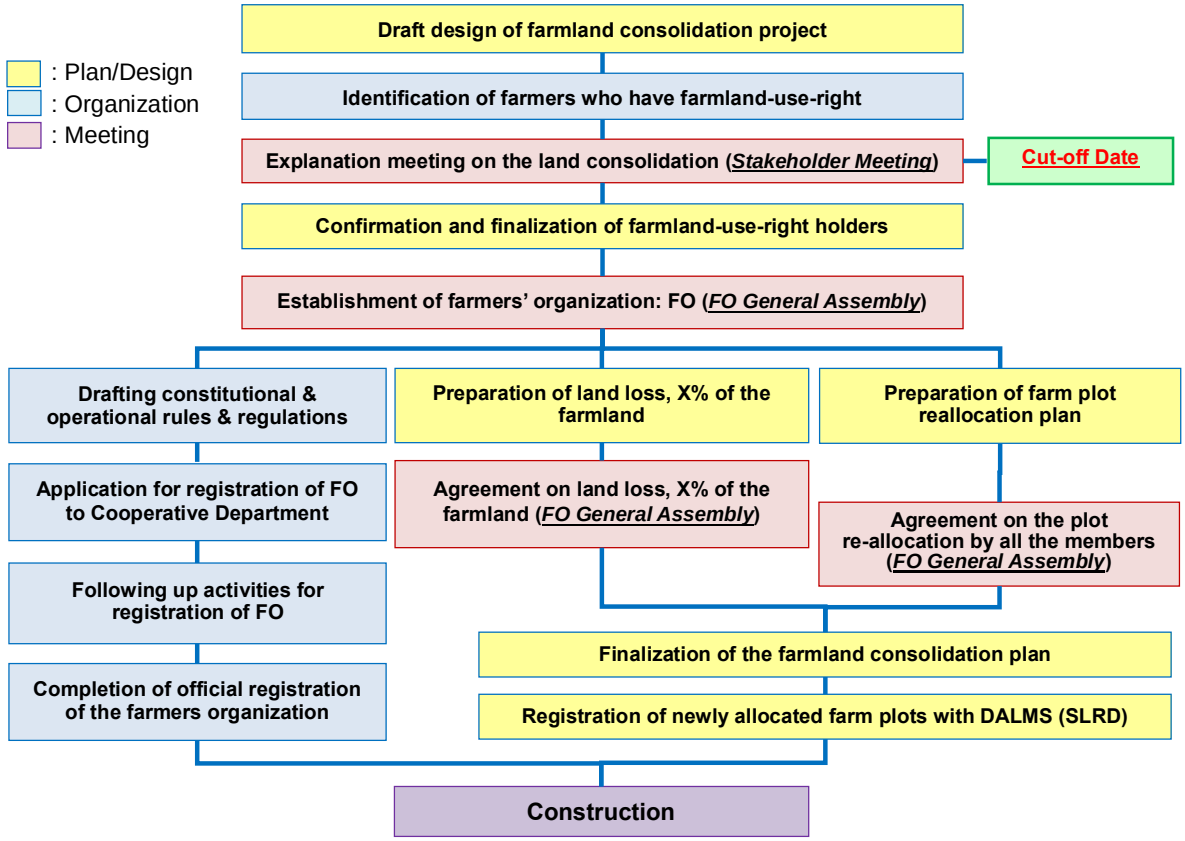


Figure 6.5.2 Implementation Flow of Land Consolidation Project

Source: Guidelines for Land Consolidation in Myanmar (JICA, 2014)

Regarding ownership of constructed facilities such as farm roads and tertiary canals/ drainages within the farmland after the land consolidation project, it is not clear in the existing laws/regulations. Ideally, constructed facilities should be owned by the group of beneficial farmers and they have to maintain and rehabilitate the facilities by themselves. In general, ID thinks that those facilities belong to farmers. However, farmers tend to request ID for maintenance and rehabilitation in case the facilities are damaged, since there may be a tendency for the farmers not to undertake a burden.

3) The World Bank

ñMyanmar Agricultural Development Support Projectò with a fund of 100 million US$ has been proposed by the World Bank in March 2015, and the proposal has been approved by the Government of Myanmar. The project will support development of on-farm water management infrastructure and land improvement pilot projects in 2-3 selected systems. These land improvement pilot projects will include the adjustment of existing irregularly shaped plots into equal-sized and regularly-shaped ones, combined with the land levelling and realignment, and construction of on-farm irrigation and drainage canals and access roads.

ñLand Acquisition and Resettlement Policy Frameworkò is attached in the final report for the project mentioned above as Annex 3. Proposed procedure for land improvement project is mentioned in the framework, in which it is emphasized that participatory approach shall be taken. A third party service provider to be hired by the Project will play a key role to minimize and mitigate social impacts under the project and he/she will help establishment of WUGs in a participatory manner.

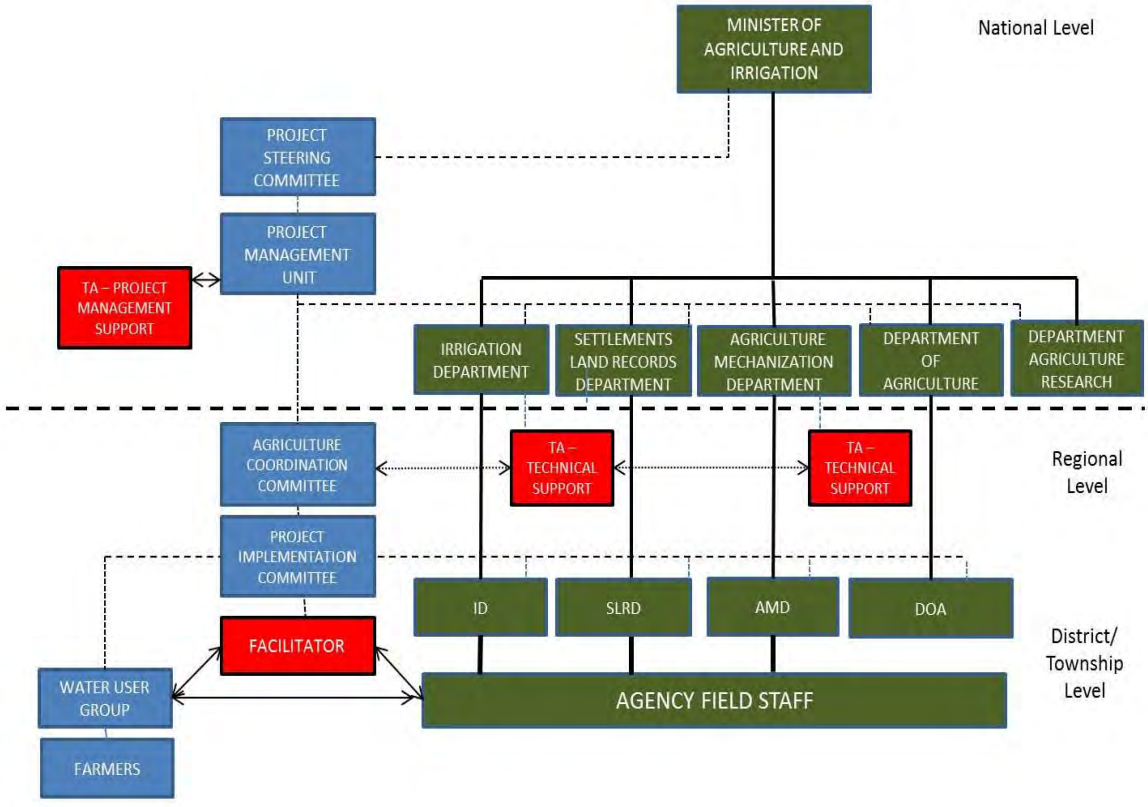


Figure 6.5.3 Proposed Organization Structure in Myanmar Agricultural Development Support Project

Source: Myanmar Agricultural Development Support Project (WB, 2015)

Compensation for land loss will not be provided; however, it is stated percentage of land loss due to the land consolidation should be less than 10% with an exception. The project will allow a land improvement to proceed even where farmers lose more than 10 percent (but not more than 15 percent) of irrigated farmland, provided that 1) the technical features of the pilot are such that income loss will likely be fully restored by the increased productivity within two cropping seasons, and that 2) the

affected farmers would receive income support in the event that their income is not recovered in two cropping seasons. On the other hand, if somebody does not want to join the project, he/she is allowed to ñopt outò of the pilot and ñsellò the land to WUGs, at least at the value which is equal to the replacement value of the affected land.

The MOAI will be the implementing agency for the WB funded project. The Project will be governed at the Union level by the National Project Steering Committee (NPSC) and at the township level by the Agricultural Coordination Committees (ACC) as in Figure 6.5.3. The main functions of the NPSC are to review project work plans and project progress, resolve implementation bottlenecks, and to provide guidance on any other matters as requested by the Project Management Unit. Implementation of the project activities will be carried out by five technical departments (ID, DOA, AMD, DAR, and DALMS) through their central, regional, district and township level structures.

4) Indian Government

Indian Government is to provide loan for 2 components; 1) land consolidation project in 6 regions and 2 states with a loan amount of 65 million US$, and 2) construction of irrigation canal network with a loan amount of 73 million US$. The land consolidation is to cover a total area of 50,800 acres (20,000 ha), which is the biggest consolidation area amongst donors projects. The approach of the land consolidation is to provide the agreed loan to the Myanmar government, and the ID and AMD are to implement the consolidation works on their own method.

CHAPTER 7 GLOBAL ISSUES

This chapter discusses the proposed components in relation to such global issues as poverty reduction, climate change, and gender. It means that this chapter explores the possibility of; 1) reduction of poverty for the beneficiaries, 2) mitigating or coping with negative impact of climate change, and 3) relevance to gender significance:

7.1 Poverty Reduction

Following table shows the poverty ratio by urban and by rural for the priority areas (note that Nay Pyi Taw is included in Mandalay and also in Bago Est). Though Sagaing and Bago East regions show almost no difference in the poverty ratio between urban and rural areas, in most cases rural poverty prevails more than that of urban area as in the cases of Mandalay and Ayeyarwady. Note that the poorest social stratum is the landless farmers engaged in farm labor works; however here, it is examined how much the proposed components could contribute to raising the farmers income.

Table 7.1.1 Poverty Ratio in the Priority Area by Urban and Rural (2005, 2010)

State, Region and Union	2005		2010		Total	
	Urban	Rural	Urban	Rural	2005	2010
Sagaing	21.9	27.4	16.0	14.9	26.6	15.1
Mandalay	24.1	44.7	14.1	31.6	38.9	26.6
Bago (E)	34.8	30.2	20.9	20.1	30.9	20.2
Ayeyarwady	24.4	30.3	23.1	33.9	29.3	32.2
Union	21.5	35.8	15.7	29.2	32.1	25.6

Note: Nay Pyi Taw is included in Mandalay for its northern part and in Bago (E) for its southern part.
Source: UNDP Integrated Household Living Conditions Survey in Myanmar, 2009-2010, Poverty Profile, June 2011

There are components which can raise the income of the beneficiaries through the increase of production of agricultural produces; namely, 1) Agriculture Extension Strengthening, 2) Irrigation Rehabilitation, 3) Polder and Drainage Improvement (Ayeyarwady), and 4) Land Consolidation. For these components, farm budgets were estimated at each case of before-after projects (impact from agriculture extension strengthening was counted together with the irrigation rehabilitation or polder and drainage improvement). Following figures summarize the net profits before and after the project implementation, and Table 7.1.2 summarizes the incremental ratio for the ñwith projectò case:

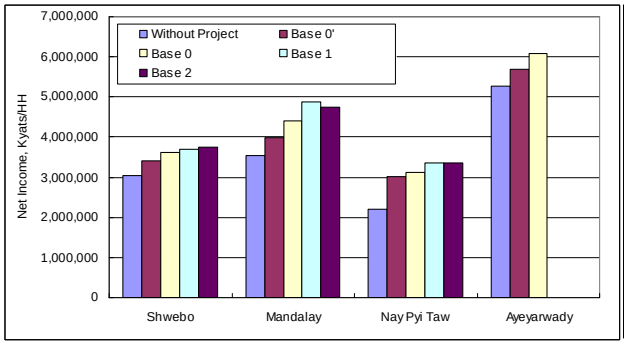


Figure 7.1.1 Income Increase by Irrigation Rehabilitation
Source: JICA Survey Team

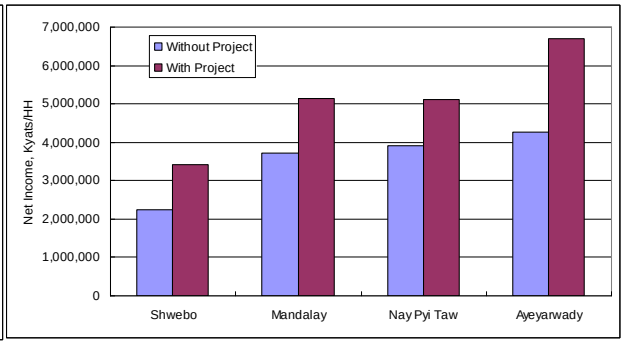


Figure 7.1.2 Income Increase by Land Consolidation
Source: JICA Survey Team

Table 7.1.2 Net Income Increase for Farmer Household by Realization of the Project

Particulars	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady	Remarks
Agri. Extension and Irrigation Rehabilitation					
Base 0' (Only yield increase)	112%	113%	136%	108%	
Base 0 (Yield and area expanded)	118%	125%	142%	115%	
Base 1 (Pulses area expanded)	121%	138%	152%	-	
Base 2 (Sesame introduced)	123%	135%	152%	-	
Land Consolidation					

Particulars	Shwebo	Mandalay	Nay Pyi Taw	Ayeyarwady	Remarks
Net Benefit (%)	152%	138%	131%	157%	
Gross Profit (%)	107%	107%	105%	106%	
Cost (%)	90%	89%	91%	89%	Cost reduced.

Source: JICA Survey Team

Based on above examination, a typical average farmer household could increase their net income to 108% - 136% in case 0ô where only yield increase was counted. Together with the impact of area expansion for the case 0, the increase of the net income would be to 115 - 142%. Note that the highest increase takes place in Nay Pay Taw area and this is thanks to the newly to-be-developed area for the mid-downstream of Paung Laung system.

In case of land consolidation, the net increase will be 131% to 157 % depending upon the area. This net income increase for land consolidation comes from both increase of gross profit, mainly increase of production, and reduction of farming cost.

With these above results, it can be concluded that the proposed components; namely, 1) Agriculture Extension Strengthening, 2) Irrigation Rehabilitation, 3) Polder and Drainage Improvement (Ayeyarwady), and 4) Land Consolidation, will collectively contribute in poverty reduction in rural areas, through increasing net profit by at least 10% to as much as 50%.

7.2 Climate Change

7.2.1 Climate Change Review and Future Simulation by UNEP

United Nations Environment Programme (UNEP) has conducted a climate change simulation and recommended a Myanmarôs National Adaptation Programme of Action (NAPA) to climate change (2012). The simulation reviewed about past 60 years climate change according to the actual records, and based on those date the simulation run a computer model of RECIS. The observed climate variability and change in Myanmar over the last six decades includes the following:

1) a general increase in temperatures across the whole country (up to 0.08°C per decade), most notably in the northern and central regions;
2) a general increase in total rainfall over most regions; however, with notable decreases occurring in certain areas (e.g. Bago Region);
3) a decrease in the duration of the south-west monsoon season as a result of a late onset and early departure times; and
4) increases in the occurrence and severity of extreme weather events, including; cyclones/strong winds, flood/storm surges, intense rains, extreme high temperatures and drought.

On the observed changes in temperature over the last six decades (1951 to 2007), the temperature in Myanmar has increased on average by up to 0.08°C per decade. This has been reflected by fewer cold days and more frequent hot days. Despite overall trends of increasing temperatures, 5 regions have experienced decreases. Appreciable decreases include Magway (-0.23°C per decade) and Bago (-0.16°C per decade). From 1951 to 2000, up to 15 heat waves occurred per year. The most extensive heat wave (covering up to 60% of the country) occurred in 1998 during an El Niño Southern Oscillation (ENSO) year.

As for the observed changes in rainfall over the last six decades (1951-2007), the rainfall in Myanmar has increased on average by 29 mm per decade. Rainfall trends have however been variable over the period. The majority of regions have experienced an increase in rainfall with the upper Sagaing region experiencing the greatest increases (up to 215 mm per decade). However, 6 regions experienced a decrease in annual rainfall. Changes in rainfall have also influenced the duration of the monsoon

season. The southwest monsoon onset has become later in the year and withdrawal earlier in the year (see figure below). Over the period 1991-2004, 32 extreme rainfalls have occurred across 16 stations in the country.

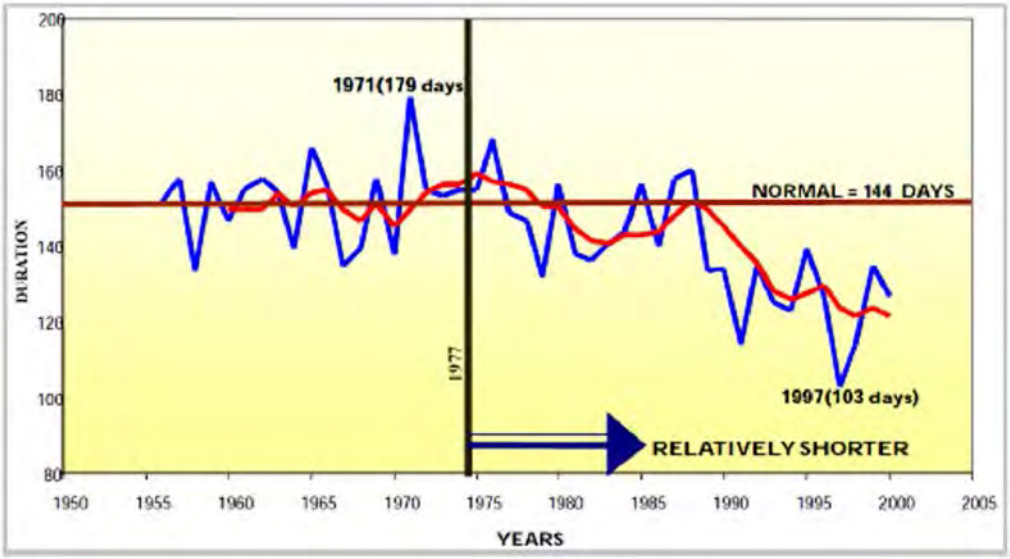


Figure 7.2.1 Departure from the Mean Normal Monsoon Duration (144 days) over the period 1950 to 2005 'blue line), indicating a relative shorter annual monsoon season since 1975

Source: UNEP: Myanmarôs National Adaptation Programme of Action to CC (2012)

After having reviewed the past 60 years climate change, the UNEP has carried out a climate change computer simulation by employing PRECIS mode over a period of 2001 to 2100. This simulation was conducted using 20km x 20km resolution, and operated by the South East Asia System Analysis Research and Training Regional Centre (SEA START RC) using A2 emission scenario. The base line information used modelled data for the period of 1971 to 2000 with reference to the 7 stations assumed to be representatives of seven physiographic regions in Myanmar. Climate change projections for Myanmar were predicted as follows:

1) a general increase in temperature across the whole country, particularly from December ï May with the Central and Northern regions experiencing the greatest increases;
2) a increase in clear sky days exacerbating drought periods;
3) an increase in rainfall variability during the rainy season including an increase across the whole country from March ï November (particularly in Northern Myanmar), and decrease between December and February;
4) an increase in the risk of flooding resulting from a late onset and early withdrawal of monsoon events;
5) an increase in the occurrence and intensity of extreme weather events, including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures and drought.

Figure 7.2.2 below indicates temperature and rainfall changes in Myanmar for the next 80 years, and Table 7.2.1 details climate change predictions in Myanmar for the time periods of 2001-2020, 2021-2050 and 2051-2100 (UNEP). These results show that the temperature will increase as has been increasing in the past and may be accelerated nearing to 2100, and also the rainfall is to increase though the incremental ratio may not be as much as that of temperature:

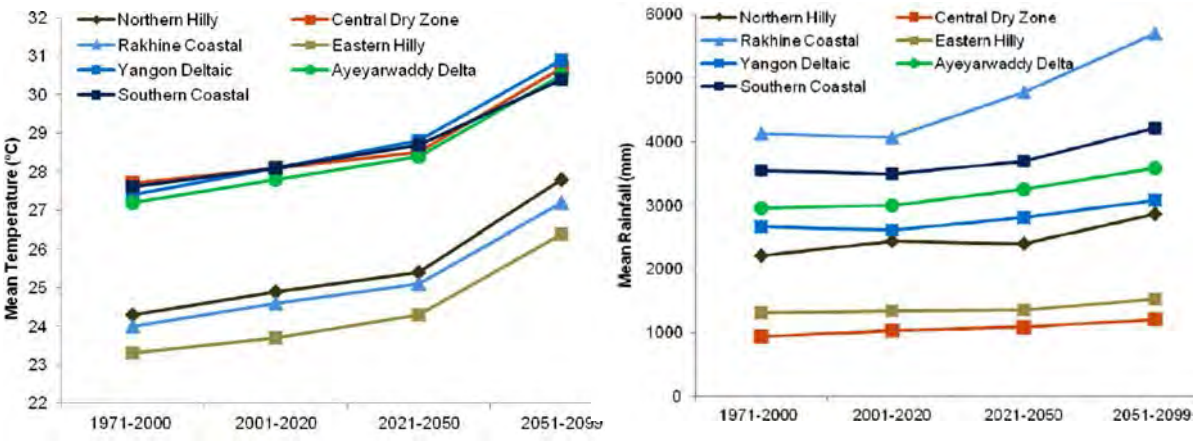


Figure 7.2.2 Predicted Temperature Trend (Left) and Predicted Mean Rainfall (Right)

Source: UNEP: Myanmarôs National Adaptation Programme of Action to CC (2012)

Table 7.2.1 Detailed Projected Climate Change Trends for 2001 to 2100 (UNEP)

CC predictions 2001 - 2020	CC predictions 2021 - 2050	CC predictions 2051 - 2100
✓ an increase in temperature of - 0.4 ºC to 0.7 ºC across Myanmar with the Yangon Deltaic region experiencing the greatest increase (-0.7 ºC); ✓ an increase in clear sky days in Northern and Central Myanmar exacerbating drought events; ✓ highly variable rainfall changes throughout the country including large increases in the Northern Hilly region (-228 mm per annum) as well as decreases in the Rakhine Coastal, Yangon Deltaic, and Southern Coastal region (-58 mm per annum); and ✓ an increase in floods and droughts resulting from variable rainfall conditions.	✓ an increase in temperature of 0.8 ºC to 1.4 ºC across Myanmar with the Yangon Deltaic (1.4 ºC) and Rakhine Coastal region (1.2°C) experiencing the greatest increases; ✓ an increase in rainfall across the country with the Rakhine Coastal region experiencing the greatest increases (-661 mm per annum) and the Eastern Hilly region experiencing the smallest increase (-36 mm per annum); ✓ periods of heavier rains; and ✓ longer dry spells.	✓ an increase in temperature of 2.8 ºC to 3.5 ºC across Myanmar with the highest increases in the Rakhine Coastal and Yangon Deltaic regions (3.5°C); ✓ a weakened monsoon climate supported by decreased cloud coverage; ✓ an increase in drought periods across most of Myanmar; and ✓ an increase in precipitation with highest increases in the Rakhine Coastal region (~1582 mm per annum) and smallest increases in the Eastern Hilly region (~209 mm per annum).

Source: UNEP: Myanmarôs National Adaptation Programme of Action to CC (2012)

7.2.2 Project Intervention in the Climate Change

Major issues relating to climate change are probably; 1) temperature increase and 2) shorter period of monsoon season though the total rainfall amount is to increase, based on the past review of the climate change as well as the simulation result covering up to 2100.

A rise of 1 ï 2 ºC combined with lower solar radiation has the potential to cause rice spikelet sterility (i.e. infertile rice seeds). Rice becomes sterile if the paddy is exposed to temperature above 35 ºC for more than one hour during flowering and consequently produces no grain[1]. This will limit rice production. Furthermore, higher temperatures will increase the incidence of crop diseases, insect pests and rodents. To avoid this sterility associated with high temperature, there should be a new variety to, which can stand against the high temperature or otherwise the flowing and pollination should be made during not day time but during early morning time. This kind of research is not included in the components proposed under this Survey. This kind of research could better be done by an international institute, e.g. IRR.

[1] Referred to in the UNEP report ôMyanmarôs National Adaptation Programme of Action (NAPA) to Climate Change (2012), Karim, Z., 1996. Agricultural Vulnerability and Poverty Alleviation in Bangladesh. In Climate Change and World Food Security, T.E. Downing (Ed.), NATO ASI Series, 137. Springer-Verlag, Berlin, Hiedelberg, 1996. pp. 307-346.

On the other hand, there are 2 components which can cope with or at least mitigate the impact of climate change concerning short monsoon season. The change to the shorter monsoon season is very much associated with intensive rainfall patter, meaning though the duration of the monsoon season becomes shorter, the rain tends to fall at once with severer intensity, often resulting in torrential rain and flood, as has been already observed. The components of irrigation rehabilitation and land consolidation would work in mitigating this climate change, rainfall and monsoon season pattern change.

As per its nature, irrigation system rehabilitated would be able to supply on-time water at the onset of monsoon season which is now predicted to come late, and also at the end of monsoon which is predicted to come sooner than before. The irrigation systems rehabilitated are expected to provide supplemental water to the unstable rainfall during monsoon season, and according the systems would contribute to mitigate and cope with the negative impact of climate change, especially the shorter period of monsoon season.

In addition, land consolidation will bring about tertiary level irrigation canals running alongside farm road. With these tertiary level canals, farmers can implement better water management at the field level. More precise water management, e.g., water supply and stop according to the crop need, and in cases drying of the paddy field in order to aerate the soils, etc., can be practiced. In addition, drainage to be established alongside the other side of the farm road would contribute to draining a part of torrential rainfall, which is also predicted in future. Thus, with land consolidation component implemented, farmers would have a possibility of keeping an expected yields even under such climate change.

7.3 Gender

7.3.1 Current Gender Conditions in Myanmar

Gender Inequality Index (GII) is recently used to examine gender-based inequalities of counties in terms of three dimensions, namely, reproductive health, empowerment, and economic activity. Myanmar has a GII value of 0.430 and is ranked at 83 out of 149 countries in 2013 (see following table). In terms of GII, Myanmar is ahead of Cambodia and Lao PDR, ranked at 105 and 118, respectively, while Myanmar is behind Thailand, which is ranked at 70 (UNDP, 2014).

As a whole, it can be said that male and female are equal in terms of population with at least some secondary education and labor force participation rate, while female seats in parliament is quite low, though. Note that the following data is for whole Myanmar, and if it is concerned to Burmese society only, the GII may become higher due to high status of Bamar women at least in the household.

Table 7.3.1 GII Values of Myanmar and other South-East Asian Countries

Country	GII Value	GII ranking in 149 countries	Maternal mortality ratio for 100,000 birth	Adolescent birth rate for 1,000 live birth	Female seats in parliament (%)	Population with at least some secondary education (%)		Labor force participation rate (%)	
						Female	Male	Female	Male
Myanmar	0.430	83	200	12.1	4.6	18.0	17.6	85.7	82.9
Cambodia	0.505	105	250	44.3	18.1	9.9	22.2	78.9	86.5
Lao PDR	0.534	118	470	65.0	25.0	22.9	36.8	76.3	78.9
Thailand	0.364	70	48	41.0	15.7	35.7	40.8	64.4	80.8
East Asia and Pacific	0.331	-	72	19.7	18.7	54.6	66.4	62.8	79.3

Source: UNDP, 2014, Human Development Report

The Constitution, which was established in 2008, provides equal rights to women and men, still, women are not well represented in the political and higher level administrative sphere outside the

traditional areas of social services, health and education. At the local levels (districts, townships, villages), there are few women representatives, particularly in key decision-making bodies (IFAD, 2013[2]). However, women are quite dominant in decision-making and often have ownership of assets at household level, and women manage family budget instead of, or in partnership with, men. Moreover, female household heads can access official land usufruct, even though male household heads usually have that.

In 2011, the Department of Social Welfare prepared a ñNational Plan of Action for the Advancement of Women 2011-2015ò. Its final goal is that all women of Myanmar are empowered and able to fully enjoy their rights, and twelve main objectives are stipulated in the plan. One of them is ñto strengthen mechanisms for gender mainstreaming in interventions that improve livelihoods and reduce poverty for women and their familiesò. One of key indicators is percentage of the national budget allocated for gender mainstreaming training activities. In agricultural sector, however, there is no unified gender mainstreaming policy/strategy, and it has been considered on project basis. International donors mainly pay attention to female headed households and landless women[3].

As for farming activities at the field level, men generally cover heavy works, namely, preparing lands for crop growing, plowing, harrowing, and transportation/sale of harvested crops, while women cover sowing, transplantation of rice, harvesting and so on. Book keeping is shouldered by women in general. In many cases, farmers hire labors for crop cultivation, and husbands and wives can be regarded as joint managers. It is usual that men make decision at households, for instance, number of labors to be hired and timing of each farming activity, while women can express their opinions and make suggestion to their husbands. Still, women have less knowledge and experience of farming techniques than men, and crop variety selection to be planted is thus determined by husbands.

7.3.2 Proposed Components and Gender

Taking into consideration gender situations in Myanmar, all of the proposed components to achieve intensive agriculture are directly/indirectly beneficial for both men and women. Therefore, it is important to provide female farmers with opportunities to expand their field of vision for the components and to spend enough time for the project explanation. Given that womenôs opinions are respected at the level of each household, it is effective to involve women equally at initial stage for effective project implementation. For instance, as for land consolidation project, both the benefit and farmland decrease due to the project should be presented sufficiently to the farmers including women.

JICA promotes gender mainstreaming for inclusive and dynamic development and has three strategic development objectives in this field. Projects related to gender are categorized based on the objectives, and the relationship between the objectives and the categories is as shown in the following table. Considering that the targets of the proposed components are farmers with farmlands, governmental organization related to agriculture, distributer, agro-enterprises and so on, the components are not ñGender equality Projectsò nor ñProject Targeting Womenò. Moreover, gender biases to be corrected are not big constraints to implement the components. Therefore, all of them are not categorized into ñGender Integrated Projectsò. However, it is still noted that involvement of female farmers in the implementation of components should be promoted, resulting in better decision-making by both the husbands and wives.

[2] IFAD, 2013, Fostering Agricultural Revitalization in Myanmar (FARM) Final Project Design Report
[3] Hearing from the Director of International Cooperation Division, DOP, 2015

Table 7.3.2 Strategic Development Objective and Project Category

Strategic Development Objective	Contents of Project	Project Category
1. Promoting Gender-Responsive Policies, Strategies and Institutions:	• Strengthening national machinery and reforming public institutions from a gender perspective; and • Supporting information management, and establishing monitoring and evaluation systems from a gender perspective	Gender Equality Projects
2. Promoting Womenôs Empowerment	• Girlsôeducation; • Mother and child health; • Womenôs entrepreneurship development and micro finance systems; and • Gender-based violence issues such as trafficking in persons and domestic violence	Projects Targeting Women
3. Promoting Gender Integration in Programs and Projects	• Projects which do not aim at gender equality and womenôs empowerment directly, but require measures to be taken to correct existing gender biases in their planning and implementation stages	Gender Integrated Projects

Source: JICA, 2011, ñGender Mainstreaming, Inclusive and Dynamic Developmentò

7.4 Possibility of Incorporating Japanese Experiences/ Knowledge

Japan may have advantages and/or potential to assist some of the components to implement on its own experiences and knowledge accumulated to date. The potential experiences/ knowledge that Japan may better provide are summarized in the following table:

Table 7.4.1 Possibility of Introducing Japanese Experiences/Knowledge

Component	Experiences/Knowledge from Japan
I. Component for Productivity Increase	
1. Agriculture Extension Strengthening	Farming knowledge to achieve more than 100 baskets/acre
2. Irrigation Rehabilitation	Introduction of IMT/ PIM (1/), with the establishment of farmer organizations in charge of O&M of secondary canal level
3. Polder and Drainage Improvement	ditto
4. Land Consolidation (LC)	Introduction of LID (2/)1 based procedure of LC
5. Agricultural Machinery Station Enhancement	Introduction of Japanese farm machineries
6. Agricultural Machinery Dissemination (TSL)	Introduction of Japanese farm machineries
7. Flood Monitoring System Establishment	-
8. Plant Breeding Enhancement	Introduction of Japanese analysis machineries/equipment
II. Component for Agribusiness Promotion	
9. Farm-to-Market Road (FMR) Improvement	-
10. Jetty Improvement	-
11. Market Improvement (District level)	-
12. PPP Wholesale Market Establishment (Mandalay)	Introduction of auction system
13. Wholesale Market Development (New, NPT))	ditto
14. Small and Medium Agro-enterprise Promotion	Promotion of Japanese machineries (especially big scale)
15. Supply Chain Improvement of Rice	Introduction of KAIZEN, HACCP
16. Value Chain Enhancement of Vegetables & Fruits	Introduction of vegetable/fruit production techniques
17. Food Processing Industry Promotion	Introduction of HACCP, and KAIZEN
18. Dissemination of Advanced Farming Technologies	Japanese machineries including upland machineries
19. Plant Protection Enhancement	Introduction of Japanese analysis machineries/equipment

Note: 1/ IMT and PIM mean Irrigation Management Transfer (from the government to farmer organization) and Participatory Irrigation Management. 2/ LID means Land Improvement District, same as water users association established legally covering a specific command area with the responsibility of O&M for irrigation facilities and land consolidation related facilities.
Source: JICA Survey Team

As indicated in above table, most of the areas that Japan could well contribute are related to software

approaches/experiences, and machineries. For example, Japan had achieved more than 100 baskets per acre yield of paddy (5.2 ton paddy/ha) already long time ago. The present yield of milled rice is more than 5 tons/ha or more. Extension services to achieve high yield should start with procurement of good quality seeds, establishment of good nursery, proper fertilization, weeding on-time, top-dressing fertilization, drying paddy field for aeration, better management in harvest and post harvest, etc. Just only single intervention can hardly achieve high yield but a set of good practices should be applied, to which Japanôs experiences can contribute under Agriculture Extension Strengthening (No.1).

On the irrigation rehabilitation (No.2), the construction is not much difficult technically and in fact ID has carried out of rehabilitation works so far. Now in this area, farmers or farmer organization should be included in its O&M. At present, ID operates and maintains from the water source down to the secondary canal, which in turn entails financial burden on the ID side. Water users association should be established, to which irrigation management should be transferred. So called IMT (irrigation management transfer) should be carried out at secondary canal level. In Japan, such farmer organization is called LID (Land Improvement District), which can be referred to in Myanmarôs irrigation system as well as in land consolidation project.

Farm machineries manufactured by Japanese makers are very much durable and advanced, though costly as compared with counterpart machineries. Considering life-cycle maintenance cost, Japanese manufactured machineries would still have advantage, especially sophisticated machines e.g. combine harvester, paddy-planter, etc. These sophisticated machines and also upland farm machineries, which are yet to be familiar in Myanmar, should be introduced and promoted by Japanese makers through such components of Agricultural Machinery Station Enhancement (No.5), and Agricultural Machinery Dissemination (No.6). In case of large scale mills, Small and Medium Agro-enterprise Promotion (No.14) component could promote a possibility of engaging Japanese manufacture.

In relation to wholesale market, auction system is not yet introduced in Myanmar. The wholesale market to be constructed by PPP in Mandalay has a plan to introduce auction system together with one-stop system for export. This auction system as well as one-stop system for export can also be introduced by and refer to in the experiences accumulated in Japan. Technical advices in this area should be provided from Japanese experts in the field.

Concerning food processing sector, HACCP and KAIZEN should be introduced. HACCP is a systematic preventive approach to food safety from biological, chemical, and physical hazards in production processes. In this manner, HACCP is referred as the prevention of hazards rather than finished product inspection. The HACCP system can be used at all stages of a food chain, from food production and preparation processes including packaging, distribution, etc. This HACCP should be introduced in such components of Supply Chain Improvement of Rice (No.15) and Food Processing Industry Promotion (No.17).

KAIZEN is a Japanese term for "improvement". When used in the business sense and applied to the workplace, kaizen refers to activities that continuously improve all functions and involve all employees from the head to the common workers. It also applies to processes, such as purchasing and logistics, which crosses organizational boundaries into the supply chain. It has been applied in many sectors, and as a first step in Myanmar food processing sector should introduce this KAIZEN approach under the components of Supply Chain Improvement of Rice (No.15) and Food Processing Industry Promotion (No.17).

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

This Preparatory Survey, taking the points below into account, concludes that Myanmar should take actions to move from the current labor-intensive agriculture to a modern capital based intensive agriculture. In this regard, this preparatory survey has identified 4 priority areas, i.e., Shwebo, Mandalay, Nay Pyi Taw and Ayeyarwady, and presented an intensive agriculture promotion program by each of the priority areas (see attached summary table).

The Government of Myanmar should, with reference to the programs presented by this preparatory survey, start internal discussions as well as consultations with potential donors engaged in agricultural and rural development sector on which ones out of the 4 priority areas should be put into implementation first, and then which area be the next, so on. Upon the discussions and decision made, the Government should embark on the next step, which is the feasibility study for the top priority area(s), possibly in collaboration with donor(s).

1) Agricultural sector plays a quite important role in Myanmar, making up 31.3% of GDP (2013/14), 19.8% of export (2013/14), and as large share as 61.2% of employed population (2011/12). Self-sufficiency rate of rice is well over 100% and its export volume reached as much as 1.7 million tons in fiscal year 2014/15, bringing nearly US$ 645 million earning. Myanmar is also a major exporting country of pulses among ASEAN members, mainly targeting India, and the cropping area has increased from 730,000 ha in 1988/89 to as much as 4.5 million ha in 2013/14.

2) Meanwhile, the current farming in Myanmar is characterized by labor-intensive agriculture and most farm households depend on farm labors. However, with the current economic development, the trend of labor movement from rural areas to urban areas or from agriculture sector to construction sector could be accelerated, making it difficult to secure farm labors. To cope with this situation, the current labor-intensive agriculture shall be transformed to modern capital-intensive agriculture with farm mechanization, introduction of quality seeds and well managed fertilizer/chemicals, introduction of improved post-harvest techniques, and also improvement of supply/ distribution chain, etc.

3) From macro point of view, agriculture sector holds surplus labors in rural areas before industrialization. Industrialization promotes labor shift from relatively low value-added industries including agriculture sector to high value-added industries such as manufacture industry and/or service sectors, resulting in economic growth. If the industrialization progresses further, industry sector peels off labor forces from agriculture sector, and accordingly the surplus labor in the agriculture sector in turn reaches bottom. The bottom is so called ñLewis Turning Pointò, after which the wages will start increasing due to tightening of demand and supply balance.

4) A theory of development economics indicates that labor shortage in rural area increases farming costs through wage increase, which results in increase in selling price of agricultural products. Increase in food prices in urban areas would seriously affect household economy of urban labors, and, as a general rule, could cause the wage increase in industry sector. This wage increase will result in weakening of competitive power of the industry sector in the world market, leading to a gear down of the industrialization process.

5) To hinder rapid progress of the negative scenario of industrial development above-mentioned, it is important to supply cheaper staple food constantly through increase in basic food production including rice, the staple food of Myanmar people. For this purpose, shifting from the labor intensive farming currently practiced in wide range of Myanmar to the capital intensive with labor saving agriculture is due necessary in this country. Shifting to the modern capital intensive

agriculture thus contributes to assuring the continuous provision of affordable and stable food, and thereby able to keep the progress of industrialization.

8.2 Recommendations

1) **Need for Feasibility Study;** This preparatory survey presented intensive agriculture promotion program for the selected 4 priority areas though a pre-feasibility study. Though the major components in the program were judged feasible in economic term through economic evaluation based on IRR, prior to putting the program(s) into implementation, a feasibility level study and detail plan formulation, including disbursement arrangement in case of loan assisted component, should be carried out taking into all the aspects such as technical soundness, financial viability, economic viability, environmental and social consideration, and institutional set-up, etc.

2) **Implementation Arrangement;** The intensive agriculture program proposed in this preparatory survey requires a set of intervention covering agriculture extension service, infrastructure improvement, land consolidation, farm mechanization, road and jetty improvement, market improvement, some of which are under other ministries than MOAI. To implement this set of components, there should be a well established Project Management Office (PMO), supported by consultants. This office could be headed by the Department of Planning, MOAI, and technical and management level officers should be seconded to this PMO from the relevant organizations.

3) **Maintenance of Irrigation Facilities:** this Survey found the budget allocated to Irrigation Department has increased over the last, say, 10 years, to a large extent of more than 10 times. With the budget increase, nowadays expenditure for the operation and maintenance on the irrigation systems in the country has improved very much. Irrigation system needs in most cases the largest investment if once it has been much deteriorated. To avoid this huge investment for rehabilitation, such level of maintenance should at least be performed to retain the irrigation systems sustainable in its operation.

4) **Agriculture Extension Strengthening:** There is still a noticeable gap between the current yields for major crops such as paddy, pulse/ beans and what are practically achievable in the fields (note that there is also a gap in the yields between what are reported by farmers and what are recorded in statistics, the former being lower). To fill the gap, agriculture extension should be strengthened in line with infrastructure improvement, starting from the improvement of seeds, farming, harvest as well as post-harvest. Infrastructure alone can hardly contributes to increasing the current yields, whereby requiring the extension services strengthened.

5) **Facilitation of Private Sector Participation;** Intensive agriculture should hardly be promoted only by the Government and donors. A wide range of private participation will be required such as input supplier, rice millers, farm machinery suppliers, traders, retailers, food processers, etc. Government should principally be in charge of making environment enable, to which such private entities can participate smoothly. The government, in this regard, should therefore try to improve basic infrastructures such as irrigation system, farm-to-market roads, and further power supply, regional and national roads, etc. and also to establish necessary laws and regulations.

6) **Necessary Laws Establishment;** There should be laws and regulations still needed in pursuing intensive agriculture promotion. As an example, there is no law for water users association which could be in charge of operation and maintenance of a part of irrigation canal network. Nor does exist a law to have farmers organization established in relation to land consolidation project. Land consolidation requires farmers to surrender a part of their farmlands for the construction of farm road together with tertiary canals/drainages. Under current condition, the farmer organization cannot officially own the farm roads and canals, and accordingly the O&M responsibility for the facilities is hung up. Define laws relating to farmer organizations should be established.

Summary of the Four Priority Areas

Particulars	Shwebo Area	Mandalay	Nay Pyi Taw	Ayeyarwady
Pros	Major rice producing area in the Upper Myanmar including high quality local variety (Paw San), and easy access to Mandalay city.	Near to the 2nd largest city of Myanmar, which is the center for nation-wide commodity transportation in the Upper Myanmar.	National Capital of Myanmar located in the middle of Yangon - Mandalay Highway, endorsing stable power supply and also demonstration effect.	Major rice producing area in the Lower Myanmar with extensive paddy field (3.9 m. acre), and one of hubs of water transportation in Lower Myanmar.
Cons	Labor shortage, being drawn to Mandalay urban area.	Deteriorated irrigation schemes, requiring huge investment.	Fewer population, targeting outside-markets.	Poor road condition hindering distribution of farm produces.
Development Direction	To increase food supply to the rice shortage area in the Central Dry Zone and Mandalay urban area, in which accumulation of manufacturing industry is progressing, Shwebo area should improve production infrastructure together with the implementation of land consolidation and farm mechanization. The high quality local rice should also be further promoted over to the nation.	To enhance function of the transshipment station of various farm products, Mandalay area should, aside from the rehabilitation of irrigation systems, promote food processing industries, enhance the agro-products distribution and marketing, improve the river port (jetty), and strengthen the plant protection function for exports especially targeting China via Muse.	To disseminate innovative technologies to both domestic and international societies including ASEAN countries, Nay Pyi Taw's important role should primarily demonstrate advanced agricultural technologies, maintaining a harmonious balance with environment, as a Green Model City. In addition, stable power supply should be utilized in promoting food processing.	Ayeyarwady Delta is internationally recognized rice producing area of Myanmar, and takes the substantial responsibility for the nation's food security. Therefore, this area should enhance supply capacity of rice through road improvement, land consolidation and farm mechanization, in addition to the improvement of drainage function.
Component and Cost TSL (Two Step Loan) TCP (Technical Cooperation Project)	**Shwebo** / Rank **I. Productivity Increase** 1. Agriculture Extension Strengthening: A 2. Irrigation Rehabilitation: B 4. Land Consolidation: B 5. Agricultural Machinery Station Enhancement: B 6. Agricultural Machinery Dissemination (TSL): A 7. Flood Monitoring System Establishment: C **II. Agribusiness** 9. Farm-to-Market Road (FMR) Improvement: B, (A) 10. Jetty Improvement: C 11. Market Improvement (District level): C 14. Small & Medium Agro-enterprise Promotion: A 15. Supply Chain Improvement of Rice: A 19. Plant Protection and Quarantine Enhancement: B Priority Area / Priority Level / Cost of Components (million kyats) / (million JPY) Shwebo / A / 24,270 / 2,840 Shwebo / B / 145,863 / 17,066 Shwebo / C / 5,179 / 606 Sub-total (A+B) / 170.133 / 19,906 Total (A+B+C) / 175,312 / 20,511 No. 6 (TSL), 14 (TSL) excluded in the above cost.	**Mandalay** / Rank **I. Productivity Increase** 1. Agriculture Extension Strengthening: B 2. Irrigation Rehabilitation: A 4. Land Consolidation: C 6. Agricultural Machinery Dissemination (TSL): B **II. Agribusiness** 9. Farm-to-Market Road (FMR) Improvement: B 10. Jetty Improvement: B 12. PPP Wholesale Market Establishment: A 14. Small & Medium Agro-enterprise Promotion: B 15. Supply Chain Improvement of Rice: B 16. Value Chain Enhancement of Veg. & Fruits: C 17. Food Processing Industry Promotion: A 19. Plant Protection and Quarantine Enhancement: A Priority Area / Priority Level / Cost of Components (million kyats) / (million JPY) Mandalay / A / 151,426 / 17,717 Mandalay / B / 50,015 / 5,852 Mandalay / C / 23,025 / 2,694 Sub-total (A+B) / 201,441 / 23,569 Total (A+B+C) / 224,466 / 26,263 No. 6 (TSL), 12 (PPP), 14 (TSL) excluded.	**Nay Pyi Taw** / Rank **I. Productivity Increase** 1. Agriculture Extension Strengthening: A 2. Irrigation Rehabilitation: B, (A) 4. Land Consolidation: C 5. Agricultural Machinery Station Enhancement: B 6. Agricultural Machinery Dissemination (TSL): B 7. Plant Breeding Enhancement: A **II. Agribusiness** 9. Farm-to-Market Road (FMR) Improvement: B, (A) 13. Wholesale Market Development (New, PPP): C 14. Small & Medium Agro-enterprise Promotion: A 15. Supply Chain Improvement of Rice: B 18. Advanced Farming Technologies: A Priority Area / Priority Level / Cost of Components (million kyats) / (million JPY) Nay Pyi Taw / A / 37,841 / 4,427 Nay Pyi Taw / B / 48,980 / 5,731 Nay Pyi Taw / C / 5,895 / 690 Sub-total (A+B) / 86,820 / 10,158 Total (A+B+C) / 92,715 / 10,848 No. 6 (TSL), 13 (PPP), 14 (TSL) excluded in the above cost.	**Ayeyarwady** / Rank **I. Productivity Increase** 1. Agriculture Extension Strengthening: A 3. Polder and Drainage Improvement: B 4. Land Consolidation: B 5. Agricultural Machinery Station Enhancement: B 6. Agricultural Machinery Dissemination (TSL): A 7. Flood Monitoring System Establishment: C **II. Agribusiness** 9. Farm-to-Market Road (FMR) Improvement: A 10. Jetty Improvement: C 11. Market Improvement (District level): C 14. Small & Medium Agro-enterprise Promotion: A 15. Supply Chain Improvement of Rice: B 19. Plant Protection and Quarantine Enhancement: B Priority Area / Priority Level / Cost of Components (million kyats) / (million JPY) Ayeyarwady / A / 35,476 / 4,151 Ayeyarwady / B / 81,572 / 9,544 Ayeyarwady / C / 8,180 / 957 Sub-total (A+B) / 117,047 / 13,695 Total (A+B+C) / 125,228 / 14,652 No. 6 (TSL), 14 (TSL) excluded in the above cost.
Economic Justification **(NPV: Million Kyats)**	Case / Shwebo EIRR (%) / Shwebo NPV (Million Kyats) / Farm Budget Ratio b/t with & without Project, (%) Irrigation Rehabilitation Base0ô: 15.1 / 496 / 111.8 Base0: 21.3 / 29,092 / 118.3 Base1: 23.2 / 39,791 / 120.8 Base2: 24.6 / 47,803 / 122.6 Land Consolidation: 12.9 / 779 / 152.1 Road Rehabilitation: 20.5 / 9,366 / – Base 0ô Yields increase of monsoon & summer paddies Base 0: Yields & summer paddy (SP) area increase Base 1: Pulses introduced Base 2: Alternative crop introduced to 10% of SP area	Case / Mandalay EIRR (%) / Mandalay NPV (Million Kyats) / Farm Budget Ratio b/t with & without Project, (%) Irrigation Rehabilitation Base0ô: 8.4 / -31697 / 112.7 Base0: 16.3 / 7,540 / 124.7 Base1: 22.5 / 51,700 / 138.2 Base2: 21.1 / 40,297 / 134.7 Land Consolidation: 16.6 / 3141 / 138.4 Road Rehabilitation: 19.7 / 9,060 / – Base 0ô Yields increase of monsoon & summer paddies Base 0: Yields & summer paddy (SP) area increase Base 1: Pulses introduced Base 2: Alternative crop introduced to 10% of SP area	Case / Nay Pyi Taw EIRR (%) / Nay Pyi Taw NPV (Million Kyats) / Farm Budget Ratio b/t with & without Project, (%) Irrigation Rehabilitation Base0ô: 16.9 (4.5) / 3162 (-9,028) / 136.2 Base0: 18.8 (10.1) / 6,629 (-4,974) / 113.0 141.6 122.3 Base1: 22.1 (17.3) / 13,216 (2,741) / 151.8 139.9 Base2: 22.0 (14.7) / 13,096 (-376) / 151.6 132.8 Land Consolidation: 10.8 / -277 / 130.7 Road Rehabilitation: 12.9 / 466 / – Reference case without Paung Laung irrigation scheme is shown in parenthesis	Case / Ayeyarwady EIRR (%) / Ayeyarwady NPV (Million Kyats) / Farm Budget Ratio b/t with & without Project, (%) Irrigation Rehabilitation Base0ô: 8.7 / -9,457 / 107.9 Base0: 16.4 / 2,628 / 115.2 Base1: - / - / - Base2: - / - / - Land Consolidation: 12.5 / 464.1 / 157.1 Road Rehabilitation: 12.9 / 956 / – Base 0ô Yields increase of monsoon & summer paddies Base 0: Yields & summer paddy (SP) area increase Base 1: Pulses introduced Base 2: Alternative crop introduced to 10% of SP area