IRRIGATION DEPARTMENT
MINISTRY OF AGRICULTURE AND IRRIGATION
THE REPUBLIC OF THE UNION OF MYANMAR

PREPARATORY SURVEY FOR THE PROJECT FOR REHABILITATION OF IRRIGATION SYSTEMS

FINAL REPORT (MAIN)

AUGUST 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
SANYU CONSULTANTS INC., JAPAN

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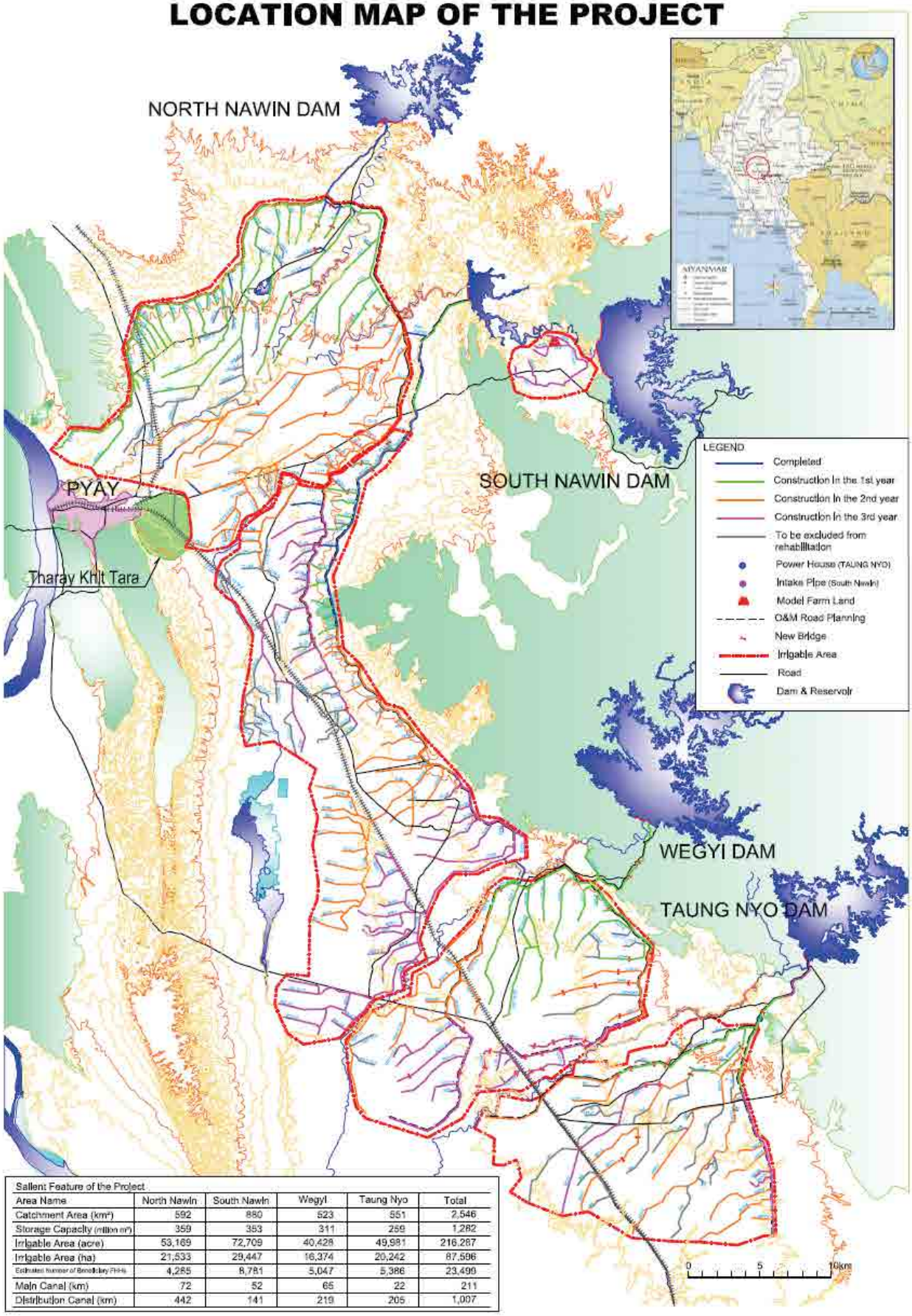
LOCATION MAP OF THE PROJECT



Salient Feature of the Project

Area Name	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Catchment Area (km²)	592	880	523	551	2,546
Storage Capacity (million m³)	359	353	311	259	1,282
Irrigable Area (acre)	53,169	72,709	40,428	49,981	216,287
Irrigable Area (ha)	21,533	29,447	16,374	20,242	87,596
Estimated Number of Beneficiary FHHs	4,285	8,781	5,047	5,386	23,499
Main Canal (km)	72	52	65	22	211
Distribution Canal (km)	442	141	219	205	1,007

EXECUTIVE SUMMARY

PREFACE

0.1 Submitted herewith is the final report prepared based on the Minutes of Discussions (MD) on 'the Project for Rehabilitation of Irrigation System (the Project)' signed on August 1, 2012 by and between Japan International Cooperation Agency (JICA) and the Irrigation Department (ID), Ministry of Agriculture and Irrigation (MOAI). A technical assistance team organized by JICA headquarters commenced a series of surveys for the Project from March 18, 2013, and this report presents all those survey results together with the plan including rehabilitation components, work volume, cost estimation, project evaluation, etc. for the Project. In addition, this Report delivers the work results for a model farmland consolidation pilot project implemented in Nay Pyi Taw.

PART I REHABILITATION OF IRRIGATION SYSTEMS

I.1 RATIONALE AND GOAL OF THE PROJECT

1.1 The Project targets 4 irrigation systems located in two districts of Pyay and Thayarwaddy. Irrigation systems in Pyay and Thayarwaddy districts were firstly planned in "Irrawaddy Development Master Plan, 1980", and its project implementation was commenced from 1980. The area is located at a western part of Bago Yoma (mountain range) and rainfall in the area is rather limited because humid air coming from southern side generates rain just at Bago Yoma, not at the area around. This is one of the major reasons why the irrigation projects were planned and implemented in the area and such irrigation projects have been playing important roles in agriculture sector to secure stable farming.

1.2 After commencement of the operation for the irrigation projects, Irrigation Department (ID) under Ministry of Agriculture and Irrigation (MOAI) has carried out maintenance and rehabilitation works for all those projects including the target 4 irrigation systems; however, due to shortage of budget allocation under the former government, irrigation systems of such projects have seriously been deteriorated year after year. Consequently, Irrigation Department can now 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.

1.3 Objective of the Project stated in the MD is therefore to increase agriculture production through recovery of the areas of the irrigated land by rehabilitating the irrigation systems, whereby contributing to food security and livelihood improvement of the people concerned. Towards the project objective to be achieved, this Survey aims at formulating a rehabilitation plan and also examining the feasibility based upon the project cost and benefit. The Survey started with status assessment of the target irrigation schemes for rehabilitation, and then conducted identification of works for rehabilitation, cost estimation, benefit estimation, environmental examination, and also project economic analysis, etc.

1.4 In addition, farmland consolidation can also be one of the project components to be examined under the Survey. Farmland consolidation may be carried out together with the establishment of irrigation and drainage network including farm roads. This farmland consolidation facilitates, aside from increasing harvest thanks to the irrigation and drainage network established, farm mechanization given leveled and consolidated farmland composed of number of rectangular shaped plots. A pilot project, as a model case, is planned to implement in Zabuthiri township of Nay Pyi Taw district, based on which its idea of farmland consolidation could be applied in the target 4 irrigation schemes.

1.5 Under such situation, Irrigation Department has requested JICA to survey and formulate necessary rehabilitation plans for the 4 irrigation systems put back to the originally planned functional

level, possibly bringing about ODA loan for the implementation of rehabilitation works as early as possible. Responding to this request, Japanese Government sent a preliminary survey team in June/August 2012, and concluded the implementation of this Survey as stipulated in the MD signed on August 1, 2012. Then, JICA organized a team of experts in charge of the formulation of rehabilitation plan, and the Team had arrived in Myanmar on March 18, 2013 for the execution of necessary surveys. The Team has completed all the required surveys with the submission of this Report.

I.2 THE SURVEY AREA

2.1 The target irrigation systems are; North Nawin Irrigation System, South Nawin Irrigation System, Wegyi Irrigation System, and Taung Nyo Irrigation System. They are located in an eastern area of Ayeyarwaddy river, just western side plain of Bago Yoma (mountain range). These irrigation systems are lined up from north to south, i.e., North Nawin irrigation system, South Nawin irrigation system, Wegyi irrigation system, and Taung Nyo irrigation system, all of which are located at a northwestern part of Bago region. Those systems spread over two districts, i.e. North Nawin, South Nawin, and Wegyi irrigation systems are under Pyay district while Taung Nyo irrigation system falls under Thayarwaddy district.

2.2 The Survey area lies in north latitude from 18.2 o to 19.2 o and east longitude from 15.3o to 96.3o. Above mean sea level of the area ranges from 45m to 60m, forming so-called Pyay plain. Pyay plain is the beginning place of alluvial fan which continues further down to Ayeyarwaddy delta. It takes about 8 hours by express-train from Yangon to Pyay departing Yangon at 13: 00 every day. Car driving is faster than the train trip; it takes about 4-6 hours. The Pyay road, upgraded with asphalt pavement in 1993, used to be the best road in Myanmar. A bridge over the Ayeyarwaddy river was also completed in 1998 starting at Pyay town.

2.3 North Nawin Irrigation System is located at the north edge of the Survey area with about 310 km distance from Yangon. Contrary, the southern edge of the Survey area is at Taung Nyo Irrigation System and it has about 200 km distance from Yangon. Beneficiary area of the 4 irrigation systems spreads within this 110 km distance of northwest– southeast direction. The planned irrigable areas for the 4 irrigation systems are available by SLRD and ID, as shown in upper rows of Table 2.1. The net irrigable area ranges from 40,428 acre (16,361 ha) to 72,709 acre (29,424 ha) with the total area of 216,287 acre (87,527 ha).

Table 2.1 Estimated Irrigable Area and Beneficiaries in Four Irrigation Systems

Items	N. Nawin	S. Nawin	Wegyi	T. Nyo	Total
Net Irrigable Area (acre) 1/	53,168.54	72,708.66	40,428.42	49,981.31	216,286.93
Net Irrigable Area (ha)	21,516.24	29,423.74	16,360.57	20,226.44	87,526.99
Average Farmland (acre) per FHH 2/	12.72	8.28	8.01	9.28	9.91
Average Farmland (ha) per FHH 2/	5.15	3.35	3.24	3.76	4.01
Estimated Number of Beneficiary FHHs	4,180	8,781	5,047	5,386	23,394
Estimated Beneficiary Population, 2/	20,858	43,818	25,186	26,876	116,738

Source: 1/ Irrigation Department, 2/ Household Questionnaire Survey conducted by JICA Survey Team covering 225 sample households in 2013, 3/ Family member is estimated at 4.99 according the Household Questionnaire Survey.

2.4 Beneficiary number of farmers relative to the irrigation systems is not available. Therefore, to estimate the beneficiary numbers, an average farmland area estimated through a household questionnaire survey conducted by JICA Survey team is employed. The survey identified an average farmland area per farmer household ranging from 8.01 acre to 12.72 acre by irrigation system, with an overall average farmland of 9.91 acre (4.01 ha). Applying this average farmland area to the net irrigable area by irrigation system, the estimated beneficiary households are between 5,047 and 8,781 by system, totaling to 23,394 households equivalent to 116,738 population.

2.5 Rainfall in the Survey area is available at each of the 4 dam sites while temperature is only available at Pyay meteorological station. Since the Survey area is located at a southern vicinity of the Central Dry Zone, the annual rainfall is not enough to support monsoon paddy, ranging from 1,000 to 1,400 mm only per annum. Average annual temperature recorded at Pyay station comes to 28.1 Co; January shows the lowest mean temperature of 24.7 Co while the highest shows up in April with 31.8 Co.

2.6 Water resources of the 4 irrigation systems are dam reservoirs. In Myanmar, dam reservoir is basically designed to have a storage capacity being able to store all the mean annual inflow running at the point of the river. Following table shows storage and effective capacity by each of the dam reservoirs, and it reveals that North Nawin dam reservoir has the largest capacity in comparison with the average annual inflow. Overflow from the North Nawin dam reservoir is therefore recorded only 3 times after 31 years from the operation commencement in 1976. Taung Nyo reservoir has a small storage capacity in comparison with the average annual inflow with the ratio of only 0.65, whereby overflow through the spillway takes place almost every year.

Table 2.2 Storage Capacity and Effective Storage Capacity of Reservoirs (4 reservoirs)

Dam Names	N. Nawin	S. Nawin	Wegyi	T. Nyo
River Name	North Nawin	Nawin	Wegyi	Taung Nyo
Average Annual Inflow (million cubic meter)	201.2	300.1	277.1	358.0
Storage Capacity (million cubic meter)	358.8	354.0	311.0	259.0
Dead Capacity (million cubic meter)	41.9	33.3	31.0	26.0
Effective Storage Capacity (million cubic meter)	316.9	320.7	280.0	233.0
Ratio (Effective Storage Capacity/Inflow)	1.58	1.07	1.01	0.65
Net Irrigable Area, acre	53,168.54	72,708.66	40,428.42	49,981.31
Net Irrigable Area, ha	21,516.54	29,424.74	16,361.57	20,226.31
Total Irrigable Area, Acre (ha)	216,287 acre (87,529 ha)			

Source: Irriagtion Department

2.7 There are three major crop seasons in the Survey area such as; 1) monsoon season, 2) winter season and 3) summer season. During monsoon season (July to October), cultivation field can use monsoon rainfall and most of the cultivated crop is paddy under rain-fed. Winter season (November to February) is called dry season with low temperature. Amount of rainfall is small in this season, and low water requirement crops (i.e. pulses) are mainly planted without much irrigation water. Summer season (March to June) falls in dry season with high temperature. All crops in this summer season need irrigation water to grow. Most of the lowland fields in this season have cultivated paddy formerly directed by a government policy.

2.8 Rice being the staple food for the population and also according to a former government policy, paddy cultivation is dominant in the area. According to the actual sown area recorded from 2008/09 to 2012/13, almost 90% of the irrigable area is in fact planted with monsoon paddy and more than 30% of the area is planted with summer paddy. In addition, even single crop with monsoon paddy reaches 20.7% in spite of the existence of irrigation system due to water shortage. Pulse is planted during the winter season with more than 40% of the total irrigable area. Pulse is cultivated as the main cash crop. There are several varieties of pulses such as black gram, green gram, groundnut, chick pea, cow pea, etc., of which black gram is the major one.

2.9 Yield survey for the last 2 years harvest was conducted in May-June 2013 covering 360 households in 12 villages which are located at upper position, middle position and lower position for the irrigation canals of the Survey area. For the paddy, lower position showed the highest harvest for both monsoon and summer paddies (monsoon: 60.8 baskets, summer: 70.8 baskets), followed by upper position (monsoon: 60.3 baskets, summer: 66.6 baskets) and lastly middle position (monsoon:

51.2 baskets, summer: 59.2 baskets). The high productivity in the lower position may have been caused by fertile soil prevalent in the lower locations.

2.10 For the winter crops planted in the irrigation systems, upper position was planted with three kinds of pulses such as black gram, green gram and groundnut while other positions were planted with only black gram. The average productivity for the black gram by position is different from that of paddy; the highest yield is marked in the middle position (18.8 baskets), then upper position (16.0 baskets), and lastly lower position (10.4 baskets). Water availability in the lower position is less than mid and upper positions, whereby the yield of lower position may have resulted in such lowest one.

2.11 As for farmland holdings by an average farmer household by position, farmers in the middle position villages have the largest lowland farm with an average area of 9.6 acre, then lower position villages with 8.6 acre and upper position villages with 6.3 acre. The maximum lowland farm size owned by a farmer was 30 acre while the minimum one was 0.5 acre, and the average lowland farm holding per farmer household came to 8.2 acre. Besides, upper position and middle position farmers have approximately 2.4 acre of each upland field. The upper and middle position villages are located on slightly hilly areas than lower position villages; hence they have some upland fields. A typical average farmer household is therefore supposed to own a total area of 9.901 acre (4.01 ha), which is in fact quite big as compared to other parts of the Country.

2.12 The average gross profit of monsoon paddy per household arrives at 1,630,874 Kyats while that of summer paddy at 963,813 Kyats. The highest gross profit shows up in the lower position villages (1,893,392.3 Kyat and 1,401,730 Kyats respectively). About half of the households cultivate black gram in upper and lower villages and it is a quarter in the middle position villages. Harvested area, yield and farm gate price are the highest in the middle position villages, thus the gross profit of 2,164,800 Kyats per household in the middle position villages is the highest accordingly. The yield and farm gate price in the lower position village is the lowest amongst the three positions, thus only 874,914 Kyats per household. The average gross profit of pulses for the 3 positions comes to 1,408,833 Kyats per household.

2.13 In terms of gross profit per unit area, monsoon paddy generates 203,759 Kyats per acre (503,396 Kyats/ha) as the average while summer paddy does 196,086 Kyats per acre (484,298 Kyats/ha). Black gram can fetches an average gross profit of 228,459 Kyats/acre (566,454 Kyats/ha). By location, monsoon paddy shows the highest of 225,403 Kyats per acre at lower position, followed by the upper position (210,859 Kyats) and lastly by middle position (179,357 Kyats). For the summer paddy, the order is same as those of monsoon paddy, i.e. 226,089 Kyats per acre, 202,986 Kyats, 164,560 Kyats for lower, middle and upper positions respectively. Black gram shows the highest gross profit of 328,000 Kyats per acre at the middle position, followed by upper position (250,167 Kyats/acre), and then by lower position (153,494 Kyats/acre).

2.14 Net profit can be estimated by subtracting the input cost mainly composed of chemical fertilizers and labor hiring from the above-mentioned gross profit. As for the average net profit per household, monsoon paddy generates 1,042,710 Kyats/household, and summer paddy does 40,340 Kyats/household only. Pulses (black gram) fetches an average of 995,433.6 Kyats per household. The largest net profit of monsoon paddy per farmer is recorded at the lower position villages (1,257,939 Kyat) and net profit ratio is also the highest in the lower position (66.4%). The highest net profit of summer paddy shows up in lower position villages (677,154.8 Kyat) same as the monsoon paddy. However, the ratio of the net profit becomes the highest in upper position village (53.1%). The net profit of black gram per farmer is the highest in the middle position villages (1,660,329 kyat) and so does the net profit ratio (76.7%).

2.15 As for the net profit from the major crops per unit area, monsoon paddy generates 130,277

Kyats per acre (321,818 Kyats/ha) as the average, and the net profit ratio arrives at 64%. On the other hand, the net profit of summer paddy per unit area of is smaller that that of monsoon paddy; it is only 93,656 Kyats per acre (231,189 Kyats/ha), and the net profit ratio is 48% only. Black gram fetches an average of 161, 422 Kyats per acre net profit (400,801 Kyats/ha) with as high as 71% of the ratio. Summer paddy requires improved seed and more amounts of chemical fertilizers than monsoon, which leads to the reducing the net profit ratio of the paddy. Black gram, pulses, usually do not need fertilizer thereby raising the ratio of net profit reaching as high as over 70%.

I.3 PROJECT PLANNING AND DESIGNING

3.1 This Project deals with rehabilitation and upgrade of 4 irrigation systems. As for canals, rehabilitation will be a main component for North Nawin irrigation system and South Nawin irrigation system while upgrade of non-lining canals by concrete/brick lining will be a main work for Wegyi irrigation system and Taung Nyo irrigation system. Since detailed design documents are available for North Nawin and South Nawin irrigation systems, it is concluded that detail designs for these irrigation systems are basically not required while Wegyi and Taung Nyo irrigation systems require detailed designs. Three directions are applied as rehabilitation criteria under the Project; 1) canal cross section shall have enough flow area, 2) gates and hydraulic structure can control irrigation flow, 3) relevant structures shall function and contribute in accelerating area development.

3.2 It is confirmed that North Nawin irrigation system receives irrigation water from South Nawin irrigation system at 4 places, so that total 17 canals are integrated into South Nawin irrigation system. Since Irrigation Department has completed rehabilitation of the main canals, rehabilitation of distribution canals will be conducted by the Project which includes total 6,626m^2 of brick lining, 140 numbers of turn-out, 12 numbers of syphon, 40 numbers of bridge, and 59 numbers of drop, and pavement for 14km of main canal road and 60 km of distribution canal road. As damage is confirmed at an outlet pipe of the intake facility of North Nawin dam reservoir, steel pipe will have to be replaced by new one under the Project.

3.3 Since some distribution canals of North Nawin irrigation system are integrated into South Nawin irrigation system, rehabilitation of hydraulic structures is required under South Nawin irrigation system in spite of that there is no hydraulic structures in the original list of South Nawin irrigation system to be rehabilitated. Under South Nawin irrigation system, rehabilitation of main canal and distribution canal is required; total 51,410 m^3 of main canal concrete lining and 7,222m^2 of brick lining. As for hydraulic structures, total 108 numbers of drops, 3 numbers of syphon, 32 numbers of bridge, and 52 numbers of bridge are to be rehabilitated/constructed. Total 30km of main canal road and 8km of distribution canal road will be rehabilitated under the Project.

3.4 Irrigation Department has commenced rehabilitation works for Wegyi irrigation system since 2011 and about 5% has already been completed. Since canal lining is basically not provided to this irrigation system, severe erosions are identified and damages on hydraulic structures are confirmed. Required rehabilitation is; total 29,151 m^3 of concrete lining for main canal, 15,317m^2 of brick lining for distribution canal, total 21 numbers of drop, total 29 numbers of turn-out, 1 syphon, total 13 number of bridge, 30km of main canal road pavement, and 50km of distribution canal pavement. In order to widen canal road as much as possible, canal slope will be steepened from 1:1.5 without lining to 1:1.25 with lining.

3.5 Taung Nyo irrigation system has a bit steep topography from dam site to canal terminals and this steep slope is considered to be a main cause of severe damages on the irrigation system. Some hydraulic structures in the irrigation system had completely been flushed off and canal-beds of the structures were scraped off by 2.0m or even more from the original bed elevation. Proposed

rehabilitation plan is; total 57,026m^3 of concrete lining for main canal, 7,194 m^2 of brick lining for distribution canal, total 97 numbers of drop, total 4 numbers of drop, 22.1km of main canal road with concrete pavement, 49.5km of distribution canal with gravel pavement.

3.6 Average runoff rate of each dam reservoir of irrigation system ranges 0.3 – 0.43. North Nawin and South Nawin systems show the lowest values of runoff coefficient which varies from 0.21 to 0.46 because the catchment areas are located at the most northern side among 4 irrigation systems, which is the edge portion of so-called Central Dry Zone that the runoff coefficient is usually 0.3 or less. Runoff coefficient of Wegyi and Taung Nyo systems show higher value than those of North and South Nawin, which ranges from 0.37 to 0.70. Daily canal discharge measurement by Irrigation Department was reviewed and revealed that it is the same as current-meter measurement or less, so that water volume available for irrigation is considered to be equal or larger than the recorded one. Consequently, recorded irrigation discharge can be used for calculation of determining future irrigable area as a safety side for irrigation planning.

3.7 Irrigation record and cropping pattern for year 2012-2013 are employed as the base year for irrigation planning since data during former government are not reliable. Reservoir water level in North Nawin fluctuates a lot while Taung Nyo shows rather stable water level cycle. Some points can be observed from averaged water level cycle; 1) water release during winter period seems much in comparison with water release during summer paddy cultivation period, 2) early bottom touching of water level in North Nawin may be caused by over cultivation of summer paddy and/or over water release for winter crops, and 3) reservoir water supply is basically sufficient for monsoon paddy.

3.8 Irrigable areas for 4 irrigation systems are revised based on actual irrigation supply and cropping area recorded from June 2012 to May 2013 (see Table 3.1). Modification on the irrigable area has been done on the area of North Nawin and South Nawin irrigation systems by transferring a part of the former to the latter system. Also, there are private irrigation areas irrigated by pumping water from nearby streams, which shall be excluded from the dam reservoir irrigation systems. Given these current conditions, total irrigable area comes to 216,287 acre (87,527 ha) in total. By system, South Nawin system shows the largest area of 72,709 acre while the smallest one is Wegyi, 40,428 acre.

Table 3.1 Revised Current Irrigable Area for 4 Irrigation Systems

Irrigation System	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Original Data from ID (ac)	83,993.24	48,976.36	43,078.42	49,981.31	226,029.33
Area Transfer (ac)	-23,732.30	23,732.30	0.00	0.00	0.00
Private Irrigation (ac)	-7,092.40	0.00	-2,650.00	0.00	-9,742.40
Current Irrigable Area (ac)	53,168.54	72,708.66	40,428.42	49,981.31	216,286.93
Current Irrigable Area (ha)	21,516.24	29,423.74	16,360.57	20,226.44	87,526.99

Source: JICA Survey Team

3.9 Based on the above revised irrigable area and available irrigation water from the reservoirs, examination of cropping pattern is carried out. In this examination, the first priority for crops is given to monsoon paddy, the second one is to winter crop, and summer paddy shall be given the third priority according to the present cultivation practices by farmers. Based on the examination, total 21.8 billion Kyat of net profit is estimated to accrue annually by farm products after implementation of the Project.

Table 3.2 Case Studies on Cropping Pattern and their Profits (Unit: acre, million Kyat)

Crops	Winter Crop (Black Gram)					Summer Paddy					Total
Case	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	
2012-2013	35,451	14,852	6,651	26,002	82,956	981	2,802	36	5,217	9,036	91,992
Million Kyat	7,744	2,469	1,025	4,196	15,434	105	241	4	554	904	16,338
Average	25,371	58,456	2,702	30,715	117,244	0	0	0	0	0	117,244
Million Kyat	5,600	10,535	327	5,381	21,843	0	0	0	0	0	21,843

Source: JICA Survey Team

3.10 Construction modality for this project is to be a direct force account carried out by Irrigation Department (ID). D has constructed a number of irrigation schemes to date by utilizing her own staff and also machineries. However, since the machineries that the ID owns are not enough in terms of both number and capacity to manage all the construction sites, machineries shown in the following table are to be procured under the Project. Note that ID shall use own machineries during the 1st year construction as indicated in the right column of the following table since the procured machineries are to be available from the 2nd years of the construction.

Table 3.3 Construction Machineries to be Procured with Use of Existing Ones

No.	Equipment Name	Specifications	Q'ty	Use of Existing Equip' in 1st Y
1	Hydraulic Excavator, Standard	20-23ton, crawler type, Tier-2, 1m3, 122kW, type, w/ crane attachment, dozer	16 units	6
2	Hydraulic Excavator, Long Arm	crawler type, super long arm, Tier-2, 0.45m3, 130kW, w/ slope bucket	8 units	-
3	Hydraulic Excavator, Small Size	6-7ton, rubber crawler type, Tier-2, 0.18m3, 43kW	20 units	-
4	Hydraulic Breaker with Base Machine	attachment to excavator, 1300kg class	1 unit	1
5	Tracked Dozer, Class II	21ton class, 150kW output, Tier-2	8 units	3
6	Tracked Dozer, Class III	11ton class, 100kW output, Tier-2	8 units	3
7	Wheel Loader	11ton, standard type, Tier-2, standard bucket capacity 2.0m3, 122kW	2 units	1
8	Earth Work Vibration Roller	steering type, single drum roller, Tier-2, 11-12ton, 103kW	5 units	2
9	Agitator Truck (Concrete Mixer Truck)	6×4, mixer capacity 9m3, 235kW	10 units	12
10	Low-bed Semi-Trailer Truck	maximum loading capacity 25t, 235kW	4 units	1
11	Dump Truck	4×4 drive, maximum loading capacity 6-7t, 165kW	10 units	5
12	Concrete Pump Truck	Boom type (15m boom), 60m3/hr, 165kW, w/mixer hopper	2 units	0
13	Workshop Equipment	4×4 drive, 177kW, w/ hydraulic crane, engine generator/ welder, oxygen-acetylene gas, etc.	1 lot	1 Lot
14	Dump Truck	10-20 ton or more		6
15	Truck Crane			1
16	Equipment for Conduit Pipe for North Win Dam			1 Lot
17	Others			1 Lot

Source: JICA Survey Team

3.11 To carry out a loan project, consultants shall be employed mainly for the 2 works such as; 1) detail design and also tender documents preparation, and 2) supervision of the construction works. Consultants will be composed of both international experts and national experts, who are to undertake 1) necessary surveys, 2) detail design for Wegyi and Taung Nyo systems, 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) supervision of works required during the construction period. There is one more task for the international consultant required specifically under this Project; monitoring and endorsing of the expenses made by the ID, which are then disbursed by the Loan.

3.12 For the international consultants, total 7 members are to be required during the detail design stage mainly assigned to irrigation/rural infrastructure works and hydraulic works while there should be total 5 members required during the implementation stage. As for the national (Myanmar) consultants, detail design stage will need a total of 10 members while during implementation stage there should be 7 members. need. Consultant key members, e.g. disbursement management, construction supervision during the implementation stage, are to be assigned almost continuously during the construction while other members are to be called upon according to the schedule/progress. Total person-month proposed here arrives at 55 and 92 for international and national consultant during the detail design stage, and 97.5 and 179.5 respectively during the implementation stage; namely total 147 MM for the international while total 277 for the national consultant.

3.13 In addition to the deployment of consultants above-mentioned, it is recommended to assign a team of experts who can support the project implementation especially from the view point of soft aspects such as strengthening of agriculture extension services, establishment of water users association, enhancement of water management coordinated with established water users associations, etc. Such aspects are basically categorized into 2 areas of; 1) agriculture extension, and 2) irrigation management. Project term for the both stages should be at least 5 years each, and the Stage 1 project 'strengthening of agriculture extension' is to need total 198 person-month over the 5-year implementation period while the Stage 2 project 'irrigation management' will also require another 198 person-month for the same 5-year period:

I.4 IMPLEMENTATION ARRANGEMENT AND PROJECT COST

4.1 Since Irrigation Department desires to apply direct force account for the project implementation, major components of the project under ODA loan are to be; rehabilitation works mainly composed of material and labor procurement, procurement of new construction machineries, engineering consulting services, other small works for preparation and clear-out of project implementation. Major items can be estimated from the bill of quantities of the proposed rehabilitation works while minor items can be calculated from a certain percentage against the rehabilitation cost. The following table summarizes project components and cost sharing by item and between donor, JICA, and Irrigation Department.

Table 4.1 Project Components and Project Cost Sharing between Donor and ID

Items	Examples	Calculation or Rate (%)	Share (%)	Investor
Construction Works	Materials, Labors, Fuel etc.	BOQ1	65.4%	Donor (JICA)
Machinery Procurement	Machines, spare parts	BOQ2	8.9%	Donor (JICA)
Price Escalation		Foreign: 1.5%, Local: 3.1%	5.6%	Donor (JICA)
Physical contingency		5% of BOQ1, BOQ2	4.0%	Donor (JICA)
Consulting Services	DD, SV	BOQ3	6.0%	Donor (JICA)
Land Acquisition		Not Applied	0.0%	ID
Administration Cost	ID Staff	10% of BOQ1	9.0%	ID
VAT		2%	1.1%	ID
Import Tax		7.5%	0.0%	ID
Interest during Construction		0.01%	0.0%	ID
Total	-	-	100%	

Source: Irrigation Department, modified by the Survey Team (2013)
Note; Calculated results of some items show only small value and they are indicated as '0.0%.'

4.2 Cost of construction works shares 65% of the total project cost and its cost is estimated at about 124 million US$. Items of machinery procurement have been revised by a Chief Mechanical Engineer of ID in order to adjust machinery's types and numbers between Irrigation Department owning ones and those ones to be newly procured. Physical contingency is set at 5% of the construction works and the machinery procurement cost. Consulting services include 'detail design' and 'construction

supervision' and it costs about 6% of the total project cost. Land acquisition including compensation and resettlement is not estimated in this project because most of the works are for rehabilitation and managed within the existing lands owned by ID.

4.3 Three years are planned for each of the rehabilitation of 4 irrigation systems together with road rehabilitation/upgrading. Out of the 4 irrigation systems, North Nawin and South Nawin systems do not need full-level detailed design because Irrigation Department has conducted certain volume of surveys on these systems. On the other hand, remaining 2 irrigation systems, Wegyi and Taung Nyo, need to have detailed design because little designs are available only for some structures. Under such situation, there should be one-year for the selection of consultant, following which another one-year is needed to complete detail design. Therefore, though each 3 years are needed for the rehabilitation work for each of the irrigation systems, total 5 years are to be required to complete the 4 irrigation systems:

4.4 For the ODA loan scheme, Project Implementation Committee (PIC) should be established in order to ensure smooth work for project implementation. The composition of PIC consists of existing administration of the head office of Irrigation Department such as mechanical, planning & works, procurement, design, and account sections. It can monitor the project status before and during implementation period and also can report some necessary information to the concerned donor organization and deliver its feedback to the Project.

4.5 At the construction site level, Project Management Unit (PMU) shall be organized in West Bago region, merged by Construction Division (2) and a part of Maintenance Division (Bago). This body will be the front line management unit for the implementation and it is an ad-hoc entity established during the implementation period. PMU is aimed at managing and monitoring the project, and is an independent organization to implement the specified project. It will be headed and staffed by a full-time Project Director (PD), and establish the project office consisting of the staff members of deputy directors, assistant directors, site engineers and accounting officers of the Construction Division (2) and Maintenance Division (West Bago). PMU will be tasked with managing and monitoring the day-to-day activities of the project at the field and regional level.

4.6 Total project cost excluding the model farm establishment and mini-hydro power construction arrives at 16,477 million Yen (164,770 million Kyats) composed of 14,813 million Yen (148,130 million Kyats: 90%) for loan eligible portion and 1,664 million Yen (16,640 million Kyats: 10%) for non-eligible portion (see Table 4.2). By component, civil and structure construction shares the most; namely, 10,898 million Yen (108,980 million Kyats) all under loan eligible portion, which occupies 66% of the total project cost. What comes next is the cost of machineries procurement, which is estimated at 1,479 million Yen all eligible for loan, sharing approximately 9 % of the project cost. Concerning in-direct cost, administration shares the most as expected, reaching 14,813 million Yen (148,130 million Kyats) which is supposed to cover by ID.

Table 4.2 Summary of the Project Cost

Breakdown of Cost	Foreign Currency (million JP Yen)			Local Currency (million Kyats)			Total (million JP Yen)			Rate (%)
	Total	Eligible Portion	Non Eligible Portion	Total	Eligible Portion	Non Eligible Portion	Total	Eligible Portion	Non Eligible Portion	
Civil & Structure Construction (NN)	885	885	0	9,132	9,132	0	1,799	1,799	0	10.92
Civil & Structure Construction (SN)	1,047	1,047	0	8,871	8,871	0	1,934	1,934	0	11.74
Civil & Structure Construction (Wegyi)	2,598	2,598	0	20,352	20,352	0	4,634	4,634	0	28.12
Civil & Structure Construction (T. Nyo)	1,446	1,446	0	10,841	10,841	0	2,531	2,531	0	15.36
Machineries Procurement	1,479	1,479	0	0	0	0	1,479	1,479	0	8.97
Price Escalation	289	289	0	4,965	4,965	0	785	785	0	4.77
Physical Contingency	387	387	0	2,708	2,708	0	658	658	0	3.99
Consulting Services	781	781	0	2,128	2,128	0	994	994	0	6.03
Land Acquisition	0	0	0	0	0	0	0	0	0	0.00

Breakdown of Cost	Foreign Currency (million JP Yen)			Local Currency (million Kyats)			Total (million JP Yen)			Rate (%)
	Total	Eligible Portion	Non Eligible Portion	Total	Eligible Portion	Non Eligible Portion	Total	Eligible Portion	Non Eligible Portion	
Administration Cost	0	0	0	14,813	0	14,813	1,481	0	1,481	8.99
VAT	0	0	0	1,783	0	1,783	178	0	178	1.08
Import Tax	0	0	0	0	0	0	0	0	0	0.00
Interest during construction	4	0	4	0	0	0	4	0	4	0.03
Commitment Charge	0	0	0	0	0	0	0	0	0	0.00
Model Farm Establishment	(11)	(11)	(0)	(46)	(46)	(0)	(15)	(15)	(0)	-
Mini-hydro power construction	(276)	(276)	(0)	(1,840)	(1,840)	(0)	(460)	(460)	(0)	-
Total	8,918	8,913	4	75,593	58,997	16,595	16,477	14,813	1,664	100.00

Note: Costs for model farm establishment and mini-hydro power construction are excluded from the Total.

4.7 Disbursement of the fund should be made as per the construction schedule; namely, 1) North Nawin and South Nawin irrigation systems are to start the construction from year 2014 and need 3 years for the completion, and 2) Wegyi and Taung Nyo irrigation systems are to commence from year 2016 and need another 3 years to complete the required rehabilitation works. It means that the disbursement for the former 2 irrigation systems is from 2014 to 2016 while that of the later 2 systems is from 2016 to 2018. Note that machineries procurement is to be done in year 2014 to around mid 2015, so that the disbursement has to be made in these 2 years. Following table shows the summary of the disbursement plan by year only for the loan eligible portions:

Table 4.3 Summary of the Annual Disbursement Plan of the Project

Fiscal Year	Foreign Currency (million JP¥)	Local Currency (million JP¥)	Total	Share by Year
2013-2014	1,402	8,523	2,254	15%
2014-2015	2,081	6,881	2,769	19%
2015-2016	2,344	19,835	4,328	29%
2016-2017	1,731	13,411	3,072	21%
2017-2018	1,355	10,348	2,390	16%
Total	8,913	58,997	14,813	100%

Note: Above amounts are only for loan eligible portions such as civil and structure construction, machineries to be procured, price escalation and physical contingency, while ID portions are not included.

I.5 PROJECT EVALUATION

5.1 There are 5 cases considered under project evaluation. Base 0 takes into account only the area expansion of black gram as the project benefit. Base 1 considered, on top of Base 0, the benefit accrued from road improvement as reduction of fuels for transporting agricultural products. Base 2 further considers, on top of Base 1, the remaining value of procured machineries after having completed the use in the project. For these 3 basic cases, no yield increase is counted but area expansion of black gram only for a direct agriculture related benefit. Aside from the basic 3 cases, there are 2 more cases; Case Ext. Service takes into account yield increase both for rice and black gram given an appropriate extension services. Last case, Case Road Only, undertakes the project cost of road improvement only and the benefit to be accrued from the road improvement only.

5.2 Following table shows the results of the economic analysis; EIRR shows up over 15% in all the cases including the Base 0 where only area expansion of black gram is counted as the project benefit. By case, the minimum EIRR shows up in Base 0 as 19.4%, and then Base 1 shows 22.36% up by 3.1% from the Base 0 by undertaking the benefit from road improvement. By considering the remaining value of procured machineries, not much hike in EIRR takes place as indicated in Case Base 2, only 0.7% top up on the Base 1. If discharging extension services, relatively high return is expected as 22.8 % as indicated under case Ext. Service. Road improvement generates the highest return, though the scale of the NPV is not much large as compared with other cases. B/C ratios are in all the cases

higher than 1.0, justifying the investment.

Table 5.1 Results of the Project Evaluation Analysis

Cases	Financial Price/Cost			Economic Price/Cost		
	FIRR	NPV (M Kyats)	B/C	EIRR	NPV, (M Kyats)	B/C
Base0	12.7%	4,948	1.04	**19.4%**	**48,894**	**1.48**
Base1	15.3%	24,089	1.22	**22.3%**	**67,766**	**1.67**
Base2	15.9%	27,797	1.26	**23.0%**	**71,606**	**1.73**
Ext. Service	17.0%	38,299	1.34	**22.8%**	**78,645**	**1.73**
Road Only	33.3%	11,496	2.48	**32.9%**	**11,304**	**2.45**

Source: JICA Survey Team

I.6 ENVIRONMENTAL AND SOCIAL EXAMINATION

6.1 As the result of scoping on environmental and social examination, such items evaluated as "B-" are Air pollution, Water pollution, Wastes, Noise / vibration, Cultural heritages, Labor environment, and Accident. These items were further exmined in order to know the extent of impact, establish the mitigation measures when required, and prepare for a monitoring plan, etc. To further examine, udnertken were site surveys, review and examination of the contents of the works, information obtained through interviews to relevant beneficiary villagers, inquiry to the people in the project area, and technical discussions with the concerned counterparts/officials, etc.

6.2 Some adverse effects by the project are in fact anticipated, however in general they are limited to construction phase only, e.g. air pollution, wastes, noise/vibration, labor environment and accidents. The damages are thus tentative and recoverable. As per possible measures to alleviate and to avoid such negative impacts likely to take place by the implementation of the Projects, countermeasures were considered necessary and recommended. The mitigation measures will be carried out by the implementation body, i.e., CON(2) and MD (Bago), and the Consultant engaged in the Projects receives the related reports from the CON(2) and MD. The Consultant, upon confirmation of the contents with reference to the site situation, submits the report to the head office of ID for seeking approval on the proceeding implementation taking due care on the environmental and social issues as planned.

I.7 CONCLUSION AND RECOMMENDATIONS

7.1 Taking into account below, this Survey concludes that the project to enhance and further develop the irrigation performance for the target 4 irrigation systems should be implemented as soon as possible. The GOM should therefore take immediate action toward requesting the required funds, approximately 15 billion Yen, for Japanese ODA loan. Appropriation from the Government coffer should also be made available for the project management, taxes relevant, arrangement of the construction machineries required for the 1st year construction, and other supportive components such as agriculture extension services, organizing of the farmers association, etc.

- ✓ The Project, from the viewpoint of national development, gives EIRR 19.4 % higher than the opportunity cost of capital, 12-15 %, applied in most of the development projects even at the Base Case 0 where no yield increase is considered but only area for pulses are to increase. It is expected with the Project that the cultivation area of pulses, e.g. black gram as the representative winter crop, will increase to 183,370 acre (74,206 ha) from the current 66,127 acre (26,760 ha) for the 4 irrigation systems, up by 117,243 acre (47,446 ha) equivalent to 277 % increase. For the overall beneficial area, the original irrigable area of 319,901 acre (129,457 ha) will increase to 437,144 area (176,903 ha), up by 117,243 acre (47,446 ha).

- ✓ The Project will realize the beneficiaries' long lasting wishes to come true; that is agricultural income increase well supported by irrigation water especially for those populations practicing agriculture at the downstream areas where irrigation water has hardly reached. For the Base Case 0 where only cultivated areas of black grams are to increase without yield increase, the total annual net profit of the back gram for the 4 irrigation systems is to increase from 12,475,579,897 Kyats to 34,318,259,212 Kyats, up by 21,842,679,315 Kyats. For the overall net profit, the original overall net profit of 43,891,290,930 Kyats per annum will increase to 65,733,970,245 Kyats, up by the same 21,842,679,315 Kyats.

- ✓ The Project furthermore will facilitate rural transportation by rehabilitating the access road to the North Nawin dam, upgrading the gravel clay inspection roads alongside the main canals to concrete paved roads, and improving the inspection roads alongside the distributary canals to well rehabilitated gravel clay ones. These improvements will greatly reduce the transportation cost for agriculture products and also facilitate rural transportation in general. As for the benefit accrued from the road improvement, the EIRR estimated only on basis of road construction/rehabilitation cost and benefit out of reducing the transportation cost for agriculture products arrives at a very high 32.9 %.

7.2 In implementing the Project as planned and scheduled as well as to achieve the project objectives afore-mentioned, following measures shall be undertaken by the Project Owner, ID, which are the recommendations obtained through this Survey;

- ✓ The consultants to be engaged in the Project will be availed from year 2015; namely spending year 2014 for the selection of the consultants under ICB. It means that the ID shall seek a way of preparing for the detail design of the conduit pipe to be replaced for the North Nawin intake as well as for the tender documents of the machinery procurement within year 2013 to early part of 2014, e.g. by requesting JICA for another arrangement apart from the loan. Otherwise, North Nawin needs total 4 years to complete and also the machineries procurement would be delayed by at least one year.

- ✓ Since the construction period for each of the 4 irrigation systems is scheduled only for 3 years and the canal rehabilitation work is limited only during rainy season, machinery procurement shall be started as early as possible after the loan agreement has become effective between the counties. In this regards, arrival of procured machinery at Yangon port shall not be later than the end of March 2015. After machinery has arrived at Yangon port, custom clearance, machine operation training, and transportation to the site will take about 2 months and it will be at the beginning of June 2015 when the machinery can be engaged in the rehabilitation and construction works at sites.

- ✓ Since current machineries which are to be procured under this Project are equipped with sophisticated electric and hydraulic control systems, OJT training on safe operation and daily maintenance shall be emphasized and organized before Irrigation Department deploys such machineries to the site. The trainings are to be incorporated as a part of the supplier's task responsibilities under the procurement contract. Irrigation Department shall mainly send heavy-machinery operators to such training.

- ✓ Irrigation Department shall arrange construction machinery required for the first year rehabilitation works; namely the works of year 2014, since the machinery procurement will need about one year to be conducted under ICB. Machineries that the ID shall arrange are; Hydraulic Excavator (6 NOS), Hydraulic Breaker (1 NOS), Tracked Dozer (6 NOS), Wheel Loader (1 NOS), Earth Work Vibration Roller (2 NOS), Concrete Mixer (12 NOS, 1cum), Lowbed Semi-Trailer Truck (1 NOS), Dump Truck (5 NOS). ID is requested to avail of all these machineries well in advance of the commencement of works, May 2014.

- ✓ Logistic management on such construction materials as diesel oil, cement, reinforcement bars should be carefully carried out throughout the construction period. Shortage of fuel and materials will directly affect the construction progress. In addition, much labor force procurement is estimated during canal rehabilitation period while it is the time for summer paddy harvesting and monsoon paddy seeding. Labor force demands in this period are estimated to overlap each other between ID and farmers, thus the arrangement of labor force shall be made well in advance and also by covering wider areas for the recruitment.

- ✓ Irrigation Technology Center (ITC) shall be fully utilized for quality control such as the checking of concrete mortar strength, confirmation of design mixture of concrete and mortar, and the level of soil compaction, etc. These test results shall be sent to the consultants for their approval before the commencement of relevant construction works. In case that testing equipment and tools are not enough, procurement or otherwise availing of existing equipment from relevant laboratories shall be arranged (for the equipment to be required, refer to '3.6 Procurement of Machineries and Equipment').

- ✓ Wasting of irrigation water through un-controlled gate operation is considered as the main reason of irrigation water shortage at the downstream and terminal areas of those 4 irrigation systems. In order to rectify such fundamental issue, employment and deployment of appropriate number of gate keepers are essential at this moment. Self-centered gate operation by farmers shall be banned, and participatory dissemination of irrigation system management is recommended to all the beneficiary farmers upon the completion of the rehabilitation works. Participatory dissemination can be the starting point of establishing water users associations, which are expected to take care of all the distributary canals under the concept of IMT or PIM in future.

- ✓ Taking into account the present low yields of paddy and black gram, there could be a lot of potential of increasing the yield given appropriate agriculture extension services together with irrigation water to be availed upon completion of the rehabilitation works. To enhance the extension services, there should be a technical assistance provided by an international institute or donor. ID together with DOA should consider of inviting a team of agricultural experts, which can be requested to JICA apart from the loan arrangement of the Project. In order to increase effectiveness of farm works, farmland consolidation shall also be considered, which can be tried as pilot together with the dissemination of the said agriculture extension services.

PART II MODEL FARMLAND CONSOLIDATION PROJECT

II.1 RATIONALE OF LAND CONSOLIDATION

1.1 Land consolidation aims at ensuring high productivity for agriculture supported by effective mechanized farming and rationalized water management to meet future agricultural requirements. The works accompany rearrangement and consolidation of farmland plots, improvement/upgrading of irrigation and drainage canals, and farm road construction. Land consolidation works will therefore result in improving and consolidating overall farm conditions, including related farmland-use rights.

1.2 Furthermore, the overall shape of farm plots will be improved by farmland consolidation works; therefore each of the beneficially farmers is supposed to reallocate their farmland. Reallocation works of farm plot is very important since farmland is a due important asset for every farmer, which shall have to be exchanged amongst the beneficiaries towards achieving more productive farmland as a whole. Reallocation plan should therefore be investigated closely by obtaining full consensus from all the beneficiaries before the commencement of the construction works.

II.2 LOCATION OF THE MODEL FARMLAND

2.1 To demonstrate the effect of farmland consolidation work, there is a model farmland area prepared by the Irrigation Department (ID). Target model farmland for the land consolidation lies in Zabu Thiri Township, Nay Pyi Taw City, and it covers an area of 137 ha (338.23 acre). The area is sandwiched by Nay Pyi Taw Council Road at its western part and Yangon – Mandalay Road at its eastern part. Nay Pyi Taw City council is located at about 1km north from the farm land consolidation site.

2.2 A census survey, which covered all the concerned farmers within the target farmland consolidation area, identified total 138 farmer households who have the right of using farmland. Total number of population for the 138 households arrives at 625 (male: 301, female: 324), giving an average of 4.5 members per family. It was confirmed with the SLRD that all the farmer households have the legal right of using their farmland. They live in 6 villages of 4 village tracts such as Gone Min Ein, Te Gyi Gone, Shar Taw, Aung Zabu, Ayinlo, and Kan Oo. Note that these villages are located outside the project area whereby no residential houses are found within the project area but agricultural land only.

II.3 DESIGN OF THE MODEL FARMLAND CONSOLIDATION

3.1 Within the consolidation area, there should be a main irrigation canal to be constructed, running almost center from the north straight down to the south. The irrigation canal functions as the dominant irrigation canal combined with the main farm road. The irrigation canal takes irrigation water from the existing Ngalaik main canal running alongside the northern peripheral of the project area. Two major drainage canals are constructed; one runs in parallel with the main irrigation canal sandwiching the main farm road in between, and the other one runs along the existing distributary canal of Ngalaik No.4. Given the network of the main irrigation canal, major drainage canals and the main farm road, supportive irrigation canals, drainage canals and farm roads are all aligned running east-west direction.

3.2 The standard plot to be constructed with the land consolidation work is set to be 1 acre each (0.405 ha each). The rectangular square is constructed having longer size along north-south direction while the east-west direction is set shorter taking into account the setting of the network of supportive irrigation and drainage canals. The rectangular square, the standard plot, is supposed to receive irrigation water from either northern edge or the southern edge, and the excessive irrigation water is to be discharged into the drain constructed at another side of the irrigation canal.

3.3 Out of the target area of 338.23 acre, 26.2 acre has to be used for the construction of public facilities such as farm road, irrigation and drainage canals. The necessary land for constructing the facilities shall be availed by all the concerned farmers. The necessary land of 26.2 acre shares 7.7 percent of the total area (26.2 / 338.2 x 100 = 7.7%). To avail of the 26.2 acre land, each and every farmer shall surrender their part of the land proportionally equivalent to the 7.7%. Remaining farmland after losing 7.7 % for the public facilities is allocated to all the farmers. Every plot is shaped at 1 acre; however, in fact 28% farmers have less than 1 acre of farm land within the target consolidation area. Those farmers have to share or divide one farm plot of 1 acre with other farmers by putting up a small earthen band.

II.4 ENVIRONMENTAL AND SOCIAL EXAMINATION

4.1 An environmental and social examination was conducted with reference to the model farmland consolidation map, plan and design of the farmland consolidation, interviews to concerned organizations, etc. The examination identified such environmental parameters which may cause

negative impacts as; air pollution, water pollution, noise and vibration, land recovery/loss, working environment including working safety, and accident. Most of these parameters are anticipated, if any, to give negative impact only during the construction phase. As a result of the construction, no negative impact was reported during the farmland consolidation works.

4.2 Basically, PAPs (project affected persons) under this project are also the beneficiaries of the project. Under this special condition, no direct compensation is arranged in this model pilot project; however as specified in the JICA Guideline, it should be noted as a pre-condition of implementing the project that the value of the land and also increase of the crop production with the project should be made more than those having been generated from the original farmland. It means that the land value and also the crop production upon the project completion should increase at least by 7.7% than those from the original area, since they are to surrender 7.7% of the originally owned area.

4.3 With reference to a farmland consolidation project already implemented just beside the target model farmland area, it was confirmed that the benefit accrued from the land consolidation work will surpass the loss of land that is 7.7% of what they own at present as: 1) land value is to be increased by about 2 times more, 2) crop yields are to increase by 18%, 19%, and 17% for monsoon paddy, summer paddy and black gram respectively, and 3) according to farm budget analysis, net profits are to increase by 54%, 42%, and 37% for monsoon paddy, summer paddy and black gram respectively, which are all much higher than the land loss.

II.5 IMPLEMENTATION OF THE CONSOLIDATION WORKS

5.1 Prior to the implementation of works, all the farmers have, as a pre-requisite, agreed on the reallocation plan of the to-be-consolidated farm plots. To establish the reallocation plan, the management committee of the farmer organization took the lead role considering that; 1) allocate a newly constructed plot area, whether whole one-acre area or a part of it, to the original farmer who used to cultivate in that same area as much as possible, and 2) if a farmer has more than one farm plot scattered in the project area, collect all the pieces of lands he/she owns, and allocate a newly constructed plot area, whether whole one-acre area or a part of it depending upon the total farm acreage, equivalent to the accumulated farm areas.

5.2 Types of the work contents implemented can be divided into 5 categories; namely, 1) ploughing and harrowing, 2) farm road construction, 3) drainage canal construction, 4) irrigation canal construction and 5) farmland leveling. Earthwork is the major work in the farmland consolidation works and construction of structures is not so big as compared to the earth work. Therefore, construction machineries were mainly used for earthwork, and structures were mainly constructed by man-power. The construction works was commenced on February 10, 2014 and completed on April 25, 2014. Total cost for the construction is around 561 million Kyats. Of the total cost, diesel, lubricant and grease together come to 184 million Kyat (33%); the construction materials cost 247 Kyat (44%); ploughing and harrowing cost 21 million Kyat (4%); and labor cost 109 million Kyat (19%).

III.6 RECOMMENDATIONS TOWARD FUTURE WORKS

6.1 During the process of undertaking the model farmland consolidation project, the JICA Team encountered a number of issues that lead to the recommendations presented below. As is the case with continuous processes, these recommendations are by no means exhaustive and may need to be changed or modified, depending upon the prevailing condition. Nevertheless, it is believed that the ones covered here constitute important issues on which the implementation of the future land consolidation works will have to be pursued:

- ✓ Before executing the farmland consolidation, SLRD should examine the number of concerned farmers, the area of farm plots and their addresses where they live. This information are quite important for obtaining consensus on the project implementation among all the concerned farmers, establishment of farmer organization, preparation of plot reallocation plan and registration of the farm plots. In case this information not completed, successive process will be very much hindered.

- ✓ Consolidation works shall not commence till all the beneficiary farmers have agreed necessary arrangement for the project implementation, e.g. establishment of farmer organization, loss of farmland for the purpose of constructing farm roads and irrigation & drainage canals (so-called non-substitute re-plotting), reallocation of consolidated farm plots, etc. Among issues, loss of farmland and farm plot reallocation are the major issues that the farmers need time to agree and settle.

- ✓ Farmer organization should be established upon making consensus among the concerned farmers. Under the farmer organization, management committee is established by selected farmer representatives. The committee is in charge of taking contact with every farmer and also of arbitration if a problem occurs among farmers for the farmland consolidation. This farmer organization shall be in charge of maintaining such agricultural infrastructure as farm roads and irrigation & canals constructed within their jurisdiction.

- ✓ The benefits accrued from land consolidation should be more than that of the land the farmers are to lose for the construction of farm roads and irrigation & drainage canals, and the ratio of the land loss should preferably be less than 10% of what the farmers own at present. If the ratio of the land loss comes to more than 10%, ID and AMD staff should review the plan and modify the designing of the farm road and canals in order not to lose more than 10% of the farmland.

- ✓ To execute farmland consolidation project, ID, AMD, SLRD, Cooperatives Department, DOA, GAO should participate and assist the farmers. After the farmer organization has been established, management committee of the farmer organization will be in charge of holding general assembly or making consensus among all the famers. In every stage, respective government office should assist the farmer organization through the management committee.

- ✓ Close collaboration and information sharing of respective works is necessary among the concerned government departments. After the farm land consolidation project has started, more than one government department have to discharge respective responsibility at the same time (e.g. designing by ID and AMD, obtaining information for beneficiary farmers and their farm plots by SLRD, registration of farmer organization by Cooperative Department, etc). To keep pace together among the concerned departments, collaboration and information sharing are due required.

- ✓ Environmental examination and social consideration should be carried out prior to the implementation of the farmland consolidation project. All the environmental parameters which may give negative impacts during and after the project implementation should be identified and monitoring plan thereof shall be established. Monitoring especially during the project implementation phase shall be carried out, and when negative impacts are to occur, necessary measures should be undertaken.

- ✓ Loss of income opportunity during the construction period, if any, should be compensated. To avoid this, the construction should be carried out during off-crop season. In Myanmar, monsoon paddy is the dominant crop, and therefore winter season coming after the monsoon season and/or summer season coming before the monsoon season could be the off-crop season. The construction

schedule shall consider these off-crop seasons, or compensation may not be avoided.

- ✓ Any properties, e.g. house, trees, etc. existent within the project area should be compensated, provided that they had been existing before the cut-off date. It is noted that no compensation can be made on the properties constructed after the cut-off date. Cut-off date here means the date when the project is officially announced, e.g. the date stakeholder meeting for the purpose of explaining the project is held or census survey covering the beneficiary farmers is commenced.
- ✓ Complaint-handling mechanism should be established prior to the commencement of the construction woks. Under farmland consolidation project, management committee may receive complaint from colleague farmers, and the committee should at first try to solve the complaint within the farmer organization. If they cannot solve the complaint within them, the management committee will bring the complaint to the concerned government office and claim the staff to solve the complaint.

CONTENTS

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
DAP	Department of Agricultural Planning
DAR	Department of Agriculture Research
DOA	Department of Agriculture
DAR	Department of Agriculture Research
ESE	Electricity Supply Enterprise
FAO	Food and Agriculture Organization
FHH	Farm Household
FOB	Free on Board
GAD	General Administration Office
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
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	Purchasing Power Parity

SLRD	Settlement and Land Records Department
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
YAU	Yezin Agriculture University
YESB	Yangon Electricity Supply Board

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 pond	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 square kilometer	0.386 sq.mile

CURRENCY EQUIVALENTS (AS AT JUNE 2014)

1 US$	=	101.68 Japanese Yen (TTB)
1 Kyat	=	0.106 Yen
1 US$	=	959 Myanmar Kyats
1 lakh	=	100,000 Kyats

MYANMAR FINANCIAL YEAR

April 1 to March 31

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PART I

REHABILITATION OF IRRIGATION SYSTEMS

CHAPTER 1 RATIONAL AND GOAL OF THE PROJECT

Submitted herewith is the final report prepared based on the Minutes of Discussions (MD) on 'the Project for Rehabilitation of Irrigation System (the Project)' signed on August 1, 2012 by and between Japan International Cooperation Agency (JICA) and the Irrigation Department (ID), Ministry of Agriculture and Irrigation (MOAI). A study team organized by JICA headquarters commenced a series of surveys for the Project from 18th March 2013, and this report presents all those survey results together with the plan including rehabilitation components, work volume, cost estimation, etc. for the Project.

1.1 Rationale of the Project

The agriculture sector in Myanmar contributes 28%[1] share of gross domestic product (GDP) in fiscal year 2010-2011; 17.5%[2] of total export earnings; and employs 61.2%[3] of the whole labor force in Myanmar. The present government inaugurated in March 2011 emphasizes importance of the agriculture sector for the purpose of poverty reduction as well as food security for the Country. Circumstances for agricultural activities differ by location due to wide range of latitude and rainfall amount from south to north.

As Myanmar is characterized with wide range of rainfall intensity in her area, the lowest one is less than 1,000 mm per annum in the Central Dry Zone (CDZ) while the highest one reaches more than 5,000 mm per annum at Taninthari Region. The CDZ is composed of three Regions such as Magway, Mandalay, and Sagaing. Parts of these Regions suffer from shortage of water in dry season while rainfall is uncertain and irregular in rainy season. The Survey area is located at just southern peripheral area of the CDZ, whereby the area cannot enjoy much rainfall even during its rainy season.

The project area is located in two districts as Pyay and Thayarwaddy. Irrigation systems in Pyay and Thayarwaddy districts were firstly planned in "Irrawaddy Development Master Plan, 1980", and its project implementation was commenced from 1980. The area is located at a western part of Bago Yoma (mountain range) and rainfall in the area is rather limited because humid air coming from southern side generates rain just at Bago Yoma, not at the area around. This is one of the major reasons why the irrigation projects were planned and implemented in the area and such irrigation projects have been playing important roles in agriculture sector to secure stable farming.

After commencement of the operation for the irrigation projects, Irrigation Department (ID) under Ministry of Agriculture and Irrigation (MOAI) has carried out maintenance and rehabilitation works for those projects; however, due to shortage of budget allocation under the former government, irrigation systems of such projects have seriously been deteriorated year after year. Consequently, Irrigation Department can now 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 such situation, Irrigation Department has requested JICA to survey and formulate necessary rehabilitation plans for the projects put back to the originally planned functional level, possibly bringing about ODA loan for the implementation of rehabilitation works as early as possible. Responding to this request, Japanese Government sent a preliminary survey team in June/August 2012, and concluded the implementation of this Survey as stipulated in the MD signed on August 1, 2012. Then, JICA organized a team of experts in charge of the formulation of rehabilitation plan, and the Team had arrived in Myanmar on March 18, 2013 for the execution of necessary surveys.

[1] Source: Statistical Year Book 2011
[2] Source: Myanmar Agriculture in Brief 2011
[3] Source: Myanmar Agriculture in Brief 2011

1.2 Objectives of the Project and the Survey

Objective of the Project stated in the MD is to increase agriculture production through recovery of the area of the irrigated land by rehabilitating the irrigation systems, whereby contributing to food security and livelihood improvement of the people concerned. Towards the project objective achieved, this Survey aims at formulating a rehabilitation plan and also examining the feasibility based upon the project cost and benefit. The Survey starts with status assessment of the target irrigation schemes for rehabilitation, and then conducts identification of works for rehabilitation, cost estimation, benefit estimation, environmental examination, and also project economic analysis, etc.

In addition, farmland consolidation is also one of the project components to be examined under the Survey. Farmland consolidation is carried out together with the establishment of irrigation and drainage network including farm roads. This farmland consolidation facilitates, aside from increasing harvest thanks to the irrigation and drainage network established, farm mechanization given leveled and consolidated farmland composed of number of rectangular shaped plots. A pilot project, as a model case, is planned to implement in Zabuthiri township of Nay Pyi Taw district, based on which its idea of farmland consolidation could be applied in those 4 targeted irrigation schemes.

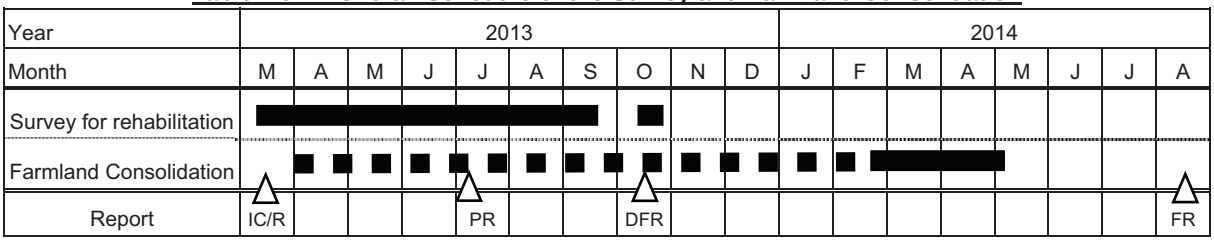
1.3 Scope and Schedule of the Survey

To attain the survey objectives aforementioned, this Survey conducts following activities;

1) Survey for the rehabilitation of main canals,
2) Survey for the repairing of access roads to dams,
3) Survey for repairing inspection roads along the main canals and farm roads running along with distribution canals,
4) Survey for repairing and reconstruction of check gates, secondary gates, and weirs,
5) Survey for the rehabilitation of secondary canals,
6) Identification of works for rehabilitation based on above activities, and cost estimation related,
7) Estimation of project benefits and accordingly economic analysis,
8) Environmental and social examination/ consideration for the rehabilitation projects,
9) Implementation arrangement demarcated by ODA loan and the Government own budget, and
10) Other necessary and relating surveys including pilot farm establishment for land consolidation.

The Survey is completed within 10 months from March to December 2013. On the way, a progress report was prepared and submitted to ID in July 2013, and the draft final report submitted in October 2013. Model farm establishment for land consolidation in Nay Pyi Taw City is carried out over almost one year, completed by mid 2014 taking into account off-farm period, during which the consolidation work can be carried out. Note that this time-frame for the land consolidation work was agreed between JICA and ID at the Inception Report explanation meeting held on April 9, 2013. Following are the overall work schedule of the Survey and the farmland consolidation in Nay Pyi Taw;

Table 1.3.1 Overall Schedule of the Survey and Farmland Consolidation



Where; IC/R: Inception Report, PR: Progress Report, DFR: Draft FR, FR: Final Reportl

1.4 The Survey Area

The target irrigation systems are; North Nawin Irrigation System, South Nawin Irrigation System, Wegyi Irrigation System, and Taung Nyo Irrigation System. The first 3 irrigation systems are located within 4 townships of Pyay, Paukkhong, Thekone and Paungde of Pyay district while the last one, Taung Nyo irrigation system, in Zeekone and Nattalin townships of Thayarwaddy district. Following table shows general feature of the Survey area in comparison with other regions and states in Myanmar;

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 (%)
6 TSs of Survey Area	6,014	974,691	162	2,622,972	147,497	5.6%
Bago Region	39,387	6,008,000	153	6,151,251	371,167	6.0%
Sagaing Region	94,582	6,541,000	69	9,557,734	1,089,503	11.4%
Taninthary Region	43,328	1,714,000	40	1,443,783	17,285	1.2%
Magway Region	44,801	5,623,000	126	8,070,036	468,185	5.8%
Mandalay Region	37,008	8,422,000	228	5,589,303	631,372	11.3%
Ayeyarwaddy 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%
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%
Shan State	155,734	5,660,000	36	4,194,450	524,671	12.5%
Whole Country	676,288	59,780,000	88	52,006,110	5,226,457	10.0%

Data Source: Statistic Year Book 2011, Pyay District Administration Office, Thayawardy Administration Office

Population density of townships for the Survey area shows nearly the same density as Bago region, which is about two times of the whole country's average. Irrigation rate of the townships shows as low as only 5.6% and Bago region does almost same ratio, which is 6.0%. On the other hand, whole country's average irrigation ratio arrives at 10%, from which it is found that the townships where the target irrigation schemes are located and Bago region by large are rather behind in terms of irrigation availability as compared to that of the national average.

1.5 Implementation Arrangement of the Survey

For the implementation of the Project, JICA has organized a JICA Survey Team, which is composed mainly of SANYU Consultants Inc. The counterpart organization of the Survey, the Irrigation Department (ID) under the MOAI, arranges counterpart personnel and together conducts the Survey with the JICA Survey Team. Figure 1.5.1 below shows the implementation arrangement of the Survey.

Given the implementation arrangement, a comprehensive approach is employed for the Survey such as primary and secondary data and information collection, review of plans and designs available, field surveys, and planning and analysis for formulating the rehabilitation components of the 4 irrigation systems. The data and information collection are conducted, aside from relevant offices, at different villages within the irrigation area which are set into three zones along the main canals; upstream, midstream, and downstream.

Following the data and information collection, data processing and project formulation are conducted to establish rehabilitation plan for the 4 irrigation systems. The project formulation includes planning, design, cost estimation, environmental and social impact consideration, and feasibility examination for the 4 irrigation systems. Arrangements for these surveys are summarized in Table 1.5.1;

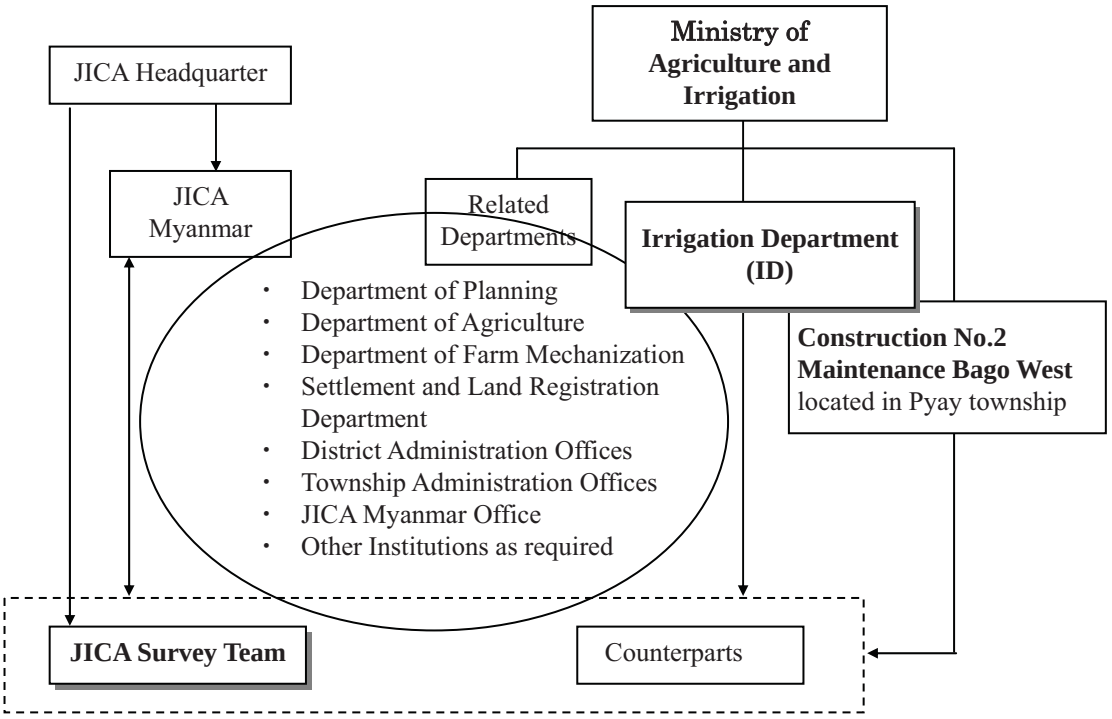


Figure 1.5.1 Implementation Arrangement

Table 1.5.1 Implementation Arrangement for the Survey

Items of Survey	Data and Information	Source and Data / Information
Irrigations Systems & Diagrams	Existing Situation, Route	ID, DOA, TS Office, District Office, Field Survey
Rehabilitation Plan	Present and Past Activities	ID, Field Survey
Cropping Pattern	Farming Activities, Future Plans	DOA, ID, District and TS Offices, Field Survey
Price and Cost	Unit Price, Work Plan	ID, Construction BOQ Standard, DOA
Farmland Consolidation	Farmland Registration, Design	SLRD, ID, TS and Village Offices
Electrification	Existing Condition, Future Plan	MOEP
Environmental and Social Consideration	Reserved Area, Relocation, Land Acquisition, Compensation	Ministry of Forest, ID, SLRD, DAP

Source: JICA Survey Team (2013)

This Survey also includes longitudinal/sectional and topographic surveys for the canal systems in order to examine the current condition of canals for rehabilitation. During irrigation period from January to May, the site surveys cannot be conducted and therefore the surveys are commenced from the beginning of June 2013 once after the irrigation has been completed in the year upon the onset of rainy season.

1.6 Irrigation Development/Rehabilitation Project in the National Context

Myanmar government once aimed at achieving 25% of irrigation development rate by year 2000; however, it is still a long way. Actual irrigation rate in fiscal year 2012/13 at national level marks at last 10%. Since Myanmar is a north-south long country, necessity of irrigation has to be considered by area. In fact, annual rainfall in Mon state exceeds over 5,000 mm while there are places where there is only 1,000 mm or even less of rainfall represented by Central Dry Zone. Actual sown areas, composed of irrigated area and not-irrigated area in fiscal year 2012/13, are summarized by region/state with the survey area (6 townships) in the following Figure 1.6.1;

Bago region, in which the target irrigation systems area located, stays at the 4th largest sown area showing as much as 6.2 million acres (2.5 million ha) in 2012/13 after Sagaing region, Magway region,

and Ayeyarwaddy region. Ayeyarwaddy region shows the highest irrigation rate of as much as 18.9%[4] while the lowest one appears with 1.2% at Taninthari region. The irrigation ratios show one of the development features of agricultural infrastructure by region/state; and also from a different view point it shows the necessity and priority for irrigation in the national context.

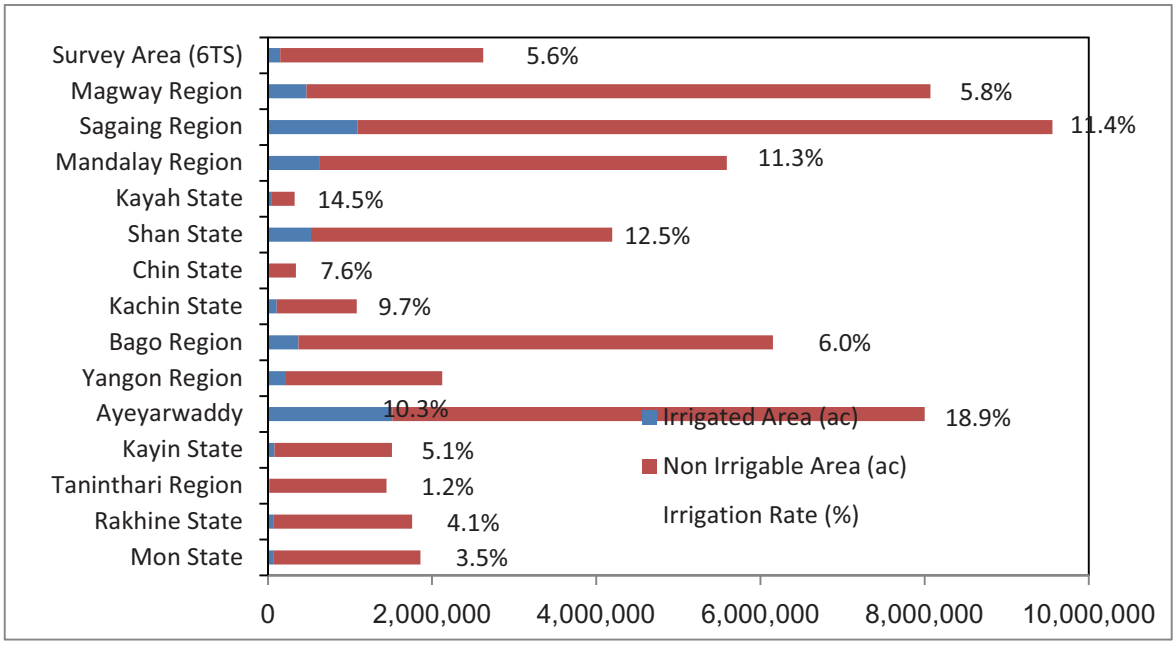


Figure 1.6.1 Sown Area (Irrigated Area + not Irrigated Area) in 2012-13

Source: SLRD, arranged by the Survey Team (2013)

Figure 1.6.2 rearranges irrigation rate by region and state in 2012/13 in comparison with annual rainfall therein. It was already stated that Taninthari region shows the lowest irrigation rate of 1.2% among those regions/ states since this area has as much annual rainfall as average 4,857 mm. A common understanding tells us that drainage facilities are required rather than irrigation system there. By employing the same viewpoint, such 4 areas as Taninthari region, Mon state, Rakhine state and Kayin state are classified into "High Rainfall Group"; where irrigation demand would be less than those of other groups.

Ayeyarwaddy region and Yangon region can receive around 3,000 mm annual rainfall, and therefore the areas can be classified into "Medium Rainfall Group". Next one is a transitional group between serious irrigation shortage areas and the medium rainfall group. Some of them have medium-low rainfall with low irrigation rate and others have medium irrigation rate with low rainfall. It may indicate hardship condition for farming activity, and further classification by district level will contribute to providing prioritization within this group for effective budget allocation on irrigation development.

The most serious farming condition exists on the last one "Low Rainfall and Low Irrigation Rate Group", which includes Magway region and this Survey area. The areas of this group receive rainfall characterized with erratic duration of falling and wide special deviation. Such circumstances work as a trigger of drought leading to crop failure or, instead, a trigger of flood sometimes in mid rainy season with casual intense showers. Thus, complete water supply system shall be installed in such areas equipped with not only irrigation system but also drainage facilities. Careful and thoughtful attention

[4] The irrigation ratio does not demarcate the irrigation method. It means that the ratio includes both gravity irrigation and pump irrigation. Therefore, the irrigation ratio of the Ayeyarwaddy region must include much pump irrigation systems since the topography of the Ayeyarwaddy region is very flat making gravity irrigation difficult. On the other hand, there is a great deal of water sources (rivers) in the region whereby it is easy to install pump irrigation systems from small-scale to even big-scale.

shall therefore be paid to this group and the first priority for irrigation development should be given to this group within the Country.

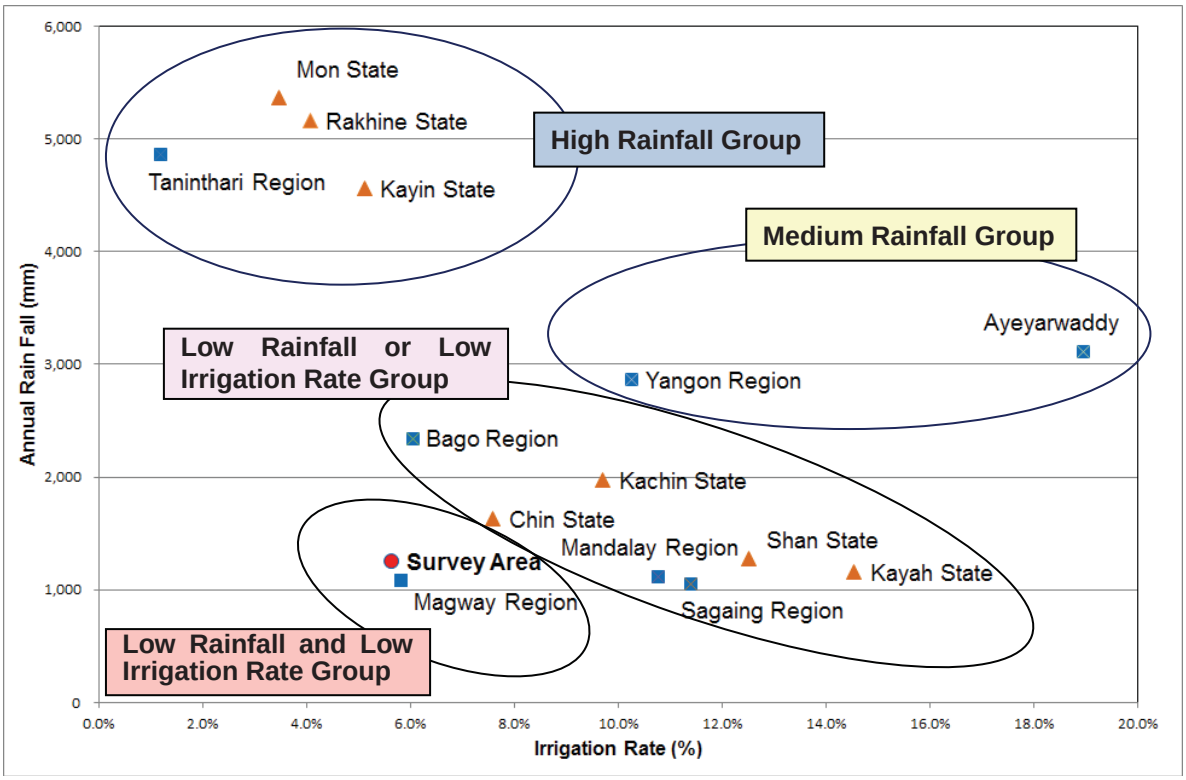


Figure 1.6.2 Irrigation Rate and Annual Rainfall by Region/State in 2012-13

Source: SLRD, Statistic Year Book 2011, arranged by the Survey Team (2013)

As aforementioned, irrigation development in and around the Survey area was firstly planned under the "Irrawaddy Development Master Plan, 1980". The master plan had identified potential irrigation development schemes as shown in Figure 1.6.3, and all the identified ones have been already developed to date. In fact, all the irrigation projects planned in the eastern side of the Ayeyawaddy river shown in the figure have been all development and even the ones located in the western side of the river have been developed except for the projects in the downstream area where dense forests still prevail. It means that to raise the irrigation ratio in the Survey area where low rainfall prevails while low irrigation rate has persisted, expansion or otherwise rehabilitation of existing irrigation systems should be given priority.

There are reports that irrigation performance of the target 4 irrigation systems has hardly been at the level as to

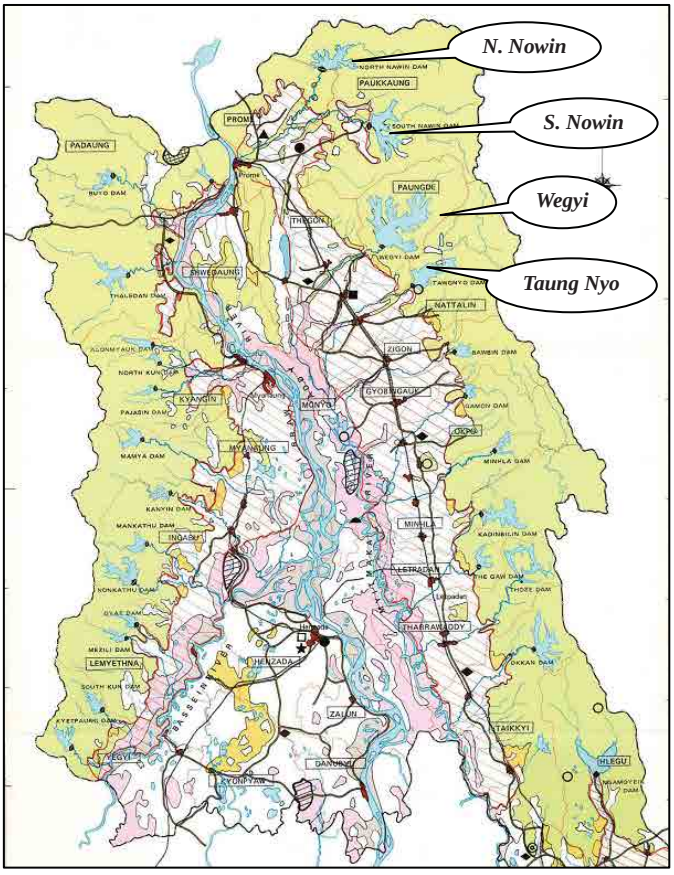


Figure 1.6.3 Irrigation (Dam) Projects planned under Irrawaddy Development Master Plan (1980)

planned or designed due mainly to dilapidated facilities, sedimentation along the canal reducing the flow sectional area, collapse of canal slopes, etc. In this regard, rehabilitation for the target 4 irrigation systems should be given the highest priority within the areas of low rainfall and low irrigation ratio and also in the national context of irrigation development by large.

In addition to what was discussed above, rehabilitation if due required is in most cases can provide high cost performance than new construction project (refer to Table 1.6.1). Common procedure of new irrigation system construction starts from weir/dam construction, followed by main canal construction, distribution canal construction, and minor canal construction, etc. As a result, construction of a new irrigation system takes always about 3-5 years or even more. After completion of all the facilities, operation of irrigation system can start at last while rehabilitation project can still avail of irrigation during every off-construction time.

Table 1.6.1 Comparison and Difference Irrigation Systems between New Construction and Rehabilitation

Type of Construction	Construction Period	Tertiary (on-farm) Canal Adjustment[5]	Irrigation System Operation
New Construction	3-5 yeas	It should be adjusted after operation	After completion of all facilities
Rehabilitation	2-3 years	It has already been adjusted	Irrigation season during off-construction time

Source: Irrigation Department, the Survey Team (2013)

Rehabilitation should therefore be one of the important activities in keeping irrigation systems fully operational as planned. Then, as aforementioned, cost performance in rehabilitation is usually quite high and it also can accrue the benefit within short period of time upon completion of the works or partial benefit can be generated even during the rehabilitation period. Thus, if there is a malfunctioning irrigation system due to aged structures, rehabilitation of such systems should be given a high priority in the sector of irrigation development.

1.7 Potential of Irrigated Agricultural Products by the Project

Crops cultivated in the target 4 irrigation systems are; monsoon paddy being the major commodity, black gram as winter crop, and summer paddy where irrigation water is much available. In fact, during monsoon season, there is no alternative other than cultivating paddy taking into account the amount of rainfall, soil condition much incorporating clay and silt, and also the fact of rice being the staple food for Myanmar population. For the winter crop, there had been cotton and in some areas sesames once cultivated. However, thanks to the surge demand from the neighbor India, not only the target irrigation schemes but also a great deal of farmlands over the Country started cultivating pulses.

Given the soil and water condition, black gram is now widely cultivated in the target area as the major winter crop. In fact, cotton once cultivated as major winter crop had been already wiped off due to dormant demand in the world market. Sesame is still cultivated in such areas where irrigation water does hardly reach. In any case, therefore, as far as irrigation water is available, paddy and black gram are and will be the major irrigated agricultural product in the target irrigation systems. Following discussions center on the future prospective of these 2 major crops.

1.7.1 Potential of Paddy Production

Rice is the staple food of Myanmar population. To examine the production potential for paddy from a view point of demand and supply, it is firstly tried to compare between internal consumption versus surplus, leading to the export potential. Figure 1.7.1 shows the paddy production trend since 1989/90 to 2009/10 by region/state, composed of both monsoon and summer paddies. The overall production has been increasing over years, and since 2006/07 the production has stayed over 30 million tons.

[5] Beneficiary farmers have to adjust their tertiary canals for water fetching from secondary (distribution) canals because tertiary canal construction is responsible for beneficiary farmers in Myanmar.

Bago region where the target 4 irrigation systems are located is ranked at 2nd position in terms of production quantity after Ayeyarwady region.

By applying 0.6 conversion factor into the weight of the paddy production, the paddy production can be the equivalent milled white rice in weight. Again by dividing the milled white rice quantity by the number of population, we can see the degree of self-sufficiency or the potential of rice export.

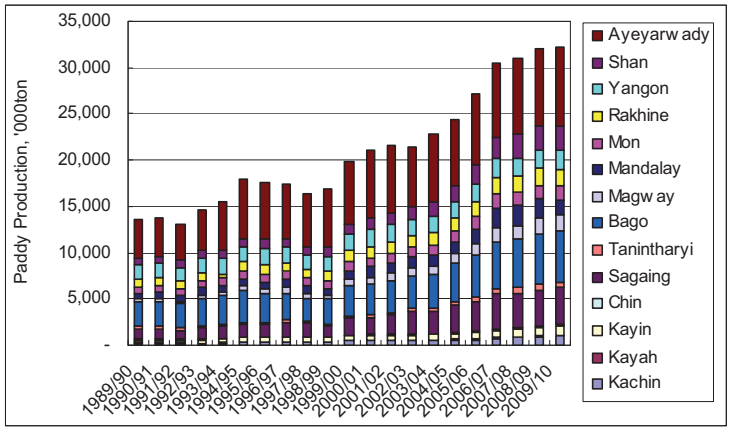


Figure 1.7.1 Paddy Production Trend by Region/State
Source: Statistical Yearbook 2011, 2008, 2004

Figure 1.7.2 depicts the calculation result where rice production per capita of the nation has been over 200 kg per annum and since 2006/07 the production started marking over 300 kg[6]. In general, a typical Myanmar population consumes approximately 150 kg[7] of milled white rice per annum. It means that there should be already much surplus of rice beyond what the nation can consume. Therefore, paddy to be produced more in the to-be-rehabilitated irrigation systems has to be export oriented.

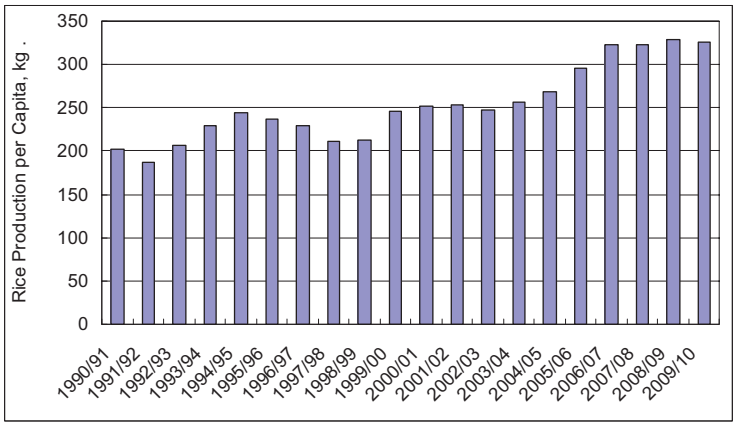


Figure 1.7.2 Converted Rice Production Trend per Capita
Source: Referred to Statistical Yearbook 2011, 2008, 2004

Figure 1.7.3 summarizes the rice in 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 (refer to the right Y-axis). As is well illustrated, the traded amount has been continuously increased, and reaching over 30 million tons for the recent years. By county, Thailand comes first as the biggest rice export country, followed by Vietnam, USA, and India where there has been a huge fluctuation due to unstable rainfall. Thailand in recent years exports approximately 10 million tons of while rice (5% broken) to the world market, followed by Vietnam with about 6 million tons export. The continuous increase trend over years provides an opportunity to Myanmar of exporting rice to the world market.

[6] There may be a possibility of having inflated the production of paddy especially during the former military regime because there had been a must that the planned paddy production should have been achieved during the era. In fact, Figure 1.7.2 shows almost twice as much as what the nation is supposed to consume. It means about half of the total production of 33 million ton of paddy could be a surplus which can be exported. In fact, the exported volume of milled white rice was 707,000 ton (2011/12), 536,000 ton (2010/11), 818,000 ton (2009/10), 666,000 ton (2008/09), 358,000 ton (2007/08), which can be converted to 1,179,000, 893,000, 1,363,000, 1,110,000, 597,000 tons in terms of paddy weight respectively in years. The actually exported volumes of rice are too little judging from the surplus estimated based on what the population can consume. Therefore, there may be a possibility for the paddy production to have been inflated than what has been actually produced. However, in any case, there has not been any report that the Myanmar is in shortage of staple food, whereby at least it can be concluded that the paddy production now satisfies what the nation is supposed to consume and there could be some surplus as is exported.

[7] Statistical Yearbook 2008, Household Consumption.

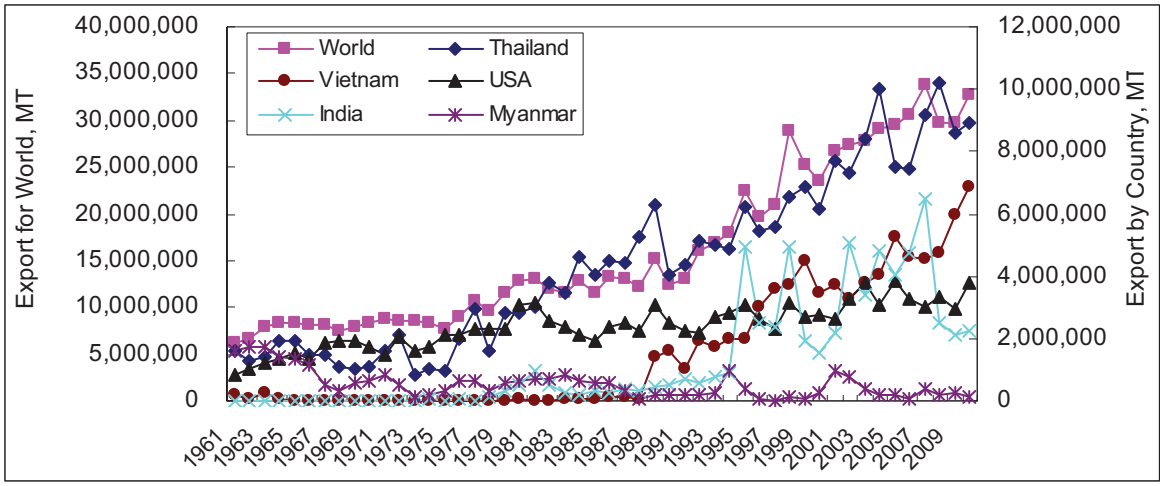


Figure 1.7.3 Long Term Trend of While Milled Rice Export by World and by Country

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

To export the rice to the world market, price should be a key factor in the competitiveness in addition to the quality. Figure 1.7.4 compares the Myanmar FOB price of rice to that of Thailand FOB rice price for the months of year 2009 to 2013. It is shown that the price of Thailand rice has been around US$ 500 per ton while that of Myanmar rice been approximately US$ 350 per ton. It means that the Myanmar rice is cheaper than that of Thailand by about as much as 30%.

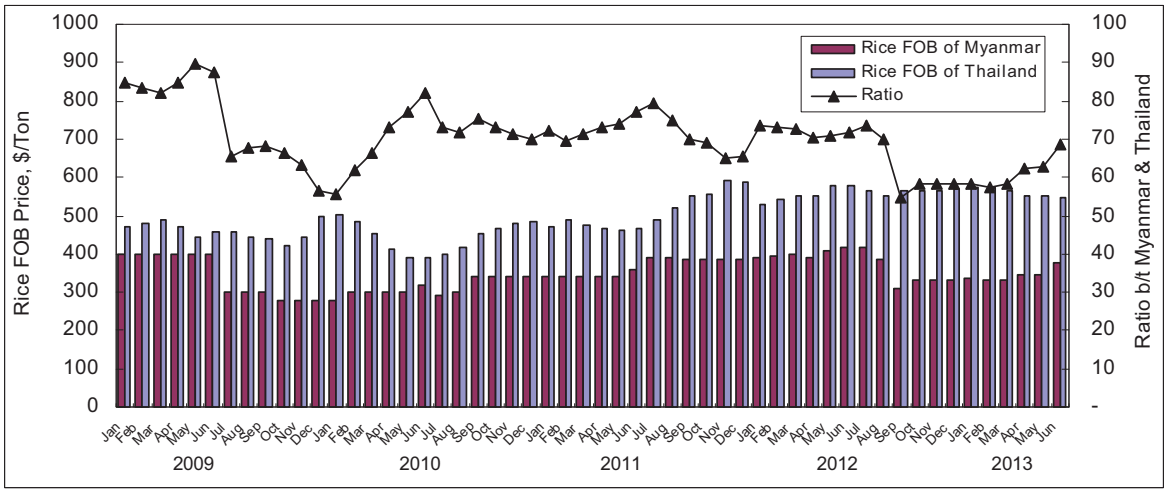


Figure 1.7.4 Comparison of Myanmar Export Rice and Thailand Export Rice (FOB price)

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. However, it is also true, taking into account the GNI per capita as well as the production cost of paddy in Myanmar, that the paddy in Myanmar can be produced at less cost comparing to Thailand.

In above regard, it can be said that the Myanmar has a competitive price power in exporting rice to the world market. Provided that the quality of Myanmar rice were improved, the Country could have enough competitive power in exporting the rice to the world market. Therefore, it can be concluded that the paddy to be produced more in the target irrigation systems will not end up in just surplus but contribute to raising the farmers income.

1.7.2 Potential of Black Gram Production

Paddy, as aforementioned, is the major crop during rainy season while black gram is the one during

the winter season in the target 4 irrigation systems. In Myanmar, in fact, pulse production is not as traditional as paddy. Before 1990, the production of pulses had been very little as shown in Figure 1.7.5 as in the case of black gram by region/state. 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 production of black gram has been skyrocketing reaching over 1.4 million ton for the whole County (see Figure 1.7.5). Bago region has been ranked at 2nd in its production quantity after Ayeyarwady region.

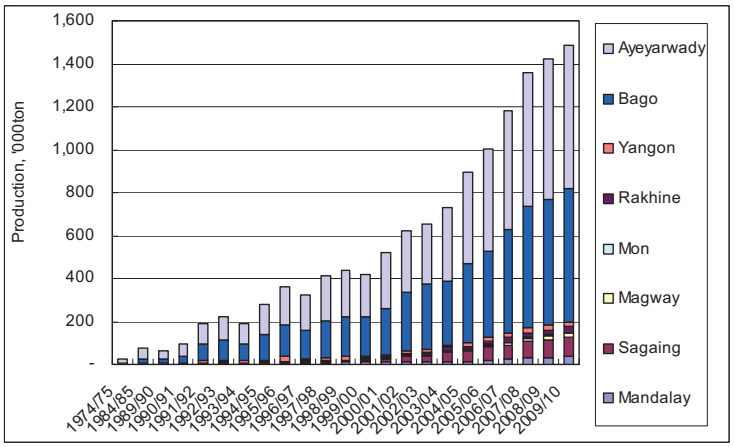


Figure 1.7.5 Black Gram Production Trend by Region/State
Source: Statistical Yearbook 2011, 2008, 2004

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 1.7.6. 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.

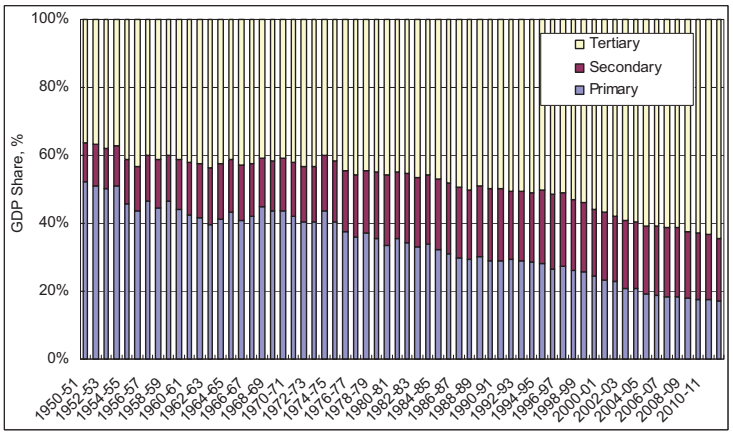


Figure 1.7.6 Change of GDP Share by Sector in India
Source: Central Statistics Office (CSO), India

Corresponding to the reduction of the primary sector's share in the national GDP, India started importing pulses from late 1980s. Figure 1.7.7 shows the world export and import, and India's import for pulses[8]. It is known that India's import for pulses shares approximately 30% to as much as 50% of what is traded in the world pulse trade market. Depending upon the weather condition (rainfall amount) in India, pulse production in the country has been 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 1.7.8 shows the total export for whole pulses and that of black gram while Figure 1.7.9 shows the export only of black gram to India and to other countries. Though export quantity has fluctuated by year, there is a tendency of increasing over years. Especially, the export of black gram to India shows almost continuous increase trend. From this examination as well as from the India's GDP position, it can be concluded that the black gram to be produced more in the target irrigation systems will not end up in just surplus but contribute to raising the farmers income by exporting to India.

[8] The volume of world export does not correspond to that of world import. The quantity of export is only around half of the world export. The reason may be that the data for export is not be complete for all the countries while the data for import may be almost complete, though it is not sure (the data was subtracted from FAOSTAT).

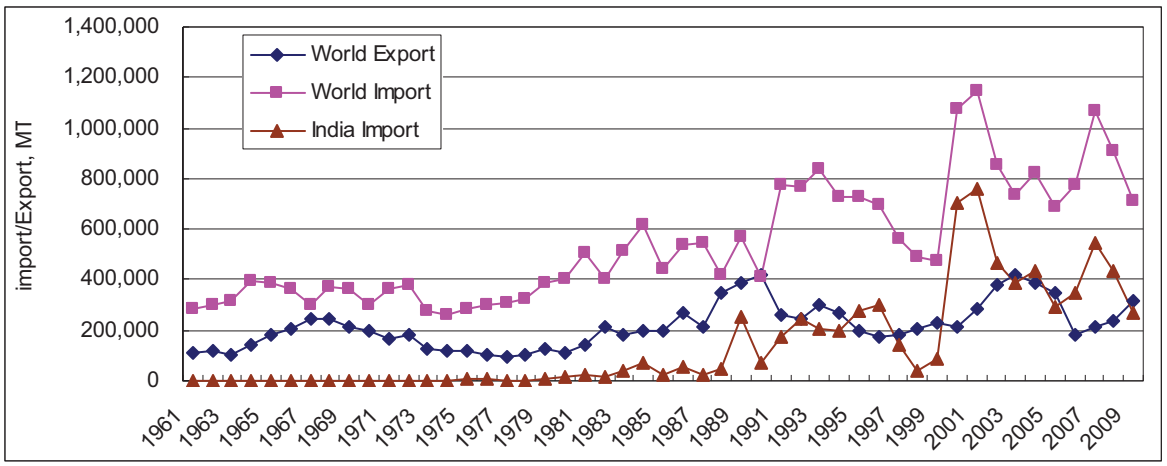


Figure 1.7.7 Long Term Trend of Pulses Export/Import by World and by India

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

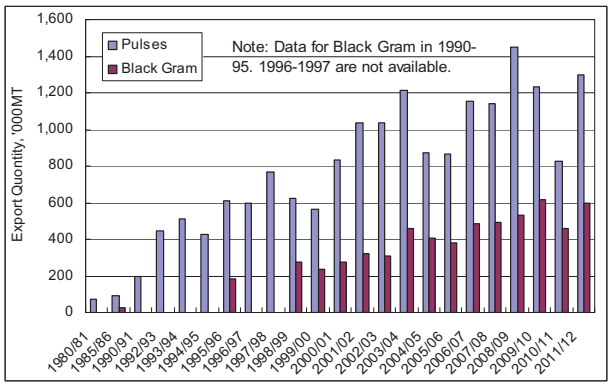


Figure 1.7.8 Export of Pulses/Black Gram from Myanmar

Source: Statistical yearbook, 2011

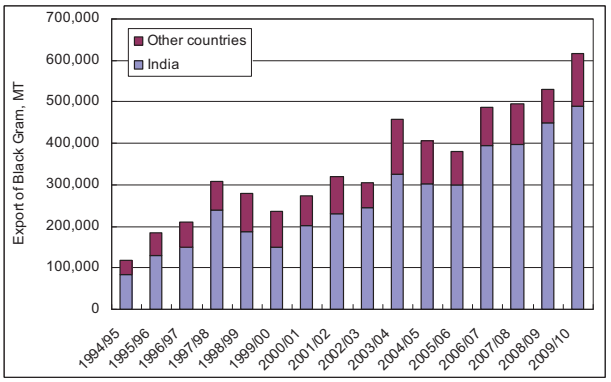


Figure 1.7.9 Export of Black Gram from Myanmar

Source: Agriculture Statistics, 2010

CHAPTER 2 THE SURVEY AREA

Chapter 2 presents status of the Survey area from different aspects and viewpoints. At first, the spatial setting of the Survey area is described together with demography, followed by economy and meteorology. Salient features of the targeted irrigation systems are also explained in this chapter with agriculture condition, household economy, and electrification status. At the end of this chapter, agricultural extension activities and also relevant donor activities in and around the Survey area are briefed.

2.1 Spatial Settings, Demography, Economy and Positioning

2.1.1 Spatial Settings

The Survey area, composed of 4 irrigation systems, is located in an eastern area of Ayeyarwaddy river, just western side plain of Bago Yoma (mountain range). These irrigation systems are lined up from north to south, i.e., North Nawin irrigation system, South Nawin irrigation system, Wegyi irrigation system, and Taung Nyo irrigation system, all of which are located at a northwestern part of Bago region. Those systems spread over two districts, i.e. North Nawin, South Nawin, and Wegyi irrigation systems are under Pyay district while Taung Nyo irrigation system falls under Thayarwaddy district.

The Survey area lies in north latitude from 18.2 ^{o} to 19.2 ^{o} and east longitude from 15.3^{o} to 96.3^{o}. Above mean sea level of the area ranges from 45m to 60m, forming so-called Pyay plain. Pyay plain is the beginning place of alluvial fan which continues further down to Ayeyarwaddy delta. Since Ayeyarwaddy delta was a swampy and flooding place before its development, Pyay was accordingly a calm place free from flood risks. The first dynasty in Myanmar was established in Pyay by Pyu ethnic people around AD the 4th century. Since then, this area had started developing.

Afterwards, favorable navigation condition along the Ayeyarwaddy river developed this Pyay area as a relay point of trading by Bagan dynasty, which is the second dynasty of Myanmar. This geographical advantage had made this area developed as a commodity repository point between upper Myanmar and Lower Myanmar. In fact, the first railway in Myanmar was constructed in 1877 between Yangon and Pyay by the British colonial government. This railway is still operational and being operated by Railway Department under Ministry of Transportation.

It takes about 8 hours by express-train from Yangon to Pyay departing Yangon at 13: 00 every day. Car driving is faster than the train trip; it takes about 4-6 hours. The Pyay road, upgraded with asphalt pavement in 1993, used to be the best road in Myanmar. A bridge over the Ayeyarwaddy river was also completed in 1998 starting at Pyay town. However, since then the geographic advantage of the trading relay point has been decreasing because developed logistics-route has on the other hand facilitated further distant transportation from a place to others. Magway, for example, located at about 240km to north direction from Pyay has currently favorable condition for upland crop trading.

2.1.2 Area, Population and Beneficiaries

North Nawin Irrigation System is located at the north edge of the Survey area with about 310 km distance from Yangon. Contrary, the southern edge of the Survey area is at Taung Nyo Irrigation System and it has about 200 km distance from Yangon. Beneficiary area of the 4 irrigation systems spreads within this 110 km distance of northwest – southeast direction. The irrigable areas for the 4 irrigation systems given by SLRD and ID are shown in upper rows of Table 2.1.1. The net irrigable area ranges from 40,428 acre (16,361 ha) to 72,709 acre (29,424 ha) with the total area of 216,287 acre (87,527 ha). Note that the original downstream area of North Nawin, 23,732 acre, is now supplied irrigation water by South Nawin system, whereby the area is counted as part of South Nawin.

Beneficiary number of farmers relative to the irrigation systems is unfortunately not available.

Therefore, to estimate the beneficiary numbers, an average farmland area estimated through a household questionnaire survey conducted by JICA Survey team is employed. The survey identified an average farmland area per farmer ranging from 8.01 acre to 12.72 acre by irrigation system, with an overall average farmland of 9.91 acre (4.01 ha). Applying this average farmland area to the net irrigable area by irrigation system, the estimated beneficiary households are between 5,047 and 8,781 by system, totaling to 23,394 households equivalent to 116,738 population.

Table 2.1.1 Estimated Irrigable Area and Beneficiaries in Four Irrigation Systems

Items	N. Nawin	S. Nawin		Wegyi	T. Nyo	Total
Net Irrigable Area (acre) 1/	53,168.54	72,708.66		40,428.42	49,981.31	216,286.93
Upstream Area (acre)	27,679.15	26,886.33	(1,440.30)	19,455.36	16,611.77	90,632.61
Midstream Area (acre)	25,489.39	23,949.60	(6,577.00)	10,096.25	18,988.74	78,523.98
Downstream Area (acre)	0.00	21,872.73	(15,715.00)	10,876.81	14,380.80	47,130.34
Original N. Nawin DS Area (acre)	(23,732.30)	-	(23,732.30)	-	-	-
Net Irrigable Area (ha)	21,516.24	29,423.74		16,360.57	20,226.44	87,526.99
Average Farmland (acre) per FHH 2/	12.72	8.28		8.01	9.28	9.91
Average Farmland (ha) per FHH 2/	5.15	3.35		3.24	3.76	4.01
Estimated No. of Beneficiary FHHs	4,180	8,781		5,047	5,386	23,394
Estimated Beneficiary Population, 3/	20,858	43,818		25,186	26,876	116,738

Source: 1/ Irrigation Department, 2/ Household Questionnaire Survey conducted by JICA Survey Team covering 225 sample households in 2013, 3/ Family member is estimated at 4.99 according the Household Questionnaire Survey. Note: Downstream area of North Nawin Irrigation System receives irrigation water from South Nawin Irrigation System, for the downstream area is counted as part of South Nawin (see the numbers in brackets).

2.1.3 Economy and Employment

Economy in 6 townships covering the 4 irrigation systems is mainly composed of farming, transportation, trading, industry, and fishery. Figure 2.1.1 shows GDP in 2012-13 fiscal year for the 6 townships. Agriculture sector shares 24.8% of the GDP, showing the biggest share. Transportation sector comes at the second by 20.5% of the GDP, followed by trading sector with 18% share of the GDP. High shares of transportation and trading sectors are a typical character in this area, being still an important relay point of commodities. Industry sector shares 17.7% of GDP, to which agriculture sector supplies raw materials such as sugarcane for sugar production, groundnut and sesame for edible oil production, etc.

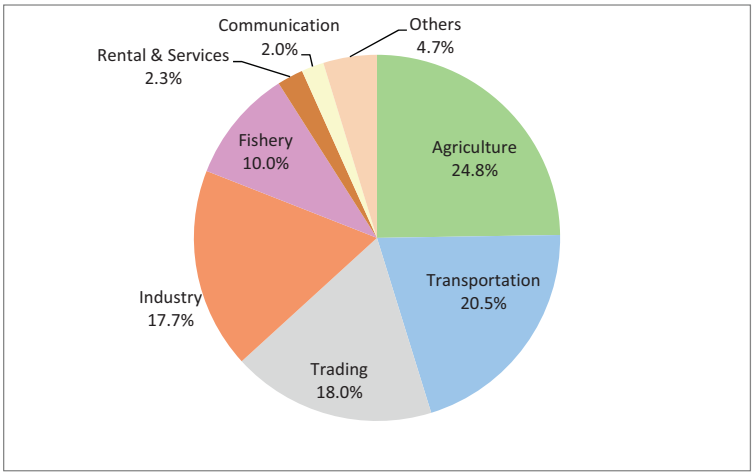


Figure 2.1.1 GDP Share in 6 Townships (2012-13)

Source: General Administration Office (Pyay, Thayarwaddy)

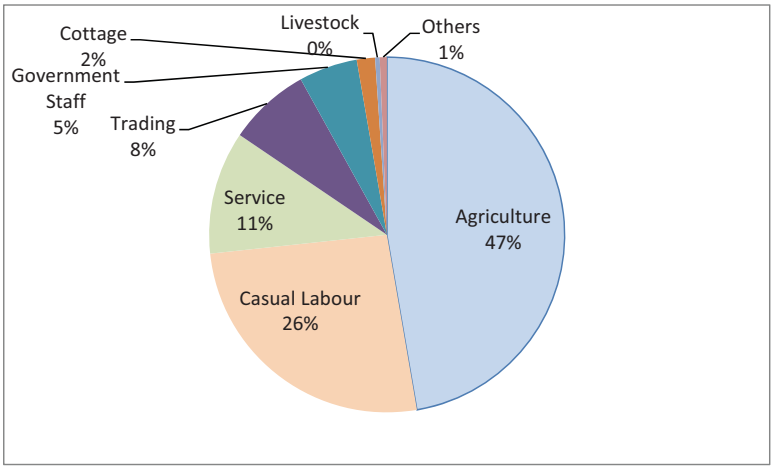


Figure 2.1.2 Workforce Distribution over Age-18 in 6 Townships

Source: Pyay and Thayarwaddy Township Administration Office

As for employment, the agriculture sector for the 6 townships provides as much as 47% of workforce opportunity. The agriculture sector also offers indirect job opportunities

to the peoples in the townships in form of "casual labor," sharing as much as 26% of total workforce. According to the administration offices of Pyay and Thayarwaddy districts, "casual labor" mainly does farm related works such as transplanting of products, weeding, and harvesting. "Casual labor" also supplies workforce to the transportation sector such as porter-works at river-ports and markets according to the aforementioned administration offices. Service sector and trading sector provide job opportunities with 11% and 8%.

2.2 Meteorology and Hydrology

2.2.1 Climate: Temperature and Rainfall

Rainfall in the Survey area is available at each of the 4 dam sites while temperature is only available at Pyay meteorological station. Since the Survey area is located at a southern vicinity of the CDZ, the annual rainfall is not enough to support monsoon paddy, ranging from 1,000 to 1,400 mm only per annum. Average annual temperature recorded at Pyay station comes to 28.1 C°; January shows the lowest mean temperature of 24.7 C° while the highest shows up in April with 31.8 C°. Rainfall by dam location and also the temperature recorded at Pyay station are illustrated in Figure 2.2.1;

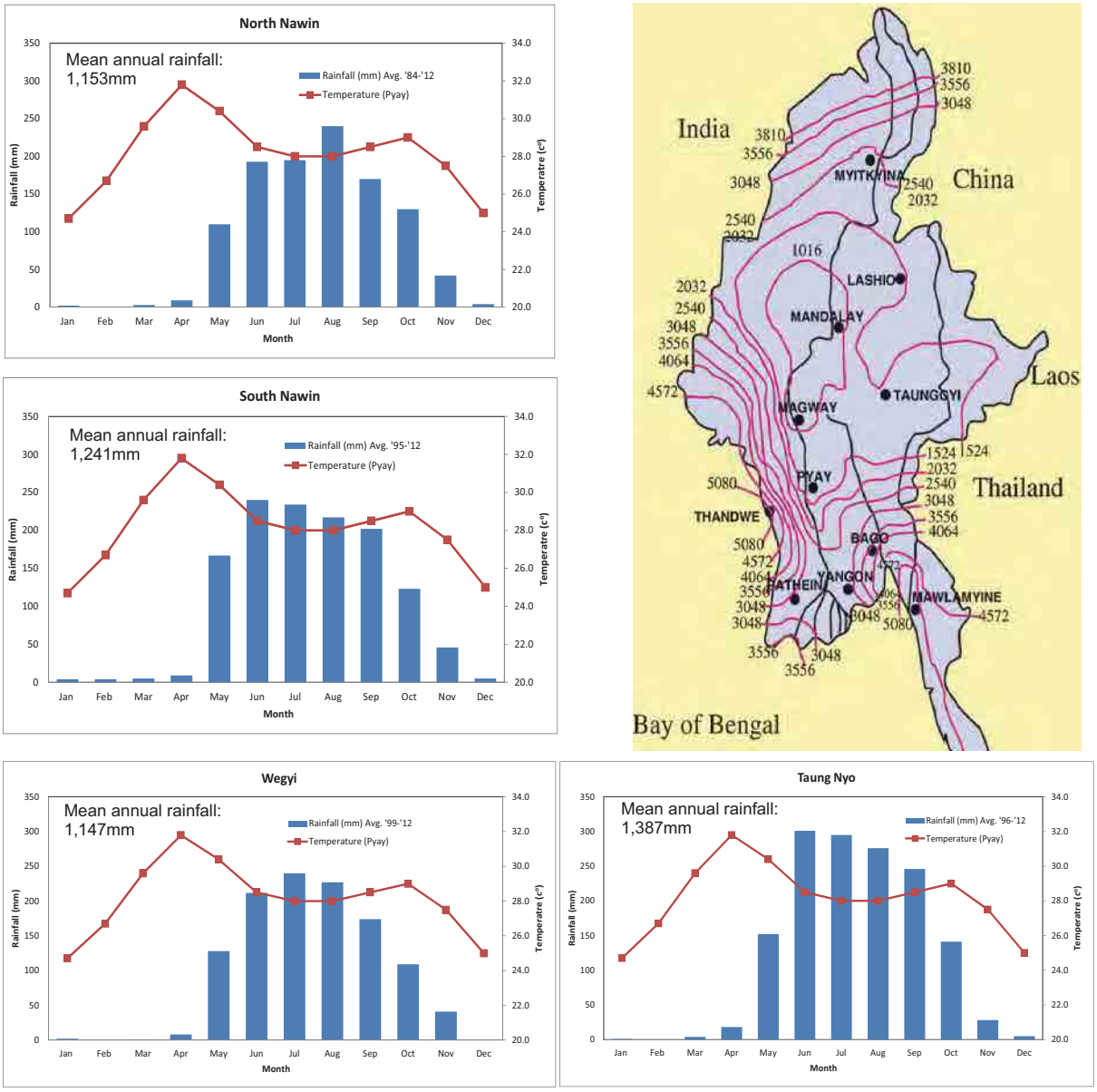


Figure 2.2.1 Monthly Mean Temperature, Rainfall, and Isohyet Graph for 4 Irrigation Systems (2001-10)

Source: ID, Statistical Year Book, arranged by the Survey Team (2013)

2.2.2 Water Resources of the Four Irrigation Systems

Water resources of the 4 irrigation systems are dam reservoirs. Bago Yoma is a mountain range running in between Ayeyarwaddy River and Sittaung River, which is the beginning point of the water source. From the mountain range, number of rivers flow into the reservoirs. Annual rainfall around mountain ridges of Bago Yoma reaches as much as 2,000mm or more but that of the Survey area is not enough as aforementioned. This is the major reason why dam reservoirs were planned and established as the sources of the irrigation development.

In Myanmar, dam reservoir is basically designed to have a storage capacity being able to store all the mean annual inflow running at the point of the river. This is the reason why overflow through the dam spillway occurs not every year; it may take place once in several years only. Following table shows storage and effective capacity by each of the dam reservoirs:

Table 2.2.1 Storage Capacity and Effective Storage Capacity of Reservoirs (4 reservoirs)

Dam Names	N. Nawin	S. Nawin	Wegyi	T. Nyo
River Name	North Nawin	Nawin	Wegyi	Taung Nyo
Average Annual Inflow (million cubic meter)	201.2	300.1	277.1	358.0
Storage Capacity (million cubic meter)	358.8	354.0	311.0	259.0
Dead Capacity (million cubic meter)	41.9	33.3	31.0	26.0
Effective Storage Capacity (million cubic meter)	316.9	320.7	280.0	233.0
Ratio (Effective Storage Capacity/Inflow)	1.58	1.07	1.01	0.65
Net Irrigable Area, acre	53,168.54	72,708.66	40,428.42	49,981.31
Net Irrigable Area, ha	21,516.54	29,424.74	16,361.57	20,226.31
Total Irrigable Area, Acre (ha)	216,287 acre (87,529 ha)			

Source: Irriagtion Department

North Nawin dam reservoir has the largest capacity in comparison with the average annual inflow; wherein 1.58 times of the average annual flow can be stored in the reservoir. Overflow from the North Nawin dam reservoir is therefore recorded only 3 times[1] after 31 years from the operation commencement in 1976. Taung Nyo reservoir has a small storage capacity in comparison with the average annual inflow with the ratio of only 0.65, whereby overflow through the spillway takes place almost every year.

2.3 Salient Features of the Target Four Irrigation Systems

2.3.1 North Nawin Irrigation System

Irrigation service of this North Nawin Irrigation system started in 1976, which means a period of 38 years has passed to date. Due to the limited budget allocation for maintenance works, there has been no major repairing works implemented for the major as well as appurtenant facilities. Partial repairs, though, for emergency cases were done by the Maintenance Division (Bago West). As is the case, presently, the system is in the condition to supply quite insufficient quantity of irrigation water against the demands due to various difficulties such as siltation in the canals, excessive vegetation of grasses and weeds along the canal surface, collapsing of brick and concrete lining,

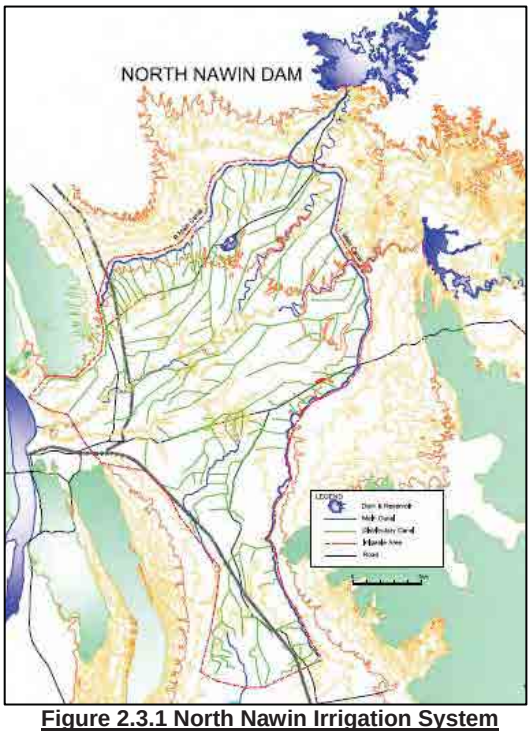


Figure 2.3.1 North Nawin Irrigation System
Source: Irrigation Department

[1] Overflow is recorded in 2002, 2007, and 2011

etc. Further to mention, the designed flow sectional area can not be secured in places due to the collapsed side slope of canals and damages on gate facilities for water diversion.

Most of the irrigable area of North Nawin irrigation system is located on the eastern part from the national railway line and this area consists of mainly sandy soil and silty loam soil according to a design report[2] of the project. According to a site survey by the Survey team, damages are often observed at the places where back-filled soil beneath lining material seems to be washed out by rainfall or water level decrease in the canal.

Based on the information provided by Irrigation Department, the Survey Team examined a present irrigation area (2012-2013) for summer paddy plus black gram that it is limited only to 18,326 acre (7,416 ha), which is about 34% of the potential irrigable area[3] in this period. Through rehabilitation works, Irrigation Department estimates that the system can increase the supply capacity for an additional area of 25,371 acre (10,267 ha), whereby with the rehabilitation completed, a total area of 43,697 acre (17,683 ha) can be irrigated.

Salient feature of the North Nawin Irrigation System is summarized below;

1. Location	Near Sesongong Village, Pyay Township, Bago Region
2. Map Reference	985 M/SZ-768172 (1 inch=1 mile scale)
3. Name of River	North Nawin Chaung
4. Catchment area	228.6 Square miles (591.8 km^2)
5. Average Annual Rain Fall	45.43 inches (1,154mm): 2000-2010
6. Average Annual Inflow	149,750 acre-feet (184.7 million m^3)
7. Type of Dam	Earth Dam (Zone Type)
8. Height of Dam	115 feet (35.1m)
9. Length of Dam	5,300 feet (1,615m)
10. Storage Capacity of Full Tank	291,000 acre-feet (358.8 million m^3)
11. Dead Storage Capacity	34,000 acre-feet (41.9 million m^3)
12. Water Spread Area of F.T.L	78,000 acre (96.2 million m^3)
13. Type of Conduit	Outer: R.C.C. pipe; Inner: Steel Pipe
14. Size of Conduit	8' (2.4m) φ Steel Pipe X 1 number
	13.5' (4.1m) φ R.C.C. Pipe X 1 number
15. Length of Conduit	414 feet (126 m)
16. Conduit Design Discharge	810 cubic feet/sec (22.9 m^3/sec)
17. Type of Spillway	Reinforce cement concrete (Duck Bill Type)
18. Width of Spillway	66 feet (20.1 m)
19. Spillway Design Discharge	21,200 cubic feet/sec (599 m^3/sec)
20. Length of Main Canal	45 miles (72 km)
21. Length of Distributary Canal	275 miles (442 km)
22. Canal Structures	2,967 numbers

[2] North Nawin Irrigation Scheme Final Design, Volume 1, Irrigation and Drainage, General, Energoprojekt Engineering and Consulting Co., Yugoslavia, 1966

[3] Potential irrigable area means the area which can be irrigated if released water is fully utilized for irrigation for summer paddy and black gram cultivation.

23. Irrigable Area	96,769 acre (39,160 ha) at planning time
24. Estimated Cost of Project	250 million Kyats
25. Construction Commencement	1967-1968
26. Construction completion	1981-1982

2.3.2 South Nawin Irrigation System

South Nawin Irrigation System was inaugurated and started irrigation in 1996, meaning that 18 years have passed since the commencement of operation to date. During the period, there has been substantially no full scale repairing works for the system, though there were some partial repairing works of emergency nature done by Maintenance Division (Bago West) of Irrigation Department. As is the case, the condition of the system has been deteriorated due to the following reasons and the system can now hardly secure the designed flow sectional area, thereby not capable to supply the irrigation water as required.

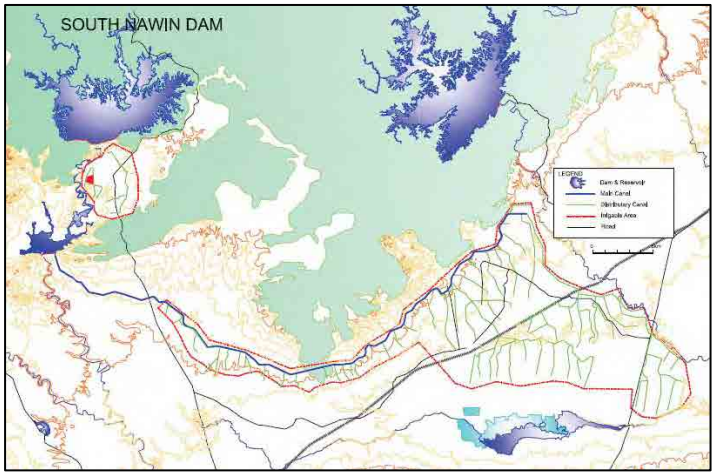


Figure 2.3.2 South Nawin Irrigation System
Source: Irrigation Department

- ✓ Siltation at the canal bed,
- ✓ Excessive vegetation by grasses and weeds on the canal bed, sometimes on collapsed side surfaces,
- ✓ Collapse in brick lining, and
- ✓ Collapse in canal sections at non-lining parts.

In particular, it is found that the collapsing of canal section side slope is more evident in case the geological condition of the location is of sandy nature. While, geologically, the eastern part (east of railway line of the beneficiary area) is of sandy and sandy loam and the western part is of clayey loam nature. Most of the main canal and lateral canals are brick-lined while no lining is predominant for the canal sections where clayey loam soil prevails.

According to the Irrigation Department, present flow capacity of the main canal is 400 cu.ft/sec (11.3 cum/sec), which is only one-third of the designed capacity of 1,161 cu.ft/sec (32.9 cum/sec). Such condition has resulted only in 14,253 acre (5,768ha) of irrigation area of black gram as a winter crop in 2012-2013. With the rehabilitation completed, the irrigable area for black gram will be increased by 58,456 acre (23,656 ha; 410 % increase). Accumulated irrigable area for black gram will therefore be 72,709 acre (29,424 ha) in total.

Salient feature of the South Nawin Irrigation System is shown below;

	Main Dam	Diversion Dam
1. Location	Pauk Khaung TS, Pyay District, Bago.	
2. Map Reference 1 inch=1 mile scale	85N/9E-918970	85N/5E-819015
3. Name of River	Nawin Chaung	South Nawin Chaung
4. Catchment area	247 Square miles (639 k m^2)	93 Square miles (241 km^2)

5. Average Annual Rainfall	49.25 inches (1,251 mm): 2000 - 2010	
6. Average Annual Inflow	210,000 acre-feet (259 million m^3)	75,800 acre-feet (93.5 million m^3)
7. Type of Dam	Earth Dam	Earth Dam
8. Height of Dam	141 feet (30.0 m)	68.6 feet (20.9m)
9. Length of Dam	16,674 feet (5.1km)	3,100 feet (945m)
10. Storage Capacity of Full Tank	287,000 acre-feet (354 million m^3)	21,000 acre-feet (93.5 million m^3)
11. Dead Storage Capacity	27,000 Acre-feet (33.3 million m^3)	10,549 acre-feet (13.0 million m^3)
12. Water Spread Area of F.T.L	10,980 acres (4,443ha)	2,075 acres (840 ha)
13. Type of Conduit	R.C.C	RCC
14. Size of Conduit	φ8.2 ft x1No	11.48ft x11.48 ft x4Nos
15. Length of Conduit	690 feet (210 m)	470 feet (143m)
16. Conduit Design Discharge	960 cuft/sec (27.2m^3/sec)	1,161.8 cuft/sec (4.6 m3/sec)
17. Type of Spillway	R.C.C (Duck Bill)	R.C.C (Broad Crest)
18. Width of Spillway	250 feet (76.2m)	197 feet (60m)
19. Spillway Design Discharge	11,650 cuft/sec (330 m^3/sec)	29,311 cuft/sec (830 m^3/sec)
20. Length of Main Canal	32 Miles (52 km)	
21. Length of Distributary Canal	88 miles (141 km)	
22. Number of Canal Structure	1,433 numbers	
23. Irrigable Area	58,058 acre (23,495 ha)	
24. Project Cost	1742.65 Million (Kyats)	
25. Construction Commencement	1985-1986	
26. Construction completion	1994-1995	

2.3.3 Wegyi Irrigation System

Wegyi dam project was listed as one of the reservoir irrigation projects under "Irrawaddy Development Master Plan, 1980". Out of 19 projects proposed in the master plan, Wegyi irrigation project was classified into Phase II group with Taung Nyo irrigation project. Myanmar government decided to allocate budget for this project through the Special Projects Implementation Committee meeting in October 1995. Reservoir dam construction was completed in July 1999. With the dam construction completed, the canal construction was commenced and completed in May 2001; it was about 2 years behind the reservoir dam completion.

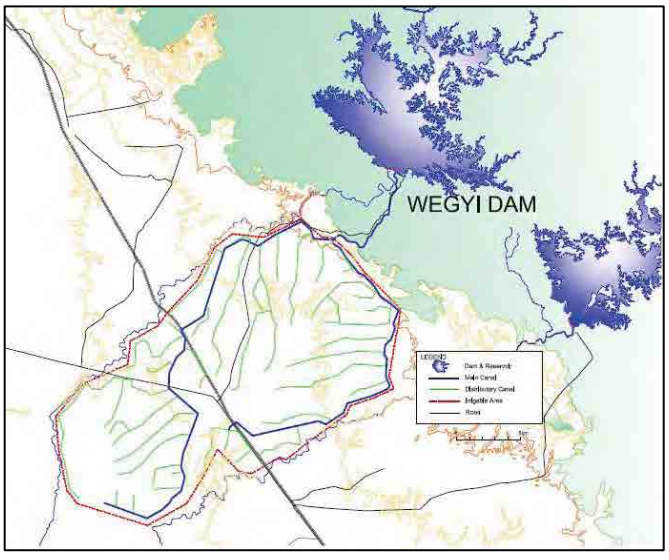


Figure 2.3.3 Wegyi Irrigation System
Source: Irrigation Department

Given strong demand for early completion of the canal system, canal lining was omitted from the construction. Concrete structures were placed at the locations of hydraulic-drops, check-points, and bifurcation points; however, concrete structure with adequate length for erosion protection could not always be placed. Thus, serious erosion is observed in many places after 13 years of operation.

Salient feature of the Wegyi Irrigation System is briefed below;

1.	Location	Near Paung Ai Village, Paung De TS, Bago Region
2.	Map Reference 1 inch=1 mile scale	1 inch= 1 mile scale, 85N/10E-945605
3.	Name of River	Wegyi Chaung
4.	Catchment area	202 square miles (523 km^2)
5.	Average Annual Rain Fall	45.23 inches (1,149mm): 2000 - 2010
6.	Average Annual inflow	298,311 acre-feet (368 million m^3)
7.	Type of Dam	Earth Dam
8.	Height of Dam	115 feet (35 m)
9.	Length of Dam	4,170 feet (1,271 m)
10.	Storage Capacity of Full Tank	252,000 acre-feet (311 million m^3)
11.	Dead Storage Capacity	25,000 area-feet (31 million m^3)
12.	Water Spread Area of F.T.L	12,500 acres (5,059 ha)
13.	Type of Conduit	Reinforced Cement Concrete
14.	Size of Conduit	4 feet x 6 feet x 3 Numbers
15.	Length of Conduit	240 feet (73 m)
16	Conduit Design Discharge	1,200 cubic feet / sec (34m^3/sec)
17.	Type of Spillway	Reinforced Cement Concrete (Broad Crested Type)
18.	Width of Spillway	100 feet (30m)
19.	Spillway Design Discharge	5,630 cubic feet /sec (159 m^3/sec)
20.	Length of Main Canal	40 miles (65 km)
21.	Length of Distribution Canal	136 miles (219 km)
22.	Nos of Canal Structure	913 Numbers
23.	Irrigable Area	45,000 acre (18,211 ha)
24.	Estimated Cost of Project	1225 million Kyats
25.	Construction Commencement	1998-1999
26.	Construction completion	2000-2001

2.3.4 Taung Nyo Irrigation System

Taung Nyo irrigation system is located at the most southern place among the 4 projects. Location of this irrigation system falls in Thayarwaddy district while other three projects are in Pyay district. Dam construction was started in November 1994 and completed in March 1996. Given similar design and construction modality with Wegyi project, canal lining for this Taung Nyo Irrigation System was also omitted from the irrigation system, which in turn has caused serious erosions along the canals after one and half decade operation. Salient feature of the Taung Nyo Irrigation System is shown below;

1.	Location	Nttalin Township, Bago Region

2.	Map Reference 1 inch=1 mile scale	1 inch= 1 mile scale, 85N/10E-066495
3.	Name of River	Taung Nyo Chaung
4.	Catchment area	213 square miles (551 km^2)
5.	Average Annual Rain Fall	54.60 inches (1,387 mm): 2000 - 2010
6.	Average Annual Inflow	180,000 acre-feet (222.0 million m^3)
7.	Type of Dam	Earth Dam
8.	Height of Dam	110 feet (33.5m)
9.	Length of Dam	3,400 feet (1,036 m)
10.	Storage Capacity of Full Tank	210,000 acre-feet at WL 255 ft (259 million m^3, 77.7m).
11.	Dead Storage Capacity	21,200 acre-feet at WL 217 feet (26 million m^3, 66m)
12.	Water Spread Area of F.T.L	8,600 acres (3,480 ha)
13.	Type of Conduit	Reinforced Cement Concrete
14.	Size of Conduit	4 feet x 6 feet x 3 Numbers
15.	Length of Conduit	338 feet (103 m)
16.	Conduit Design Discharge	1,000 cubic feet / sec (28 m^3/sec)
17.	Type of Spillway	Reinforced Cement Concrete (Ogee Type)
18.	Width of Spillway	90 feet (27m)
19.	Spillway Design Discharge	49,714 cubic feet/sec (1,407 m^3/sec)
20.	Length of Main Canal	13.5 miles (22 km)
21.	Length of Distribution Canal	127 miles (205 km)
22.	Numbers of Canal Structures	1,371 numbers
23.	Irrigable Area	50,000 acre (20,234 ha)
24.	Estimated Cost of Project	1,225 million Kyats
25.	Construction Commencement	1993-1994
26.	Construction completion	1995-1996

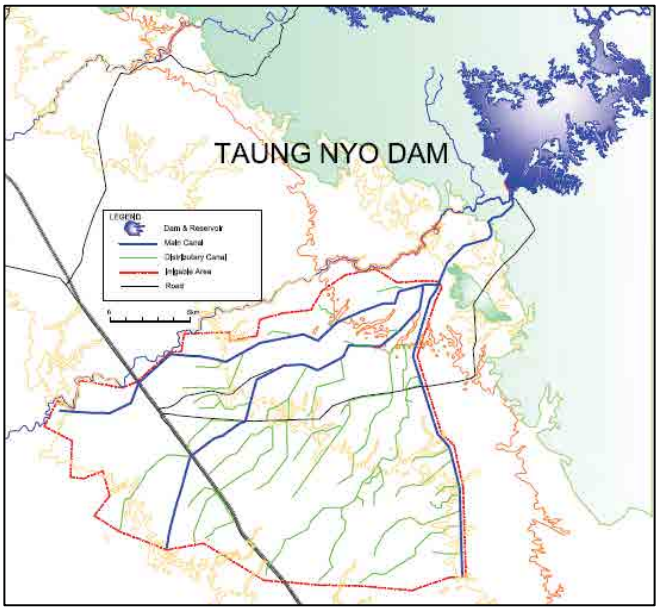


Figure 2.3.4 Taung Nyo Irrigation System
Source: Irrigation Department

2.4 Agriculture in the Project Area

2.4.1 Agricultural Land Use

Referring to the SLRD annual statistical data, the agricultural land use in the Survey area is categorized in 5 groups such as 1) lowland, 2) upland[4], 3) shoal or riverbank field, 4) garden, and 5) upland with shifting cultivation. The area and the percentage of agricultural land use in 2012/13 for the 6 townships, wherein the target 4 irrigation systems fall, are shown in Table 2.4.1. It is known that most of the agricultural area falls in the categories of lowland and upland with the former being further majority. Pyay township area and Pauk Khaoung township area are located at relatively hilly position, and therefore upland share is larger than those of others. Remaining 4 townships are located in lower parts of the area, whereby more than 70% of the agricultural area is categorized as lowland.

Table 2.4.1 Agricultural Land Use in the 6 Townships (2012/13) covering the Survey Area

Dam Site Name	NNW & SNW						Wegyi	
District Name	Pyay District							
Town Ship Name	**Pyay**		**Pauk Khaung**		**Thae Kone**		**Paung Tae**	
Land Category	Acre	(%)	Acre	(%)	Acre	(%)	Acre	(%)
Lowland	75,867	68.6	41,470	43.7	83,436	85.0	72,292	73.5
Upland	24,897	22.5	51,608	54.4	10,699	10.9	20,398	20.7
Shoal or Riverbank Field	1,558	1.4	1,380	1.5	137	0.1		
Garden	8,225	7.4	413	0.4	3,944	4.0	2,617	2.7
Upland (with shifting cultivating)							3,077	3.1
Total Agricultural Land	110,547	100.0	94,871	100.0	98,216	100.0	98,384	100.0

Dam Site Name	Taung Nyo				**Total**		
District Name	Tharyarwadi District						
Town Ship Name	**Zee Kone**		**Nat Ta Linn**				
Land Category	Acre	(%)	Acre	(%)	Acre	Ha	(%)
Lowland	42,295	99.4	108,368	89.9	**423,728**	**171,474**	**75.0**
Upland	80	0.2	9,956	8.3	**117,638**	**47,606**	**20.8**
Shoal or Riverbank Field	11	0.03			3,086	1,249	0.5
Garden	145	0.3	2,271	1.9	17,615	7,128	3.1
Upland (with shifting cultivating)					3,077	1,245	0.5
Total Agricultural Land	42,531	100.0	120,595	100.0	565,144	228,702	100.0

Source: SLRD, Pyay District & Thayarwaddy District

Irrigable area of North Nawin and South Nawin were revised by Irrigation Department in 2006/07 for the purpose of re-calculating the water requirement referring to the then-prevalent cropping pattern. Table 2.4.2 shows the agricultural land use of irrigable area under the two irrigation systems of North Nawin and South Nawin. More than 90% of the irrigable areas of these systems (North Nawin: 92.6%, South Nawin: 96.3%) are categorized as lowland. Based on the comparison between Table 2.4.1 and Table 2.4.2, 63.3% of total lowland area (lowland area of Pyay, 75,867 acre, Pauk Khaung, 41,470 acre, and Thae Kone, 83,436 acre, respectively) can be irrigated under North Nawin(78,557 acre) and South Nawin (48,578 acre) irrigation systems.

Table 2.4.2 Agricultural Land Use in the North Nawin and South Nawin Irrigation Systems

Dam Site Name	**North Nawin**		**South Nawin**	
Land Category	Acre (ha)	(%)	Acre (ha)	(%)
Lowland	**78,557 (31,790.9)**	**92.6**	**48,578 (19,658.8)**	**96.3**
Upland	3,183 (1,288.1)	3.8	826 (334.3)	1.6
Shoal or Riverbank Field	1,368 (553.6)	1.6	62 (25.1)	0.1
Garden	1,734 (701.7)	2.0	969 (392.1)	1.9
Total	84,842 (34,334.3)	100.0	50,435 (20,410.3)	100.0

Source: ID, Bago West

[4] In Myanmar term, lowland is called 'Le', literally meaning paddy field while upland is called 'Ya'.

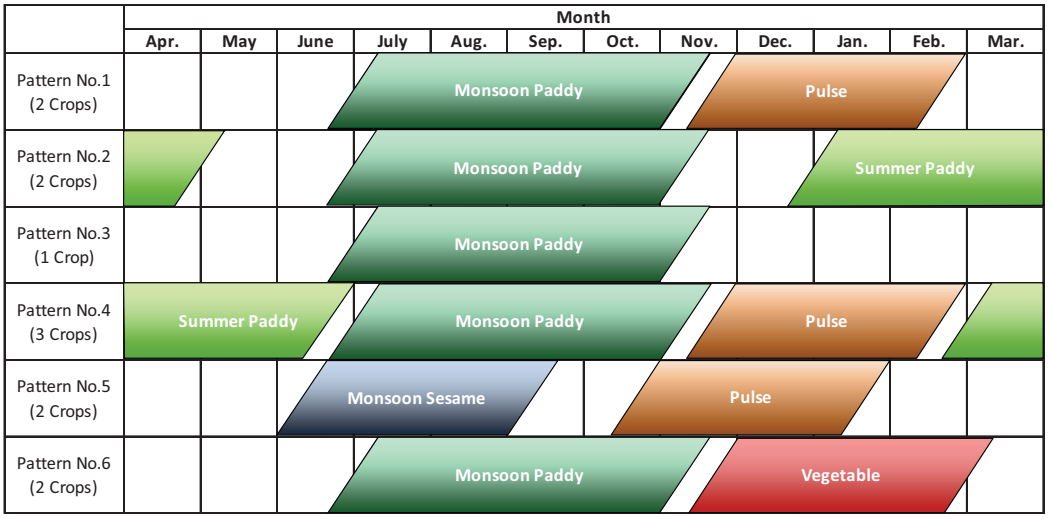
Though irrigable area of Wegyi and Thaung Nyo were revised at the same time with North Nawin and South Nawin, the report mentioned only the decreased area; i.e., the agricultural land use by category was not mentioned. Table 2.4.1 showing the total agricultural land use by township indicates that most of the land for the townships wherein Wegyi and Thaung Nyo irrigation systems are located falls under lowland area, and therefore most of the irrigable area can be considered as lowland. In short, the irrigation systems of all the 4 dams mainly support the cultivation of lowland crop, i.e. paddy.

2.4.2 Cropping Patterns and Changes for the Target 4 Irrigation Systems

1) Cropping Patterns in the Target 4 Irrigation Systems

There are three major crop seasons in the Survey area such as; 1) monsoon season, 2) winter season and 3) summer season. During monsoon season (July to October), cultivation field can use monsoon rainfall and most of the cultivated crop is paddy under rain-fed. Winter season (November to February) is called dry season with low temperature. Amount of rainfall is small in this season, and low water requirement crops (i.e. pulses) are mainly planted without much irrigation water. Summer season (March to June) falls in dry season with high temperature. All crops in this summer season need irrigation water to grow. Most of the lowland fields in this season have cultivated paddy formerly directed by a government policy.

According to the actual sown area data in the Survey area from 2008 to 2013, six types of typical cropping patterns were found (see Figure 2.4.1). Of the 6 cropping patterns, one pattern entails 3-cropping cultivation in a year; four patterns do 2-cropping cultivation, and the remaining one does single cropping. Five types of cropping patterns include monsoon paddy; 2 types include summer paddy while the remaining 3 types include pulse. Rice being the staple food for the population and also according to a former government policy, paddy cultivation is dominant in the area. Pulse is cultivated as main cash crop. There are several varieties of pulses planted such as black gram, green gram, groundnut, chick pea, cow pea, etc.



Source: DOA, Bago West

Figure 2.4.1 Typical Cropping Calendar During 2008 to 2013

Source: DOA, Bago West

Average actual sown area with the percentage under irrigable area from 2008/09 to 2012/13 is shown in Table 2.4.3. Almost 90% of the irrigable area is in fact planted with monsoon paddy (pattern 1, 2, 3, 4, and 6) and more than 30% of the area was planted with summer paddy (pattern 2 and 4). In addition, even single crop with monsoon paddy reached 20.7% (pattern 3) in spite of the existence of irrigation system. Pulse was planted during the winter season with more than 40% of the total irrigable area (patterns 1, 4 and 5).

Table 2.4.3 Area and Percentage of Cropping Pattern for the Target 4 Irrigation Systems

Pattern No.	Monsoon Season	Winter Season	Summer Season	Actual Sown Area	
				Acre	%
1	Paddy	Pulse		78,340.8	32.1
2	Paddy		Paddy	57,058.8	23.4
3	Paddy			50,431.6	20.7
4	Paddy	Pulse	Paddy	20,037.2	8.2
5	Sesame	Pulse		9,461.2	3.9
6	Paddy	Vegetable		8,995.6	3.7
7	Others			19,656.6	8.1
Total				243,981.8	100.0

Source: DOA, Bago West

2) Change of the Cropping Patterns by Year

Trend of each cropping pattern from 2008/09 to 2012/13 is shown in Figure 2.4.2. Cropping pattern No.1, which cultivates monsoon paddy and winter pulses, started increasing rapidly from the season of 2010/11. On the other hand, cropping pattern No.2 cultivating monsoon and summer paddy started declining contrary to the cropping pattern No.1. One of the reasons thought about is a policy change. Because of the then-government policy stressing the cultivation of rice, farmers could not select planting crop freely before 2010. It is considered that farmer changed cultivation crops rapidly in order to earn more profit after the government policy has changed. In fact, pulses give more profit to farmers than summer paddy.

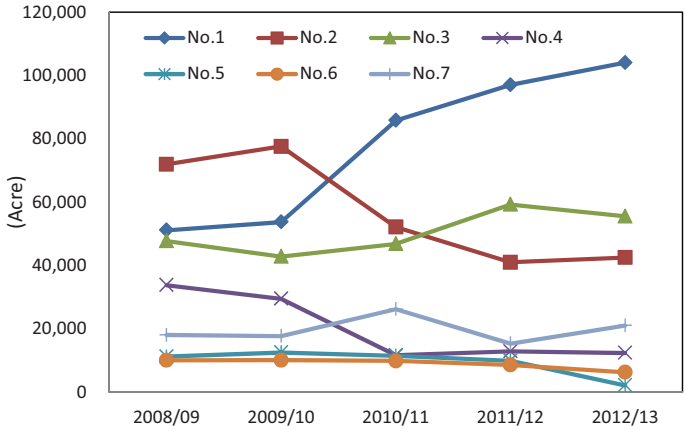


Figure 2.4.2 Trend of Cropping Pattern from 2008 to 2013

Source: DOA, Bago West, SLRD

The single cropping, pattern No.3, takes almost constant share in the period. Farmlands with single crop have not received irrigation water in most cases due to water distribution problem. According to the interviews with township DOA officers and the field observation, the irrigation water can hardly reach the fields which are located far from the irrigation canal. In fact, most of the farmers want to change the single cropping to double-multiple cropping in order to increase agricultural income. Therefore, pattern No.3 fields would be changed to double-multiple cropping after irrigation systems have been recovered with rehabilitation.

3) Cropping Times per Year by Location

In addition to above data/information, JICA Survey team carried out household questionnaire survey in April-May 2013 covering total 225 samples, which were divided into villages located in 3 positions such as upper location, mid location and lower location along main canals[5]. Table 2.4.4 summarizes the number of households with percentage by cropping time per year; namely, how many times of cropping the farmers have carried out by location along the reach of main canals.

It is found that most of the households in the upper and middle position villages carry out more than 2 times cropping in a year. Particularly, 44% (33 household) of the surveyed households in the upper

[5] The household interview survey was carried out in April-May 2013 covering 225 households in 12 villages with random sampling method. Based on the information of irrigation water situation from the maintenance branch of ID and district DOA offices, 3 sample villages were selected each from upper, middle and lower position of the main canal respectively for each of the 4 irrigation systems. The survey covered general information, agricultural situation, income, expenditure, etc.

position villages practice 3 times cropping. The percentage of single cropping is the highest in lower position villages (29.3%, 22 household). According to the interviews with farmers and township DOA officers, most of the farmers want to cultivate with double-multiple cropping in order to increase the income. The high percentage of single cropping in the lower position villages suggests lack of water for cultivation.

Table 2.4.4 Cropping Pattern by Village Location

No. of Cropping	Upper Position (N=75)		Middle Position (N=75)		Lower Position (N=75)	
	No. of HH	(%)	No. of HH	(%)	No. of HH	(%)
3 cropping	33	**44.0**	20	26.7	21	28.0
2 cropping	40	53.3	55	73.3	32	42.7
1 cropping	1	1.3	-	-	22	**29.3**
Other	1	1.3	-	-	-	-
Total	75	100.0	75	100.0	75	100.0

Source: Questionnaire Household Survey, the Survey Team (2013)

2.4.3 Paddy Crop Farming for the Target 4 Irrigation Systems

The major agricultural product in the Survey area is paddy as aforementioned. The production of paddy by region/state in 2009/2010 is shown in Figure 2.4.3. The Bago region, where the Survey area is located, shows the second largest production of paddy after Ayeyawady region. The Bago region produced 4,790,000 tons (with 18.2% share) of monsoon paddy and 791,000 tons (with 13.8% share) of summer paddy. By comparing the production among three paddy growing regions of Ayeyawady, Bago and Sagaing, it is found that the ratio of summer paddy of Bago region is smaller than the others (Ayeyawady: 44.7%, Sagaing: 15.2%). It may be said that though the paddy area in the Bago region is large, irrigated area for paddy in percentage could be smaller than other paddy growing regions.

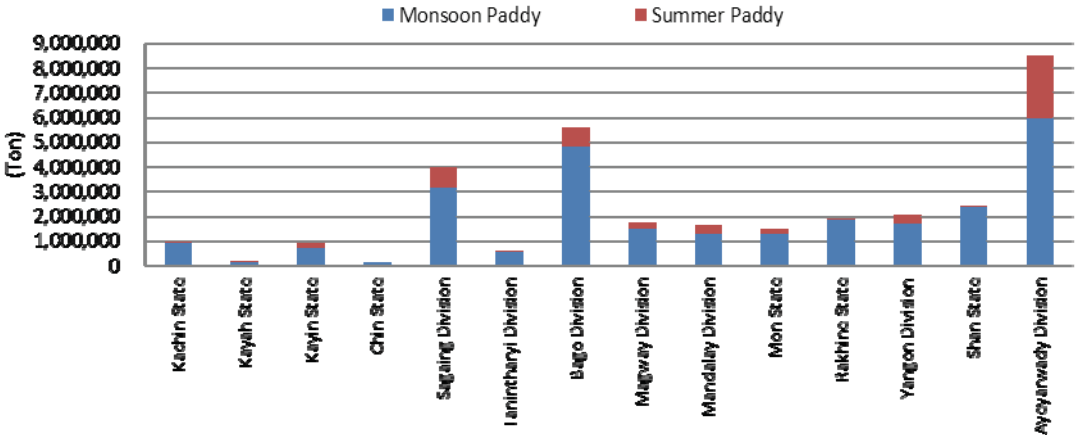


Figure 2.4.3 Production of Paddy by Region and State in 2009/2010

Source: Statistical Yearbook, 2011 (CSO), DAO

Figure 2.4.4 shows the paddy production per capital by region and state as of 2009/10. The production per capital in Bago region is the second largest after Ayeyarwaddy region same as Figure 2.4.3. The Bago region could be characterized being one of the major rice supply areas in the Country. It can be said that one person consumes about 200 kg of not-husked paddy per year. Taking this consumption into account, Bogo region where more than 900 kg of paddy is produced is in fact a rice export region to other areas in the Country where rice production can not meet what the people need.

Paddy sown area and the production in the Survey area by crop season from 2008/09 to 2012/13 are shown in Figure 2.4.5. The sown area and production for monsoon paddy are on a slightly increase trend during the period. The sown area came to 225,230 acre in 2008/2009 and then arrived at 231,664 acre in 2012/2013. The production has also increased from 17,058,574 baskets to 17,688,168 baskets during the same years, as so did the sown area. Therefore, it is indicated that the yield per unit area has

been almost stable during the same period.

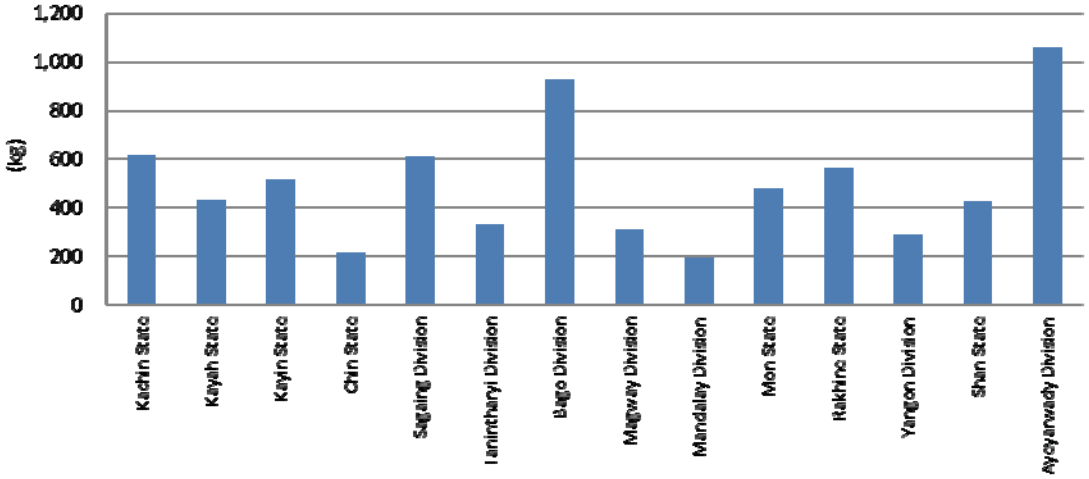


Figure 2.4.4 Per-capita Production of Paddy by Region and State in 2009/2010

Source: Statistical Yearbook, 2011 (CSO)

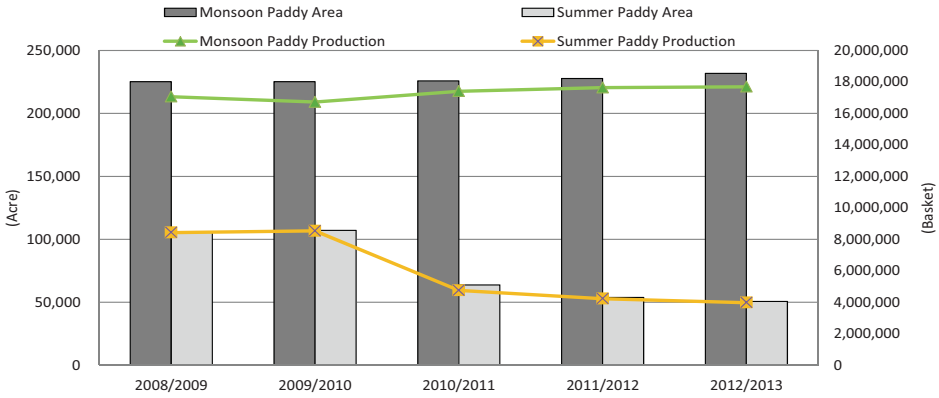


Figure 2.4.5 Sown Area and Production of Monsoon and Summer Paddy in the Project Area

Source: Settlement and Land Records Department

On the other hand, summer paddy's sown area and the production have decreased in the period. The sown area in 2008/2009 was 105,778 acre, and it had reduced to 50,657 acre in 2012/2013, just four years later. Especially from 2009/2010 to 2010/2011, an area of as much as 43,224 acre had been lost. One of the reasons of this decrease could be the then-government policy change. Besides, high yield varieties, e.g. hybrid variety from China and/or Philippines, were distributed to the farmers for summer paddy with DOA's extension in recent years according to interviews with township DOA officers. However, the increase of yield per acre is yet unclear as implied in the figure.

Concerning marketing, the produced rice by farmers are purchased by merchants and/or rice mill owners in the village or township level firstly, and then transported and sold to middlemen who have storages in Pyay town. The middlemen sell the rice to the other middlemen operating in other towns or cities, and these middlemen sell the purchased rice to retail sellers. In other case, for example, middle size rice mill owner buys rice from contracted farmers, and then the owner transports the polished rice to Yangon city.

2.4.4 Subsidiary Crop Farming for the Target 4 Irrigation Systems

Important subsidiary crops in Myanmar are oil crop and pulses. Planting area of oil crop (groundnut and sesame) and major pulses are shown in Figure 2.4.6 by region/state. Production areas can be classified into 3 groups. First group consists of Ayeyawady and Bago regions (including the Survey area), Second group is composed of Sagaing, Magway and Mandalay regions while the third group

covers other states and regions. The first group including the Survey area is mainly planted with black gram and small area of green gram. The second group is planted with groundnut, sesame and pulses except for black gram. The third group has smaller planted areas than the 1st and 2nd group areas.

Paddy cultivation is dominant in the Survey area as aforementioned, and therefore most of the subsidiary crops are cultivated during winter season where paddy is not cultivated. Major subsidiary crops in the Survey area are pulses, and oil crops e.g. sesame to lesser extents. Sown area with the production of the major pulses such as black gram, groundnut and green gram and sesame during 2008/9 to 2012/13 is shown in Figure 2.4.7.

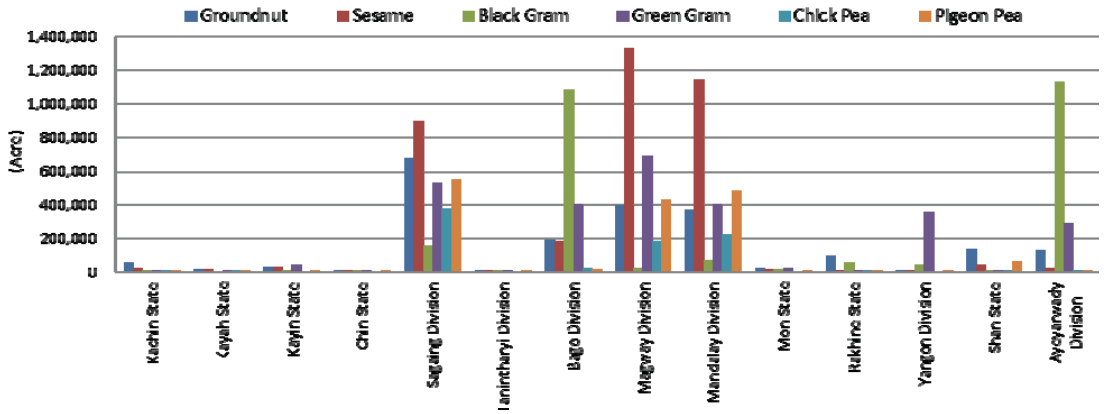


Figure 2.4.6 Sown Acreage of Subsidiary Crops by Region and State

Source: Settlement and Land Records Department

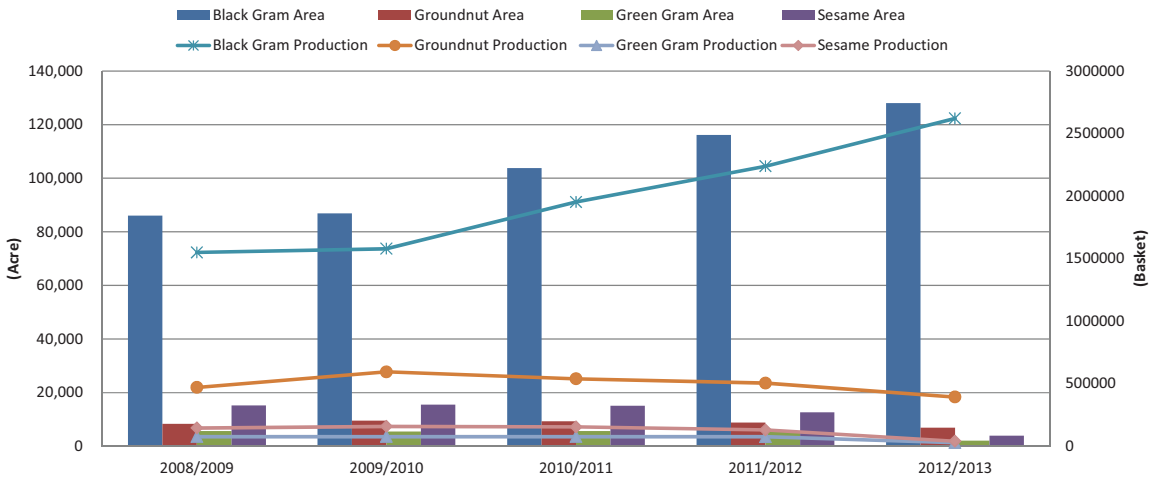


Figure 2.4.7 Sown Area & Production of Subsidiary Crops in the Project Area during 2008/09-2012/13

Source: DOA, Bago West

Looking at the figure above, only black gram has an increasing trend. The increasing has started from 2010/2011; namely, it is correlated with summer paddy decreasing. The sown area in 2008/09 was 86,058 acre and it has increased to 128,019 acre in 2012/2013, an increase of 149%. Production did the same accordingly from 1,549,999 baskets to 2,620,909 baskets, an increase of 169%. Other crops are, on the other hand, slightly on a decreasing trend in the planted area during the same period. These facts show that cultivation varieties may have been simplified in the Survey area after 2010/2011.

As for the marketing, pulses are sold to village merchants and/or township merchants, and then it is sold to middlemen in Pyay city. The pulses are mainly sold to the other middlemen in Yangon city or Mandalay city; depending on the prevalent market price. The pulses which are bought by the Mandalay middlemen are transported to China and India via road while those of Yangon are mainly transported to India by ship.

2.4.5 Yields by Location for the Target 4 Irrigation Systems

Yield survey for the last 2 years harvest was conducted in May-June 2013 covering 360 households in 12 villages which are located at upper position, middle position and lower position for the irrigation canals of the Survey area (see Table 2.4.5). For the paddy, lower position showed the highest harvest for both monsoon and summer paddies (monsoon: 60.8 baskets, summer: 70.8 baskets), followed by upper position (monsoon: 60.3 baskets, summer: 66.6 baskets) and lastly middle position (monsoon: 51.2 baskets, summer: 59.2 baskets). According to a previous report[6], soil of the lower position contains clay more than upper position. It means that the high productivity in the lower position may have been caused by rich soil.

Table 2.4.5 Yield of Crops by Locations in Irrigation Systems

Land Category	Season	Crop name	Upper position			Middle position			Lower position		
			2011	2012	Avg.	2011	2012	Avg.	2011	2012	Avg.
Lowland	Monsoon	Paddy	58.0	62.6	60.3	49.8	52.5	51.2	59.6	61.9	60.8
	Winter	Black gram	15.7	16.4	16.0	18.4	19.2	18.8	9.8	11.0	10.4
		Green gram	7.5	10.0	8.8						
		Groundnut	26.7	26.7	26.7						
	Summer	Paddy	62.2	71.0	66.6	57.1	61.4	59.2	69.6	72.0	70.8
		Sesame	5.3	5.1	5.2						
Upland	Monsoon	Groundnut	33.5	34.1	33.8	21.8	22.8	22.3			
		Pigeon pea	5.9	6.1	6.0						
		Sesame	4.3	5.2	4.7				4.0	5.3	4.7
	Winter	Black gram	16.0	16.0	16.0	8.0	8.0	8.0	12.5	12.5	12.5
		Green gram	5.1	5.7	5.4						
		Groundnut				16.1	20.0	18.0			
		Lab Lab bean	8.3	8.3	8.3						

Source: Yield Interview Survey, the Survey Team (2013)

For the winter crops planted in the irrigation systems, upper position was planted with three kinds of pulses such as black gram, green gram and groundnut while other positions were planted with only black gram. The average productivity for the black gram by position is different from that of paddy; the highest yield is marked in the middle position (18.8 baskets), then upper position (16.0 baskets), and lastly lower position (10.4 baskets). Water availability in the lower position is less than mid and upper positions, whereby the yield of lower position may have resulted in such lowest one.

Upland field was planted with pulse and sesame. The upper position shows varieties of crops with higher production for all of the crops except for groundnut in winter season which is planted only in the middle position. One of the reasons, of why upper position shows higher yield, may be attributed to the availability of irrigation water. It can be thought that irrigation water availability is higher in the upper position than mid and lower positions. It is therefore able to achieve higher yield with various crops in the upper position.

2.4.6 Farmland Holdings for the Target 4 Irrigation Systems

Farmland holding was surveyed by the JICA survey team under the household questionnaire survey covering total 225 farm households divided into 3 areas equally such as upper position, mid position and lower position within the irrigated area. The result shows that the farmers have 3 major types of agricultural land use such as lowland, upland and shoal or riverbank field in the Survey area. In fact, all farmers surveyed have lowland field with 1,833.9 acre in total. The maximum lowland farm size owned by a farmer was 30 acre while the minimum one was 0.5 acre, and the average lowland farm holding per farmer household came to 8.2 acre.

[6] Main Report, The Master Plan Survey Report on the Irrawaddy Basin Integrated Agricultural Development, March 1980, JICA

Eighty seven (87) farmers have upland farmland with an aggregated total area of 375.3 acre. For the upland farmland, the maximum size owned by a farmer was 20 acre; minimum one was 0.3 acre only, and the average arrived at 4.3 acre. Three farmers have shoal or riverbank field with 7.0 acre in total. Others include gardens such as banana plantation, backyard small kitchen garden, etc. whose total area is only 12.9 acre owned by 20 farmer households in total.

Total area of the farmlands owned by the 225 sampled households arrives at 2,229 acre. Therefore, a typical average farmer household is supposed to own 9.901 acre (4.01 ha), which is in fact quite big as compared to other parts of the Country. Reason given by interviews to farmers revealed that since Pyay is not so far from Yangon, there have been migrant people to those urban areas, leaving their farmland behind. The present farmers have been purchasing such farmlands from peer farmers and relatives. This high transaction may have contributed to keep such bigger farmland area per farmer household.

Table 2.4.6 Farm Land Holdings in the Project Area

Items	Lowland	Upland	Shoal or Riverbank Field	Others	Total/ Average
No. of HH (N=225)	225	87	3	20	225
Total Area (Acre)	1,833.9	375.3	7.0	12.9	2,229
Maximum Area (Acre)	30.0	20.0	4.0	2.0	30.0
Minimum Area (Acre)	0.5	0.3	1.0	0.1	0.1
Average Area (Acre)	8.2	4.3	2.3	0.6	9.907 (4.01ha)

Source: Questionnaire Household Survey, the Survey Team (2013)

Figure 2.4.8 shows farmland holdings by an average farmer household by position; upper, middle and lower positions along main canals. Farmers in the middle position villages have the largest lowland farm with an average area of 9.6 acre, then lower position villages with 8.6 acre and upper position villages with 6.3 acre. Besides, upper position and middle position farmers have approximately 2.4 acre of each upland field. The upper and middle position villages are located on slightly hilly areas than lower position villages, hence they have upland field as compared to the villages located in lower position.

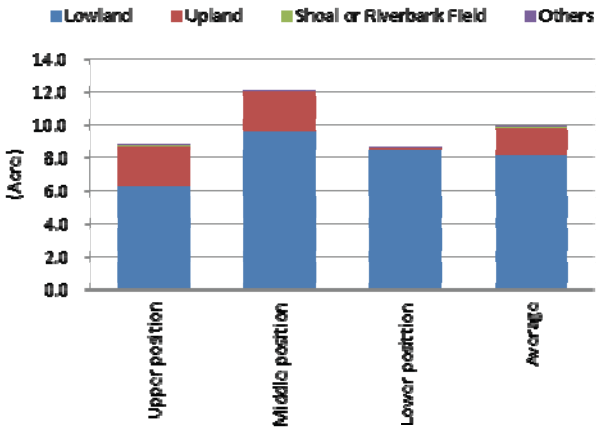


Figure 2.4.8 Average Farmland per Farmer by Position

Source: Questionnaire Household Survey, the Survey Team (2013)

2.4.7 Farmers' Asset and Agricultural Machineries

Figure 2.4.9 summarizes the farmers' asset holding by item. About 80% of the sampled households have radio and TV set. Tube wells are more existent in upper villages since lower positioned villages can utilize pond in addition to tube wells. More than 80% of the sampled households have cattle plough and bull cart while about 30 – 50 % have hand tractor. By position, the shares of those are relatively higher in the middle position villages than others. The households located in the middle position cultivate larger area than other areas according to a survey result, which implies higher percentage of owing such agricultural tools/machinery in those villages.

Approximately 50-80% of the sampled households have sprayer depending upon the location. Share of the sprayer is higher in the upper and lower positioned villages. Bigger number of winter crop farmers could be one of the reasons of it. Engine pumps are owned by about 20-40% of the sampled households, depending upon the location. Share of engine pump is higher again in the upper and lower

positioned villages. For the upper positioned villages, it may be associated with topography needing pumps while for the lower positioned villages it must be associated with water shortage whereby the farmers may be pumping up water from drainages nearby.

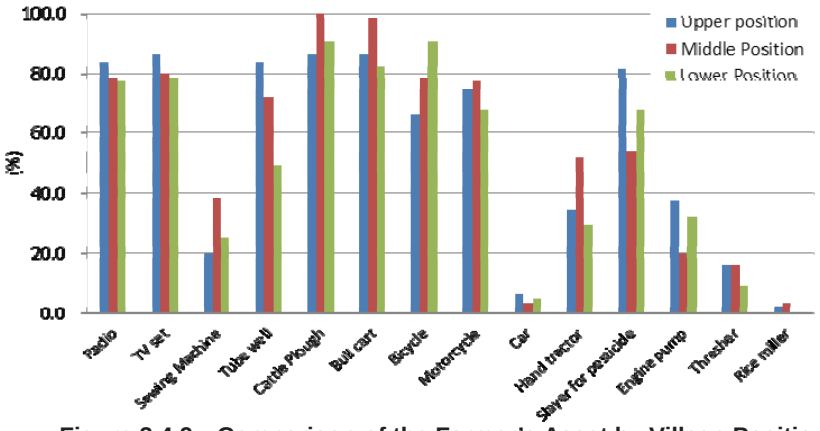


Figure 2.4.9 Comparison of the Farmer's Asset by Village Position

Source: Questionnaire Household Survey, the Survey Team (2013)

Percentage of owning agricultural machineries is shown in Figure 2.4.10. Its share of owing hand tractor ranges from 30 to over 50% with the middle positioned villages being the maximum. Of the hand tractors owned, about 5 – 20% of them are also rented out. According to some interview results with farmers, more than half of the cultivation area is nowadays plowed by hand tractor.

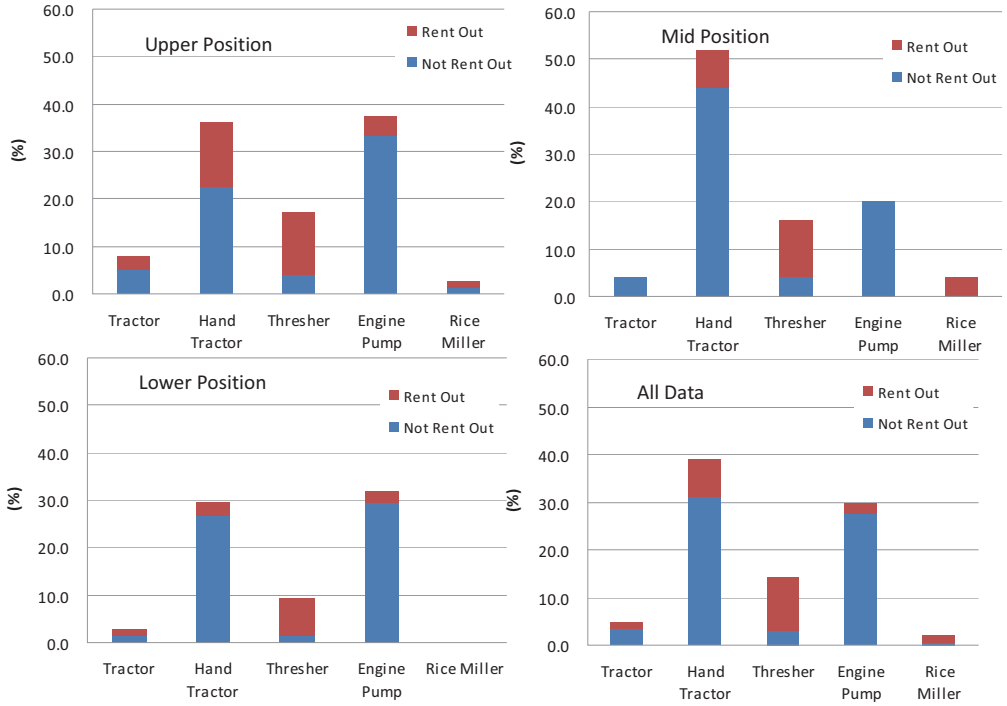


Figure 2.4.10 Comparison of Agricultural Machineries Ownership by Village Position

Source: Questionnaire Household Survey, the Survey Team (2013)

On the other hand, thresher is not yet popular among the sampled households, owned by less than 20% in all positions. In fact, since the number of thresher is not enough to meet the individual's household need, more than 80% of the owners are renting out to neighbor farm households. Engine pump is owned relatively higher in the upper and lower position villages, and the ratio of renting out is low. Tractor and rice miller are little owned in the Survey area.

Increase of agricultural machineries from 1990 to 2013 for the interviewed households is shown by histogram in Figure 2.4.11. Most of the machineries were bought in 2000s. The number of the hand tractor was increased smoothly till 2010; however it was decreased afterward. Percentage of owning hand tractor is now reaching to about half of the farmer households (see Figure 2.4.10). The number of engine pump was increased greatly in 2008, and it started going down from 2011. The engine pump is

in most cases used for irrigating winter crops out drainage water.

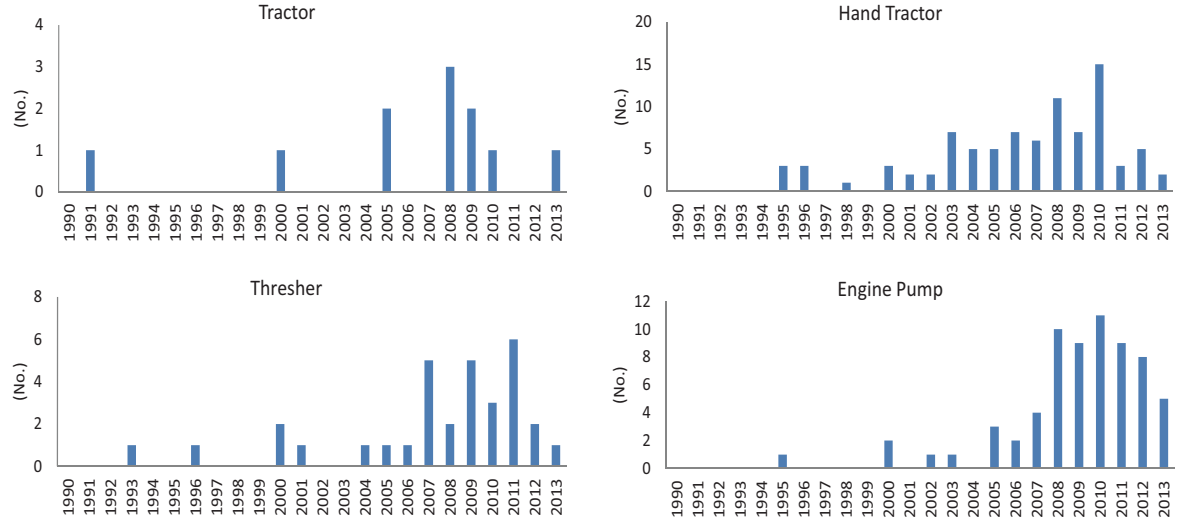


Figure 2.4.11 Year of Owning of Agricultural Machineries

Source: Questionnaire Household Survey, the Survey Team (2013)

The questionnaire survey has also identified the cohort of the sampled household members. There found a total of 1,123 people (mail: 549, female: 574) in the sampled 225 households, giving an average number of household members of 5.0. The population cohort surveyed is illustrated by age group in Figure 2.4.12. Surprisingly, peak population shows up in the age group 25-29, below which very fewer populations are presented. The younger the age group is, the fewer the population is in case of under-25-year old group. It suggests a sharp decrease in terms of the number of children in the area. There may be two reasons for such small number of young population such as; 1) dissemination of family planning, and 2) migration to urban areas looking for lucrative jobs. This trend, less population in young generations, implies that agricultural mechanization will be in due need in this area near future. About 40% of the farmer households have already hand tractors, and this trend will increase.

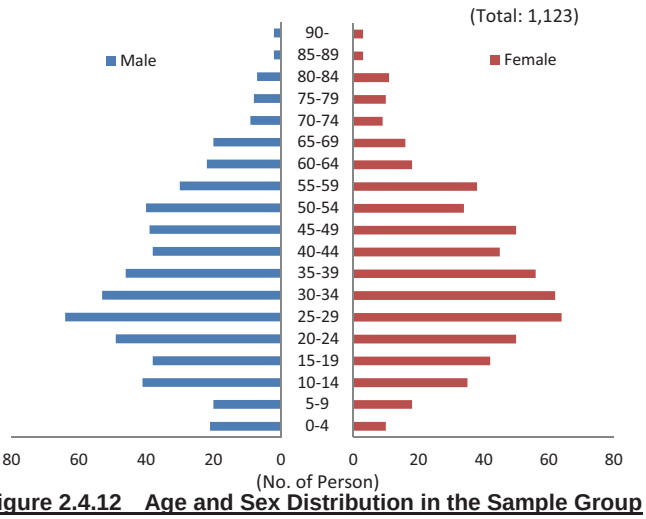


Figure 2.4.12 Age and Sex Distribution in the Sample Group

Source: Questionnaire Household Survey, The Survey Team (2013)

2.4.8 Farmers' Situation and Problems

To understand the crop production in recent years, production trend within ten years were interviewed by 4 levels such as worst (less than 20% of normal year's production), worse (about 20% to 80% of normal year's production), average (about 80% to 120% of normal year's production) and better (about 120% of normal year's production) under the aforementioned questionnaire survey. Note that the production is not based on quantitative measurement but on the farmers' comparative report. Table 2.4.7 summarizes the average score of each of the 4 levels by village position.

In overall, score of average year is the highest with more than 6 years out of 10 years for both paddy and pulses; the second is better or worse with about 1.5 years. The score of worst is the lowest with less than 1 year out of 10 years. In sum, through all village positions and crops, it is found that out of the last 10 years the crop production was equal or higher than that of average year in 8 years while it

was lower than that of average year in just 2 years. Irrigation has played a great role in this result.

Table 2.4.7 Crop Production in Last Decade

Crops and Locations		(Less than 20%) (year)	Worse (20-80%) (year)	Average (80-120%) (year)	Better (Over 120%) (year)
Paddy	Upper position	0.31	1.60	6.88	1.21
	Middle position	0.43	1.67	6.17	1.73
	Lower position	0.61	1.52	6.59	1.28
Pulses	Upper position	0.03	1.07	8.10	0.79
	Middle position	0.00	0.35	6.88	2.76
	Lower position	0.29	0.62	8.81	0.29

Source: Questionnaire Household Survey, the Survey Team (2013)

Figure 2.4.13 shows the reason of low production for all the villages. The highest percentage is the shortage of rainfall. In the irrigation area under the 4 irrigation systems, monsoon paddy is the main crop which is mostly dependent on rainfall. The second reason is the shortage of irrigation water. In fact, numbers of the winter and summer season cultivation farmers are lower than that of monsoon paddy; however, the share of the answer is quite high ranked at second. It means many irrigation water users have been facing irrigation water shortage due probably to the dilapidated distribution systems.

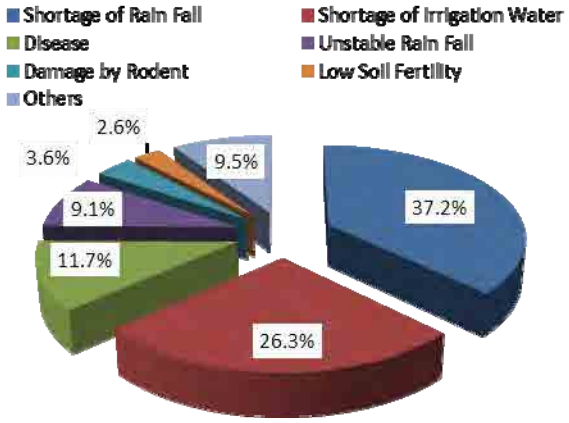


Figure 2.4.13 Reasons of Low Production in a Past Decade

Source: Questionnaire Household Survey, the Survey Team (2013)

A total of 73% of the low production reason is associated with water such as shortage of rainfall, shortage of irrigation water and unstable rainfall. Small amount of rainfall and the instability are one of the typical characteristics for low production in Myanmar, which may have been aggravated by global climate change. These can hardly be corrected by an artificial way while irrigation water shortage could be overcome with the rehabilitation works completed for the 4 irrigation systems targeted under this Survey.

Agriculture related difficulties in the Survey area are summarized in Figure 2.4.14 by village position. Though the water is the major problem as indicated in the aforementioned figure, percentage of irrigation water shortage is higher in the lower position. High price of agricultural input was listed as a difficulty in all the areas. According to a report[7], chemical fertilizer and fuel for agricultural use were once supplied with cheap price from the Government. However, the Government turned unable to supply enough amount of those inputs since 2000s because of the rise in the international prices.

Low market price is a problem more in the lower position villages, which has been felt due mainly to the low price of the summer paddy. The summer paddy cultivation takes about 4 months within the period from January to July. If the planting is delayed due to such reasons as late supply of irrigation

[7] Myanmar's Economy in Transition :Market Versus Control, Myanmar Agriculture in the Transition to an Open Economy2005, JETRO

water or delaying of winter crop cultivation, the harvest of summer paddy goes into rainy season. It is difficult to dry up the paddy in the rainy season, whereby the quality of rice is deteriorated leading to low market price.

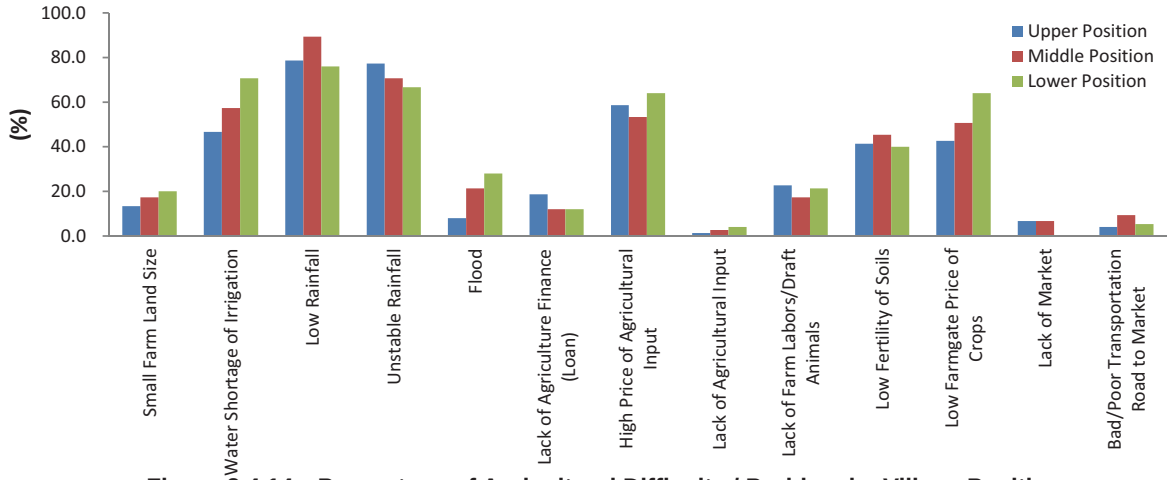


Figure 2.4.14 Percentage of Agricultural Difficulty / Problem by Village Position

Source: Questionnaire Household Survey, the Survey Team (2013)

2.4.9 Source of Agricultural Information

Figure 2.4.15 shows the percentage of agricultural information access by source. As shown in the figure, information from other farmers shows the highest reply for all the locations. The second information source is DOA extension staff. According to the interviews with township DOA officers, some extension staff live in the villages and discuss with the farmers about agricultural issues and new technics at least 4 days per week. Aside from such service, DOA has carried out several trainings for farmers such as GAP (good agricultural practice), agricultural chemical usage, etc. Agricultural business companies have also carried out some lectures for farmers in order to promote their inputs. Information from such companies shares the most in the reply of 'Others'.

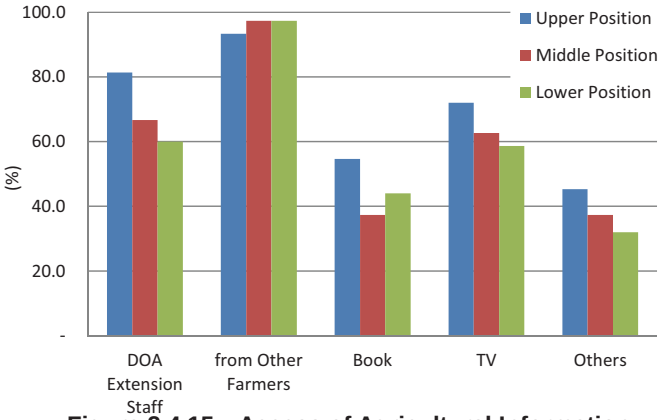


Figure 2.4.15 Access of Agricultural Information

Source: Questionnaire Household Survey, the Survey Team (2013)

2.4.10 Agriculture Extension

Agriculture extension in Myanmar is undertaken by Department of Agriculture (DOA[8]), one of 14 departments under MOAI. The DOA is headed by the director general (DG), under whom there are 2 deputy director generals (DDG). One of the 2 DDGs leads the 6 technical divisions of the headquarters while the other DDG leads the extension cadre of DOA offices starting at region/state, followed by district and then township (TS)/ sub-township (see Figure 2.4.16). So-called extension officers are posted in those offices of region/state, district and township/sub-township totaling as many as 14,221 composed of both officers and staff as of 2012/13.

[8] It was formerly called MAS (Myanma Agricultural Services), and changed to DOA in 2011/12.

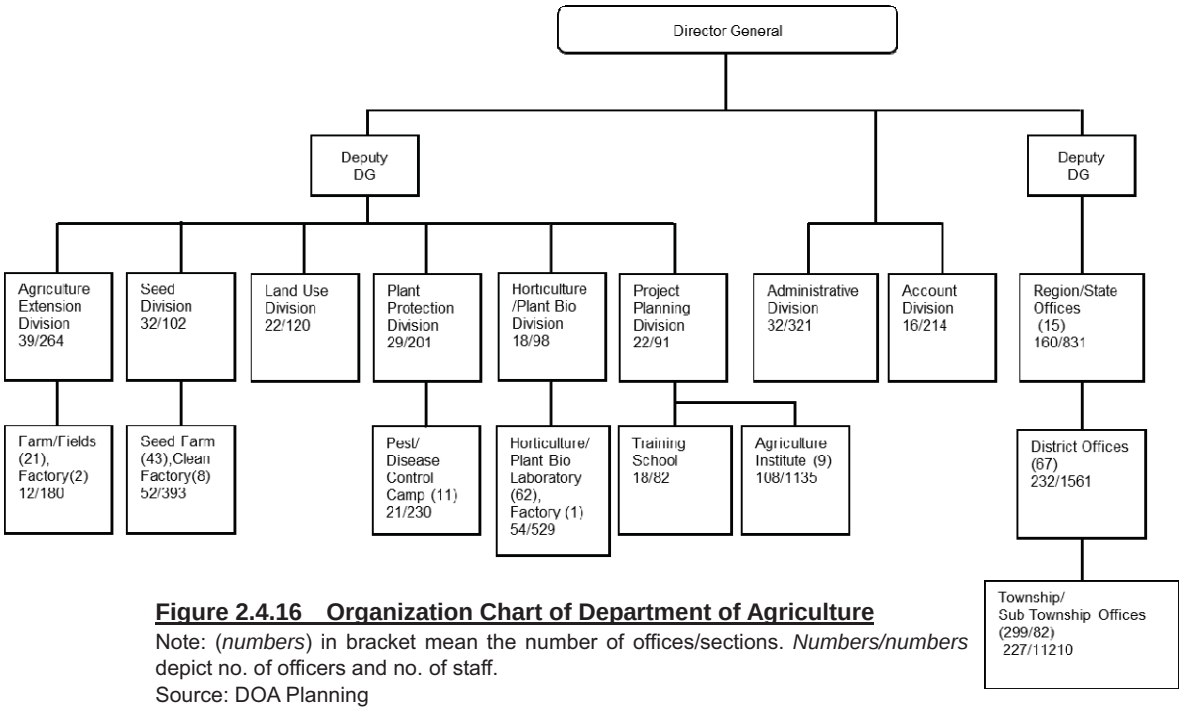


Figure 2.4.16 Organization Chart of Department of Agriculture

Note: (*numbers*) in bracket mean the number of offices/sections. *Numbers/numbers* depict no. of officers and no. of staff.
Source: DOA Planning

1) Agriculture Extension in the Target Project Area

The target 4 irrigation systems are located in 6 townships of Pyay, Paung De, Thae Kone, Pauk Khaung, Zee Kone, and Nattalin, which are then covered by 2 districts. The first 4 townships are under Pyay district while the remaining 2 townships fall in Tharrawaddy district. DOA has extension office at all the 6 townships as well as at the 2 districts. Table 2.4.8 summarizes numbers of village tracts, villages and number of farmer households by township together with staff allocation while Table 2.4.9 shows those of district DOA offices.

Table 2.4.8 Staffing of Township DOA Offices (2013)

Township	Village Tract	Village	No. of Farmer Hhs	Town-ship Officer	Deputy Officer	Assis-ttant DO	Sub Assis-ttant DO	Appren-tice	Total	Village / Staff
Pyay	60	272	22,280	1	5	13	2	3	24	11
Pauk Khaung	58	227	26,490	1	2	4	2	8	17	13
Thae Kone	53	345	26,444	1	3	18	12	3	37	9
Paung De	44	238	28,598	1	5	10	8	10	34	7
Nattalin	78	331	32,519	1	6	12	6	9	34	10
Zee Kone	29	132	13,398	1	3	15	7	10	36	4
Average	54	258	24,955	1	4	12	6	7	30	9

Note: For the number of farmer households, those of Nattalin and Zee Kone were estimated at 80% of total number of households in the township while the others were based on the no. of agricultural land holders.
Source: DOA Planning, according to interviews to the township DOA offices, JICA Survey Team

Table 2.4.9 Stuffing of District DOA Offices (2013)

District	Township	District Officer	Deputy DO	Seed	Plant protection	Land use	Extension	Total
Pyay	6	1	1	2	2	1	10	17
Tharrawaddy	8	1	7	1	2	1	13	25
Average	7	1	4	1.5	2	1	11.5	21

Note: Deputy DO holds the post of administration and planning.
Source: according to interviews to the township DOA offices, JICA Survey Team

At the township level, there is one township officer, the head of the township DOA office, under whom there are deputy officers (DOs), assistant DOs, sub-assistant DOs, and apprentices. Total number of staff ranges from 17 to 37 per township DOA office with an average of 30. Accordingly, it is known that each one of the township officer/staff is supposed to take care of 4 to 13 villages with an

average of 9 villages, equivalent to approximately 400 to 1,600 farmer households (average 800). However, in fact, assistant DOs and sub-assistant DOs mostly take charge of many villages, who are thus the central figure in delivering agricultural extension services.

According to above Table 2.4.9, there are 17 personnel and 25 personnel of the district DOA offices of Pyay and Tharrawaddy. They are composed of district officer (DO), deputy DO, and the rest assigned to technical sections such as seed, plant protection, land use, and extension. In fact, workforce assigned to extension section shares the largest number of personnel, occupying about half to more than that (e.g. 10 extension staff out of 17, 13 out of 25 for Pay and Tharrawaddy respectively).

2) Educational Background for Extension Personnel

An interview was made to Tharrawaddy district DOA office and 3 township DOA offices of Thae Kone, Paung De and Pyay, asking their educational background. According to the figure below, they are all from one of the three institutes as; Yezin University of Agriculture, State Agricultural Institutes (SAI), and State Agricultural High school (SAH). Graduates from Yezin University of Agriculture are more found in the district office. For the both offices at district and township levels, the majority are from State Agricultural Institutes, who in fact are the ones working in the field the most.

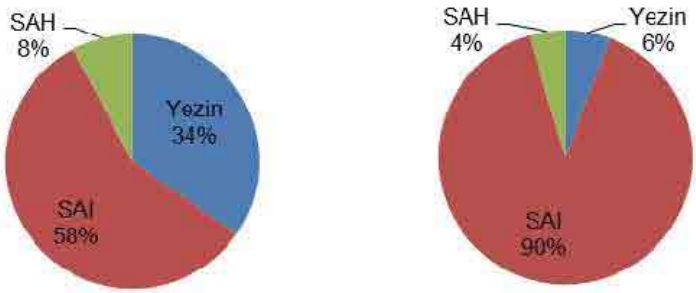


Figure 2.4.17 Educational background of Extension Officers/Staff

Note: left figure shows educational background for Tharrawaddy district, while the right figure for the townships of Pyay, Thae Kone, and Paung De

Source: according to interviews to the District and the township DOA offices, JICA Survey Team

3) Logistics Availability and Expenditures

Logistics availability is shown in Table 2.4.10 by district and township offices. Each district office owns one vehicle, which has been used to make an inspection visit to the subordinate township offices and model farms. Motorcycles and bicycles have not been provided by the government to most of the district and township offices. Extension officers/staff have therefore been using their own motorcycles and bicycles when they need to work in the villages. Those officers/staff who do not have motorcycles or bicycles usually go to the villages using a line bus or share motorcycles with their colleagues.

Table 2.4.10 Logistics Availability of District and Township DOA Offices (2013)

District / Township		Total no. of staff	Office owned, NOS			Personal owned, NOS		
			Vehicle	Motorcycle	Bicycle	Vehicle	Motorcycle	Bicycle
Township	Pyay	24	-	-	-	-	4	3
	Pauk Khaung	17	-	2	1	-	15	-
	Thae Kone	37	-	-	3	-	32	-
	Paung De	34	-	-	-	-	27	5
	Nattalin	34	-	-	-	-	28	8
	Zee Kone	36	-	-	-	-	37	2
	Average	32	-	0.3	0.7	-	23.8	3.0
District	Pyay	17	1	-	-	1	6	-
	Tharrawaddy	25	1	-	-	-	10	7
	Average	21	1.0	-	-	0.5	8.0	3.5

Source: according to interviews to the township DOA offices, JICA Survey Team

Table 2.4.11 shows actually spent expenditures in 2012/13 for the purpose of agricultural extension by

each township DOA office. The average expenditure for the agricultural extension works comes to about 1.9 million Kyat/year except for 2 townships (Pyay & Paung De which include salary). The expenditures were used for procuring agricultural materials (fertilizer, seed, etc.) of demonstration or training, reception for visit of Headquarters or regional/state officers and producing materials for trainings (e.g. pamphlets, vinyl posters, signboards, etc.).

Expenditure for fuel was spent from 1.3 million Kyats to 3.1 million Kyats by township DOA office. In fact, most of the township offices have a fixed amount for fuel allocation of motorcycle by the position s/he holds. For example, in Pauk Khaung township DOA office, 15,000 Kyats/month is provided for staff officer; 10,000 Kyat/month for deputy officer, 7,000 Kyats/month for assistant DO, 5,000 Kyats/month for sub-assistant DO and apprentice. Since fuel cost as of July 2013 stands at 1,100 Kyats/liter, such allocation hardly allows them to fully engage in extension.

Table 2.4.11 Expenditure for Agricultural Extension Works by Township DOA Office (2012/13)

Township	Actual expense for extension work		Expense for fuel	Expense for camp repair
Pyay	1/	27,976,205	1,813,450	–
Pauk Khaung		1,521,000	1,356,000	–
Thae Kone		2,720,000	3,096,000	500,000
Paung De	1/	17,607,445	1,998,000	–
Nattalin		1,710,000	2,925,000	–
Zee Kone		1,780,000	2,602,000	–
Average	2/	1,932,750	2,298,408	83,333

Note: 1/ the expenditures include salary, 2/ average expenditure except for two townships
Source: according to interviews to the township DOA offices, JICA Survey Team

There is one more item for the expenditure; expenditure for camp establishment. Camp is a sort of demonstration farm where new agricultural techniques are introduced and disseminated. The camps are established within a government owned farmland or in a privately owned farmland. When a new camp is to be constructed, an earmarked budge for that purpose is allocated to the township DOA office from the Headquarters. However, since budget for maintaining the camp is not always allocated as shown in the table, renovation/rehabilitation of camps have rarely taken up.

Table 2.4.12 shows the extension related expenditures from 2010/11 to 2012/13 for the 2 districts of Pay and Tharrawaddy. The expenditures are categorized in 3 groups such as the one for extension work, for fuel and for traveling allowance. The average expenditure for the agricultural extension works comes to about 1.9 to 2.1 million Kyat/year almost same as those of township DOA offices.

For the expenses of vehicle fuel, the 2 district offices used almost same amount of approximately 1 million Kyats/year as the average for the last 3 years. On the other hand, the expense for the travel allowance is much higher in Tharrawaddy district; 1.8 million for Pyay district and 2.7 million Kyats/year for Tharrawaddy district as the average of the last 3 years, which is due to the many number of officers/staff in the latter office (17 vs 25 officers/staff in total).

Table 2.4.12 Expenditure for Agricultural Extension Works by District Office (2010/13)

Township	Particular (kyat/year)	2010-2011	2011-2012	2012-2013	Average
Pyay	Expense for extension work	1,314,000	2,660,000	2,000,000	1,991,333
	Expense for fuel (vehicle)	810,000	850,500	1,766,250	1,142,250
	Expense for traveling allowance, 1/	1,431,680	1,872,000	2,155,000	1,819,560
	Total	3,555,680	5,382,500	5,921,250	4,953,143
Tharrawaddy	Expense for extension work	2,129,000	992,500	3,220,000	2,113,833
	Expense for fuel (vehicle)	1,014,000	615,250	1,273,950	967,733
	Expense for traveling allowance, 1/	2,285,305	2,988,980	2,841,000	2,705,095
	Total	5,428,305	4,596,730	7,334,950	5,786,662

Note: 1/ it includes fuel of motorcycle they use.
Source: according to interviews to the district DOA offices, JICA study team

4) Extension Activities

According to interviews to the township DOA offices, the township officer usually visits villages at three times per month, and the deputy officers do six times per month. For the assistant DOs and sub-assistant DOs, they are supposed to visit villages at 15 times per month on average. Major contents of agricultural extension service are on cultivation methods, recommendable cropping patterns, promotion of GAP (Good Agricultural Practice), appropriate application of fertilizer, pesticide and fungicide, production of good seed, promotion of high yield variety, and in cases hybrid variety of paddy.

Extension activities become more intensive when approaching to the season's start. Extension activities, of course, depend on what crops are to be cultivated in the farmlands, outbreak condition of pests and diseases and also according to requests from the clientele farmers. Sometimes district and/or regional officer/staff are dispatched to the townships or even to villages depending upon the situation. The places where training is held are, in most cases, monastery, school, individual villager's house yard, farmland of e.g. village chairperson, camp, and model farmland.

Extension officers/staff deliver training/lecture on the recommended cropping pattern following the target yield and target area pre-set by each township; however, practically most of the farmers apply their cropping patterns themselves depending upon the availability of irrigation water and also the amount of rainfall. Model farms are often established, at which high yield variety or hybrid variety of paddy is usually demonstrated in recent years. Aide from the township officers, regional and district officers also make visit to such model farm frequently.

Hybrid variety of paddy, especially 'Palae Thwe', is promoted to the farmers in recent years. It needs about 110 days of cultivation period and is expected to harvest 120-160 baskets/acre. Farmers can buy seeds of 'Palae Thwe' at 3,000 Kyats/kg in their township DOA office. However, pest and disease, e.g. *Bacterial leaf blight, Bacterial leaf stripe*, have occurred in some fields growing the hybrid variety.

Therefore, high yield varieties are also extended to farmers. According to interviews to the Tharrawaddy district DOA office 'Sin Thwe latt' and 'Yadanar Toe', Myanmar adopted high yield varieties, can be cultivated in 135 days, less than other local varieties requiring 145-150 days. Yield of the high yield variety usually ranges from 80 to 100 baskets/acre given the input of 0.5 – 1 bag/acre of urea (1bag=50kg), 0.5 bag/acre of NPK and manure.

2.5 Farm and Farmers Economy

2.5.1 Farm Economy by Major Crop

Table 2.5.1 shows the gross profit per farmer household by major crop and by position. As indicated, the average size of monsoon paddy area harvested per household is the largest in the middle position villages with 9.5 acre, secondly lower position villages with 8.4 acre and thirdly upper position villages with 6.0 acre. The highest yield shows up in lower position villages among the three locations. Farm gate price does not change much by location. The largest gross profit of monsoon paddy per household shows up in the lower position villages (1,893,392.3 Kyat), then the middle position villages (1,703,889.6 Kyat), and the last is upper position villages (1,265,153.4 Kyat).

For the summer paddy, upper position villages show the highest in the cultivation households, followed by middle position villages and lastly lower position villages. The yield of lower position villages is the highest same as monsoon paddy (73.2 baskets). Accordingly, the gross profit in lower position villages is the highest (1,401,730.2 Kyat). Farm gate price of upper position villages is higher than others by about 300 Kyat per basket. Higher farm gate price in the upper position villages may be correlated with the availability of irrigation water earlier than mid and lower locations, enabling the

harvest before the onset of rainy season.

About half of the households cultivate black gram in upper and lower villages and it is a quarter in the middle position villages. Harvested area, yield and farm gate price are the highest in the middle position villages, thus gross profit in the middle position villages is the highest accordingly. The yield and farm gate price in the lower position village is the lowest amongst the three positions. Winter crop, mostly black gram here, grows with irrigation in the 4 irrigation systems. It can be said that low yield and low quality indicated by low farm gate price may have been caused by the lack of irrigation water.

Table 2.5.1 Gross Profit by Crop and By Position per Farmer Household

Crops and Positions		% of household	Area Harvested	Yield	Production	Farm Gate Price	Gross Profit
		(%)	(Acre)	(Basket/Acre)	(Basket)	(Kyat/Basket)	(Kyat)
Monsoon Paddy	Upper Position	97.3	6.0	55.3	331.8	3,813.0	1,265,153.4
	Middle Position	100.0	9.5	47.6	452.2	3,768.0	1,703,889.6
	Lower Position	100.0	8.4	60.8	510.7	3,707.3	1,893,392.3
	Total. Ave.	99.1	8.0	54.2	433.5	3,762.3	1,630,847.4
Summer Paddy	Upper Position	92.0	4.1	59.6	244.4	3,405.8	832,241.3
	Middle Position	80.0	5.1	54.4	277.4	3,025.0	839,256.0
	Lower Position	46.7	6.2	73.2	453.8	3,088.6	1,401,730.2
	Total. Ave.	72.9	4.9	61.3	301.3	3,198.8	963,812.7
Pulses (Black Gram)	Upper Position	50.7	6.4	15.7	100.5	15,934.2	1,601,068.4
	Middle Position	25.3	6.6	20.5	135.3	16,000.0	2,164,800.0
	Lower Position	52.0	5.7	10.1	57.6	15,197.4	874,914.3
	Total. Ave.	42.7	6.2	14.6	90.0	15,647.9	1,408,832.6

Source: Questionnaire Household Survey, the Survey Team (2013)

Table 2.5.2 shows the gross profit by crop and by position per unit of area, acreage and hector. For the monsoon paddy, given the highest yield at lower position, the profit in the lower position comes highest, followed by that of upper position and then mid position. Trend of the summer paddy's gross profit by position is same as that of monsoon paddy. Comparing the gross profit between monsoon paddy and summer paddy per unit area, gross profit for the former is higher than that of summer paddy since the farm gate price of the former is higher. This is because drying condition for the monsoon paddy is better than that of summer paddy which has to be dried up already during rainy season. On the black gram, with the lowest yield and lowest farm gate price in the lower position, the lower position black gram fetches the lowest gross profit accordingly.

Table 2.5.2 Gross Profit by Crop per Acre/Ha by Position

Crops and Positions		% of household	Production		Farm Gate Price	Gross Profit	
		%	Basket/ac	Basket/ha	Kyat/Basket	Kyat/ac	Kyat/ha
Monsoon Paddy	Upper Position	97.3	55.3	136.5	3,813.0	210,858.9	520,474.5
	Middle Position	100.0	47.6	117.6	3,768.0	179,356.8	443,116.8
	Lower Position	100.0	60.8	150.1	3,707.3	225,403.8	556,465.7
	Total. Ave.	99.1	54.2	133.8	3,762.3	203,758.8	503,395.7
Summer Paddy	Upper Position	92.0	59.6	147.2	3,405.8	202,985.7	501,333.8
	Middle Position	80.0	54.4	134.4	3,025.0	164,560.0	406,560.0
	Lower Position	46.7	73.2	181.0	3,088.6	226,085.5	559,036.6
	Total. Ave.	72.9	61.3	151.4	3,198.8	196,086.4	484,298.3
Pulse (Black Gram)	Upper Position	50.7	15.7	38.9	15,934.2	250,166.9	619,840.4
	Middle Position	25.3	20.5	50.7	16,000.0	328,000.0	811,200.0
	Lower Position	52.0	10.1	24.9	15,197.4	153,493.7	379,935.0
	Total. Ave.	42.7	14.6	36.2	15,647.9	228,459.3	566,454.0

Source: Questionnaire Household Survey, the Study Team (2013)

Table 2.5.3 summarizes the input cost by crop per household. For the monsoon paddy, the harvested area per farmer in the middle position villages is the largest (9.5 acre), leading to the highest input cost at the middle position amongst the 3 locations with 188,541.3 Kyats. Further for the summer paddy,

the harvest area and input cost in the upper position village is the lowest (4.1 acre and 137,898.6 Kyat) but the yield is higher than that of middle position (59.6 baskets vs. 54.4 baskets). Among all paddy cultivation, the cost of urea is the highest among fertilizer and agricultural chemicals.

As for the black gram, representative crop for winter season, seed cost at lower position villages is higher than others while the cost of agricultural chemicals and also total cost are lower as per farmer household. Cost of fertilizer per farmer household is quite low across the 3 positions and it does not change much among the three positions. On the other hand, farmers spend certain cost on the agricultural chemicals, especially, insecticide, fungicide and bio-pesticide or bio- fertilizer for growing the black gram.

Table 2.5.3 Cost of Input for Cultivation per Household

Particulars	Area Harvested	Seed	Urea	Triple Super-phosphate	Compound Fertilizer	Compost	Insecticide	Fungicide	Herbicide	Bio Pesticide & Fertilizer	Total
	(Acre)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(Kyat)
Monsoon Paddy											
Upper Position	6.0	2,914.4	74,924.7	25,760.3	2,746.6	12,609.6	2,842.5	390.4	6,801.4	-	128,989.7
Middle Position	9.5	3,440.0	98,709.3	37,985.3	16,933.3	27,286.7	1,786.7	-	2,400.0	-	188,541.3
Lower Position	8.4	3,700.0	127,303.3	17,700.0	4,680.0	17,269.3	3,702.7	-	400.0	-	174,755.3
Total Ave.	8.0	3,355.4	100,540.1	27,161.0	8,168.2	19,113.0	2,776.7	127.8	3,168.2	-	164,410.3
Summer Paddy											
Upper Position	4.1	16,876.8	64,050.7	20,891.3	5,108.7	20,437.7	4,023.2	679.7	5,758.0	72.5	137,898.6
Middle Position	5.1	23,941.7	93,533.3	30,502.5	15,237.5	34,641.7	2,568.3	-	333.3	166.7	200,925.0
Lower Position	6.2	54,685.7	129,371.4	22,014.3	9,400.0	21,828.6	7,414.3	85.7	-	-	244,800.0
Total Ave.	4.9	27,530.5	88,777.4	24,647.3	9,730.2	25,931.1	4,214.6	304.3	2,544.5	91.5	183,771.3
Black Gram											
Upper Position	6.4	4,315.8	-	-	-	-	107,171.1	60,394.7	-	77,276.3	249,157.9
Middle Position	6.6	4,736.8	-	-	-	210.5	106,789.5	62,368.4	-	70,368.4	244,473.7
Lower Position	5.7	14,128.2	2,505.1	-	-	-	25,405.1	17,628.2	-	28,428.2	88,094.9
Total. Ave.	6.2	8,385.4	1,017.7	-	-	41.7	73,878.1	43,411.5	-	56,064.6	182,799.0

Source: Questionnaire Household Survey, the Survey Team (2013)

Table 2.5.4 shows the input costs by major crop per unit area. For the monsoon paddy, total input cost per unit area shows the highest at the upper position, followed by lower position and then mid position though the difference is not much amongst the 3 positions. Input cost for summer paddy is much higher than that of monsoon paddy, approximately 2 times higher. Much difference comes from the seed and also from the urea fertilizer. The seed for summer paddy is a high yield one, including hybrid type, whereby it requires more amount of fertilizer. For the pulses (black gram), the input cost at the lower position is by far lower than those of upper and middle positions, less than half. Lower position farmers use little amount of agriculture chemicals than upper and middle positions' farmers.

Table 2.5.4 Cost of Input for Cultivation per Acre/Ha by Position

Crops and Positions	Seed	Urea	Triple Super-phosphate	Compound Fertilizer	Compost	Insecticide	Fungicide	Herbicide	Bio-Pesticide Bio-Fertilizer	Total	
	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ha
Monsoon Paddy											
Upper Position	483.7	12,434.9	4,275.3	455.8	2,092.8	471.8	64.8	1,128.8	-	21,407.9	52,899.9
Middle Position	362.5	10,401.4	4,002.7	1,784.3	2,875.3	188.3	-	252.9	-	19,867.4	49,093.3
Lower Position	438.2	15,077.4	2,096.3	554.3	2,045.3	438.5	-	47.4	-	20,697.4	51,144.4
Total. Ave.	419.2	12,561.5	3,393.5	1,020.5	2,388.0	346.9	16.0	395.8	-	20,541.5	50,759.1
Summer Paddy											
Upper Position	4,135.3	15,694.2	5,119.0	1,251.8	5,007.8	985.8	166.5	1,410.9	17.8	33,789.1	83,494.5
Middle Position	4,671.5	18,250.4	5,951.7	2,973.2	6,759.3	501.1	-	65.0	32.5	39,204.9	96,877.3
Lower Position	8,820.3	20,866.4	3,550.7	1,516.1	3,520.7	1,195.9	13.8	-	-	39,483.9	97,566.7
Total Ave.	5,601.0	18,061.7	5,014.5	1,979.6	5,275.6	857.5	61.9	517.7	18.6	37,388.0	92,387.8
Pulse (Black Gram)											
Upper Position	670.1	-	-	-	-	16,639.4	9,376.9	-	11,998.0	38,684.4	95,591.1
Middle Position	718.6	-	-	-	31.9	16,199.6	9,461.1	-	10,674.7	37,085.8	91,641.0
Lower Position	2,482.0	440.1	-	-	-	4,463.1	3,096.8	-	4,994.1	15,476.1	38,242.3
Total Ave.	1,359.8	165.0	-	-	6.8	11,980.2	7,039.7	-	9,091.6	29,643.1	73,249.6

Source: Questionnaire Household Survey, the Survey Team (2013)

Table 2.5.5 summarizes average total cost of labor and out-sources per farmer household by crop and by village position. Almost all farmers hire labors during busy farming season such as land preparation, seeding & transplanting, harvesting and threshing for paddy cultivation. Weeding is also done by labor in many farms. Fertilizer application and agricultural chemicals application are mainly done by own farmers in paddy cultivation. Summer paddy needs to apply the irrigation water. According to the interviews to farmers, the water fee for summer paddy is 1,950 Kyat per acre; however, in fact farmers seldom pay the fee, thus the average water fee in the table is lower than the prescribed price.

Same as paddy cultivation, land preparation cost, harvesting cost and threshing cost are high in the black gram cultivation. In addition, pesticide or fungicide application costs are also high, relatively. Weeding is done by farmer themselves or otherwise not done much. Fuel cost for pumping is higher in the middle position villages where they use personal diesel engine pump to lift water from nearby drainages. Comparing the paddy cultivation with black gram, seeding & transplanting cost and weeding cost are lower for the black gram cultivation. As a result, the total labor and outsourcing cost for black gram is lower than those of paddy cultivation.

Table 2.5.5 Labor and Outsourcing Costs per Household

Items	Unit	Monsoon Paddy				Summer Paddy				Pulse (Black Gram)			
		Upper position	Middle Position	Lower Position	Total Ave.	Upper position	Middle Position	Lower Position	Total Ave.	Upper position	Middle Position	Lower Position	Total Ave.
Area Harvested	(Acre)	6.0	9.5	8.4	8.0	4.1	5.1	6.2	4.9	6.4	6.6	5.7	6.2
Land preparation	(Kyat)	45,532.9	64,265.3	86,764.0	65,700.0	40,552.2	26,456.7	49,751.4	37,358.5	51,210.5	58,539.5	80,128.2	64,408.9
Seeding & Transplanting	(Kyat)	95,446.6	158,517.3	157,164.7	137,415.9	66,153.6	90,480.4	115,188.6	85,518.4	5,368.4	-	1,846.2	2,875.0
Fertilizer application	(Kyat)	116.4	253.3	1,066.7	482.1	152.2	250.0	500.0	262.2	328.9	-	-	130.2
Pesticide/fungicide application	(Kyat)	68.5	-	300.0	123.3	-	-	285.7	61.0	13,513.2	6,315.8	11,871.8	9,078.1
Herbicide application	(Kyat)	89.0	-	-	29.1	146.4	-	-	61.6	-	2,052.6	-	406.3
Weeding	(Kyat)	39,129.5	49,216.0	34,014.7	40,801.6	15,535.5	27,915.0	28,257.1	22,779.6	-	-	-	-
Harvesting	(Kyat)	93,911.4	118,605.0	98,321.3	103,699.6	63,537.7	72,175.0	77,022.9	69,575.6	105,782.9	108,000.0	76,200.0	94,203.6
Threshing	(Kyat)	48,312.3	69,400.0	68,920.0	62,335.4	39,277.5	43,070.8	59,555.7	44,993.0	54,647.4	62,668.4	45,102.6	52,357.3
Transporting (Farm to dry yard)	(Kyat)	1,239.7	3,840.0	12,693.3	5,966.4	12,356.5	31,395.8	139,442.9	46,444.2	394.7	4,105.3	1,589.7	1,614.6
Drying / Packing	(Kyat)	1,246.6	1,853.3	600.0	1,233.2	2,376.8	1,433.3	285.7	1,585.4	300.0	1,210.5	256.4	462.5
Transporting (to market)	(Kyat)	4,493.2	11,976.0	853.3	5,785.7	8,673.9	5,180.0	-	5,544.5	3,765.8	-	-	1,490.6
Water Fee / Fuel cost for Pumping	(Kyat)	137.0	326.7	-	154.7	3,892.0	5,056.3	9,485.4	5,511.7	-	17,105.3	461.5	3,572.9
Total	(Kyat)	329,723.1	478,253.0	460,698.0	423,727.0	252,654.3	303,413.3	479,775.4	319,695.7	235,311.8	259,997.4	217,456.4	230,600.0

Source: Questionnaire Household Survey, the Survey Team (2013)

Table 2.5.6 indicates the labor and out-sourcing costs per unit area by major crop and by the location. Summer paddy needs the highest cost of labor and out-sourcing than monsoon paddy and also than pulses (black gram). Summer paddy's cost per unit area is higher than that of monsoon paddy by about 13 – 16% depending upon the position, and the paddy produced at the lower position needs the highest labor and out-sourcing cost amongst the 3 positions, i.e. 77,383 Kyats per acre. The cost of labor and out-sourcing per unit area for pulses is very low, which is about two-thirds of those of paddy.

Table 2.5.6 Labor and Outsourcing Costs per Acre/ Ha

Particulars	Unit	Monsoon Paddy				Summer Paddy				Pulse (Black Gram)			
		Upper position	Middle Position	Lower Position	Total Ave.	Upper position	Middle Position	Lower Position	Total Ave.	Upper position	Middle Position	Lower Position	Total Ave.
Land preparation	Kyat/ac	7,556.9	6,771.9	10,276.0	8,208.6	9,936.4	5,162.3	8,024.4	7,600.5	7,951.0	8,880.2	14,076.6	10,444.7
Seeding & Transplanting	Kyat/ac	15,840.9	16,703.6	18,614.1	17,168.8	16,209.5	17,654.7	18,578.8	17,398.6	833.5	-	324.3	466.2
Fertilizer application	Kyat/ac	19.3	26.7	126.3	60.2	37.3	48.8	80.6	53.3	51.1	-	-	21.1
Pesticide/fungicide application	Kyat/ac	11.4	-	35.5	15.4	-	-	46.1	12.4	2,098.1	958.1	1,072.1	1,472.1
Herbicide application	Kyat/ac	14.8	-	-	3.6	35.9	-	-	12.5	-	311.4	-	65.9
Weeding	Kyat/ac	6,494.1	5,186.1	4,028.6	5,097.8	3,806.6	5,446.8	4,557.6	4,634.5	-	-	-	-
Harvesting	Kyat/ac	15,586.1	12,497.9	11,644.8	12,956.3	15,568.5	14,082.9	12,423.0	14,155.1	16,423.9	16,383.2	13,386.5	15,276.3

Threshing	Kyat/ac	8,018.2	7,313.0	8,162.7	7,788.2	9,624.1	8,404.1	9,605.8	9,153.8	8,484.6	9,506.6	7,923.4	8,490.4
Transporting (Farm to dry yard)	Kyat/ac	205.8	404.6	1,503.4	745.4	3,027.7	6,126.0	22,490.8	9,449.0	61.3	622.8	279.3	261.8
Drying / Packing	Kyat/ac	206.9	195.3	71.1	154.1	582.4	279.7	46.1	322.5	46.6	183.6	45.0	75.0
Transporting (to market)	Kyat/ac	745.7	1,262.0	101.1	722.9	2,125.4	1,010.7	-	1,128.0	584.7	-	-	241.7
Water Fee / Fuel cost for Pumping	Kyat/ac	22.7	34.4	-	19.3	953.7	986.6	1,529.9	1,121.3	-	2,594.8	81.1	579.4
Total	**Kyat/ac**	**54,722.7**	**50,395.5**	**54,563.5**	**52,940.6**	**61,907.5**	**59,202.6**	**77,383.1**	**65,041.7**	**36,534.6**	**39,440.7**	**37,188.3**	**37,394.6**
	Kyat/ha	**135,222.6**	**124,529.8**	**134,829.3**	**130,819.1**	**152,976.6**	**146,292.7**	**191,217.7**	**160,721.3**	**90,279.0**	**97,460.1**	**91,894.2**	**92,404.0**

Source: Questionnaire Household Survey, the Survey Team (2013)

Estimated net profit of each village position per household is summarized in Table 2.5.7. As shown in the table, the largest net profit of monsoon paddy per farmer is recorded at lower position villages (1,257,939 Kyat) and net profit ratio is also the highest in the lower position (66.4%). The highest net profit of summer paddy shows up in lower position villages (677,154.8 Kyat) same as the monsoon paddy. However, the ratio of the net profit becomes the highest in upper position village (53.1%). The net profit of black gram per farmer is the highest in the middle position villages (1,660,329 kyat) and so does the net profit ratio (76.7%).

Table 2.5.7 Net Profit from Farming per Household

Crops and Location		% of cultivation household	Area Harvested	Gross Profit	Total Cost of Input	Cost of Labor & Outsource	Total Net Profit	Net Profit Ratio
		(%)	(Acre)	(Kyat)	(Kyat)	(Kyat)	(Kyat)	(%)
Monsoon Paddy	Upper Position	97.3	6.0	1,265,153.4	128,989.7	329,723.1	806,440.6	63.7
	Middle Position	100.0	9.5	1,703,889.6	188,541.3	478,253.0	1,037,095.3	60.9
	Lower Position	100.0	8.4	1,893,392.3	174,755.3	460,698.0	1,257,939.0	66.4
	Total Ave.	99.1	8.0	1,630,847.4	164,410.3	423,727.0	1,042,710.1	63.9
Summer Paddy	Upper Position	92.0	4.1	832,241.3	137,898.6	252,654.3	441,688.4	53.1
	Middle Position	80.0	5.1	839,256.0	200,925.0	303,413.3	334,917.7	39.9
	Lower Position	46.7	6.2	1,401,730.2	244,800.0	479,775.4	677,154.8	48.3
	Total Ave.	72.9	4.9	963,806.8	183,771.3	319,695.7	460,339.8	47.8
Pulses (Black Gram)	Upper Position	50.7	6.4	1,601,068.4	249,157.9	235,311.8	1,116,598.7	69.7
	Middle Position	25.3	6.6	2,164,800.0	244,473.7	259,997.4	1,660,328.9	76.7
	Lower Position	52.0	5.7	874,914.3	88,094.9	211,687.2	575,132.2	65.7
	Total Ave.	42.7	6.2	1,408,832.6	182,799.0	230,600.0	995,433.6	70.7

Source: Questionnaire Household Survey, the Survey Team (2013)

Table 2.5.8 shows the net profit from the major crops per unit area. In sum, for the lower position villages, paddy cultivation both monsoon and summer seasons can get high profit per unit area but winter crop (black gram) does lower profit. Percentage of cultivation household of summer paddy is lower in the position (46.7%), and to increase the percentage of it would contribute to increase the crop production. In the middle position, net profit ratio of paddy cultivation is lower (monsoon paddy: 60.8%, summer paddy: 40.2%) while winter crop profit and the ratio get higher (76.7%).

Table 2.5.8 Net Profit from Farming per Acre/ Ha

Crop and Positions		% of cultivation household	Gross Profit	Total Cost of Input	Cost of Labor & Outsource	Total Net Profit		Net Profit Ratio
		(%)	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ac	Kyat/ha	(%)
Monsoon Paddy	Upper Position	97.3	210,858.9	21,407.9	54,722.7	134,728.3	332,351.9	63.9
	Middle Position	100.0	179,356.8	19,867.4	50,395.5	109,094.0	269,493.7	60.8
	Lower Position	100.0	225,403.8	20,697.4	54,563.5	150,142.9	370,492.0	66.6
	Total Ave.	99.1	203,758.8	20,541.5	52,940.6	130,276.7	321,817.5	63.9
Summer Paddy	Upper Position	92.0	202,985.7	33,789.1	61,907.5	107,289.1	264,862.7	52.8
	Middle Position	80.0	164,560.0	39,204.9	59,202.6	66,152.5	163,390.0	40.2
	Lower Position	46.7	226,085.5	39,483.9	77,383.1	109,218.5	270,252.2	48.3
	Total Ave.	72.9	196,085.2	37,388.0	65,041.7	93,655.5	231,189.2	47.7
Pulse (Black Gram)	Upper Position	50.7	250,166.9	38,684.4	36,534.6	174,947.9	433,970.4	70.0
	Middle Position	25.3	328,000.0	37,085.8	39,440.7	251,473.5	622,099.0	76.7

Lower Position	52.0	153,493.7	15,476.1	37,188.3	100,829.3	249,798.5	65.7
Total Ave.	42.7	228,459.3	29,643.1	37,394.6	161,421.7	400,800.5	70.8

Source: Questionnaire Household Survey, the Survey Team (2013)

2.5.2 Farmers Economy: Income and Its Distribution (Gini Index)

The questionnaire household survey has identified farmers' income. The income under this Survey is defined as the cash the household has got from any kind of economic activities and plus the monetary value of any kind of production converted with farm gate price less the cost of necessary inputs. The former is very simple, e.g. cash from cottage industry, remittance, wage work, etc. and for the latter, for example, agriculture production is once valued with prevalent farm gate price at the area and its relevant gross income is subtracted by necessary cost of input required e.g. chemical fertilizers. Therefore, the income here discussed means only net monetary value.

Figure 2.5.1 shows the net average income per household divided into 2 categories of agriculture income and others than the agriculture income. The income is summarized by the location of villages where the questionnaire survey was conducted i.e. upstream (Up), midstream (Md) and downstream (Dn). It is known that the most of income come from agriculture production as was expected, ranging from 60% (South Nawin, mid) to 93% (Taung Nyo, upstream) with an average of 80.2 %. In terms of monetary value, the net income per household ranges from 1.27 million Kyats (South Nawin, Up) to 5.19 million Kyats (Taung Nyo, Up) with an average income of 2.4 million Kyats. The difference comes mainly from the size of the farmland.

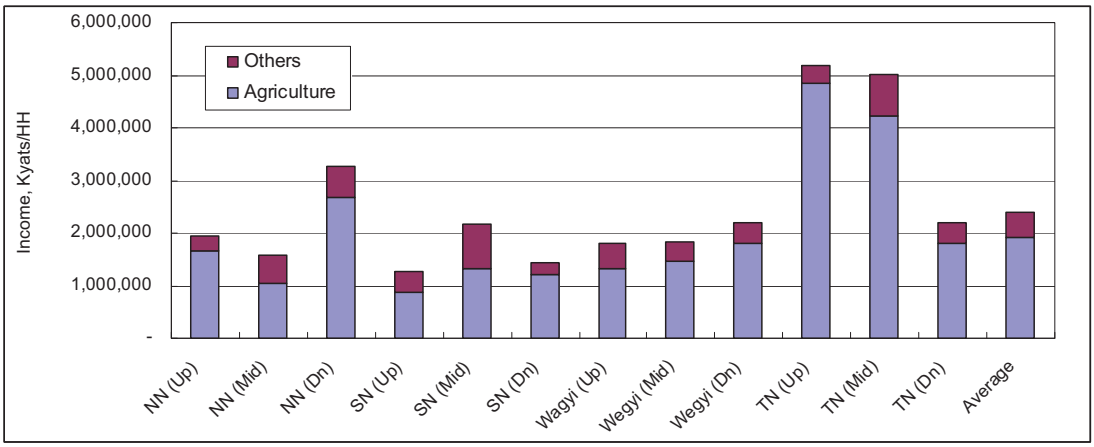


Figure 2.5.1 Household Income by Location, composed of Agricultural Income and Others

Source: Household Questionnaire Survey covering 225 HHs, JICA Survey Team

To measure the inequality for the income among the sampled households, Gini index is employed here. Gini index is understood by the geometry definition "area enclosed by the Lorenz curve and the diagonal". If one takes the horizontal axis as the cumulative share of people from lower income and draw the cumulative share of income earned, then the curve becomes Lorenz curve, and the area between the curve and the straight line (diagonal = even distribution line) becomes Gini index (the triangular area composed of the axis and the diagonal is assumed to be 1.0).

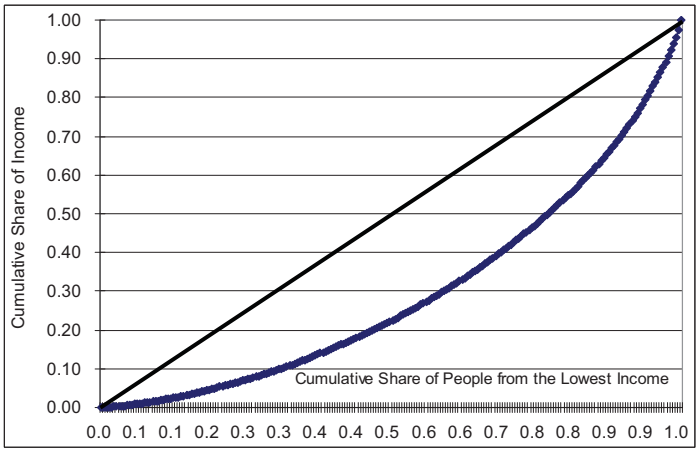


Figure 2.5.2 Lorenz Curve for the 225 Sampled Households

Source: JICA Survey Team (questionnaire household survey)

Figure 2.5.2 shows the Lorenz curves for the cumulative income of 225 sampled

households from the lower side, based on which Gini index is calculated. The Gini index is calculated at 0.362, which may seem slightly big comparing to those examples of other rural areas where economic difference by individual household is not existent much. However one may say the magnitude of Gini index is yet to be so big, rather falling in a range of a status where there is a desirable respect in the improvement of economy through competition as indicated in Table 2.5.9.

Table 2.5.9 Standard Interpretation of Gini Index

Gini Index	Standard Interpretation of Gini Index
Less than 0.1	There is an artificial background for leveling.
0.1 – 0.2	Though considerably equal, there is an anxiety to obstruct the effort to the improvement.
0.2 – 0.3	Usual distribution type that exists in general in society.
0.3 – 0.4	Though there are some differences, there is also a desirable respect in the improvement of economy through competition.
0.4 – 0.5	The difference is serious.
Over 0.5	The improvement is required except under special circumstances

Source: Wikipedia

2.6 Electrification in the Project Area

2.6.1 General Description of Electrification in Rural Area

Electric power industry in Myanmar is presently governed by the Ministry of Electric Power (MOEP), which came into an incorporation process between the MOEP1 and the MOEP2 in September, 2012. The MOEP2 was composed of Department of Electric Power (DEP), Myanmar Electric Power Enterprise (MEPE), Yangon City Electricity Supply Board (YESB) and Electricity Supply Enterprise (ESE). These departments and enterprises still exist under the MOEP as shown in Figure 2.6.1.

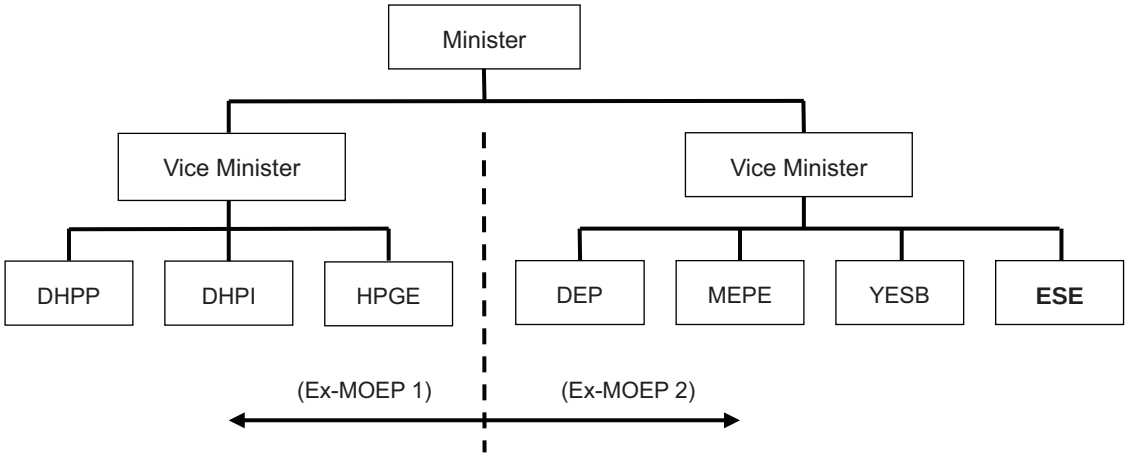


Figure 2.6.1 Organization of the MOEP

Source: Report of Research on Electric Power Situation in Myanmar as of 2012 (JEPIC)

Presently, electric power supply in rural areas is mainly performed by the ESE. In case that the access to the national transmission network is secured, the ESE constructs, operates and maintains distribution facilities from a substation connected to the national transmission network. If the access to the national transmission network is limited, the ESE installs small-scale power plant and/or diesel generator and supplies electricity through a distribution network independent from the national transmission network.

As for Bago region where the South Nawin, North Nawin, Wegyi and Taung Nyo irrigations systems are located, the electrification ratio is only 21.5%, as of 2011 which is less than the national average of 26.1% (source: Final Report of Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams). Considering that rural areas are generally electrified after electrification of urban areas has been progressed, it is predicted that there is plenty of scope for rural electrification in

Bago region, e.g. by taking advantage of released water from irrigation dams.

Concerning policy for rural electrification, in June, 2012, it was announced through an administrative policy speech by the President that the ratio of household electrification in Myanmar should be more than 75 % by 2015. In this regard, the MOEP has conceptualized some plans[9] for advancement of electrification as saying; 1) both extension of the national transmission networks and buildup of substations including upgrade of the existing facilities are implemented in every region and state, and 2) for the area where electric power is not supplied from the national transmission networks, electric power is supplied by means of small-scale hydroelectric power generation, diesel generator, biomass, etc.

The low electrification ratio in Myanmar is cause by many issues. Major difficulties to the progress of rural electrification are budgetary deficit and also procedure required for the government's permission which takes more than one year. Although lots of non-electrified villages hope to be electrified, the ESE has a principle to electrify a village which can bear the construction cost for electrification in preference to a village which cannot bear the cost. This is because the time required for the budgetary arrangement before the commencement of the construction is much shorter for the village which can bear the cost.

To progress the rural electrification, utilizing irrigation water can be an option. However, in general, a hydroelectric power generation using an irrigation system has a disadvantage unable to supply electricity when amount of irrigation water decreases. According to an operation plan, irrigation water is generally discharged from January to June for summer paddy and from October to November for monsoon paddy. On the other hand, release of irrigation water from July to September is very minimal only for making up for precipitation. Further, it is planned not to discharge irrigation water in December because December is the harvest season of monsoon paddy.

In above cases, electricity supply in July, August, September and December becomes problem. In case that a small-scale power generation plant can be connected to the national transmission network, electricity can be supplied from the national transmission network during the low water discharge period. Otherwise, other power source such as diesel generator shall be equipped together with a small-scale power generation plant, and consequently, cost for power generation increases.

In this regard, the MOEP considers small-scale power plant unreliable based on its past experience and does not permit to link a small-scale power plant less than 2,000kW to the national transmission network. However, considering that most of small-scale hydroelectric power plants less than 2,000kW are connected to the national grid in Japan, such small-scale hydroelectric power plant can be linked with the national transmission network. Further, according to the report on the "*Collection of Information regarding Small-Scale Hydroelectric Power generation utilizing Agricultural Water, etc., in Japan*," a hydroelectric power plant whose output is ranging from several dozen kW to 1,000kW can also be connected to a transmission line.

2.6.2 Present Situation of Electrification in the Project Area

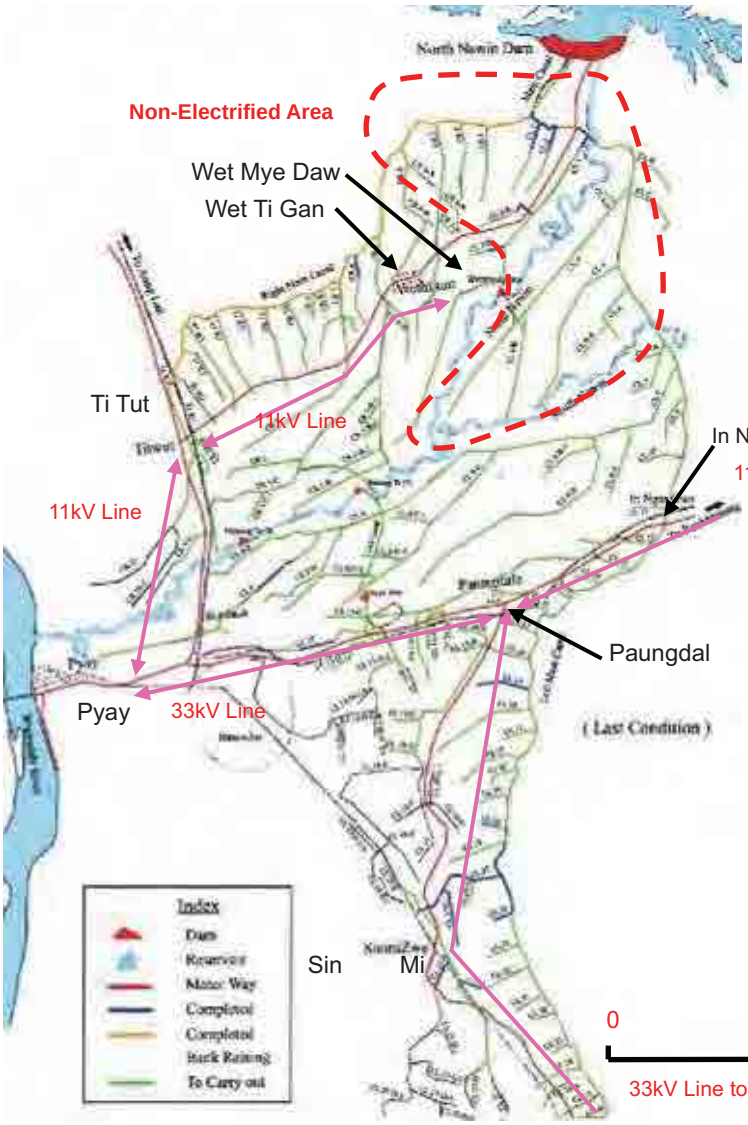
1) North Nawin Irrigation Area

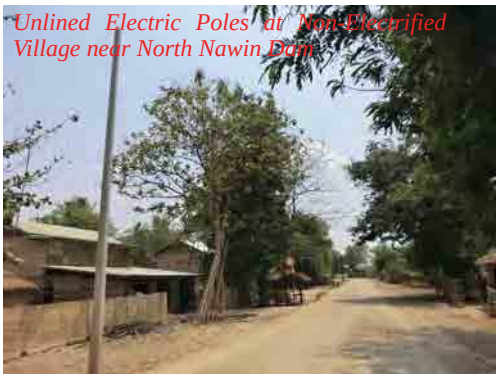
It is found that electrification has been done up to Wet Ti Gan town located at the halfway of the concrete-paved access road from Ti Tut village to the dam and that distribution line reaches Wet Mye Daw village located 2km-east from Wet Ti Gan town. However, the upstream area of Wet Ti Gan town is not electrified, and the most of households get electric power by means of solar power generation and storage it in batteries. However, not only production of electricity depends on a weather condition,

[9] Source: Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams

usage of electric power is also limited. Therefore, stable supply of electric power with an affordable price is strongly desired by the people in non-electrified area.

As of August 2013, unlined electric poles and a transformer are found in Si Zon Gon village located at 1 km-downstream from the dam. According to a villager, villagers living in several villages pooled money to purchase the electric poles and transformer for early electrification. This case seems to follow the ESE's principle for rural electrification as afore-mentioned that a village which can bear construction cost for electrification should be electrified earlier than a village which cannot bear the cost. According to the MOEP's West Bago office, seven non-electrified villages in the upstream of the irrigation canal often urge this office to electrify the villages, but the MOEP explains that the MOEP cannot undertake construction for electrification immediately due to budgetary restriction.





Unlined Electric Poles at Non-Electrified Village near North Nawin Dam

Transformer Placed by such Non-Electrified Villagers in North Nawin Irrigation System

Figure 2.6.2 Outline of Non-Electrified Area in North Nawin Irrigation System

Source: the Survey Team (2013)

2) South Nawin Irrigation Area

According to the MOEP's Bago West office in Pyay, 33kV transmission line reaches Paungdale town, which is located almost halfway of the asphalt-paved access road between Pyay town and Paukkaung town near South Nawin dam; and, at present, 11kv distribution line is extended from Paungdale town to Paukkaung town. Consequently, the surrounding area 3 miles (4.8 km) from Paukkaung town has

already been electrified, so that most of the upstream of South Nawin Irrigation system has also been electrified.

Furthermore, the MOEP has a plan to extend the above 33kV transmission line up to Paukkaung town and to newly place a substation. According to the MOEP, the surrounding area 10 miles (16.1 km) from Paukkaung town will be additionally electrified in near future.

Electrified Situation in Paukkaung Town near South Nawin Dam

Considering the above situation, the MOEP has an opinion that the development of the suspended South Nawin Hydroelectric Power Plant at the dam site does not have a priority even though this site has a potential for hydroelectric power generation. The reason is that most of other areas are still non-electrified, so that resource for electrification should be allocated to those non-electrified areas. If the hydroelectric power plant were developed, electric power could be supplied to the upstream of the dam which has not been electrified yet because the MOEP at present has no plan to extend distribution line there.

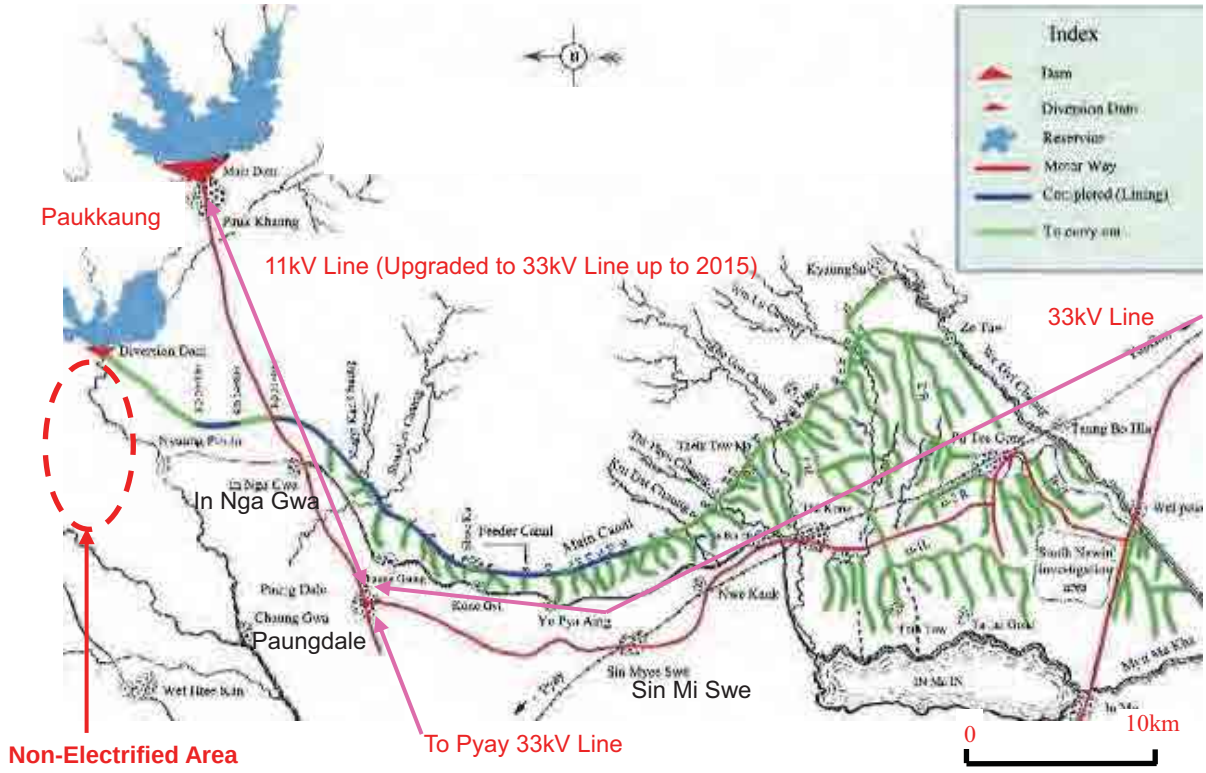
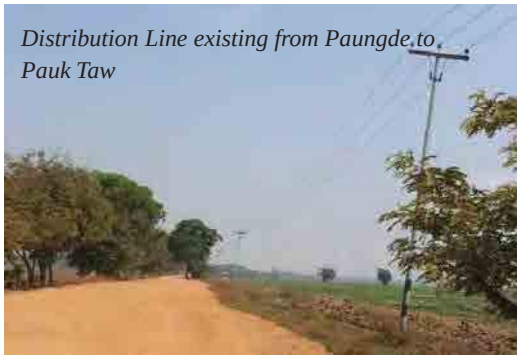


Figure 2.6.3 Outline of Non-Electrified Area in South Nawin Irrigation System

Source: the Survey Team (2013)

3) Wegyi Irrigation Area

As for the area along the Right Main Canal, an ID's site engineer explains that most of villages along the unpaved access road from Paungde town to Wegyi dam have been electrified because the distribution line connected to the national transmission network reaches Pauk Taw village located at almost 8km-southwest from the dam. In addition, the distribution line is branched out in an eastern direction at Pa Ya Nga Zu village on the



Distribution Line existing from Paungde to Pauk Taw

way to Pauk Taw village and reaches Le U Zu village.

On the other hand, the area along the Left Main Canal is not electrified, so that there is plenty of scope for electrification in this area. According to the MOEP's Bago West office, the MOEP presently has no plan to newly place a power plant and to extend distribution line to the non-electrified area. Considering budgetary restriction in the MOEP and priority given to the large-scale electric power development, the MOEP needs a support in this field.

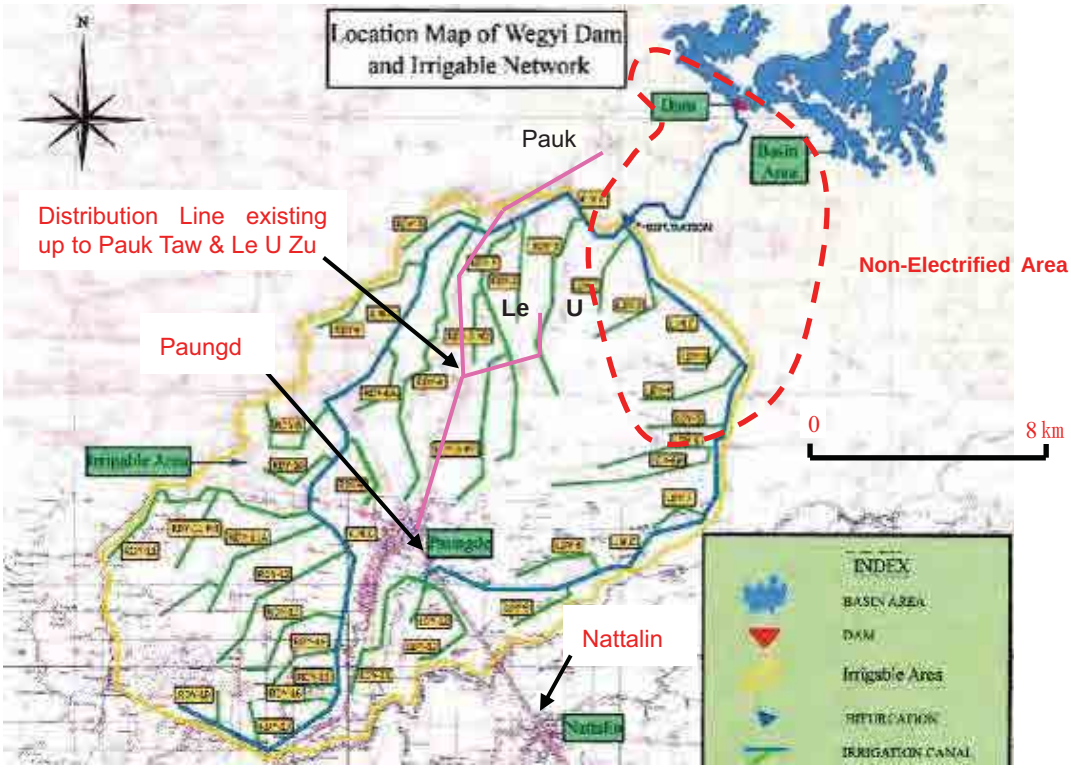


Figure 2.6.4 Non-Electrified Area in Wegyi Irrigation System

Source: the Survey Team (2013)

4) Taung Nyo Irrigation Area

As for the situation of electrification in the area along Taung Nyo Irrigation System, it is found that most of villages have not been electrified yet even though some areas which are close to the No.2 national highway connecting Yangon to Pyay are electrified. Tha Du Gan village located in almost 2 km-east from the center of Nattalin town has been electrified, while any other villages located in the east side of the village have not been electrified.

On the other hand, unlined electric poles are found in The Gyaung village located northeast of the electrified village. And, in Shan Zu village located next to The Gyaung village, it is found that distribution line is fixed on electric poles, but no electric power is supplied according to a villager in Shan Zu village. He explains that the distribution line was fixed in 2012, but it is unclear when electric power will be supplied. According to the MOEP's Bago West office, the MOEP presently has no plan to newly place any power plant and to extend distribution line to the non-electrified area.

In the non-electrified area, most of the households get electric power by means of solar power generation and storage it in batteries of automotive. However, not only production of electricity depends on a weather condition, usage of electric power is also limited. Therefore, stable supply of electric power with an affordable price is strongly desired by the rural population in the non-electrified areas.

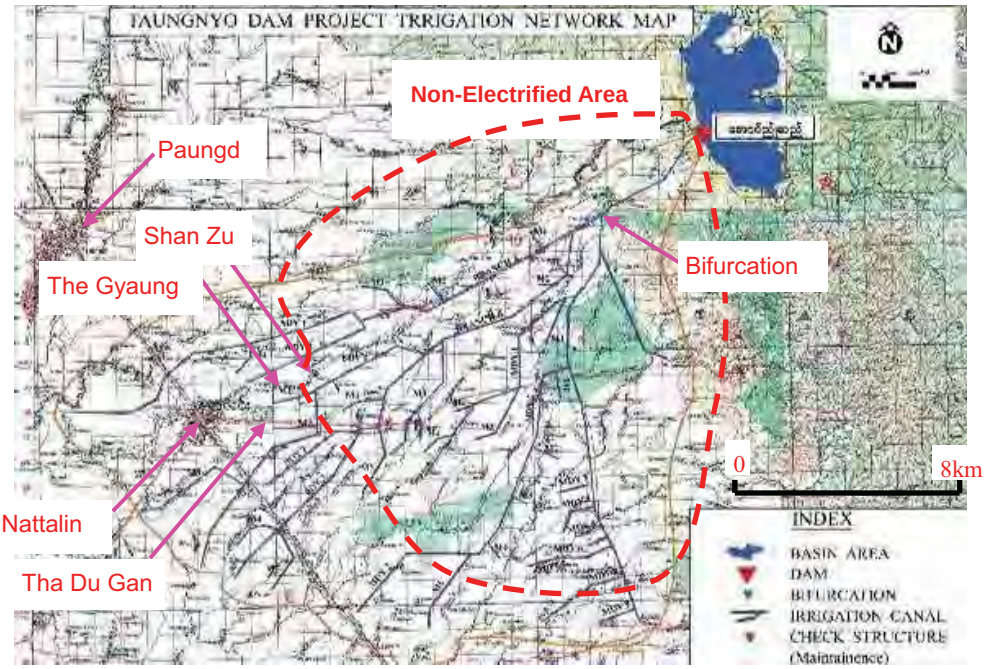


Figure 2.6.5 Outline of Non-Electrified Area in Taung Nyo Irrigation System

Source: the Survey Team (2013)

2.6.3 Potential Sites for Small-Scale Hydroelectric Generation in the Project Area

There are two ways to develop hydroelectric power generation utilizing irrigation facility. One is to make use of water head in an irrigation canal, and the other is to exploit water head created by an irrigation dam. As for the former, potential water head is generally found at a drop structure in an irrigation canal. A drop structure is placed in order to convert steep longitudinal gradient of canal into gentle one. And, vertical gap between water surfaces of the upstream and downstream canals are created by a drop structure.

In this study, the Survey Team mainly looks for potential sites in the upstream of the irrigation canals because amount of water in the upstream of an irrigation canal is larger than that of the downstream. In addition, it is found that the most of the downstream parts of 4 irrigation systems along the national highway have been already electrified. Note that turbines for hydroelectric power generation for lower water head less than 2 m is still in a validation phase even though the development is commenced. Therefore, the Survey Team precludes a site with such low water head.

As for the latter in which water head created by an irrigation dam is to be exploited, even though relatively high water head is created between reservoir water level and tail water level by irrigation dams, most of them are still unused for hydroelectric power generation in Myanmar. So, it could be possible to develop such potential sites for hydroelectric power generation according to the site condition and the pattern of releasing the reservoir water.

1) North Nawin Irrigation System

Any drop structure which is suitable for hydroelectric power generation cannot be found in the upstream of the irrigation canal. As for the dam, the irrigation outlet structure is malfunctioning at present. The sluiceway exposes steel conduit whose diameter is 8 feet (2.4m), and the steel conduit is inserted into the reinforced concrete encasement whose internal diameter is 13.5 feet (4.1m). The space between the steel conduit and the concrete encasement is filled with air in the original design. However, water surface in the manhole behind the valve chamber is found and the water surface is surging.

According to the " *Comprehensive Survey Report on Accident of Steel Conduit at North Nawin Dam*" released in November, 2010, it was suspected that the steel pipe was deformed and split by the fatigue fracture due to vibration and corrosion as well as tensile fracture due to temperature stress. The report concluded that the damaged steel pipe was not reusable and recommended to replace the damaged steel pipe with stronger one fixed with enough stiffener for keeping rigidity and to fill the space with concrete for prevention of vibration.

However, the ID is still using the damaged steel pipe with repair to cover the splits with steel plate, but water still leaks from the steel conduit. In addition, the gauge to indicate opening of the intake gate is also malfunctioning. Consequently, the gate operator does not know how much amount of water is released from the dam to the irrigation canal.

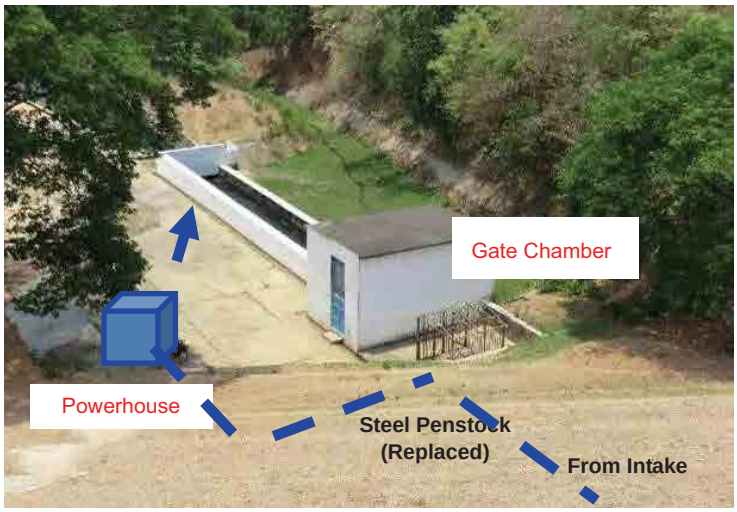


Figure 2.6.6 Conceptual Arrangement of Hydroelectric Power Plant at North Nawin Dam, Source: the Survey Team (2013)

Judging from the above, the Survey Team proposes to renew the malfunctioned irrigation outlet structure. Considered that the sluiceway is a pressured conduit, it is expected that a hydroelectric power plant can be additionally built into the irrigation outlet structure. For the reduction of head loss and increase of output, following should be studied in the next stage: 1) the position of the powerhouse to be the current position of the gate house suitable or not, and 2) the diameter of the steel penstock should be larger than the present one.

a) Maximum Discharge

Since the amount of discharge of irrigation water based on the cropping pattern has not been obtained, the maximum discharge of this plant is set to be a 50% probable outflow discharge for irrigation. From the duration curve of monthly irrigation water release from the dam from 1997 to 2012 as shown below, the maximum discharge of this project, *Qmax*, is set at 4.1m^3/s.

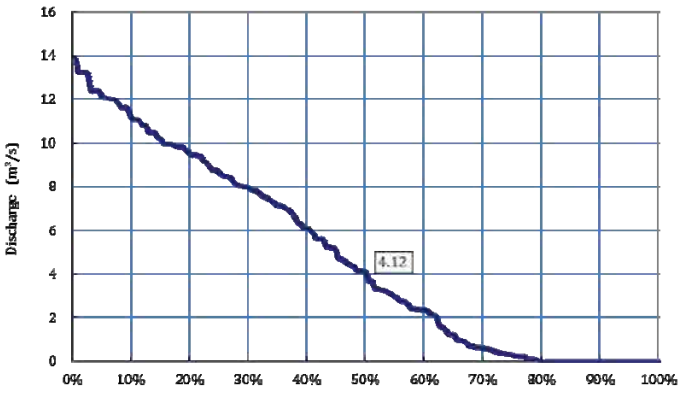


Figure 2.6.7 Discharge-Duration Curve of Irrigation Water Released from North Nawin Dam
Source: the Survey Team (2013)

Before the detailed design of this hydroelectric power plant, it is required for raising the precision to restudy the amount of discharge for hydroelectric power generation in accordance with the amount of discharge for irrigation based on the cropping pattern.

b) Effective Head

According to the "*Small-Scale Hydropower Generation by Japanese Institute of Irrigation and Drainage*," it is suggested to estimate a head loss as 7% to 9% of a gross head if it is difficult to calculate each head loss such as friction, inflection, contraction, etc. In fact, Tail Water Level is not shown in the longitudinal drawing of the irrigation outlet provided by the ID even though Full Tank Level is 323.50ft (98.60m). Therefore, Tail Water Level is assumed as 255.91ft (78.00m) based on the

surface elevation of the invert concrete under the bridge (251.17ft = 76.56m).

So, effective head is set to be 91% of the gross head.

$$H_e = H_g \times 91\% = (93.60m - 78.00\ m) \times 91\% = 16.75m$$

where; Hg Gross Head (m)
He Effective Head (m)

For raising the precision of this hydropower planning, it is indispensable to confirm the Tail Water Level before the detailed design.

c) Efficiency

According to the report on the "*Collection of Information regarding Small-Scale Hydroelectric Power generation utilizing Agricultural Water, etc., in Japan*," an estimated product between the gravity acceleration and the combined efficiency of turbine, generator and speedup gear is approximately 7. Since this is a conceptual study, this value is applied to calculate the output.

d) Maximum Output

The maximum output at this site is calculated as below;

$$P_{max} = 9.8 Q_{max} H_e \eta = 7 Q_{max} H_e = 7 \times 4.1 \times 18.75 = 538kW \cong 530kW$$

e) Minimum Operation Level for Power Generation

To prevent any adverse influence such as cavitation, vibration, etc., a variation of an effective head must be confined within a specified range. In consideration of the rated effective head and the maximum discharge for power generation, horizontal Francis turbine, cross flow turbine, S-shaped tubular turbine and underwater pump turbine can be applied judging from the following diagram. Assuming that a horizontal Francis turbine is applied, the ratio of the maximum effective heads to the rated one is to be less than 1.2, and the ratio of the minimum effective head and the rated one must be more than 0.7. In this site, Full Tank Level is EL.98.30 m, and Tail Water Level is assumed to be EL.78.00 m. If the head loss is 9% of the gross head, the estimated head loss is 1.85 m.

On the basis of the above, if the Minimum Operation Level and Rated Intake Water Level are EL.90.30 m and EL.95.83 m respectively, the maximum, rated and minimum heads are to be 18.75 m, 15.98 m and 11.20 m respectively. Consequently, the above stipulation on variation of effective head is cleared. Even though Minimum Operation Level for irrigation is set at EL.81.38 m (=265.0ft), Minimum Operation Level for hydroelectric power generation is to be set at EL.90.30 m, which is almost 9 m-higher than that for irrigation.

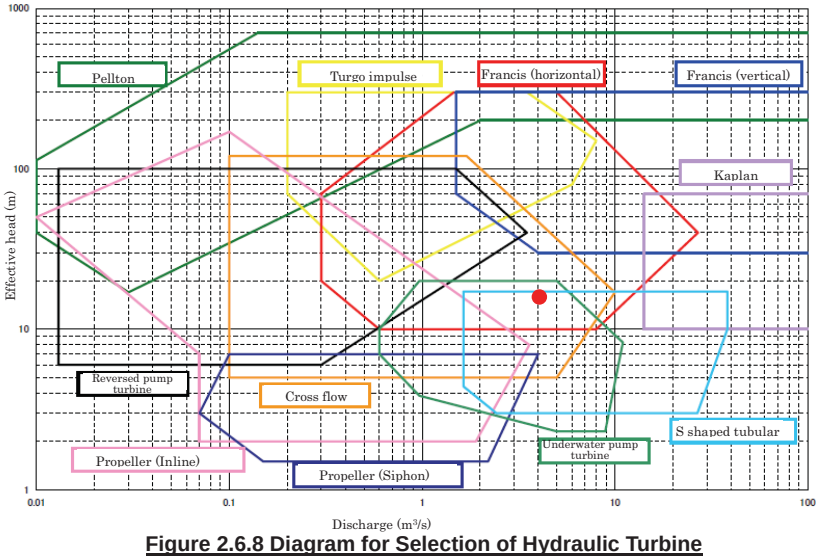


Figure 2.6.8 Diagram for Selection of Hydraulic Turbine

Source: NEF Guidebook for Hydro-Valley Planning

In the meantime, if the Minimum Operation Level for irrigation is also modified to EL.90.30 m, the effective storage capacity decreases from 318 x 10^6 m^3 to 210 x 10^6 m^3. On the other hand, annual average inflow and irrigation supply from 1997 to 2012 are 229 x 10^6 m^3 and 217 x 10^6 m^3 respectively. Considering that the reservoir is mainly impounded in rainy season and that the impounded water is mainly discharged in dry season, it may be possible to modify Minimum Operation Level for irrigation from EL.81.38 m to EL.90.30 m on the basis of rough estimation.

The above supposition is based on some assumptions such as Tail Water Level, head loss, etc. In addition, both year-round reservoir operation and the amount of discharge of irrigation water based on the cropping pattern are unclear at present. Therefore, this matter is required to be reviewed prior to the detail design in case this site is selected for hydropower generation.

2) South Nawin Irrigation System

Any drop structure which is suitable for hydroelectric power generation cannot be found in the upstream of the irrigation canal. However, a hydroelectric power plant which has been suspended to be constructed is found at the downstream of the dam. According to *the final design report on South Nawin Irrigation Project*, this hydroelectric power plant was designed to produce electric power all day long including 4 hours-peak power generation, and its maximum and firm output were designed to be 2,100kW and 1,200kW respectively. Consequently, it is found that this site has the largest potential for hydroelectric power generation among the 4 irrigation areas.

Considering the MOEP's view aforementioned, however, it may not be reasonable to develop the hydroelectric power plant in this site for the purpose to advance the electrification in non-electrified villages. The reasons are that the distribution line has already reached the ID's field office at the dam and that the MOEP has a plan to extend 33kV transmission line to Paukkaung town near the dam by 2015. Consequently, the area within 10 miles from Paukkaung town will be newly electrified by the extension project, not in need to be electirified by the dam's hydropower generation.

The construction of the above hydroelectric power plant, in fact, has been suspended after the installation of the inlet valves, but the inlet valves have never been operated since the suspension of the construction. Therefore, it is not clear whether the inlet valves work well or not. Given no intake gate, the inlet valves are the only devices to interrupt water flow from the reservoir and thus they need to have high reliability. As a result, it is indispensable to check whether the inlet valves work well in advance of restart of the construction. The Survey Team considers that, at least, the hydraulic power unit and electric component shall be replaced, and the existing valves be replaced for reliability.

Present Situation of Inlet Valve placed for Suspended South Nawin Hydroelectric Power Plant

In addition, it is necessary to lower the reservoir water level below the Minimum Operation Level for installation of the stop log in order to drain water for connection of the existing steel pipes and the newly-placed pipes. The reason is that there is no intake tower with intake gate which can stop inflow into the inlet pipes, though there is gate slot for temporary stop logs. Further, according to a gate operator engaged in the construction of the dam, the MOEP tried to restart constructing the hydroelectric power plant; however the MOEP gave up due to large amount of seepage water in excavation. Therefore, it is required to care for suitable measure against seepage water.

3) Wegyi Irrigation System

3.1) No.1 & No.2 Drop Structures in the Left Main Canal

No.1 and No.2 drop structures are located approximately 110 m and 300 m downstream the bifurcation respectively, and the water head between the upstream and the downstream of the drop structures is roughly 2.4 m and 1.7 m respectively, measured by GPS and staff rod. Considering that each water head is low and that the drop structures are close to each other, it is suggested to develop a hydroelectric power plant by covering both of the two drop structures as below.

Figure 2.6.9 Locations of No.1 & No.2 Drop Structures in Left Main Canal of Wegyi Irrigation System
Source: the Survey Team (2013)

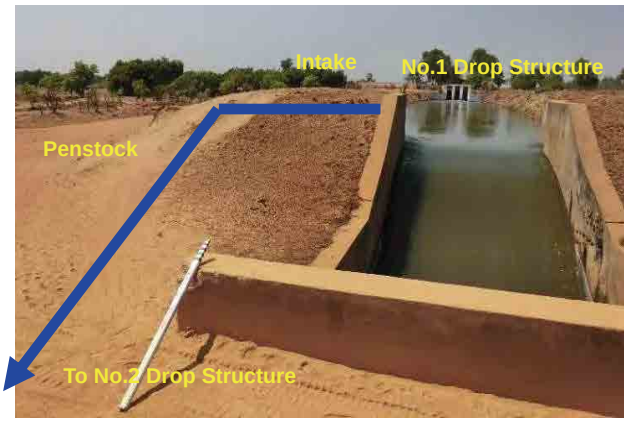


Figure 2.6.10 Conceptual Arrangement of Hydroelectric Power Plant at No.1 & No.2 Drop Structures in Left Main Canal of Wegyi Irrigation System Source: the Survey Team (2013)

a) Maximum Discharge

Since there is no data on the amount of irrigation water in both Right and Left Main Canals, the maximum discharge is set to be a half of irrigation water discharged from Wegyi dam. From the duration curve of monthly amount of irrigation water released from Wegyi Dam between 2000 and 2012 as shown below, a 50% probable discharge of irrigation water released from the dam is

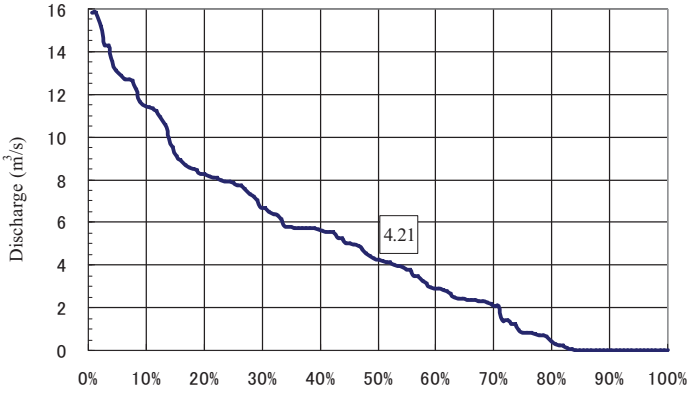


Figure 2.6.11 Discharge-Duration Curve of Irrigation Water Released from Wegyi Dam, Source: the Survey Team (2013)

4.2 m^3/s, so that the maximum discharge of this plant, *Qmax*, is 2.1 m^3/s.

Before the commencement of this hydroelectric power plant, it is required to restudy amount of discharge for hydroelectric power generation in accordance with amount of discharge for irrigation based on the cropping pattern for raising the precision.

b) Effective Head

According to the "*Small-Scale Hydropower Generation by Japanese Institute of Irrigation and Drainage*," it is suggested to estimate a head loss as 7% to 9% of a gross head if it is difficult to calculate each head loss such as friction, inflection, contraction, etc. Thus, the effective head set is to be 91% of the gross head which is measured by GPS and staff rod.

$$H_e = H_g \times 91\% = (2.4m + 1.7m) \times 91\% = 3.73m$$

where; Hg Gross Head (m)
He Effective Head (m)

c) Efficiency

According to the report on the "*Collection of Information regarding Small-Scale Hydroelectric Power generation utilizing Agricultural Water, etc., in Japan*," an estimated product between the gravity acceleration and the combined efficiency of turbine, generator and speedup gear is approximately 7. Since this is a conceptual study, this value is applied to calculate the output.

d) Maximum Output

The maximum output at this site is calculated as below;

$$P_{max} = 9.8 Q_{max} H_e \eta = 7 Q_{max} H_e = 7 \times 2.1 \times 3.73 = 54.8kW \cong 55kW$$

3.2) Other Potential Site

In addition to the above site, Wegyi dam and No.1 Drop Structure in the Right Main Canal are prospective sites for small-scale hydroelectric power generations. These sites were also studied in the "feasibility study on Small Scale Hydropower Development with Existing Irrigation Dams." The maximum outputs are designed to be approximately 360kW and 130kW respectively. If these hydroelectric power plants are commissioned, almost 2,450 households will be electrified on the same assumption as the abovementioned Taung Nyo dam. The salient feature of this site is shown as below:

Table 2.6.1 Outline of Hydroelectric Power Development Plans at Wegyi Dam and Drop Structurel

Items	Dam	RMC	Remarks
Maximum Output	366 kW	132kW	
Rated Output	311 kW	132kW	
Annual Energy	2,001 MWh	688 MWh	
Plant Factor	62.4 %	59.8%	
Number of Households	7,718		Within almost 10km from the dam
Power Demand	1,544 kW		
Electrified Households	2,835		Demand per household is assumed as 200kW.
Construction Cost	698,000,000 JPY	235,000,000 JPY	Estimated in June 2013 under the condition of 1 USD = 885 Kyat = 101.10 JPY, 1 Kyat=0.1 JPY

Source: Final Report of Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams

4) Taung Nyo Irrigation System

4.1) Bifurcation of Main Canal and Branch-A Canal

A bifurcation structure is located at RD.21+952 where the main canal branches off to the branch canal

called “Branch-A.” At this point, relatively high water head is made between the upstream and the downstream of the bifurcation just before the main canal branches off to the Branch-A. According to the longitudinal drawing of the irrigation canal from RD.19+200 to RD.25+200 provided by ID, the foundation levels of the upstream and the downstream are 30.30 m (99.42 ft) and 28.36 m (93.05 ft) respectively, and the vertical interval is 1.94m. In this study, the vertical interval is regarded as the gross head of the small-scale hydroelectric power plant. For reference, the hydroelectric power plant is conceptually arranged as follow.

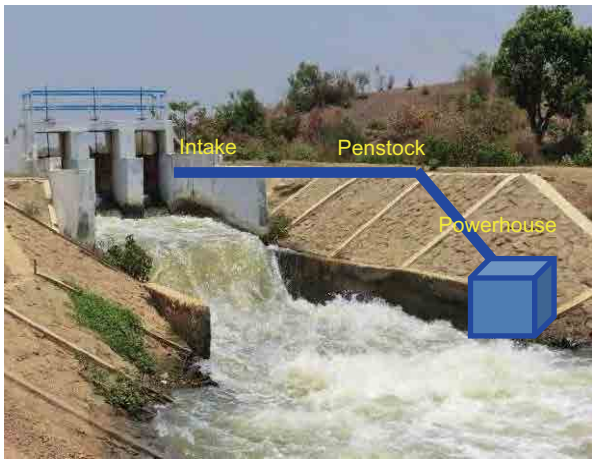


Figure 2.6.12 Conceptual Arrangement of Hydropower Plant at Bifurcation in Taung Nyo Irrigation System
Source: the Survey Team (2013)

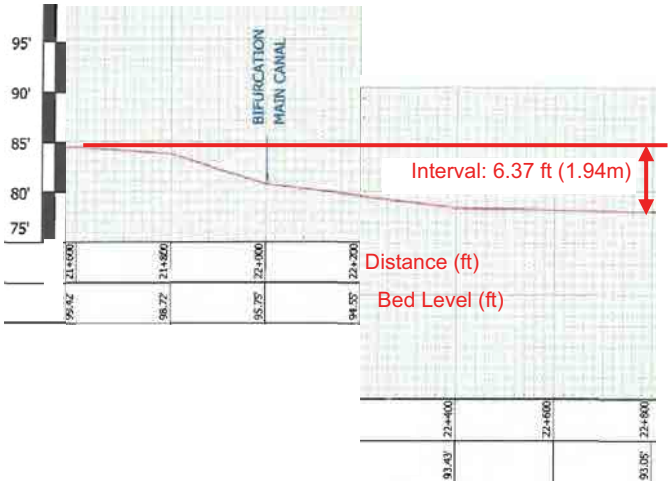


Figure 2.6.13 Vertical Interval of Irrigation Canal Beds between Upstream and Upstream of the Bifurcation
Source: the Survey Team (2013)

According to the rough measurement by means of GPS and staff rod by the Survey Team, the difference of water surfaces between the upstream and the downstream of the bifurcation is measured as 2.9 m, which is almost 1.0 m difference from the aforesaid vertical interval as shown above. Considered that output largely varies depending on water head, especially in case of low-water-head hydroelectric power plant, detailed survey is required in the detailed design stage.

a) Maximum Discharge

In this project, a hydroelectric power generation utilizing irrigation facilities is studied under the condition that water use for power generation is subordinate without any disturbance to farming. However, amount of discharge for irrigation in accordance with a cropping pattern in the irrigated area has not been consolidated yet. Therefore, this hydroelectric power plant is planned on the basis of actual discharge for irrigation recorded by the ID.

In case of a run-off-river power plant for a non-electrified area, the maximum discharge for power generation is generally set at a 90% or 95% probable discharge, which is called as a firm discharge. However, the actual amount of irrigation water varies widely in this irrigation system; what is more, no irrigation water often flows in the irrigation canal for more than one month. In addition, the hydroelectric power plant is far from the national transmission network and the hydroelectric power plant is operated separately from the national transmission network, and consequently, any electric power is not supplied when the small-scale hydroelectric power plant does not produce electricity.

Considering the above, the maximum discharge of the project is set at a 50% probable outflow discharge for irrigation, and the Survey Team proposes to use a diesel generator complementally in case that a hydroelectric power plant cannot produce electricity due to several reasons such as less outflow discharge, decline of water level below Minimum Operation Level for hydroelectric power generation, an overhaul of a plant, etc.

Because there is no data on amount of water flow in the irrigation canal, the maximum discharge of

the project is set on the basis of a 50% probable discharge of irrigation water released from the dam. Since there is no branch for irrigation between the dam and the bifurcation, it is assumed that all of water released from the irrigation outlet of the dam reaches the bifurcation. From the duration curve based on monthly amount of irrigation water released from Taung Nyo Dam from 2000 to 2012, a 50% probable discharge is 8.2m^3/s as shown below.

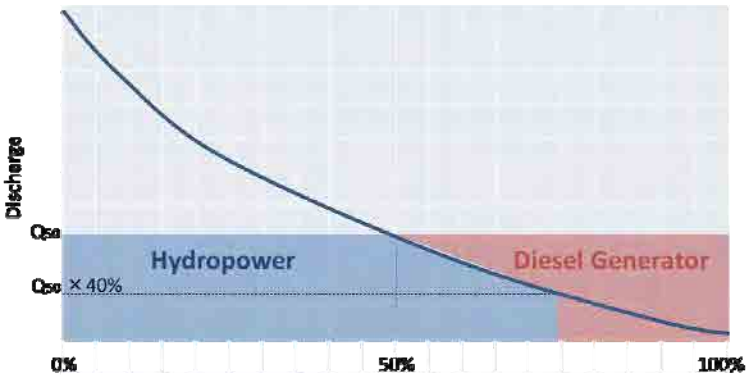


Figure 2.6.14 Concept of Supplementary Usage of Diesel Generator Source: Final Report of Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams

And, taking into consideration that the design discharges of the main canal and the Branch-A canal after the bifurcation are 681.2 ft^3/s and 435 ft^3/s respectively, the maximum discharge for power generation is set as 60% of the aforesaid 50% probable discharge, and consequently the maximum discharge for power generation is estimated to be 4.9 m^3/s.

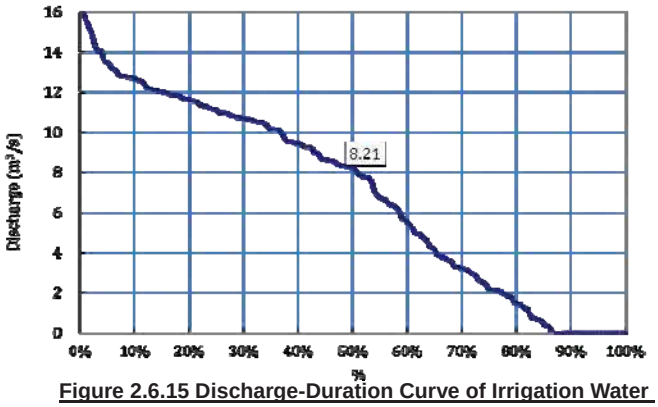


Figure 2.6.15 Discharge-Duration Curve of Irrigation Water Released from Taung Nyo Dam
Source: the Survey Team (2013)

Before the implementation of the detailed design, it is required, for raising the precision, to restudy the amount of discharge for hydroelectric power generation in accordance with the amount of discharge for irrigation based on the cropping pattern.

b) Effective Head

According to the "*Small-Scale Hydropower Generation by Japanese Institute of Irrigation and Drainage*," it is suggested to estimate a head loss as 7% to 9% of a gross head in case that it is difficult to calculate each head loss such as friction, inflection, contraction, etc. Thus, the effective head is set to be 91% of the gross head.

$$H_e = H_g \times 91\% = 1.94m \times 91\% = 1.77m$$

where; Hg Gross Head (m)
He Effective Head (m)

c) Efficiency

According to the report the "*Collection of Information regarding Small-Scale Hydroelectric Power generation utilizing Agricultural Water, etc., in Japan*" provided by JICA, a product between the gravity acceleration and the combined efficiency of turbine, generator and speedup gear is approximately estimated to be 7. Since this is a conceptual study, this value is applied to calculate the output.

d) Maximum Output

Power output is calculated by the following formula:

$$P = 9.8QH_e\eta = 7QH_e$$

where; P Power Output (kW)
Q Discharge (m^3/s)
He Effective Head (m)
η Combined Efficiency

So, the maximum output at this site is calculated as below;

$$P_{max} = 9.8 Q_{max} H_e \eta = 7 Q_{max} H_e = 7 \times 4.9 \times 1.77 = 60.7 kW \cong 60 kW$$

4.2) Destroyed Drop Structure at the Upstream of Bifurcation

A destroyed drop structure exists at the R.D 18+900 of the main canal, which is the upstream of the aforesaid bifurcation. In addition to the above, one more drop structure is also found at the R.D 19+250 of the main canal. Compared the above reference distances shown in the ID's list of the structures in the Taung Nyo irrigation canal with those shown in the longitudinal drawing of the canal from RD.19+200 to RD.25+200 provided by ID, it is found that their R.Ds do not match between the list and the longitudinal drawing.

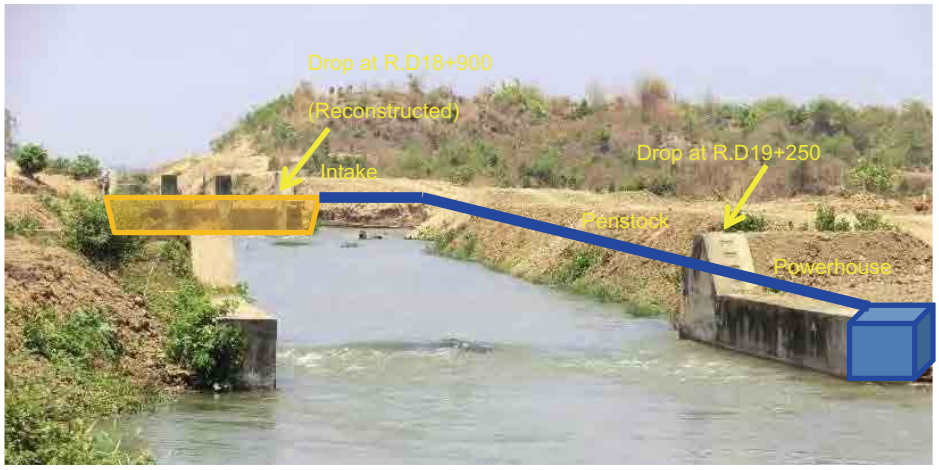


Figure 2.6.16 Conceptual Arrangement of Hydropower Plant at Destroyed Drop Structure
Source: the Survey Team (2013)

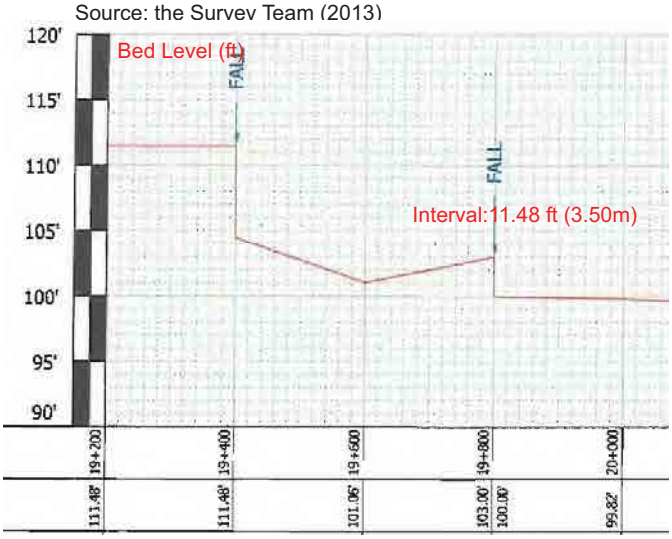
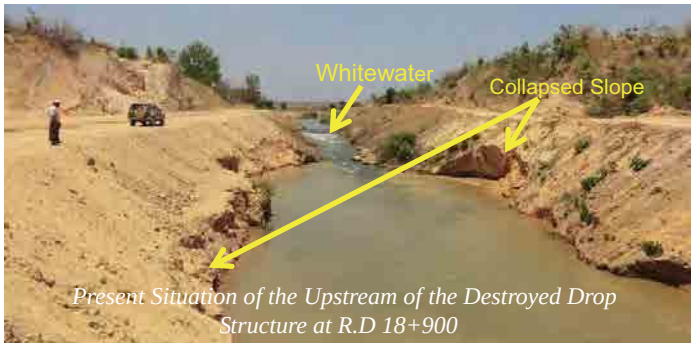


Figure 2.6.17 Vertical Interval of Irrigation Canal Beds between Drop Structures Source: the Survey Team (2013)

Therefore, on the assumption that drop structures existing at the R.D 18+900 and the R.D 19+250 in the list are equal to those existing at the R.D 19+400 and the R.D 19+800 in the longitudinal drawing, the foundation levels of the upstream and the downstream are 33.98 m (111.48 ft) and 30.48 m (100.00 ft) respectively, and the vertical interval is 3.50 m. Since any Full Supply Level is not mentioned in the longitudinal drawing, the vertical interval is regarded as the gross head of this site.

Additionally considered the present situation of the upstream of the destroyed drop structure at R.D 18+900, there is a possibility that more water head can be obtained. The reason is that whitewater



Present Situation of the Upstream of the Destroyed Drop Structure at R.D 18+900

can be observed in the upstream. So, the detailed survey is required in the detailed design stage.

a) Maximum Discharge

As mentioned above, the 50% probable discharge between the dam and the aforesaid bifurcation can be regarded as 8.2 m^3/s. Since this site is located between the dam and the aforesaid bifurcation, the maximum discharge for hydroelectric power generation is to be 8.2 m^3/s.

b) Effective Head

According to the "*Small-Scale Hydropower Generation by Japanese Institute of Irrigation and Drainage*," it is suggested to estimate a head loss as 7% to 9% of a gross head if it is difficult to calculate each head loss such as friction, inflection, contraction, etc. So, the effective head is to be 91% of the gross head which is measured by GPS and staff rod.

$$H_e = H_g \times 91\% = 3.5m \times 91\% = 3.19m$$

where; Hg Gross Head (m)
He Effective Head (m)

c) Efficiency

According to the report on the "*Collection of Information regarding Small-Scale Hydroelectric Power generation utilizing Agricultural Water, etc., in Japan*," an estimated product between the gravity acceleration and the combined efficiency of turbine, generator and speedup gear is approximately 7. Since this is a conceptual study, this value is applied to calculate the output.

d) Maximum Output

The maximum output at this site is calculated as below;

$$P_{max} = 9.8 Q_{max} H_e \eta = 7 Q_{max} H_e = 7 \times 8.2 \times 3.19 = 183.1kW \cong 180kW$$

4.3) Other Potential Site

In addition to the above two sites, Taung Nyo dam itself is also a good source for small-scale hydroelectric power generation. This site was already studied in the *Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams*. The maximum output was designed to be approximately 840kW, and it concluded that the electric power could be supplied to the most of non-electrified household in the upstream of the irrigation area, assuming that the unit electricity consumption per household is 200W. The salient feature of this site is shown as below:

Table 2.6.2 Outline of Hydroelectric Power Development at Taung Nyo Dam

Items	Value	Remarks
Maximum Output	841 kW	
Rated Output	711 kW	
Annual Energy	3,330 MWh	
Plant Factor	45.2 %	
Number of Households	4,539	Within almost 10km from the dam
Power Demand	908 kW	
Electrified Households	4,205	Demand per household is assumed as 200kW.
Construction Cost	1,265,000,000 JPY	Estimated in June 2013 under the condition of 1 USD = 885 Kyat = 101.10 JPY, 1 Kyat=0.1 JPY

Source: Final Report of Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams

2.6.4 Site Selection for Study of Electrification by Small-Scale Hydroelectric Power Generation

As mentioned in the previous sections, all irrigation systems have potential sites for small-scale

hydroelectric power generation. As for the access roads to the potential sites, those of North Nawin and South Nawin irrigation systems are concrete pavement and asphalt pavement respectively, though some parts are required repair. The access roads of Wegyi and Taung Nyo irrigation systems are presently unpaved, but they are planned to be paved under this project. Consequently, there are no substantial differences among the 4 irrigation systems in transportation. However, present situations of electrification are different among the 4 irrigation systems as summarized below:

Table 2.6.3 Outline of Situations of Electrification in the Project Areas

Irrigated Area	Situation of Electrification
North Nawin	Although villages along the concrete-paved access road up to the midstream of the irrigation system have been electrified, the upstream of the irrigation canal has not been electrified. However, several villages prepare electric poles and transformer for future electrification by MOEP by themselves.
South Nawin	Distribution line reaches the ID's site office at the main dam, and most of areas have been electrified. Additionally, the MOEP has a plan to extend 33kV transmission line from Paungdale town to Paukkang town and to newly place a substation, so electrified area will be expanded near future.
Wegyi	Distribution lines reach Pauk Taw and Le U Zu villages located in the upstream of the Right Main Canal side, but area along the Left Main Canal has not been electrified.
Taung Nyo	Only area near the No.2 National Highway is electrified and most of the irrigation areas have not been electrified.

Source: the Survey Team (2013)

Most of the non-electrified households obtain electric power by means of private solar energy generation and wish to receive sufficient and affordable electric power from a distribution line managed stably by the government. Judging from the situations of progress of electrification as above, it is found that the Taung Nyo Irrigation Area is the least electrified among the 4 irrigation areas, and the Taung Nyo Irrigation area is expected to be the last area to be electrified among the 4 irrigation areas. Therefore, the Survey Team selects the Taung Nyo irrigation area to study the feasibility of the electrification by means of small-scale hydroelectric power generation.

Regarding the candidate site for the Taung Nyo Dam, it was already studied in *the Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams*. In the study, the newly-electrified villages were selected within almost 10 km in radius from the dam not to drop the voltage. As a result, most of the villages not located along the irrigation canal were selected as the potential electrification village.

On the other hand, both candidate sites for small-scale hydroelectric power generation in the irrigation canal can supply electricity to such non-electrified villages along the irrigation canal. Considering that this electrification can improve quality of life in the irrigable area, the Survey Team addresses the candidate sites in the irrigation canal. In comparison of the expected power outputs of the 2 candidate sites as shown below, the Team chooses the candidate site located at the R.D 18+900 where the drop structure is presently destroyed.

Table 2.6.4 Candidate Sites for Small-scale Hydroelectric Power Plant in Taung Nyo Irrigation Canal

Potentials Sites	Damaged Drop Structure at R.D 18+900	Bifurcation at R.D 21+952
Installed Capacity	180 kW	60 kW
Maximum Discharge	8.2 m^3/s	4.9 m^3/s
Gross Head	3.50 m	1.94 m
Effective Head	3.19 m	1.77 m
Annual Energy Production	1,101 MWh	357 MWh
Selection	Recommended	-

Source: the Survey Team (2013)

2.7 Donor Involvement in the Sector

As of the end of May 2013, the Irrigation Department has a plan for irrigation projects which require

foreign technical and financial assistances; a total of 18 irrigation projects are listed up. Out of the 18 projects, 15 projects are for rehabilitation of existing irrigation systems while the remaining 3 projects are for new construction including construction of dam reservoir. The total project cost is estimated at US$ 317.78 million; of which total project cost for the rehabilitation schemes comes to US$ 155.92 million and a total cost for the new construction projects shares the rest, US$ 161.86 million. Following table summarizes the list of these projects:

Table 2.7.1 Proposed Projects for Foreign Assistance by ID as at End May 2013

Sr.	Project	Region /State	Est. Cost (mill. US$)	Remarks	
1.	Kingtal Weir Irrigation Network Rehabilitation Project	Sagaing	22.00	Shwebo, Ye U, Butalin	WB to inspect
2.	Kabo Weir (Shwebo) Irrigation System Rehabilitation Project	Sagaing	6.57	Kanbalu, KhinU, Shwebo, Wetlet, Sagaing	WB to inspect
3.	Kabo Weir (YeU) Irrigation System Rehabilitation Project	Sagaing	3.97	Shwebo	On going by ID
4.	Kindat Weir (Left/ Right) Irrigation System Rehabilitation Project	Sagaing	21.17	Shwebo, YeU, Butalin	WB to inspect
5.	North Nawin Irrigation System Rehabilitation Project	Bago	26.69 a/	Pyay (West Bago)	Under this JICA Survey
6.	South Nawin Irrigation System Rehabilitation Project	Bago	16.49 a/	Pauk Khaung (West Bago)	Under this JICA Survey
7.	Wegyi Irrigation System Rehabilitation Project	Bago	2.63 a/	Paung De (West Bago)	Under this JICA Survey
8.	Taung Nyo Irrigation System Rehabilitation Project	Bago	4.68 a/	Nttalin (West Bago)	Under this JICA Survey
9.	Nyaung Gaing Irrigation System Rehabilitation Project	Bago	1.87	Padaung (West Bago)	Indian Gov. inspected
10.	Khawa Irrigation System Rehabilitation Project	Bago	1.70	Padaung (West Bago)	Indian Gov. inspected
11.	Kinda Left-Canal (Myittha) Irrigation System Rehabilitation Project	Mandalay	8.57	Myittha	Indian Gov. Loan
12.	Kinda Left-Canal (TadaU) Irrigation System Rehabilitation Project	Mandalay	5.10	TadaU	WB to inspect
13.	Sedawgyi Irrigation System Rehabilitation Project	Mandalay	17.57	Madayar	WB to inspect
14.	Megali Irrigation System Rehabilitation Project	Magway	9.95	Pyintphyu	WB to inspect
15.	Linzin Irrigation System Rehabilitation Project	Magway	6.96	Salin	WB to inspect
1.	*Thaphanseik (Right canal) Irrigation Network New Construction Project*	*Sagaing*	*14.45*	*Kyun Hla*	*WB to inspect*
2.	*Nam Sein Dam New Construction Project*	*Mandalay*	*8.00*	*Thapeikkyin*	*No inspection by Donors*
3.	*Phyu Chaung Weir and Irrigation System New Construction Project*	*Bago*	*139.41*	*Phyu*	*Kuwait Fund (applying)*
	Total		317.78	Million US $	

Note: a/ the project costs are preliminarily estimated ones by ID, therefore different from what is proposed in this report after JICA Survey team has scrutinized.
Source: Irrigation Department, arranged by the JICA Survey Team (2013)

Indian government had conducted an inspection on existing irrigation systems which require certain degree of rehabilitation works back in 2011. JICA followed, and had made an inspection on some irrigation rehabilitation systems; accordingly this Survey was agreed to implement between the both parties for the preparation of project components to be covered by an ODA loan. The World Bank is scheduled to conduct an inspection on several rehabilitation project located mainly in upper Myanmar such as Sagaing region and Mandalay region in June 2013.

CHAPTER 3 PROJECT PLANNING AND DESIGNING

This chapter describes about formulation of rehabilitation project. Irrigation Department has original plans for rehabilitation and the Survey Team has revised them with some viewpoints such as technical aspects, economic effectiveness, and environmental and social considerations as follows.

3.1 Identification of the Rehabilitation Components

Rehabilitation under the project deals with not only simple rehabilitation but also upgrading of facilities. Wegyi and Taung Nyo irrigation systems are not equipped with concrete lining along canals; non-lining structures have been exposed to water flow long period, so that many of facilities have been collapsed and/or eroded, and then damaged. These damages required the Irrigation Department much amount of maintenance cost while the government of Myanmar could not afford to allocate enough budget to Irrigation Department until the end of March 2011. Non-lining canal requires frequent maintenance and rehabilitation at many places; consequently, it has ended up with over-budget. This is why upgrade of irrigation system such as concrete lining comes up with one of components of the project.

Water loss is also one of issues of four irrigation systems. Malfunction of distribution gates causes water loss or waist at upstream area in each irrigation system. Water supply records of Irrigation Department show continuous water release from dam reservoirs every year especially during summer season while beneficiary farmers complain that irrigation water have not reached until terminal areas of irrigation systems. Some voices from farmers exposed that irrigated area had decreased by one third from planned irrigable areas. Several reasons for these water losses have been studied by Irrigation Department such as; seepage loss from non-lining or broken-lining portions, flow area reduction of canals due to canal embankment collapse, and damage of gates and so on. Based on site investigation by the Survey team, proper or functional distribution gates are hardly found in the irrigation systems which should control water distribution; this is probably the main cause of aforementioned water losses and waste of the irrigation systems.

After rehabilitation, farmland consolidation will strengthen farming system in irrigable area. It is composed of two elements; one is separation of canals into irrigation and drainage purposes, the other is farm mechanization. Separation of irrigation and drainage secures flexibility of farm practices. Each individual farmer can plant any crops without being bothered with farming practices at neighboring farmlands. Paddy plantation often requires flood in farmland but the neighboring farmlands have to also be flooded if irrigation and drainage are not separated. This separation can increase effectiveness of irrigation, and then farm mechanization can be applied to such improved farmland. Farm mechanization can reduce farming-practice period for ploughing, transplanting, and harvesting. Farmers will be released from troubles with workforce shortage during the busiest faming season.

Inspection roads along irrigation canals have to be utilized as access road between villages and markets or inter-villages. Canal crossing bridges will help and increase accessibility of road-networks because canal systems completely shut off area-connection and their accesses. Small engine drive carts become popular transportation measures day by day in the Survey area and they require well paved roads coupled with concrete bridges crossing over canals. The existing inspection roads have to be reshaped and paved. The existing bridges with poor wooden logs have to be replaced by sturdy concrete bridge. Such upgrade will contribute to increase accessibility of the project areas.

Areas of Wegyi and Taung Nyo irrigation systems are isolated from electrification but those systems have water-drop structures along main canals. Installation of mini-hydro-power system is one of ideas to contribute rural electrification by utilizing water head at these water-drops. Several villages can obtain lighting-up in night time. Suitable places have been examined along the irrigation networks based on engineering viewpoints.

Table 3.1.1 Summary of Rehabilitation Components for each Irrigation System

Items	North Nawin	South Nawin	Wegyi	Taung Nyo
Overview	- Lining is provided along canals. - Partial maintenance works have been provided but not enough for whole system - Serious erosion and/or collapse are not found. - Gates are damaged - There are a lot of syphon structures along right main canal - Roads adjacent to canal have discontinuity due to syphon structures - Intake structure at a dam has cracks; necessity for pipe replacement	- Total length of main canals is the longest among 4 irrigation systems (52km) - Lining is provided along the canals. - Partial maintenance works have been carried out but not enough for whole system - Serious erosion and/or collapse are not found. - Distribution gates malfunction; it becomes cause of waste water release Water diversion to North Nawin irrigation system	- main canal near dam reservoir was constructed by cutting hilly area - Difficulty of canal excavation at soft rock stratum causes narrow canal section; widening works will be necessary - There is no lining along canals. - Check gates and water drop structures are seriously damaged - Serious erosion and structure collapse are observed - Water diversion to South Nawin irrigation system	- There is no lining along canals. - Check gates and water drop structures are seriously damaged - Left main canal has steep slope; serious erosion and structure collapse are observed - Inspection road near dam site has slope collapse - Intake gate at dam reservoir malfunctions
Necessity of Detailed Design	- Basically it is not required - Design documents are available	- Basically it is not required - Design documents are available	- Detailed design is required. - Design documents are available partially	- Detailed design is required. - Design documents are available partially
Necessity of alternative design in comparison with original design	- Alternative design is basically not necessary - Lining materials and methods will be changed from brick lining to concrete lining - Gate structures will be renewed	- Alternative design is basically not necessary - Lining materials and methods will be changed from brick lining to concrete lining - Gate structures will be renewed	- Alternative design will be required from non-lining to concrete lining - Concrete structures; checks, drops, and distributions are necessary to confirm hydraulic conditions	- Alternative design will be required from non-lining to concrete lining - Concrete structures; checks, drops, and distributions are necessary to confirm hydraulic conditions
Mini hydropower installation	- There is potential at dam site	- There is potential at dam site but construction cost becomes high	- There is potential at dam site and drops	- There is potential at dam site and drops
Inspection road and farm road	- Access road does not run along with main canals - There is requirements of farm road with pavement - Bridges are required due to discontinuity of access.	- Improvement of access road is required because of its long length - There is requirements of farm road with pavement - Bridges are required due to discontinuity of access.	- Access road along main canal is so bad that cars cannot drive smoothly - There is requirements of farm road with pavement - Bridges are required due to discontinuity of access.	- Access road along main canal is so bad that cars cannot drive smoothly - There is requirements of farm road with pavement - Bridges are required due to discontinuity of access.

Source: the Survey Team (2013)

3.1.1 Rehabilitation Criteria

Three directions are employed and applied to this rehabilitation project as follows.

- Canal cross section has enough flow area for irrigation; canal rehabilitation
- Gate can control irrigation water flow according to irrigation plan; gate and hydraulic structures rehabilitation
- Relevant structures contribute area development; road and bridge rehabilitation

The following sub-sections explain criteria for each direction of the rehabilitations.

1) Canals

Narrow canal cross sections are identified at some places along the irrigation systems. Water flow is disturbed at those narrow sections, which made canal systems end up with malfunction. Some causes for narrow cross section of canals are identified by the site inspection as follows.

- Collapse of canal banks and side slopes mainly caused by no-lining along canals in Wegyi and Taung Nyo irrigation systems.
- Back side collapse and/or erosion at concrete or brick lining portions mainly caused by heavy rainfall and/or frequent up-and-downs of water level in canals.
- Sediment in canals, which is transported from upstream areas such as a reservoir and/or collapsed canal areas
- Waterweed flourishing on canal bed where the places mostly covered by thick sediment

Concrete lining shall be provided at all side slope surfaces of main canals. Proper soil compaction at the back side of concrete lining is essential for long-life of canals. Brick canal bed sometimes causes water leakage from joints between bricks and roots of the waterweed enter into such joints. Finally, the roots lift brick up and the canal beds become undulated condition. Thus, such brick bed in main canals shall be replaced by concrete. Typical cross section of concrete lining is shown as follows.

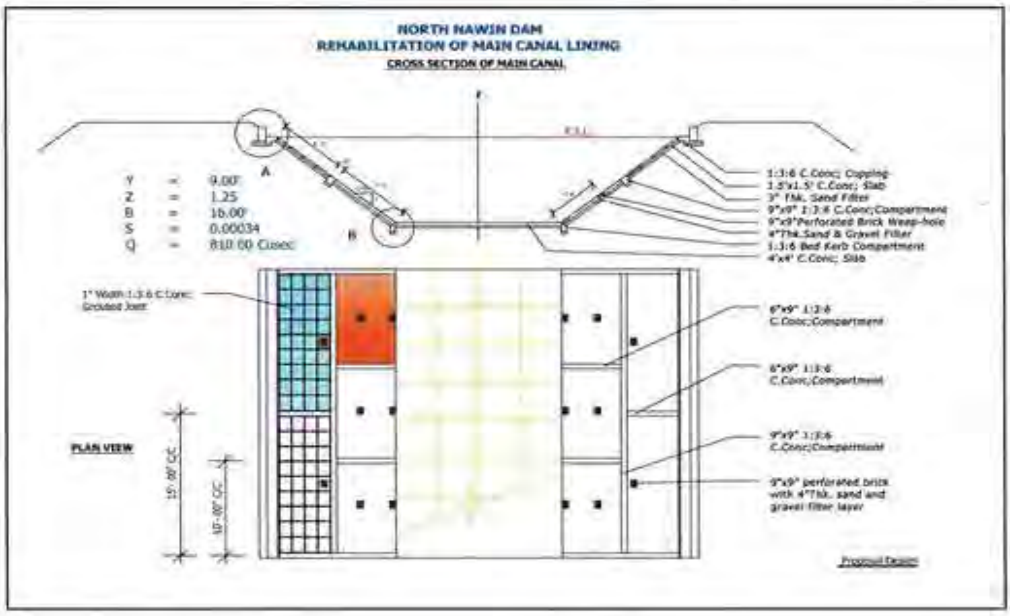


Figure 3.1.1 Typical Cross Section of Concrete Lining at Main Canals for North Nain Irrigation System

Source: Irrigation Department

The Survey Team and Irrigation Department discussed about principle of canal rehabilitation for 4

irrigation systems and proposed the following points;

- All places of main canal shall be rehabilitated except recently rehabilitated portions because back side of lining works may collapsed and/or eroded, which are usually invisible because they are behind of lining structures.
- Rehabilitated portions recently done by the Irrigation Department on main canals are not targeted for the coming rehabilitation.
- Concrete lining shall be applied for main canals.
- Brick lining will be employed for distribution canals but bricks shall be made of concrete.
- Required water flow area shall be kept after rehabilitation, which the water flow condition shall follow the original designs.

2) Gate

Gate at bifurcation point of canal is a key element of irrigation system. The gate facility requires proper operation which shall be based on irrigation demand of irrigable area. It is often observed at the bifurcation points along canals the situation such as removal or disappearance of gate-plates, broken of gate base concrete structures, and non-usable spindles and handles due to destruction. Consequently, irrigation water flows out from a main canal to distribution canals mainly at upstream area without control. This continuous water release results downstream water shortage. Malfunction of gates coupled with non-lining canals could supply enough water for weed growing, and then, canals and gates are covered over by thick weeds. These weeds disturb water flow as a matter of course. The following photos show one of examples of gate and canal rehabilitation by Irrigation Department.

Before (left) and After (right) Rehabilitation for Gates and Canals by Irrigation Department

Source: Irrigation Department

Since a gate is a water control structure by day-to-day operation, it should always be operational as well as functional. Gate operation requires access ways for gate-keepers for the day-to-day operation, and proper water flow shall come to the gate structures for keeping an irrigation system functional. Thus, road rehabilitation and canal rehabilitation shall be carried out in advance to gate rehabilitation.

3) Road

Mechanization of farming practices are now developing in the Survey area. Bull-cart is gradually replaced by trollergyi (a small cart with an engine). Roads along main canals require function of inspection road which shall have2.5 m of road width. The road also functions as rural transportation network, so that concrete pavement is basically suitable for this purpose. As for distribution canal, trollergyi transportation shall be taken into account. Pavement with laterite or gravel materials will be reasonable.

Irrigation Department has land use right within 50 feet from main canal slope edge and 30 feet from distribution canal slope edge according regulation in Myanmar. Some farmers plant crops inside of those areas of Irrigation Department after completion of canal construction. Irrigation department has to compensate cropping benefit to farmers who plant crops within 50/30 feet range at the commencement of rehabilitation even though such area belongs to the Irrigation Department. Similar case will occur if rehabilitation requires expansion of area due to enlargement of canal and/or road width. Contrary, if rehabilitation period is not in cropping season, it is not necessary to compensate such crop benefit to farmers.

After new government, some claims have been raised against land acquisition by the former government, which was done under military regimes. Irrigation Department is quite difficult to confirm that such 50/30 feet area has legally registered or not because most of these places in the project area is registered as a blank area according to a regional branch office of Settlement and Land Records Department under MOAI. In previous government, such blank area was clearly and definitely government's property and nobody could claim it against the military regime while some farmers are nowadays claiming and accusing against the present government which is so called forced-land-acquisition under military regimes.

There are some roads where do not have enough width along canals. Expansion of road width will take long time for obtaining acceptance from farmers who are farming within the 50/30 feet area even though Irrigation Department has rights to occupy and use it. Regional government will have to conduct assemblies for road width expansion and obtain acceptances from farmers. If compensation is necessary, the regional government will pay farmers it. Taking into account such situation, this rehabilitation project shall keep areas of irrigation facilities within existing ones or expansion of roads shall be minimized as less as possible. The followings are main criteria for road rehabilitation.

- ✓ Inspection road along the main canals are reshaped by 2.5 m design width
- ✓ Road width expansion is confined to the area within government owned land
- ✓ If farmers request to expand road width, it shall not include in this project, it shall be considered as one of items for farm land consolidation in future.

3.1.2 Standard Design

There are 3 major components for irrigation system rehabilitation. One is canal rehabilitation, the second is hydraulic structure rehabilitation, and the last one is road rehabilitation. As aforementioned, lining works are necessary for the canals but material shall be considered in terms of budget. During this survey, it was identified that there is no collapsed hydraulic structures to be repaired or rehabilitated in South Nawin irrigation system. Thus, standard designs of hydraulic structures shall refer to designs of South Nawin irrigation system. Since this rehabilitation project starts up with voices of farmers that there is no irrigation water at the end points of irrigation systems, restoration of irrigation network function is the first priority.

Table 3.1.2 Standard Design Values for Rehabilitation of Irrigation Systems

Facilities	Main Canal Portion	Distribution Canal portion
Canal	- Concrete lining with In-site concrete placement - Sand bed: 7.5 cm thickness before concrete placement - Concrete thickness: 12.5cm at canal bed, slopes - Weep holes with 0.9m interval	- Cement brick lining - Sand bed: 7.5 cm thickness before brick placement - Brick thickness: 11.3 cm at bed, 7.5 cm at slopes - Weep holes in cement brick with 0.9m interval
Hydraulic structures	- Refer to South Nawin irrigation system (turn out, syphon, drop, bridge)	Refer to South Nawin irrigation system (turn out, syphon, drop, bridge)
Road	- Base concrete without reinforcement bar: 7.5cm - Reinforced concrete pavement (D5@180mm), 12.5cm thickness - Concrete design mix: Cement: Sand: Gravel =	- Gravel clay pavement: 10cm - 2.5 m width if it is available

Facilities	Main Canal Portion	Distribution Canal portion
	1:3:6 for base concrete - Concrete design mix: Cement: Sand: Gravel = 1:2:4 for reinforced concrete - 2.5 m width for inspection road, 4.8 m width for access road	

Source: Irrigation Department, the Survey Team (2013)

3.2 Rehabilitation on North Nawin Irrigation System

Some irrigation canals of North Nawin irrigation system receive irrigation water from the canals of South Nawin irrigation system because water storage of North Nawin reservoir is neither reliable nor sufficient. Canals receiving diversion water is summarized as follows.

Table 3.2.1 Water Diversion from South Nawin irrigation System to North Nawin Irrigation System

Diversion Points of Canals in South Nawin	Canals receiving diversion water in North Nawin
DO 9	CL 18, CL 19, CL 20, CL 21, CL 22, CL 23, CL 24, CL 25, CL 26, CL 27,
DY 18	CL 30, CL 31
DY 20	CL 32, CL 33, CL 34
DY 22	CL 35, CL 36

Source: Irrigation Department

Total 17 canals in North Nawin irrigation system are receiving irrigation water from South Nawin. These canals are receiving irrigation water from South Nawin permanently and quite long period after South Nawin irrigation system operation. Thus, rehabilitation works of these canals are integrated into South Nawin irrigation system.

3.2.1 Rehabilitation of Canals

Irrigation Department commenced rehabilitation works of North Nawin irrigation system since 2011. Rehabilitation of main canal has already been completed while distribution canal requires further rehabilitation works. Rehabilitation period is divided into 3 years and quantity of works is as follows:

Table 3.2.2 Proposed Canal Rehabilitation Works in North Nawin Irrigation System

Distribution Canal Rehabilitation	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Preparatory Works	m	233,711	92,674	12,436	338,822
Earth Works	m^3	797,412	337,146	143,569	1,278,127
Lining Works	m^2	5,613	696	317	6,626

Source: Irrigation Department, the Survey Team (2013)

3.2.2 Rehabilitation of Hydraulic and Other Structures

Rehabilitation of hydraulic structures and other structures along the main canals have already completed. Total 140 of turn-out, 12 numbers of syphon, 40 numbers of bridge, 50 numbers of drop structures are required for rehabilitation works under the project.

Table 3.2.3 Proposed Rehabilitation Works on Hydraulic and Other Structures in North Nawin Irri. Sys.

Structures along Distribution Canal	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Rehabilitation of Turn Out	Nos	55	74	11	140
Rehabilitation of Syphon	Nos	7	2	3	12
Rehabilitation of Bridge	Nos	18	16	6	40
Rehabilitation of Drop	Nos	20	28	11	59

Source: Irrigation Department, the Survey Team (2013)

3.2.3 Rehabilitation of Road

Inspection road is designed along main canals of North Nawin irrigation system. Among those

inspection roads, roads along a main canal and a right main canal are segmented by syphon-structures while left main canal are not. This is why an access road was constructed from a main road in Pyay township to a dam site. The access road becomes a local route in this area. Planned rehabilitation works on road is shown as follows.

Table 3.2.4 Proposed Road Rehabilitation Works in North Nawin Irrigation System

Road Rehabilitation	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Main Canal Road	km	0.0	11.0	3.0	14.0
Distribution Canal Road	km	0.0	43.0	17.0	60.0

Source: Irrigation Department, the Survey Team (2013)

3.2.4 Rehabilitation of Outlet Pipe at Intake

Malfunction of outlet-steel-pipe is found at the intake of North Nawin dam reservoir. Site investigation from inside of the pipe has identified serious damages on the steel pipe, which is fixed to the concrete stands installed at inside of a concrete conduit by steel bands. Both sides of the pipe are firmly fixed to the concrete structures of the intake while an intermediate portion is somewhat free from the concrete stands. This is why the steep pipe shows torsional bending at the center and serious cracks are found inside as well as outside of the pipe. Cast steel plates may have been welded at the inside/outside of the pipe as repairing works but there is no record to trace it. Due to such circumstances, the pipe always cannot stay fixed when irrigation water is released from the reservoir, thus, replacement of the pipe is considered to be essential.

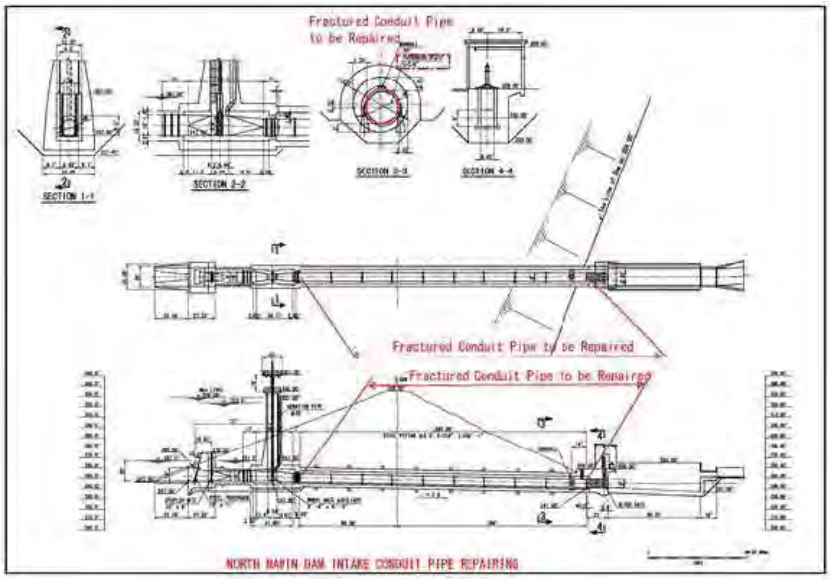


Figure 3.2.1 Damaged portion of Conduit Outlet Pipe of the Northe Nawin Intake

Source: Irrigation Department, Survey Team (2013)

Steel Pipe Crack of Inside-view (left) and Outside-view (right) along Outlet Pipe of the Intake

Source: Survey Team (2013)

Pipe replacement will be done in 2nd year and/or 3rd year of rehabilitation period of the North Nawin Irrigation System.

3.2.5 Land Consolidation

Model farm of land consolidation is studied and planned in beneficiary area of North Nawin irrigation system. Total area of those candidate farmlands is 14.4 ha. Basic design of land consolidation is shown as follows.

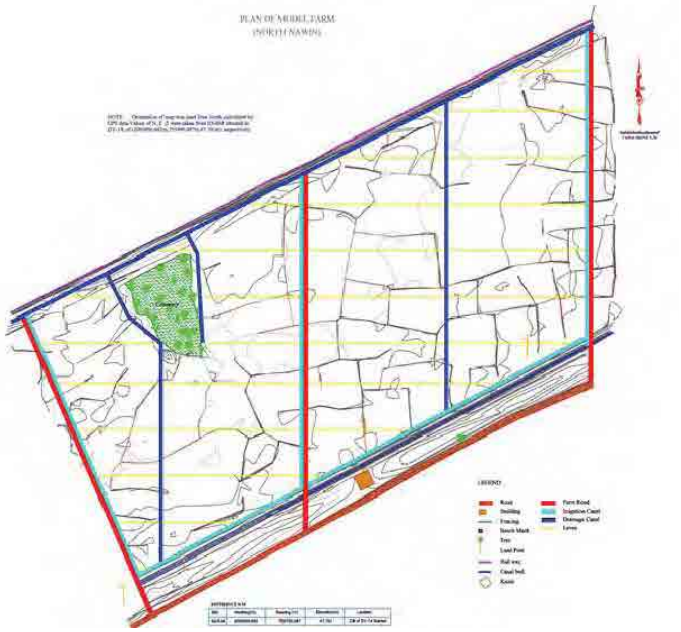


Figure 3.2.3 Basic Design Map for Land Consolidation in Irrigable Area of North Nawin Irrigation System

Source: Survey Team (2013)

3.3 Rehabilitation on South Nawin Irrigation System

As aforementioned, some distribution canals of North Nawin irrigation system receive water from distribution canals of South Nawin irrigation system. Due to this fact, some hydraulic structures in the North Nawin irrigation system shall be counted as the facilities of South Nawin irrigation system in spite of that there is no hydraulic structures to be rehabilitated in the South Nawin irrigation system.

3.3.1 Rehabilitation of Canals

Irrigation Department commenced rehabilitation works of South Nawin irrigation system since 2011. About 40% of rehabilitation works for main canal has completed. Most part of distribution canal requires rehabilitation works by the project. Proposed rehabilitation period is divided into 3 years and quantity of works is shown as follows.

Table 3.3.1 Proposed Canal Rehabilitation Works in South Nawin Irrigation System

Canal Rehabilitation		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Preparatory Works	m	6,099	0	0	6,099
	Earth Works	m^3	31,350	238	105	31,692
	Concrete Lining Works	m^3	15,696	24,154	11,558	51,408
Distribution Canal	Preparatory Works	m	29,526	133,069	110,478	273,073
	Earth Works	m^3	48,541	598,329	654,620	1,301,490
	Brick Lining Works	m^2	911	2,462	3,850	7,222

Source: Irrigation Department, the Survey Team (2013)

3.3.2 Rehabilitation of Hydraulic and Other Structures

As aforementioned, there is no hydraulic structures requiring rehabilitation by the project but some

structures have transferred from North Nawin irrigation system to South Nawin irrigation system based on the current condition. Total 108 of turn-out, 3 numbers of syphon, 32 numbers of bridge, 52 numbers of drop structures are required for rehabilitation works under the project.

Table 3.3.2 Proposed Rehabilitation Works on Hydraulic and Other Structures in South Nawin Irri. Sys.

Structures along Distribution Canal	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Rehabilitation of Turn Out	Nos	0	44	64	108
Rehabilitation of Syphon	Nos	0	0	3	3
Rehabilitation of Bridge	Nos	0	19	13	32
Rehabilitation of Drop	Nos	0	23	29	52

Source: Irrigation Department, the Survey Team (2013)

3.3.3 Rehabilitation of Road

Gravel pavement was provided along main canals of South Nawin irrigation system and current condition is not so bad according to site inspection by the Survey Team. As for distribution canal, there is no pavement on the surface of road but existing condition shows it is not so bad. By this project, total 30 km of inspection road along main canal and 8 km of distribution canal road will be rehabilitated.

Table 3.3.3 Proposed Road Rehabilitation Works in South Nawin Irrigation System

Road Rehabilitation	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Main Canal Road	km	0.0	17.0	13.0	30.0
Distribution Canal Road	km	0.0	6.0	2.0	8.0

Source: Irrigation Department, the Survey Team (2013)

3.3.4 Watering Point for Cattle

There are some damaged places where footprint of cattle can be observes. It is estimated that cattle comes to canal bank and tries to take water from such point during dry season. Such place also functions as crossing point of cattle from this side bank to the opposite. Thus, numbers of cattle come to such places and give damages on canal linings. In order to prevent canal lining from such damages by cattle, watering point is designed by this project as follows.

Collapsed canal bank by cattle moving

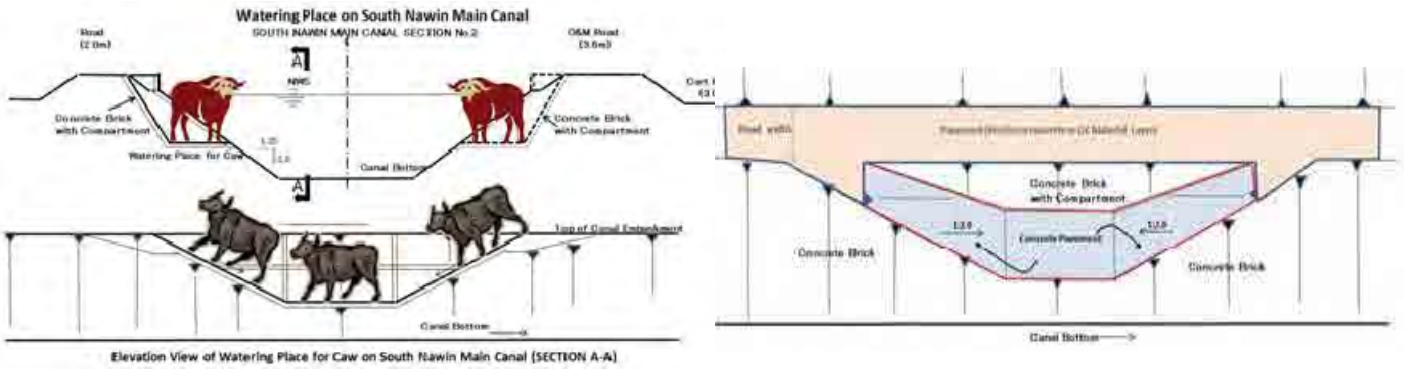


Figure 3.3.1 Damaged Slopes by Cattle Walk (left) and Illustration of Watering Point for Cattle (right)

Source: Survey Team (2013)

3.3.5 Land Consolidation

In an irrigable area under South Nawin irrigation system, a model farm for land consolidation is also planned and surveyed. Expected beneficiary area is 16.17 ha and its basic design is shown as follows.

Figure 3.3.2 Basic Design Map for Land Consolidation in Irrigable Area of South Nawin Irrigation System

Source: Survey Team (2013)

3.4 Rehabilitation on Wegyi Irrigation System

Rehabilitation works for Wegyi irrigation system has commenced in 2011 but progress of works doesn't go well. The progress is estimated about 5% more or less. Basically, canal lining is not provided to this irrigation system, so that severe erosions are identified at some changing points of hydraulic gradient along canals. Since no lining work is provided on canal surface, rehabilitation works to date tend to be waste of budget. Flow area reduction can be easily assumed throughout canals but it is difficult to grasp how much area reduction has proceeded.

3.4.1 Rehabilitation of Canals

Irrigation Department has been trying to rehabilitate Wegyi irrigation system since 2011, however, rehabilitation is going on without any lining on canals. Bare earth canal surface will be easily eroded again by canal water flow and rainfall. As aforementioned, concrete lining will be provided to main canal and cement brick lining will be provided to distribution canal. Proposed rehabilitation period is limited to 3 years and quantity of works is summarized as follows.

Table 3.4.1 Proposed Canal Rehabilitation Works in Wegyi Irrigation System

Canal Rehabilitation		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Preparatory Works	m	7,772	0	0	7,772
	Earth Works	m^3	219,056	0	0	219,056
	Concrete Lining Works	m^3	29,151	0	0	29,151
Distribution Canal	Preparatory Works	m	92,793	104,205	85,103	282,102
	Earth Works	m^3	661,923	697,232	634,535	1,993,690
	Brick Lining Works	m^2	4,789	6,140	4,388	15,317

Source: Irrigation Department, the Survey Team (2013)

Existing canal has no lining on the surface and its slope is designed as 1:1.5 while the canal slope of North Nawin and South Nawin is 1:1.25. In order to keep a canal road width as wide as possible, design slope of Wegyi irrigation system is proposed 1:1.25 as follows.

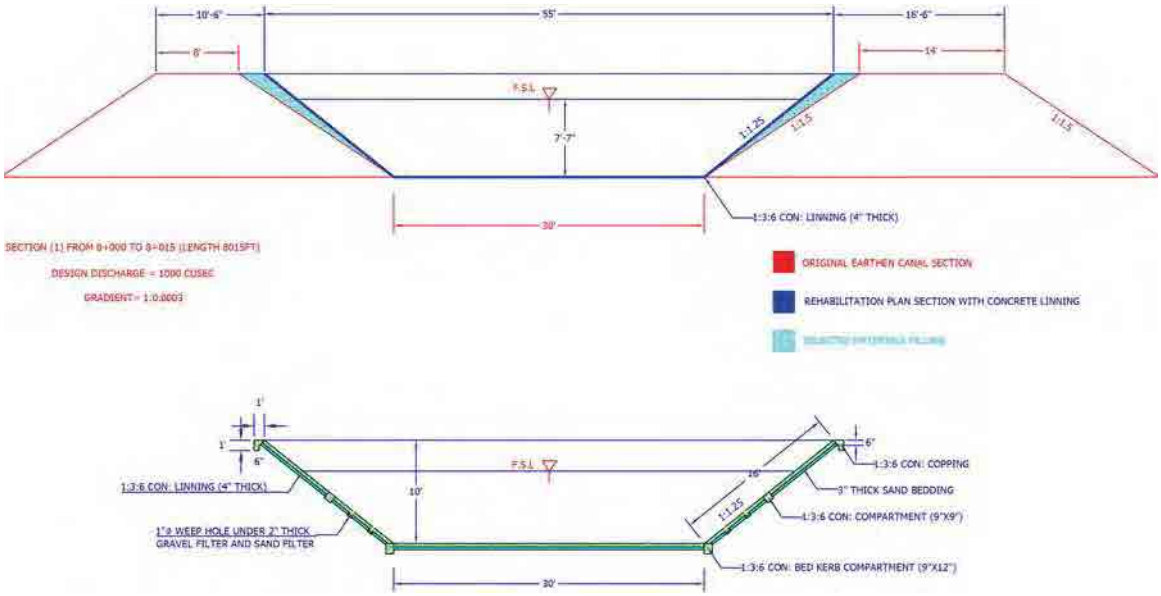


Figure 3.4.1 Proposed Main Canal Slope with Concrete Lining for Wegyi Irrigation System

Source: Survey Team (2013)

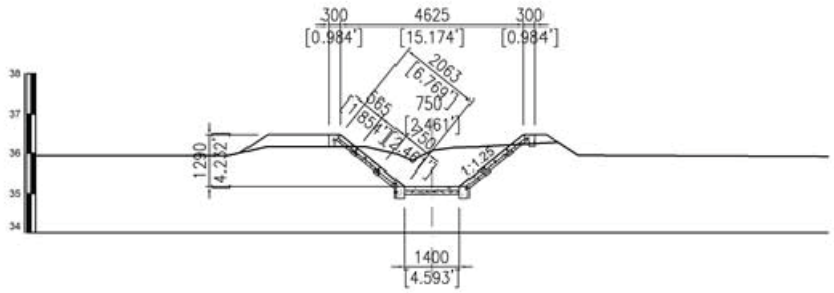


Figure 3.4.2 Proposed Distribution Canal Slope with Cement Brick Lining for Wegyi Irrigation System

Source: Survey Team (2013)

Severe damage of distribution canal is identified at some places of distribution canals most probably due to erosion and cattle passing. Sometimes original shape cannot be imagined from the present view. Figure 3.4.2 shown above is proposed as the distribution canal design for rehabilitation works.

3.4.2 Rehabilitation of Hydraulic and Other Structures

Irrigation operation without canal lining resulted severe damage on hydraulic structures that some hydraulic structures were completely flushed away during irrigation period. This is why numbers of drops should be constructed again by the rehabilitation project. Total 29 numbers of turn-out, 12 numbers of bridges, 1 number of syphon, will be rehabilitated, and then, 1 number of bridge and 21 numbers of drops shall be re-constructed by the project.

Table 3.4.2 Proposed Rehabilitation Works on Hydraulic and Other Structures in Wegyi Irri. Sys.

Structures along Canals		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Rehabilitation of Bridge	Nos	2	0	0	2
	Construction of Drop	Nos	1	0	0	1
Distribution Canal	Rehabilitation of Turn Out	Nos	14	11	4	29
	Rehabilitation of Syphon	Nos	0	1	0	1
	Rehabilitation of Bridge	Nos	7	2	1	10
	Construction of Bridge	Nos	0	1	0	1
	Construction of Drop	Nos	15	5	0	20

Source: Irrigation Department, the Survey Team (2013)

3.4.3 Rehabilitation of Road

Pavement was not provided for roads in Wegyi irrigation system. During rainy season, wet soil at the surface of road becomes muddy after bull-carts passing by. After such condition, undulated road surface becomes quite bumpy and vehicle cannot go over well during dry season. Thus, pavement is quite necessary for the road of this irrigation system. It is planned that total 30 km of inspection road along main canal and 50 km of distribution canal road are proposed as targeted rehabilitation works.

Table 3.4.3 Proposed Road Rehabilitation Works in Wegyi Irrigation System

Road Rehabilitation	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Main Canal Road	km	0.0	21.5	8.5	30.0
Distribution Canal Road	km	0.0	35.5	14.5	50.0

Source: Irrigation Department, the Survey Team (2013)

3.5 Rehabilitation on Taung Nyo Irrigation System

Taung Nyo irrigation system has a steep topography from dam site to canal terminals and this slope has caused severe damage on the irrigation system. Some hydraulic structures in the irrigation system had completely been flushed off and canal-beds of the structure were scraped off by 2.0m or more from the original bed elevation. Sandy soil is dominant in this area, so that water erosion is estimated easily to take place. Some damaged structures and canals are difficult to imagine their original shapes and forms. Since North Nawin irrigation system and South Nawin irrigation system are located on sandy soil foundation, structures of these irrigation systems can be referred to designs for this project.

3.5.1 Rehabilitation of Canals

Irrigation Department has been carried out rehabilitation works of Taung Nyo irrigation system since 2011. It is partial rehabilitation coupled with non-ling, thus, erosions take place year after year and it can be said not effective. This is because that progress of the rehabilitation doesn't go on well. Proposed rehabilitation period is only 3 years and quantity of canal rehabilitation works is shown as follows.

Table 3.5.1 Proposed Canal Rehabilitation Works in Taung Nyo Irrigation System

Canal Rehabilitation		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Preparatory Works	m	8,239	0	13,405	21,644
	Earth Works	m^3	80,196	0	106,970	187,166
	Concrete Lining Works	m^3	26,990	0	30,035	57,026
Distribution Canal	Preparatory Works	m	19,477	90,379	17,355	127,211
	Earth Works	m^3	95,238	252,899	46,996	395,133
	Brick Lining Works	m^2	237	5,545	1,412	7,194

Source: Irrigation Department, the Survey Team (2013)

3.5.2 Rehabilitation of Hydraulic and Other Structures

Rehabilitation designs on some damaged hydraulic structures were prepared by Irrigation Department but those deigns shall have to be checked up hydraulic condition. In addition, foundation and base structures shall have enough strength, then, those foundation designs shall also be revised. Total 4 bridges and 97 drops are proposed for rehabilitation under this project.

Table 3.5.2 Proposed Rehabilitation Works on Hydraulic and Other Structures in Taung Nyo Irri. Sys.

Structures along Canals		Unit	Quantity			
			1st year	2nd year	3rd year	Total
Main Canal	Rehabilitation of Turn Out	Nos	0	0	0	0
	Rehabilitation of Syphon	Nos	0	0	0	0

Structures along Canals		Unit	Quantity			
			1st year	2nd year	3rd year	Total
	Rehabilitation of Bridge	Nos	2	0	0	2
	Construction of Bridges	Nos	0	2	0	2
	Rehabilitation of Drop	Nos	5	0	5	10
	Construction of Drops	Nos	0	0	0	0
Distribution Canal	Rehabilitation of Turn Out	Nos	0	0	0	0
	Rehabilitation of Syphon	Nos	0	0	0	0
	Rehabilitation of Bridge	Nos	0	0	0	0
	Construction of Bridges	Nos	0	0	0	0
	Rehabilitation of Drop	Nos	30	47	10	87
	Construction of Drops	Nos	0	0	0	0

Source: Irrigation Department, the Survey Team (2013)

3.5.3 Rehabilitation of Road

It is the same as Wegyi irrigation system, pavement was not provided for roads in Taung Nyo irrigation system. During rainy season, surface soil becomes muddy and swampy that no-vehicle can run on such road. In dry season, such swampy road turns to uneven road and vehicle transportation again becomes difficult. For this project, total 22.1 km of main canal road and 49.5 km of distribution road are proposed for rehabilitation as follows.

Table 3.5.3 Proposed Road Rehabilitation Works in Taung Nyo Irrigation System

Road Rehabilitation	Unit	Quantity			
		1st year	2nd year	3rd year	Total
Main Canal Road	km	0.0	15.0	7.1	22.1
Distribution Canal Road	km	0.0	29.0	20.5	49.5

Source: Irrigation Department, the Survey Team (2013)

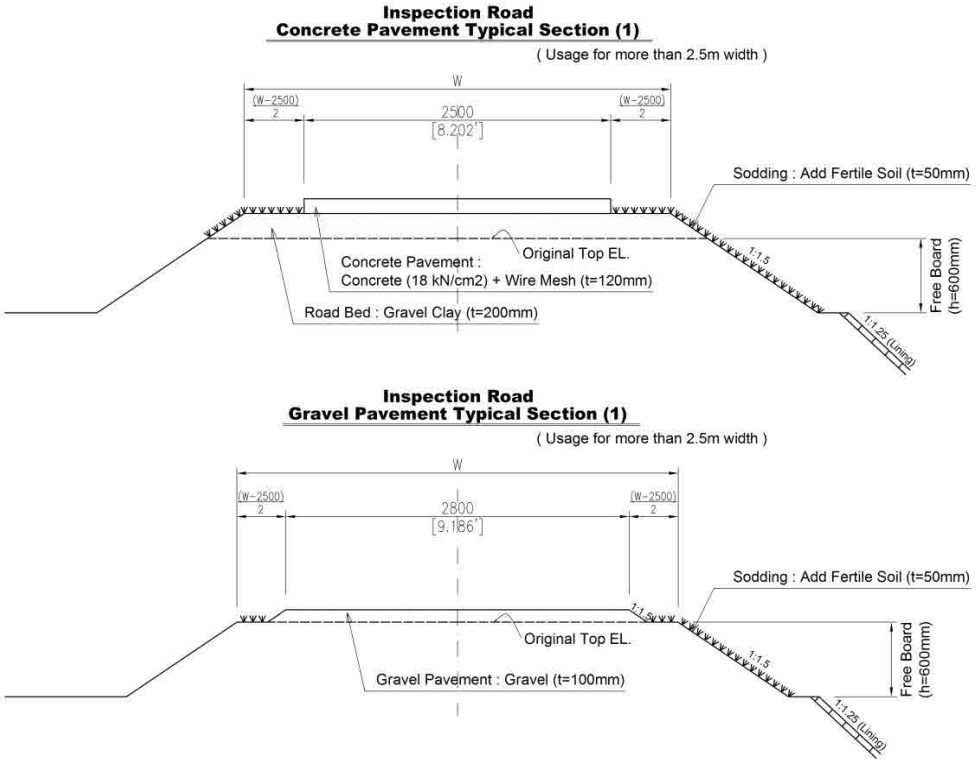


Figure 3.5.1 Proposed Inspection Road Pavement for Distribution Canal Road

Source: Survey Team (2013)

3.6 Procurement of Machineries and Equipment

Construction modality for this project is to be a direct force account carried out by Irrigation Department (ID). In fact, ID has constructed a number of irrigation schemes to date by utilizing her own staff and also machineries. However, the machineries that the ID owns are not enough in terms of both number and capacity to manage all the construction sites. Therefore, it is recommended for the ID to procure construction machineries required for this Project.

Here, there is one issue towards procuring such machineries. Machinery procurement is to be arranged under ICB (international competitive bidding), which needs usually one-year starting from pre-qualification of the potential bidders, tendering by the P-Q passed bidders, bidding, bid evaluation, manufacturing of the machineries and delivery as well as training required prior to the deployment of the machineries to the sites. It means that the machineries to be newly procured under the envisaged loan could be available from year 2015. This makes ID to use her own construction machineries for the works of year 2014.

ID is therefore supposed to deploy necessary machineries to carry out required amount of works planned in year 2014 and then the new machineries would take over the construction work from year 2015. ID is then to take back her own machineries to the other construction sites after one-year deployment of these own machineries. Discussions between the JICA survey team and ID have identified the Government of Myanmar has a top priority to complete the Project at an earliest time, thereby the ID is ready to arrange her own construction machineries brought about to the Project site from other construction sites.

At the same time, ID's machineries are always in shortage as compared to the total work volume of on-going construction sites. In addition, about 15% of the ID owned 3,000 machineries are aged over 15 years waiting for renewal. Given the top priority to the Project requiring the completion at an earliest time, the ID owned existing machineries are to be deployed in year 2014 and then the to-be-procured machineries under this Project will be deployed from year 2015, replacing the first deployed own machineries to accelerate the construction schedule. With this in mind, following discussion centers on those machineries and equipment that the ID is recommended to procure in line with the construction works envisaged:

3.6.1 Criteria in Selecting Machineries and Equipment Procured

For the selection of machineries and equipment, which are to be employed in the implementation of the Project, what comes first should meet the construction plan on the rehabilitation of the 4 irrigation systems, and then following criteria should together be considered:

1) Utilization of the existing machineries and equipment should be considered first, above which newly to-be-procured machineries and equipment should be planned,

2) Abilities of ID mechanics in the field of maintenance of construction machineries should be considered,

3) Requests from the ID Construction Circle No.2, in charge of the implementation of the construction works, should be referred to on the specifications of the machineries and equipment in order to meet the working conditions and the working scales,

4) Such equipment which can accelerate the working speed should be considered taking into account the limited implementation periods, say only during rainy seasons in 3-year construction period for each of the 4 irrigation systems, and

5) Such equipment which can secure quality of the concrete structures and the canal banks should

be selected taking into consideration lessons learnt through South Nawin Irrigation Project (OECF loan, completed in November 1995) and other canal construction projects having been so far implemented by ID.

3.6.2 Major Civil Works Expected

Construction planning for rehabilitation of the 4 irrigation systems includes such major works as 1) earth works, 2) canal lining works and 3) road construction aside from other appurtenant construction works. Machineries and equipment, which are to be procured under the Project, should accordingly be planned based on the requirements by such major construction work. The requirement by the major work is summarized below;

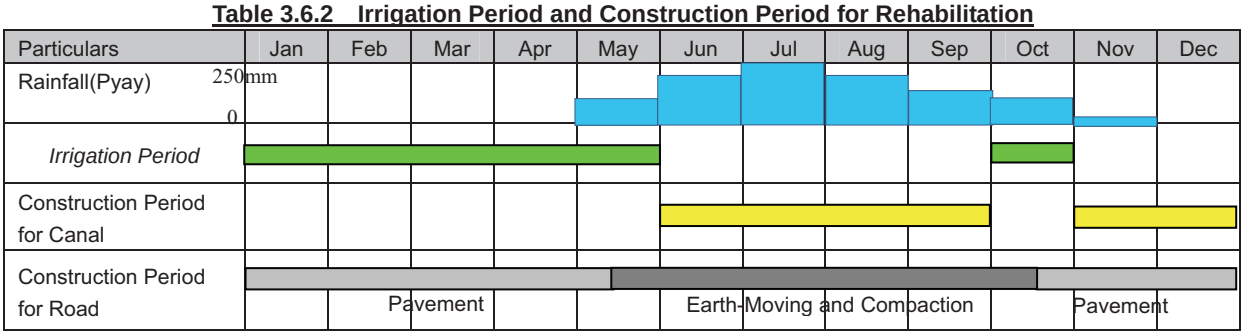
Table 3.6.1 Requirement by the Major Construction Work

Category	Earth Works	Canal Lining Works	Road Construction Works
Main Canals	Embankment and compaction	In-situ concrete lining	Concrete pavement (2.5mW)
Access Road in North Nawin	Embankment in inundated places	-	Concrete pavement (5.0mW)
Distributary Canals (large)	Embankment and compaction	Cement brick lining	Gravelly clay pavement (1.5-2.0mW)
Distributary Canals (small)	Excavation	Cement brick lining	No road construction, embankment, and compaction only
Tertiary Canals	No earth works	No lining works (implemented by beneficiaries)	No road construction

Source: JICA Survey Team

Of the major construction works, canal rehabilitation work should be implemented during total 6 months composed of 4 months (Jun-Sep) and 2 months (Nov-Dec). During the periods, farmland dose not need irrigation water; i.e. during the former 4 months season only paddy is cultivated in the field which almost fully grow by rainfall and during the later 2 months season already planted winter crops, mainly black gram, can grow utilizing residual moisture provided just before the period, in October. The road construction works are, on the other hand, continued throughout year except for concrete pavement. Concrete pavement should be carried out only during the dry season. The effective annual working days are thus set at 154 days for canal rehabilitation works, and 292 days for road construction works.

Table 3.6.2 Irrigation Period and Construction Period for Rehabilitation



Note: From January to May, later cultivation period of winter crop and also summer paddy need irrigation water. From June to September, monsoon paddy can grow by rainfall whereby no irrigation water is needed. In October, irrigation water is needed for planting winter crop, e.g. black gram. From November to December, the planted winter crop, e.g. black gram, can grow by utilizing residual moisture.
Source: JICA Survey Team

3.6.3 Utilization of Existing Construction Machineries and Equipment

ID Construction Circle No.2 possesses heavy machineries and equipment rendered mainly for dam construction (see table below). These machineries and equipment are operated by the mechanical

section of the Circle No.2. Most of the machineries are of large capacity, and have been utilized over 10-20 years (more than the standard economic life). The heavy machineries are repaired or overhauled terminally by Earth–Moving Equipment (EME) of Workshop Mechanical Circle No.3 of ID, and the scraped heavy machineries are kept in the their compounds for the purpose of taking spare parts. Genuine spare parts are stored in the warehouses of EME workshop and also in the Construction Circle No.2 mechanical section. The machineries owned by the Construction Circle No.2 are at present utilized in 8 irrigation projects shown below:

Table 3.6.3 The Existing Machineries and Equipment maintained by ID in Pyay

Major Heavy Machineries and Vehicles	Management	Specifications	Offices in Pyay	Project Sites								Total	Repairing
				Ma Day	Shwe Laung	Tarli	TIF Model Farm	Min Hla	Ga Mone	Taung Nyo	South Nawin		
Track Dozer (medium: class-2)	Con2	200hp, 2.4m^3	1	1	2	1	1	1	1	2		10	
Hydraulic Excavator	Con2	1.0-1.2m^3	2	3	1	1			2	3	1	13	
Dump Truck	Con2	10,15 & 18.6m^3	11		1				1			14	1
Wheel Loader	Con2	2.4m^3	1	1	2	1						5	
Motor Scraper	Con2	145hp	1		1							2	
Truck Crane	Con2	6-10ton	1	1								2	
Sheep Foot Roller	Con2	Local-made	1									2	1
Water Bowser	Con2	1200gal	1									1	
Fuel Bowser	Con2	1600gal	7									7	
Cargo Truck	MT	6ton	5									5	
Semi-trailer Truck	ME	20ton	1									1	
Earth-Moving Workshop	ME	processing machines	1									1	
Scraped Machineries	ME	For taking spare parts	15									15	

Remarks; Con2 = Construction Circle No. 2, MT = Maintenance Division-Bago Region, and ME = Mechanical Circle No.3
Source: Mechanical Section of Construction Circle No.2, August 2013 et al

The above listed machineries and vehicles are kept good conditions to operate. Track dozers and hydraulic excavators are in fact used for all the projects for maintaining irrigation canals. Since procurement procedure of the machineries and equipment under the Project will need more than 1 year under ICB (international competitive bidding), the machineries and equipment available in the Construction Circle No.2, Mechanical Circle No.3 and Maintenance Division-Bago Region should be utilized as much as possible by the time the procured machineries are to arrive at the site.

Workshops for maintaining construction machineries are allocated under Construction Circle No.2 and also under Mechanical Circle No.3. Both Circles have workshops located within Pyay township as summarized in the following table. Mechanics and operators assigned under the Construction No.2 have enough experiences in operating and maintaining such machineries and equipment; however trainings for newly procured construction machineries are due required when the machineries have arrived at Pyay.

Table 3.6.4 Operation and Maintenance of the Machineries and Equipment

Organization	Irrigation Department Construction Division Construction Circle No. 2 Pyay Office – Mechanical Workshop	Irrigation Department Mechanical Division Mechanical Circle No. 3 Earth-Moving Equipment (EME) Workshop at Pyay
Regional headquarters	Pyay Township, Bago (West) Region	Magway Township, Magway Region
Permanent engineers & technicians engaged in workshop	44 (permanent employ) Bachelor in Engineering (3) Agri. Tech. Institute (10) Technical High School (1)	82 (permanent employ) Bachelor in Engineering (2) Agri. Tech. Institute (20) Technical High School (3)

	Others (30)	Others (57)
Duties	• Operation of heavy machineries and vehicles • Daily maintenance and simple repair • Stock of spare parts	• Operation of EME Workshop (class B) including processing machines to produce parts • Annual maintenance of heavy machineries and vehicles • Production of spare parts (shaft, mechanical parts, etc.) • Overhaul of engines and chassis • Stock of spare parts and scraped machineries
Major facilities	• 2 Garage and 4 repair rooms 30mx6m • 3 Stores • 2 Sheds • 1 Office	• Modern workshop with office 40mx12m • 3 Garages • 4 stores
Major machines and tools	• Hand tools • Hand grinder	• Owned machines 4 laths, 3 bench drilling machines, 2 hack saw, 1 arc welder, 1 injector pump tester, 1 table grinder, 1 air compressor, 1 roof crane, 1 generator

Source: JICA Survey Team, August 2013

3.6.4 Planning of Construction Machineries and Equipment Procured

Mechanical engineers in the mechanical section of Construction Circle No.2 recommend relatively small to medium scale construction machines in order to meet the working conditions on site. In addition, excavators should equip with super long arm so that it can reach the bottoms and slopes for the main canals. To enter and operate on the roads of distributary canals, mini sized hydraulic excavators can be effective to work. ID owns large sized track dozers (or bulldozers) and dump trucks, which are in fact not suitable for canal rehabilitation works.

ID wishes to introduce diesel engine driven machineries and vehicles due to its lower cost for procurement by a lot purchase contract between ID headquarters and Myanmar Petroleum Products Enterprise (MPPE). Gasoline is, on the other hand, purchased for electrical generators, small pumps, light vehicles and motorcycles in commercial prices. Following types of machineries are recommended by ID to procure under the Project:

Table 3.6.5 Recommended Specifications of Machineries and Equipment by ID

Kind of Work	Construction Machinery	Capacity	Power Output	Equivalent Maker & Model
Earth work of canal banks and dredging work for main canals	Hydraulic Excavator (super long arm)	Bucket 0.5m^3	158hp (118kW)	Hitachi EX220-5 (LC track, super long arm)
Earth work of canal bank and excavating work for distributary canals	Hydraulic Excavator (mini)	Bucket 0.07m^3	21hp (15.7kW)	Komatsu PC20 MR-2
Dozing work of main canals and large distributary canals	Track Dozer (class-2)	-	124hp (92.5kW)	Komatsu D53A-17
Compacting work of access road	Road Roller	21 ton weight	150hp (112kW)	Dyanapac CC431
Concreting work	Concrete Pump	35m^3/hr	56hp (41.8kW)	Symtec MKW35SVH
Transport of concrete	Concrete Mixer Truck	3m^3	225hp (167.8kW)	Mitsubishi Fuso FP418-A
Removing of slug and mud	Portable Mud Pump	0.16m^3/min	7.6hp (5.7kW)	Bomag BW160A

Source: Mechanical Section of Construction Circle No.2, July 2013

The specifications of the machineries and equipment recommended for the procurement under the Project should be selected according to each of the major civil works and also the related works. As much as possible, usage of the existing machineries and equipment are to be considered in planning the procurement of machineries. In addition, the completion report for South Nawin Irrigation Project issued in September 1998 shall be referred to since the report indicates following issues, which should

be considered in selecting the machineries and equipment:

1) Insufficient Compaction of Soils on the Canal Banks

Compaction of soils was implemented by traditional manual methods, hence leaving loosely compacted portions in the filling of embankment. As a result, some defects have occurred such as slope sliding at high filling sections, breach of brick lining caused with settlement of embankment and erosion of embankment slopes by rainfall. It was in fact understandable because there was a government policy which was meant to reduce unemployment prevalent in rural areas. By this to be considered, several sizes and kinds of compactors have to be included, which will help to facilitate the compaction of the banks. In addition, introduction of super long arm excavators will help to dredge the deposited sands on the canal bottom.

2) Narrow Width of Top Berms of Canal Banks

In the original design, the width of the top berms along main canals was determined to be 3.6 meters on the right side. In parallel, a cart road of 3.0 meters wide was also provided along the skirts of canal banks to avoid deterioration of the top berm road. The width of the left side berm is, on the other hand, only 2.0 meters. These widths are not big enough to let bigger sized machineries to fully operate. The construction machineries to be operated from these berms should therefore be such small to medium sizes that they are to be accommodated within the top berms. Small sizes of machineries mean the crawler width or the wheel axis width should be about 2.0 metres.

3) Back Water Pressure on Brick Lining and Backfilling of Embankment

As to the original canal lining, ID used bricks having 6 weep holes with 1.5 cm diameter as draining back water pressure. However, ID has not placed suitable filters at the entrance of the weep holes. Consequently, some weep holes were blocked with sands, whereby some brick linings especially on the bottom were broken by uplift of the back water. Backfilling for the lining as well as for hydraulic structures had been done in a rushed way and manual compaction employed mostly at that time could not stop leaving loose portions. Referring to such situation, small compactors have to be included in the machineries to be procured, which will definitely help to solve the issue.

4) Low Quality of Mortar Used for Brick Joints and Concrete Structures

Proportion of mortar used for the brick lining joint was designed and specified at 1:3 (cement : sand in weight). However, actual proportions were less than that of the designed as 1:6 to 1:8. Compressive strength of the bricks is estimated approximately at 150 kgf/cm^2 while the mortar strength may have obtained only less than 40% of the proposed strength. It is therefore required to equip measurement bucket for the concrete mixer. Moreover the proportions should be at 1:3:6 (cement: sand: river gravel) for canal lining concrete and 1:2:4 for reinforced concrete with steel bars. Concrete specimen sampled during the construction stage should be sent to Irrigation Technology Center Regional Laboratory located at Pyay and analyzed for their compressing strength.

3.6.5 Relationship between Existing Machineries and To-be-newly Procured Ones

Existing construction machines and equipment owned by the Construction Circle No.2 will have to be fully utilized during the construction. In addition to these existing machines and equipment, additional machines and equipment are to be procured in order to complete the planned construction works within the specified construction period, i.e. 3 years for each irrigation system. Works in which the machineries and equipment are to be engaged can be categorized into; 1) preparation works, 2) earth works, 3) canal lining works, 4) hydraulic structuring works, 5) road works and 6) appurtenant works. Arrangement of the machineries between the newly procured ones and existing ones are described in the following table according to the works:

Table 3.6.6 Relation of Major Works and Major Machineries/ Equipment

Major Works	Major Machineries and Equipment	
	Procuring Machineries and Equipment under the Project	Existing Machineries and Equipment of ID Construction No.2
Preparatory Works	excavator (standard), track dozer, wheel loader	topographic survey instrument, wheel loader, passenger truck
Earth Works		
(1) Rehabilitation of canal banks	excavator (all types), track dozer, dump truck	excavator (standard) in quarry
(2) Refill and compaction of gravel clay	excavator (standard), excavator (long arm) with slope bucket, vibration roller, compactor	excavator (standard)
(3) Construction of temporary coffer dams	excavator (long arm), engine pump, submersible pump with generator	
(4) Dredge	excavator (long arm)	
Canal Lining Works		
(1) Cement brick lining	truck with crane	cargo truck
(2) Concrete works for bed kerb and copping	truck with crane	cargo truck, heavy dump truck
(3) In-situ concrete lining	concrete mixer, concrete mixer truck, concrete pump truck, wheel loader	cargo truck, heavy dump truck
(4) Timber shuttering	truck with crane	
Hydraulic Structuring Works		
(1) Construction of structures	concrete mixer, concrete mixer truck, concrete pump truck, high cycle vibrator/generator	
(2) Repair of structures	hydraulic breaker, excavator (long arm), dump truck	
Road Works		
(1) Gravel clay pavement	excavator (standard), dump truck, track dozer, water bowser, vibration roller	excavator and front loader in quarries, motor scraper
(2) Concrete pavement	dump truck, track dozer, water bowser, roller, concrete mixer, concrete mixer truck, concrete pump truck, vibrator, excavator (standard), hydraulic breaker	heavy dump truck, heavy track dozer, stone crasher, concrete leveler
Conduit pipe dismantle and installation works (North Nawin Dam)		acetylene burner/welder, chain block, blower, crane truck
Appurtenant Works		
(1) Repair of heavy machineries and equipment	semi-trailer truck, mobile workshop, workshop equipment	processing machines and tools in Earth-Moving Equipment Workshop
(2) Excavation of drainage canal	excavator (long arm)	
(3) Transport of materials and equipment	semi-trailer truck, dump truck	heavy dump truck, fuel bowser, fuel tank
(4) Dewatering works	engine pump, submersible sand pump	
(5) Replacement of diesel generator for the gates (South Nawin)	diesel generator	electrical tool kit, chain block
(6) Laboratory test of soils and concrete	Additional laboratory soil and concrete testing apparatus	laboratory soil and concrete testing apparatus

Remarks: Three types of excavators will be required depending on the working conditions.

3.6.6 Selection and Quantities of Machineries and Equipment Procured

Based on the aforementioned discussions and also the discussions with the engineers of mechanical section of Construction Circle No.2, following 27 categories of machineries and equipment are recommended for ID to procure and utilize for the implementation of the Project. Following table also summarizes the major functions and specifications required for each of the necessary construction works. Note that EQ-13 is for workshop, EQ-25 for ITC Regional Laboratory for testing of sample soil and sample concrete, and EQ-26 and EQ-27 are agricultural machineries for demonstration purposes. ID and JICA Fact Finding Mission, dispatched in early September 2013, agreed to give the

first priority to EQ-1 to EQ-13 to procure in the Project on 6th September, 2013:

Table 3.6.7 Major Functions and Specification of the Proposed Construction Machineries/ Equipment

Equip't Name	Image	Major Function	Specifications
First Priority (The machineries and equipment will be procured under the Project.)			
EQ-1 Hydraulic Excavator, Standard		• Earth works for main and distributary canals • Road construction works including demolishment of deteriorated concrete pavement of access roads • Unload of bricks and concrete blocks • Construction of structures including hoist of heavy materials and machines	20-23ton, crawler type, Tier-2, 1.0m^3, 122kW, w/ crane attachment, dozer
EQ-2 Hydraulic Excavator, Long Arm		• Earth works for main and distributary canals including temporary coffer dams, compaction of slops of canal banks and dredge of sedimentation of sands in main and distributary canals • Earth works for drain canals	crawler type, super long arm, Tier-2, 0.45m^3, 130kW, w/ slope bucket
EQ-3 Hydraulic Excavator, Small Size		• Earth works of branches of distributary canals (tertiary canals) and small-wide distributary canals • Earth works for drain canals	6-7ton, rubber crawler type, Tier-2, 0.18m^3, 43kW
EQ-4 Hydraulic Breaker with Basic Machine		• Demolishment for existing structures in main and distributary canals and deteriorated concrete pavement of roads	20-13ton, crawler type, 122kW, w/ 1300kg class hydraulic breaker
EQ-5 Tracked Dozer, Class II		• Dozing of soils and compacting soils on the main canal banks and access roads	21t class, 150kW output, Tier-2
EQ-6 Tracked Dozer, Class III		• Dozing of soils and compacting soils on the distributary canal banks	11t class, 100kW output, Tier-2
EQ-7 Wheel Loader		• Loading of soils, sands and concrete debris to dump trucks at the main canals, access roads or quarries	11ton, standard type, Tier-2, standard bucket capacity 2.0m^3, 122kW

Equip't Name	Image	Major Function	Specifications
EQ-8 Earth Work Vibration Roller		• Earth works for compaction of maintenance roads on canal banks of main canals and access road	steering type, single drum roller, Tier-2, 11-12ton, 103kW
EQ-9 Agitator Truck (Concrete Mixer Truck)		• Transport of concrete from the stock yards to the site for concrete road construction works in order to secure concrete quality	6×4 drive, drum capacity 9m^3, 235kW
EQ-10 Lowbed Semi-Trailer Truck		• Transport of heavy machineries such as hydraulic excavators, track dozers and vibration rollers	maximum loading capacity 25t, 235kW
EQ-11 Dump Truck		• Transport of materials and aggregates such as sand, cement, reinforce steel bar, cement brick, etc.	4 × 4 drive, maximum loading capacity 6-7t, 165kW
EQ-12 Concrete Pump Truck		• For concrete lining works, placing of concrete from the concrete mixers or concrete mixer trucks to the canal slopes or the concrete structures in order to reduce working periods	Boom type (15m boom), 60m^3/hr, 165kW, w/mixer hopper
EQ-13 Workshop Equipments		• Daily maintenance and temporary repair of machineries at working sites	4 × 4 drive 177kW, w/ hydraulic crane, engine generator/welder, oxygen-acetylene gas welder/cutter, air compressor, mechanic tools, electrical tools, lubricating tools, diesel engine service kit
		• Repair of machineries at the workshop of Construction Division Circle No.2 in terms of replacement of tires/ crawlers, check of leakage of hydraulic systems, etc.	electrical air compressor, portable hydraulic press, hydraulic pressure meter, portable drill, mechanic tool set, etc.
Second Priority (The machineries and equipment are requested to purchase or prepare by ID.)			
EQ-14 Hand-guide Vibration Roller		• Earth works for compaction of on narrow-width canal banks of main canals and distributary canals	120(front)-130(rear)kgf/cm in dynamic pressure, φ355x575, 55Hz, 4.6kW, diesel engine

Equip't Name	Image	Major Function	Specifications
EQ-15 Vibrating Plate Compactor		• Backfilling of linings on canal slopes	15kN, 500mmx525mm, 3.5kW, diesel engine
EQ-16 Tilting Drum Concrete Mixer		• Production of uniform quality of concrete • Production of concrete accompanied by the working sites such as concrete lining works and canal structure construction works.	diesel engine drive, 0.5m^3 wet capacity, 7.5kW, pneumatic tires, w/ mixing materials charging device, water measuring tank, pump & pipe
EQ-17 Truck with Crane		• Transport of light machineries such as engine pumps, generators, forming timber, etc.	maximum loading capacity 6t, crane capacity 2.9t, 132kW
EQ-18 Water Bowser		• Transport of water for soil compaction	5.5～6.5kl, 132kW
EQ-19 Concrete Inner Vibrator and Voltage & Frequency Converter		• Strengthening of concrete by means of removal of air bubbles during concreting works	frequency & voltage converter (input 230V, output 48V 200Hz), 3 extension codes (15m, 2.0mm2) and 3 inner headers (φ32mm rod, 6m)
EQ-21 Engine Pump		• Drainage of water during construction of structures, rehabilitation of siphons or medium-scale lining works in rain seasons	1m^3/min at 10m total head, nominal diameter 100mm, maximum total head 24m, diesel engine 6.3kW
EQ-22 Submerge Pump		• Drainage of water during construction of structures or small-scale lining works in rain seasons	φ50mm, 2 poles, 0.8kW, single phase 230V/50Hz
EQ-23 Diesel Engine Generator, Small		• Power supply for the concrete inner vibrators through the converter, submersible pumps and labor camps	rated output 2.7KVA, 3.4kW, single phase 230V/50Hz

Equip't Name	Image	Major Function	Specifications
EQ-24 Diesel Engine Generator, Large		• Replacement of the generator for the gate lifting for South Nawin Diversion Dam	rated output 125KVA, 134kW, Tier-2, three phase 400V/50Hz
EQ-25 Soil Mechanics and Concrete Testing Apparatus	Refer to Table 3.6.10 Soil Mechanics and Concrete Testing Apparatus (EQ-25).	• Equipment and instruments for testing of sample soil and sample concrete by ITC Regional Laboratory	soil mechanics testing, concrete testing and others
Third Priority (The farm machinery will be used for the model farms in the future.)			
EQ-26 4-Wheel Tractor		• Improvement of model farms for land consolidation such as dike construction and leveling works • Traction of concrete mixers • Tillage demonstration in model farms	37.5kW, w/ dozer, disc plow and rotary, In-direct Injection (IDI) diesel engine
EQ-27 Combine Harvester		• Mechanization of paddy harvesting in model farms and surrounding areas	52.2kW, w/ grain tank, tractor-driven trailer, In-direct Injection (IDI) diesel engine

Remarks: The 4-wheel tractor and combine harvester will be handed out to AMD.

In determining quantities of the construction machineries and equipment, three working units will be formed for each area of the 4 irrigation systems. For each working unit, ID shall appoint the Assistant Engineer to supervise and manage machineries. One of three units will work for main canal, and two will work for distributary canal except North Nawin where one unit is required for the rehabilitation of access road to the dam which is to be sifted to the main canal upon completion. These working units will, of course, be shifted to other irrigation areas according to the progress by site.

Table 3.6.8 Working Unit Arrangement by Site

Numbers of Working Units (2014-2018)					
Irrigation Area / Work Site	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Main Canal	-	1	1	1	3
Distributary Canal	2	2	2	2	8
Access Road	1	-	-	-	1

Source: JICA Survey Team

Following discussion centers on the quantities by machinery and equipment according to the No., EQ-1 to EQ-13 which are all placed under the 1st priority procurement, indicated in the above table:

EQ-1: Standard excavators with crane are used for loading gravel clay at quarry and for earth works in short excavating depth. The standard excavators will be allocated 4 units to each of the 4 irrigation sites including the access road rehabilitation of North Nawin irrigation system.

EQ-2: Super long arm excavators will be used for excavation and embankment of canal banks, canal slope trimming and canal bottom dredging (un-silting) for main canals. Necessary numbers will be 8 units calculated based on earth volume of the main canals. It is expected that the rehabilitation works of the main canal in North Nawin are completed in 2013. Therefore, there is no works for the main canals in North Nawin from 2014.

EQ-3: Small sized excavator will be used for earth works for distributary canals. Necessary numbers of units will be 20 calculated from earth volume of the distributary canals. The numbers of units for each irrigation area are determined by mechanical earth work volume for distributary canals starting after year 2015.

EQ-4: One unit of hydraulic breakers with basic machine will be allocated to access road rehabilitation work for the North Nawin irrigation system. The machine will be used for the demolishment of deteriorated concrete pavement of the existing access roads for North Nawin dam.

EQ-5: Tracked dozers class-II (medium size) will be allocated 2 units to each irrigation area. The access road in North Nawin is close to the distributary canals. After dozing works in the access have been completed, the tracked dozer will be transferred to the canal rehabilitation working unit of North Nawin.

EQ-6: Tracked dozers class-III (small size) will be allocated 2 units to each irrigation area. The access road in North Nawin is close to the distributary canals. After dozing works in the access have been completed, the tracked dozer will be transferred to the canal rehabilitation working unit.

EQ-7: The wheel loaders will be used for the quarries of gravelly clay; one unit for North Nawin and South Nawin irrigation systems and another unit for Wegyi and Taung Nyo irrigation systems.

EQ-8: Earth work vibration rollers will be allocated total 4 units for the main canal inspection path construction works, one each for each of the 4 irrigation systems, and 1 unit for access road works, totaling 5 units.

EQ-9: Agitator truck (concrete mixer truck) will be allocated 2 units to each irrigation area and access road working unit; namely total 10 units will be procured.

EQ-10: Low-bed semi-trailer truck will be allocated one unit to each of the 4 irrigation systems. Upon completion of the works, Mechanical Division Circle No.3 in Pyay township has strong intention to manage the trailer trucks for maintaining heavy machineries.

EQ-11: Dump trucks (6-7ton) will be allocated to distributary canal working units. Necessary quantity comes to 10 units in total based on the volume of base course materials.

EQ-12: Concrete pump trucks will be flexibly managed and allocated 1 unit for North Nawin and South Nawin irrigation systems and another 1 unit for Wegyi and Taung Nyo irrigation systems.

EQ-13: Workshop equipments will be consisted of 2 units of mobile workshop and 1 set of workshop tools. One set of mobile workshop equipped with tools will be allocated for the group of North Nawin and South Nawin irrigation systems and also another group for Wegyi and Taung Nyo irrigation systems. One set of Workshop tools will be allocated to the workshop of the Construction Circle No.2 located at Pyay Township.

Table 3.6.9 below elaborates the list of the EQ-25 for the soil mechanics and concrete testing apparatus, which will be needed by ITC Regional Laboratory for testing the materials and soils to secure work quality. Though these apparatus are not included in the ICB procurement, ID is recommended to procure the following items for securing high quality standard work.

Table 3.6.9 Soil Mechanics and Concrete Testing Apparatus (EQ-25)

No.	Equipment and Materials	Specifications	Q'ty
1.	Soil Mechanics Test		
1-1.	Filter for Soil Permeability Test	0.42mm, 0.074mm	20
1-2.	Pycnometer		20
1-3.	Straight Edge	Large	10
1-4.	Spatula		10
1-5.	Plane Photometer		1
1-6.	Laboratory Tong	9" length	3
1-7.	Pin Hole Test		1
1-8.	Power Auger		3
1-9.	Auger		3
1-10.	Hydrometer Jar and Mechanical Analysis Stirrer		1
1-11.	Hydrometer Bath		1
1-12.	Automatic Mechanical Compactor		1
1-13.	Drying Oven	1φ, 230V/50Hz,	2
1-14.	Volumetric Cylinder	1000ml	10
1-15.	Electric Precision Balance	1φ, 230V/50Hz	1
1-16.	Soil Grinder		3
1-17.	Sprayer		5
1-18.	Shrinkage Limit Test Set		2
1-19.	Electric Density Gauge		2
1-20.	Speedy Moisture Tester (0-50%)		2
1-21.	Speedy Moisture Tester (0-20%)		2
2.	Concrete Material Test		
2-1.	Schmidt Test Hammer		3
2-2.	Mixing Bowl and Spoon		3
2-3.	BS Cube Mold		30
2-4.	Cylinder Mole		30
2-5.	Slump Cone		10
2-6.	Base Plate		10
2-7.	Tamping Rod		10
2-8.	Trowel		20
2-9.	Compressive Machine		3
2-10.	Organic Impurity Tester		2
2-11.	Sand Absorption Cone and Tamper		3
2-12.	Le Chatelier Bath		1
2-13.	Le Chatelier Flask		10
3.	Water Quality Test		
3-1.	Suspended Solid Tester		3
3-2.	Filter Paper	5A, 5B, 5C	5
3-3.	Multi-parameter Water Analysis Set		1
3-4.	Distillation Apparatus	5 litre	2
3-5.	pH Meter		3
3-6.	Electrical Conductivity Meter		3

Source: Irrigation Technology Centre Regional Laboratory at Pyay and JICA Survey Team

In conclusion, the summary of the machineries that the ID is requested to procure under ICB is presented in Table 3.6.10. The table summarizes the type and kind of the machineries together with major specifications, assignment arrangement by irrigation system, and further shows the machineries and unit numbers that the ID should prepare for the 1st year work since the to-be-newly procured machineries are to be available from the second year construction, year 2015.

Table 3.6.10 Summary of Machineries and Equipment Allocation

No.	Equipment Name	Specifications	Q'ty	Allocation (Unit)					Use of Existing Equipment in 1st Year Calculated	Say (units)
				North Nawin & Pyay	South Nawin	Wegyi	Taung Nyo	Access Road		
1	Hydraulic Excavator, Standard	20-23ton, crawler type, Tier-2, 1m3, 122kW, type, w/ crane attachment, dozer	16 units	3	4	4	4	1	6.2	**6**
2	Hydraulic Excavator, Long Arm	crawler type, super long arm, Tier-2, 0.45m3, 130kW, w/ slope bucket	8 units	0	4	2	2	0	Manual earth work	**-**
3	Hydraulic Excavator, Small Size	6-7ton, rubber crawler type, Tier-2, 0.18m3, 43kW	20 units	5	5	8	2	0	Manual earth work	**-**
4	Hydraulic Breaker with Base Machine	attachment to excavator, 1300kg class	1 unit	0	0	0	0	1	0.4	**1**
5	Tracked Dozer, Class II	21ton class, 150kW output, Tier-2	8 units	1	2	2	2	1	3.1	**3**
6	Tracked Dozer, Class III	11ton class, 100kW output, Tier-2	8 units	1	2	2	2	1	3.1	**3**
7	Wheel Loader	11ton, standard type, Tier-2, standard bucket capacity 2.0m3, 122kW	2 units	0	1	0	1	0	0.8	**1**
8	Earth Work Vibration Roller	steering type, single drum roller, Tier-2, 11-12ton, 103kW	5 units	1	1	1	1	1	2.0	**2**
9	Agitator Truck (Concrete Mixer Truck)	6×4, mixer capacity 9m3, 235kW	10 units	2	2	2	2	2	Concrete Mixer,1m3	**12**
10	Lowbed Semi-Trailer Truck	maximum loading capacity 25t, 235kW	4 units	1	1	1	1	0	1.6	**1**
11	Dump Truck	4×4 drive, maximum loading capacity 6-7t, 165kW	10 units	2	2	3	3	0	5.1	**5**
12	Concrete Pump Truck	Boom type (15m boom), 60m3/hr, 165kW, w/mixer hopper	2 units	1		1		0	0.8	**0**
13	Workshop Equipments	4×4 drive, 177kW, w/ hydraulic crane, engine generator/ welder, oxygen-acetylene gas welder/ cutter, air compressor, mechanic tools, electrical tools, lubricating tools, diesel engine service kit and workshop tools in garage	1 lot	1	0	0	0	0		**1 Lot**
Equipment not listed in the ID Requirement										
14	Dump Truck	10-20 ton or more								**6**
15	Truck Crane									**1**
16	Equipment for Conduit Pipe for North Nawin Dam									**1 Lot**
17	Others									**1 Lot**

Source: JICA Survey Team

3.7 Water Resources and their Availability for Irrigation

3.7.1 Inflow to Reservoirs

During the period of military government, there were unwritten rules and/or ways of thinking which every government staff seemed to have to follow. GDP-growth was one of such items. Under military government, GDP had always to grow year after year and such endless growth had to always arrive at a targeted value which the government announced. Irrigable area coupled with yield was an important indicator which could directly affect crop production in an area as well as GDP growth of agriculture sector. Some necessary arrangement had been continued until 2010-2011 fiscal year. The following fiscal year 2011-2012 can be considered as a transition period according to interview to Maintenance Division (Bago West) of Irrigation Department and DOA Pyay office by the Survey Team. Then, the government staff interviewed said that data from fiscal year 2012-2013 is reliable to use as statistic.

Irrigation Department calculates inflow to a dam reservoir based on area-capacity curve which was prepared at the design stage of each project. Relationships between reservoir water levels and storage volumes are known-factors, and then, river inflow can be estimated by water volume which can be obtained from a calculation by reservoir water level change. Average runoff rate of each dam can also be calculated based on dam site rainfall data and it ranges 0.3 – 0.43. North Nawin project and South Nawin project show the lowest values of runoff coefficient which vary from 0.21 to 0.46 because it catchment area located at the most northern side among 4 projects, where is the edge portion of a central dry zone that the runoff coefficient is usually 0.3 or less. Runoff coefficient in southern side is higher than the northern side, which ranges from 0.37 to 0.70 as follows.

Table 3.7.1 Rainfall and Runoff Coefficient of Reservoirs for 4 Irrigation Systems

Project	North Nawin	South Nawin	Wegyi	Taung Nyo
Catchment Area (Km^2)	592	639	523	551
Annual Rainfall (mm)	990 – 1,,603	2,025 – 1,961	809 – 1,200	1,267 – 1,955
Runoff Coefficient	0.21 – 0.46	0.21 – 0.42	0.43 – 0.70	0.37 – 0.49
Annual Inflow (MCM)	134 - 435	235 – 492	198 - 388	294 - 465

Source: Irrigation Department

3.7.2 Past Irrigation Supply

Irrigation Department has recorded irrigation supply since reservoir operation commencement. It was revealed that several measuring methods have been applied for discharge calculation; one is calculation from reservoir water level change, the second is water level measurement in the main canal just after an outlet of intake facility, the last one is to calculate it by gate opening of intake facility. Since April 2011, gate opening has been used for discharge recording while canal water depth had been used before that time. There are also records of discharge for each irrigation system mainly calculated from reservoir water level. The following table shows measured discharge by the Survey Team and calculated discharge recorded by Irrigation Department.

Table 3.7.2 Comparison of Discharge by Record, Calculation, and Measurement

Measurement	North Nawin	South Nawin	Wegyi	Taung Nyo
Measurement date	7 May 2013	15 June 2013	8 May 2013	16 June 2013
Discharge Recorded by ID (m^3/sec)	10.422	1.113	10.136	5.673
Calculated Discharge by Gate Opening (m^3/sec)	12.304	1.110	10.064	11.253
Measured at the site (m^3/sec)	10.717	1.220	17.940	10.630

Source: Irrigation Department, the Survey Team (2013)

In the table 3.7.2, 'discharge recorded by ID' shows a value recorded in discharge record book by Maintenance Division (Bago West) of Irrigation Department. 'Calculated discharge by gate opening' means a result of calculation by the Survey Team based on actual gate opening and gate width.

'Measurement at the site' shows in-situ discharge measurement result just downstream of an intake gate of each reservoir. North Nawin and South Nawin show not so much difference among those results. Wegyi and Taung Nyo show much difference of discharge especially between measured discharge and recorded one. According to Irrigation Department, gauging systems are not functioning well, so that there is necessity of gate and gauging system repair for each irrigation system.

Concerning the availability of irrigation water, ID record is the same as measurement or less than measured value, and then irrigable water volume will be equal or larger than recorded value by Irrigation Department. Consequently, ID recorded value of irrigation supply 'irrigation record in 2012-2013' is used for calculating future irrigable area as a safety side for irrigation planning. The following table shows difference between 'irrigation record 2012-2013' and 'average irrigation supply since reservoir operation to 2012' for each irrigation system.

Table 3.7.3 Average Irrigation Supply in Past and 2012-2013 Irrigation Supply (Unit: acre-feet)

Sys	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
N. N	Avg. '89-'12	14,802	14,942	15,139	15,589	11,313	4,883	8,081	7,965	3,815	7,339	5,251	1,085	110,206
	'12-13.	6,531	15,031	18,824	21,704	16,356	6,158	0	0	2,605	17,378	9,253	0	113,840
	Difference	-8,271	89	3,685	6,115	5,043	1,275	-8,081	-7,965	-1,210	10,039	4,002	-1,085	3,634
S. N	Avg. '98-'12	25,936	31,499	34,310	35,923	33,389	9,064	9,269	11,225	8,442	9,451	8,007	4,136	220,650
	'12-13.	11,262	15,050	18,836	20,835	22,659	7,644	0	0	0	5,664	10,956	8,108	121,014
	Difference	-14,674	-16,449	-15,474	-15,088	-10,730	-1,420	-9,269	-11,225	-8,442	-3,787	2,949	3,972	-99,636
Wegyi	Avg. '98-'12	16,380	18,581	22,344	24,227	19,995	7,535	5,051	6,834	5,436	5,120	1,555	5,217	138,274
	'12-13.	10,350	14,700	22,600	24,000	14,686	7,000	2,300	7,750	6,500	8,600	4,300	0	122,786
	Difference	-6,030	-3,881	256	-227	-5,309	-535	-2,751	916	1,064	3,480	2,745	-5,217	-15,488
T. Nyo	Avg. '02-'12	20,388	19,651	23,807	24,334	18,000	9,571	14,118	13,761	15,924	9,963	1,184	7,610	178,312
	'12-13.	8,732	8,687	14,955	29,900	35,229	19,460	17,927	27,174	25,307	5,293	128	3,984	196,776
	Difference	-11,656	-10,964	-8,852	5,566	17,229	9,889	3,809	13,413	9,383	-4,670	-1,056	-3,626	18,464

Source: Irrigation Department, the Survey Team (2013)

During the period 2012-2013, North Nawin, Wegyi, and Taung Nyo have approximately the same value as average irrigation supply since reservoir operation and their difference to the averages are +3,643ac-ft (+3% to average value), -15,488 ac-ft (-11% to average value), and +18,464 ac-ft (+10% to average value) respectively while South Nawin shows much decrease as low as -99,636 ac-ft (-45% to average value) most provably due to less rainfall. The rainfall at the South Nawin dam site recorded about 81% of the averaged rainfall in 2012. The following table shows adopted irrigation supply for cropping pattern examination and its non-exceeding provability.

Table 3.7.4 Adopted Irrigation Supply and Non-exceeding Probability (Unit: acre-feet)

Irrigation System	2012-2013	Average	Difference to 12-13	Non-exceeding Provability of Average
North Nawin	113,840	110,206	-3,634	49.5%
South Nawin	121,014	220,650	99,636	51.5%
Wegyi	122,786	138,274	15,488	49.4%
Taung Nyo	196,776	178,312	-18,464	49.7%
Total	554,416	647,442	93,026	-

Source: Irrigation Department, the Survey Team (2013)

As aforementioned, the average irrigation supply in South Nawin shows particularly high value in comparison with the irrigation record in 2012-2013 record while others do not change so much; however, the average value shows about 50% in non-exceeding provability. It means the irrigation supply in 2012-2013 was unusually low. Consequently, average irrigation supply values are adopted for irrigation examination.

3.7.3 Reservoir Operation

Water levels of reservoirs for 4 irrigation systems have been recorded since reservoir water impounding. Since the reservoir water levels depend on inflow and irrigation discharge, the levels do

not show regular up and down. North Nawin shows quite irregular water level change in comparison with other 3 reservoirs. Water level of Taung Nyo changes regularly and it can be said relatively reliable and certain water resources among them. South Nawin and Wegyi show intermediate water level amplitude in those systems.

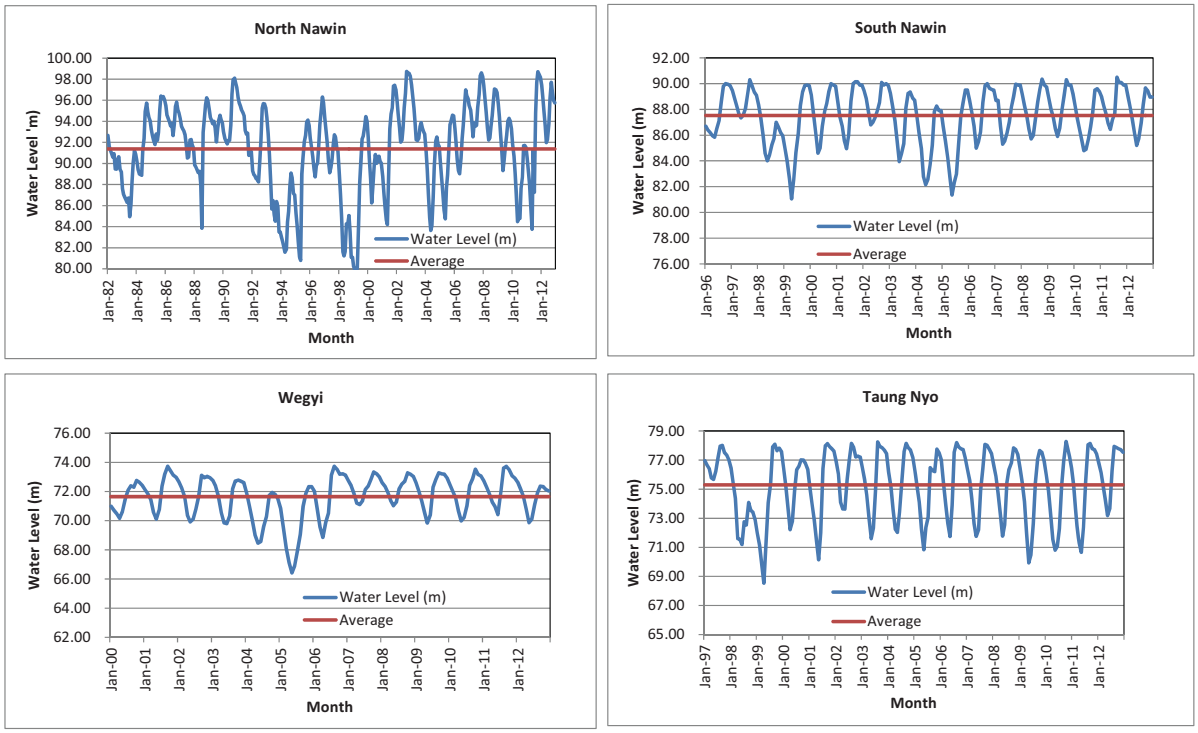


Figure 3.7.1 Water Level of 4 Reservoirs of Irrigation Systems

Source: Irrigation Department, the Survey Team (2013)

Based on water level data and information on cropping in the area, typical reservoir operation pattern for irrigation system is prepared and shown as follows.

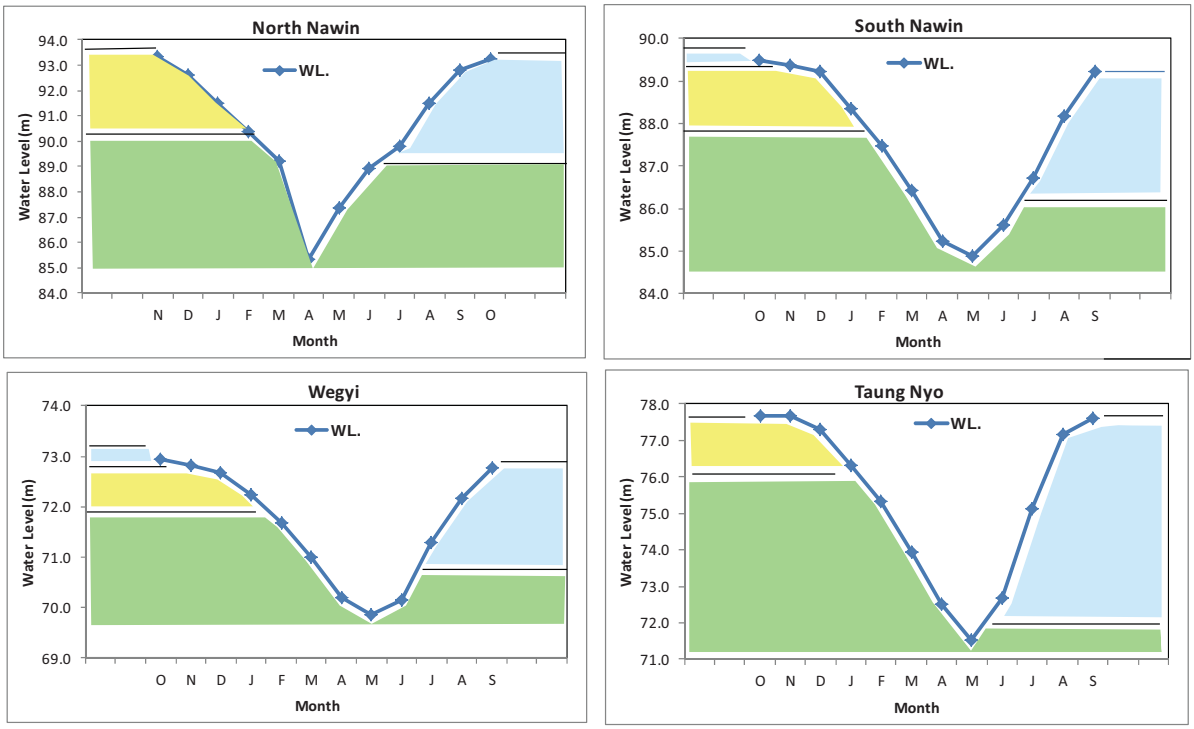


Figure 3.7.2 Average Water Level of 4 Reservoirs and Typical Cropping Period of Major Crops

Source: Irrigation Department, the Survey Team (2013)

In figure 3.7.2, yellow color indicate winter crop (black gram) cultivation season, green color shows summer paddy cropping season, and blue color represents monsoon paddy cropping season for each irrigation system. The figure implies that winter crop (black gram) and summer paddy are cultivated during reservoir water level descending period while monsoon paddy is cultivated in reservoir water level increasing period. Water level decrease during winter crop (black gram) farming period seems to have more volume than crop water demand because a design water requirement of black gram is 1/6 of summer paddy's water requirement. In fact, sown area of summer paddy (9,397) in North Nawin is almost same as black gram sown area (8,929) in 2012-2013. Then, other irrigation systems also show somewhat high water level decrease in black gram cultivation.

Table 3.7.5 2012-2013 Cropping area under 4 Irrigation Systems(Unit: acre)

Crop	Monsoon Paddy (June/July - Early Oct/Early Nov)				Summer Paddy (Feb/Mar - May/June)				Black Gram (Middle Oct/Middle Nov - Jan/Feb)			
Location	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
North Nawin	27,679.15	25,489.39	0.00	53,168.54	6,804.39	2,592.95	0.00	9,397.34	3,587.23	5,342.19	0.00	8,929.42
South Nawin	26,886.33	23,949.60	21,872.73	72,708.66	5,718.37	1,096.21	0.00	6,814.58	9,277.67	1,807.69	3,167.51	14,252.87
Wegyi	19,455.36	10,096.25	10,876.81	40,428.42	772.64	5,420.55	10,441.55	16,634.74	15,964.75	5,221.16	2,492.46	23,678.37
Taung Nyo	16,611.77	18,988.74	14,380.80	49,981.31	1,324.97	2,589.96	724.98	4,639.91	7,507.30	8,305.30	3,454.00	19,266.60
Total	90,632.61	78,523.98	47,130.34	216,286.93	14,620.37	11,699.67	11,166.53	37,486.57	36,336.95	20,676.34	9,113.97	66,127.26

Source: Irrigation Department, the Survey Team (2013)

Area-capacity curves of these 4 reservoirs show almost linear correlation between water level and reservoir capacity within those ranges of water level. Rainfall starts usually from May in the project area but a bottom of water level in North Nawin is located in May. It is significant that water level descending from April to May in North Nawin reservoir shows quite sharp inclination in comparison with other reservoirs, and then, summer paddy cultivation period continues until 2 months after May.

From the views aforementioned, the following points are indicated;

- Water release during winter crop (black gram) farming period may exceed a crop irrigation demand in comparison with water release during summer paddy cultivation period,
- Early bottom touching of water level in North Nawin may be caused by over cultivation of summer paddy and/or over water release for winter crops (black gram),
- Monsoon paddy growing period is well inside of water level increasing period, then, reservoir water supply is basically sufficient for monsoon paddy.

Thus, it is considered that some studies on water management and technical assistant will be necessary to confirm above points and improve them if necessary after completion of rehabilitation works.

3.8 Irrigation Management Improvement

With the rehabilitation completed, the water is supposed to reach to the tail end portion, whereby all the beneficiaries are to enjoy irrigated agriculture along all the canal reaches. However, just facility improvement does not automatically entail equal water distribution among the beneficiary farmers depending upon where they are located, i.e. upstream, midstream and downstream. Here discussed is irrigation management together with farmer organization in order to make the irrigation systems function at the planned level.

3.8.1 Cadre of Irrigation Management

Irrigation system is basically composed of; 1) water source which is dam reservoir, 2) main canal, 3) distributary canal, and 4) tertiary canal or otherwise plot-to-plot irrigation. The first 3 facilities such as dam, main canal and distributary are under the ID responsibility in terms of operation & maintenance. Irrigation water release from the dam reservoir is commanded by the ID field staff and all the gates

installed along the main and distributary canals are also operated and maintained by ID field staff.

Along the distributary canals, there are outlets withdrawing water from the distributary canals to tertiary canals or to the farmlands directly. In fact, all the target 4 irrigation systems had been provided non-gated outlets which are mere concrete pipes with a diameter of 12 – 18" reinforced by brick and cement walls (see photo). The maintenance responsibility for the outlets is basically with ID since it is attached to the distributary canals, though there is not much routine maintenance as a matter of fact.

Left: an outlet installed at a North Nawin distributary canal, which does not have gate but 15" pipe only, after which there is tertiary canal managed by farmers. Right: an 18" outlet installed at a Wegyi distributary canal providing water directory to the neighbor paddy field.

After the outlets attached to distributary canals, all the responsibilities are with the farmers concerned, e.g., for maintaining tertiary canal if there exists and water distribution among the farmers located within the command area by an outlet. Right now, there is no established water user group in charge of the outlet command area. The farmers for an outlet command area just cooperate mutually when need arises. By and large, at this moment, there is no farmer water user group in charge of some responsibility of distributary canal or main canal.

To make an irrigation system function at full-fledged level, not only the system owner, ID, but also the users, farmers, shall work jointly by demarcating each party's jurisdiction and responsibility. In this regard, appropriate farmer organization shall be established according to the cadre of the canal system such as; tertiary level group, secondary canal level and if needed at main canal level. Taking into account the present operational and maintenance system of ID commanded irrigation systems, a step wise management over certain period of time is presented hereunder:

3.8.2 Direction of Irrigation Management

World wide practice in irrigation management shows a gradual turn over of the responsibility of O&M from the government entity to farmers; namely to organized farmer association e.g. water users association legally established. The movement of turning over took place in 1960s in Mexico first, and to date it has been spread to most of the countries where lot numbers of national irrigation systems exist. The background for the turn-over was originally linked up in reducing government burden for the O&M. The turn over was once called IMT, Irrigation Management Transfer.

The IMT having spread over the world to date has proved high degree of farmers' responsible participation in operation and maintenance of irrigation systems. Accordingly, most of the IMT irrigation systems in the world have raised its functionality, performance, and sustainability, whereby leading to increment in terms of irrigated agriculture production. From the farmer participation point of view, the IMT is sometimes called Participatory Irrigation Management; PIM.

In any way either IMT or PIM, farmer participation in the operation and maintenance of irrigation

systems is the key in raising the performance of irrigation systems. On the government side, less O&M cost is required by involving the farmers in O&M work whereby reducing the burden on the national coffer. From the farmer point of view, terminal condition of irrigation systems, with which water is delivered to their farmland, is best known by those relevant farmers. They are therefore best suited to operate and maintain those terminal facilities such as outlets and tertiary canals, and then distributary canals as well.

If a farmer organization is established along a distributary canal, coordinated and cooperated arrangement among the farmers all concerned to each outlet will contribute to equal water distribution amongst such outlet groups. Further, if a farmer association is established along a main canal, same manner of coordinated and cooperated arrangement amongst the farmers concerned to each and every distributary canal will contribute to equal water distribution amongst such distributary canals.

Taking into account what have been discussed above, there should be a stratified farmers' organization to be established in the target 4 irrigation systems upon completion of the rehabilitation works. With this organized farmer group/association, the modality of future irrigation management for the 4 irrigation systems will be of a joint management to be made by both the ID and the organized farmers.

3.8.3 Farmer Organization: Water Users Association (WUA)

For the target irrigation systems, hydraulically decentralized WUA is proposed in conformity with any head gate that controls the flow into relevant irrigation area. This is so made by establishing a WUA consistent with each head gate of distributary canal. The WUAs are stratified, starting in all the cases with on-farm water users group, called WUG, whose irrigation area is commanded by an outlet. After having firmed up WUGs along a distributary canal, a responsible organization for the canal will be established as the Water Users Association or upon combining neighboring tertiary level groups.

Referring to the canal networks, there will be a total of 132 WUAs; 54, 35, 27, 16 for North Nawin, South Nawin, Wegyi and Taung Nyo respectively (see Table 3.8.1). The area coverage by a WUA ranges from 1,009 to 3,124 acre with an average of 1,649 acre while the number of farmer members will range from 79 to 337 by irrigation system. Number of WUGs per WUA will be 16 to 53. As all WUAs are to have the responsibility of O&M of the relevant distributary canal, the head gate will be the responsible demarcation between the ID and the WUAs; namely, above which the ID maintenance office will be the responsible and below which the WUAs will be the responsible for operation and maintenance.

Table 3.8.1 Water Users Association and Water Users Group by Irrigation System

System	Command Area, Acre (acre)	No. of WUAs (no. of distributary canal)	Av. area coverage per WUS (acre)	No. of WUGs	Average No. of WUGs per WUA	Av. No. of farmers per WUA 3/	Av. No. of farmers per WUG 3/	Av. farm land (acre)
North Nawin	54,506	54	1,009	1,828	34	79	3	12.72
South Nawin	72,709	35	2,077	719	21	250	12	8.28
Wegyi	40,429	27	1,497	430	16	187	12	8.01
Taung Nyo	49,981	16	3,124	852	53	337	6	9.28
Total/ave (acre)	217,624	132	1,649	3,829	29	166	6	9.91
Total/ave (ha)	88,068		667					4.01

Note: 1/To estimate the average number of farmers by WUA/WUG, an average farmland area owned by a typical farmers was applied.

Proposed structure of WUA is presented below. General assembly (GA) or the board of directors (BOD) exercises the responsibility in decision making. Under the board of directors, a management board comprising of chairperson of the WUA, a vice chairperson, a secretary, a treasurer, an auditor and probably some members is established to implement a plan according to the decision made by the GA or the BOD. There should be some committees in charge of planning such as water delivery,

financial matter, agriculture development issues, etc. The base of WUA is composed of number of water user groups established at each level of outlets.

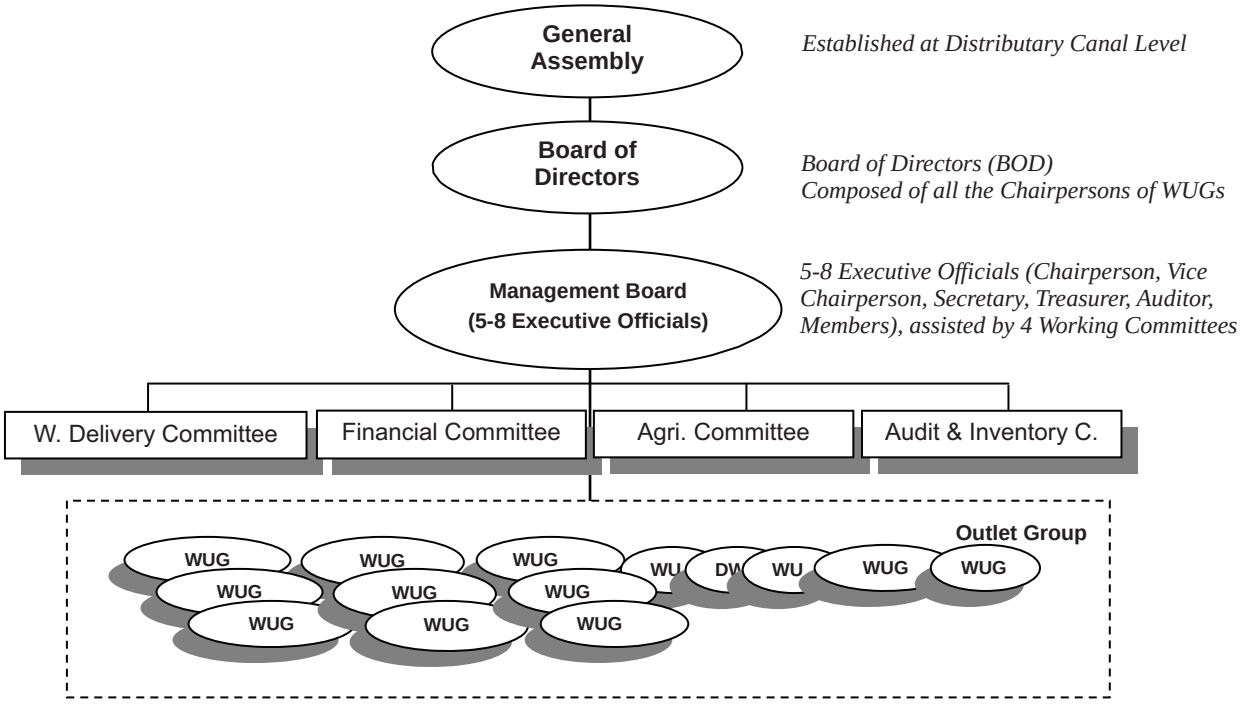


Figure 3.8.1 Organizational Structure of WUA for Distributary Canal

To set up the Board of Directors (BOD) of a WUA, all the WUGs' chairpersons should represent since WUGs are the most fundamental organization. This arrangement enables all the concerned WUGs to convey its problem/opinion to the WUA's apex easily. Thus, the BOD is to be composed of all the WUGs' chairpersons. In some cases, there are only several members of WUGs under a WUA. In this case, not only chairperson of the WUG but also vice-chairperson and if needed secretary can also consist of the BOD to let the BOD members around 20 taking into account the burden they are to undertake.

General assembly (GA), proposed here, is a general assembly of representatives. This does not mean that only the chairperson of WUGs decide the most important issues such as policies, strategies, etc. Since it is not practical to convene all the members amounting to more than hundreds, the general assembly convenes only the WUGs' chairperson by whom the issues are conveyed to all the members of his/her WUG. Then, actual general assembly takes place at every WUG level at different places and different times or otherwise simultaneously. Once after the issue is agreed among WUG members, the WUG's decision is conveyed by the WUG chairperson and then consolidated by all the WUGs' chairpersons at the general assembly of the representatives.

WUA should have standing committees that will be in charge of planning and recommending the plan to the BOD or otherwise GA depending upon the level of importance of issues. Standing committees will serve the WUA as a think-tank wherein plans such as training, cropping pattern, water delivery, irrigation fee collection, etc. are formulated according to the committees' mandate. The WUAs will be furnished with four committees as: 1) Water Delivery Committee, 2) Finance Committee, 3) Agriculture Committee, and 4) Audit and Inventory Committee.

Water delivery Committee will be headed by the WUA's vice chairperson, Finance Committee by the WUA's treasurer, Agriculture Committee by the WUA's secretary, and Audit and Inventory Committee by the WUA's Auditor. All the board members, except the WUA chairperson and the officers mentioned above, will serve one of the committees as the member according to their preferences. Plan

is formulated in a committee above and recommended to the BOD/GA.

BOD/GA is the decision making body, and if a plan requires referendum, general assembly of representatives (WUG chairpersons) shall always be convened. The plan goes down to all the members via WUG chairpersons and again is backed to the general assembly wherein final decision is made. Management officers of WUA, composed of 1) chairperson, 2) vice chairperson, 3) secretary, 4) treasurer and 5) auditor are in charge of executing the plan according to the decision made and have to take responsibility of day-to-day management.

Decision-making by either BOD or GA is dependent on the issues, as specified in their By-laws, to what extent it affects the WUA. Planning, decision-making and implementation are on a consistent line; namely, the persons who plan and make decision are the implementers as well. The principle to support this WUA structure, especially for the arrangement of BOD, GA and WUA management board, centers on a concept of decentralization in authorities and also centralization in implementation.

3.9 Agriculture Development and Land Use Plan

During military regime, paddy was a assigned and priority crop if irrigation was available. This meant that farmers had to plant paddy despite the fact that they did not want to do so. Thus, distinctive cropping patterns were formulated in Myanmar, which always includes paddy cropping in the cropping patterns. Paddy itself is staple food in Myanmar and farmers tend to cultivate it as their first priority crop but the former government assigned another one paddy cropping under national irrigation project. This is why irrigated paddy cultivation has mostly developed in Myanmar but irrigated cultivation for other crops has not been well developed.

Since transfer of technology and its acquisition usually take time, utilization of present cropping pattern will be the most appropriate direction in terms of agricultural development for farmers as well as extension officers of the government. As it is described in chapter 2, a cropping pattern of 3 cropping is now rapidly increasing in the project area while the major cropping pattern is 2 cropping by monsoon paddy and winter crop. Rehabilitation of irrigation system will improve water convey condition and increase availability of irrigation water in the project area. Then, this section argues on 3 cropping which is considered to be appropriate for future agricultural development.

3.9.1 Current Irrigable Area

Percentage of annual irrigation supply to annual reservoir inflow of 4 Irrigation Systems changes year by year and it ranges from 20 % to 80 % since reservoir operation commencement. Volume of irrigation supply depended on cropping pattern but cropping pattern data up to March 2011 were not reliable as aforementioned. Irrigable areas were also over-counted during the period of the military government. This is why only datum 2012-2013 can be considered showing a current and representative cropping pattern.

In addition, there are some farmlands which obtain irrigation water from private irrigation systems and/or small streams/drainage-canals in the project area, not directly from government irrigation systems; however, such areas were also counted as irrigable areas under the projects up to date. Since such private irrigation or drainage-canals cannot be controlled by the projects, those farmlands are excluded from irrigable areas of the projects.

Data on irrigation supply are internal information within Irrigation Department. It means there had been no influences to change them from outside organizations while irrigable area coupled with crop yield in each year had been directly concerned from GDP growth rate in the former military government. In order to achieve targeted GDP growth, cropping pattern, irrigable area, and yield had been adjusted by some means. All kinds of efforts were paid to accomplish the target GDP growth.

In order to grasp a relationship between current irrigation supply and actual cropping area under irrigation, irrigated area records from June 2012 to May 2013 are employed according to recommendations from Irrigation Department. Before the present government, irrigable area should reflect the targeted GDP growth; especially for summer paddy production. Monsoon paddy and winter crop (black gram) were not the target for this purpose. Based on necessary GDP growth rate, irrigable area was firstly discussed and calculated in District Peace and Development Council (DPDC). This is why data before April 2011 are said that it does not reflect actual cropping situation. Thus, irrigable area of 4 irrigation systems are shown as follows.

Table 3.9.1 Revised Current Irrigable Area for 4 Irrigation Systems

Irrigation System	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Original Data from ID (ac)	83,993.24	48,976.36	43,078.42	49,981.31	226,029.33
Area Transfer (ac)	-23,732.30	23,732.30	0.00	0.00	0.00
Private Irrigation (ac)	-7,092.40	0.00	-2,650.00	0.00	-9,742.40
Current Irrigable Area (ac)	53,168.54	72,708.66	40,428.42	49,981.31	216,286.93

Source: Irrigation Department, the Survey Team (2013)

3.9.2 Irrigation Planning

Improved Penman method was used to calculate irrigation demand in Irrigation Department but it has already been simplified for each crop because research works have been left behind long time and fundamental data have not been collected. The following figures are being used for irrigation demand calculation in Irrigation Department.

Table 3.9.2 Irrigation Demand of Crops for 4 Irrigation Systems

Crops	Monsoon Paddy	Summer Paddy	Winter Crop (Black Gram)
Crop Water Demand (Including losses)	457 mm	1,829 mm	305 mm
Cropping Season	Jun/Jul – Early Oct/Nov	Feb/Mar – May/Jun	Mid-Oct/Mid-Nov–Jan/Feb

Source: Irrigation Department

Rain fall above 5 mm is considered to be effective rainfall for crop water supply. Average irrigation supply after reservoir operation commencement is employed as utilizable irrigation water for each irrigation system.

3.9.3 Crop Selection

There is no doubt that the first priority crop is monsoon paddy in the project area because all farm households require their own staple food. There are 2 candidates for the second position; one is summer paddy which follows former government assignment and the other is winter crop such as black gram, peanut, sesame, and so on. The following table summarizes crop selection for 4 irrigation systems.

Table 3.9.3 Crop Selection by Prioritization for 4 Irrigation Systems

Crops	Monsoon Paddy	Summer Paddy	Winter Crop (Black Gram)
Staple Crop	✓	✓	
Irrigation demand	457 mm (relatively low)	1,829 mm (high)	305 mm (low)
Cultivation Period	3.5 months	3.5 months	3 months
Yield (lowland)	60.3 basket/acre	66.6 basket/acre	8.8 basket/acre
Net Profit (average)	130,277 Kyat/acre	93,656 Kyat/acre	161,422 Kyat/acre
Profit per mm of irrigation	285 Kyat/acre/mm	51 Kyat/acre/mm	529 Kyat/acre/mm
Export Potential	✓	✓	✓
Priority by this table	1	3	2

Source: Irrigation Department, the Survey Team (2013)

As shown in the above table, summer paddy can obtain only 51 Kyat/acre/mm while black gram can earn 529 Kyat/acre/mm which is as 10 times much as that of summer paddy. For stable and well maintaining irrigation systems, it is recommended to encourage winter crop cultivation in the project area as the second priority. There will be some summer crops which do not need much irrigation but cultivation technique may be hardly available at this moment. Thus, crop selection results; monsoon paddy is the first priority, the second is winter crop, the third position is given to summer paddy.

3.9.4 Prospected Benefit

Paddy cultivation had been the firstly prioritized crop under national irrigation projects in spite of its low net profit or it sometimes made a deficit. Irrigated agriculture in Myanmar had developed under such condition, so that diversity of cropping pattern which can promise certain profit to farmers will be developed from here on. At this moment, such promising cropping pattern is not available. This section seeks profitable cultivation plan by applying a present cropping pattern. The selected cropping pattern is 3 crops a year starting from monsoon paddy, winter crop (black gram), and summer paddy. The winter crop is recently increasing in the project area.

Table 3.9.4 Case Studies on Cropping Pattern and their Profits (Unit: acre, million Kyat)

Crops	Winter Crop (Black Gram)					Summer Paddy					Total
Case	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	N. Nawin	S. Nawin	Wegyi	T. Nyo	Sub total	
2012-2013	35,451	14,852	6,651	26,002	82,956	981	2,802	36	5,217	9,036	91,992
Million Kyat	7,744	2,469	1,025	4,196	15,434	105	241	4	554	904	16,338
Average	25,371	58,456	2,702	30,715	117,244	0	0	0	0	0	117,244
Million Kyat	5,600	10,535	441	5,381	21,957	0	0	0	0	0	21,957

Source: Irrigation Department, the Survey Team (2013)

The first one is area increase based on 2012-2013 irrigation that available irrigation is calculated based on irrigation discharge of each irrigation system, winter season water release is allotted to black gram and summer season water release is allotted to summer paddy. Examination on monsoon paddy is not considered in this study. There will be a potential of sown area increase with total 82,956 acre of black gram and 9,036 acre of summer paddy in comparison with 2012-2013 actual sown area datum. Total 16 billion Kyats of profit increase is prospected in this case.

The second one is that an irrigation discharge is an average irrigation discharge after reservoir operation of each irrigation system. In this case, monsoon paddy sown area is not increased but supplemental water of 457 mm is allotted as monsoon paddy irrigation demand. 305 mm for irrigation water is applied to black gram and its sown area is increased as large as possible. Irrigation water of 1,829 mm is applied for summer paddy but sown area of summer paddy keeps the same value as base case 2012-2013. There will be a potential to increase sown area for black gram 177,244 acre in total, which will create additional 22 billion Kyat benefit in comparison with 2012-2013 base case.

Thus, sown area increase of winter crops will be a key for agricultural development in the project area, which summer paddy sown area shall keep the same level as current condition or be revised for effective irrigation water utilization.

3.10 Model Farm Establishment

Under the Project, it is planned to establish a model farm where land consolidation, farm mechanization, agricultural extension, etc. are to be carried out and demonstrated. In fact, land consolidation works are now on-going many in nearby Nay Pyi Taw capital area. Land consolidation, accompanied with irrigation and drainage network together with farm road, will facilitate not only yield increase but also reduction of post-harvest loss. In addition, such consolidated farmland with neatly shaped and leveled land will definitely contribute to smoothly bringing about farm mechanization. Following section discusses such model farm establishment, which in fact is to be

implemented by Myanmar government, not covered by loan arrangement.

3.10.1 Willingness on Land Consolidation

A questionnaire survey, which was carried out at 3 locations of upstream, mid stream and downstream along main canals and covered 225 farm households, asked the sampled farmers; 1) if they know land consolidation, 2) if they accept re-plotting, 3) if they agree to donate a part of their farmland for the construction of irrigation & drainage canal with farm road, and 4) if agree how much acreage they are ready to surrender. Table 3.10.1 summarizes the first 3 questions:

Table 3.10.1 Summary of Farmers' Replies on Land Consolidation

Reply	Awareness of Land Consolidation	Acceptance of re-plotting	Acceptance of Donation of Farmland	Remarks
Yes (%)	33	91	84	
No (%)	67	9	16	

Source: JICA questionnaire survey, carried out in April and May, 2013

From the table above, one-third of the respondents know about land consolidation while the rest, two-thirds, do not know it. After having explained what the land consolidation is, about 90% of the respondents replied they can accept the re-plotting of farmlands while only 9% said no. To construct on-farm level, or tertiary level, irrigation and drainage canals together with farm road, there should be some allocated land set aside. When they were asked the acceptance of the donation on the land required for the construction, 85% replied yes while the rest, 16%, said no.

Concerning the area they would be willing to donate for the construction of irrigation & drainage canal with farm road, Figure 3.10.1 depicts the summary of the farmers' replies. As indicated, the most frequent reply was 'a little' without specifying how much acreage, followed by 'as little as possible' excepting 'no reply'. There were farmers who replied how much acreage they would willingly donate such as less than 0.2 acre, a quarter (0.25) acre, half (0.5) acre, three quarters (0.75) acre, etc. A quarter acre was the most frequently replied answer followed by less than 0.2 acre. There were very few replies for those who would contribute more than half acre.

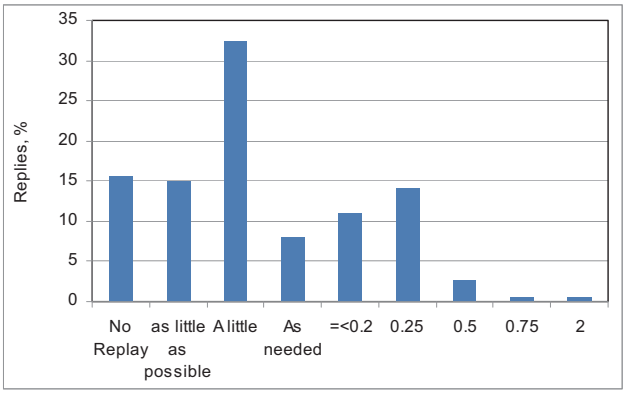


Figure 3.10.1 Replies on the Donation of Land
Source: JICA Questionnaire Survey

In fact, the average farmland a typical farmer owns within the target 4 irrigation systems is about 10 acre (9.909 acre for the 225 sampled farmers) while according to examples for land consolidation there should be about 5-10 % of farmland loss for the sake of the construction of irrigation & drainage canals with farm road. It means approximately 0.5 – 1.0 acreage of farmland per farmer would be required to lose in carrying out land consolidation, which goes beyond what the most farmers replied on the acreage they willingly donate. Therefore, there should be through explanation meeting with all the concerned farmers in order to reach consensus on the implementation of land consolidation.

3.10.2 Potential Places for the Model Farm Establishment

Model farm establishment under this Survey is planned one each at North Nawin and South Nawin irrigation systems. Selection criteria of the model farms are; 1) the potential sites should be located near road so that they can show demonstration effect, 2) at least one side of each potential site should be closely located along irrigation canal making the farmland well able to receive irrigation water, and 3) there should be coordinated farmer members well linked up with DOA township office.

With the 3 criteria above, JICA Survey team discussed with relevant DOA township offices and finally the officers found out one each potential site for the North Nawin and South Nawin irrigation systems (see circle in the figure below). Note that though the model farm for South Nawin is located in an isolated upstream area, it was the result that the farmers in the main irrigable area did not accept the idea of model farm. This is may be that the farmers still do not have good sense or feeling to any plan recommended by the government as was the case during the former military regime.

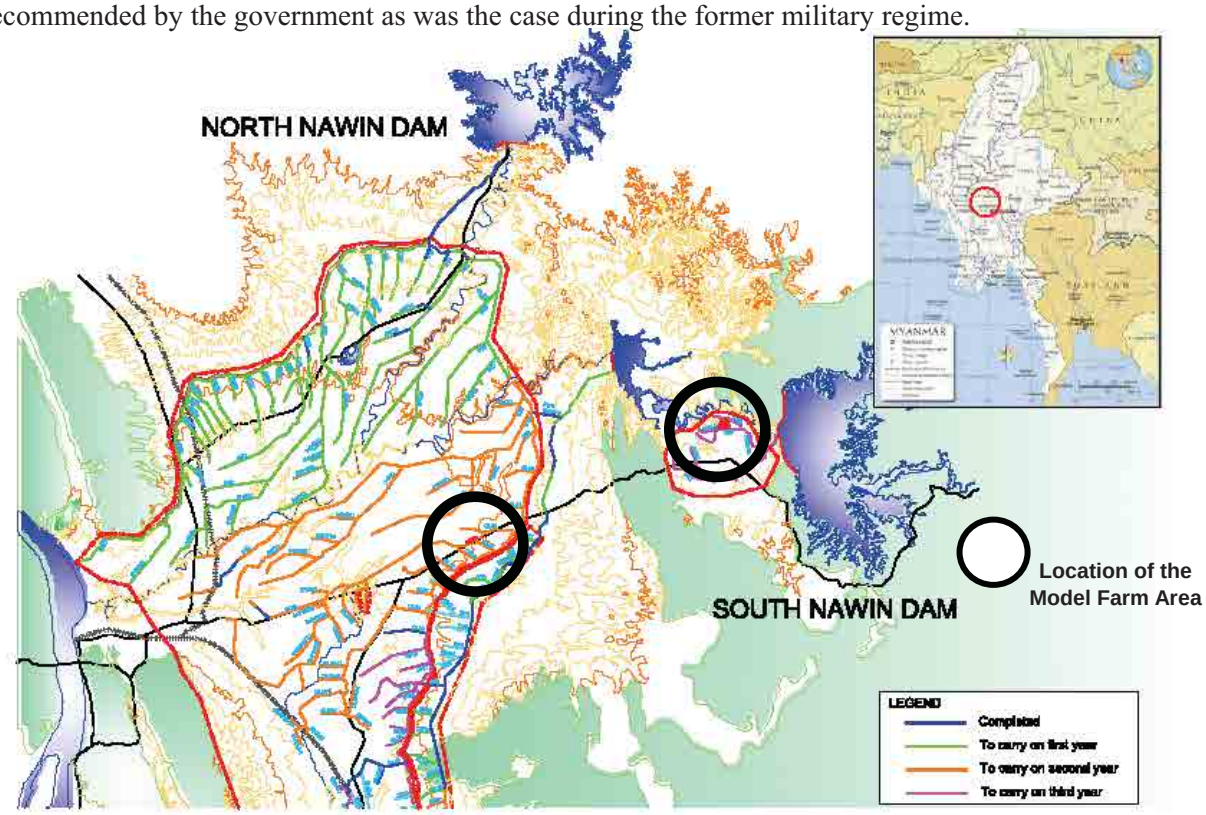


Figure 3.10.2 Locations of the Potential Model Farm Establishment (North Nawin, and South Nawin)
Source: JICA Survey Team

After having identified the potential sites, JICA team conducted a census survey for all the landowners within the 2 sites. Following table summarizes the census results; there are total 6 farmers and 16 farmers in each of the potential model farm areas of North Nawin and South Nawin irrigation systems with total land areas of 24 acre (9.7 ha) and 27 acre (11 ha) respectively. Maximum land areas owned by each farmer are 9 acre and 6 acre for the North Nawin and South Nawin irrigation systems while the minimum ones are 0.5 acre each respectively. The average farmland areas are 4 acre and 1.7 acre, and grand average for the both areas comes to 2.3 acre (0.94 ha):

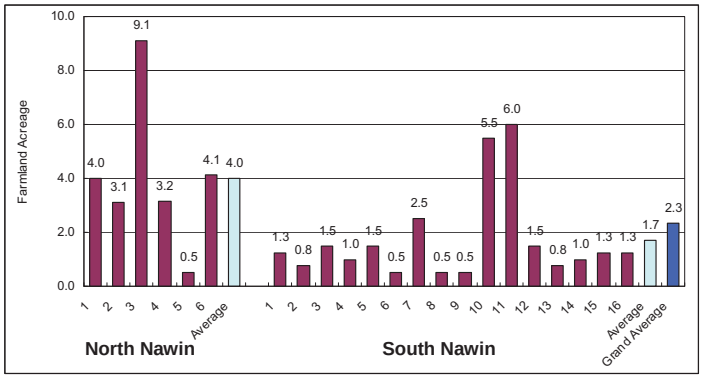


Figure 3.10.3 Farmland Area owned by Each Farmer
Source: Census Survey by JICA Survey Team, May 2013

Table 3.10.2 Summary of Census Result for the Farmers in the Model Farms

Particular	North Nawin	South Nawin	Remarks
No. of Farmers	6	16	
Total Land Area, acre (ha)	23.99 (9.71)	27.25 (11.03)	
Max. Land Area, acre	9.09 (3.68)	6.00 (2.43)	

Min Land Area, acre	0.50 (0.20)	0.50 (0.20)	
Average Land Area, acre	4.00 (1.62)	1.70 (0.69)	2.33 (0.94) for the both

Source: JICA Census Survey for the Landowners, June, 2013

All the farmers in the potential model farm areas cultivate both monsoon paddy and summer paddy since their plots are blessed with irrigation water thanks to the location near the main canal. Figure 3.10.4 shows the yield of summer paddy, from which it is known that the yield is relatively high especially in the North Nawin potential model farm area where the farmers cultivate high yield varieties. In addition to the paddy, there are 9 farmers out of 16 farmers of South Nawin site who grow pulses. Out of the 9 pulses growing farmers, one cultivate black gram while the rest, 8 farmers, does groundnut. In fact, the soil there is somewhat sandy so that they prefer to cultivating groundnut than black gram.

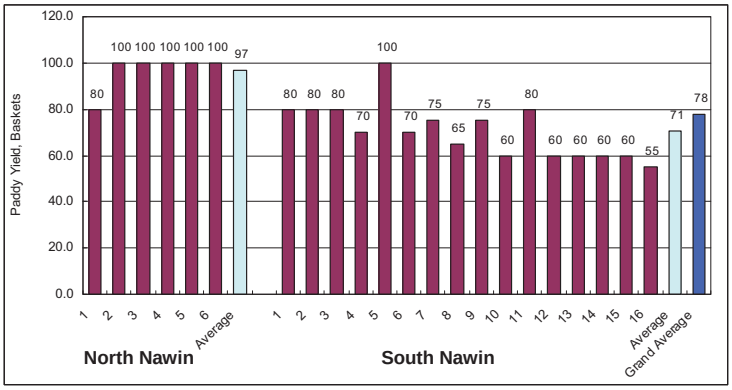


Figure 3.10.4 Yield of the Summer Paddy by Each Farmer

Source: Census Survey by JICA Survey Team, May 2013

Concerning the land consolidation project, all the 6 farmers in the potential model farm area of North Nawin system have heard about it. On the other hand, there were 5 farmers who have not heard about such consolidation projects out of the 16 farmers for the potential model farm site of South Nawin system. In fact, according to the other questionnaire survey which had covered 225 sampled farmer households about one-third farmers did not know about consolidation project. During the planning and prior to the commencement of such project, thorough explanation shall be arranged with all the farmers concerned.

3.10.3 Standard Design of the Model Farm

24 acre (9.7 ha)

Model farmland in North Nawin

27 acre (11 ha)

Model farmland in South Nawin

Figure 3.10.5 Current Situation of Model Farm Sites in North Nawin and South Nawin

Source; Measurement survey by JICA survey team, June 2013

Land consolidation entails rearrangement of farm plots, improvement of irrigation and drainage, and farm road construction with the aim of ensuring highly productive conditions for effective mechanized farming and rationalized water management to meet future agricultural requirements. Land consolidation works will therefore improve overall farm conditions, whereby increase agricultural production while reducing the farm man-power manual works. Figure 3.10.5 shows the current situation of the planned model farm lands in North Nawin and South Nawin, to which land consolidation works are to be demonstrated.

1) Planning of Farm Block, Field Block and Field Lot

Farm blocks are generally rectangular in shape surrounded by roads on four sides and adopted as the units for farm management and cultivation to ensure uniform water management and work control within the blocks. The farm blocks are planned in perpendicular to the distribution canal, the road and the drainage canal. One farm block basically consists of two field blocks extending along both sides of the small drainage canal. The field blocks are the largest units of farmland which enable the adequate water management for paddy cropping as well as winter cropping. These are bordered by permanent structures of irrigation canals, drainage canals and roads.

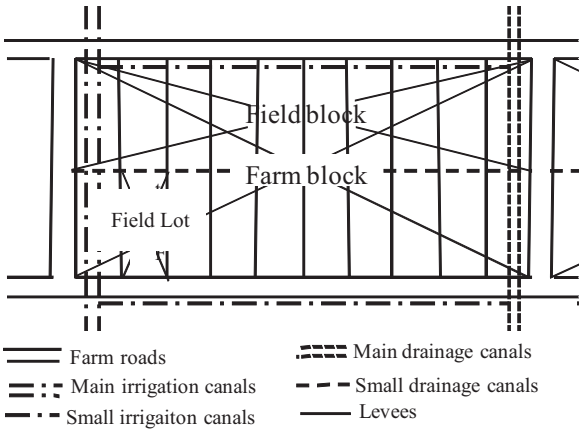


Figure 3.10.6 Farm Block, Field Block and Field Lot
Source JICA Survey Team

Within the field block, there are number of field lots, which are the smallest units of farmland clearly bordered by boundary levees. The shape and the size of the field lots are arranged in such a manner as to allow the efficient farm management with good performance of the farm machinery along with adequate irrigation/ drainage. From the experience up to now in Myanmar, the size and the shape of the field lot is recommended at 1 acre (360ft x 120 ft). The relation of the farm blocks, the field blocks and the field lots are shown in Figure 3.10.6

2) Farm Road and Irrigation Canal

Farm roads and irrigation canals are important permanent structures which delineate the farm blocks. It is very common in Myanmar to have irrigation canals on both side of the farm road. In this method, farmers can get the water from the irrigation canal quite easily with a simple outlet structure. In the project planning, conventional layout plan having one farm road with two irrigation canals on both sides is applied. The typical cross section of the farm road and irrigation canal is shown in Figure 3.10.7.

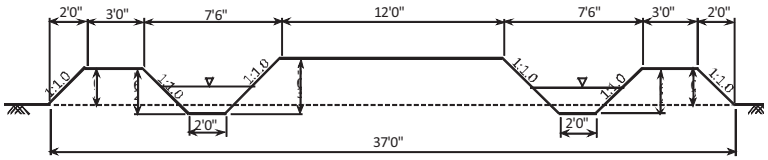


Figure 3.10.7 Farm road and Irrigation Canal
Source JICA survey team

3) Drainage Canal

Drainage canals are planned along the center of the each farm blocks. The depth of the drainage canal is set at 3 feet, which could be sufficient for the surface drainage of excessive rain water. The typical cross section of the drainage canal

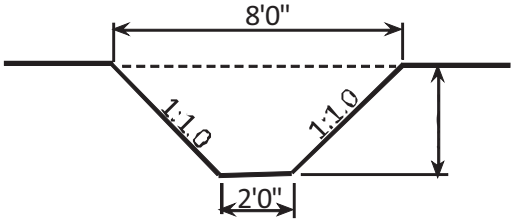


Figure 3.10.8 Typical Cross Section of Drainage Canal
Source JICA Survey Team

is shown in Figure 3.10.8.

4) Boundary Levee

Boundary levees are provided to divide a field block into suitable size of the field lots. Farm management, especially water management for each field lot can be ensured by these boundary levees constructed along each peripherally of the field lots. Typical cross section of the boundary levees is shown in Figure 3.10.9

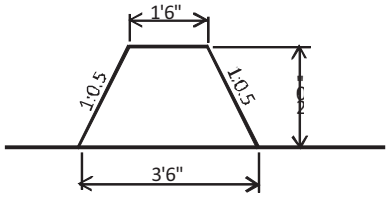
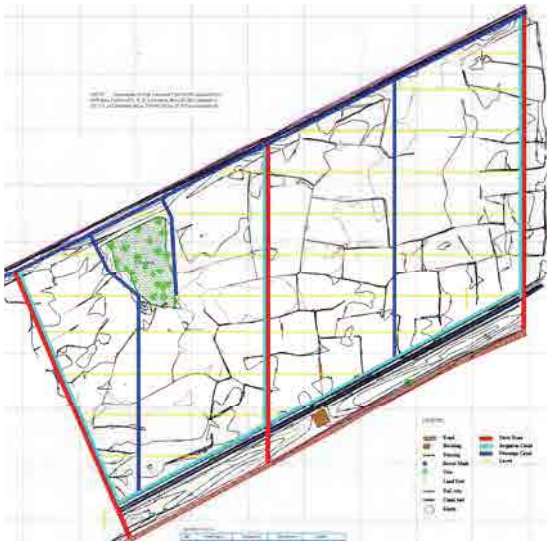


Figure 3.10.9 Typical Cross Section of Levee
Source JICA Survey Team

5) Outline Plan

Outline planning for the land consolidation is depicted in Figure 3.10.10. For the North Nawin irrigation system (see left figure), new irrigation canal and farm road are planned to connect an existing irrigation canal and road which are already in place at the southern part of the farm land. There is cemetery in the north-western side of the farmland and this cemetery area is not included in the model farm land consolidation. Furthermore, there is railway at the northern part of the farm land, and therefore drainage canal is planned taking a distance at least 4m from the railway to prevent any influence to the railway.



Model farmland in North Nawin

Model farmland in South Nawin

Figure 3.10.10 Outline Planning Drawings of Model Farmland Consolidation
Source JICA Survey Team

With Regard to the South Nawin irrigation system (see right figure), the model farm land consolidation site extends about 600m north and south direction, 200m east and west direction, and leans about 40 degrees so that the shape of farm land is parallelogram. There is an existing road at the eastern part of farm land, canal at northern and southern part of the farmland. New irrigation canal is planned to construct along the road and each plot are settled in parallel to the road and irrigation canal in this planning.

3.10.4 Agricultural Machineries Introduced

One may say that Myanmar has quite high potential for industrialization due to decline of manufacturing attractiveness in China associated with recent high labor cost, high motivation for foreign investors taking into account rich human and land resources of Myanmar, growing ASEAN markets, etc. Farm mechanization had taken place bit by bit to date, and is now rapidly taking off in

line with the hike of labour costs under present rapid industrial development and economic growth in Myanmar.

Agricultural machineries in Myanmar are manufactured by AMD (Agricultural Mechanization Department) under MOAI and by Heavy Industry Enterprises No.1 under MOI (Ministry of Industry), aside from the ones imported. Their main products are 2-wheel hand tractor (10-22 hp), engine-driven paddy thresher, flat bed drier, rice trans-planter (5hp), 4-wheel tractor (80-90 hp), reaper, rice harvester and roller boat[1]. However, what they produce is not many unable to meet the farmers' demands.

Countering the few production by AMD and Heavy Industry Enterprises No.1, private merchants of general and agricultural machines become occupying the market shares. In case of 2-wheel hand tractors, for example, the private sector has the market share of as much as 78.4%[2] or even more recent days in Myanmar. At Pyay Township, for example, 2-wheel tractors are sold by private sector at an average 1,000 units/year or more in 2012 according to one of the leading dealers 'Good Brothers Co., Ltd.' while AMD had provided only 37 units in 2012/2013. Most of the machines sold are imported from Chinese manufacturers. Following are findings on the farm mechanization given by the dealer and AMD officers in Pyay district:

1) Normally, the size of farm plots in Pyay area is very small and not formed in rectangle shapes yet. Therefore, hand tractor is better to operate in the paddy fields rather than 4-wheel tractors. Cost of the 2-wheel tractors is 1,600,000 Kyat for Chinese Dongfeng or Jieneng and 2,000,000 Kyat for Thai Siam Kubota. Dealers can mediate the loan services between the bank and the purchasing farmers.

2) For most of the farmers, purchase of farm machines is the first time. Therefore, they have a typical consumers' behavior buying cheaper machines, and thus tend not to consider longer durability. It is the reason for them mostly to buy Chinese made machines. However, 2-wheel tractors of the Japanese manufacturer (Thai Siam Kubota) are now becoming popular due to the longer durability.

3) After land consolidation has been introduced to the model farms, this time 4-wheel tractors will have more advantages to operate. AMD has 3 tractor stations in and around the Survey area such as Pyay town, Paungdale township and Natallin township. The need of tillage service by machines is very high due to very short period of time available between the harvest of summer paddy and onset of rainy paddy as well as shortage of cows/water buffaloes for tillage purpose. Majority of the farmers can not purchase the 4-wheel tractors facing cash shortage.

4) AMD Pyay office has a 4-wheel tractor aged surprisingly almost 40 years made in Czech (90hp), which is in fact almost deteriorated. AMD service station officers recommend introducing 40-50 hp class of 4-wheel tractors taking into account avoiding of stuck in the fields by heavy weight of the tractor body.

5) Markets of harvester, reaper and trans-planter have not yet come out in Pyay area. However, *Tragyi* (22-30hp engine-driven trucks) is very popular for transporting agricultural products, passengers, domestic goods, etc. Engine-driven thresher is also very much utilized in the rural area.

6) Combine harvesters of an imported model have been introduced by AMD. Regrettably, the combine harvesters made in India (KS-9300) procured under cooperation with Indian Government have not been used in the fields due to its too large and heavy scale to enter the

[1] A roller boat is a sort of boat with tiller on board, driven by engine. This is used in heavy clay dominant paddy fields.
[2] Source: JICA Preliminary Study on Agricultural Mechanization, 2011

paddy fields. On the other hand, MOI No.18 Factory located in Inngone assembles combine harvesters (Korean Daedong DSC48), which are in fact a copy model of a Japanese manufacturer. It is reported that the engine is not durable, often broken down.

Following table summarizes the farm machineries together with those priorities to be required in line with farm mechanization in the Pyay area and its vicinity. Considering current situation and future expectation as summarized in the table, introduction of tractors should be given the highest priority, followed by improvement of transportation, rice mill, and further by improvement of drying facilities, tools for pest control, and combine harvester (reaper). Other machineries are evaluated as low in their priorities.

Table 3.10.3 Expected Mechanization on Rice Production in the Project Areas

Works	Current Situation (trans-planting)	Future Expectation (trans-planting or direct sowing)	Priority
Plough, tillage, paddle	cow/ water buffalo plough, 2-wheel tractor with rotary tiller, roller boat	2-wheel tractor with rotary tiller, 4-wheel tractor with disc plough & rotary tiller, roller boat in heavy clay dominant fields	high
Seed broadcast (trans-planting)	manual	seed bed container for trans-planter	low
Seed broadcast (direct sowing)	(Direct sowing is not prevailed in the project areas.)	seed driller	low
Trans-plant	manual	trans-planter	low
Weeding	manual	sprayer for herbicide	low
Fertilization	manual, cow cart or not implemented	spreader	low
Pest control	manual or not implemented	sprayer for pesticide/fungicide	medium
Supplemental irrigation	engine pump taken from drain canal or groundwater	engine pump, screw pump driven by tractor	medium
Harvest	manual	combine harvester reaper	high low
Threshing	engine-driven thresher	combine harvester	high
Drying	manual on ground or road	concrete yard or paddy husk dryer at rice mill	medium
Transport	cow cart, *tragyi,* truck	*tragyi*, tractor with trailer, truck	medium-high
Rice mill	old rice milling unit	modern rice milling unit	medium-high

Source: JICA Survey Team, 2013

AMD has a plan of improving plot size and shape of paddy fields, accessibility for large machines such as a harvester, leveling of lands to unify water levels, and constructing small dikes between plots. A 4-wheel tractor can undertake, besides the farm work intended, the construction of small dikes, transportation of goods, and maintenance of canal inspection road, etc. Further, the highest need from the farmers is in fact tractor tillage services.

AMD service stations, on the other hand, do not possess enough number of tractors to meet their need. The working speed of 2-wheel tractors the AMD presently has can not cover enough areas as requested by the farmers. In addition, period of tillage between 2 crops becomes very short due to incentive farming (2 to 3 cropping in a year). The model farms to be constructed under the Project should therefore be provided with 4-wheel tractors and combined harvesters with the highest priority

In addition to the 4-wheel tractor, combine harvesters should also be provided from the view points of; 1) at present it takes as much as 2 months for harvesting summer paddy constrained by manual harvesting of the paddy and man-power or cattle transportation from the fields to drying yard (roads), 2) some summer paddy can be easily damaged by rain water due to the delay of harvesting ,and 3) remaining paddy straws are not effectively utilized into the field but just burnt beside roads after threshing. To cope with these issues, combine harvesters should be introduced, provided that there should be larger and leveled fields.

Table 3.10.4 Equipment Plan for Model Farms

Equipment Name	Specifications	Q'ty
4-wheel tractor	35kW (47HP, medium size), 4WD, 2200cc, equipped with PTO shaft, with attachment of dozer, rotary tiller and disc plough	3 units per site
Combine harvester	52kW (70HP), rubber clawer type, wheel type header, equipped with grain tank	1 unit per site

Source: JICA Survey Team, 2013

3.10.5 Agricultural Extension Activities to be Demonstrated

In the model farm area of North Nawin, monsoon paddy and summer paddy are cultivated while in the model farm area of South Nawin some farmers cultivate black gram or groundnut as a winter crop in addition to the monsoon and summer paddies. There is some possibility of increasing cultivation area by practicing three crops in a year due to being able to use sufficient amount of water with the rehabilitation works under the Project. By introducing winter crop such as black gram and groundnuts, two types of cropping patterns are recommended in the model farm areas as shown in Figure 3.10.11.

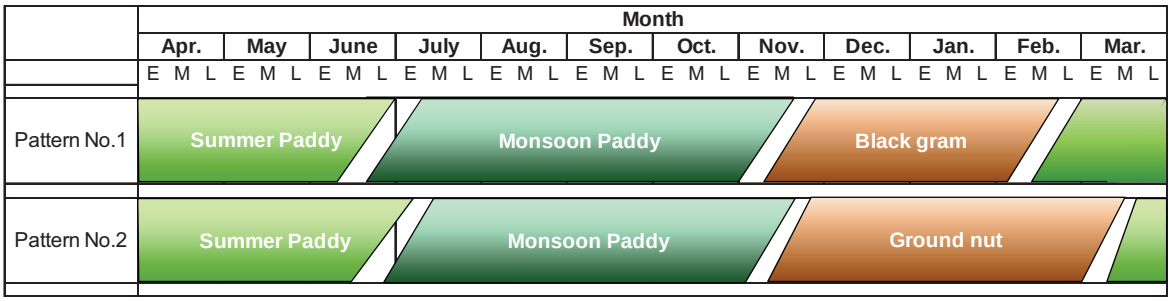


Figure 3.10.11 Cropping Patterns Recommended for the Model Farms

Source: JICA Survey Team

Black gram is cultivated in 75-90 days, and therefore it can be properly cultivated able to be accommodated with the available cropping season as a winter crop. Groundnut is suitable for sandy soil which is prevalent in the model farm areas than black gram. However, cropping duration of groundnut needs about 90-120 days, which means a short maturity variety which can be cultivated in a short period of time should be introduced in case that the groundnuts is cultivated during winter season rather than black gram.

It is also necessary for the extension workers to deliver extension services of how to select good varieties, to adjust time of planting or harvesting and to practice due cultivation method. Table 3.10.5 shows characteristics of rice varieties cultivated in Pauk Kaung township where the 2 model farm areas are located. It is necessary to select rice variety correctly considering cropping duration, and regional and seasonal characteristics. In case that that three cropping pattern is tried in a year, rice varieties which can be cultivated in a short period, namely, high yield varieties or hybrid varieties cultivated in 105-135 days should be introduced instead of presently cultivated varieties. Such varieties are for example Sinn thwelat, Yesinn lonethwe, Manawthukha and Palethwe.

Table 3.10.5 Rice Varieties and Characteristics Cultivated in Pauk Kaung Township

Particular	Variety	Life span	Plant's height cm	Tillering	Seed per ear	Successful seed (%)	Quality of rice	Taste	Yield basket / ac
High yield variety	Sinn thwelat	135	12	9 -11	246	84	clear	good / soft	100 -150
	Shwe pyitan	145	105 -120	10 -12	183	83	clear	good	85 -135
	Yesinn lonethwe	125	105	10 -12	159	90	clear	good	100 -150
	Manawthukha	130-135	105 -120	10-12	234	-	Clear	Good	100
	Hmawbi-2	135-140	105 -120	10-12	141	-	Clear	Good	80-100
Hybrid variety	Palethwe	130-135	105 -120	9-10	150	-	abdominal white	Fair	80-100
Local	Innmayebaw	Harvest Mid Dec	137-152	10-15	170	-	Clear	Good	60-70

Source: Pauk Kaung township DOA office and Department of Agricultural Research.

DOA has been extending Good Agricultural Practices (GAP) of rice for farmers. In a pamphlet, 14 methods are mentioned, e.g. how to make a seedbed, how to supply nutrient and water, how to practice weed control, and etc. In addition to the GAP, some cultivation methods shown in Table 3.10.6 are recommended to be practiced in the model farms, which are very essential activities to improve yield and quality of rice.

Table 3.10.6 Essential Activities and Expected Effects

Particular	Activities	effects
Seed	Seed selection and seed disinfection	Decreasing of disease
Land preparation	Leveling the field	Supplying water and fertilizer equally in the field and decreasing the irregular plant
Nursery	Proper sowing ratio, early transplanting	Decreasing of disease in nursery
Fertilization	Fertilizer or manure application in proper time and amount	Effective utilization of fertilizer or manure
Water management	Intermittent irrigation and midseason drainage	Proper number of tillers and activating root performance

Source: JICA Survey Team

In Pyay Township, an agricultural materials shop sells many kinds of chemical fertilizer made in Myanmar, China or Thailand. The price of urea 50 kg bag ranges from 17,000 Kyat/bag to 21,000 Kyat/bag, while the price of compound fertilizer is from 18,000 Kyat/bag to 42,000 Kyat/bag depending on ratio of the elements. According to interviews to the farmers who cultivate the field of the model farms, they mix the urea, compound fertilizer or super-phosphate and cow dung or straw ash, then put them in the field at a few times in the cultivation period. However, the fertilizer may not be used effectively if not properly applied in terms of timing and amount. It is therefore necessary to demonstrate proper selection and usage of fertilizers.

Some organic fertilizers made in Shan region are also sold by Shan Maw Myae, one of private companies in Myanmar. Photo right shows an organic fertilizer called ZM made out of crop wastes, cow dung, chopped straw, animal bones and gypsums. Organic fertilizer acts slowly than chemical fertilizer; however, it can activate bacteria in the soil whereby improving the soil characteristics. Quality of crops grown can be improved and the total input cost was also reduced by the use of the organic fertilizer, according to the interviews to farmers who use the organic fertilizer, ZM, and some organic materials.

Organic Fertilizer, ZM
Source: JICA Survey Team

Taking those points into account, it is recommended to practice fertilizer experiment as shown in the following table. Table 3.10.7 indicates fertilizer application with GAP, application of organic fertilizer, and basic application method of fertilizer in Japan. Fertilizer application with GAP is to use 1 bag compound fertilizer at the time of land preparation, and a quarter bag urea mixed with 3 bags cow dung manure at the time when tillering comes to the maximum stage and one more application of the mixture just before the flowering. One bag ZM of organic fertilizer can be used at land preparation stage while other bio fertilizers for the period from tillering to flowering by 2 bottles.

Under basic application method in Japan, compound fertilizer and cow dung manure are used for land preparation and compound fertilizer or urea are applied 20 days after the transplantation and 20 days before the heading. The amount of fertilizer or manure should be decided based on analysis of soil component and/or by checking the leaf color. Comparison of these fertilization method and conventional method will identify proper timing and amount for fertilization.

Table 3.10.7 Fertilization Methods of GAP, Organic Fertilizer and Basic Method in Japan

Particular		0	10	20	30	40	50	60	70	80	90	100	110	120
		Sow-ing	Nur-sery	Trans-plant-ation	Tillering			Panicle Initia-tion	Boot-ing	Head-ing	Flower-ing	Ripening		
		Land preparation												
GAP	Compound fertilizer	1bag												
	Urea					0.25 bag				0.25 bag				
	Cow dung manure					3 bags				3bags				
Organic fertilizer	ZM	1bag												
	Bio fertilizer				2bottels bio fertilizer									
Basic method in Japan	Compound fertilizer	○				○		○			△			
	Urea													
	Cow dung manure	○												

Note: In basic method in Japan, the amount of fertilizer or manure will be decided by analysis of soil component or check of leaf color. Circle means necessity and triangle means adaptable to growing condition.
Source: Booklet published by DOA, booklet published by Shan Maw Myae, JICA Survey Team

Concerning pulses, interviews to farmers in the model farms found that some farmers have never cultivated pulses. Therefore, extension workers have to deliver extension services for the basic cultivation methods of black gram and groundnut to the farmers. It is well known that nitrogen fixation in root nodules of pulses leads soil fertilization and improvement of soil physical characteristics, whereby the introduction of pulses should be promoted in the model farm.

Table 3.10.8 shows the content and schedule of the demonstration and study tour. To deliver extension services for the above agricultural techniques to the farmers of the model farm, demonstration should be carried out 5 times a year by extension workers of Pauk Kaung Township DOA office. Schedule of the demonstration should be carried out along the cropping pattern. The demonstrations about cultivation methods of monsoon paddy should be held in July and August, similarly the demonstration about cultivation methods of monsoon paddy should be held in March and April, while the demonstration about cultivation methods of pulses should be held in November. In the demonstration should be held for not only farmers but also casual labors because the above contents of extension service are not conducted if they can't understand them.

Study tour to visit the two model farms should be arranged with Pauk Kaung Township DOA office. Result from the model farms will disseminate to the surrounding areas three cropping pattern, i.e. monsoon paddy - winter crop - summer paddy, correct cultivation method and water management especially for summer paddy. During the study tour, extension workers and the farmers of the model farms are requested to show the record of cultivation to the participant farmers.

Table 3.10.8 Schedule of the Demonstration and Study Tour in the Model Farm

Particular	Month	Contents	Participants
Demonstration	April	Cultivation methods of monsoon paddy (fertilization, water management, etc.)	farmers of the model farm
	June	Cultivation methods of monsoon paddy (seed and land preparation, nursery controlling, transplant, etc.)	
	August	Cultivation methods of monsoon paddy (fertilization, water management, etc.)	
	November	Cultivation methods of black gram or groundnut	
	March	Cultivation methods of summer paddy (seed and land preparation, nursery controlling, transplant, etc.)	
Study tour	June	Result of summer paddy	farmers of other site and DOA staffs of other township
	October	Result of monsoon paddy	
	February	Result of black gram or groundnut	

Source: JICA Survey Team

3.11 Small-Scale Hydroelectric Power Generation

3.11.1 Concept

As concluded in the Chapter 2.6, the Survey Team studies small-scale hydropower generation at the destroyed drop structure at the R.D 18+900 in the Taung Nyo Irrigation Canal. As mentioned in the Chapter 2.6, the maximum output is estimated at 180 kW under the conditions that the maximum discharge and effective head are 8.2 m^3/s and 3.19 m respectively.

Regarding turbine, judging from the maximum discharges for power generation and the effective heads, a bulb turbine or S-shaped tubular turbine classified into a sort of Kaplan turbine which is a propeller turbine with movable blade can be adopted judging from the diagram for selection of a turbine shown in the Figure 3.11.1. In general, these turbines are applied in case that amount of water is large even though an effective head is small. As for characteristic for variations of an effective head and amount of water, it is known not only that decline of a turbine efficiency is relatively small in case of decrease of an effective head but also that this type turbine can produce electricity even though amount of water goes down to almost 20% of the maximum if both guide vane and runner vane are movable as shown in the Figure 3.11.2.

Although a submerged turbine also meets the requirements in light of the effective head and the discharge, this turbine is rejected because the generator for the turbine is limited to an induction generator and the generator cannot be used in an isolated grid.

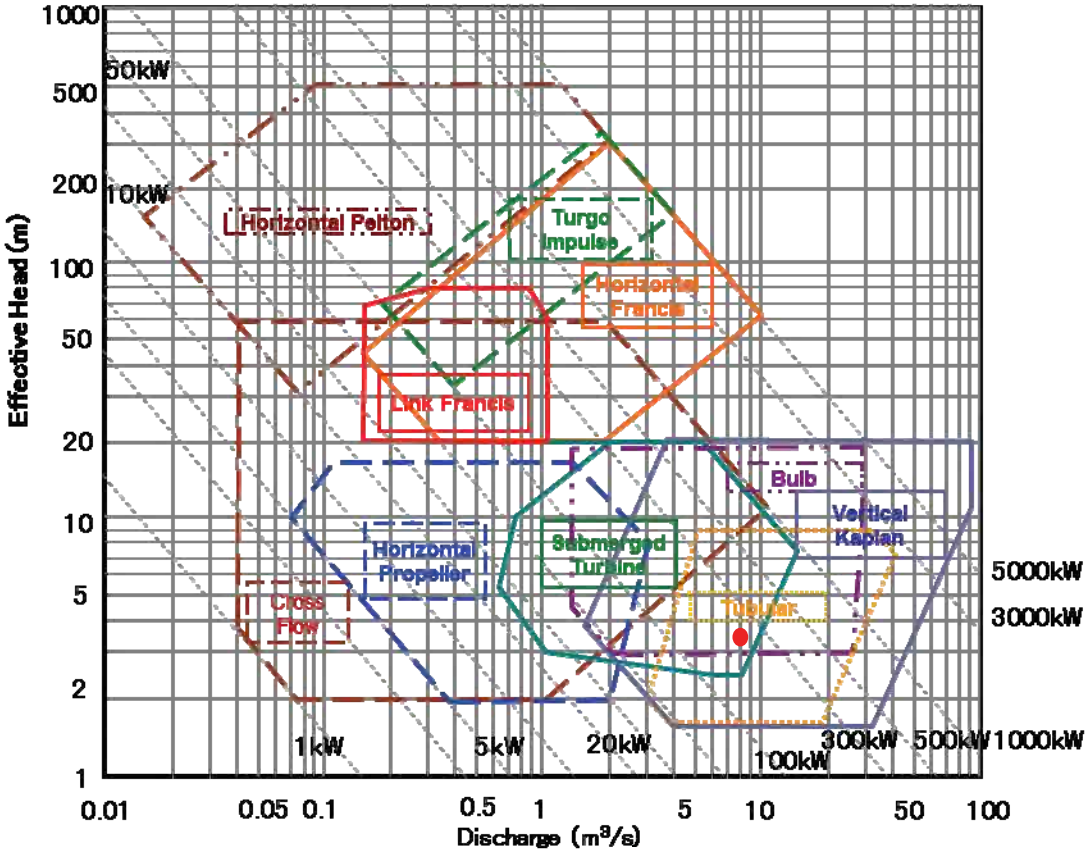


Figure 3.11.1 Diagram for Selection of Turbine

Source: Collection of Information on Small-Scale Hydroelectric Power Generation utilizing Agricultural Water, etc., in Japan

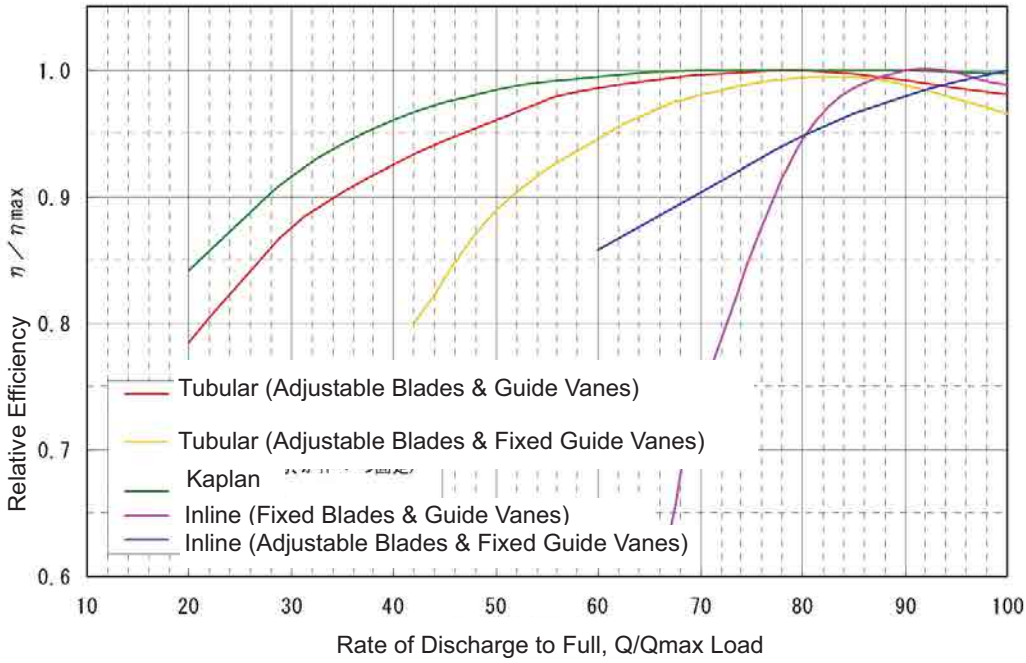


Figure 3.11.2 Relative Efficiency of Tubular Turbine

Source: The Guide for Estimation of Construction Cost of Hydroelectric Power Plant in Planning Stage

Considered that the power station is arranged in the irrigation canal, downsizing of the powerhouse is one of key factors. In this regard, these turbines are advantageous because the width of the powerhouse gets narrow due to the arrangement of the generator above the turbine or the draft tube. Moreover, due to the inclination of the turbine in case of adoption of a bulb turbine, the excavation volume is also reduced, and consequently cost for civil works comes down.

For fear of contamination of irrigation water due to leakage oil from a turbine, a mechanism to operate a runner vane shall be electric motor-driven type, not hydraulic-driven type. In addition, a mechanism to operate a guide vane which adjusts amount of inflow discharge can be electric motor-driven type, too. Consequently, an oil pressure supply system composed of hydraulic pump, pressure oil tank, oil sump tank, piping, etc., as well as a pressure relief valve can be omitted. For the omission of a pressure relief valve, a rotor of a generator and a pressure conduit to convey water to a turbine shall be designed to bear an increase of a runaway speed and a rise of an internal pressure respectively in case of load rejection of a turbine. Taking into consideration that the powerhouse is placed in the irrigation canal, the omission of the aforesaid equipment is advantageous from the viewpoint of the arrangement of the powerhouse in the limited space.

On the other hand, regarding generator, there are two type generators. One is a synchronous generator, and another is an induction generator. Although an induction generator is lower-priced and easier in maintenance than a synchronous generator, an induction generator cannot be adopted in an individual transmission and distribution network. Considered that the small-scale hydropower plant is operated individually apart from the national transmission network, a synchronous generator is selected.

Regarding civil structure, it is designed later together with the irrigation canal. The reason is that the small-scale hydroelectric power plant is constructed by using a part of the irrigation canal, and the small-scale hydroelectric power plant is required to be designed in parallel with the irrigation canal.

3.11.2 Villages Supplied Electricity

The maximum output of the small-scale hydroelectric power plant planned at the R.D 18+900 existing

the destroyed drop structures is estimated at 180 kW. On the assumption that unit electricity demand per household is from 150 W to 200 W based on "*Guideline and Manual for Hydropower Development Vol. 2 Small Scale Hydropower (March 2011, JICA)*", numbers of households supplied electricity are estimated as 900 to 1,200 households. Considered numbers of households in the villages around the candidate site, electricity is supplied to the following villages:

Table 3.11.1 Beneficiaries Newly-Electrified by Power Plant Planned at the Damaged Drop Structures

Village Tract	Village	Households	Population
Pa Lan Bin	Sha Zi Bo (Atet Su)	179	713
Ditto	Sha Zi Bo (Auk Su)	176	642
Ditto	Pa Lan Bin (Ywa Thit)	133	485
Ditto	Pa Lan Bin (Ywa Ma)	113	430
Ditto	Pa Lan Bin (Anauk Su)	145	452
Kyauk Kwet	Kyauk Swe	210	808
Total		956	3,530

Source: The Survey Team

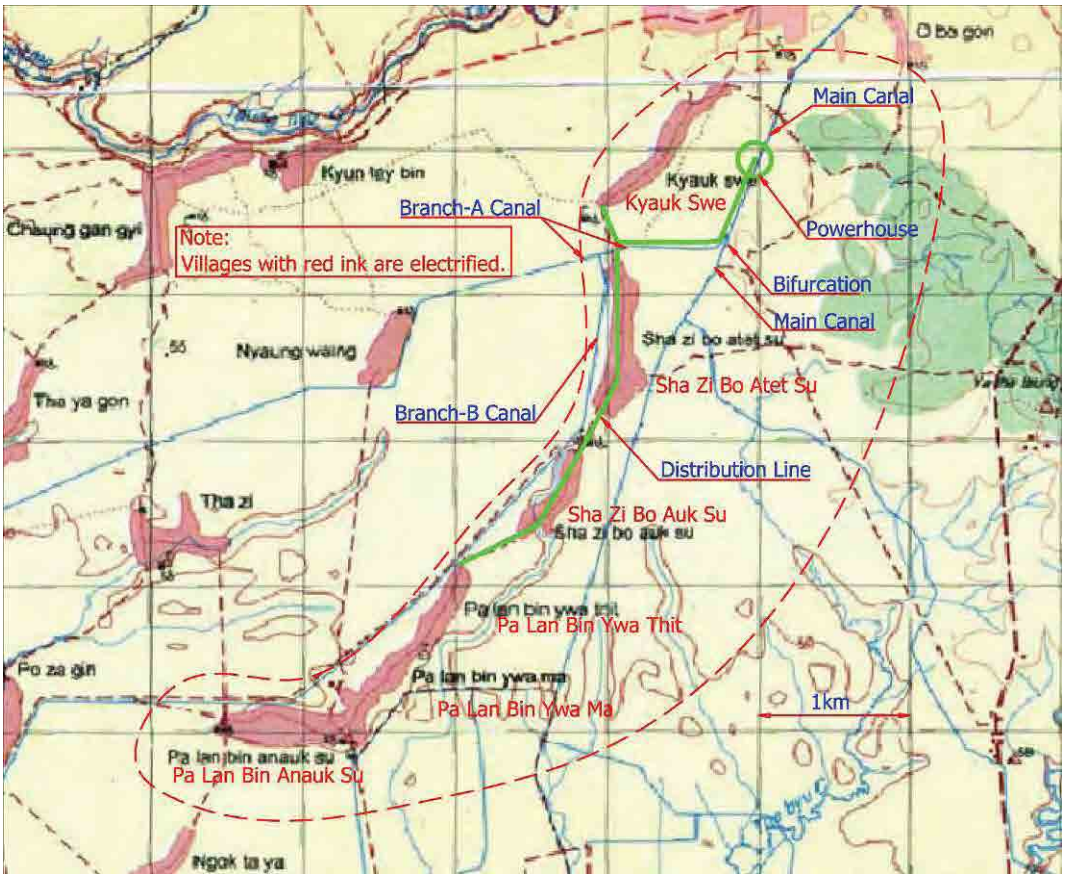


Figure 3.11.3 Service Area and Distribution Line from the Power Plant in Taung Nyo Irrigation Canal

Source: The Survey Team

3.11.3 Cost Estimation

The construction cost of the small-scale hydroelectric power plant is estimated. The construction cost for the small-scale hydroelectric power plant at the destroyed drop structures at the R.D 18+900 in the Taung Nyo Irrigation Canal is estimated as below. In addition, the construction costs of three small-scale hydroelectric power plants at the Taung Nyo Dam, the Wegyi Dam and the Wegyi Right Main Canal, which were introduced in the Section 2.6 that they were studied in other project, are also shown in the following table for reference.

Table 3.11.2 Construction Costs of Hydropower Plants in Taung Nyo and Wegyi Irrigation Areas

No.	Work Item	Taung Nyo Drop Structure	Taung Nyo Main Dam	Wegyi Main Dam	Wegyi Right Main Canal
(1)	Land Acquisition &Compensation	0	0	0	0
(2)	Upper Structure of Powerhouse	13,000,000	22,000,000	17,000,000	12,000,000
(3)	Civil Work	60,000,000	198,000,000	127,000,000	42,000,000
	3-1 Waterway	52,000,000	171,000,000	110,000,000	42,000,000
	c Intake dam	0	0	0	0
	d Intake	47,000,000	0	0	0
	e Sand Settling Basin	0	0	0	38,000,000
	f Sand Flashing Structure	0	0	0	0
	g Headrace	0	0	0	0
	h Head Tank	0	0	0	0
	i Spillway	0	0	0	0
	j Penstock	0	126,000,000	78,000,000	0
	k Tailrace	0	0	0	0
	l Outlet	0	29,000,000	22,000,000	0
	m Diversion Structure	0	0	0	0
	n Others	5,000,000	16,000,000	10,000,000	4,000,000
	3-2 Reservoir	0	0	0	0
	3-3 Substructure of Powerhouse	8,000,000	27,000,000	17,000,000	0
(4)	Electro-mechanical Equipment	266,000,000	632,000,000	320,000,000	140,000,000
	s&t Turbine-Generator	252,000,000	580,000,000	281,000,000	140,000,000
	u Diesel Generator	14,000,000	52,000,000	39,000,000	0
(5)	Transmission & Distribution Line	50,000,000	235,000,000	136,000,000	0
(6)	Temporary Facility	17,000,000	43,000,000	24,000,000	10,000,000
(7)	Administration & Engineering	54,000,000	135,000,000	74,000,000	31,000,000
	Total	460,000,000	1,265,000,000	698,000,000	235,000,000

Notes: As for the cost for the small-scale hydroelectric power plant at the Wegyi Right Main Canal, note that costs for the diesel generator as well as transmission & distribution facilities are excluded and their costs are included in the cost of the site at the Wegyi Main Dam.
Source: The Survey Team

3.11.4 Electricity Tariff

1) Basic Policy

Basically, electricity tariff shall be priced by cost valuation basis under the condition that all the cost for power generation, transmission and distribution shall be absorbed by beneficiary. However, in rural electrification project by a small-scale power plant, it is commonly known that such rural electrification project is financially unfeasible if the initial construction cost is added to the cost for electric power generation. The reason is that the initial construction cost is considerably large in comparison to the revenue of electricity tariff, so that an initial construction cost of a small-scale hydroelectric power plant is generally borne by government or grant aid.

2) Billing Structure and Level of Electricity Tariff

Electricity tariff is divided into fixed charge and metered charge in general. Fixed charge is a charge to be paid by all the electricity users without relation to amount of consumption of electricity. On the other hand, metered charge is priced per 1kWh and charged in accordance with amount of consumption of electricity. In case of a small-scale power plant in rural area, electricity tariff is often decided on the basis of number and kind of electric appliance such as lighting, TV, DVD player, etc., on a monthly basis.

In Myanmar, in case of receiving electricity from the national transmission network or power sources

managed by the government for household use, the fixed charge and the metered charge are 1,000 kyat/month and 35 kyat/kWh respectively. According to *Report on Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams,* it is reported that the households receiving electricity from the national grid along the Wegyi Right Main Canal pay 2,650 kyat on monthly average.

On the other hand, in case of electricity supply from private generator in one village existing in the upstream of the Taung Nyo Irrigation Area, the electricity tariff for one 40W lighting is priced at 2,500 kyat per month, and the time period supplied electricity is limited only for four hours per day from 6:00 pm to 10:00 pm. In case of additionally using TV and VCD or DVD player, a user is requested to additionally pay 2,500 kyat per month.

Table 3.11.3 Comparison of Electricity Supply between the National Grid and Private Generator

Irrigation Area	Wegyi (RMC)	Taung Nyo (One Village)	Note
Power Source	National Grid	Private Generator	
Power Demand (W/ household)	180 (average)	40	In Taung Nyo, 40 W means one lighting bulb only. In case of using TV & VCD or DVD player, 2,500 kyat is additionally required to be paid.
Service Charge (Kyat/ month)	1,000	2,500	2,500 kyat/ month is cost for one 40 W lighting bulb.
Metered Charge (Kyat/ kWh)	35	(312.5)	In the case of Taung Nyo, on the assumption that 1,000 Kyat is included in the above 2,500 Kyat, the metered charge is computed as 312.5Kyat/kWh. [1,500 Kyat/ (0.04kW x 4 hr/day x 30 days)]
Total Charge (Kyat/ month)	2,650 (average)	2,500	
Time Period Supplied Power	24 hr	4 hr (6 PM to 10 PM)	

Source: Report on Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams

Although tariff of electricity supplied from the national grid is intentionally held down by the Myanmar's government in consideration of average income in Myanmar, it is found that electricity supplied from the private generator is more costly than that supplied from the national grid even though electricity supplied from the private generator cannot be used all day long freely. Consequently, it is supposed that people who receive electricity from a private generator or are not electrified wish to receive electricity stably with reasonable price.

3) Affordable Electricity Tariff in Non-Electrified Area

Regarding cost for lighting in non-electrified villages, according to *the Report on Feasibility Study on Small Scale Hydropower Development with Existing Irrigation Dams*, it is reported that non-electrified households located within 10 km from the Taung Nyo Dam pay a little less than 4,000 kyat per month for lighting such as candle, dry battery, fuel for lamp, etc., on average.

On the other hand, on the assumption that most of households in the non-electrified villages use lighting and television receiving electricity from the private generator, the monthly payment comes to 5,000 kyat in total.

Considering the above, affordable electricity tariff is supposed to range from 4,000 kyat to 5,000 kyat per month in the early stage just after electrified under the condition that a households use some lighting apparatus and television.

4) Estimation of Cost of Electricity Supplied by Small-Scale Hydroelectric Power Plant

In this section, the cost of electricity supplied by the small-scale hydroelectric power plant placed in

the Taung Nyo Irrigation Canal is estimated in accordance with the "*Guideline and Manual for Hydropower Development Vol. 2 Small Scale Hydropower (March 2011, JICA).*" The cost is estimated in two cases. The Case-1 is under the condition just after electrified, and the Case-2 is under the condition that electricity demand reaches almost 200 W per household. Here, the organization of the management body and monthly labor cost are assumed as below:

Table 3.11.4 Assumption of Organization of Management Body and Its Monthly Labor Cost

Position	Number	Unit Rate (USD)	Sum (USD)	Notes
Chief Manager	1	120	120	Holding the post of backup operator concurrently
Deputy Manager	1	100	100	Doubling as administrative issue & backup operator
Operator	6	80	480	Two shift system by three teams
Toll Collector	2	80	160	Holding the post of checking the distribution line & administrative issue concurrently
Total	10		860	

Source: The Survey Team (Unit: USD)

Under the above conditions, costs of power generation and distribution supplied by the small-scale hydroelectric power plant per month are estimated as below:

Table 3.11.5 Estimation of Monthly Costs of Electricity per Household

Items	Unit	Case-1	Case-2	Notes
		Just After Electrified	After Several Years	
Condition of Electrification				
Number of Households	HH	956	956	HH : Household
Length of Distribution Line	km	3.5	3.5	
Maximum Output	kW	180	180	
Max. Electricity Demand per HH	W/ HH	188	188	=180 kW / 956 HH
Dairy Load Factor		15%	50%	
Dairy Electricity Consumption per HH	kWh/ HH/ day	0.7	2.3	
Yearly Total Electricity Consumption	MWh/ year	244	803	
Monthly Total Electricity Consumption	MWh/ month	20.4	66.9	
Number of Employee	Nos	10	10	
Cost				
Labor Cost	USD/ month	860	860	
Office Expense	USD/ month	516	516	60% of Labor Cost
Maintenance Cost	USD/ month	430	430	50% of Labor Cost
Depreciation Cost	USD/ month	0	0	
Reserve Fund	USD/ month	903	903	50% of Sum of Labor, Office & Maintenance Costs
Overhead Cost	USD/ month	90	90	5% of Sum of Labor, Office & Maintenance Costs
Sub Total		2,799	2,799	
Fuel for Diesel Generator	USD/ month	1,412	4,639	Fuel Charge: 1.2 USD/L Consumption Rate: 0.17 L/ kWh Using Factor: 34% of Consumption
Grand Total		4,211	7,438	
Cost per kWh	USC/ kWh	20.7	11.1	
Cost per household	USD/ month	4.4	7.8	
	Kyat/ month	3,900	6,900	1USD = 885 Kyat

Source: The Survey Team (2013)

The costs of electricity just after electrified and at the time when electricity demand per household reaches almost 200 W are estimated at 3,900 kyat and 6,900 kyat per month respectively. Considered that affordable electricity tariff is supposed to range from 4,000 kyat to 5,000 kyat per month in the early stage after electrified, 3,900 kyat per month is regarded as reasonable price in the early stage after electrified.

In the above estimation, the difference of the monthly costs between the Case-1 and the Case-2 comes

due to difference of fuel cost for diesel generator which is the only variable cost. So, depending on increase of electricity produced by a diesel generator, cost of electric power generation also increases. Considered that the large-scale reservoir which can control amount of discharged water daily and seasonally exists in the upstream of the irrigation canal, it is one of the solutions to modify rule to release irrigation water without spilling water over the spillway for reduction of electricity produced by a diesel generator. And, it goes without saying that connection of the small-scale hydroelectric power station to the national transmission network is the most desirable solution for supply electricity when electricity produced by the small-scale hydropower plant decreases.

5) Initial Cost for Beneficiary

Although initial cost for construction of a hydroelectric power plant is borne by government or grant aid, the following costs are absorbed by beneficiary.

- Installation of wire from an electric pole to a house (if a wattmeter installed at an electric pole)
- Indoor wiring works
- Installation of wattmeter (depending on project, it is unnecessary for beneficiary to bear the cost)
- Deposit for default of payment

3.11.5 Organization for Operation and Maintenance

1) Organization for Operation and Maintenance

According to *"the Guideline and Manual for Hydropower Development Vol. 2 Small Scale Hydropower",* the following three kinds of organization are suggested for operation and management of small-scale hydroelectric power plant.

Table 3.11.6 Type of Organization of Operation & Management for Small-Scale Hydroelectric Power Plant

Type of Organization	Notes
Directly operated by an existing government-run or state-run corporation	From the viewpoint of sustainability, this type is the most advisable.
Operated by a local community	In case that electrification scale is relatively small (below 200 households) and that a government-run or state-run corporation cannot manage a plant, this type is applied.
Operated by a newly-established public corporation	In case that electrification scale is relatively large (500 to 1,000 households) and that a government-run or state-run corporation cannot manage a plant, this type is applied.

Source: Guideline and Manual for Hydropower Development Vol. 2 Small Scale Hydropower (March 2011, JICA)

In this regard, an engineer of MOEP Bago West Branch has an opinion that any type shown above is acceptable for MOEP, and such small-scale power plant is generally managed by ESE which is one of the public corporations under the control of the MOEP. However, there is a possibility that electric power industry in rural areas may be transferred from national government to local governments by 2015 according to headquarter of the MOEP. Then, following section describes an establishment of the Type-c management body.

2) Establishment of Organization for Operation & Management

For starter, a preparatory management organization including local residents is better to be established for smooth execution of a project when a hydroelectric development project gets concrete. The role of the preparatory management organization will be handed over to a newly-established organization for operation and management of the small-scale hydroelectric power plant. For example, Figure 3.11.4 shows organization for operation and management for a small-scale hydroelectric power plant.

Table 3.11.7 Member & Role of Preparatory Management Organization

Members	➢ Development promotion administrative official at central level ➢ Development promotion administrative official at provinces level ➢ Related administration organizations in a region. ➢ Delegate of beneficiary
Roles	➢ Acknowledgment of plan promotion ➢ Establishment of Organization system plan of management organization ➢ Explanation of cost absorbed by beneficiary ➢ Employment and recruiting of staff for operation and maintenance work ➢ Training of operation and maintenance staff

Source: Guideline and Manual for Hydropower Development Vol. 2 Small Scale Hydropower (March 2011, JICA)

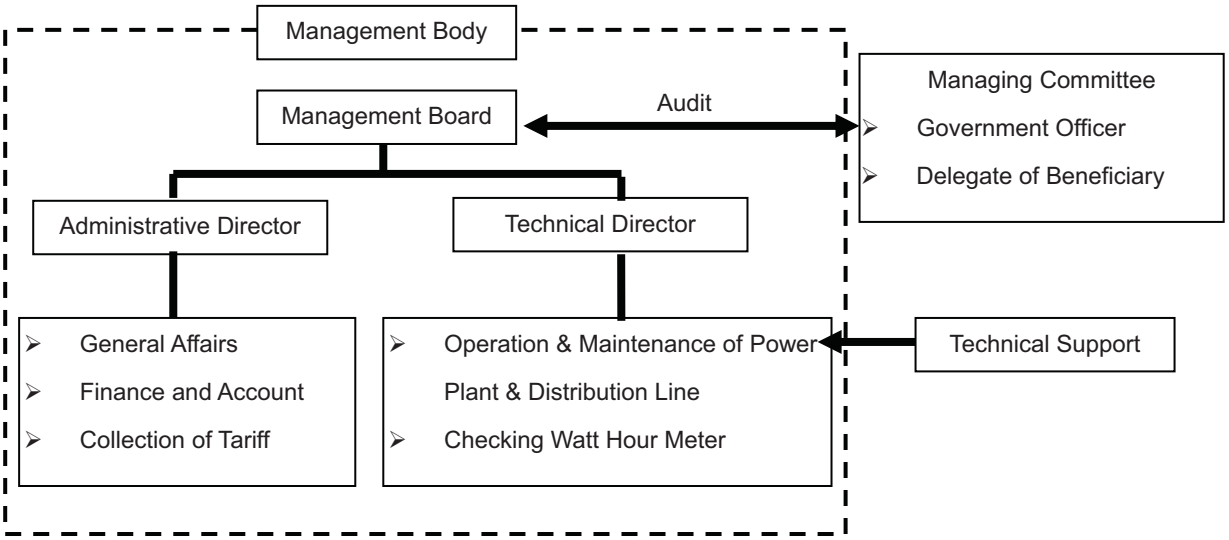


Figure 3.11.4 Example of Organization for O&M of Small-Scale hydroelectric Power Plant

Source: Guideline and Manual for Hydropower Development Vol. 2 Small Scale Hydropower (March 2011, JICA)

3.11.6 Requirements for Development of Small-Scale Hydroelectric Power Generation

For realization of the small-scale hydroelectric power plants, the following are required to be considered.

Table 3.11.8 Requirements for Development of Small-Scale Hydroelectric Power Generation

Requirement(s)	Content(s)	Organization/ Person in Charge
Review of Hydroelectric Power Generation Plan based on Annual Plan of Amount of Water Discharged for Irrigation	The hydroelectric power generation is roughly planed on the basis of the past records of amount of water discharged from the dams which are provided by the ID. However, judging from the records, it seems that irrigation water has been discharged without any rule to set amount of irrigation water released from the dams and passing through the canals according to the demand of irrigation water. For effective utilization of water resource, such rule is indispensable. After setting such rule, the hydroelectric power generation plan shall be reviewed. Unless such rule is set, observation of amount of irrigation water is required for one year at least. In addition, the water head shall be reviewed. The reason is that the head is roughly estimated by measurement using GPS and/or staff rod or the elevations of the canal foundation which is provided by the ID. So, the water head is to be obtained in the detailed design stage.	MOAI (ID) Engineer in charge of detailed design
Possibility of Connection to the National Transmission Network	Presently, MOEP prohibits that a power station whose maximum output is less than 2,000kW connects to the national grid on the ground of MOEP's customary practice. Consequently, alternative	MOEP

	power source is required to supply electricity when production of electricity reduces due to decrease of amount of irrigation water, and a diesel generator is proposed to be placed in consideration of stable power supply. As a result, economical efficiency of the small-scale hydroelectric power plant gets worse due to fuel cost for diesel generator. However, a small-scale hydroelectric power station whose maximum output is from several dozen kW to 1,000kW can be connected to the national grid. If such small-scale hydroelectric power station connects to the national grid, electricity can be supplied supplementally when amount of irrigation water decreases. Moreover, in the future when electricity mainly supplies from thermal stations which exhaust lots of carbon dioxide in the process of power generation, such small-scale hydroelectric power station makes a contribution to reduction of expenditure for fossil fuel as well as amount of emission of greenhouse effect gas. Therefore, it is desired that MOEP permits a small-scale hydroelectric power station to connect to the national transmission network.	
Capacity Building for Operation and Maintenance of Power Plant	In case that the small-scale hydroelectric power plant is managed by a newly-established organization which is mainly composed of local residents, acquisition of skills for operation and maintenance are indispensable for a management body. And, it is also necessary how to manage the electric enterprise. Therefore, it shall be considered how to transfer necessary the above skills to a management body.	Consultant Local residents selected as members of the management body

Source: the Survey Team

3.12 Technical Assistances Required

To lead the project implementation smoothly, technical assistances should be arranged involving international and national consultants/experts. Those consultants/experts shall work closely with engineers of the Irrigation Department and relevant offices e.g. DOA. Technical assistances discussed here are basically categorized into 2 groups; 1) consultancy services which shall be arranged under the prospective loan agreement, and 2) technical assistances which may be provided in grant under a JICA's technical cooperation scheme.

3.12.1 Consultancy Services

To carry out a loan project, consultants shall be employed mainly for the 2 works such as; 1) detail design and also tender documents preparation, and 2) supervision of the 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 supervision is to be under an Assistant Concept. Task concept means that the responsibility for the works done by the consultants shall be with the consultants under the guidance and subject to the approval from the Project Owner, ID. Under the assistance concept, main responsibility of the consultants is to assist the Project Owner in implementing the works required under the Project.

As for the detail design, not all the 4 irrigation systems need it. In fact, North Nawin and South Nawin irrigation systems have been rehabilitated by ID since 2011/12. Especially, rehabilitation works along the main canals of the 2 irrigation systems have been progressing to date. On the other hand, very little rehabilitation works have been done for the Wegyi and Taung Nyo irrigation systems, and these 2 systems need high level rehabilitation works, or in other word, almost new construction-like works such as canal lining both for the main and distributary canals together with re-establishment of hydraulic structures. Therefore, for the Wegyi and Taung Nyo systems, detail design shall be conducted before its implementation while the North and South Nawin systems do not need much.

Consultants will be composed of both international experts and national experts, who are to undertake

1) necessary surveys, 2) detail design for Wegyi and Taung Nyo systems, 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) supervision of works required during the construction period. There is one more task for the international consultant required specifically under this Project. The implementation modality of the Project is by ID direct force account, whereby the consultants have to be in charge of monitoring and endorsing the expenses made by the ID, which are then disbursed by the Loan.

Table 3.12.1 shows consultants to be required with major tasks by detail design stage and implementation stage, which are further composed of international and national consultants. For the international consultants, total 7 members are to be required during the detail design stage mainly assigned to irrigation/rural infrastructure works and hydropower works while there should be total 4 members required during the implementation stage. As for the national consultants, detail design stage will need a total of 8 members while during implementation stage there should be 6 members.

Table 3.12.2 indicates the assignment of the consultants according to the need. Consultant key members, e.g. disbursement management, construction supervision during the implementation stage, are to be assigned continuously during the construction while other members are to be called upon according to the schedule/progress of the detail design and implementation process, not always be on-site. Total person-month proposed here arrives at 53 and 70 for international and national consultant during the detail design stage, and 81 and 130.5 respectively during the implementation stage; namely total 134.0 MM for the international while total 200.5 for the national consultant;

Table 3.12.1 Consultants to be Required by Stage (Detail Design, Implementation)

Particulars	Major Tasks	MM
International Consultants		
Detail Design Stage		
1 Team Leader (Design)	Overall management of the project, liaison between the financier and ID	10.0
2 Irrigation Design Engineer	Planning and designing of irrigation system	10.0
3 Hydraulic Structure Engineer-1	Designing of hydraulic structures e.g. drops, gates (NN, SN)	10.0
4 Hydraulic Structure Engineer-2	Designing of hydraulic structures e.g. drops, gates (Wegyi, Taung Nyo)	10.0
5 Hydraulic Mech Eng.(NN pipes)	Designing of hydraulic mechanical structures	3.0
6 Water Management/ WUA	Planning of water management, & establishment of WUA	6.0
7 Cost Estimation	Project cost estimation	4.0
Sub-total MM		53.0
Implementation Stage		
1 Team Leader (Supervision)	Overall MGT of the project, liaison between the financier and ID	28.0
2 Construction Supervision	Construction supervision for the 4 irrigation systems	29.5
3 Disbursement Management	Overall disburse management	7.5
4 Water Management/ WUA		12.0
5 EIA Monitoring	Environmental and social monitoring	4.0
Sub-total MM		81.0
Total MM for International		134.0
National Consultants		
Detail Design Stage		
1 Co-team Leader	Overall acting project management, liaison to the international c. and ID	11.0
2 Irrigation Design Engineer-1	Designing of major irrigation facilities	11.0
3 Irrigation Design Engineer-2	Designing of minor irrigation facilities	11.0
4 Hydraulic Structure Engineer-1	Designing of hydraulic structures e.g. drops, gates (North Nawin)	11.0
5 Hydraulic Structure Engineer-2	Designing of hydraulic structures e.g. drops, gates (South Nawin)	11.0
6 Cost Estimation-1	Cost estimation on irrigation systems	6.0
7 Cost Estimation-2	Cost estimation on irrigation systems	6.0
8 Procurement Expert (machineries)	Planning of construction machineries, preparation of tender document	3.0
Sub-total MM		70.0
Implementation Stage		
1 Co-team Leader	Overall acting project management, liaison to the international c., ID	41.0
2 Operation Management Expert	Overall construction management	33.0
3 Construction Supervision-1	Supervision of construction works for North Nawin irrigation system	15.0
4 Construction Supervision-2	Supervision of construction works for South Nawin irrigation system	21.0
5 Water Mgt/WUA		12.0
6 Disbursement Management	Disbursement management	8.5
Sub-total MM		130.5
Total MM for National		200.5

Source: JICA Survey Team (2013)

Table 3.12.2 Assignment Schedule of the Consultants by Stage and by International and National

Position			2015												2016												2017												2018												Total
			4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
Consulting Services (Detailed Design)																																																	
A	1	Team Leader	1	1	1	1		1	1	1		1	1	1																																				10.0
A	2	Irrigation Design Engineer	1	1	1	1		1	1	1	1		1	1																																				10.0
A	3	Hydraulic Structure Engineer-1	1	1	1	1		1	1	1		1	1	1																																				10.0
A	4	Hydraulic Structure Engineer-2	1	1	1	1		1	1	1		1	1	1																																				10.0
A	5	Hydro-mechanical Engineer (N.N Pipe+Gate)			1	1	1																																									3.0
A	6	Water Mgt/ WUA									1	1	1	1	1	1																																		6.0
A	7	Cost Estimation									1	1	1	1																																		4.0
B	1	Co-team Leader	1	1	1	1	1	1	1	1		1	1	1																																				11.0
B	2	Irrigation Design Engineer-1	1	1	1	1	1	1	1	1		1	1	1																																				11.0
B	3	Irrigation Design Engineer-2	1	1	1	1	1	1	1	1		1	1	1																																				11.0
B	4	Hydraulic Structure Engineer-1	1	1	1	1	1	1	1	1		1	1	1																																				11.0
B	5	Hydraulic Structure Engineer-2	1	1	1	1	1	1	1	1		1	1	1																																				11.0
B	6	Cost Estimation -1					1	1	1	1	1	1																																						6.0
B	7	Cost Estimation -2					1	1	1	1	1	1																																						6.0
B	8	Procurement Expert (machineries)					1	1	1																																							3.0
Consulting Services (Construction Supervision)																																																	
A	8	Team Leader		1	1		1	1		1		1		1		1	1		1	1		1		1		1		1	1		1	1		1		1		1		1	1	1		1	1	1	1			28.0
A	9	Construction Supervision-1		0.5	1	1	1	1	1	1	1	1					1	1	1	1	1	1	1						1	1	1	1	1	1	1	1					1	1	1	1	1	1	1			29.5
A	10	Desbursement Management		0.5	1	1	1	1		1	1	1																																				7.5
A	11	Water Mgt/ WUA																			1	1	1	1			1	1							1	1	1	1	1	1										12.0
A	12	EIA Monitoring												1										1											1											1				4.0
B	9	Co-team Leader		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	41.0
B	10	Operation Management Expert		1	1	1	1	1	1	1	1	1	1	1		1	1		1	1		1	1		1	1		1	1		1	1		1	1		1	1		1	1		1	1		1	1		33.0
B	11	Construction Supervision-1			1	1	1	1	1	1	1	1					1	1	1	1	1	1	1																											15.0
B	12	Construction Supervision-2															1	1	1	1	1	1	1						1	1	1	1	1	1	1	1					1	1	1	1	1	1	1			21.0
B	13	Water Mgt/ WUA																			1	1	1	1			1	1							1	1	1	1	1	1										12.0
B	14	Disbursement Management-1		0.5	1	1	1	1	1	1	1	1																																				8.5
		[Total of Pro-A]	**75.0**												**21.0**												**21.0**												**17.0**												**134.0**
		[Total of Pro-B]	**108.5**												**37.0**												**32.0**												**23.0**												**200.5**
		[Total of Pro-A+Pro-B]	183.5												58.0												53.0												40.0												334.5
		Grand Total	**183.5**												**58.0**												**53.0**												**40.0**												**334.5**

3.12.2 Technical Assistances from JICA

In addition to the deployment of consultants aforementioned, it is recommended to assign a team of experts who can support the project implementation especially from the view point of soft aspects such as strengthening of agriculture extension services, demonstration of farm mechanization coupled with land consolidation pilot implementation, establishment of water users association, enhancement of water management coordinated with established water users associations, etc. Such aspects are basically categorized into 2 areas of; 1) agriculture extension, and 2) irrigation management.

It is therefore basically recommended to deploy 2 teams of experts undertaking each of the 2 major areas. However, in terms of priority and urgency, agriculture extension strengthening should come first, and then irrigation management can follow. This is because the present yields for paddy and also winter crop, i.e. black gram, are not competitive to the potential ones. It means there could be a high potential to increase the yields given suitable agriculture extension services by the extension officers of DOA.

In addition, at present there are many ID maintenance field staff/workers in charge of canal maintenance, gate operation, etc (see table below). These many government staff/workers can and should still be engaged in operating and maintaining the rehabilitated irrigation facilities for sometime more. It means that the irrigation systems can be operated and maintained even without much involvement of the beneficiary farmers in a form of water users association.

Table 3.12.3 Field Staff Workforce of ID Maintenance for the Target 4 Irrigation Systems

Dam	Dam	Canal	Gate Keeper	Total	Remark
North Nawin	11	71	22	104	
South Nawin	14	24	40	78	
Wegyi	8	34	15	57	
Taung Nyo	10	12	6	28	
Total	43	141	83	267	

Source: ID Maintenance (Bago)

Establishment of water users association entails irrigation management transfer from the irrigation system owner, ID, to the established farmer association. The transfer should be implemented gradually here for the 4 irrigation systems with the fact that currently there are many government staff workforce engaged in the operation and maintenance of the irrigation systems. As gradually the staff workforce is reduced by for example natural retirement, gradual turnover of irrigation management from the ID to the established farmer association should be pursued at the distributary canal level.

In this regard, it is proposed that there could be only one team of experts putting emphasis on the strengthening of agriculture extension services first as the Stage 1 and then after a period of, e.g., 5 years has passed, the team's focal activity area should be shifted to irrigation management including the establishment of water users association as Stage 2. Accordingly, expertise of the team has to change by stage, for the former stage the team is composed more of agriculture related experts while for the latter stage, most of the members are from such fields of water management, water users association, irrigation service fee, etc.

Project term for the both stages should be at least 5 years each. The first stage, 'strengthening of agriculture extension' is to start in the third year of the implementation of rehabilitation work taking into account the preparation period of organizing such experts of the team. Experts deployment schedule required are indicated below, and the Stage 1 project 'strengthening of agriculture extension' is to need total 198 person-month over the 5-year implementation period while the Stage 2 project 'irrigation management' will also require another 198 person-month for the same 5-year period:

Table 3.12.4 Proposed Person-month Schedule of Technical Cooperation Project

No.	Activities	2014 Consul Selection	2015 Preparation	2016 Year 1	2017 Year 2	2018 Year 3	2019 Year 4	2020 Year 5	2021 Year 6	2022 Year 7	2023 Year 8	2024 Year 9	2025 Year 10	26	MM
I	**Project Implementation**														
1	North Nawin														
2	South Nawin														
3	Wegyi														
4	Taung Nyo														
II	**Technical Assistances**														
II.1	Agriculture Extension								MM						
	Chief Advisor								55						
	Agriculture (paddy)								32						
	Agriculture (pulses)								20						
	Farm Mechanization								15						
	Post Harvest								10						
	Training/ Coordinator								46						
	Irrigation/ Water Management								20						
									198						
II.2	Irrigation Management														MM
	Chief Advisor														55
	Water Management														25
	Water Users Association														37
	Irrigation Service Fee														16
	Rural Society														5
	Agriculture/ Post Harvest														10
	Farm Mechanization														6
	Training/ Coordinator														44
															198

CHAPTER 4 IMPLEMENTATION ARRANGEMENT AND PROJECT COST

This chapter describes necessary implementation arrangement for the irrigation system rehabilitation. Under Irrigation Department, Maintenance Division (Bago West) is the responsible for daily maintenance and common rehabilitation for the systems while Constriction Division (2) is the responsible for full-scale or major rehabilitation works. This rehabilitation project deals full-scale rehabilitation, and therefore the Construction Division (2) will mainly handle the project with assistance from the Maintenance Division (Bago West). Following sub-chapters discuss the implementation arrangement of the project and also the project cost required:

4.1 Project Components and Scoping for Yen Loan

Since Irrigation Department desires to apply direct force account for the project implementation, major components of the project under ODA loan are to be; rehabilitation works mainly composed of material and labor procurement, procurement of new construction machineries, engineering consulting services, other small works for preparation and clear-out of project implementation. Major items can be estimated from the bill of quantities of the proposed rehabilitation works while minor items can be calculated from a certain percentage against the rehabilitation cost. The following table summarizes project components and cost sharing by item and between donor, JICA, and Irrigation Department. Note that shares were calculated base on the costs indicated in '4.5 Cost Estimation and Disbursement Plan'.

Table 4.1.1 Project Components and Project Cost Sharing between Donor and ID

Items	Examples	Calculation or Rate (%)	Share (%)	Investor
Construction Works	Materials, Labors, Fuel etc.	BOQ1	65.4%	Donor (JICA)
Machinery Procurement	Machines, spare parts	BOQ2	8.9%	Donor (JICA)
Price Escalation		Foreign: 1.5%, Local: 3.1%	5.6%	Donor (JICA)
Physical contingency		5% of BOQ1, BOQ2	4.0%	Donor (JICA)
Consulting Services	DD, SV	BOQ3	6.0%	Donor (JICA)
Land Acquisition		Not Applied	0.0%	ID
Administration Cost	ID Staff	10% of BOQ1	9.0%	ID
VAT		2%	1.1%	ID
Import Tax		7.5%	0.0%	ID
Interest during Construction		0.01%	0.0%	ID
Total	-	-	100%	

Source: Irrigation Department, modified by the Survey Team (2013)
Note; Calculated results of some items show only small value and they are indicated as '0.0%.'

Cost of construction works shares 65% of the total project cost and its cost is estimated at about 124 million US$. Items of machinery procurement have been revised by a Chief Mechanical Engineer of ID in order to adjust machinery's types and numbers between Irrigation Department owning ones and those ones to be newly procured. Physical contingency is set at 5% of the construction works and the machinery procurement cost. Consulting services include 'detail design' and 'construction supervision' and it costs about 6% of the total project cost. Land acquisition including compensation and resettlement is not estimated in this project because most of the works are for rehabilitation and managed within the existing lands owned by ID.

Irrigation Department usually estimates and spends cost required for administration by certain rate ranging between 10% and 15%. In this project, 10% is employed since consultants who can be in charge of supporting the ID's administration are to be involved and also cost of construction works arrives at relatively high value, in which percentage of administration cost becomes small. Value Added Tax (VAT) and import tax are set as 2% and 7.5% respectively. Finally, the total project cost arrives at US$ 165.5 million: 149.7 million US$ is for Yen loan (90.5% of the total project cost) while US$ 16.8 million is for ID portion (9.5% of the total project cost).

4.2 Construction Modality and Schedule

Irrigation Department has employed direct force account system for construction of dams and irrigation schemes. This direct force account system can be seen in other ministries as well. Consequently, there is no private company in Myanmar, which knows well about the construction of irrigation systems. Irrigation Department has accumulated adequate experiences for the force account system in the long history for implementing irrigation projects, which in fact has been established since British colonial period. All rehabilitation procedures for 4 irrigation systems shall utilize the force account system as much as possible in order to maintain discipline of advantages accumulated in the organization. This sub-section mainly explains force account system of the Irrigation Department.

4.2.1 Procurement of Contractors

Under the force account system, Irrigation Department will procure contractors for materials and construction machinery supply while construction works are to be directly done by Irrigation Department. There will be cases that some materials are necessary to be procured by the head office of Irrigation Department such as cement, reinforced bars, and fuels. Tender procedure will be utilized for the procurement of these materials, which can keep transparency through the procurement. There are also governmental corporations, which can supply such materials. On-time material procurement and delivery are essential for this project, whereby it is considered that the tender procedure is more suitable for this project.

4.2.2 Construction Modality: ID Direct Force Account

There are basically two ways of material procurement under force account system of Irrigation Department. First one is to procure common materials with bulk unit while the second one is to purchase particular and small amount of materials. Bulk materials such as diesel, reinforced bars, and cement are usually procured by the Procurement Division of the head office because those are common materials required for construction works and these materials have to be delivered to all the construction divisions of Irrigation Department.

Procurement condition for small unit and/or particular materials, e.g. sand, gravels, wood and labors, is different from one locality to the other. There is also regional fixed ceiling price for such materials and workforces, and then each Construction Division and Maintenance Division of Irrigation Department (so-called ‘a site office’) has to purchase them with reference to the fixed ceiling price. Therefore, local purchase will be employed for procuring these small unit and particular materials under this project.

As for head office procurement, Procurement Division and Planning & Works Division of Irrigation Department request the site office to submit procurement list and delivery schedule for common materials. After that, the Procurement Division prepares procurement documents such as tender documents for procurement from private companies, contract documents for governmental corporations, etc. The Procurement Division prepares and makes a contract with the contractor who won the tender, and the contractor will deliver the materials to the site.

Monitoring and confirmation follow the aforementioned delivery of the procured materials and goods. A responsible Assistant Engineer will confirm material delivery at the site and sign on the delivery note, and then he receives the receipt instead. After this confirmation, site office in charge will report the Procurement Division together with the receipt of materials. Account Division will receive the documents from the Procurement Division and check the contract and the receipt, and then Deputy Director General and Director General will check and confirm them, and submit them to JICA for budget disbursement.

In case of local purchase, procedure differs a bit from the head office procurement. A necessary

contract will be made between the site office and a contractor. After delivery of materials, a sub-assistant engineer receives the delivery note and the invoice of materials delivered at the site and puts his signature on the invoice and reports to an assistant engineer. The assistant engineer checks it and signs on it and submits it to an assistant director.

The assistant director confirms it and sends it to the head office through the Director of Construction Division together with other invoices. The Procurement Division will check them up and send them to the Account Division. After Account Division, Planning and Works Division will check them with reference to the progress of works at the site and adjust them within the planned budget. The Director General will approve it after Deputy Director General's checking. Documentation and description of these procedures are usually prepared in English. Sample of receipt is shown below:

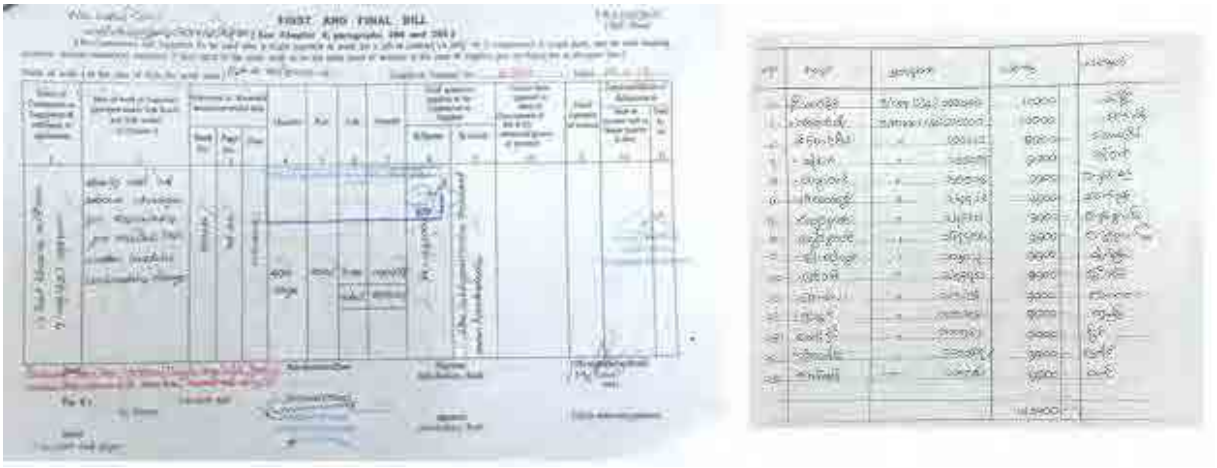


Figure 4.2.1 ID Payment Record (Left: total payment for labors, right: signature of payment by labors)
Source: Irrigation Department

4.2.3 Implementation Schedule

Currently, irrigation in the 4 targeted irrigation systems is provided from January to May mainly for summer paddy, and from June to December irrigation is not carried out, not necessary due to the rainfall, except for October. October is the month for flowering and maturing period of monsoon paddy, which needs more water than what is provided by rainfall. Construction period for canal rehabilitation is therefore planned based on this current irrigation practice. The following table shows irrigation practice and available construction period for the canal rehabilitation; namely, construction work for canal rehabilitation is carried out only during off-irrigation season.

Table 4.2.1 Irrigation Period and Construction Period for Canal Rehabilitation

Practices	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Irrigation Period	▦	▦	▦	▦	▦					▦		
Construction Period						▨	▨	▨	▨		▨	▨

Source: Irrigation Department, modified by the Survey Team (2013)

Under the project, rehabilitation of the inspection roads, which run alongside the main canals, is also planned as one of the project components. Road rehabilitation requires soil embankment, so that dry works are essential for this component. If the soil embankment is carried out during rainy season, necessary compaction can hardly be obtained. Therefore, inspection road work will be carried out during dry season. After or before the canal rehabilitation work, inspection road rehabilitation and upgrading of minor road will be carried out accordingly.

Three years are planned for each of the rehabilitation of 4 irrigation systems together with road rehabilitation/upgrading. Out of the 4 irrigation systems, North Nawin and South Nawin systems do

not need full-level detailed design because Irrigation Department has conducted certain volume of surveys on these systems and necessary portions of canal rehabilitation have already been identified and work volume has been calculated. In fact, ID has been implementing partial rehabilitation works since 2 years ago.

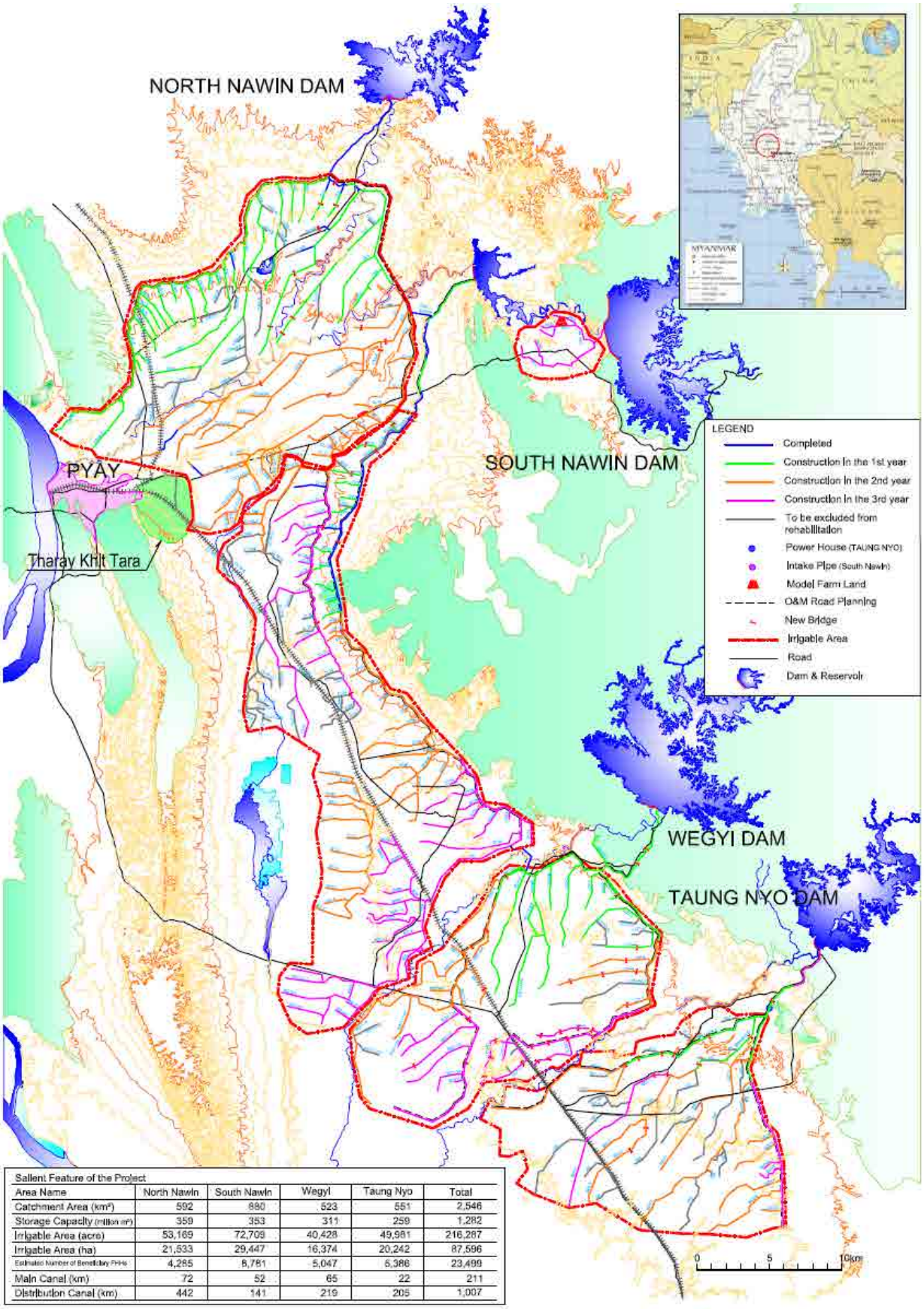
On the other hand, remaining 2 irrigation systems, Wegyi and Taung Nyo, need to have detailed design because little designs are available only for some structures. This detailed design stage will take about 1 year. Under such situation, there should be one-year for the selection of consultant, following which another one-year is needed to complete detail design. It means that the commencement of the 2 irrigation systems could be started 2 years later from the commencement of the North and South Nawin irrigation systems. Therefore, though each 3 years are needed for the rehabilitation work for each of the irrigation systems, total 5 years are to be required to complete the 4 irrigation systems:

Table 4.2.2 Proposed Rehabilitation Plan for 4 Irrigation Systems

Project	Items for Implementation	Implementation Year				
		1st Year	2nd Year	3rd Year	4th Year	5th Year
North Nawin	Rehabilitation	▬	▬	▬		
	Construction Machinery	▬				
	Project management	▪▪▪	▪▪▪	▪▪▪		
	Consultation (Engineering)	▪▪▪	▪▪▪	▪▪▪		
South Nawin	Rehabilitation	▬	▬	▬		
	Construction Machinery	▬				
	Project management	▪▪▪	▪▪▪	▪▪▪		
	Consultation (Engineering)	▪▪▪	▪▪▪	▪▪▪		
Wegyi	Rehabilitation			▬	▬	▬
	Construction Machinery					
	Project management			▪▪▪	▪▪▪	▪▪▪
	Consultation (Engineering)			▪▪▪	▪▪▪	▪▪▪
Taung Nyo	Rehabilitation			▬	▬	▬
	Construction Machinery					
	Project management			▪▪▪	▪▪▪	▪▪▪
	Consultation (Engineering)			▪▪▪	▪▪▪	▪▪▪

Source: Irrigation Department, the Survey Team (2013)

Figure 4.2.2 shows rehabilitation plan for each irrigation system; blue color shows the canal potions that the Irrigation Department has already conducted major rehabilitation; green color shows canal areas for which rehabilitation will be carried out in the 1st year; orange color shows for the 2nd year implementation and red color shows for the 3rd year implementation. Note that the 1st, 2nd and 3rd years mean its implementation year from the commencement of each of the irrigation systems, not corresponding to the scheduled year for the case of Wegyi and Taung Nyo indicated in Table 4.2.2. Likewise, it doesn't mean that the canal portions of same color in different systems will be implemented simultaneously either.



Sallent Feature of the Project

Area Name	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
Catchment Area (km²)	592	880	523	551	2,546
Storage Capacity (million m³)	359	353	311	259	1,282
Irrigable Area (acre)	53,169	72,709	40,428	49,981	216,287
Irrigable Area (ha)	21,533	29,447	16,374	20,242	87,596
Estimated Number of Beneficiary FHHs	4,285	6,781	5,047	5,386	23,499
Main Canal (km)	72	52	65	22	211
Distribution Canal (km)	442	141	219	205	1,007

Figure 4.2.2 Irrigation Systems for Rehabilitation and their Schedule

Source: Irrigation Department, the Survey Team (2013)

4.3 Institutional Setup for Project Implementation and Monitoring

This section describes responsible organizations for rehabilitation works of the 4 irrigation systems. There are total 3 organizations which have to take responsibilities for the works by different manners. Irrigation Department is the responsible organization of the works and the roles of it are to manage and control the whole works. Construction Division (2) and Maintenance Division (Bago West) are responsible for implementation of the rehabilitation works. Details of implementation setup are discussed hereunder;

4.3.1 Irrigation Department

Irrigation Department is one of the organizations under Ministry of Agriculture and Irrigation (MOAI). Total number of staff counts as many as 20,000. Out of 20,000 staff, number of engineers is about 1,020; most of them have engineering educational background. Budget in fiscal year 2010-11 was about 111 billion Kyats which is equivalent to US$ 123 million (1$ = 900 Kyats). The following table and figure show recent budget and organizational chart of Irrigation Department respectively:

Table 4.3.1 Budget of Irrigation Department in Recent 5 Years (Unit; million Kyats)

Type of Budget	2006-07	2007-08	2008-09	2009-10	2010-11
Capital Budget	48,863	70,561	126,043	88,314	73,699
Recurrent Budget	20,259	24,796	27,187	32,636	37,123
Total	69,122	95,357	153,230	120,950	110,822

Source: Irrigation Department

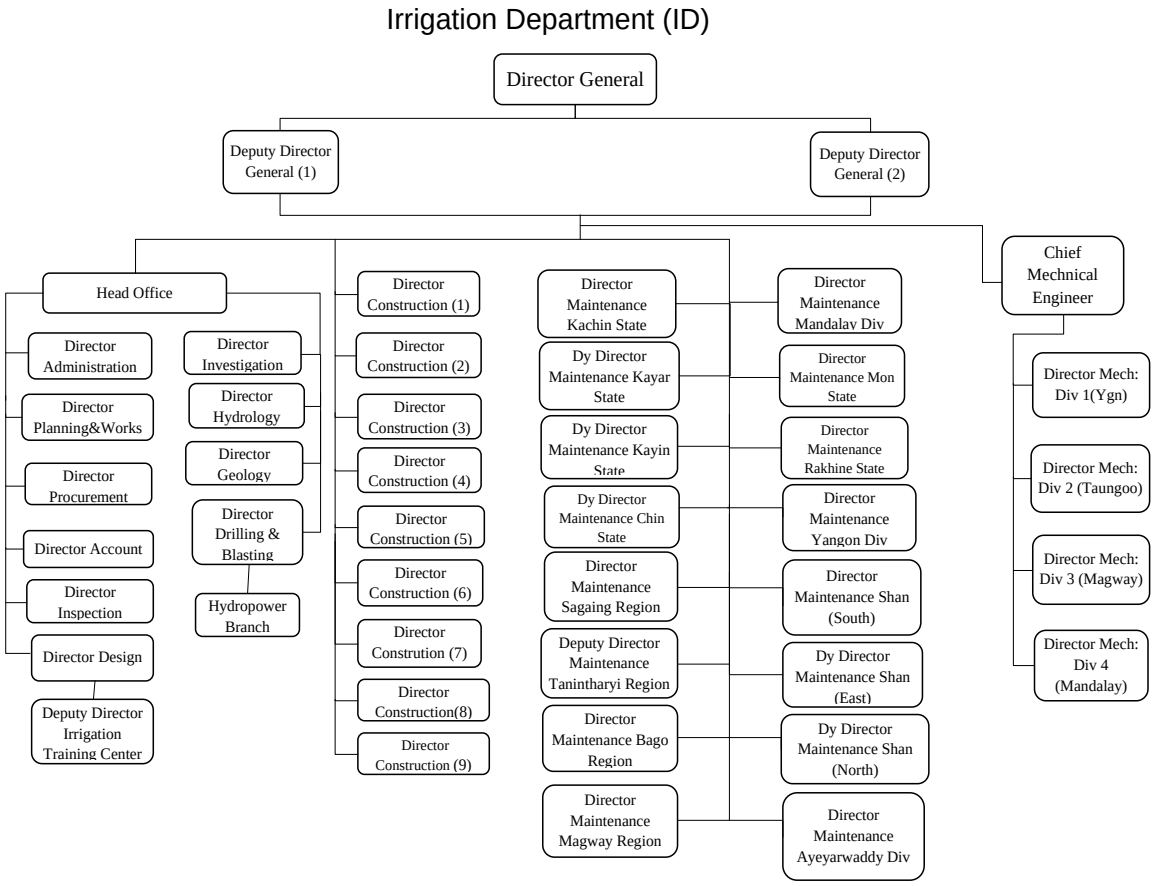


Figure 4.3.1 Organization Chart of Irrigation Department

Source: Irrigation Department

Irrigation Department has 2 types of budgets; one is capital budget and the other is recurrent budget. Capital budget is used for dam construction, irrigation network construction, vehicle purchase,

computer purchase, and so on while recurrent budget is applied for maintenance works for dams and irrigation networks, staff salary, transportation, fuel, and so on. Capital budget has been always allocated twice or more than the recurrent budget during the former government. This could be one of the reasons why maintenance works could not be carried out properly.

Irrigation Department under the present government steers the policy toward irrigation water distribution rather than irrigation reservoir/dam construction. This is the major reason why many maintenance works have been commenced since 2011-12 fiscal year. Capital budget is applied for some major repairing works under such policy. Consequently, rehabilitation of canal systems is now one of the major works of Irrigation Department.

Irrigation Department has 4 primary objectives as follows;

i) to carry out hydrological and geological investigations and topographic surveys of works currently under implementation and other prospective major projects; and to draw designs based on data and information collected,
ii) To undertake planning and construction of new projects,
iii) To perform operation and maintenance of the existing irrigation, drainage and flood protection works, and
iv) To provide technical assistances to rural irrigation works, rural development and rural uplift implemented by the Border Areas and National Races Development.

Irrigation Department has such technical oriented objectives with certain background of rich human resources, technical know-how, and experiences. In fact, Irrigation Department has completed total 239 numbers of irrigation projects from 1988 to 2012. It means that about 10 projects had been completed every single year. Present government intends to supply adequate irrigation water to farmland as much as possible while the former government preferred reservoir dam construction rather than irrigation network construction. The policy aforementioned will hardly change under the present government and also the successors.

Here, Irrigation Department is proposed as the main implementing agency for the irrigation system rehabilitation, and the Department is responsible for all kinds of arrangement for rehabilitation works. Actual implementation organization will be selected by the head office of Irrigation Department. At this moment, there are 2 candidates of organizations under Irrigation Department; one is Construction Division (2) and the other is Maintenance Division (Bago West). These 2 organizations will jointly formulate one construction implementation body and this body will implement the rehabilitation works under ODA loan.

The implementation body can receive supports from the Irrigation Department in technical fields, financial aspects, and human resources provision as well. The following subsection explains Construction Division (2) and Maintenance Division (West Bago), which are the most likely to be the implementation body for the upcoming rehabilitation works.

4.3.2 Responsible Implementation Body at Central Level

For the purpose of project implementation, Irrigation Department usually sets up 2 clusters of management units at different administration level; one is at a head office and the other is at a construction site. The administration cluster at the head office is a ‘Project Implementation Committee’ and the other cluster at the construction site is a ‘Project Management Unit’.

1) Functions and Duties of Project Implementation Committee (PIC)

Project Implementation Committee (PIC) is an organization, which will be established in Irrigation Department as a principle entity for an individual project at a central level in order to facilitate smooth

project implementation through suitable deployment of construction machineries, on-time material procurement and delivery, appropriate budget allocation, provision of necessary technical guidance, and control of budget expenditure. A chairperson of PIC is the Director General of Irrigation Department, and the Deputy Director General (Lower Myanmar) plays the duty of vice-chairperson. PIC is responsible for overall supervision and execution of the Project, and the member of PIC consists of total 5 directors under the chairpersons.

Concerning the members of PIC, the first one is a Chief Mechanical Engineer who has duties of machine deployment to the project site and for mechanical trouble-shooting. The second one is a Director of Planning & Works Division who monitors and controls progress of works, and deals with correspondences between Donors and Irrigation Department. The third is a Director of Procurement Division who conducts international/local tenders for purchasing construction materials and equipment at the central level, store the materials, and deliver them to the project site. The fourth is a Director of Design Division (Work 1) who is responsible to provide necessary technical guidance and instruction to the Project. The last is a Director of Account Division to control budget expenditure and to record project accounts which are submitted from the project site and other divisions concerned.

PIC has a secretary under the 5 members. In this Project, the Director of Construction Circle (2) plays this role and receives guidance and instructions from the members and reflects them for the implementation of the Project.

Main functions of the PIC for this Project are summarized as follows:

i) To be comprehensively responsible for the project implementation in accordance with a loan contract,
ii) To coordinate and manage the Project activities,
iii) To establish a monitoring and evaluation system that will track the progress of the Project,
iv) To support the Project in planning and implementation technically and financially such as machinery deployment, budget allocation, materials provision, and technical guidance,
v) To Provide timely feedback on project planning and implementation to the Project,
vi) To report to the government on the overall progress of the Project,
vii) To summarize and keep project account, and
viii) To call regular meetings (usually once every three-month) throughout the duration of the Project, and special meetings when need arises.

As aforementioned, PIC has responsibility and authority of all activities such as planning, coordination between sections, its project management and so on at the central level. PIC also has an authority to supervise financial and accounting section as well in order to secure sufficient financial allocation and appropriate payment for smooth project implementation. The final decision is made by the Chairpersons who are the Director General and the Deputy Director General of Irrigation Department. PIC can transmit those instructions, guidance, and decisions to the Project through the secretary which holds the position of Project Director at the site.

For the ODA loan scheme, PIC should be established in order to ensure smooth work for project implementation. The composition of PIC consists of existing administration of the head office of Irrigation Department such as mechanical, planning & works, procurement, design, and account sections. It can monitor the project status before and during implementation period and also can report some necessary information to the concerned donor organization and deliver its feedback to the Project. Thus, it can work as information and financial hub between the donor organization and the Project. PIC will be also effective to employ experts or specialized consultants in order to enhance the ODA procedure smoothly. PIC organization is quite simple and mandates are demarcated by duties

and responsibilities of each Division of the head office, consequently, PIC will be the functional organization for ODA project implementation.

2) Organization Chart of PIC

Organization chart of the PIC is shown below;

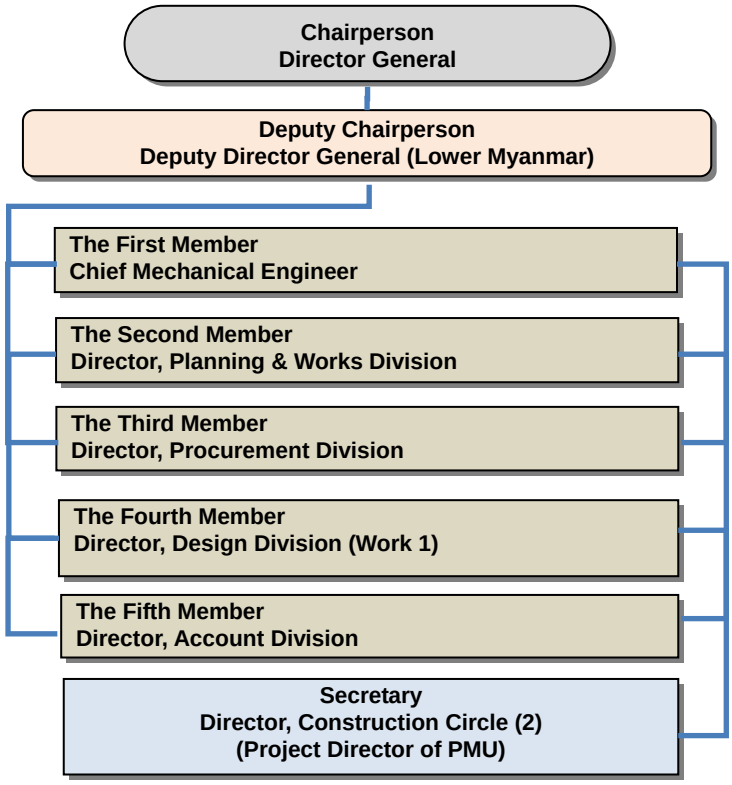


Figure 4.3.2 Organization Chart of Project Implementation Committee (PIC), Central Level

Source: Irrigation Department

4.3.3 Responsible Implementation Body at Site

1) Functions and Duties of Project Management Unit (PMU)

For this project, Project Management Unit (PMU) will be organized in West Bago region, merged by Construction Division (2) and a part of Maintenance Division (Bago). Newly organized body will be the front line management unit for the implementation and it is an ad-hoc entity established during the implementation period. PMU is aimed at managing and monitoring the project, and is an independent organization to implement the specified project. It will be headed and staffed by a full-time Project Director (PD), who will probably be the Director of Construction Division (2), and establish the project office consisting of the staff members of deputy directors, assistant directors, site engineers and accounting officers of the Construction Division (2) and Maintenance Division (West Bago).

PMU will be tasked with managing and monitoring the day-to-day activities of the project at the field and regional level. The Project Director has a responsibility and an authority for overall regional activities such as material procurement at local level, construction works, quality control, accounting, progress and schedule management, and reporting of those activities to the PIC at central level. PMU will consist of 4 fundamental entities which will be headed by Assistant Directors. Each minimum unit will deal with each one of the 4 irrigation systems under the Project.

At this moment, 3 executive engineers of the Construction Division (2) and 1 executive engineer of the Maintenance Division (Bago West) will manage and supervise construction works of 4 irrigation

systems. Under the executive engineers, some assistant engineers and officers will be incorporated into the minimum units. These engineers and officers will carry out construction supervision, material procurement, financing and accounting of the project. Main functions of the PMU are summarized below:

i) Supervising and monitoring the day-to-day project activities,
ii) Preparing project implementation and work plan and reporting the progress of the Project with the assistance of the consultants,
iii) Arranging and supervising construction works,
iv) Arranging procurement of goods, and works for the project,
v) Organizing monitoring and evaluation activities,
vi) Receiving budget and payment of cost for project activities, and
vii) Maintaining accounts of the project and report it to PIC.

PMU undertakes all activities of construction and its relevant works such as construction planning, local procurement, construction supervision, and project management, etc. within the project. PMU also has an authority to make a contract with regional contractors to procure local materials and labors. Financial and accounting works of the Project are important tasks for the PMU in order to secure transparency of procurement process and appropriate payment as well as smooth construction works.

PMU itself is the specific project implementation body under the PIC, and PMU will implement this Project according to guidance and instructions received from PIC in order to ensure smooth works. The organization of PMU mainly consists of engineers under Construction Division (2) and Maintenance Division (West Bago). PMU manages financial and administration sections as well as engineering sections. Head of the PMU is the Director of Construction Division (2) who will also be the secretary of PIC. Thus, PMU is an appropriate and functional entity which can smoothly share information and knowledge with the PIC.

2) Organization Chart of PMU

Organization chart of PMU is shown below:

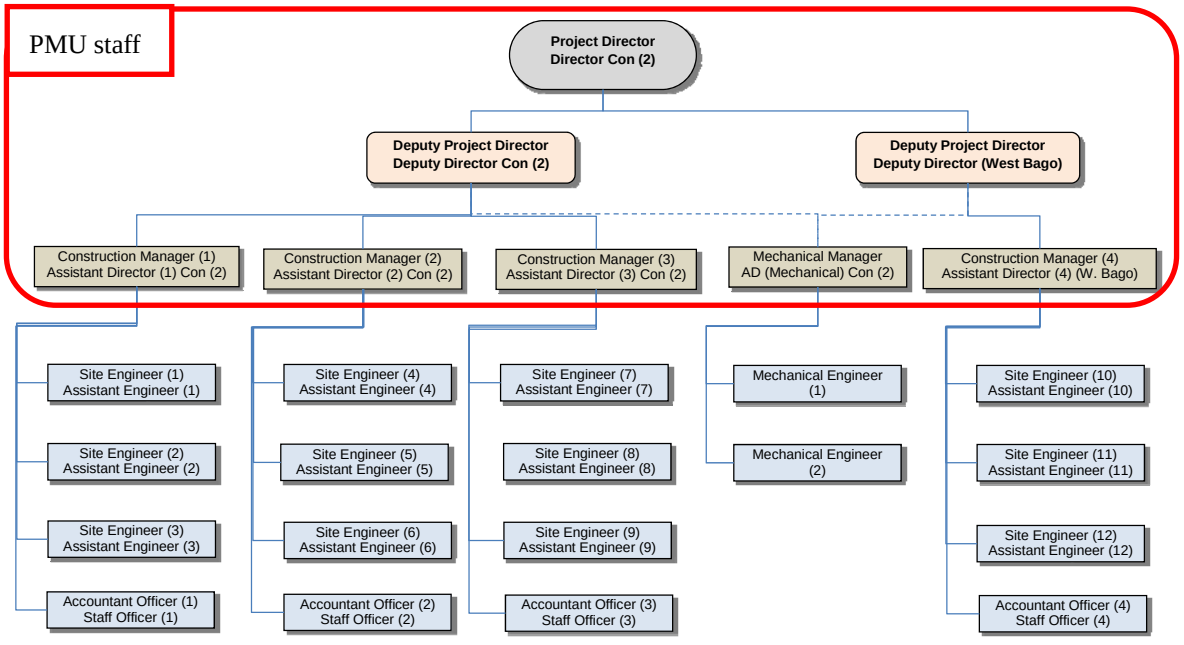


Figure 4.3.3 Organization Chart of Project Management Unit (PMU), Regional Level
Source: Irrigation Department

3) Construction Division (2)

Total 513 staff is currently assigned to the Construction Division (2) and they are responsible for construction of major irrigation facilities, major rehabilitation works of irrigation networks, and land consolidation. Of the 513 staff, there are 151 engineers, 227 technicians, 135 administration staff. Capital budget is usually allocated to this office, so that works under this office are of large scale rather than small or minor scale.

An assistant director is usually assigned as a project manager for a project. There are 3 assistant directors of civil works; thus each assistant director will be assigned for one rehabilitation project out of the 4 irrigation systems. Remained one post will be reinforced from the Maintenance Division (Bago West). An assistant director (mechanical) is responsible for management of construction machineries including machine maintenance and their operations. Most technicians are composed of operators of machineries such as excavators, dump trucks, and compactors. The following table shows detail of the human resources of Construction Division (2):

Table 4.3.2 Human Resource Distribution and Positioning under Construction Division (2)

Office	Sections	Engineer	Technician	Administration	Total
Director	Work	14	15	0	29
	Account	0	0	9	9
	Administration	0	0	32	32
	Subtotal	14	15	41	70
Assistant Director (1)	Work	31	40	0	71
	Account	0	0	10	10
	Administration	0	0	21	21
	Subtotal	31	40	31	102
Assistant Director (2)	Work	31	27	0	58
	Account	0	0	11	11
	Administration	0	0	12	12
	Subtotal	31	27	23	81
Assistant Director (3)	Work	35	7	0	42
	Account	0	0	9	9
	Administration	0	0	12	12
	Subtotal	35	7	21	63
Assistant Director (Mechanical)	Work	40	138	0	178
	Account	0	0	6	6
	Administration	0	0	13	13
	Total	40	138	19	197
Total of Construction Division (2)	Work	151	227	0	378
	Account	0	0	45	45
	Administration	0	0	90	90
	Total	151	227	135	513

Source: Irrigation Department

4) Maintenance Division (Bago West)

Maintenance Division (Bago West) is composed of total 415 staff and there are 1 deputy director office and 2 assistant director offices. Ratio of engineers and technicians is only 29% while that of Construction Division (2) counts as much as 74%. There are a lot numbers of permanent labors under this division such as gate keepers, canal maintenance workers, and watchmen. There is no assistant director office for mechanical because number of allocated heavy machineries is limited. Recurrent budget is usually allocated to this office, so that works under this office are of small and minor scale.

An assistant director of maintenance division is usually assigned as a responsible person for operation and maintenance of irrigation systems within a division. The assistant director (Pyay) office is in charge of; 1) North Nawin irrigation system, 2) South Nawin irrigation system, 3) Wegyi irrigation system, 4) Shwe Taung irrigation system, 5) Nyaung Gine irrigation system, 6) Kan Gyi Gone

irrigation system, and 7) Khawar irrigation system. The assistant director (Thayarwaddy) office manages 1) Taung Nyo irrigation system, 2) Thonese irrigation system, 3) The Kaw irrigation system, 4) Sin Ku Chaung Gaung irrigation system, 5) Gadin Belin irrigation system, 6) Min Hla irrigation system, 7) Gamone irrigation system, and 8) Bawbe irrigation system.

When rehabilitation project is implemented, one assistant director will be assigned as project manager of rehabilitation for 1 irrigation system. If work force of engineers is not enough for the implementation, some engineers will be sent from other offices to the project office. This decision will be made by the Director General of Irrigation Department. The following table shows detail of human resources of Maintenance Division (Bago West):

Table 4.3.3 Human Resource Distribution and Positioning under Maintenance Division (West Bago)

Office	Sections	Engineer	Technician	Admin. + Others	Total
Deputy Director	Work	1	3	0	4
	Account	0	0	4	4
	Admin. Maintain	0	1	11	12
	Subtotal	1	4	15	20
Assistant Director (Pyay)	Work	39	25	0	64
	Account	0	0	10	10
	Admin. Maintain	0	0	165	165
	Subtotal	39	25	175	239
Assistant Director (Thayarwaddy)	Work	22	26	0	48
	Account	0	0	9	9
	Admin. Maintain	0	3	96	99
	Subtotal	22	29	105	156
Total of Maintenance Division (West Bago)	Work	62	54	0	116
	Account	0	0	23	23
	Admin. Maintain	0	4	272	276
	Total	62	58	295	415

Source: Irrigation Department

4.4 Consultancy Services

Consultancy services are necessary for the rehabilitation project of the 4 irrigation systems. North Nawin and South Nawin will start early and detailed design may not be required; however, consultancy services are necessary for supporting the disbursement procedure on direct account. Disbursement procedure will be done as follows:

i) Confirmation of rehabilitation schedule and disbursement schedule according to on-going situation,
ii) Confirmation of rehabilitation area to be carried out according to rehabilitation plan not only on drawings but also at the site,
iii) Confirmation of monthly progress of rehabilitation based on the plan and site situation,
iv) Checking on necessary documents for disbursement, and
v) Report to JICA for progress and conditions on rehabilitation.

For Wegyi and Taung Nyo irrigation systems, engineering services are firstly necessary for detailed design coupled with revise of construction schedule and disbursement plan. Necessary services are as aforementioned in '3.12 Technical Assistances Required'.

4.5 Cost Estimation and Disbursement Plan

4.5.1 Basic Conditions of Cost Estimation

Basic conditions in estimating the project cost should clarify unit ratios to be employed and also components/categories for direct cost and in-direct cost. Direct cost is estimated with reference to the

work volume and those unit prices specified. As per the in-direct cost, on the other hand, common practices applied in Myanmar are to be applied and often ratios/percentages against the basic cost, e.g. the direct cost, may be applied.

As for the unit ratio by work and item, government offices related to publish works such as local offices of ID and Ministry of Construction, divisional and district administrative offices, and municipal offices are in charge of setting those ratios (for the responsible local office, see the following table). Those offices every year set the regional rate prevalent, unit price, of for example construction materials such as cement, fuel, sand, etc., and labor charges depending on the skill level. In addition, construction productivity is established by the ID HQs, whereby project direct cost can now be estimated on basis of those unit prices with work volume and those productivities.

Table 4.5.1 Office in charge of Unit Price Setting by Irrigation System

Project Site	Office in charge of Unit Price Setting
North Nawin Irrigation System	Pyay District, Bago Division
South Nawin Irrigation System	
Wegyi Irrigation System	
Taung Nyo Irrigation System	Thar Yar Wady District, Bago Division

Source: Construction No.2, Pyay, Irrigation Department

Direct costs under this Project are composed of; direct civil and structure construction cost, machineries procurement cost, model farm establishment cost, mini hydro-power procurement & establishment cost, and consulting services cost, while in-direct cost shall cover price escalation, physical contingency, administration cost, interest during the construction, land acquisition and compensation when required, and VAT and import taxes. The in-direct costs under this Project are estimated as follows;

1) Price escalation for foreign currency portions of direct cost is set at 1.3% of inflation index while the price escalation of local currency portions to be 3.1% of inflation index. Note that the price escalation is applied for the direct construction cost, machineries procurement cost, and consulting services cost, latter of which is also a part of the direct cost.

2) Physical contingency is set at 5% to be applied both for foreign and local portions and also for all the direct cost such as construction and procurement costs and the consulting services cost. This physical contingency ratio is applied over the direct cost plus the above price escalation cost.

3) Administration cost covers wage of ID staff including various allowance, depreciation cost for existing machineries, maintenance cost of storage facilities of Mechanical Division, material management cost, material testing cost by Irrigation Technology Center, etc. The ratio of the administration cost is set at 10% over the direct costs for the rehabilitation works, machineries procurement and consulting services and also those price escalation and physical contingencies. Note that ID usually applies 10 – 15% of the direct construction cost as the administration cost, and under this Project, since consultants are to be employed, its minimum ratio, 10%, is applied.

4) Ratio of interest during the construction is set to be 0.01% against the direct cost, applied both for the foreign and local portions of the construction, procurement and consulting services as well.

5) VAT is set at 2% while import tax is set at 7.5% according to information given by Irrigation Department. Note that import tax ranges from 5 to 10 % for most of the construction related materials and equipment so that the average, 7.5%, is applied in this cons estimation.

6) Foreign exchange ratios are set at 99.7 Yen against one US dollar and 975 Kyats against one US dollar, accordingly 0.1 Yen per one Kyat, which values were also applied by the Fact Fining mission dispatched in early September 2013 for the purpose of setting the loan eligible portions with the costs.

4.5.2 Eligible and Non-eligible Portion under Japanese ODA Loan

This Project is planned to be funded by a Japanese ODA (Yen) loan, for which there should be a demarcation between loan eligible and non-eligible portions. Following table summarizes the portions eligible and non-eligible for the loan; namely, direct costs and those relevant supportive costs including inflation and contingency are covered by loan while administration cost, tax and duties, and land and property acquisition including compensation should be born by the recipient county, Myanmar. Note that since the construction is done by ID direct force account, such costs as wage of ID staff including machinery operators, depreciation for the existing machineries to be utilized, and maintenance of storage facilities in Mechanical Division, etc. are not to be covered by the Loan.

Table 4.5.2 Eligible and Non Eligible Portion for Japanese Yen Loan

Name of Portion		Contents of portion	Investor
1.	Consultant Fee	(1) Detail Design	Donor
		(2) Procurement management etc	
2.	Civil Work	(1) Construction materials (Cement, sand, Gravel, Brick, Reinforcing bar etc.)	Donor
		(2) Wage of Labor(Common labor, Technician, Mason, Machine driver etc.)	
		(3) Consumables for machineries (Fuel, oil, lubricant cost etc)	
		(4) Construction cost for creation and removal	
		(5) Miscellaneous for construction	
3.	Machinery and Equipment	(1) Construction machineries etc	Donor
		(2) Spare parts for construction machineries etc	
		(3) Operation and maintenance training for construction machineries etc	
		(4) Hiring car cost in the construction site (Including driver, fuel etc)	
4.	Supporting Activities	(1) Procedures for raising funds	Donor
		(2) Supervision of tender & contract (Buyer and Supplier)	
		(3) Pre-shipment inspection and loading inspection for Machineries	
		(4) Other supporting activities	
5.	Price Escalation	(1) Construction materials, fuel, Labor cost etc	Donor
6.	Physical Contingency	(1) Extreme weather phenomena, earthquake, flood etc	Donor
		(2) War, terrorism, labor troubles etc	
7.	General Administration Expense	(1) Wage of ID staff including various allowance (Machineries operators, Maintenance staff, secretary etc.)	Myanmar
		(2) Depreciation cost for existing machineries	
		(3) Maintenance cost of storage facilities in Mechanical Division	
		(4) Material management cost (repairs cost for warehouse etc)	
		(5) Inland transportation for Construction Machineries	
		(6) Other general administration expense	
8.	Tax and Duties	(1) Customs duty	Myanmar
		(2) Value-added tax etc	
9.	Purchase of Land & Other Real Property	(1) Purchase of land for irrigation system etc	Myanmar
10.	Compensation	(1) Compensation for moving	Myanmar
		(2) Land on lease for construction etc	
11.	Other Indirect Items	(1) Testing material cost in Irrigation Technology Center	Myanmar
		(2) Transportation cost for labors	
		(3) Labor management cost etc	

Source: JICA Survey Team

4.5.3 Project Cost

The project cost is firstly categorized into; 1) civil and structure construction works, 2) machineries procurement, 3) consulting services, 4) price escalation, 5) physical contingency, 6) administration cost, 7) VAT and import tax, and 8) interest during the construction. Note that land acquisition and compensation do not take place since all the works are to be managed within the existing project areas owned by the project owner, ID. Likewise, commitment charge usually applied under ODA loan is not enforced either for Myanmar.

In addition to the 1) civil and structure construction works and 2) machineries procurement, there are in fact other project components; namely, model farm construction and mini-hydro power establishment. From the discussions with ID and JICA, these 2 components are to be excluded from the loan components. Model farm construction may be included in a technical cooperation project, one of JICA's technical corporation schemes. ID is, on the other hand, planning to implement hydro-power component under a packaged grant assistance including other potential sites. Therefore, direct costs only are indicated for these 2 components separately from the above 1) to 8) components.

1) Construction Works

Main component of this Project is the rehabilitation for main canals & distribution canals of the 4 irrigation systems. Most of the existing main canals, except for those of Wegyi and Taung Nyo, were once clay-brick lined where at present there are many collapsed and eroded portions. Most of the existing distribution canals were not lined whereby there has happened a great amount of erosions along the distribution canals. In this Project, taking into account the deteriorated present situation, main canal slope & bed will be concrete-lined while distribution canal slope & bed will be cement-brick lined. Maintenance roads alongside the main canals will be concrete-paved and also the access road to the North Nawin dam is to be repaired using concrete paving.

The civil works are further categorized into; 1) preparatory works including survey and profiling works, establishment of temporary camps & stores, putting up of stock pile yards, site clearing, etc., 2) earth works such as canal bank raising and canal re-sectioning works, earth work filling and excavation, un-silting, etc., 3) repairing and construction of linings employing either concrete lining or brick lining, 4) repairing & reconstruction of such structures as drop, bridge, siphon, box culvert, etc., 5) road works made of concrete paving, gravelly clay laying work, etc., 6) repairing and construction of permanent buildings including guest house, meeting hall, office, etc., and 7) other related works e.g. repairing of heavy machines, management of construction materials, etc.

2) Machineries Procurement

Machineries should be procured through an international completive bidding (ICB). Since the rehabilitation works are urgently needed whereby so do the required machineries, one lot ICB is to be practiced. Taking into account the scale of the expected bidding, around US$ 15 million, one time package procurement can be established without difficulties from the potential suppliers. Major machineries are Hydraulic Excavator (Back-hoe), Track Dozer (Bulldozer), Hydraulic Breaker, Wheel Loader, Vibration Roller, Dump Truck, Workshop Equipments, etc.

3) Model Farm Establishment

Model farm establishment is planned one each at North Nawin and South Nawin irrigation systems. There are total 6 farmers and 16 farmers in each of the potential model farm areas of North Nawin and South Nawin irrigation systems with total land areas of 24 acre (9.7 ha) and 27 acre (11 ha) respectively. Activities to be demonstrated in these model farms are to be land consolidation together with on-farm irrigation and drainage establishment, farm road establishment, introduction of agriculture good practices, study tours, etc. This components is, however, excluded from the loan covering portions, so that the construction is to be arranged by ID while the demonstration of agriculture good practices by respective township DOA.

4) Small Scale Hydroelectric Generation

A small-scale hydropower generation is planned at a destroyed drop structure of the R.D. 18+900 canal of Taung Nyo irrigation system. Here, the maximum output is estimated at 180 kW under the conditions that the maximum discharge and effective head are 8.2 m^3/s and 3.19 m respectively. On

the assumption that unit electricity demand per household is from 150 W to 200 W, numbers of households supplied electricity are estimated at 900 to 1,200 households. The cost comes to around 460 million Yen including ICB procurement of the turbine and generator. This small scale hydroelectric plant is excluded from the project components covered by Yen loan.

5) Consulting Services

Consulting service is divided into Detailed Design and Construction Supervision. Consultant will conduct Detailed Design for Wegyi irrigation system and Taung Nyo irrigation System from year 2015 since the procurement of consultants will require almost 1-year starting from TOR preparation, PQ for potential consultants, issuing of request for proposal, preparation and submission of the proposal from the potential consulting firms, and selection of the consultants and its concurrence from JICA. Construction supervision by the procured consultant will begin from May 2015 in parallel with the detail design for the 2 irrigation systems. Construction supervision will take 3 years for each of the 4 irrigation schemes, namely totaling 5 years.

6) Project Cost and Construction Cost

Based on the above discussions, total project cost excluding the model farm establishment and mini-hydro power construction arrives at 16,477 million Yen (164,770 million Kyats) composed of 14,813 million Yen (148,130 million Kyats: 90%) for loan eligible portion and 1,664 million Yen (16,640 million Kyats: 10%) for non-eligible portion (see Table 4.5.3). By component, civil and structure construction shares the most; namely, 10,898 million Yen (108,980 million Kyats) all under loan eligible portion, which occupies 66% of the total project cost. What comes next is the cost of machineries procurement, which is estimated at 1,479 million Yen all eligible for loan, sharing approximately 9 % of the project cost. Concerning in-direct cost, administration shares the most as expected, reaching 1,481 million Yen (14,813 million Kyats) which is supposed to cover by ID.

Looking into detail of the civil and structure construction cost shown in Table 4.5.4, Summary of Civil and Structure Construction Cost, the civil and structure construction cost ranges from 1,799 million Yen (17,985 million Kyats) of North Nawin system to as much as 4,634 million Yen (46,337 million Kyats) of Wegyi irrigation system. Since the main canal and distributary canals of Wegyi need a huge amount of lining work, the cost goes very high followed by Taung Nyo irrigation system.

Table 4.5.3 Summary of the Project Cost

Breakdown of Cost	Foreign Currency (million JP Yen)			Local Currency (million Kyats)			Total (million JP Yen)			Rate (%)
	Total	Eligible Portion	Non Eligible Portion	Total	Eligible Portion	Non Eligible Portion	Total	Eligible Portion	Non Eligible Portion	
Civil & Structure Construction (NN)	885	885	0	9,132	9,132	0	1,799	1,799	0	10.92%
Civil & Structure Construction (SN)	1,047	1,047	0	8,871	8,871	0	1,934	1,934	0	11.74%
Civil & Structure Construction (Wegyi)	2,598	2,598	0	20,352	20,352	0	4,634	4,634	0	28.12%
Civil & Structure Construction (T. Nyo)	1,446	1,446	0	10,841	10,841	0	2,531	2,531	0	15.36%
Machineries Procurement	1,479	1,479	0	0	0	0	1,479	1,479	0	8.98%
Price Escalation	289	289	0	4,965	4,965	0	785	785	0	4.76%
Physical Contingency	387	387	0	2,708	2,708	0	658	658	0	3.99%
Consulting Services	466	466	0	594	594	0	526	526	0	3.19%
Land Acquisition	0	0	0	0	0	0	0	0	0	0.00%
Administration Cost	0	0	0	14,813	0	14,813	1,481	0	1,481	8.99%
VAT	0	0	0	1,783	0	1,783	178	0	178	1.08%
Import Tax	0	0	0	0	0	0	0	0	0	0.00%
Interest during construction	4	0	4	0	0	0	4	0	4	0.02%
Commitment Charge	0	0	0	0	0	0	0	0	0	0.00%
Model Farm Establishment	(11)	(11)	(0)	(46)	(46)	(0)	(15)	(15)	(0)	-
Mini-hydro power construction	(276)	(276)	(0)	(1,840)	(1,840)	(0)	(460)	(460)	(0)	-
Total	8,918	8,913	4	75,593	58,997	16,595	16,477	14,813	1,664	100.00%

Note: Costs for model farm establishment and mini-hydro power construction are excluded from the Total.

Table 4.5.4 Summary of Civil and Structure Construction Cost, million Kyats

No		Name of work	FC or LC*	North Nawin Irrigation System			South Nawin Irrigation System			Wegyi Irrigation System			Taung Nyo Irrigation System			Total	
				Main Canal	Distribution Canal	Total	Main Canal	Distribution Canal	Total	Main Canal	Distribution Canal	Total	Main Canal	Distribution Canal	Total	Cost	Rate
1		Preparatory Works	FC	0.000	64.090	64.090	0.840	98.376	99.216	2.734	55.779	58.513	2.897	11.085	13.982	235.801	1.52 (%)
			LC	0.000	466.385	466.385	7.561	338.096	345.657	2.540	486.080	488.620	23.102	96.935	120.037	1,420.699	
			Sub-total	0.000	530.475	530.475	8.401	436.472	444.873	5.274	541.859	547.133	25.999	108.020	134.019	1,656.500	
2		Earth Works	FC	0.000	385.567	385.567	11.919	594.041	605.960	79.929	981.441	1,061.370	66.052	193.500	259.552	2,312.449	4.31 (%)
			LC	0.000	1,920.111	1,920.111	106.917	226.814	333.731	27.266	51.655	78.921	42.575	10.184	52.759	2,385.522	
			Sub-total	0.000	2,305.678	2,305.678	118.836	820.855	939.691	107.195	1,033.096	1,140.291	108.627	203.684	312.311	4,697.971	
3		Repairing and Construction of Linings Works															
	a	Brick Lining works	FC	0.000	6,524.859	6,524.859	0.000	6,053.255	6,053.255	0.000	19,200.026	19,200.026	0.000	8,302.178	8,302.178	40,080.318	65.18 (%)
			LC	0.000	5,140.279	5,140.279	0.000	4,955.947	4,955.947	0.000	14,579.482	14,579.482	0.000	6,273.379	6,273.379	30,949.087	
			Sub-total	0.000	11,665.138	11,665.138	0.000	11,009.202	11,009.202	0.000	33,779.508	33,779.508	0.000	14,575.557	14,575.557	71,029.405	
	b	Concrete Lining works	FC	0.000	0.000	0.000	2,024.734	0.000	2,024.734	1,866.303	0.000	1,866.303	2,705.671	0.000	2,705.671	6,596.708	10.27 (%)
			LC	0.000	0.000	0.000	1,449.153	0.000	1,449.153	1,276.377	0.000	1,276.377	1,864.695	0.000	1,864.695	4,590.225	
			Sub-total	0.000	0.000	0.000	3,473.887	0.000	3,473.887	3,142.680	0.000	3,142.680	4,570.366	0.000	4,570.366	11,186.933	
4		Repairing & Reconstruction of Canal Structures	FC	0.000	514.707	514.707	0.000	477.654	477.654	19.904	1,486.766	1,506.670	1,377.854	531.791	1,909.645	4,408.676	7.24 (%)
			LC	0.000	493.604	493.604	0.000	343.933	343.933	21.970	1,100.146	1,122.116	1,174.339	349.202	1,523.541	3,483.194	
			Sub-total	0.000	1,008.311	1,008.311	0.000	821.587	821.587	41.874	2,586.912	2,628.786	2,552.193	880.993	3,433.186	7,891.870	
5		Pipe Installation Works (Outlet Conduit of Dam)	FC	300.000	0.000	300.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	300.000	0.37 (%)
			LC	100.000	0.000	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.000	
			Sub-total	400.000	0.000	400.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	400.000	
6		Road Works	FC	630.590	188.094	818.684	934.165	25.079	959.244	1,011.227	232.910	1,244.137	800.503	188.615	989.118	4,011.183	6.99 (%)
			LC	551.210	151.198	702.408	907.976	20.160	928.136	943.015	176.775	1,119.790	709.175	147.228	856.403	3,606.737	
			Sub-total	1,181.800	339.292	1,521.092	1,842.141	45.239	1,887.380	1,954.242	409.685	2,363.927	1,509.678	335.843	1,845.521	7,617.920	
7		Buildings for Maintenance Activities	FC	0.000	88.451	88.451	0.000	20.103	20.103	0.000	0.000	0.000	0.000	0.000	0.000	108.554	0.32 (%)
			LC	0.000	198.759	198.759	0.000	45.173	45.173	0.000	0.000	0.000	0.000	0.000	0.000	243.932	
			Sub-total	0.000	287.210	287.210	0.000	65.276	65.276	0.000	0.000	0.000	0.000	0.000	0.000	352.486	
8		Other Related Works	FC	0.000	157.158	157.158	25.775	205.360	231.135	243.400	804.307	1,047.707	284.736	0.000	284.736	1,720.736	3.80 (%)
			LC	0.000	110.390	110.390	72.922	396.467	469.389	1,568.472	118.619	1,687.091	150.268	0.000	150.268	2,417.138	
			Sub-total	0.000	267.548	267.548	98.697	601.827	700.524	1,811.872	922.926	2,734.798	435.004	0.000	435.004	4,137.874	
Total Cost			FC	930.590	7,922.926	8,853.516	2,997.433	7,473.868	10,471.301	3,223.497	22,761.229	25,984.726	5,237.713	9,227.169	14,464.882	59,774.425	100.00 (%)
			LC	651.210	8,480.726	9,131.936	2,544.529	6,326.590	8,871.119	3,839.640	16,512.757	20,352.397	3,964.154	6,876.928	10,841.082	49,196.534	
			Total	1,581.800	16,403.652	17,985.452	5,541.962	13,800.458	19,342.420	7,063.137	39,273.986	46,337.123	9,201.867	16,104.097	25,305.964	108,970.959	
Rate				16.51 (%)			17.75 (%)			42.52 (%)			23.22 (%)			100.00 (%)	

* FC : Foreign Currency, LC : Local Currency

4.5.4 Disbursement Plan

Disbursement of the fund should be made as per the construction schedule; namely, 1) North Nawin and South Nawin irrigation systems are to start the construction from year 2014 and need 3 years for the completion, and 2) Wegyi and Taung Nyo irrigation systems are to commence from year 2016 and need another 3 years to complete the required rehabilitation works. It means that the disbursement for the former 2 irrigation systems is from 2014 to 2016 while that of the later 2 systems is from 2016 to 2018. Note that machineries procurement is to be done in year 2014 to around mid 2015, so that the disbursement has to be made in these 2 years. Following tables show the summary and detail of the disbursement plan by year only for the loan eligible portions according to the construction and procurement schedule.

Table 4.5.5 Summary of the Annual Disbursement Plan of the Project

Fiscal Year	Foreign Currency (million JP¥)	Local Currency (million JP¥)	Total	Share by Year
2013-2014	1,402	8,523	2,254	15%
2014-2015	2,081	6,881	2,769	19%
2015-2016	2,344	19,835	4,328	29%
2016-2017	1,731	13,411	3,072	21%
2017-2018	1,355	10,348	2,390	16%
Total	8,913	58,997	14,813	100%

Note: Above amounts are only for loan eligible portions such as civil and structure construction, machineries to be procured, price escalation and physical contingency, while ID portions are not included.

Table 4.5.6 Detailed Annual Disbursement Plan of the Project

Item	2014			2015			2016			2017			2018			Total			Rate
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC*1	LC*2	Total Cost*3	
I) Procurement / Construction																			
Civil & Structure Construction (NN)	567	6,327	1,200	226	1,938	420	93	868	179	0	0	0	0	0	0	885	9,132	1,799	12.14 (%)
Civil & Structure Construction (SN)	159	1,546	314	431	3,445	775	457	3,880	845	0	0	0	0	0	0	1,047	8,871	1,934	13.06 (%)
Civil & Structure Construction (Wegyi)	0	0	0	0	0	0	995	8,577	1,852	859	6,388	1,498	745	5,388	1,284	2,598	20,352	4,634	31.29 (%)
Civil & Structure Construction (T.Nyo)	0	0	0	0	0	0	486	3,528	838	589	4,532	1,042	372	2,782	650	1,446	10,841	2,531	17.08 (%)
Machineries Procurement	591	0	591	887	0	887	0	0	0	0	0	0	0	0	0	1,479	0	1,479	9.98 (%)
Price escalation	17	244	42	40	339	74	80	1,616	242	77	1,418	219	75	1,347	209	289	4,965	785	5.30 (%)
Physical contingency	67	406	107	79	286	108	105	923	198	76	617	138	60	476	107	387	2,708	658	4.44 (%)
II) Consulting services																			
Base cost	0	0	0	387	783	465	118	385	157	118	385	157	93	290	122	716	1,842	901	6.08 (%)
Price escalation	0	0	0	10	49	15	5	37	8	6	50	11	6	48	11	27	184	46	0.31 (%)
Physical contingency	0	0	0	20	42	24	6	21	8	6	22	8	5	17	7	37	101	47	0.32 (%)
Total (I+II)	1,402	8,523	2,254	2,081	6,881	2,769	2,344	19,835	4,328	1,731	13,411	3,072	1,355	10,348	2,390	8,913	58,997	14,813	100.00 (%)
	15.22 (%)			18.69 (%)			29.22 (%)			20.74 (%)			16.13 (%)			100.00 (%)			

*1 FC : Foreign Currency (million JP Yen)

*2 LC : Local Currency (million Kyats)

*3 Total Cost: million JP Yen

4.6 Operation and Maintenance of the Project

4.6.1 Operation of the Project

The objectives of irrigation system operation are to distribute irrigation water to the irrigable area as broadly and equitably as possible and to supply water to farmland in time according to crops' growth. There are two major types of operation; one is operation at the reservoir and the other one is operation at each mouth of distribution canals.

The operation at reservoir depends on rainfall and runoff from the respective catchment area. If rich rain and runoff are obtained during rainy season, reservoir will be operated fully from full water level to low water or minimum operation level. There is one particular case in Wegyi reservoir. Since overflow from spillway sometimes causes rural road inundation at downstream villages, Irrigation Department sometimes releases water from intake facility and diverts and drains it to natural stream but not Wegyi river during rainy season. Except such special operation, operation at reservoir is carried out based on a monthly irrigation plan. In particular year, there may be sometimes a special requirement from farmers.

Gate operation along canals plays important and significant parts of the operation at each mouth of distribution canals, which are located along the main canals. Since main canal length is long, assignment arrangement for gate keepers shall be well examined based on real gates' intervals. Malfunction gates are found at many places along main canals at present and it seemed to have been destroyed by somebody. In order to protect gates from uncertain damage and/or inappropriate handling, a balanced assignment arrangement for the gate keepers shall be examined and planned by the Irrigation Department.

The monthly irrigation plan is formulated by a committee, which is composed of representatives from District Administration Office, Irrigation Department (District), Department of Agriculture (District), and Settlement and Land Records Department (District). At the end of rainy season, the first committee is held, which discusses about cropping plan and to-be-irrigated area. Based on the cropping plan and area, irrigation demand and monthly irrigation plan are decided. In the former government, this committee had to follow a targeted GDP growth of area as well as a targeted paddy cultivation area coupled with targeted production. After having changed to the present government, this obligation is eliminated, and real irrigation demands are discussed and reasonable irrigation plans can be formulated.

There is sometimes a special irrigation requirement from farmers when draught or less rain occurs. In such case, farmers request their village chairman and the village chairman requests to the township administration office. Chairman of the township administration office starts to confirm shortage of irrigation water within the township and grasps real situation that how many villages and acreage are really going to be affected.

Then, the township chairman goes to the relevant district administration office to request irrigation water release from the respective dam reservoir based on a survey conducted in advance. Chairman of the district administration office calls representatives from townships under irrigable areas to confirm the fact, at which farmers are facing. Eventually, the chairman of the district administration office requests Irrigation Department (District) to release water for crop survival and Irrigation Department (District) will supply water by available volume.

4.6.2 Maintenance of the Facilities

As aforementioned, current budget has been applied to maintenance works but total amount of maintenance budget was not adequate over long period under the former government. Maintenance

Division (West Bago) could have employed much more number of permanent labors according to a regulation of Irrigation Department. Canal maintenance worker is one of the major permanent employments but total number of the workers actually applied is limited only 80, who are allocated for 7 irrigation systems under the assistant director office (Pyay). Only average 11 workers for 1 irrigation system seem to be quite few; for example, North Nawin irrigation system has 71 km of main canal and 442 km of distribution canals. Actually, the assistant director office (Pyay) has been permitted by Irrigation Department head office to employ 200 maintenance labors for a canal system but they cannot have done so because of shortage of budget allocation.

According to Maintenance Division (Bago West), they have no experiences of adequate budget allocation to date but they are sure that they can manage common maintenance if given enough budget. If the common maintenance can be done well continuously by year, there is not so much necessity for major or heavy maintenance works on irrigation systems. Field observation by the Survey Team has also identified that the main cause for necessity of major rehabilitation is the deficiency of common maintenance activities, which in fact do not require high technology or special equipment but require ordinary works and equipment.

After completion of major maintenance works under the Project, three methods can be considered for common maintenance works to avoid inadequate performance; one is to increase budget for this purpose, second is to employ rotation maintenance system by year, and third one is to turn-over some maintenance works and their responsibilities from Irrigation Department to beneficiary farmers including operation works. Budget increase is uncertain and rotation maintenance cannot cope with accidental and/or irregular needs of maintenance. Thus, partial turn-over of works will be a realistic and practical direction for future maintenance activities (see the discussion in Chapter 3.8). Then, to accomplish such partial turn-over of responsibilities and works, technical assistances will play an important role at its initial stage for the Project.

4.7 Proposed Indicators for Project Operation and Effects

Several numbers of indicators are considered and proposed for the irrigation systems upon rehabilitation as follows:

- ✓ Cultivated area by crops (operation indicator),
- ✓ Production volume of major crops (effect indicator),
- ✓ Yield of major crops per unit area (effect indicator), and
- ✓ Vehicle operation cost saving (effect indicator)

Monsoon paddy is cultivated throughout project area but summer paddy and black gram are limited where irrigation water is available in dry season. There is not much potential for monsoon paddy increase of cultivated area while summer paddy and black gram, especially black gram, have much potential of area increase by the project. As aforementioned, cultivated area in 2012-2013 represents the current situation, and therefore the proposed base values of this indicator are shown below:

Table 4.6.1 Proposed Base Indicators on Cultivated Area by Crops (Unit: acre)

Irrigation Systems	Monsoon Paddy	Summer Paddy	Black Gram
North Nawin	53,168.54	9,397.34	8,929.42
South Nawin	72,708.66	6,814.58	14,252.87
Wegyi	40,428.42	16,634.74	23,678.37
Taung Nyo	49,981.31	4,639.91	19,266.60
Total	216,286.93	37,486.57	66,127.26

Source: Irrigation Department, the Survey Team (2013)

There are currently 3 major crops in the project area and those crops' production in total is prospected to increase after project implementation. Crop production coupled with cultivated area increase will

directly contribute to raise farm income and food production. Currently, Myanmar can produce enough food for self-consumption, so that 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 for this indicator are shown as follows.

Table 4.6.2 Proposed Base Indicators on Production Volume of Major Crops (Unit: Ton)

Irrigation Systems	Upper Area	Middle Area	Lower Area
Monsoon Paddy	104,555	77,973	59,778
Summer Paddy	18,178	13,277	17,052
Black Gram	18,628	13,840	3,006

Source: Irrigation Department, the Survey Team (2013)

A field study has identified significant gaps of yields of major crops in the project area and it means there is potential to increase yield in some areas 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. A technical assistant project will be one of appropriate methods to accomplish yield increase, so that such project shall be implemented just after finishing canal rehabilitation. Proposed base data for this indicator are shown as follows.

Table 4.6.3 Proposed Base Indicators on Yield of Major Crops (Unit: ton/ha)

Irrigation Systems	Upper Area	Middle Area	Lower Area
Monsoon Paddy	2.85	2.45	3.13
Summer Paddy	3.07	2.80	3.77
Black Gram	1.27	1.56	0.81

Source: Irrigation Department, the Survey Team (2013)

Transportation plays important roles in farming activities. There are three major transportation methods in the Project area; one is transportation by labor, second is transportation by bull-cart, and third one is transportation by tolloergyi, a cart with a small engine. Harvesting period of summer paddy is usually at the beginning of rainy season and earthen road becomes muddy and sometimes swampy in this period.

To cope with above situation, farmers have to employ labors to transport their harvest from farmlands to major roads. If road is upgraded, farmers will use trolloergyi as close as possible to their farmland. Then, some labor cost can be saved. Road upgrade can also contribute to reduce fuel consumption of trollergyi, and therefore the transportation cost for harvest and farm input can be reduced for farming of all crops. Transportation cost saving will accrue on farm input mainly for fertilizer and harvest (grain for paddy, stalk with grain for black gram). Following table summarizes the cost saving for each crop with the road upgrading.

Table 4.6.4 Proposed Base Indicators of Transportation Cost Saving by Road Upgrading (Kyat/acre)

Irrigation Systems	Monsoon Paddy	Summer Paddy	Black Gram
Input/Stalk Transportation	4,430	4,430	9,303
Grain Transportation	60,000	60,000	-

Source: Irrigation Department, the Survey Team (2013)

CHAPTER 5 PROJECT EVALUATION

This chapter carries out project evaluation by examining a project feasibility in terms of investment based on the benefit accrued by the project and the project cost to be invested. To judge the feasibility, EIRR (Economic Internal Rate of Return) is basically employed in this project evaluation, and also NPV (Net Present Value) as well as B/C ratio (Benefit-Cost ratio) are to be estimated.

5.1 Condition of Economic Evaluation of the Project

The proposed Project is to rehabilitate 4 irrigation systems such as North Nawin, South Nawin, Wegyi and Taung Nyo irrigation systems. The major component is to rehabilitate main and distributary canals of the 4 irrigation systems in order to make the water reach down to the terminal points of those canals. To accelerate the work, machineries are to the procured, one of the investment. In addition, road improvement and pavement are also planned under the Project. Given these investment, the systems are to produce more agricultural products and also reduce the transportation cost of those products, which are the major benefits. The following are the basic assumptions of the economic evaluation:

1) Referring to other similar projects in the irrigation/agriculture sector, the economic life of the Project is designed at 30 years. It means that economic 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, 0.3% of the initial investment cost is counted as the base case, and in addition, as a sensitivity analysis, 3% O&M cost is also examined.
2) 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 therein with reference to practices that the World Bank, ADB and JICA have done so far in the sector of irrigation/agriculture development over 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.
3) 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.
4) Prices employed in the evaluation refer to the prevalent market ones in year 2013. After having collected those market prices, 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 FOB, CIF cost/prices and import and export duties have been examined to establish such factors, presenting the following factors:

Table 5.1.1 Applied Conversion Factors

Particulars	Factor	Remarks
Standard Conversion Factor (SCF)	0.990	Based on export/ import & duties for 2010/11 – 2012/13
Pulses	1.070	Estimated based on FOB at Yangon Port
Rice	0.784	ditto
Fertilizer	0.770	Estimated based on CIF at Yangon Port
Agricultural Inputs	0.770	Assumed same as fertilizer
Skilled Labor	1.000	Assumed placed under competitive market
Unskilled Labor/ Family labor	0.600	Assumption with reference to rural unemployment

Source: JICA Survey Team

5.2 Cases for Project Evaluation

5.2.1 Base Cases for Project Evaluation

Table 5.2.1 shows the cases to examine the project economic variability; namely, there are 5 cases in total. Base 0 takes into account only the area expansion of black gram as the project benefit, not considering other benefits such as the benefit from road improvement and yield increase. Base 1

considered, on top of Base 0, the benefit accrued from road improvement as reduction of fuels for transporting agricultural products. Base 2 further considers, on top of Base 1, the remaining value of procured machineries after having completed the use in the project. For these 3 basic cases, no yield increase is counted but area expansion of black gram only for a direct agriculture related benefit.

Aside from the basic 3 cases, there are 2 more cases; Case Ext. Service takes into account yield increase both for rice and black gram given an appropriate extension services supported by a team of experts, e.g. a team of technical cooperation project. The level of the yield increase for paddy refers to the outcomes from a pilot project implemented udder a JICA development study[1]. The level of the increase applied is 15% and 13% for monsoon paddy and summer paddy respectively. As for the black gram, yield is assumed to increase to the midstream one, which is the highest one amongst the 3 locations of upstream, midstream and downstream.

Last case, Case Road Only, undertakes the project cost of road improvement only and the benefit to be accrued from the road improvement only. The benefit is estimated how much transportation cost will be reduced with the improvement of the road mainly by the reduction of the fuel cost for Trollergyi, a common transportation mean mounted with tractor diesel engine. Note that though road improvement will facilitate rural transportation whereby enhancing rural economy as a whole, this benefit is not counted since it is difficult to estimate such benefit.

Table 5.2.1 Cases for Project Evaluation

Case	Monsoon Paddy	Summer Paddy	Black Gram	Remarks
Base 0	Yield not changed	Yield not changed	Yield not changed	Benefit from road improvement not considered.
	Area not changed	Area not changed	Area to expand by 117,243ac (47,446ha)	
Base 1	Yield and Area same as Base 0			Benefit from road improvement considered.
	In addition to Base 0, benefit from road improvement considered.			
Base 2	Yield and Area same as Base 0			Road benefit and machineries' remaining value considered.
	In addition to Base 1, remaining value of procured machineries considered.			
Ext. Service	Yield increase by 15%*1	Yield increase by 13%*1	All yields to the MD*2 (highest) one	Road benefit and machineries' remaining value NOT considered.
	Area not changed	Area not changed	Area to expand by 117,243ac (47,446ha)	
Road Only	Cost for road improvement only considered with the benefit from the road improvement only			Only for road cost/benefit

Note; *1 Yield increases were recorded by the pilot project under Development Study on Sustainable Agricultural and Rural Development for Poverty Reduction Programme in the CDZ, July 2010
*2 Yield of black gram for midstream area (MD) is 20.5 basket/acre while those of upstream and downstream are 15.7 and 10.1 basket per acre respectively (Source: Household Questionnaire Survey, 2013 by JICA Survey Team

5.2.2 Cases for Sensitivity Analysis

Aside from above basic cases, there should be a sensitivity analysis to know to what extent the project variability is affected by such factors as hike of construction cost, reduction of benefit, delay of construction schedule whereby delaying the benefit to take place, etc. Table 5.2.2 shows the cases of sensitivity analysis where total 5 cases are to be examined against a base case, which is Base 1 where the benefits from area expansion of black gram and road improvement are taken into account. The 5 cases are; cost increase by 10%, benefit reduction by -10%, cost increase together with benefit reduction of each 10%, construction delayed by 2 years, and increase of O & M cost to 3% from the base 0.3% of the initial investment cost:

[1] Development Study on Sustainable Agricultural and Rural Development for Poverty Reduction Programme in the Central Dry Zone, 2006 – 2010

Table 5.2.2 Cases for Sensitivity Analysis (against Base 1)

Case	Cost	Benefit	Base Cost and Benefit	Remarks
SA 1 (C+10%)	+10%	No change	Base 1	
SA 2 (B-10%)	No Change	-10%	Base 1	
SA 3 (C+10B-10)	+10%	-10%	Base 1	
SA 4 (+2years)	Construction delayed by 2 years		Base 1	
SA 5 (O&M 3%)	No Change	No change	Base 1	0.3% for base O&M

Source: JICA Survey Team

5.3 Project Costs and Benefits and those Converted Values

5.3.1 Project Costs and Converted Economic Values

The Project has proposed to rehabilitate the 4 irrigation systems together with necessary engineering services and procurement of construction machineries. Total Project including contingencies, project management, miscellaneous and O& M (3% of the direct cost) is now estimated at 165,429 million Kyats at financial price, composed of foreign portion (FC) of 85,810 million Kyats and local portion (LC) of 79,619 million Kyats. As per the economic price, the total comes to 159,027 million Kyats composed of FC 85,810 million Kyats and LC 73,216 million Kyats. Concerning civil and structure construction cost, so-called direct cost, by irrigation system, Wegyi system shows the largest cost as 46,337 million Kyats for FC and 43,688 million Kyats for LC, followed by Taung Nyo, and South Nawin and lastly North Nawin.

Table 5.3.1 Financial and Economic Project Costs, '000Kyats

Particulars	FINANCIAL PRICE			ECONOMIC PRICE		
	FC ('000Kyat)	LC ('000Kyat)	Total ('000Kyat)	FC ('000Kyat)	LC ('000Kyat)	Total ('000Kyat)
North Nawin	8,853,517	9,131,937	17,985,454	8,853,517	7,502,789	16,356,306
South Nawin	10,471,300	8,871,117	19,342,417	10,471,300	7,635,235	18,106,535
Wegyi	25,984,725	20,352,398	46,337,123	25,984,725	17,703,744	43,688,469
Taung Nyo	14,464,884	10,841,082	25,305,966	14,464,884	9,972,119	24,437,003
Total of Above	59,774,426	49,196,534	108,970,960	59,774,426	42,813,887	102,588,313
Machineries Procurement	14,785,510	147,855.1	14,933,365.1	14,785,510	146,376	170,713,785
Engineering Service (DD)	2,838,040	729,824	3,567,864	2,838,040	722,526	3,560,566
Engineering Service (SV)	4,326,290	1,112,540	5,438,830	4,326,290	1,101,415	5,427,705
Physical Contingency (5%)	4,086,213.3	2,559,337.7	6,645,551.0	4,086,213.3	2,559,337.7	6,645,551
Project Management (10%)		10,897,096	10,897,096.0		10,897,096.0	10,897,096
Others (Miscellaneous) (5%)		5,744,258	5,744,258		5,744,258	5,744,258
O&M (0.3%)		9,231,226	9,231,226		9,231,226	9,231,226
Total	85,810,479	79,618,671	165,429,150	85,810,479	73,216,122	159,026,601

Source: JICA Survey Team

Disbursement of the rehabilitation cost is divided over 3 years for each of the 4 irrigation systems and the procurement of construction machineries over 2 years. The disbursement is scheduled to start from year 2014 for North Nawin and South Nawin irrigation systems while the remaining 2 systems of Wegyi and Taung Nyo are to start from year 2016, upon completion of the detailed design. The disbursement of the detail design is planned in year 2015, meaning during year 2015 the selection of the consultants are to be made. Disbursement of the machinery procurement is scheduled in year 2014 and 2015. Other costs such as supervision by consultants, contingencies, miscellaneous, and O&M are to incur according to the progress of the construction and operation.

5.3.2 Project Benefits and Converted Economic Values

Table 5.3.2 summarizes the project benefit by irrigation system accrued in a year after completion of the rehabilitation works. The benefits are summarized by such cases of; benefit accrued by area

expansion of black gram (no yield increase) corresponding to Base 0 (refer to Table 5.2.1), benefit associated with road improvement corresponding to Base Road Only, combination of these 2 benefits (Base 1), benefit or counted as minus cost for the remaining value of the procured construction machineries which accrues one time in the following year of the construction completion (part of Base 2 benefit), and benefits which are expected with technical assistances targeting yield increase corresponding to the case of Ext. Service.

Table 5.3.2 Financial and Economic Project Benefits, '000Kyats

Particulars	North Nawin	South Nawin	Wegyi	Taung Nyo	Total
FINANCIAL PRICE ('000 Kyats)					
1. Agriculture Production *1	5,692,712	8,696,585	369,657	3,739,194	18,498,149
2. Road Improvement *2	192,632	215,183	1,284,633	1,441,516	3,133,963
3. Black Gram + Road Improvement	5,885,344	8,911,767	1,654,291	5,180,710	21,632,112
4. Remaining Machineries Value	7,320,111				7,320,111
5. Ext. Service	7,664,040	11,881,902	10,466,036	6,226,693	36,238,671
M-Paddy	4,944,875	7,315,882	4,121,669	1,695,319	18,077,744
S-Paddy	699,707	1,462,419	1,109,387	275,747	3,547,260
Black Gram	2,019,458	3,103,602	5,234,980	4,255,627	14,613,666
ECONOMIC PRICE ('000 Kyats)					
1. Agriculture Production *1	7,166,753	11,706,649	503,737	4,833,729	24,210,868
2. Road Improvement *2	148,029	213,166	1,271,787	1,427,100	3,060,082
3. Black Gram + Road Improvement	7,314,782	11,919,814	1,775,524	6,260,830	27,270,950
4. Remaining Machineries Value	7,246,910				7,246,910
5. Ext. Service	6,648,095	10,591,617	10,508,589	9,279,506	37,027,807
M-Paddy	3,859,592	5,873,535	3,419,459	3,940,552	17,093,138
S-Paddy	421,371	896,780	702,199	174,835	2,195,186
Black Gram	2,367,132	3,821,302	6,386,930	5,164,119	17,739,483

Remarks: *1 family labor cost is considered (subtracted from the gross benefit). *2 benefit accrued from fuel reduction for transportation machineries. Source: JICA Survey Team

Total benefit accrued annually by the expansion of black gram arrives at 18,498 million Kyats for financial price and 24,211 million Kyats for economic price, of which the benefit from South Nawin shows the highest one, 8,697 million Kyats, while the one from Wegyi bears the lowest[2]. Total benefit from road improvement is estimated at 3,134 million Kyats and 3,060 million Kyats for financial and economic values respectively. The remaining value for the construction machineries is estimated at 7,320 million Kyats and 7,247 million Kyats for financial and economic values respectively. Under the case where extension services are to be introduced to increase the yields, annual total benefit is expected to arrive at 36,239 million Kyats and 37,028 million Kyats for financial and economic terms respectively.

Above benefits are scheduled to take place according to the completion ratio of rehabilitation works, which means that at the 4th year from the commencement of rehabilitation works, full benefit is to occur (rehabilitation works are to complete at the 3rd year) except for the remaining value of construction machineries. The remaining value of the construction machineries is counted in the following year of the completion of all the works. As for the benefits associated with the Ext. Service, it is planned to reach the expected full level at the following year of the completion of the technical assistances, meaning 6th year from the commencement of the technical assistances.

[2] Agricultural benefit of the black gram expansion for Wegyi irrigation system is only 369,657,000 Kyats, which is less than one-tenth as compared with other 3 irrigation systems. This is because that the Wegyi irrigable area is planted much with summer paddy and therefore there is little water which can be re-allocated for the expansion of back gram. In fact, the summer paddy's area for Wegyi is 16,635 acre (40,428acre, 41%) while those of N. Nawin, S. Nawin and Taung Nyo are 9,397 acre (53,169acre, 18%), 6,815 acre (72,709acre, 9%), 4,649 acre (49,981acre, 9%) as of the base year of 2012-2013. Note that the numbers in brackets are the total net irrigable areas of the irrigation systems.

5.4 Results of the Project Economic Evaluation

Table 5.4.1 shows the results of the economic analysis; EIRR shows up over 15% in all the cases including the Base 0 where only area expansion of black gram is counted as the project benefit. By case, the minimum EIRR shows up in Base 0 as 19.4%, and then Base 1 shows 22.2% up by 2.8% from the Base 0 by undertaking the benefit from road improvement. By considering the remaining value of procured machineries, not much hike in EIRR takes place as indicated in Case Base 2, only 0.7% top up on the Base 1.

If discharging extension services, relatively high return is expected as 22.8 % as indicated under case Ext. Service even without considering the benefit of road improvement and remaining value of the machineries. Road improvement generates the highest return, though the scale of the NPV is not much large as compared with other cases since only fuel reduction is counted as the project benefit. B/C ratios are in all the cases higher than 1.0, justifying the investment.

Table 5.4.1 Summary of the Project Evaluation Analysis

Cases	Financial Price/Cost			**Economic Price/Cost**		
	FIRR	NPV (M Kyats)	B/C	**EIRR**	**NPV, (M Kyats)**	**B/C**
Base0	12.7%	4,948	1.04	19.4%	48,894	1.48
Base1	15.3%	24,089	1.22	22.2%	67,176	1.66
Base2	15.9%	27,797	1.26	22.9%	71,016	1.72
Ext. Service	17.0%	38,299	1.34	22.8%	78,645	1.73
Road Only	32.9%	11,290	2.45	32.6%	11,100	2.42

Source: JICA Survey Team

Table 5.4.2 summarizes the results of the sensitivity analysis against the case Base 1. Base 1 has generated a high return of 22.2% as indicated in the EIRR above, and this EIRR never goes down below 15% under all the 5 sensitivity analysis cases. Therefore, it is concluded that the project investment still keeps viability under such cases of 10% increase of cost, 10% reduction of benefit, both events taking place, 2 years construction delay, and even with 3% cost in O&M against the initial investment cost. All these results conclude that the Project should be viable under the planned investment, whereby the project owner, ID, be recommended to invest.

Table 5.4.2 Cases for Sensitivity Analysis (against Base 1: EIRR 22.2%)

Cases	Cost	Benefit	Economic Price/Cost		
			EIRR	NPV (M Kyats)	B/C
SA 1 (C+10%)	+10%	No change	19.9%	57,188	1.51
SA 2 (B-10%)	No change	-10%	19.6%	50,270	1.49
SA 3 (C+10%, B-10%)	+10%	-10%	17.5%	40,282	1.36
SA 4 (+2years)	Construction delayed by 2 years		16.2%	24,278	1.24
SA 5 (O&M 3%)	No change	No change	19.5%	49,117	1.41

Source: JICA Survey Team

5.5 Farm Budget Analysis: Income Increase per Farmer Household with Project

Above discussion centered on the project economic justification from the view point of what extent the project contributes to in the national economy. As concluded, the Project was justified by showing high return of investment, higher than the opportunity cost of 12-15% applied in most of developing countries. Here in this section, the extent of how the project benefits in the beneficiary's income is explored by comparing the net income between the present (without-project) and the after the project has been completed (with-project).

To explore the change with project at the level of farmer household, we should establish a model farmer's farm budget. To know the model farm budget, a typical average farmer's agricultural income should be estimated. In the project economic analysis as discussed before, current net agricultural

benefit and the benefit with project (both in financial term) have been estimated at the level of irrigation system, and the present and with-project benefits can further be calculated by the location where the farmers do farming such as upstream, midstream and downstream.

The upper part of Table 5.5.1 summarizes the net benefits without- and with-projects, which are shown by irrigation system and further by location. As for the number of farmer households, there is no data available. However, a sample household survey conducted by JICA team, which had covered 225 households, has made out the area of farmlands of the sampled farm households. Dividing the irrigation scheme's irrigable area by the farmland area, already averaged by scheme and by location, we can estimate the number of famers (see the mid part of Table 5.5.1).

Table 5.5.1 Farm Budget Analysis (Farm Net Benefit Increase per Farmer)

Particular	N. Nawin	S. Nawin	Wegyi	T. Nyo	Total
Net Benefit without Project (Kyats)	9,382,466,365	12,602,248,547	11,294,887,739	10,611,688,279	43,891,290,930
Upstream Benefit (Kyats)	5,086,780,059	5,858,977,188	5,497,082,916	3,693,616,741	20,136,456,904
Midstream Benefit (Kyats)	4,295,686,306	3,139,858,430	2,773,005,601	4,331,450,892	14,540,001,229
Downstream Benefit (Kyats)	0	3,603,412,929	3,024,799,222	2,586,620,646	9,214,832,797
Net Benefit with Project (Kyats)	14,982,533,756	23,136,984,480	11,735,472,055	15,992,839,829	65,847,830,120
Upstream Benefit (Kyats)	6,869,877,048	8,939,575,277	5,893,990,715	5,286,424,648	26,989,867,688
Midstream Benefit (Kyats)	8,112,656,708	8,707,962,035	2,773,005,601	7,018,052,940	26,611,677,284
Downstream Benefit (Kyats)	0	5,489,447,168	3,068,475,739	3,688,362,241	12,246,285,148
Net Irrigable Area (acre) 1/	53,168.54	72,708.66	40,428.42	49,981.31	216,286.93
Upstream Area (acre)	27,679.15	26,886.33	19,455.36	16,611.77	90,632.61
Midstream Area (acre)	25,489.39	23,949.60	10,096.25	18,988.74	78,523.98
Downstream Area (acre)	0	21,872.73	10,876.81	14,380.80	47,130.34
Average Farmland (acre/FHH 2/	12.72	8.28	8.01	9.28	9.91
Upstream Area (acre/FHH)	9.90	8.22	5.50	11.48	8.89
Midstream Area (acre/FHH)	18.23	9.30	9.37	8.15	12.06
Downstream Area (acre/FHH)	10.03	7.31	9.17	8.22	8.77
No. of FHHs	4,180	8,781	5,047	5,386	23,394
No. of FHHs (upstream)	2,796	3,271	3,537	1,447	11,051
No. of FHHs (midstream)	1,398	2,575	1,078	2,330	7,381
No. of FHHs (downstream)	0	2,992	1,186	1,749	5,928
Per Farmer Household	N. Nawin	S. Nawin	Wegyi	T. Nyo	Total
Net Benefit without Project (Kyats/FHH)	2,244,654	1,435,133	2,237,833	1,970,266	1,876,152
Upstream Benefit (Kyats/FHH)	1,819,388	1,791,274	1,554,017	2,552,571	1,822,127
Midstream Benefit (Kyats/FHH)	3,072,273	1,219,256	2,573,536	1,859,066	1,969,963
Downstream Benefit (Kyats/FHH)	NA	1,204,283	2,550,142	1,478,501	1,554,516
Net Benefit with Project (Kyats/FHH)	3,584,410	2,634,820	2,325,125	2,969,381	2,814,694
Upstream Benefit (Kyats/FHH)	2,457,149	2,733,110	1,666,222	3,653,323	2,442,285
Midstream Benefit (Kyats/FHH)	5,802,168	3,381,436	2,573,536	3,012,160	3,605,502
Downstream Benefit (Kyats/FHH)	NA	1,834,607	2,586,965	2,108,251	2,065,913
Ratio b/t with & without Project (%)	160	184	104	151	150
Upstream Area (%)	135	153	107	143	134
Midstream Area (%)	189	277	100	162	183
Downstream Area (%)	NA	152	101	143	133

Note: the downstream area of North Nawin is supplied with irrigation water by South Nawin irrigation system, and therefore the downstream area of North Nawin is counted at Nil producing no benefit therein but counted in the benefits of South Nawin.
Source; 1/Irrigation Department, 2/ Sample Survey (225 households), JICA

With the estimated number of famers by system and by location, a typical average famer's benefit can now be calculated by dividing the net benefits for with- and without-projects with the number of farmers. The results are summarized in the bottom part of Table 5.5.1. As shown, a typical average farmer at present, namely without project, fetches net income ranging from 1.2 million Kyats (downstream of South Nawin) to 3 million Kyats (midstream of North Nawin) with an overall average net income of 1.88 million Kyats.

The net income of 'with-project' would increase to a range of 1.7 million Kyats (upstream of Wegyi)

to as much as 5.8 million Kyats (midstream of North Nawin) with an overall average net income of 2.81 million Kyats. It is by percentage concluded that the net income per farmer household would increase by 104% (Wegyi) to as much as 184% (South Nawin) by irrigation system with an overall increase of 150%. With the project, overall farmer's income would therefore increase by 1.5 times, presenting a great impact on the beneficiary farmers' income.

CHAPTER 6 ENVIRONMENTAL AND SOCIAL CONSIDERATION

This chapter explores impacts on the environmental and social issues, which may be caused by the project for rehabilitation of the 4 irrigation systems. It starts with confirmation of regulatory settings in Myanmar concerning environmental examination, and discusses areas/issues to be affected by the project implementation, the impacts including both negative and positive ones, and then mitigation measures and also monitoring plans are to be presented with an environmental checklist.

6.1 Legislative and Institutional Framework of Environmental Consideration in Myanmar

In Myanmar, a draft procedure of the environmental assessment has been formulated as shown in the figure right in 2013. In line with the procedure, the project implementer is supposed to prepare for EIA report in case that the project is to cause a significant environmental impact, and submits it to the Ministry of Environmental Conservation and Forestry, under which Environmental Conservation Committee will review the report and take the charge of issuing the approval for project implementation. In fact, rule, regulation and environmental quality standard are now under preparation in the Ministry of Environmental Conservation and Forestry, and it is said to be submitted to the parliament for approval in late 2013 according to the Environmental Conservation Department, Ministry of Environmental Conservation and Forestry. According to the draft, rehabilitation project is not to be included in the category of projects which require the EIA procedure in Myanmar.

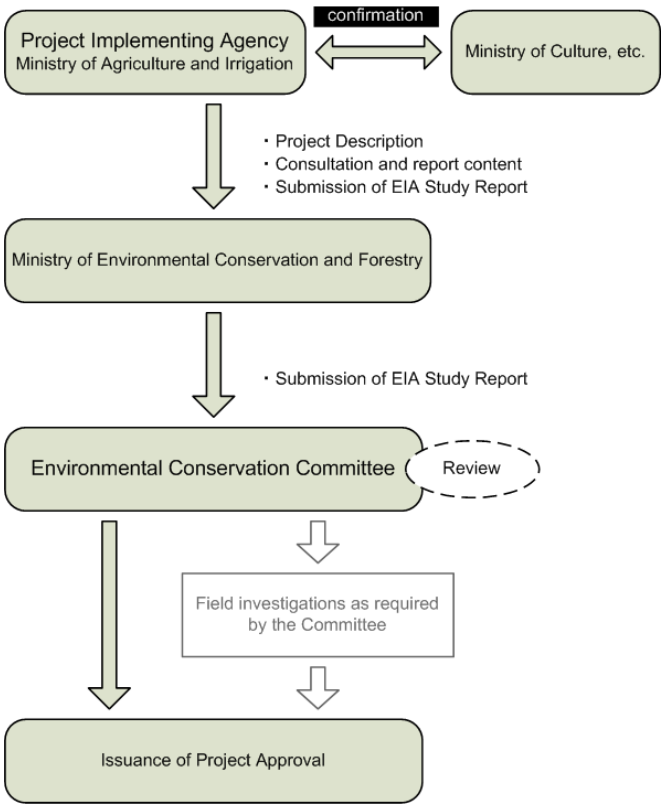


Figure 6.1.1 Procedure of Environmental and Social Considerations (Plan)

Aside from the on-going movement concerning EIA legal setting up, the current environmental law is executed based on; 1) the Environment Conservation Law, the Pyidaungsn Law No.9/2012 (30 March 2012), 2) the Protection and Preservation of Cultural Heritage Regions Law (10 September 1998), and 3) the Law amending the Protection and Preservation of Cultural Heritage Regions Law (20 January 2009). This current Environment Conservation Law dose not stipulate EIA requirement concerning rehabilitation projects, and these laws do not mention about detail rule and regulation such as examination of scoping and alternatives of proposed project either.

This current Law only stipulates that those projects which may cause a ‘significant impact’ on the environment require EIA procedure and its approval. Rehabilitation works envisaged under the Project will not entail ‘significant negative impact’ on the environment; hence EIA procedure with its official approval for the Project by the Myanmar relevant authority will not be required. However, to know the extent of the scale and size of the environmental impacts beforehand the project implementation, JICA survey team carries out environmental and social examination based on the JICA Guidelines for Environmental and Social Considerations (April 2010).

6.2 Environmental and Social Consideration

6.2.1 Current Environmental and Social Conditions

Figure 6.2.1 shows the location of the 4 project sites for the rehabilitation of irrigation systems (the Project). The project area spreads in the eastern bank side of the Ayeyarwaddy river, and covers a total area of around 216,300 acre (87,500 ha) wherein there are as many as around 23,400 beneficially households estimated, equivalent to about 117,000 population. The project area lies in north latitude from 18.2 degrees to 19.2 degrees and east longitude from 15.3 degrees to 96.3 degrees. Above mean sea level of the area ranges from 45m to 60m, presenting relatively low altitude.

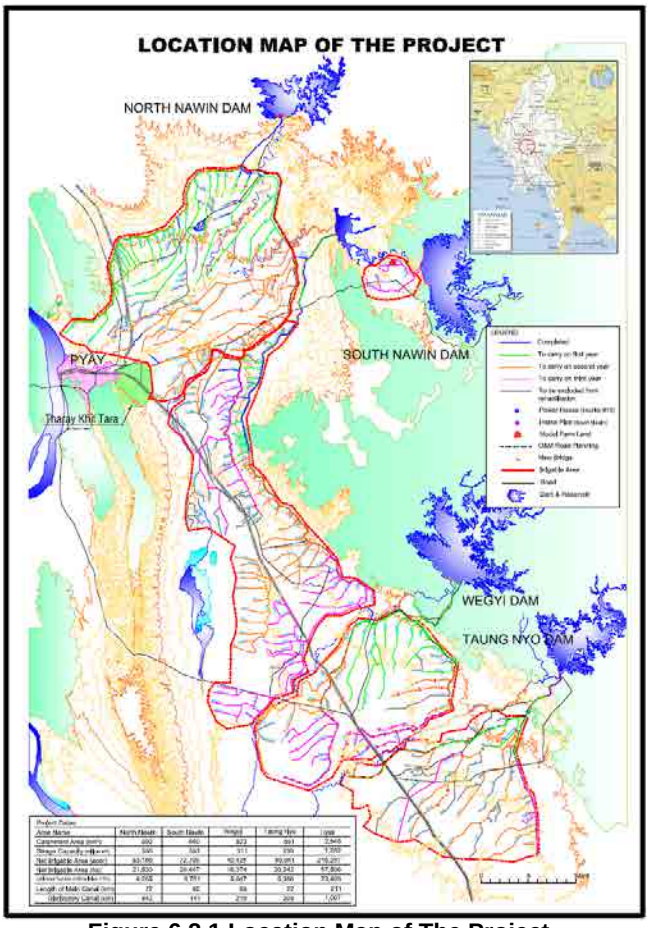


Figure 6.2.1 Location Map of The Project

1) Current Environment

The irrigation systems start with 4 reservoir dams, and the command area spreads towards lower elevation approaching to the great Ayeyarwaddy river. North Nawin irrigation project, one of the 4 irrigation systems, encompasses Pyay city, the capital Bago regional division. The project area does not belong to military zone, politics zone, and hotel zone. There is a national park called Pegu Yomas located at an east-southern direction from the irrigation systems (see Figure 6.2.2). This national park, a designated natural conservation area by the Ministry of Environmental Conservation and Forestry, is in fact not overlapped with the project area, whereby no such protected area is affected by the Project.

However, one of the distribution canals of North Nawin irrigation system passes a cultural/historical monument, which in fact should be protected from any human artificial activities. The heritage is called “Tharay Khit Tara” (see Figures 6.2.1 & 6.2.2 for the green colored area located in east-southern part from the Pyay town).

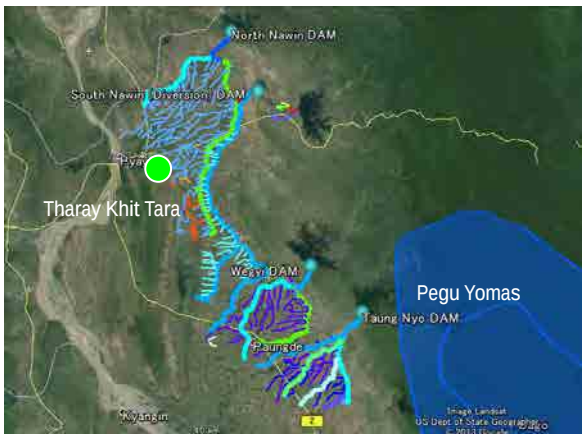


Figure 6.2.2 Protected Area of Myanmar

Source : World Database on Protected Areas

Figure 6.2.3 Location of Tharay Khit Tara and CL13-D-2

2) The Heritage of Tharay Khit Tara

Tharay Khit Tara is located in the Hmawzar village tract, Pyay Township, Bago Division. The archaeological investigation had been started since 1882-83. The intermittent excavations of ancient monument have been conducted since 1907 and intensive excavation and preservation carried out from 1964 onwards. At present, 53 mounds have been exposed in the site (Source: http://www.archaeologymm.com/php/hz.php).

One of the distribution canals of North Nawin irrigation system runs through this archaeological monument (see Figure 6.2.3), and the present situation is shown in the photos below. From the photos, as of August 2013, it is observed that the canal is no longer in use. This is because the area is located at the almost terminal end of the CL13-D-2 distributary canal where irrigation water has been hardly reaching since long time ago.

In addition, taking into account the cultural value of the monument, the Ministry of Culture (MOC) issued a letter dated July 26, 2013, prohibiting any human artificial activities within the Heritage. Therefore, automatically the rehabilitation and any construction work within this Heritage are excluded from the project. It is therefore the project will not give any impact to the Heritage. Note that the letter from the MOC is attached at the end of this chapter.

2) To-be-affected Population

Total number of affected farmers, who are in fact the beneficiaries for the Project, arrives at around 23,400 households. Beneficiary household number by irrigation system ranges from about 4,200 for North Nawin irrigation system to around 8,800 for South Nawin system. Applying 4.99 family members per household, average household members of a typical family referring to the result of household survey conducted by JICA survey team, it is estimated that the total beneficiary population is around 117,000. Breakdown of the households and population to be affected/ benefitted by the Projects is summarized below:

Table 6.2.1 Number of Households and Population affected by the Projects

Items	N. Nawin	S. Nawin	Wegyi	T. Nyo	Total
Net Irrigable Area (acre)	53,169	72,709	40,428	49,981	216,287
Net Irrigable Area (ha)	21,516	29,424	16,361	20,226	87,527
Estimated Number of Beneficiary FHHs	4,180	8,781	5,047	5,386	23,394
Estimated Beneficiary Population	20,858	43,818	25,186	26,876	116,738

Source: ID Maintenance Division (Bago West), JICA Survey Team (2013)

6.2.2 Examination of Alternatives

As an examination of alternative activities, following three alternatives are examined by comparison; namely, alternative Option 0: the existing state of irrigation (zero-option), alternative Option 1: ODA assisted project by a donor, e.g. JICA, on rehabilitation basis, and alternative Option 2: new canal construction together with new farming settlement. As shown in the following table, it can be concluded that the alternative Option 1 (the Project) is the most feasible one amongst these three alternatives.

Table 6.2.2 Examination of Alternative Project on the Project

Environmental items	Option 0 (no project)	Option 1 Rehabilitation of canal	Option 2 New canal construction
Construction site	-	Same site as the present facilities	New canal constructions should be prepared
Technical/ financial difficulty	same as it is now	Techniques to be applied have already been established. Since the project consists mainly of rehabilitation of the existing canals,	This requires new study, survey, design and construction work to realize.

Environmental items	Option 0 (no project)	Option 1 Rehabilitation of canal	Option 2 New canal construction
		the incurred cost is lower than that of the whole new construction	
Resettlement and land acquisition (land recovery)	-	-	XXX From the necessity of new canal reclamation, huge areas of land acquisition (land recovery) will be sought; hence great negative impact which may include resettlement in local environment will arise.
Effect of project	-	+++ The Project enables to secure stable supply of irrigation water, thus increased crop production can be expected.	Same as left column.
Project cost	Zero	Medium	High
Selection	-	Selected	X

X : small-scale negative impact, XX: middle-scale negative impact, XXX: large-scale negative impact

+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact

6.2.3 Scoping and TOR for Environmental and Social Consideration

The following table gives scoping on impacts to environment and society, which may be caused by major components/activities of the Project. The scoping is made by construction phase and by operation phase, and further ranked by; A+/-: Significant positive/negative impact is expected, B+/-: Positive/negative impact is expected to some extent, C+/-: Extent of positive/negative impact is unknown, and D: No impact is expected. A further examination is needed for the case 'C', and the impact shall be clarified beforehand the commencement of the Project:

Table 6.2.3 Scoping of the Project by Construction and Operation Phases

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operation phase	
1. Air Pollution	B^-	D	**Under construction:** 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. **During the use:** Once offered for use, no impact of air pollution arises.
2. Water Pollution	B^-	D	**Under construction:** Accompanying with rehabilitation works, turbid water may occur in the canals. **During the use:** Once offered for use, no impact of water pollution arises.
3. Waste	B^-	D	**Under construction:** Wastes and scraps (mostly excavated soils and bricks of existing canal) are resulted from excavation and other construction works to some extent. **During the use:** Once offered for use, no waste is generated
4. Soil Pollution	D	D	The Project is to supply irrigation water throughout the canal system; hence no soil pollution arises during both the construction and operation phases.
5. Noise and Vibration	B^-	D	**Under construction:** 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. **During the use:** Once offered for use, no noise/ vibration is emitted.

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operation phase	
6. Land Subsidence	D	D	Since no groundwater lifting is planned in the Project, no land subsidence takes place.
7. Odor Emission	D	D	Since the Project deals with irrigation water supply, no cause of odor is resulted from the construction work and operation stage either.
8. River Bottom State	D	D	Since the Project has the objective of irrigation water supply, no erosion of river bottom is resulted from the work, and operation stage either.
9. Protected Area	D	D	There is no protected area in and around the Project sites (Note that a heritage site called "Tharay Khit Tara" is discussed under 18. Cultural Heritage).
10. Ecosystem	D	D	As the Project undertakes rehabilitation of existing canals and there is no rare species of animal or plant in this area, no impact of ecosystem is expected.
11. Hydrological Situation	D	D	No hydrological situation for existing rivers and drainages will change by the Project, whereby no impact on it.
12. Topography/ Geology	D	D	Since this Project deals with rehabilitation of existing facilities, no topographical and geographical change by the works will be caused, whereby no impact is expected.
13. Evacuation, Removal of Local Population	D	D	Since the contents of the construction in the Project undertake rehabilitation of the existing canal systems which are located on/along public lands owned by the Government, non-voluntary/ forcible removal of the inhabitants will not arise.
14. Vulnerable Strata, Ethnic Minority	D	D	Any minority ethnic exists in the target Project area. Also, no impact thereon arises from activities of the Project.
15. Local Economy on Employment Opportunities and Livelihood Improvement	B^+	B^+	**Under construction:** Since hiring opportunities of local inhabitants are generated by the construction work, possibly beneficial impact on local economy is expected. **During the use:** Upon completion of the Project, increase of crop production is to take place, hence local economy will improve not only for the farm households but also it is to provide more job opportunities to farm casual labors. In addition, pavement of the roads along the main canals and improvement of the roads along distributary canals will significantly facilitate and improve transportation along all these roads.
16. Water Use	D	A^+	Since the Project carries out rehabilitation works for the existing facilities, water distribution will be improved upon completion of the project.
17. Biased Benefit and Unequal Distribution	D	D	Agricultural benefits arising from the Project are equitably distributed among all the beneficially farmers according to the farm size the farmers own. By this reason, no biased distribution of benefits and suffering takes place from the Project.
18. Cultural Heritages	B^-	B^-	Particular cultural heritage exists within the Project area. This area is called "Tharay Khit Taya" located over the alignment of CL13-D-2 distribution canal of North Nawin Irrigation System. Possibility of impact by the Project on the heritage culture is conceivable if the rehabilitation works are to be made on the canal within the heritage.
19. Landscape	D	D	Since the Project carries out rehabilitation works for the existing facilities, no change of landscape is resulted from the work.
20. Resettlement	D	D	Since the project deals with rehabilitation of existing facilities, no resettlement by the works will take place, whereby no impact is expected on the resettlement.
21. Ethnic Minorities and Indigenous Peoples	D	D	There are no ethnic minority and indigenous peoples in and around the project area, whereby no impact is expected on such ethnic minorities and indigenous peoples.
22. Labor Environment (including labor safety)	B^-	B^+	**Under construction:** Careful consideration on possible accidents during the construction phase is required. **During the use:** Since canal systems including gates are rehabilitated, system operation especially gate operation is made easier resulting in improved labor condition.
23. Accident	B^-	D	**Under construction:** Potential risk of accidents would arise from the Project such as possibility of traffic accidents caused by vehicles of the construction work giving damages to local inhabitants. **During the use:** No accident is expected during the operation stage.

Environmental Parameters	Evaluation		Reasons
	Construction phase	Operation phase	
24. Hazards (Risk), Infectious diseases such as TB, HIV/AIDS, etc.	B-	D	**Under construction:** 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. **During the use:** No impact is expected during the operation stage.
25. Global Warming	D	D	No global warming by the works 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.

As the result of scoping mentioend above, such items evaluated as "B-" are 1. Air pollution, 2. Water pollution, 3. Wastes, 5. Noise / vibration, 18. Cultural heritages, 22. Labor environment, and 23. Accident. No.2. These items are further exmined in order to know the extent of impact, establish the mitigation measures when required, and prepare for a monitoring plan, etc. To further examine, TORs are prepared as follows;

Table 6.2.4 TORs on the Items examined further for Environmental and Social Impact

Environmental Parameters	Study Contents	Study Method
1. Air Pollution	• Study the influence under the construction phase	• Examine the location of hospitals, schools, resident areas, to which the air pollution will give nasty and unhealthy effects. In addition, construction time/period and construction sites will also be surveyed.
2. Water Pollution	• Study the influence under the construction phase	• Examine the degree of the water pollution and the sites where the pollution will take place. • Examine the location of resident areas, to which the water pollution will give nasty and unhealthy effects.
3. Wastes	• Study the influence under the construction phase	• Examine the contents of waste disposal and the disposal site(s) required for the construction work in order to know the degree of the hazardousness of the waste and safe disposal method(s).
5. Noise / Vibration	• Study the influence under the construction term	• Examine the location of hospitals, schools, residence areas, to which the noise and vibration will give nasty and unhealthy effects. In addition, construction time/period and construction sites will also be surveyed.
18. Cultural Heritages	• Study the influence under the construction phase	• Examine the area and the alignment of O&M road and irrigation canals first in relation to the cultural heritage, and establish measures in order to protect the heritage or otherwise drop parts of the works which may give damage on the heritage.
22. Labor Environment	• Study the influence under the construction phase.	• Examine the contents of the works of the Project and compare with examples for other similar projects, base on which assess the impacts to the labor environment including the establishment of mitigation measures if needed.
23. Accidents	• Check the influence under the construction phase	• Check the components of construction works, passes and ways served for the construction, construction time/period, kind of construction machineries, number of driving trucks, etc., and also conduct site surveys concerning present traffic condition.
24. Hazards (Risk), Infectious diseases such as TB, HIV/AIDS, etc.	• Study the influence under the construction phase	• Check the scale of the employed labors in terms of numbers, and examine prevalent infectious diseases so far experienced in similar projects.

Source: JICA Survey Team (2013)

6.2.4 Results of Environmental and Social Examination

Following the terms of reference (TORs) indicated in Table 6.2.4, Environmental and Social Examination was carried out based on the site surveys, review and examination of the contents of the works, information obtained through interviews to relevant beneficiary villagers, inquiry to the people in the project area, and technical discussions with the concerned counterparts/officials, etc. The results of the examination are as follows:

1) No.1 Air Pollution

Major construction machineries to be used are excavator, dozer, breaker, roller, loader, truck, and trailer truck. These machineries emit exhaust gasses to some extent. During the 1st year construction, ID owned machineries are to be employed, and these machineries should be well maintained in order not to emit excessive hazardous exhaust gasses. From the 2nd year construction, machineries newly procured under the Project will be available, which all are of low-emission gas specification, whereby little influence on the air pollution is expected.

Instead, dust may be expected to take place during the construction and when transporting necessary materials to the construction site. However, most of the construction is scheduled to take place during rainy season except for road construction/improvement, whereby the dust is naturally subsided. Construction is also done at the beginning of winter (dry) season, during which dust may arise. In this case, spraying water along and at the construction site should be observed, which can greatly reduce such dust.

Further, most of the construction sties are along and at the canals, which are far away from any of the residential areas. Such public institutes as schools and hospitals where many people gather are not existent within a reach of the construction sites. Therefore, air pollution will not cause any hazardous impact on such institutes taking into account the distance whereto.

In all these regards taken into account, Air Pollution is expected to be within an accepted and/or controlled level. Therefore, measures that the ID should undertake are to well maintain the machineries not to emit unacceptable level of exhaust gases, and spray water when dust is to take place, pay attention not to enter residential villages but to follow just major trunk road for transporting materials to the sites, etc.

2) No.2 Water Pollution

Most of the rehabilitation works are carried out on the canals. During rainy season, turbid water may be generated from such rehabilitation sites accompanying soil excavation. It means that the turbid water takes place within the canals, which are placed under rehabilitation works. Such turbid water will not affect any residential areas and public institutes such as hospital, schools, etc. since they are located far away from such construction sites.

Possible measure that the ID should take is, at first, to confine the turbid water within a reach of the canal being rehabilitated, preventing the water from spilling over to the downstream areas. The level of the turbidity is expected not to be much and also confining of the water can be made by putting up an earthen band within the canal. Therefore, the water pollution can be expected to control within the acceptable range, hence water pollution is considered not to be a major issue.

3) No.3 Wastes

Wastes are generated out of excavation of soils, removal of bricks from dilapidated canal portion, and removal of concrete pavement from the dilapidated portions of the access road to North Nawin dam site. Excavated soils can be reused for the backfilling of embankment, at which slope had collapsed,

except for such soils containing organic matters. Removed bricks can also be re-used for the protection/lining of distributary canals, mostly around which structures are to be established or at which canal bottom portions were eroded. Removed concrete debris may be re-used for gravel-like basement for the inspection roads along the main canals.

However, after having re-used such waste, there may be a possibility that some excessive wastes still remain. Such remaining wastes may be given to local villagers nearby if they need to make simple pavement in and around their villages, especially for the village roads as well as for filling gullies taking place nearby. After having such arrangement, still remaining wastes shall properly be disposed of. In this regard, disposal site(s) and/or proper disposal methods should be established prior to the commencement of the work.

4) No.5 Noise / Vibration

Public institutes such as hospital and schools are not located near construction site. In addition, residential areas are not located near the construction sites in most cases either. Therefore, noise and vibration generated from the construction work will not give noticeable impacts on them. However, approach roads for the construction sites may have to pass through villages in some cases. In such cases, attention should be paid not to cause noticeable impact to the villagers.

5) No.18 Cultural Heritages

“Tharay Khit Tara” heritage is a distinguished monument which should be protected. In fact, the Ministry of Culture has already issued a letter dated July 26, 2013, prohibiting any construction work within the heritage. ID has agreed to observe the request made by the ministry, whereby the canal reach within the heritage is excluded from any of the rehabilitation work. It is therefore that the project will not give any impact on the cultural heritage.

6) No.22 Labor Environment and No.23 Accident

If the construction schedule is made tight or otherwise operators/workers are not allotted with enough numbers, labor environment will be deteriorated leading to an accident. In addition, if pre-explanation to workers employed at sites are not made well for the contents of the works together with safety measures, there may tend for some accident to take place frequently. Vehicles which are passing near villages may become a cause of traffic accident due to the increase of the transport. Therefore, safety measures should be addressed prior to the commencement of the project.

7) No. 24 Hazards (Risk), Infectious diseases such as TB, HIV/AIDS, etc.

There will be number of labors during the construction stage. Under such situation there may be a possibility of extending infectious diseases such as TB, HIV/AIDS among the labors, though with reference to similar construction works, no noticeable examples have been reported so far. The supervisors of the contractor, or CON (2) and MD (west Bago) of ID, should always pay attention to the labors’ health condition, and should there be such possibility, the supervisors shall inform the health office of the township as well as the Consultant office. Also, awareness creation on HIV/AIDS shall be made among the labors, which can be initiated by the township health office.

6.2.5 Impact Evaluation of the Environmental and Social Examination

Evaluation regarding environmental impacts is summarized below comparing those at the scoping stage and the ones after environmental and social examination was carried out as aforementioned. After the examination, such changes took place as:

- ✓ On No.2 Water Pollution, evaluation at the scoping stage was B- for the construction stage, and this result changes to D. This is because the project will not give any water pollution by its nature,

though turbid water takes place within a reach of canal being rehabilitated. Even such turbid water can be easily confined not to be over-spilled to downstream. Therefore, the impact for this turbid water is considered negligible.

✓ On No.18 Cultural Heritage, evaluation at the scoping stage was B- for the both construction and operation stages, and this result changes to N/A for the both phases. This is because no construction work is conducted within the heritage in accordance with the letter issued by the Ministry of Culture dated July 26, 2013, prohibiting any human artificial activities.

Table 6.2.5 Environmental Evaluation at Scoping and After Examination

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
1. Air Pollution	B-	D	B-	D	**Under construction:** 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. **During the use:** Once offered for use, no impact of air pollution arises.
2. Water Pollution	B-	D	D	D	**Under construction:** Accompanying with rehabilitation works, turbid water may occur in the canals; however the level is very minimal and it can be confined within a reach of the canal. Therefore, negative impact is not conceivable. **During the use:** Once offered for use, no impact of water pollution arises.
3. Wastes	B-	D	B-	D	**Under construction:** Wastes and scraps (mostly excavated soils and bricks of existing canals) are resulted from excavation and other construction works to some extent. **During the use:** Once offered for use, no waste is generated
4. Soil Pollution	D	D	N/A	N/A	The Project is to supply irrigation water throughout the canal system; hence no soil pollution arises during both the construction and operation phases.
5. Noise and Vibration	B-	D	B-	D	**Under construction:** 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. **During the use:** Once offered for use, no noise/ vibration is emitted.
6. Land Subsidence	D	D	N/A	N/A	Since no groundwater lifting is planned in this Project, no land subsidence takes place.
7. Odor Emission	D	D	N/A	N/A	Since the Project deals with irrigation water supply, no cause of odor is resulted from the construction work and operation stage either.
8. River Bottom State	D	D	N/A	N/A	Since the Project has the objective of irrigation water supply, no erosion of river bottom is resulted from the work, and operation stage either.

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
9. Protected Area	D	D	N/A	N/A	There is no protected area in and around the Project site (Note that a heritage site called "Tharay Khit Tara" is discussed under 18. Cultural Heritage).
10. Ecosystem	D	D	N/A	N/A	As the Project undertakes rehabilitation of existing canals and there is no rare species of animal or plant in this area, no impact of ecosystem is expected.
11. Hydrological Situation	D	D	N/A	N/A	No hydrological situation for existing rivers and drainages will change by the Project, whereby no impact on it.
12. Topography/ Geology	D	D	N/A	N/A	Since this Project deals with rehabilitation of existing facilities, no topographical and geographical change by the works will be caused, whereby no impact is expected.
13. Evacuation, Removal of Local Population	D	D	N/A	N/A	Since the contents of the construction in the Project undertake rehabilitation of the existing canal systems which are located on/along public lands owned by the Government, non-voluntary/ forcible removal of the inhabitants will not arise.
14. Vulnerable Strata, Ethnic Minority	D	D	N/A	N/A	No minority ethnic exists in the target Project area. Also, no impact thereon arises from activities of the Project.
15. Such local economy as employment and livelihood means	B^+	B^+	B^+	B^+	**Under construction:** Since hiring opportunities of local inhabitants are generated by the construction work, possibly beneficial impact on local economy is expected. **During the use:** Upon completion of the Project, increase of crop production is to take place, hence local economy will improve not only for the farm households but also it is to provide more job opportunities to farm casual labors. In addition, pavement of the roads along the main canals and improvement of the roads along distributary canals will significantly facilitate and improve transportation along all these roads.
16. Water Use	D	A^+	D	A^+	Since the Project carries out rehabilitation works for the existing facilities, water distribution will be improved upon completion of the project.
17. Biased Benefit and Damage Distribution	D	D	D	D	Agricultural benefits arising from the Project are equitably distributed among all the beneficially farmers according to the farm size the farmers own. By this reason, no biased distribution of benefits and suffering takes place from the Project.
18. Cultural Heritages	B^-	B^-	N/A	N/A	Letter from the Ministry of Culture forbids any rehabilitation work within the "Tharay Khit Taya". Therefore, the related canal is excluded from the rehabilitation works.
19. Landscape	D	D	N/A	N/A	Since the Project carries out rehabilitation works for the existing

Environmental Parameters	Evaluation at Scoping		Evaluation based on the result of Environmental and Social Examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
					facilities, no change of landscape is resulted from the work.
20. Resettlement	D	D	N/A	N/A	Since the project deals with rehabilitation of existing facilities, no resettlement by the works will take place, whereby no impact is expected on the resettlement.
21. Ethnic Minorities and Indigenous Peoples	D	D	N/A	N/A	There are no ethnic minority and indigenous peoples in and around the project area, whereby no impact is expected on such ethnic minorities and indigenous peoples.
22. Labor environment (including labor safety)	B^-	B^+	B^-	B^+	**Under construction:** Careful consideration on possible accidents during the construction phase is required. **During the use:** Since canal systems including gates are rehabilitated, system operation especially gate operation is made easier resulting in improved labor condition.
23. Accident	B^-	D	B^-	N/A	**Under construction:** Potential risk of accidents would arise from the Project such as possibility of traffic accidents caused by vehicles of the construction work giving damages to local inhabitants. **During the use:** No accident is expected during the operation stage.
24. Hazards (Risk), Infectious diseases such as HIV/AIDS	B^-	D	B^-	D	**Under construction:** 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. **During the use:** No impact is expected during the operation stage.
25. Global Warming	D	D	N/A	N/A	No global warming by the works 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.

6.3 Mitigation Measures and Monitoring

6.3.1 Mitigation Measures and Cost

Some adverse effects by the project are anticipated, and in general they are limited to construction phase only, e.g. air pollution, wastes, noise/vibration, labor environment and accidents. The damages are thus tentative and recoverable. As per possible measures to alleviate and to avoid such negative impacts likely to take place by the implementation of the Projects, following countermeasures are considered necessary. These impact alleviating or avoiding measures can be realized to put into practice within the indirect cost included in the management of the construction cost, thus no additional cost is required for taking them.

Table 6.3.1 Mitigation Measures to/against the Negative Impacts

Negative impact	Alleviating or avoiding measures	Responsible Agency
1. Air pollution Exhaust gas emission takes place. Dust occurs during the passage of construction vehicles.	• Utilize such construction machines equipped with gas emission reduction system. • Conduct regular check and full maintenance of construction machineries and vehicles. • Spray water in and around entrances of construction sites and on the road, along which machineries are to move.	CON(2) and MD ID
2. Wastes Excavated earth evolves from some construction works. In rehabilitating the existing canals, waste scrap pieces evolves. In improving the access road to North Nawin dam, concrete debris will take place.	• Re-use excavated soils as back-filling materials for collapsed canal portions as much as possible. • Dispose of such soils containing organic matters in the lands running alongside the canals, the lands of which are owned by ID (50ft width for main canals and 30 ft width for distributary canals from the edge of embankment are owned by ID). • Dispose wastes out of machineries according to construction regulation in Myanmar. • Confine turbid water which may take place during canal rehabilitation works within the canals, so that no such turbid water will be discharged out of the construction sites. • Re-use the removed bricks out of the dilapidated main canal portions for the protection/lining of distributary canals, mostly around which structures are to be established or at which canal bottom portions were eroded. • Re-use the dilapidated concrete portions for the access road to North Nawin dam, after having been crushed, for the basement of concrete pavement of the inspection roads along the main canals. • Further, distribute the removed bricks and concrete debris to villages upon requests where the villagers hope to use them for, e.g., simple pavement of village road. • Note that the remaining ones which can not be re-used will be dumped and buried in the ID owned lands stretching alongside the main and distributary canals (Note that the land having width of 50 ft (15.24m) for the main canals and 30ft (9.14m) for distributary canals belong to the ID). • Finally, entrust proper disposal of waste, which can not be reused, though such waste will be minimal.	CON(2) and MD ID
5. Noise/ vibration During construction work, noise/ vibration evolve from the operation of back-hoes and passage of trucks., etc.	• Employ construction machinery mounted with silencers and adequate mufflers to minimize the noise emission. • Refrain construction work at night in such areas where residential quarters are located.	CON(2) and MD ID
22. Labor environment 23. Accident During construction work, traffic and/or site-work accidents may take place.	• Identify if there is too tight operation schedule or not, and if so rectify it. • Place traffic control staff along the construction roads. • Explain contents of the work to the workers with necessary care taking for their safety prior to the start of the work, and make daily confirming safe meeting before starting the work.	CON(2) and MD ID
24. Hazards (Risk), Infectious diseases such as HIV/AIDS During construction stage, infectious diseases such as TB and HIV/AIDS may take place among the workers.	• Pay attention to the workers' health condition, and if there is a possibility of incident of infectious diseases taking place, immediately inform the township health office and the Consultant office. • Request the township health office to carry out awareness creation on HIV/AIDS among the workers and recommend them to voluntary check the status of HIV/AIDS.	CON(2) and MD, Township Health Office

Source: JICA Survey Team

Those mitigation measures will be carried out by the implementation body, i.e., CON(2) and MD (Bago), and the Consultant engaged in the Projects receives the related reports from the CON(2) and MD. The Consultant, upon confirmation of the contents with reference to the site situation, submits the

report to the head office of ID for seeking approval on the proceeding implementation taking due care on the environmental and social issues as planned.

6.3.2 Monitoring Plan

Anticipated environmental impacts are limited to construction phase, and thus related monitoring will be implemented during the period. Since the environmental parameters which can be affected by the construction works are air pollution, wastes, noise/vibration, labor environment and accidents, and infectious diseases such as HIV/AIDS, those items shall be monitored. The monitoring is basically conducted every day, and the results are recorded in monthly progress report submitted to ID head office.

The environment monitoring is to be made by CON(2) and MD. A statement of dissatisfaction or claim from neighbor villagers is to be received by a sub assistant engineer at site. Then, CON(2) and MD should report it to the Consultant, and the Consultant should report to ID head office recorded in the monthly progress report and also taking such opportunity of periodical site inspection or site meeting by the ID head office. Table 6.3.2 shows the recommended monitoring plan, and the procedure of the monitoring and reporting are as follows:

Table 6.3.2 Recommended Monitoring Plan (For the Project Construction Phase)

(1) Response and actions by the government

Monitoring Item	Monitoring Results during Report Period
Number and contents of formal comments made by the public	
Number and contents of responses from the people	

(2) Pollution

- Noise / Vibration

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Referred Japanese Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise	dB			-	85	Once per month
Vibration	dB			-	75	Once per month

- Air Pollution

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Referred Japanese Standards	Remarks (Measurement Point, Frequency, Method, etc.)
At construction site						
SO_2	ppm			-	average daily less or equal 0.04ppm/hr and less or equal 0.1ppm/hr	Once per month
CO	ppm			-	average daily less or equal 10ppm/hr and average 8hr less or equal 20ppm/hr	Once per month
SPM	mg/m^3			-	average daily less or equal $0.10mg/m^3$/hr and less or equal $0.20mg/m^3$/hr	Once per month
NO_2	ppm				average daily less or equal 0.04 - 0.06ppm/hr	Once per month
Ox	ppm				less or equal 0.06ppm/hr	Once per month

- Maintenance of heavy machine

Type of machine	Kinds of disorder	Measures taken	Monitoring date
Hydraulic Excavator			Every day
Hydraulic Breaker			Every day
Track Dozer (Bulldozer)			Every day
Wheel Loader			Every day
Earth Work Vibration Roller			Every day
Agitator Truck (Concrete Mixer Truck)			Every day
Lowbed semi-Trailer Truck			Every day
Dump Truck			Every day
Concrete Pump Truck			Every day
Workshop Equipments			Every day

(3) Natural environment

Environmental parameter	Monitoring results	Measures taken	Monitoring date
Wastes In principle, re-use excavated soils as back-filling materials, re-use the removed bricks out of the dilapidated main canal portions for the protection/ lining of distributary canals, and re-use the dilapidated concrete portions of NN access road for basement of concrete pavement. Further, remaining ones which can not be re-used will be dumped and buried in the ID owned lands stretching alongside the canals.			Every day

(4) Working environment (Include working safety)/ Accident

Environmental parameter	Monitoring results	Measures taken	Monitoring date
Safety check for carrying the heavy machineries into the work area.			First time of the construction work.
Safety check for refueling car accessing the work sites.			Every day.
Safety check for carrying-out of the heavy machineries from the work sites.			Last time of the construction work.
Checking of the heavy machineries if keeping correct routes and speed.			Every day
Installation of project sign board around the field.			First time of the construction work.

(5) Hazards (Risk), Infectious diseases such as HIV/AIDS

Environmental parameter	Monitoring results	Measures taken	Monitoring date
Pay attention to the workers health condition.			Every day
Arrange with the township health office to carry out awareness creation on HIV/AIDS among the workers.			Once half a year

Source: the Survey Team (2013)

6.4 Notice of the Project to the Stakeholders

In Myanmar, monthly meeting at township level is always held attended by the township level government offices and chairpersons of village tracts. ID has periodically informed the contents of the construction and rehabilitation works to this township level monthly meeting. After the township level meeting, the village tract chairpersons have delivered the information concerning the

construction/rehabilitation to the relevant villagers through village chairpersons in charge.

Since the commencement of the on-going rehabilitation works, this notice of the construction/rehabilitation has been done as per the regulation. ID has delivered to the meeting such detail information as machineries to be employed, volume and size of the works, schedule, etc., and this practice has continued to date. So far, complaints or objection against the Project has not been made, according to ID and the township administration offices. This same arrangement will follow during the project implementation under loan arrangement.

Though the JICA Team has not carried out public hearing on the Project to examine whether they accept or not, the project purpose and preliminary contents of the works were explained prior to a household questionnaire survey administered by the JICA Team. The survey covered 12 villages whereby chairpersons of the 12 villages[1] and of course the 225 interviewees in total were given the notice of the Project. The village chairpersons and all the interviewees have expressed early implementation of the Project taking into account the project purpose of rehabilitating and upgrading the irrigation facilities whereby they could receive irrigation water timely and enough. Through these practices, project has been informed to the beneficiary people and so far no objection has been made.

6.5 Environmental Check List

Check list is attached in the following page, which shows environmental concerned items, main check items, responses whether the check has been done or not, and confirmation results of the environmental considerations.

[1] The household questionnaire survey covered each 3 villages (upper, mid and lower position of an irrigation system) of the 4 irrigation systems, totaling 12 villages.

Environmental Check List

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) NA (b) NA (c) NA (d) NA	(a) In Myanmar, environmental law is executed based on; 1) the Environment Conservation Law, the Pyidaungsn Law No.9/2012 (30 March 2012), 2) the Protection and Preservation of Cultural Heritage Regions Law (10 September 1998), and 3) the Law Amending the Protection and Preservation of Cultural Heritage Regions Law (20 January 2009). The current Environment Conservation Law dose not stipulate EIA requirement concerning rehabilitation works/projects, whereby no official EIA procedure has been made but environmental and social examination was done by JICA survey team according to the JICA Guideline for Environmental and Social Consideration, April 2010. (b/c) Since EIA procedure is not required for rehabilitation projects in Myanmar, no such procedure of report being approved by the authority is needed. (d) There is a cultural heritage within the Project area, which is commanded by the Ministry of Culture. Though there is a canal passing through this cultural heritage, no rehabilitation work is implemented within the heritage subject to a letter prohibiting such activities issued by the ministry. Therefore, no permission was obtained since no work is done within the heritage.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) ID has informed the rehabilitation works which had been already started 2-3 years ago to the concerned beneficiaries and villagers through township administration, village tract leaders, village leaders and the beneficiaries. The beneficiaries are therefore already aware of the rehabilitation work partly already being implemented. So far, no claims/complaints have been made to the ID from the concerned villagers and beneficiary farmers. (b) Concerned villagers and beneficiary farmers requested the ID to additionally construct bridges passing through canals, and water service points for cattle and buffalos along main canals. Such requests have been incorporated in the rehabilitation plan/design, whereby the villagers and beneficiary farmers' comments have been reflected.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Three (3) alternative plans; 1) the rehabilitation plan, 2) no project, and 3) new construction project, had been examined, out of which the present rehabilitation project was concluded the most feasible plan.
2 Pollution Control	(1) Water Quality	(a) Are considerations given to water pollution of the surrounding water bodies, such as rivers and groundwater by effluents or leachates from agricultural lands? Are adequate use/disposal standards for fertilizers, agrochemicals, and livestock wastes established? Is a framework established to increase awareness of the standards among farmers? (b) Is a monitoring framework established for water pollution of rivers and groundwater?	(a) N (b) N	(a) Since this project undertakes rehabilitation works, no water pollution is expected whereby no impact on such water quality. Note that upon completion of the rehabilitation works, farmlands which had not received irrigation water will be able to receive irrigation water whereby agricultural activities will expand. In this case, extension officers under DOA (Department of Agriculture) will disseminate appropriate use of fertilizers and chemicals, so that water pollution originating in such use is not expected. (b) Since water pollution is not expected, no framework is needed.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Wastes	(a) Are wastes properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Soils which may accrue from excavation works will be re-used as filling material for the collapsed canal sections, whereby no soil waste is expected except for such soils containing organic materials. The soils containing organic materials will be disposed of alongside the main canal, the lands of which are owned by ID. Wastes out of machineries will be disposed of according to construction regulation in Myanmar. Turbid water which may take place during canal rehabilitation works will be confined within the canals, so that no such turbid water will be discharged out of the construction sites. In addition, bricks are to be removed from the dilapidated main canal portions, and also dilapidated concrete portions for the access road to North Nawin dam will also be removed. For the bricks, they are to be re-used for the protection/lining of distributary canals, mostly around which structures are to be established or at which canal bottom portions were eroded as filling materials. For the concrete debris, they are to be utilized after having been crushed for the basement of concrete pavement of the inspection roads along the main canals. Further, the removed bricks and concrete debris are to be distributed to villages upon requests where the villagers hope to use them for, e.g., simple pavement of village road. The remaining ones which can not be re-used will be dumped and buried in the ID owned lands stretching alongside the main and distributary canals (Note that the land having width of 50 ft (15.24m) for the main canals and 30ft (9.14m) for distributary canals belong the ID).
	(3) Soil Contamination	(a) Is there a possibility that impacts in irrigated lands, such as salinization of soils will result? (b) Are adequate measures taken to prevent soil contamination of irrigated lands by agrochemicals, heavy metals and other hazardous substances? (c) Are any agrochemicals management plans prepared? Are any usages or any implementation structures organized for proper use of the plans?	(a) N (b) NA (c) Y	(a) The 4 Project sites have been under operation at least more than 10 years (started in 1976 for North Nawin, 1996 for South Nawin, 2001 for Wegyi and 1996 for Taung Nyo). During the operation periods, no salinity problem has occurred in these areas. Therefore, even after completion of the rehabilitation project, no such salinity problem will take place. (b) At present, there is minimal use of chemical fertilizers and pesticides by local farmers in the project area. Even after the completion of the project, farmers will not overdose such input and also extension officers in DOA will extend the proper usage of fertilizers and chemicals. (c) Township DOA offices have proper management plan of agrochemicals, and in fact the extension officers have been extending such necessary services, and this services will continue to be extended to the beneficiary farmers.
	(4) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Under this project, no groundwater will be abstracted whereby no ground subsidence is expected. The main source of irrigation water is the reservoirs of North Nawin, South Nawin, Wegyi and Taung Nyo dams, all originating in rivers.
	(5) Odor	(a) Are there any odor sources? Is there a possibility that odor problems will occur to the inhabitants?	(a) N	(a) This project will not generate any odor.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) One of the distribution canals of North Nawin irrigation system passes a cultural/historical monument, which in fact should be protected from any human artificial activities. The heritage is called "Tharay Khit Tara", and on this issue, Ministry of Culture issued a letter dated on 6 July 2013, prohibiting all the human artificial activities within the heritage. Therefore, the canal passing through the heritage was excluded from the rehabilitation project, and accordingly no impact takes place on the protected heritage. Aside from this Tharay Khit Tara, no other protected area exists in and around the Project site.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will result in the loss of breeding and feeding grounds for valuable wildlife? If they are lost, are there substitutes for the grounds near the original locations? (d) Is there a possibility that overgrazing will cause ecological degradation, such as impacts on wildlife habitats and desertification? (e) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	(a) N (b) N (c) N (d) N (e) N	(a) The Project area falls outside of any forest areas. The Project site extends over already opened farm lands long time ago. (b) Habitats of rare species are not existent in the Project area. The site extends over large areas of farmlands where no rare species live. (c) Breeding sites and feeding grounds of rare species are not existent in the Project site. The site extends over huge areas of farmlands. (d) The Project will not generate additional livestock or other animals that could lead to overgrazing. (e) The projects does not give any impact on the present ecological situation.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N	(a) No involuntary resettlement will occur as the project undertakes rehabilitation works, which take place along the existing irrigation canals where there are no settlements. (b) Because there is no need for resettlement. (c) No resettlement will take place. (d) No resettlement will take place. (e) No resettlement will take place. (f) No resettlement will take place. (g) No resettlement will take place. (h) No resettlement will take place. (i) No resettlement will take place. (j) No resettlement will take place.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is proper allotment made for rights to agricultural land use? Is there a possibility that the allotment will result in inequitable distribution or usurpation of land and available resources? (c) Are proper allotments, such as water rights allotment in the project area made? Is there a possibility that the allotments will result in inequitable distribution or usurpation of water rights and available resources? (d) Is there a possibility that the amount of water used (surface water, groundwater) by the project will adversely affect the downstream fisheries and water uses? (e) Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? Is adequate consideration given to public health education, if necessary?	(a) N (b) N (c) N (d) N (e) N	(a) The project will avail of irrigation water up to the end of the irrigation system where currently there is water shortage. Therefore, the farmers practicing agriculture at the downstream sides will benefit more than those farmers in midstream and upstream, contributing to equitable benefit sharing than before. They will improve their agriculture based livelihood. (b) Since this Project deals with the existing farmland and no land consolidation arrangement nor new land reclamation is carried out, no impact on such issue is expected. (c) Currently, irrigation water does not reach down to the end of irrigable area due to dilapidated canal situation. Upon the completion of the Project, the irrigation water starts running up to the end of irrigation canals whereby equitable distribution of water resources and benefit will accrue by this Project. (d) Since water is provided from the dam reservoirs made solely for the irrigation purpose, no impact will take place on the downstream water use. (e Since this Project undertakes rehabilitation works, no introduction of such water born diseases is made.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	See 3. (1): One of the distribution canals of North Nawin irrigation system passes a cultural/historical monument, called "Tharay Khit Tara". On this issue, Ministry of Culture issued a letter dated on 6 July 2013, prohibiting all the human artificial activities within the heritage. Therefore, the canal passing through the heritage was excluded from the rehabilitation project, and accordingly no impact takes place on the protected heritage.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) The Project will not cause any changes to the existing landscape since this Project rehabilitates and improve the existing facilities only.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a) (b) There are no ethnic minority groups in the Project area. The Project will not change the rights of any groups in relation to land and other resources.
4 Social Environment	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) N (b) Y (c) Y (d) Y	The implementation of the project considers the safety of the working individuals by conducting proper trainings on safety. Adequate trainings are given for equipment handling in order to avoid accidents. Security guards are stationed in strategic locations for proper implementation of safety measures in the Project area.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) NA (c) NA (d) Y	(a) Maintenance for the equipment and machineries will be done every day by ID maintenance staff, so that such impacts, e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes, will be reduced and safely disposed of. (d) Since most of the rehabilitation works are to take place along the canals, traffic is not much expected by nature. However, when traffic congestion were to take place, traffic guards will be assigned.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) NA	(a) Monitoring program was prepared and will be conducted by ID during the rehabilitation work. (b) Refer to the monitoring plan (incorporated in the Final Report). (c) Monitoring framework was prepared and will be established prior to the commencement of the Project implementation. (d) No regulatory equipment in Myanmar, and instead monitoring framework will be used by ID.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry checklist should also be checked. (b) For the projects including construction of large-scale weirs, reservoirs, and dams, where necessary, pertinent items described in the Hydropower, Dams and Reservoirs checklist should also be checked.	(a) NA (b) NA	(a) The project dose not deals with forestry. No forest area within the Project area exists. (b) No large-scale weirs, dams and reservoirs will be constructed under this Project.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) NA	(a) No such concerns are expected.

Attachment: Letter from MOC about "Tharay Khit Tara" (translated version from Myanmar text)

The following letter states that "Tharay Khit Tara" heritage zone should be forbidden from any kind of human artificial activities, especially irrigation canal construction as specified in (G):

District Administration Officer
District General Administration Office, Pyay District
Township Administration Officer
Township General Administration Office, Pyay Township

Regional Government
Bago
Letter No. 8 / 5 – 4 /Yae 2
Date: 26-Julv-2013

Subject: Survey Matter to Pyu ancient 3 cities by International Council on Monuments and Sites (ICOMOS)

Reference: Letter No. 1/4 -11/2013(3554) of Head Quarter of Ministry of Culture with Date (12.7.2013)

1. International Council on Monuments and Sites (ICOMOS) group will investigate and assess Pyu ancient (3) cities that will import in world heritage list on October, 2013. So, Ministry of culture negotiate to cooperate and serve beforehand the following works with reference letter to each regional departments with Pyu ancient cities steering committee(PYU COM) for old city and its neighbor environment conservation.

   (A) Not to extend housing area of the new Tharay Khit Taya city to Tharay Khit Taya heritage zone.

   (B) Not to extend existing buildings of Shwe Tagar and Maw Zar railway stations even though railway transportation is not prohibited at this moment.

   (C) Not to extend airport and its relating business into Tharay Khit Taya heritage zone.

   (D) Not to leave any garbage in the heritage zone at old Tharay Khit Taya city and its neighboring area.

   (E) Not to leave any garbage at neighboring places at west of old Tharay Khit Taya city that garbage has already been cleared and it has already been replaced by Roselle nursery.

   (F) To forbid stone and pebble digging at west of old Tharay Khit Taya city restricted zone.

   (G) To forbid the irrigation canal construction, farmland harrowing by machines, commercial plantation in the heritage zone (AZ, MZ and AZ) of old Tharay Khit Taya city and its neighboring area (Not to prohibit farmland cultivation by native farmers).

   (H) Not to construct any hotel, motel and guest house within the specified culture zone at old Tharay Khit Taya city and its neighboring area.

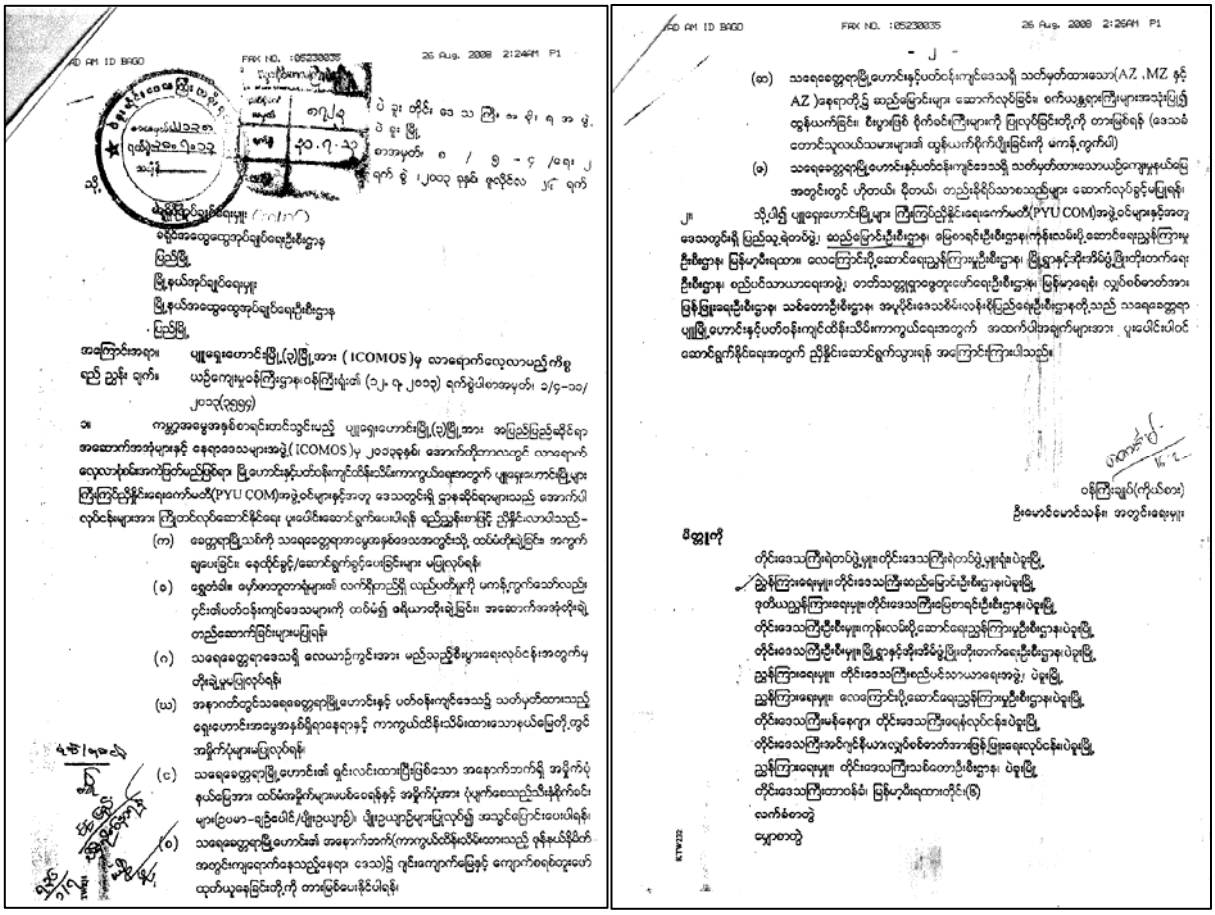
2. The Ministry of Culture informs to those concerned organizations; the Regional Police, Irrigation Department, Settlement and Land Record Department, Land Transport Department, Railway and Airline Transport Department, Department of Human Settlement and Housing Development, Development Committee, Mining and Mineral Department, Myanmar Petrol and Electrical Power Department, Forestry Department, and Tropical Green land Department with Pyu ancient cities steering committee to collaborate the issues mentioned above for Tharay Khit Taya ancient city and its conservation.

Copy to;
Regional Police Force officer, Regional Police Force office, Bago Town
Executive Director, Regional Irrigation Department, Bago Town
D Excutive Director, Regional Settlement and Land Record Department, Bago Town
Regional Officer, Land Transport Department, Bago Town
Department of Human Settlement and Housnig Development, Bago
Executive Director, Regional Development Committee, Bago Town
Executive Director, Airline Transport Department, Bago Town
Regional Manager, Regional Petrol Supply Enterprise, Bago Town
Regional Engineer, Electrical Power Enterprise, Bago Town
Executive Director, Regional Forestry Department, Bago Town
Regional Executive Officer, Myanmar Railway (6)
Received Office Document file
Received Office Output file

Signature

Prime Minister (Represent)
U Mg Mg Than
Secretary

Attachment: Letter from MOC about “Tharay Khit Tara” (original version)



CHAPTER 7 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Taking into account below, this Survey concludes that the project to enhance and further develop the irrigation performance for the target 4 irrigation systems should be implemented as soon as possible. The GOM should therefore take immediate action toward requesting the required funds, approximately 15 billion Yen, for Japanese ODA loan. Appropriation from the Government coffer should also be made available for the project management, taxes relevant, arrangement of the construction machineries required for the 1st year construction, and other supportive components such as agriculture extension services, organizing of the farmers association, etc.

1) The Project, from the viewpoint of national development, gives EIRR 19.4 % higher than the opportunity cost of capital, 12-15 %, applied in most of the development projects even at the Base Case 0 where no yield increase is considered but only area for pulses is to increase. It is expected with the Project that the cultivation area of pulses, e.g. black gram as the representative winter crop, will increase to 183,370 acre (74,206 ha) from the current 66,127 acre (26,760 ha) for the 4 irrigation systems, up by 117,243 acre (47,446 ha) equivalent to 277 % increase. For the overall beneficial area, the original irrigable area of 319,901 acre (129,457 ha) will increase to 437,144 acre (176,903 ha), up by 117,243 acre (47,446 ha).

2) The Project will realize the beneficiaries' long lasting wishes to come true; that is agricultural income increase well supported by irrigation water especially for those populations practicing agriculture at the downstream areas where irrigation water has hardly reached. For the Base Case 0 where only cultivated areas of black grams are to increase without yield increase, the total annual net profit of the back gram for the 4 irrigation systems is to increase from 12,475,579,897 Kyats to 34,318,259,212 Kyats, up by 21,842,679,315 Kyats. For the overall net profit, the original overall net profit of 43,891,290,930 Kyats per annum will increase to 65,733,970,245 Kyats, up by the same 21,842,679,315 Kyats.

3) The Project furthermore will facilitate rural transportation by rehabilitating the access road to the North Nawin dam, upgrading the gravel clay inspection roads alongside the main canals to concrete paved roads, and improving the inspection roads alongside the distributary canals to well rehabilitated gravel clay ones. These improvements will greatly reduce the transportation cost for agriculture products and also facilitate rural transportation in general. As for the benefit accrued from the road improvement, the EIRR estimated only on basis of road construction/rehabilitation cost and benefit out of reducing the transportation cost for agriculture products arrives at a very high 32.9 %.

7.2 Recommendations

1) The consultants to be engaged in the Project will be availed from year 2015; namely spending year 2014 for the selection of the consultants under ICB. It means that the ID shall seek a way of preparing for the detail design of the conduit pipe to be replaced for the North Nawin intake as well as for the tender documents of the machinery procurement within year 2013 to early part of 2014, e.g. by requesting JICA for another arrangement apart from the loan. Otherwise, North Nawin needs total 4 years to complete and also the machineries procurement would be delayed by at least one year.

2) Since the construction period for each of the 4 irrigation systems is scheduled only for 3 years and the canal rehabilitation work is limited only during rainy season, machinery procurement shall be started as early as possible after the loan agreement has become effective between the counties. In this regards, arrival of procured machinery at Yangon port shall not be later than the end of March

2015. After machinery has arrived at Yangon port, custom clearance, machine operation training, and transportation to the site will take about 2 months and it will be at the beginning of June 2015 when the machinery can be engaged in the rehabilitation and construction works at sites.

3) Since machineries which are to be procured under this Project are equipped with sophisticated electric and hydraulic control systems, OJT training on safe operation and daily maintenance shall be emphasized and organized before Irrigation Department deploys such machineries to the site. The trainings are to be incorporated as a part of the supplier's task responsibilities under the procurement contract. Irrigation Department shall mainly send heavy-machinery operators to such training.

4) Irrigation Department shall arrange construction machinery required for the first year rehabilitation works; namely the works of year 2014, since the machinery procurement will need about one year to be conducted under ICB. Machineries that the ID shall arrange are; Hydraulic Excavator (6 NOS), Hydraulic Breaker (1 NOS), Tracked Dozer (6 NOS), Wheel Loader (1 NOS), Earth Work Vibration Roller (2 NOS), Concrete Mixer (12 NOS, 1cum), Lowbed Semi-Trailer Truck (1 NOS), Dump Truck (5 NOS). ID is requested to avail of all these machineries well in advance of the commencement of works, May 2014.

5) Logistic management on such construction materials as diesel oil, cement, reinforcement bars should be carefully carried out throughout the construction period. Shortage of fuel and materials will directly affect the construction progress. In addition, much labor force procurement is estimated during canal rehabilitation period while it is the time for summer paddy harvesting and monsoon paddy seeding. Labor force demands in this period are estimated to overlap each other between ID and farmers, thus the arrangement of labor force shall be made well in advance and also by covering wider areas for the recruitment.

6) Irrigation Technology Center (ITC) shall be fully utilized for quality control such as the checking of concrete mortar strength, confirmation of design mixture of concrete and mortar, and the level of soil compaction, etc. These test results shall be sent to the consultants for their approval before the commencement of relevant construction works. In case that testing equipment and tools are not enough, procurement or otherwise availing of existing equipment from relevant laboratories shall be arranged (for the equipment to be required, refer to '3.6 Procurement of Machineries and Equipment').

7) Wasting of irrigation water through un-controlled gate operation is considered as the main reason of irrigation water shortage at the downstream and terminal areas of those 4 irrigation systems. In order to rectify such fundamental issue, employment and deployment of appropriate number of gate keepers are essential at this moment. Self-centered gate operation by farmers shall be banned, and participatory dissemination of irrigation system management is recommended to all the beneficiary farmers upon the completion of the rehabilitation works. Participatory dissemination can be the starting point of establishing water users associations, which are expected to take care of all the distributary canals under the concept of IMT or PIM in future.

8) Taking into account the present low yields of paddy and black gram, there could be a lot of potential of increasing the yield given appropriate agriculture extension services together with irrigation water to be availed upon completion of the rehabilitation works. To enhance the extension services, there should be a technical assistance provided by an international institute or donor. ID together with DOA should consider of inviting a team of agricultural experts, which can be requested to JICA apart from the loan arrangement of the Project. In order to increase effectiveness of farm works, farmland consolidation shall also be considered, which can be tried as pilot together with the dissemination of the said agriculture extension services.

PART II
MODEL FARMLAND CONSOLIDATION PROJECT

CHAPTER 1 RATIONALE AND SCOPE OF THE MODEL FARM ESTABLISHMENT

1.1 Rationale of Land Consolidation

Land consolidation aims at ensuring high productivity for agriculture supported by effective mechanized farming and rationalized water management to meet future agricultural requirements. The works accompany rearrangement and consolidation of farmland plots, improvement/upgrading of irrigation and drainage canals, and farm road construction. Land consolidation works will therefore result in improving and consolidating overall farm conditions, including related farmland-use rights.

Furthermore, the overall shape of farm plots will be improved by farmland consolidation works; therefore each of the beneficially farmers is supposed to reallocate their farmland. Reallocation works of farm plot is very important since farmland is a due important asset for every farmer, which shall have to be exchanged amongst the beneficiaries towards achieving more productive farmland as a whole. Reallocation plan should therefore be investigated closely by obtaining full consensus from all the beneficiaries before the commencement of the construction works.

1.2 Location of the Model Farmland

To demonstrate the effect of farmland consolidation work, there is a model farmland area prepared by the Irrigation Department (ID). Figure 1.2.1 shows the location of the model farm consolidation site located in Nay Pyi Taw capital area. Planned farmland for the land consolidation lies in Zabu Thiri Township, Nay Pyi Taw City, and it covers an area of 137 ha (338 acre). The area is sandwiched by Nay Pyi Taw Council Road at its western part and Yangon – Mandalay Road at its eastern part. Nay Pyi Taw City council is located at about 1km north from the farm land consolidation site. The number of farmers who have their own right of using the plots within the target farm land consolidation area counts at 138 farmers.

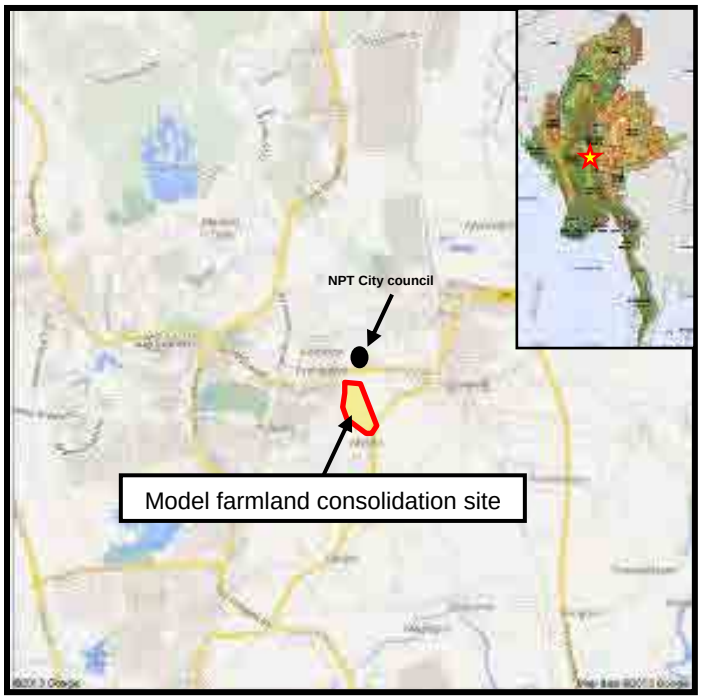


Figure 1.2.1 Location Map of Model Farm Consolidation Site

1.3 Scope of the Model Farm

Figure 1.3.1 shows the current status of the model farmland area. Given the present condition, the target 138 beneficiary farmers can hardly manage irrigation water for their farmland need since irrigation canals have yet to be established within the target farmland area. At present, those farmers can use irrigation water only by over-flowing irrigation water from upper side neighboring farm plots or otherwise they are dependent only on rainfall.

In addition, under the present farm plot conditions farmers can hardly use agricultural machineries because farm roads have not yet been prepared within the farm land area. Without farm roads which can avail of the accessibility to their farm plots, they can not bring about agricultural machineries. With this present situation, therefore, it is very difficult for the farmers to increase the agricultural production beyond what the farmers at present harvest.

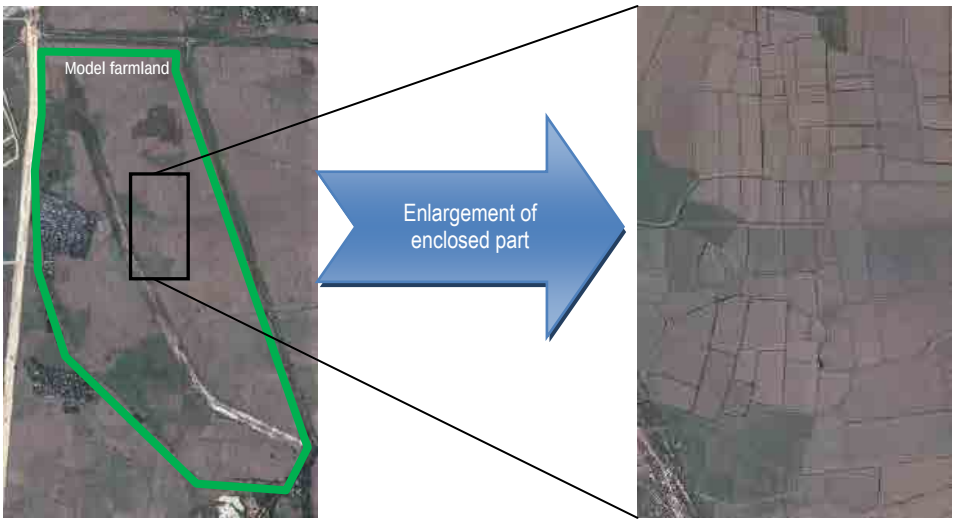


Figure 1.3.1 Current Situation of the Model Farm Land Area

To improve the present situation, farmland consolidation works are implemented in the above-mentioned target project area. The works provide a series of rectangular larger sized farm plot instead of existing irregular shaped farm plots. In addition, the works will establish irrigation and drainage canals together with farm roads within the target project area.

The construction necessary for the model farm establishment is to be done by AMD and ID, while series of facilitation for the farmers, e.g. consensus making in terms of farm plot re-arrangement, establishment of farmer association, etc. are to be made by Settlement and Land Records Department (SLRD) and Cooperative Department (CD). The role of the JICA survey team is to support AMD and ID technically in finalizing the plan and design of the farm consolidation work, financially in implementing the necessary works, and to advise SLRD and CD in facilitating the farmers. In addition, environmental and social examination is conducted by the JICA team.

1.4 Process and Schedule of the Model Farm Establishment

Table 1.4.1 describes the process of farm land consolidation work; namely,

1) Confirmation of farmland consolidation area: Confirmation of the target project area with reference to topographic and cadastral maps shall be carried out as the first step, and then investigation of environmental and social conditions will start,

Table 1.4.1 Draft Process of Farm Land Consolidation Works

No	Activities
1	Confirmation of Land Consolidation Area
2	Planning and Designing of the Farmland Consolidation
3	Identification of Farmland Use Right Holders.
4	Participatory Stakeholder Meetings
5	Farmer Organization Set-up in Charge
6	Reallocation Plan for Farm Plots, and it's Settlement

Source: JICA Survey Team

2) Planning and designing of the farmland consolidation: Upon confirmation of the target area, draft design of the model farmland for the consolidation should be prepared clearly indicating re-allocation of farmland plots, irrigation and drainage canals together with farm roads. Note that the design will be modified, as needs arise, by obtaining feed-back from the concerned farmers,

3) Identification of farmland-use-right holders: Before executing the farm land consolidation works, the names of all the beneficiary farmers and how many plots they have must be clearly identified,

4) Participatory stakeholder meetings: After having identified all the concerned farmland use holdings, explanation meeting has to be held inviting all the concerned farmers and government offices (ID, AMD, DOA, SLRD and Cooperative Department) about farmland consolidation works,

5) Farmer organization set-up in charge: Farmer organization which is a legal entity must be established, to which the legal right of owing and managing farm roads, and irrigation and drainage canals is to be vested,

6) Reallocation plan for farm plots: Reallocation plan for farm plots shall be prepared and the settlement of the plan amongst all the concerned farmers shall be made before the commencement of farm land consolidation work. Note that the established farmer organization should take the lead-charge of settling the reallocation of farmlands amongst the member farmers facilitated by SLRD and CD.

Overall work schedule is indicated below. Confirmation of the land consolidation area with the planning and designing of the farmland consolidation is made by the end of May 2013, followed by the identification of farmland use right holders. To identify the holders, beneficiary census survey is conducted together with sample household economic survey. Participatory meetings are planned and conducted at such occasions; information sharing on the project, agreement making on the project and the plan/design of the farmland consolidation, consensus-building on the re-allocation of the farmland plots, etc. Farmer organization shall be established by the end of year 2013, with about 3-month period for the official registration. The construction is scheduled in early part of year 2014 where no crops are cultivated in the field.

Table 1.4.2 Overall Schedule for the Farmland Consolidation

Activities	2013									2014					
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1. Confirmation of Land Consolidation Area	■	■													
2. Planning and Designing of the Farmland Consolidation	■	■													
3. Identification of Farmland Use Right Holders		■	■	■											
4. Participatory Stakeholder Meetings		■	■	■	■	■	■	■	■						
5. Farmer Organization Set-up in Charge			■	■	■	■	■	■	■	■	■	■	■		
6. Reallocation Plan for Farm Plots, and it's Settlement			■	■	■	■	■	■	■						
7. Construction														■	■

Source: JICA Survey Team

Note: though the construction was firstly scheduled in May-June as indicated above, it was shifted to February to April according to the farmers' request. This is because farmers requested to cultivate summer paddy, so that the construction had to be shifted to before the commencement of the summer paddy cultivation.

1.5 Implementation Arrangement

Farm land consolidation works have already been carried out in some cases in Myanmar. However, during the works so far conducted, there was no relationship between ID/AMD and SLRD; the former two organizations are in charge of construction[1] while the latter in charge of farmland re-allocation and registration. ID/AMD in fact has started the construction works without having the plan of plot re-allocation. Upon completion of the construction works, SLRD comes in and then has to struggle to settle the re-allocation with the farmers.

Due to this no relationship between the ID/AMD and SLRD on the course of implementing the farmland consolidation works, there has been many difficulties especially given to SLRD. SLRD has been struggling to settle the re-allocation issue with all the concerned farmers since there has been little opportunity for the farmers to give their feedback to the design of the farmland consolidation. To improve this situation, ID/AMD and SLRD have to establish coordination mechanism since the onset of the project planning.

[1] Concerning construction, ID is in charge of construction of farm roads and irrigation & drainage canals while AMD is in charge of the other works such as farmland leveling, farmland shaping, levee making, etc. AMD usually uses tractors, 70 – 90 HP, for their work while ID uses excavator, dump truck, roller, and in cases bulldozer.

Farmer organization shall be established before implementing farmland consolidation works. There should be mainly 2 reasons why the origanizaion is required; 1) there should be a legal entity who can possess the ownership of the irrigation and drainage canals with farm roads to be constructed within the project area, and 2) settlement of the farm plot re-allocation should be better undertaken by the farmer member representative, that is the farmer organization.

It means that the property right for the common facilities, i.e. irrigation and drainage canals and farm road, will be vested in the farmer organization legally established, not in the Government. In fact, this arrangement enables the farmers to officially request government offices, e.g. ID, to carry out rehabilitation works supported financially by the Government. Also, the one who shall be in charge of obtaining the final consensus on the plot re-allocation is the farmer themselves supported by the concerned offices such as SLRD and Cooperative Department.

The following are the roles and responsibilities by each concerned government office:

1) ID (Irrigation Department): Planning and designing of farm land consolidation project together with AMD, and execution of farmland consolidation works for the parts of farm roads, irrigation and drainage canals,

2) AMD (Agriculture Mechanization Department): Planning and designing of farm land consolidation project together with ID, and land leveling by using farm machineries (in general, tractors 70HP and 90HP), making plot boundary levees within one-acre standard plot, and first-time harrowing and ploughing for the preparation of cultivation,

3) SLRD (Settlement and Land Record Department): Assistance to farmer origination to establish farm plot reallocation plan, conduct of the farmland area survey upon completion of consolidation works, and issuing of registration for the right of cultivating farmland.

4) DOA (Department of Agriculture): Facilitation and coordination in respective necessary tasks which have to be done between beneficiaries and concerned government departments,

5) CD (Cooperative Department): Assistance to farmers in establishing farmer organization, acceptance of application of registration and issuing of the registration certificate, and

6) GAO (General Administration Office): Responsible office for coordination between farmer organization and concerned government departments, and consultation to solve complaints/ grievances from concerned farmers.

CHAPTER 2 THE MODEL FARM AREA

2.1 Potential Target Areas and Its Selection

Farmland consolidation is not so common in Myanmar. Farm road, irrigation canal and drainage canal within a farmland area are not yet provided to almost all the farmlands in Myanmar. Therefore farmer cannot manage irrigation water as his/her farm plot needs, thereby they have to depend on rain water or otherwise use over-flow water from the upper farmlands for his/her cropping. This means if upper farmland owner stops irrigation water, automatically lower farmland owner faces irrigation water shortage.

In addition, most farmers cannot access directly to farm road from their plots, making them difficult to use agricultural machines not able to bring about into their farm plots. The Government of Myanmar in fact aims at introducing farm mechanization nation-widely in order to increase farm productivity. In this regard, consolidation of farm lands should be implemented suitable for mechanized farming. Otherwise, under the present situation, to increase crop production more than the current level is very difficult in Myanmar.

Taking into account the farming practices in Myanmar somewhat similar to that of Japan practiced in previous days, experiences and technical know-how accumulated in Japan for farm land consolidation works would be considered useful if utilized in Myanmar. Under this project, a farmland area in Nay Pyi Taw is designated as a model farmland for land consolidation, to which experiences in Japan are to be introduced. Through the consolidation works, guidelines for design and construction of land consolidation are also prepared, facilitating the consolidation work nation-widely.

2.2 Present Condition of the Selected Target Area

The model farm land for the land consolidation is located in Zabu Thiri Township, Nay Pyi Taw City, and it covers an area of 137 ha (338 acre). The number of farmers who have their own right of using the plots within the target farm land consolidation area counts at 138 farmers[1]. A census survey and also sample household economic survey were carried out to examine the concerned farmers and their farm lands in April and May 2013. The surveys were conducted with the staff of Zabu Thiri Township DOA. Surveyors went to the concerned villages where the farmers live and asked them referring to a prepared questionnaire form. The list of the concerned farmers in the target consolidation area was prepared by SLRD Zabu Thiri Township office.

2.2.1 Population Census

The census survey, which covered all the concerned farmers within the target farmland consolidation area, identified total 138 farmer households who have the right of using farmland (see Table 2.2.1). Total number of population for the 138 households came to 625 (male: 301, female: 324), giving an average of 4.5 members per family. It was confirmed with the SLRD that all the farmer households have the legal right of using their farmland. They live in 6 villages of 4 village tracts such as Gone Min Ein, Te Gyi Gone, Shar Taw, Aung Zabu, Ayinlo, and Kan Oo. Note that these villages are located outside the project area whereby no residential houses are found within the project area but agricultural land only.

[1] In Myanmar, land ownership right belongs to the nation “Republic of the Union of Myanmar” and land using right belongs to each farmer (“The Farm land law” effected in March 2012). Settlement and Land Records Department (SLRD) under MOAI is in charge of maintaining farmer’s right of using farmland and they have the list and map of “Who” and “How many” land use right for each of the farmers.

Table 2.2.1 Number of Households and Population affected by Farmland Consolidation

Village Tract	Village	Households	Male	Female	Total
Te Gyi Gone	Gone Min Ein	53	156	159	315
	Te Gyi Gone	5			
	Shar Taw	16			
Aung Zabu	Aung Zabu	24	56	55	111
Ayinlo	Ayinlo	32	66	83	149
Kan Oo (pyin ma nar)	Kan Oo	9	23	27	50
Total		138	301	324	625

Source: Census Survey by JICA Survey Team, April, 2013

Figure 2.2.1 shows farm size together with the number of farmers who own the farm size within the model farm land consolidation area. Total Number of farmers is as aforementioned counted at 138, total area of farmland is 338.23 acre (136.87 ha) and therefore the average of the farmland area per farmer comes to 2.45 acre (0.99 ha). The number of farmers who have less than 1 acre counts at 38 farmers, sharing 28%. It means around one out of every 4 farmers has less than 1 acre of farmland within the model farm land area.

According to the census survey conducted by JICA survey team, farmers' major income source was found agriculture as a matter of course. 120 households out of the total 138 are engaged in agriculture, sharing as much as 87%, from which the major income is generated. Other income sources apart from the agriculture are not many just sharing less than 3% each by cottage worker, casual labor, carpenter, government staff, grocery shop, trader, etc.

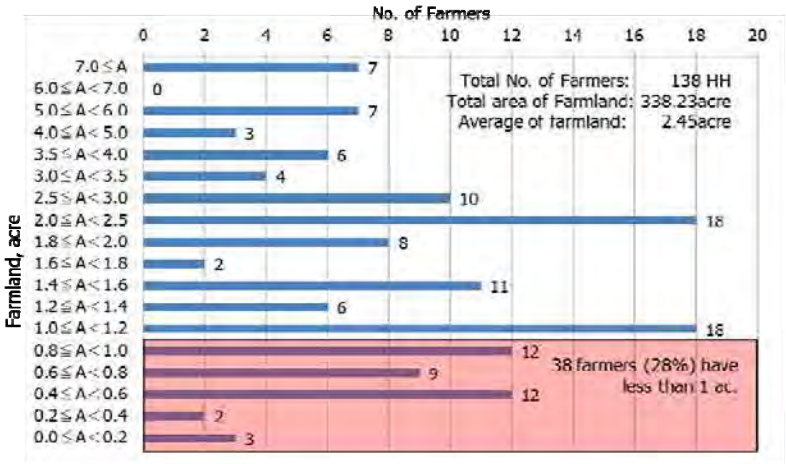


Figure 2.2.1 Farm Size and No. of Farmers

Source: Census Survey by JICA Survey Team, April, 2013

Table 2.2.2 Main Income Source

Item	Households	Percentage %	Remarks
Agriculture	120	87.0	
Cottage Worker	4	2.9	
Casual Labor	3	2.2	
Carpenter	2	1.4	
Government Staff	2	1.4	
Grocery Shop	2	1.4	
Trader	2	1.4	
Farm Labor	1	0.7	
Vendor	1	0.7	
Wage Worker	1	0.7	
Total	138	100 %	

Source: Census Survey by JICA Survey Team, 2013

Since a canal provides irrigation water, though not enough, to the target farmland consolidation area, all the farmers practice either double-cropping or triple-cropping and no farmer does single-cropping. The share of the double-cropping farmers counts at 67% while 33% of them do the triple-cropping. Their main crop is monsoon paddy mostly dependent on rainfall and partly irrigated by the canal; second crop is black gram cultivated during winter season; and the third one is summer paddy if enough water is provided. As for the average annual income (gross term), double-cropping farmers earn about 1.7 million Kyats per annum while those of triple-cropping earn 2.2 million Kyats.

Table 2.2.3 Average Annual Income

Particulars	Number of HHs	Average of annual income (Kyats), /1	Average Area/FHH, acre, /2
Double Crop Farming	92 (67%)	1,726,000	1.9
Triple Crop Farming	46 (33%)	2,173,000	2.9
Total	138 (100%)	1,950,000	2.4

Note: /1 the annual income includes not only the income from the target farmland consolidation area but from others, namely, total income for the farmers.
2/ the average area is the land area they own only within the target land consolidation area.
Source: Census Survey by JICA Survey Team, 2013

2.2.2 Sample Household Economic Survey

Apart from the census survey, JICA survey team conducted a sample household economic survey covering 59 farmer households, equivalent to about 43%, in order to obtain farmers' basic information. Figure 2.2.2 shows population cohort for those sampled households. One of the typical characters is that the younger generation shows smaller number of populations. Also, number of young males such as those between 15 years old and 34 years olds becomes relatively smaller, suggesting out-migration for wage work getting popular in nowadays Myanmar. Number of persons whose age is between 30 and 60 are 138 (48 percentage of the total sampled farmers) while that of between 0 and 29 is 110 (38 percentage of the total sampled farmers).

Above sample survey results indicate that number of farmers who cultivate in the fields will decrease in the coming near future. Improvement of agricultural production is one of the major development policies in Myanmar, and therefore farmland consolidation works should be executed, viewing farm mechanization. With the farm mechanization facilitated under farmland consolidation works completed, such less number of farmers can still produce more products with efficient agriculture practices.

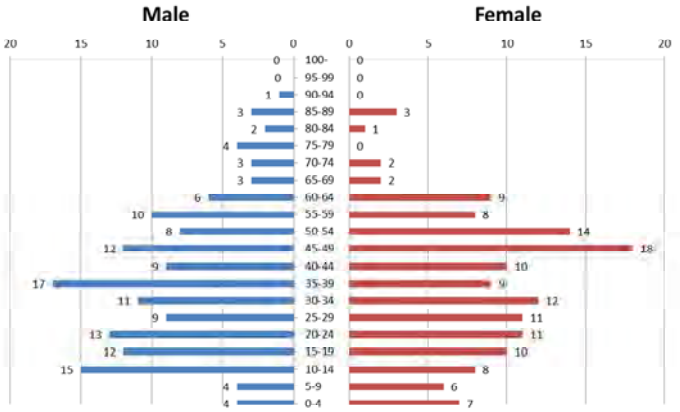


Figure 2.2.2 Population Cohort
Source: Sample HH Economic Survey, April 2013

The sample household economic survey also identified the harvest area, yield, and gross income by crop. Monsoon paddy is the first main income crop in the survey area, whose average area of harvest comes to 4.0 acre and average yield arrives at 82.1 basket/acre. Average annual gross income is estimated at 986,000 Kyats. Gross income in Ayinlo village reaches as high as 2,022,000 Kyats, and 894,000 Kyats for Gone Min Inn, 675,000 Kyats for Aung Zabu and 354,000 Kyats for Sha Taw village.

Table 2.2.4 Annual Yield and Gross Income of Monsoon Paddy

Village tract	Village	No of samples	Total harvest area (acre)	Average harvest area (acre)	Average paddy production		Gross income
					Yield basket/ac	Production basket	Kyats
Gone Min Inn	Te Gyi Gone	30	105.2	3.51	79.38	278.35	894,443
Sha Taw	Te Gyi Gone	5	10.2	2.04	55.00	112.20	354,200
Ayinlo	Ayinlo	13	88.6	6.82	89.30	608.62	2,022,431
Aung Zabu	Aung Zabu	6	14.0	2.33	77.15	180.01	675,350
4 Villages Total		**54**	**218.0**	**4.0**	**82.1**	**331.6**	**986,606**

Source: Sample HH Economic Survey, April 2013

Black Gram is the second main income crop in the survey area. The average area of harvest is

calculated at 4.0 acre (same as monsoon paddy) and average yield arrives at 11.7 basket/ acre. Average annual gross income for the sampled farmers comes to 310,000 Kyats. Ayinlo village shows the highest income of 674,000 Kyats, followed by Gone Min Inn (441,000 Kyats), Aung Zabu (91,000 Kyats) and lastly Sha Taw (35,000 Kyats).

Table 2.2.5 Annual Yield and Income of Black Gram

Village tract	Village	No. of samples	Total harvest area (acre)	Average harvest area (acre)	Average black gram production		Gross income Kyats
					Yield basket/ac	Production basket	
Gone Min Inn	Te Gyi Gone	30	105.22	3.51	10.0	34.9	441,933
Sha Taw	Te Gyi Gone	5	10.2	2.0	8.9	18.1	35,583
Ayinlo	Ayinlo	13	88.61	6.8	15.1	102.9	674,767
Aung Zabu	Aung Zabu	6	14.0	2.3	12.9	30.0	91,250
4 Villages Total		**54**	**218.0**	**4.0**	**11.7**	**46.5**	**310,883**

Source: Sample HH Economic Survey, April 2013

CHAPTER 3 PLANNING AND DESIGNING OF THE MODEL FARM

3.1 Planning of Model Farmland Consolidation

Figure 3.1.1 presents the current land parcels (actual situation of the farm land) in left figure and the design of the farm land consolidation in the right side. The shape of the model farm land is longer in the north-south direction (about 2km) than that of west-east direction (about 1km). The area where the farmland consolidation work is implemented is estimated at 338.23 acre (136.87 ha).

In fact, within the total 338.23 acre, there is a government owned land aside from the farm lands. The government owned land runs from north-west to south-east as indicated in the left figure below. The land was once purchased from the farmers for the purpose of constructing a new highway road but it has been already cancelled. The composition of the land is as follows where the government-owned land shares 8.5% while the rest by the concerned farmers.

Table 3.1.1 Land within the Target Land Consolidation Project Area

Land	Acre	Ha	%	Remarks
Farmer owned land	309.47	125.24	91.5	
Government owned land	28.76	11.64	8.5	Purchased for road construction purpose
Total	338.23	136.87	100.0	

Source: Settlement and Land Registration Department (SLRD)

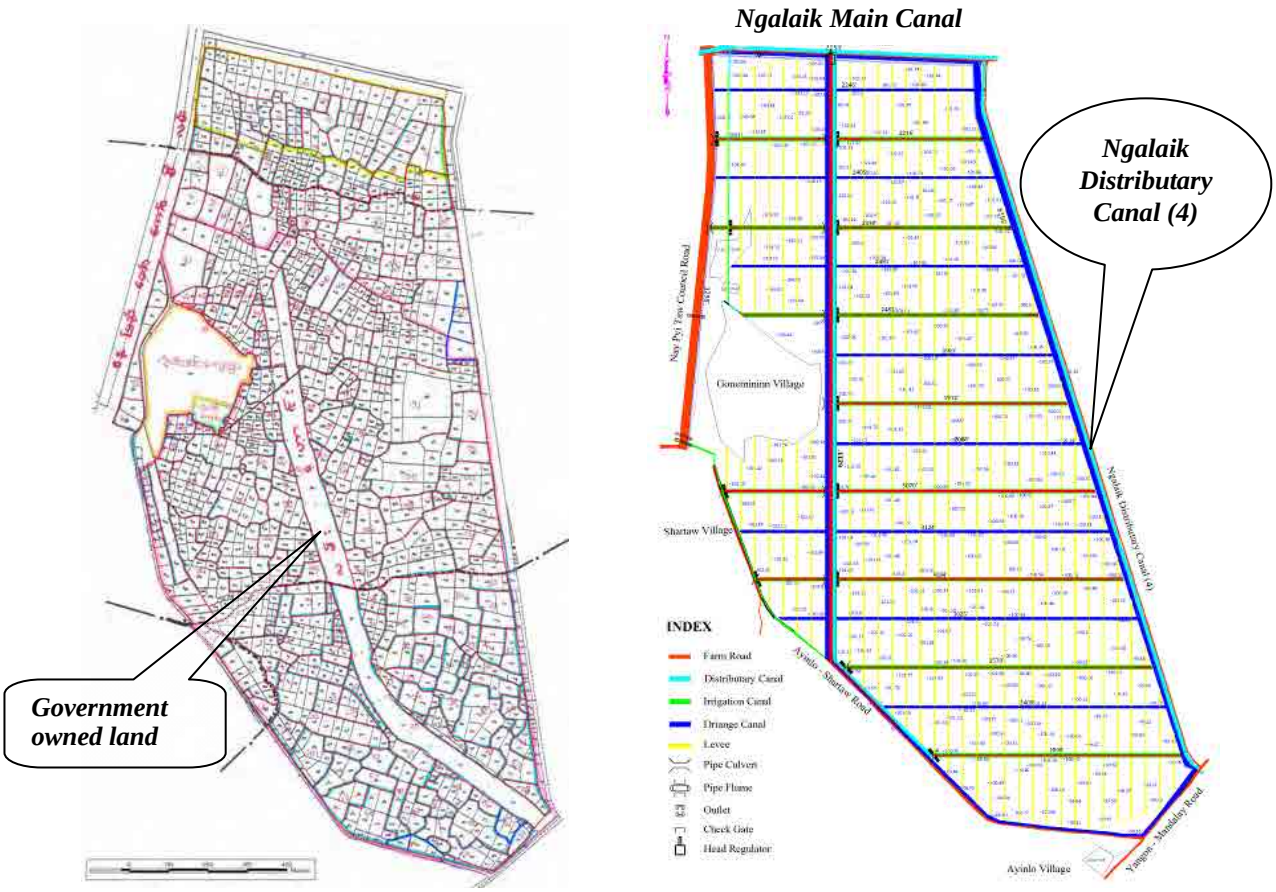


Figure 3.1.1 Actual Situation and Design Drawing of the Model Farm Land

Source: SLRD (Left figure), ID (Right figure)

3.2 Basic Design of Land Consolidation Model Farm

Within the consolidation area, there will be a main irrigation canal to be constructed, running almost center from the north straight down to the south. The irrigation canal functions as the dominant

irrigation canal combined with main farm road. The irrigation canal will take irrigation water from the existing Ngalaik main canal running alongside the northern peripheral of the project area. Two major drainage canals are to be constructed; one will run in parallel with the main irrigation canal sandwiching the main farm road in between, and the other one runs along the existing distributary canal of Ngalaik No.4.

Given the network of the main irrigation canal, major drainage canals and the main farm road, supportive irrigation canals, drainage canals and farm roads are all aligned running east-west direction as indicated in the above Figure 3.1.1 (right). The supportive irrigation canals and drainage canals are allocated alternately, and supportive farm roads are aligned alongside the supportive irrigation canals.

3.3 Standard Design of the Model Farm Facilities

3.3.1 Main Irrigation Canal, Drainage Canal and Farm Road

The main canal constructed in the consolidation area is planned to receive irrigation water from the Ngalaik main canal with the head regulator located at about 250 m upstream of the head regulator of the Ngalaik distribution canal (4). The main canal runs from north to south on the east of the Gonemininn village. About 80% of the project beneficial area located on the east of the canal will be commanded by this canal. For the rest of the area located in the vicinity of the Gonemininn village on the west of the canal, water is supplied from the canal running along the Nay Pyi Taw Council Road. The typical cross section of the distribution canal, road and drainage canal is shown in Figure 3.3.1.

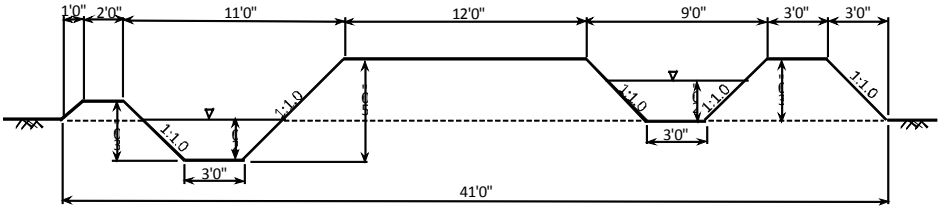


Figure 3.3.1 Typical cross section of Main Canal, Road and Drainage

Source: Irrigation Department, Ministry of Agriculture Irrigation, 2013

3.3.2 Supportive Irrigation Canals and Farm Roads

Supportive farm roads and irrigation canals are important permanent structures, aside from the main ones, which are meant to delineate the farm blocks. It is very common in Myanmar to have irrigation canals on both side of the farm road. In this method, farmers can get the water from the irrigation canal quite easily with a simple outlet structure. In the project planning, conventional layout plan having one farm road with two irrigation canals on both sides is applied. The typical cross section of the farm road and irrigation canal is shown in Figure 3.3.2. The farm roads with irrigation canals running both sides are designed to run east-west direction within the target project area.

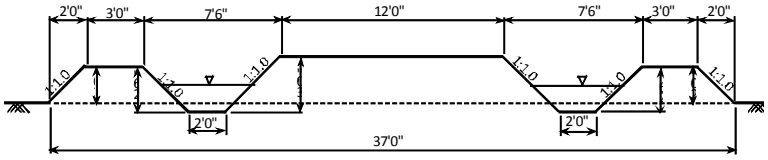


Figure 3.3.2 Farm road and Irrigation Canal

Source JICA survey team

3.3.3 Supportive Drainage Canal

Supportive drainage canals are planned along the center of the each farm blocks; namely along the center of 2 supportive irrigation canals. The drainages are therefore set to run east-west direction same as that of supportive irrigation canals. The depth of the drainage

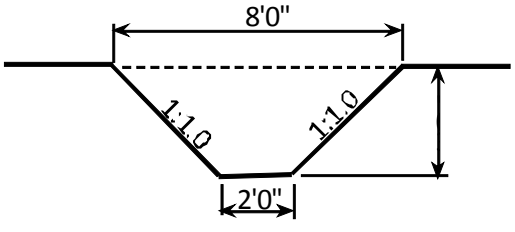


Figure 3.3.3 Typical Cross Section of Drainage Canal

Source JICA Survey Team

canal is set at 3 feet, which could be sufficient for the surface drainage of excessive rain water. The typical cross section of the drainage canal is shown in Figure 3.3.3.

3.3.4 Boundary Levee

Boundary levees are provided to divide a field block into suitable size of the field lots. Farm management, especially water management for each field lot, can be ensured by these boundary levees constructed along each perimeter of the field lots. Typical cross section of the boundary levees is shown in Figure 3.3.4

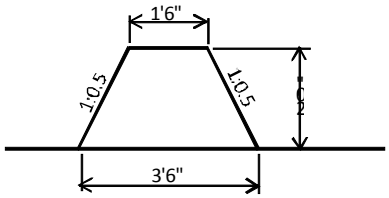


Figure 3.3.4 Typical Cross Section of Levee
Source JICA Survey Team

3.3.5 Standard Plot Arrangement

The standard plot to be constructed with the land consolidation work is set to be 1 acre each (0.405 ha each). The examples are indicated by number of rectangular squares as in the right of Figure 3.1.1. The rectangular square is constructed having longer size along north-south direction while the east-west direction is set shorter taking into account the setting of the network of supportive irrigation and drainage canals. The rectangular square, the standard plot, is supposed to receive irrigation water from either northern edge or the southern edge, and the excessive irrigation water is to be discharged into the drain constructed at another side of the irrigation canal.

3.4 Reallocation Plan for Farm Plots

Under the model project, planned area of consolidation farm land is 338.23 acre. Out of 338.23 acre, 26.2 acre will have to be used for the construction of public facilities such as farm road, irrigation and drainage canals. According to an original plan, the land acquired by the government was planned to be utilized for the establishment of such public facilities.

However, the Nay Pyi Taw city council has decided to sell back the land to the former owners of the farmlands at the same price at which it was compensated. This is because the plan of constructing a highway road was already cancelled and there was advocacy during a series of meetings for the project that the former owners of the farmlands were eager to follow the decision made by Nay Pyi Taw city council.

Therefore, the necessary land for constructing the facilities shall be availed by all the concerned farmers. The necessary land of 26.2 acre shares 7.7 percent of the total area (26.2 / 338.2 x 100 = 7.7%). To avail of the 26.2 acre land, each and every farmer shall surrender their part of the land proportionally equivalent to the 7.7%. By applying such arrangement, unfairness amongst the farmers will not take place.

Plot re-allocation plan will be prepared by the management committee of farmer organization which is organized by all the concerned farmers under the project supported by SLRD, ID, Cooperative Department and JICA survey team. After the preparation of re-allocation plan, management committee will negotiate with each and every farmer to finalize the consolidation plan under the support of SLRD, ID, Cooperative Department and JICA survey team.

Remaining farmland after losing 7.7 % for the public facilities will be allocated to all the farmers. Every plot will be shaped at 1 acre; however, in fact 28% farmers have less than 1 acre of farm land within the target consolidation area. Therefore, farmers have to share or divide one farm plot of 1 acre with other farmers by putting up a small earthen band. This arrangement should be discussed between the farmers mediated by the management committee of the farmer organization.

CHAPTER 4 ENVIRONMENTAL AND SOCIAL CONSIDERATION (NAY PYI TAW)

Farmland consolidation work brings about an improvement of irrigation and drainage canals, adjustment of small or separated farmland plots to bigger farmlands, and improvement or new establishment of farm roads. On the other hand, there could be a possibility that the consolidation works may cause some negative environmental impacts on the surrounding environment and also the society. This chapter discusses expected impacts taking into consideration current natural and social conditions in the area and how to mitigate expected negative impacts.

4.1 Location and Basic Design of the Project

Figure 4.1.1 indicates the location of model farm consolidation site while Figure 4.1.2 shows the proposed design of the farm land consolidation. Planned farm land for the land consolidation occupies an area of 338 acre (137 ha) and beneficially households are counted at 138. The model farm land is located in Zabu Thiri Township, Nay Pyi Taw City. The shape of model farm land is longer in the north-south direction (about 2km) than that of west-east direction (about 1km).

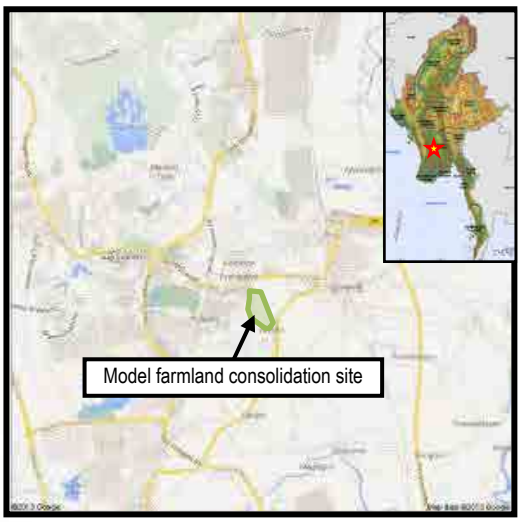


Figure 4.1.1 Location of the Model Farmland Site
Source: the Survey Team (2013)

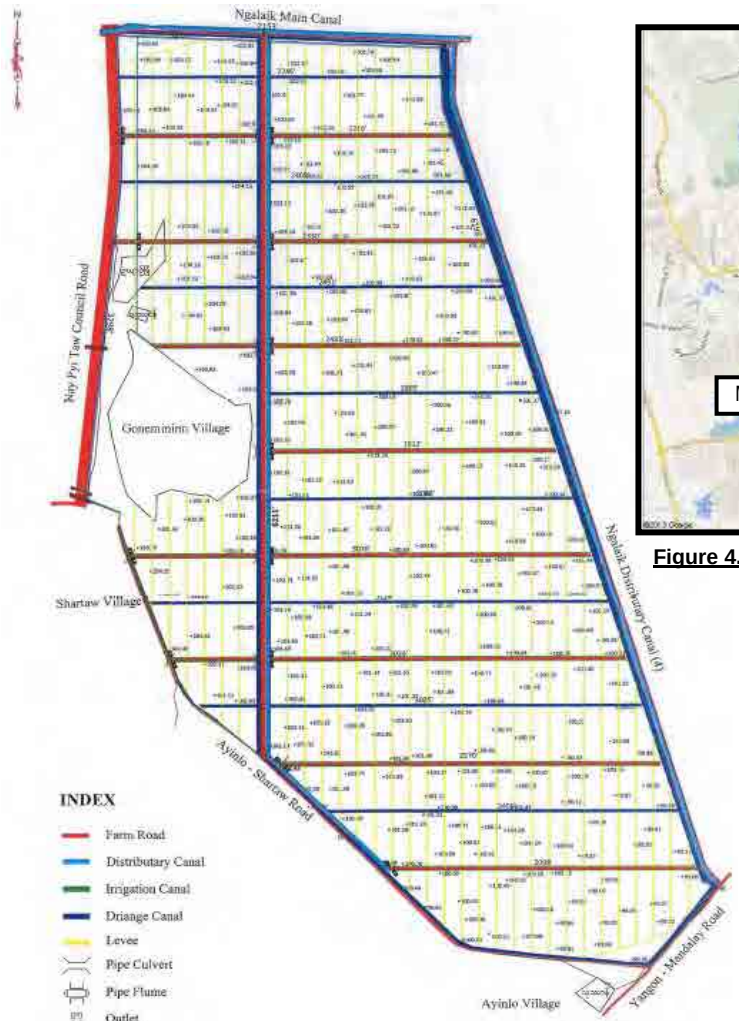


Figure 4.1.2 Plan of the Model Farm Consolidation in Nay Pyi Taw
Source: Irrigation Department, technical assistant by the Survey Team (2013)

4.2 Organizations Concerned for the Land Consolidation Work

Concerned organizations for this model farmland consolildation work are; Agricultural Mechanization Department (AMD), Construction No.4 (CON4) of Irrigation Department (ID), SLRD (Settlement and Land Record Depaertment), and Cooperative Department (CD) aside from the relevant township

administration office and also the beneficiary farmers.

AMD and CON4 are in charge of design as well as the construction of farmland consolidation works, both of which are under the Ministry of Agriculture and Irrigation (MOAI). AMD has a number of 70HP- 90HP tractors which are utilized in leveling the farmlands while CON4 has such machineries as excavator, dump truck and rollers employed in the construction of farm roads, irrigation and drainage canals.

SLRD is also under the Ministry of Agriculture and Irrigation, in charge of farm land registration. The SLRD has registration record of all the existing farmlands though there are cases of not being updated. Cooperative Department belongs to the Ministry of Cooperatives. The cooperative department is in charge of establishment and registration of farmer organization. Under this land consolidation project, a farmer organization is officially established where the Cooperative Department takes the major role.

4.3 Current Environmental and Social Conditions

Villagers around the model consolidation site are mostly engaged in farming and in fact their main income source is pinned at agriculture. The first main crop in the model site and its surrounding areas is monsoon paddy cultivated during rainy season from July to October, and the second crop is black gram which is cultivated during winter from November to March. Some farmers grow summer paddy from April to July, which is in fact cultivated in between the black gram (winter crop) and monsoon paddy.

The model farmland does not belong to residential area, whereby no residential houses and livestock houses are erected within the area. The area does not belong to military zone, political zone and hotel zone either. The site occupies just farm land only rendered for paddy cultivation and black gram cultivation as aforementioned. There are no cultural/historical monument and natural conservation area that should be protected from any human activities in and around the model farmland area.

4.4 Legislative and Institutional Framework of Environmental Consideration in Myanmar

In Manmar, environmental issue is enforced according to “the Environment Conservation Law, the Pyidaungsn Law No.9/2012” enacted on 30 March 2012. The Environment Conservation Law states that a project or activity exptected to cause a ‘significant impact’ on the environment should be put under EIA. However, the Law in fact does not specify what kinds/types of projects need EIA, nor specify detail rule/proess of scoping, examination of alternatives for the proposed projects, etc.

The model farmland consolidation project may cause negative environmental and soicial impacts; however it is not expected to cause ‘significant impact’ with reference to past examples and experiences especially accumulated in Japan. In addition, though land consolidation works have already been started by Myanmar government in some places near Nay Pyi Taw, no EIA procedure has been so far enforced for those consolidation projects.

Therefore, this report is to conduct such examinations with reference to the JICA Environmental and Social Consideration Guideline, based on which mitigation measures and monitoring and compensation if required are to be recommended. However, official EIA procedure which is to obtain official approval from the concerned authority in Myanmar before the commencement to the work is thought not necessary according to the Law.

4.5 Examination of Alternatives

Taking into consideration geographic conditions, convenience/easiness of farmland consolidation works, necessity of resettlement, local people’s request, budgetary issues and so on, proper location of farm land consolidation site is examined. For farmland consolidation, two options are examined,

namely, 1) farmland consolidation and 2) new farmland development.

Based on the examination, farm land consolidation at the current farm land is recommended as examined in the following table. Concerning new farm land development (Option 2), there is no available area to replace the farm land nearby since this area is within the Capital area of Myanmar. If this project selects Option 2, new farm land will therefore be far from the current farm land and those farmers will be forced to move to the new farm land. Therefore, the Option 2 cannot be selected, whereby Option 1 is selected.

Table 4.5.1 Examination of Alternative Project on Farm Land Consolidation

Environmental items	Option 0 (no project)	Option 1 Farm land consolidation	Option 2 New farm development
Farmland consolidation work site	-	Same site as current farm land	New farm land should be prepared
Resettlement and land acquisition (land recovery)	-	X Construction of farm road and irrigation and drainage canals needs land.	XXX Full scale of land acquisition is required.
Access	-	++ Thanks to the establishment of new farm road into the farmland area, better access is expected.	XXX New farm is to be developed at a far place from the present.
Effect of project	-	+++ New farm road and irrigation system will increase agriculture production.	XX New land may not be as fertile as the present one, resulting in lower yields of crops.
Project cost	Zero	Medium	Very High
Selection	-	Selected	-

X : small-scale negative impact, XX: middle-scale negative impact, XXX: large-scale negative impact
+ : small-scale positive impact, ++: middle-scale positive impact, +++: large-scale positive impact
Source: the Survey Team (2013)

4.6 Scoping and TOR for Environmental and Social Consideration

Prior to the Environmental and Social Examination for the model farmland consolidation project, examination of degree of environmental impacts by the project, so called “Scoping” shall be conducted. By the scoping, some environmental parameters, on which negative impacts likely take place, are to be identified. For those parameters, terms of reference (TOR) to specify study/survey method of Environmental and Social Examination are prepared. Results of the scoping as well as TOR for necessary surveys are presented as follows:

Table 4.6.1 Scoping of the Pilot Farmland Consolidation Project in Nay Pyi Taw

Environmental parameters	Evaluation		Reasons
	Construction phase	Operational phase	
1. Air pollution	B^-	D	Due to the farmland consolidation works, air quality deterioration such as dust generation and gas emission from heavy machines is expected. After the completion of the works, no air pollution is anticipated.
2. Water pollution	B^-	D	Due to civil work, some sediment may drain into main canal running alongside the project area. Oil leakage from heavy machines, vehicles, etc. may be expected during the construction phase.
3. Waste	B^-	D	Some construction waste including soils to be moved may be dumped during farmland consolidation works.
4. Soil contamination/ salinization	D	D	Some heavy machine may leak their oil. However, the scale of leakage is too small to

Environmental parameters	Evaluation		Reasons
	Construction phase	Operational phase	
			influence soil contamination, whereby no impact is expected on this parameter.
5. Noise and vibration	B^-	D	Noise and vibration from heavy machines seem to influence residents living nearby. After completion of the work, no noise and vibration are expected.
6. Ground subsidence	D	D	Only the shape of farm land surface will be improved by this farmland consolidation works. Therefore, ground subsidence is not expected both during and after works.
7. Offensive odor	D	D	Mainly earth works will be conducted under the farmland consolidation works. Therefore offensive odor is not expected both during and after works.
8. Protected area	D	D	There is no protected area in and around the model farm consolidation area, and therefore no impact on this parameter.
9. Ecosystem	D	D	This project targets existing farmland area and there is no rare species of animal or plant at this area. Therefore, no impact on the ecosystem is expected.
10. Hydrological situation	D	D	This project targets only 134ha. This scale is too small to cause some impact to hydrological situation.
11. Topography and geographical features	B^-	B^-	Due to the re-shaping of existing farmland and new preparation of farm road and irrigation & drainage canals, topographical and geographical features will be changed.
12. Involuntary resettlement	D	D	There is no residential house within the land consolidation area. Therefore, no resettlement is to take place under the project.
13. Land recovery/ loss	B^-	B^-	Some parts of farmland area will be changed to farm road, and irrigation and drainage canals due to the farm land consolidation work. Therefore, the beneficiary farmers are supposed to surrender a part of their farmlands, resulting in loss of their land.
14. The poor	D	D	The poor, who are those farmers possessing smaller farmland in this Project, is not excluded from the land consolidation work, whereby no specific impact takes place only on the poor.
15. Indigenous and ethnic people	D	D	There is no ethnic minority in and around the farmland consolidation sites, and therefore no impact is expected on them.
16. Employment	D	D	Most of the works are to be done by machineries; hence little employment opportunities takes place during construction stage. During operation stage, the employment situation will be same as the present. Therefore, no impact on the employment by the project.
17. Livelihood for local economy	D	A^+	There is high expectation for increasing local economy thanks to the established road/canals upon completion of the farmland consolidation. Road and canals will increase agriculture production, i.e. their major livelihood.
18. Land use and regional resources	D	A^+	After the completion of farmland consolidation works, every farmer can use their own farmland equipped with farm road, irrigation and drainage canals more efficiently.
19. Water usage or water rights and rights of common	B^-	A^+	During the farmland consolidation works, farmer cannot use irrigation water, and accordingly

Environmental parameters	Evaluation		Reasons
	Construction phase	Operational phase	
			cultivation cannot be practiced either. After completion of the works, every farmer can use irrigation water more efficiently than before.
20. Existing social infrastructures and services	D	D	This project aims at upgrading the farmland operation. Therefore no negative influence is expected under this project to the existing social infrastructures and services.
21. Social organization, such as a decision making organization or social fund.	D	A^+	In line with the consolidation works, a new farmer organization will be established and they will be in charge of O&M of road and canals. This organization will contribute to enhancing the agriculture production by facilitating efficient water use, bulk purchase of e.g. fertilizer, etc.
22. Misdistribution of benefit and damage	B^-	B^-	During the process of farmland re-plotting, some misdistribution of farmland re-plotting may take place, giving larger portion to some farmers if not well monitored.
23. Social institutions	D	D	No influence for social institutions is expected because there is no hospital, school, etc. in and around the project area.
24. Cultural heritage	D	D	There is no cultural heritage in and around the model site, hence no impact is expected.
25. Landscape	D	A^+	Actual farmland will be upgraded to be in good shape by the farmland consolidation works, therefore no adverse effect on landscape is anticipated, rather positive impact on the landscape after the completion of the work.
26. Gender	D	D	Mainly earth work is done by the farmland consolidation works, and therefore no negative impact is expected in terms of gender. During the operation stage, both women and men engaged in agriculture will be benefited from the farm road and canals, whereby no segregated negative impact on the gender is expected.
27. Children's rights	D	D	Mainly earth work is done by the farmland consolidation works, and therefore any damage to children's rights is not anticipated. After completion of the work, improved agriculture will not affect any children's rights.
28. Hazards (Risk), Infectious diseases.	D	D	No hazard or infectious disease is expected both during and after works because this farmland consolidation works will be finished within only 2 months, not employing many numbers of workers.
29. Working environment. (Including working safety)	B^-	A^+ (for farmers)	Working environmental safety measures should be enforced during the farmland consolidation works. After the farmland consolidation works completed, the working environment for the farmers will be upgraded thanks to the establishment of farm road and canals.
30. Accidents	B^-	D	During farmland consolidation works, there is a possibility that accident may be increased due to traffic increase for the farmland consolidation works.
31. Global warming	D	D	This project targets only 134ha, and therefore no global warming by the works 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.
Source: JICA Survey Team (2013)

Table 4.6.2 Terms of Reference for the Environmental Parameters Identified by Scoping

Environmental parameters	Study contents	Study method
1. Air pollution	• Study the influence to social institutes under the farmland consolidation phase. • Study the heavy machines which are planned to use under the farm land consolidation work.	• Examination of location of hospital, school, residential area, farmland consolidation works period and site. • Examination of what kind of and how many heavy machines are used under this farm land consolidation works.
2. Water pollution	• Study the sedimentation basin. • Study the heavy machines which are planned to use under farm land consolidation work.	• Examination of sedimentation basin in the sites during the farmland consolidation work. • Examination of what kind of and how many heavy machines are used under this farm land consolidation works.
3. Waste	• Study the kind of dumped wastes under the farmland consolidation phase.	• Examination of construction plan of waste disposal contents and the disposal site(s).
5. Noise and vibration	• Study the influence under the farmland consolidation works term.	• Examination of location of hospital, school, residential areas, etc. • Examination of construction plan of working time.
11. Topography and geographical features	• Study the farmland consolidation plan and design.	• Examination of planning and design of farmland consolidation works.
13. Land recovery/ loss	• Study the area to be changed to farm road and canals.	• Examination the area of right of farm road, irrigation canal and drainage canal.
19. Water usage or water rights and rights of common	• Study the farm consolidation work phase.	• Examine the farm land consolidation working period and farming period.
22. Misdistribution of benefit and damage	• Study the re-plotting plan.	• Examination of the re-plotting plan and monitor the distribution process.
29. Working environment. (Include working safety)	• Study the influence under the farmland consolidation works phase. • Study the heavy machines which are planned to use.	• Examination of the other similar project cases. • Examination of what kind of and how many heavy machines are used under this farm land consolidation works.
30. Accidents	• Check the influence under the farmland consolidation works phase. • Study the heavy machines which are planned to use.	• Examination of what kind of and how many heavy machines are used under this farm land consolidation works.

Source: JICA Survey Team (2013)

4.7 Results of Environmental and Social Examination

Following the TOR mentioned above, Environmental and Social Examination was conducted with reference to the model farmland consolidation map, plan and design of the farmland consolidation, interviews to concerned organizations such as “Irrigation Department, Department of Agriculture, Zabu Thiri Township Office”, and also the JICA team conducted census survey covering all the affected households. The results based on the examination are summarized below:

✓ No.1 Air pollution: Considering that the farmland consolidation work period is limited only in two months and the number of heavy machines which are planned to use under this project are not so many, i.e. Crawler Tractor x 2, Hydraulic Excavator x 2, Dump Truck x 2, Vibrater x 1 and Mini Back hoe x 2, significant negative impact is not expected and any noticeable air pollution by other similar projects has not been reported either. It is however noted that there is a residential area nearby at a western part from the model farm land area, so that all the heavy machineries should be well maintained to minimize the air pollution during the farmland consolidation work phase.

✓ No.2 Water pollution: Considering that the farmland consolidation works period is relatively limited and furthermore what is to be undertaken under this farmland consolidation work is an earth work, any large scale negative impact for water pollution is not expected and any large scale water pollution by other similar projects has not been reported either. However, since

construction is expected to take place in rainy season (May and June), sedimentation basin should be prepared in the field to prevent the sediment from draining into Ngalaik main canal and Ngalaik distributary canal (4) running northern and eastern peripherals of the model farmland area.

- ✓ No.3 Waste: Small amount of excavated soils are to be emitted by farmland consolidation works, however almost all the excavated soils can be reused for irrigation and drainage canal embankment, levee construction, and farm road embankment. As a result, negative impact will not be expected on the waste. Any waste problem has not been reported for other similar projects either.

- ✓ No.5 Noise/vibration: There is a primary school at a western part of the model farm land. However, no negative impact of noise/ vibration to this school is expected because this primary school will be off from May to June, during which the model farm consolidation works are to be implemented. It is noted that there is a residential area around the primary school, whereby the construction works should be stopped from 18:00 to 8:00 near the residential area in order not to give annoyance to the residents.

- ✓ No.11 Topography and geographical features: The highest elevation in the project area is 31.6m (104ft) while the lowest elevation is 30.2m (99ft). Difference of these elevations is only 1.5m (5ft) within the project area of 331acre (134ha). In this farmland consolidation works, the shape of farm plot will be fixed within the difference of elevation, 1.5m (5ft), and therefore no negative impact of topography and geographical features is expected.

- ✓ No.13 Land recovery/ loss: After the farmland consolidation works, 26.2acre (10.6ha) area will be changed to farm road, irrigation canal and drainage canals. Therefore, each and every farmer beneficiary is supposed to surrender a part of their farmland proportionally according to the area presently owned. The total project area arrives at 338 acre (137 ha) while the land to be lost is 26.2acre (10.6ha), thereby each farmer has to surrender 7.8% of what they own at present (10.6 divided by 137 ha)[1]. The property right of land (this "land" means constructed irrigation canal, drainage canal and farm road under this farmland consolidation project) is to be transferred to a farmer organization to be established by the beneficiary farmers. This farmer organization shall be registered officially by making application to Cooperatives Department, Ministry of Cooperatives. Therefore, the land will be a sort of common property of the members of the farmer organization.

- ✓ No.19 Water usage or water rights and rights of common: Farm land consolidation work is scheduled in May and June, during which no cultivation is practiced on the target farmlands. It is therefore expected that the farmers will not suffer from any water usage or water right from this project (note that actual construction was carried out from February to April, during which no crop was cultivated). Upon completion of the project, the farmers will benefit more efficient water usage for irrigating their crops thanks to the irrigation and drainage canals to be established.

- ✓ No.22 Misdistribution of benefit and damage: Some misdistribution of benefit may be expected at the re-allocation of the farm plots. Some farmers may insist in moving to profitable plot (for example, plots near the main farm road). In addition, some farmers may insist in surrendering

[1] In fact, Nay Pyi Taw Council had once purchased a farm land of 11.6 ha (28.8 acre) within the project area, which was meant to construct a highway. However, the plan was cancelled and the 11.6ha of the already purchased land is planned to be brought back to the original farmers at the same price of what the Council purchased. Therefore, this 11.6 ha (28.8 acre) can not be used to directly compensate the area to be lost by the establishment of farm road and irrigation & drainage canals.

less percentage of the farmland required for the establishment of farm road and canals, regardless the fact that all the farmers shall surrender part of their farmlands proportionally to the extent of area they own at present.

- ✓ No.29 Working environment. (including working safety): This kind of farmland consolidation works deal mainly with earth work and it is not complex work by nature. However, still such machineries are used as Crawler Tractor x 2, Hydraulic Excavator x 2, Dump Truck x 2, Vibrater x 1 and Mini Back hoe x 2, and therefore working safety should be enforced by the supervisor appointed by the Irrigation Department (ID) during the construction phase.
- ✓ No.30 Accident: The heavy machineries employed for the works will be carried into the field at the first time of the consolidation works, and not go outside of the field during the work phase until the completion of works, resulting in little possibility of accidents to passersby. For the fuel supply to the heavy machines, however, one refueling car will have to access into the field every day. Access way into the field is limited only at southern part of the field, and watchman should check the access of refueling car every time and pay attention to passersby not to be near the site. There should be a need to allocate the watchman to avoid any traffic accident.

4.8 Impact Evaluation

Based on the results mentioned in 4.5 Scoping and TOR for Environmental and Social Consideration, environmental impacts were examined in 4.6 Results of Environmental and Social Examination. With the examination completed, evaluation of No.3, namely “Waste”, No.11 Topography and geographical features, and No.19 “Water usage or water rights and rights of common” were changed as follows:

- ✓ On No.3 Waste, the evaluation at the scoping stage was B^- for the construction stage, and this result changes to D. This is because though the project will generate soils by the consolidating works, almost all the excavated soils are to be re-used for leveling the farmland, embankment of the farm road to be established, embankment of the irrigation canals where the elevation is relatively low, whereby wastes are not to take place.
- ✓ On No. 11 Topography and geographical features, the evaluation at the scoping stage was B^- for the construction stage, and this result changes to D. In fact, topography and geographical features will be changed according to the result of farmland consolidation work; however the scale of change is very small, to take place only within the difference of 1.5m (5ft). In addition, actual farmland will be upgraded to be in good shape by the consolidation works, therefore no adverse effect on the landscape is anticipated; rather positive impact on it after the completion of the work is expected.
- ✓ On No.19 Water usage or water rights and rights of common, the evaluation at the scoping stage was B^- for the construction stage, and this result changes to D. It is because that the farmland consolidation work will be done during the off-crop season, namely, the season before the commencement of monsoon paddy, during which no crop is cultivated whereby no water usage is needed.

Table 4.8.1 Impact Evaluation

Environmental parameters	Evaluation at scoping		Evaluation based on the result of environmental and social examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
1. Air pollution	B^-	D	B^-	D	Due to the farmland consolidation works, air quality deterioration associated with dust generation and gas emission from farmland

Environmental parameters	Evaluation at scoping		Evaluation based on the result of environmental and social examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
					consolidation works is expected, though it will be temporally. There is a residential area at a western part from the work area, so that maintenance of heavy machineries is due required. After the completion of the works, no air pollution is anticipated.
2. Water pollution	B-	D	B-	D	Because farmland consolidation works will be held during rainy season (May and June), some sediment may drain into main canal. To prevent the sediment from draining into canal, sedimentation basin should be prepared in the field and maintenance should also be done.
3. Waste	B-	D	D	D	Some amount of excavated soils seems to be discharged; however, almost all of soils can be reused for the farmland consolidation works.
4. Soil contamination/ salinization	D	D	D	D	No negative impact is expected.
5. Noise and vibration	B-	D	B-	D	There is a residential area at the western part of farm land, to which some noise and vibration from the heavy machines may give annoyance. Therefore construction should stop during 18:00 to 8:00 near the residential area.
6. Ground subsidence	D	D	D	D	No negative impact is expected.
7. Offensive odor	D	D	D	D	No negative impact is expected.
8. Protected area	D	D	D	D	There are no protected areas in and around the model farm land.
9. Ecosystem	D	D	D	D	There are no rare spaces of animal or plant in and around the model farmland area, therefore no negative impact is expected.
10. Hydrological situation	D	D	D	D	No negative impact is expected.
11. Topography and geographical features	B-	B-	D	D	Topography and geographical features will be changed, however the scale of changes is very small, therefore no negative impact on the topography and geographical features is expected.
12. Involuntary resettlement	D	D	D	D	There are no inhabitants in model farm land area; therefore no involuntary resettlement is expected.
13. Land recovery/ loss	B-	B-	B-	B-	About 8% of farmland area will be changed to farm road, and irrigation & drainage canals due to the land consolidation work. Therefore, the beneficiary farmers are supposed to surrender a part of their farmlands proportionally to what they have, resulting in loss of their land.
14. The poor	D	D	D	D	No negative impact is expected.

Environmental parameters	Evaluation at scoping		Evaluation based on the result of environmental and social examination		Reasons
	Construction phase	Operation phase	Construction phase	Operation phase	
15. The indigenous and ethnic people	D	D	D	D	No negative impact is expected.
16. Employment	D	D	D	D	No negative impact is expected.
17. Livelihood for local economy	D	A^+	D	A^+	Thanks to the increase of agricultural product after the consolidation works, local economy is to be improved.
18. Land use and regional resources	D	A^+	D	A^+	After the completion of farmland consolidation works, every farmer can use their own farmland equipped with farm road, irrigation and drainage canals more efficiently.
19. Water usage or water rights and rights of common	$\underline{B^-}$	A^+	$\underline{D}$	A^+	Farmland consolidation work will be done in May and June. At that time, farmer doesn't cultivate crops in their farm lands. Therefore, no negative impact for water usage is expected..
20. Existing social infrastructures and services	D	D	D	D	No negative impact is expected.
21. Social organization such as a decision making organization or social fund	D	A^+	D	A^+	In line with the consolidation works, a new farmer organization will be established and they will be in charge of O&M of road and canals. This organization will contribute to enhancing the agriculture production by facilitating efficient water use, bulk purchase of e.g. fertilizer, etc.
22. Misdistribution of benefit and damage	B^-	B^-	B^-	B^-	During the process of farmland re-plotting, some misdistribution of farmland re-plotting may take place, trying to have larger portions if not well monitored.
23. Social institutions	D	D	D	D	Since this project is not concerned to social institutions, no impact on social institution will take place.
24. Cultural heritage	D	D	D	D	There are no cultural heritages in and near the model farmland area; therefore no impact is expected.
25. Landscape	D	A^+	D	A^+	No negative impact is expected.
26. Gender	D	D	D	D	No negative impact is expected.
27. Children's rights	D	D	D	D	No negative impact is expected.
28. Hazards (Risk), Infectious diseases.	D	D	D	D	No negative impact is expected.
29. Working environment. (Include working safety)	B^-	A^+ (for farmers)	B^-	A^+ (for farmers)	Consideration of working environment safety should be paid attention during farmland consolidation working phase.
30. Accidents	B^-	D	B^-	D	During farmland consolidation works, there is a possibility that an accident may take place due to increase of traffic associated with the farmland consolidation works.
31. Global warming	D	D	D	D	No negative impact is expected.

Source: the Survey Team (2013)

4.9 Mitigation Measures and Cost

Some adverse impacts which are caused by the project are anticipated, and in general they are limited to farmland consolidation work phase only, about two months during off-crop season, except for land recovery/loss. It is therefore that the most damages are tentative and recoverable, e.g. air pollution, water pollution and noise. Those mitigation measures should be carried out by Irrigation Department (ID) and Agricultural Mechanization Department (AMD).

It is possible to minimize such impacts by some mitigation measures shown in the following table (note that mitigations for working environment and accidents are indicated as a same group, and measures on land recovery/ loss are elaborated in the following chapter "Land Acquisition: Simplified Resettlement Action Plan"). Necessary monitoring cost is all included in the management cost for the farm land consolidation works, and therefore no separate allotment for the fund is made.

Table 4.9.1 Mitigation Measures

Environmental parameters	Proposed environment management plan		Implementing organization	Monitoring /responsible organization
	Farmland consolidation works phase	Operation phase		
Air Pollution	• To prevent causing air pollution, carry out regular check and maintenance for the farmland consolidation works vehicles/ machineries. • Spray water in and around the farmland consolidation works sites in order to prevent dust arouse. • Monitor the complaints from the relevant inhabitants who live in near the farmland consolidation works site.	-	ID (CON4)	ID (CON4)
Water pollution	• To prevent the sediment drain into Ngalaik main canal and Ngalaik distributary canal (4), sedimentation basin should be prepared at a lower part of the field. • If the sedimentation basin becomes full with sediment, the sediment should be removed from the basin. The removed sediments will have to be brought back to and spread over the farm area after having been dried.	-	ID (CON4)	ID (CON4)
Noise and Vibration	• Carry out regular check up and maintenance of heavy machineries in order to prevent big noise and vibration. • Do not carry-on the work near the residential area at night time, from 18:00 to 8:00. • Monitor the complaints from the relevant inhabitants.	-	ID (CON4)	ID (CON4)
Land recovery/ loss Note: this issue is elaborated in the following chapter.	• Get consensus on the surrender of a part of their land, about 8% of what they own at present, from all the beneficiary farmers. • Make arrangement to place the title deed for the farm road and canals under the farmer organization to be established, implying that the land areas occupied by the road and canals will be a common property for all the beneficiary farmers.	Once agreed before the commencement of the work, no impact during operation phase.	Cooperative Department, SLRD	Cooperative Department
Working environment (Include working safety)/ Accident	• To prevent causing accident from heavy machineries, carry out regular check-up and maintenance of heavy machineries. • Carry out safety checking during the time of bringing the heavy machineries into the field at the first time of the farmland consolidation works and bringing out these machineries after the farmland consolidation works. • Carry out safety checking every day when refueling car accesses into the field. • To inform the farmland consolidation works to the inhabitants who live near the site, put up a sign board for the work. • Instruct all the drivers/operators on compliance with prescribed routes, speed, working hours, etc.	-	ID (CON4)	ID (CON4)

Source: JICA Survey Team (2013)

4.10 Monitoring Plan

Anticipated environmental impacts are limited only to the farmland consolidation works phase, and related monitoring will be implemented during the period. Since the environmental parameters which can be affected by the farmland consolidation works are air pollution, water pollution, noise/vibration, working environment and accident, those items shall be monitored (note that issue of land recovery/ loss is discussed further in detail in the following chapter):

Table 4.10.1 Recommended Monitoring Plan (Farmland consolidation works Phase)

Environmental parameter	Survey point	Monitoring item	Frequency	Responsible organization
Air pollution	Residential area near the farmland consolidation works site.	Monitor the complaints from the relevant inhabitants near the site.	Once per week	ID (CON4)
	Maintenance of heavy machineries	Check the heavy machineries whether some troubles or damages have happened to the machines or not. If some trouble is found, it should be repaired.	Every day	ID (CON4)
	Water spray	Spray Water during the farmland consolidation works to prevent the dust taking place.	Every day	ID (CON4)
Water pollution	Sedimentation basin	Monitor the quantities of sediment. If the sedimentation basin becomes full with sediment, the sediment should be removed, and brought/spread over the farmlands.	After rain fall in the field.	ID (CON4)
Noise and vibration	Residential area near the farmland consolidation works site.	Monitor the complaints from the in habitants near the site.	Once per week	ID (CON4)
	Maintenance of heavy machineries	Check the heavy machineries whether some trouble or damage are happening to the machines or not. If some trouble is found, it should be repaired.	Every day	ID (CON4)
	Farmland consolidation works time	Do not continue the work near the residential area at night time, from 18:00 to 8:00.	Every day	ID (CON4)
Land recovery/ loss	To be discussed in the next chapter			
Working environment (Include working safety)/ Accident	Farmland consolidation works area and around the residential area	Check the management/ operation of machineries, vehicle routes and speed.	Every day	ID (CON4)
	Maintenance of heavy machineries	Check the heavy machineries whether some trouble or damage take place to the machines or not. If some trouble is found, it should be repaired.	Every day	ID (CON4)
	Access of machineries into the field.	Conduct safety checking during the carrying and carry-out the heavy machine.	First and end time of the farmland consolidation works	ID (CON4)
		Conduct safety checking during the time refueling car accesses to the field.	Every day	ID (CON4)
	Installation of project sign board	Installation of sign board which explains the farmland consolidation works.	First time of the farmland consolidation works	ID (CON4)

Source: the Survey Team (2013)

Based on the Table 4.10.1 Recommended Monitoring Plan, monitoring formats for environmental parameters are prepared below (refer to Table 4.10.2). Grievances given by the people on the course of the monitoring and also responses by the government are needed to be recorded. Monitoring method of land recovery/loss is elaborated in the next chapter.

Table 4.10.2 Draft Monitoring Form (Farmland consolidation works Period)

(1) Grievances from the habitant near the site.

Environmental parameter	Monitoring results	Measures taken	Monitoring date
Air Pollution			Once per week
Noise, and vibration			Once per week

(2) Maintenance of heavy machine

Type of machine	Kinds of damage	Measures taken	Monitoring date
Crawler Tractor			Every day
Hydraulic Excavator			Every day
Dump Truck			Every day
Vibromax			Every day
Mini Back hoe			Every day

(3) Natural Environment

Environmental parameter	Percentage of sediment in basin	Measures taken	Monitoring date
Water pollution If the percentage of sediment comes over 70%, the sediment should be removed.			After the rain fall in the field.

(4) Working Environment (Include working safety)/ Accident

Environmental parameter	Monitoring results	Measures taken	Monitoring date
Safety check of carrying the heavy machineries into the field.			First time of consolidation work.
Safety check of refueling car accessing into the field.			Every day.
Safety checks of carrying-out the heavy machineries from the field.			Last time of consolidation work.
Checking the heavy machine are keeping correct routes and speed.			Every day
Do not run the heavy machineries from 18:00 to 8:00 in the field.			Every day
Installation of project sign board around the field.			First time of the consolidation work.

Source: the Survey Team (2013)

CHAPTER 5 LAND ACQUISITION: RESETTLEMENT ACTION PLAN (RAP)

In carrying out farmland consolidation work, beneficiary farmers are supposed to surrender a part of their farmland proportionally to the present area of what they own. The surrendered land is to be owned collectively by the farmer organization which is to be established for the efficient management of farm road and irrigation and drainage canals within their jurisdiction. Though the land will be their common property, they have to submit a part of their land. Therefore, land acquisition for the project is discussed under this chapter:

5.1 Needs and Scope of Land Acquisition

An ordinal farmland consolidation works construct new farm road, irrigation canal and drainage canal. Therefore the area for new farm road, irrigation and drainage canals shall be procured out of the beneficially farmers' farmland. On this model farm land consolidation project, total 338.2 acre of farmland will be consolidated and 26.2acre out of the 338.2 acre (7.7 percentage of farmland) will have to be availed for the construction of the new farm road, irrigation and drainage canals.

5.2 Legislative and Institutional Framework of Land Acquisition in Myanmar

5.2.1 Overview of Land Acquisition and Resettlement System in Myanmar

In Myanmar, land acquisition and resettlement is in fact not regulated by laws. During the former regime, the government merely required inhabitants to move out, specifying the due date, if their lands are located in the planned construction sites for public facilities such as irrigation systems. In fact, under such practices, no compensation had been made under the principle that the land belongs to the state while the population is given only the right to cultivate.

On the other hand, the right of using farm land is stipulated by a law, "The Farm Land Law, March 2012". Procedure of having the right of using farmland is mentioned in the law as; 1) farmer shall apply for the right of using their farmland to the Township Department, 2) Township Department shall scrutinize the application of the right of using their farmland and submit it to the relevant township government office, SLRD, for the registration, and 3) the SLRD shall issue the certificate for the right of using the farmland to the applicant farmer.

5.2.2 JICA Policy of Resettlement

No farmer has his/her residential house within the model farmland area, and therefore there is no resettlement under this model farm consolidation project. However, to acquire the land for the establishment of farm road and irrigation and drainage canals[1], a percentage of each farmer's land has to be surrendered. Since there is no laws relevant to such land acquisition in Myanmar, JICA policy of involuntary resettlement should be applied for the implementation of the model farmland consolidation project.

Following No.1 to No.9 are the policies that the JICA upholds for involuntary resettlement, which are further complemented by World Bank OP 4.12 as listed in No.10 to No.15 since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies":

[1] Note that Nay Pyi Taw Council had once purchased a farm land of 11.6 ha (28.8 acre) within the project area, which was meant to construct a highway. However, the plan was cancelled and the 11.6ha (28.8 acre) of the already purchased land was planned to be brought back to the original farmers at the same price of what the Council purchased. Therefore, this 11.6 ha (28.8 acre) could not be used to directly compensate the area to be lost by the establishment of farm road and irrigation & drainage canals. It means each and every farmer beneficiary is supposed to surrender a part of their farmland proportionally to the area of what they have at present to avail of the land.

1) Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
2) When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.
3) 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 the pre-project levels.
4) Compensation must be based on the full replacement cost as much as possible (Note that the cost here means the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes).
5) Compensation and other kinds of assistances must be provided prior to displacement.
6) For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan includes elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
7) 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. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
8) Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
9) Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.
10) 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 prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
11) Eligibility of benefits includes the PAPs (Project Affected Persons) 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.
12) Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
13) Provide support for the transition period (between displacement and livelihood restoration).
14) Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elder people, women and children, ethnic minorities etc.
15) For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

Underlined statements, No.3, 4, 7, 8, 9, are the most relevant to the land consolidation project; namely, 1) restoration of their agricultural mean commensurable for the loss of farmland, 2) full replacement cost basis compensation against the loss of the farmland, 3) consultations with the affected people and

also the participation in the process of the project planning, designing and implementation, and 4) establishment of appropriate and accessible grievance mechanisms.

5.2.3 Gap between JICA Guideline and Myanmar Law

The project implementer, AMD and ID, will enforce neither involuntary land acquisition nor farmland re-allocation under this model farmland consolidation project. Since there is no law concerning land acquisition and also land re-allocation, the land consolidation project is to be implemented based on the JICA guideline. Table5.2.1 shows the comparison about the resettlement (land acquisition and/or land re-allocation) between JICA guideline and the law in Myanmar together with the measures to be applied under this project:

Table 5.2.1 Comparison of Farmland Reallocation between JICA Guideline and Myanmar Law

No.	JICA guidelines	Laws of Myanmar	The gap between JICA guidelines and laws of Myanmar	Outline at this project
1.	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)	Not defined in Myanmar Law.	Preparation of resettlement action plan is not defined in Myanmar Law.	Consultation for the ownership of new farm road, irrigation and drainage canal and also the re-allocation of each farmer's plot will be done in the planning stage. Before the farm land consolidation works, farmer organization will be established and this organization will take responsibility of the title deed of the farmland facilities and also in carrying out the plot re-allocation among the farmer members..
2.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	Not defined in Myanmar Law.	Consultation is not defined in Myanmar Law.	Consultation will be held by form, manner, and language that are understandable to the affected people.
3.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Not defined in Myanmar Law.	Appropriate participation of affected people is not defined in Myanmar Law.	Concerned farmer members, or otherwise established farmer organization, will participate in the planning, implementation, and monitoring of plot re-allocation plan and M&O of agricultural facilities.
4.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Not defined in Myanmar Law.	Appropriate and accessible grievance is not defined in Myanmar Law.	Farmer organization will take the responsibility of grievances from affected farmers and their communities. If the organization cannot handle, the grievances are to be forwarded to concerned government offices.
5.	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 socio-economic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB	Not defined in Myanmar Law.	Identification of affected people is not defined in Myanmar Law.	Affected people are already identified and recorded by a population census survey which was held in March and April, 2013 by JICA survey team.

No.	JICA guidelines	Laws of Myanmar	The gap between JICA guidelines and laws of Myanmar	Outline at this project
	OP4.12 Para.6)			
6.	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)	Not defined in Myanmar Law.	Eligibility of benefits is not defined in Myanmar Law.	There are no PAPs who do not have legal rights of using the farmland within the model farmland area.
7.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Not defined in Myanmar Law.	Preference of land-based resettlement strategies is not defined in Myanmar Law.	There is no displaced farmer in this model farm consolidation project.
9.	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)	Not defined in Myanmar Law.	Particular attentions to the need of the vulnerable groups are not defined in Myanmar Law.	At the planning of plot re-allocation in this project, particular attention for the farmers who have less than 1 acre should be considered.

Source: the Survey Team (2013)

5.3 Scale and Scope of the Land Acquisition

A population census survey (2013, JICA) carried out covering all the beneficiary farmers identified that number of concerned households in the model farm land area arrives at 138 HHs, and the number of affected population at 625 consisting of male 301 and female 324 (see Table 5.3.1). There is no illegal inhabitant or farmland occupier within the model farmland consolidation area. All the farmers within the farmland area have registered cultivation right of the farmland.

Table 5.3.1 Number of Project Affected Units (PAUs) and Affected Persons (PAPs)

Type of loss	No of PAUs			No of PAPs		
	Legal	Illegal	Total	Legal	Illegal	Total
Required for farm plot re-allocation.						
1 HH (Farm user on gov. land)	-	-	-	-	-	-
2 HH (Farm user on private land)	138	0	138	625	0	625
3 HH (Tenants)	-	-	-	-	-	-
4 CBEs (Farm user gov. land)	-	-	-	-	-	-
5 CBEs (Farm user on private land)	-	-	-	-	-	-
6 CBEs (Tenants)	-	-	-	-	-	-
7 Community owned structures	-	-	-	-	-	-
Grand Total (1 – 9)	138		138	625		625

Source: No of PAUs is from the office of Settlement and Land Records Deartment, No of PAPs is from the census survey carried out by JICA survey team (2013, JICA), HH: Household, CBEs: Commercial and Business Enterprises

Concerning property, there is no residential house, nor other erected buildings inside the model farmland consolidation area. It means the property to be affected by the project is only the farmland owned by the 138 farmers. The land to be affected by the consolidation work is shown below; total 338.2 acre, out of which an area of total 26.2 acre will be used for the construction of farm road, irrigation and drainage canals. The area of 26.2 acre farmland should be surrendered by all the

beneficiary farmers based on the non-substitute ratio of 8% uniformly applied to the present area of what each farmer owns.

Table 5.3.2 Model Farmland Consolidation Area

Area	Area to be lost by farm road and canal construction	Total farmland	Total household
Ac	26.2 (7.7% of 338.2)	338.2	138
Ha	10.6 (7.7% of 136.6ha)	136.6	ditto

Source: Settlement and Land Records Deparment (MOAI) for the farm land area. Irrigation Department (MOAI) for the area to be lost by farm road and canal construction

5.4 Compensation Measures

Basically, PAPs (project affected persons) under this project are also the beneficiaries of the project. The land consolidation, upon completion, brings about farm road and irrigation and drainage canal network to the consolidation area. With this arrangement, farmers can enhance their agriculture production. Investment here is made into a sort of private property, farm land, though they are the PAPs of surrendering a part of their property.

Under this special condition, land consolidation work carried out widely in Japan has not made any compensation against the loss of the land. On top of this, there is a pre-condition applied in the land consolidation works carried out in Japan. The pre-condition is that the one who applies the project should be the farmers, or farmer representatives. This entails a pre-requisition that the farmers who want to execute land consolidation work must have already agreed to surrender a part of their farmland before the application is submitted. Given this pre-requisition, no compensation has been arranged in Japan.

Under the target model project, there should be no direct compensation against the loss of land same as the case in Japan. If direct compensation is provided, principle of public works may rather be hindered since the investment under the land consolidation is to be disbursed to private properties though the fund comes from government coffer or donors, sort of fund which shall be spent for the public rather than specifically targeted private entities.

Taking into consideration the above issue, no direct compensation will be arranged in this project; however as specified in the JICA Guideline as ‘compensation must be based on the full replacement cost as much as possible’, it should be noted as a pre-condition of implementing the project that the value of the land and also increase of the crop production with the project should be made more than those having been generated from the original farmland. It means that the land value and also the crop production upon the project completion should increase at least by 8% than those from the original area, since they are to surrender 8% of the originally owned area. Otherwise, JICA team does not recommend carrying out the consolidation work.

5.4.1 Land Value

There is an existing farm land consolidation area located nearby from the project site. The site is located just beside the project area at an eastern side. The consolidation project was implemented in year 2011/12, and consolidated a total area of 288 acres. Ten beneficiary famers were interviewed on the land value. Farmers in Myanmar can purchase right of cultivating a farm land, which is a sort of private deal though the title deed of cultivation shall be registered with SLRD. Following table summarizes the price of purchasing the cultivation right per acre before the consolidation work and the present.

The price after the project has quadrupled compared to the price before the project. Of course, price escalation should be considered in making this comparison. An average monthly inflation rate from

2010 to 2013 was recorded at 2.85%[2]. Applying the 2.85% monthly inflation ratio over 2 years period, the inflation index comes to 190%, 1.9 times more. Since the land price has increased to 4 times more, the loss caused by the establishment of farm road and canals can be said to have been enough compensated in terms of monetary value of the land.

Table 5.4.1 Comparison of Farmland Price before and after the Land Consolidation

Farmer	Before (2011), x100,000 Kyats	After (2013) x100,000 Kyats	Changing rate %	Remarks
1	10	40	400	Price per acre
2	10	40	400	ditto
3	10	40	400	ditto
4	10	40	400	ditto
5	10	40	400	ditto
6	10	40	400	ditto
7	10	40	400	ditto
8	10	40	400	ditto
9	10	40	400	ditto
10	10	40	400	ditto
Average	10	40	400	ditto

Source: JICA Survey Team (2013)

5.4.2 Crop Production Yield

With reference to the survey quoted above, it was reported by all the 10 interviewed farmers that yields for monsoon paddy, summer paddy and black gram have all been increased. Note that summer paddy had been cultivated only by 5 farmers out of the interviewed 10 farmers before the land consolidation since irrigation water could not reach those other farmers. Table 5.4.2 shows yield increase by 18%, 19%, and 17% for monsoon paddy, summer paddy and black gram respectively. The yield increase is all much higher than the land loss of 8%.

Table 5.4.2 Comparison of Crop Yields before and after the Land Consolidation, basket per acre

Sr. No.	Monsoon paddy yield(bsk/ac)			Summer paddy yield(bsk/ac)			Black gram (bsk/ac)		
	Before	After	Change	Before	After	Change	Before	After	Change
1	85	100	1.18	100	120	1.20	14	16	1.14
2	95	105	1.11	NA	130	-	15	18	1.20
3	95	105	1.11	NA	132	-	16	20	1.25
4	85	100	1.18	110	130	1.18	13	15	1.15
5	80	100	1.25	NA	130	-	12	14	1.17
6	90	110	1.22	NA	135	-	12	15	1.25
7	95	115	1.21	NA	132	-	15	17	1.13
8	84	103	1.23	113	130	1.15	12	13	1.08
9	85	100	1.18	100	120	1.20	14	16	1.14
10	95	112	1.18	114	124	1.09	15	17	1.13
Average	89	105	**1.18**	112	128	**1.19**	14	16	**1.17**

Source: JICA Survey Team (2013) Note: NA for summer paddy means the farmers had not cultivated summer paddy before the land consolidation due to water shortage.

In addition to the yield increase, number of farmers who cultivate summer paddy was increased from 5 to all the 10 farmers. Since summer paddy requires the highest water requirement among crops, it can hardly be cultivated without irrigation and drainage canals nearby. In the project area, about 46 farmers (33%) out of the total 138 farmers are cultivating summer paddy at present (refer to Table 2.2.3 Average Annual Income). This ratio of summer cultivation will be increased to nearly 100% upon completion of the consolidation work bringing about irrigation canals into their farmland.

Further, the following table summarizes the loss of monsoon paddy before and after the land consolidation. The loss of monsoon paddy before the consolidation was around 16 basket per acre

[2] Source: http://www.tradingeconomics.com/myanmar/inflation-cpi

while that after the land consolidation was reduced to 10 baskets per acre only. As average, 5.9 baskets of monsoon paddy per acre was saved, equivalent to 6.8 % of the yield before the land consolidation. Though this 6.8% saving against the original yield is not yet commensurate to the land loss of 8% under the target project, even only the reduction of loss can almost compensate the loss. The reduction of the loss came mainly from the establishment of farm road.

Table 5.4.3 Comparison of Loss after Harvesting before and after the Land Consolidation, basket per acre

Sr. No.	Monsoon paddy yield (bsk/ac)			Loss for Monsoon Paddy (bsk/ac)			
	Before	After	Change	Before	After	Saved	Change, %
1	85	100	1.18	15	10	5	5.88
2	95	105	1.11	10	5	5	5.26
3	95	105	1.11	10	5	5	5.26
4	85	100	1.18	15	10	5	5.88
5	80	100	1.25	20	10	10	12.50
6	90	110	1.22	20	15	5	5.56
7	95	115	1.21	20	17	3	3.16
8	84	103	1.23	19	10	9	10.71
9	85	100	1.18	15	10	5	5.88
10	95	112	1.18	17	10	7	7.37
Average	89	105	1.18	16	10	**5.90**	**6.75**

Source: JICA Survey Team (2013)

5.4.3 Crop Farm Budget Increase

Land consolidation brings about double effects into farmers income increase; 1) gross income hike by increasing the yield as aforementioned, and 2) cost reduction by improving the transportation of their harvest out of the fields, fertilizer into the fields, etc., whereby the net income is further increased. Figure 5.4.1 summarizes the gross income, cost, and net income per acreage before and after the land consolidation by such crops as monsoon paddy, summer paddy, and black gram.

As is seen in the figure, monsoon paddy's net income has marked such increment of 154% thanks to the land consolidation work, summer paddy by 142% and black gram by 137%. This net income increase surpasses much more what they had to lose in terms of land area. The scenarios can also be expected in the target model farmland consolidation area since the example is located just beside the target area, suggesting soil condition, water condition and others are not much different.

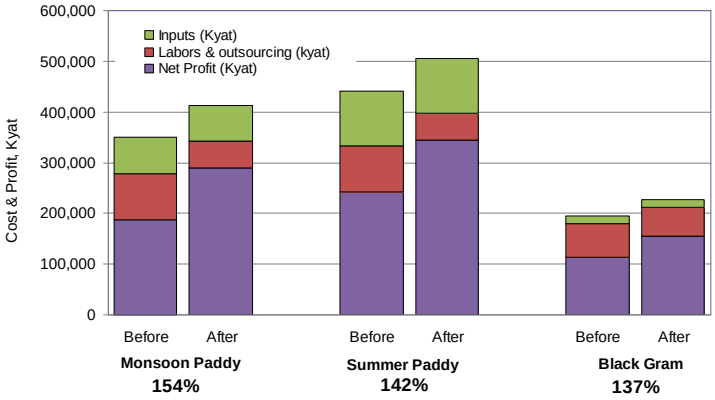


Figure 5.4.1 Comparison of Incomes by Crop before and after the Land Consolidation

Source: JICA Survey Team

5.4.4 Summary of the Compensation consummate to the Loss of Land

Summarizing above survey results, it can be concluded that the benefit accrued from the land consolidation work will surpass the loss of land that is 8% of what they own at present as indicated below:

- ✓ Land value is to be increased by about 2 times more with reference to an example of land consolidation work carried out just beside the project area where 400% hike took place over 2 years after the land consolidation was completed, during which inflation index marked 190% (considering the index, the net increment is calculated at 211%),

- ✓ Crop yields are to increase by 18%, 19%, and 17% for monsoon paddy, summer paddy and black gram respectively with reference to the same example, which are all higher than the land loss of 8%.
- ✓ According to farm budget analysis, net profits are to increase by 54%, 42%, and 37% for monsoon paddy, summer paddy and black gram respectively with reference to the same example, which are all much higher than the land loss of 8%.
- ✓ In addition to above, loss which takes place on the course of ferrying out the harvested crops is to reduce by about 7% for the case of monsoon paddy in the neighboring farmland where land consolidation had been already done. This loss reduction can be said to be almost commensurate to what they have to surrender, 8% of the farmland.
- ✓ Further in the target project area, approximately two thirds of the farmers cannot cultivate summer paddy due to the absence of irrigation canal at present. Provided with such canal by the consolidation project, these farmers can cultivate summer paddy, enjoying 3-time cropping in a year. It means that about two thirds farmers can have an opportunity of increasing their income by 150% based on the change from 2 crops to 3 crops per annum.

5.5 Supports provided by the Government/JICA Team

The main support to the farmers is to facilitate them to form a farmer organization officially registered. This organization is meant to not only undertake the management and O&M of facilities such as farm road and canals but also play a central role of obtaining consensus from all the farmers on the re-plotting of farmland. Difficult part pertaining to the land consolidation is concerned with the arrangement of farmland re-plotting. With the consolidation work implemented, farmers are often meant to move their original farm plot to a newly arranged area. If a farmer has 2 – 3 plots apart each other within the consolidation area, it is better to collect all the pieces of plot into one merged area. By this, the original farmer who had been cultivating in there is pushed out and shall newly be settled nearby.

It takes time in fact to obtain the agreement for this plot re-allocation from all the 138 famers. In Myanmar, surprisingly before the commencement of the construction work no such arrangement has been made under already implemented consolidation projects, but had to be done upon completion of the consolidation. This backward process gave a lot of burden to SLRD in charge of land registration as the famers had to spend a lot of time to amicably settle among them. Under the target model project, this agreement should be reached unanimously before the commencement of the consolidation work or otherwise donor/JICA should not support such project.

Then, the farmer organization, or precisely the management committee of the organization, shall be in charge of obtaining the agreement from all the farmers supported by SLRD and Cooperative Department. This is because the farmer themselves know the best of their colleagues. Government officers should play a role of facilitating them to form the organization as well as supporting the process of obtaining the agreement by farmer themselves. Government officers should not discharge the authoritative power in the process of getting agreement on the plot re-allocation.

The basic structure of the organization can be as follows, and the establishment should be supported by the Cooperative Department: The highest organ in the organization is the General Assembly, which shall be composed of all the member farmers. This is the supreme organ in the organization especially vested in the decision making power. All the plans shall be forwarded to the general assembly and the decision shall be made at this assembly level, meaning all the important decision, like agreement on the plot re-allocation, shall be made by all the members themselves.

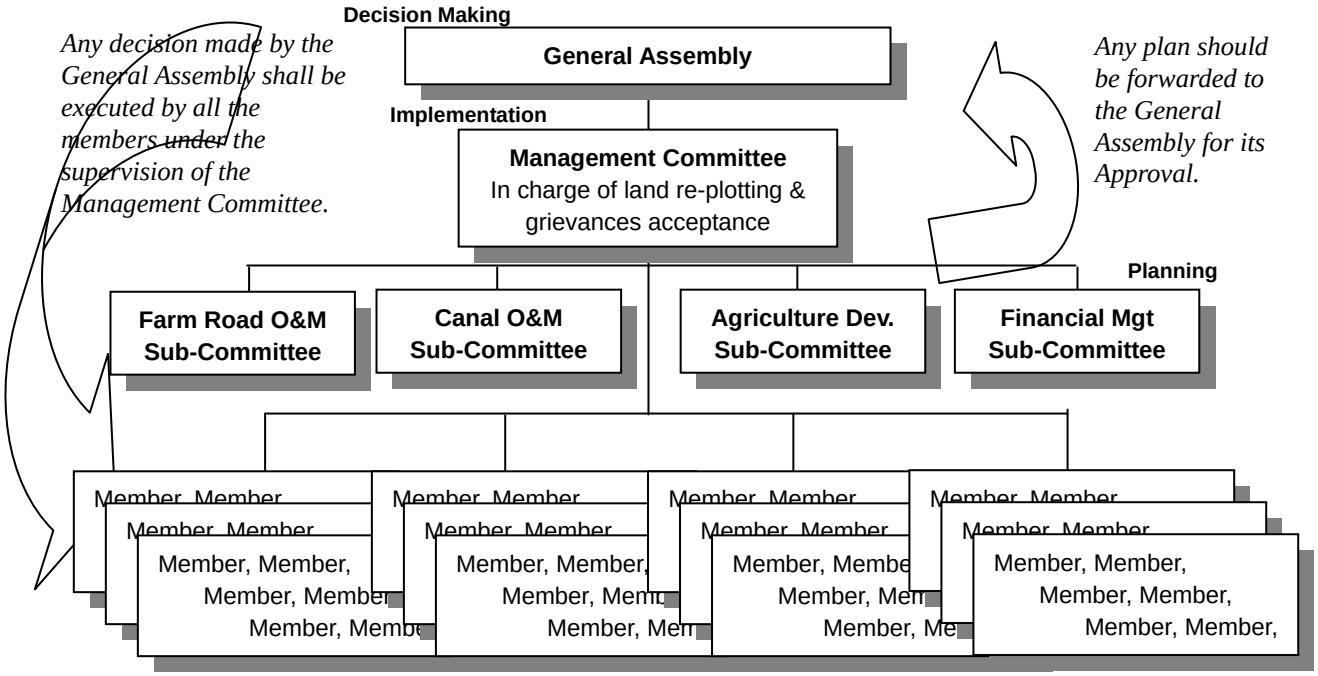


Figure 5.5.1 Internal Organizational Set-up for the Farmer Organization

Source JICA Survey Team, 2014

Under the general assembly, there should be the management committee in charge of responsibility of execution and day-to-day management of the consolidation area. The members of the management committee shall, of course, be selected by the general assembly, and in fact the members had been already selected on September 1, 2013. The members are composed of; 1) chairperson, 2) secretary, 3) 2 auditors, and 4) 12 members coming from all the concerned 6 villages for the model land consolidation project.

There are sub-committees in charge of planning formed by volunteers or elected persons within the organization (see the 3rd row from the top in figure above). These sub-committees can be led by the members of the management committee. The basic role of the planning sub-committees is to prepare for a plan e.g. maintenance schedule of farm road and canals, bulk purchase of farm input, etc., and forward it to the General Assembly for the decision.

In above regard, management committee is, in principle, in charge of execution or day-to-day management of the issues decided by the general assembly. In addition, under the target land consolidation project, there should be 2 special roles vested in the management committee; namely, 1) planning of the plot re-allocation and obtaining of agreement on the re-allocation plan from all the farmers, and 2) acceptance and mediation of grievances from the member farmers. SLRD shall assist the management committee to plan the re-allocation and obtain the agreement from the famer members while the Cooperative Department should assist the committee when they are to solve problems.

5.6 Handling of Complaints

When a farmer has some complaints associated with the land consolidation work, the management committee is to receive the complaints first. After the committee has accepted the complaints, they at first demarcate the complaints by category such as; 1) those associated with plot re-allocation, 2) those associated with construction, 3) those associated with land registration, and 4) others.

For the first category, complaints concerning plot re-allocation, the management committee calls upon the concerned farmers, the one who made the complaint and the other who is affected by the claim,

and tries to mitigate the issue. Most expected complaint may be the location to which the farm plot is to be moved not preferably by the affected farmer. To solve this issue, the committee should be in the position of mediating the concerned farmers, and the farmer themselves should reach the agreement. Project implementer should wait for the unanimous agreement for the plot re-allocation.

On the 2nd issue concerning construction, the management committee is to receive any complaint from their member farmers and deliver the complaint to the construction supervisor at site. If the complaint is not taken up by the site supervisor, the committee shall deliver the issue to the ID staff officer in Zabu Thiri Township, Nay Pyi Taw Region. The committee will discuss the issue with the ID staff officer, and the feedback/mitigation measures will be instructed by the officer to the construction site.

Concerning the 3rd issue, land registration, likewise the management committee is to receive any complaint from their member farmers and go together with the claimant to the township officer of SLRD in charge of the registration of land cultivation deed. The committee will assist the member farmers to have the registration process done smoothly or assist in solving any problems associated with land registration. For other complaints, the committee may try to solve with the claimant or otherwise they may have to go to General Administration Department of Nay Pyi Taw city council.

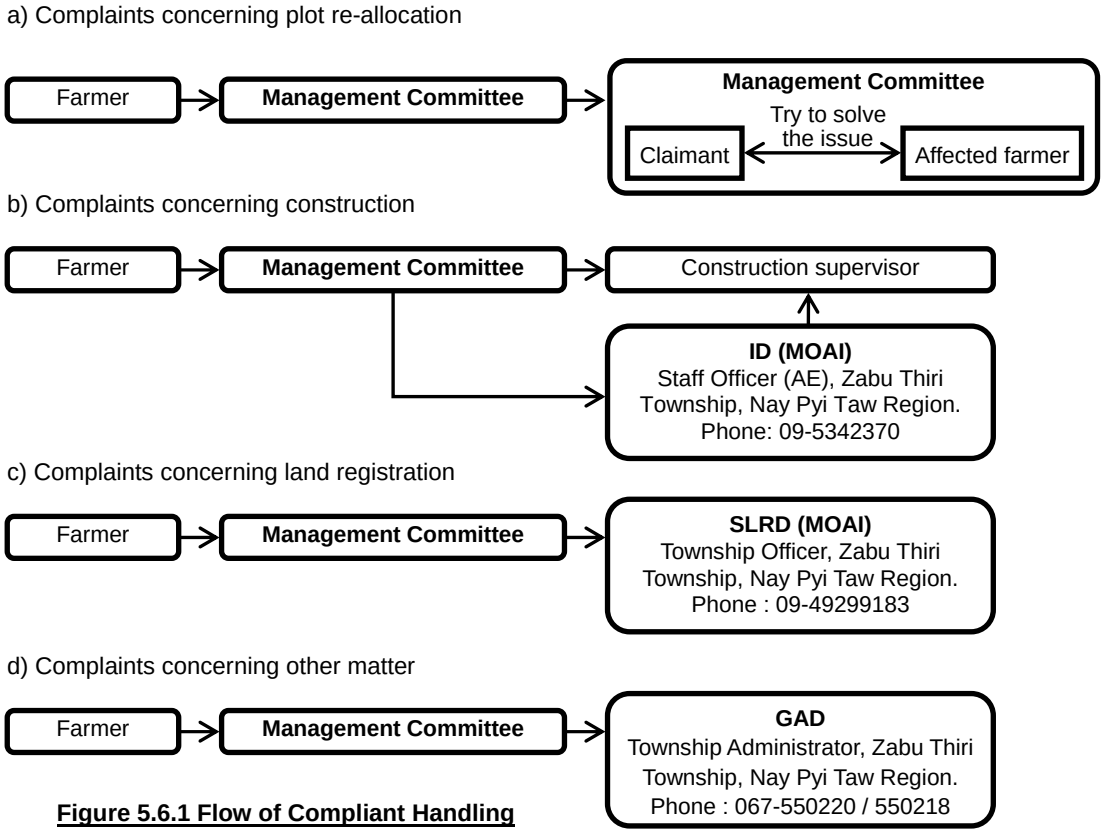


Figure 5.6.1 Flow of Compliant Handling

Source: JICA survey team, 2013

5.7 Implementation Structure

At this model farmland consolidation project, ID (Irrigation Department), SLRD (Settlement and Land Record Department), AMD (Agriculture Mechanization Department) and DOA (Department of Agriculture) which are under MOAI, and GAO (General Administration Office), CD (Cooperative Department) and also the Management Committee of Farmers Organization concerned should be involved as the project implementer, facilitator for the establishment of farmer organization, the office in charge of registering the farmer organization, the office in registering farmland-use-right, etc. The relationship among the organizations is shown in Figure 5.7.1 with the farmer organization at the

center, and major responsibilities by each organization are summarized below:

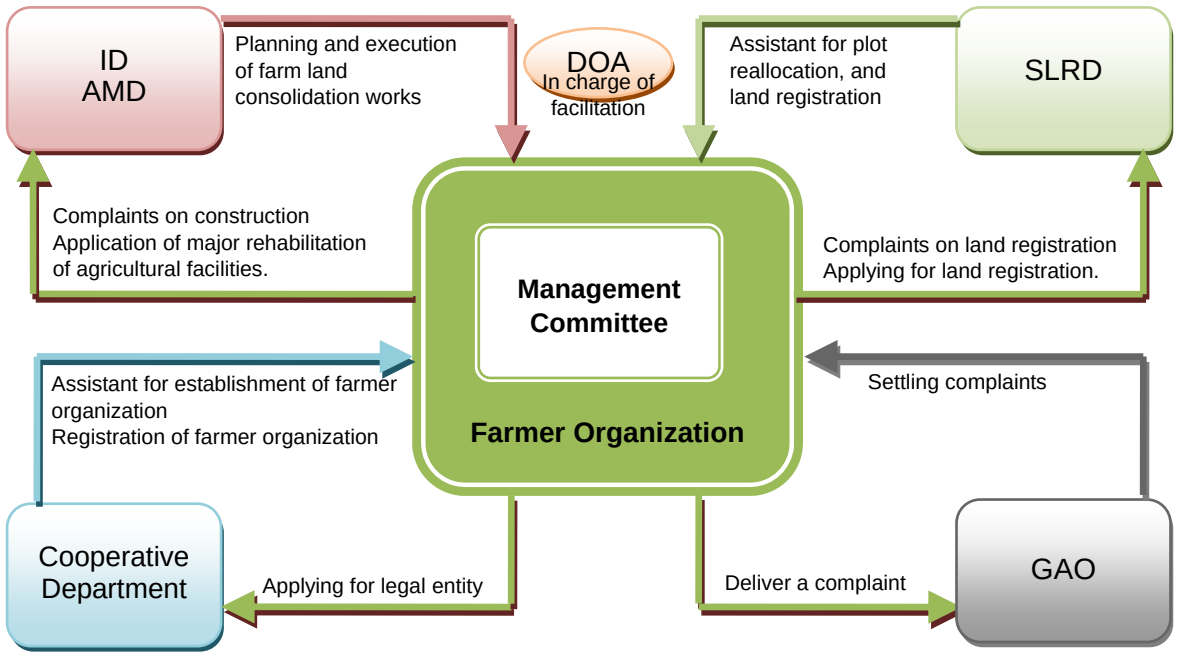


Figure 5.7.1 Implementation Structure of Land Consolidation Project

Source: JICA Survey Team, 2014

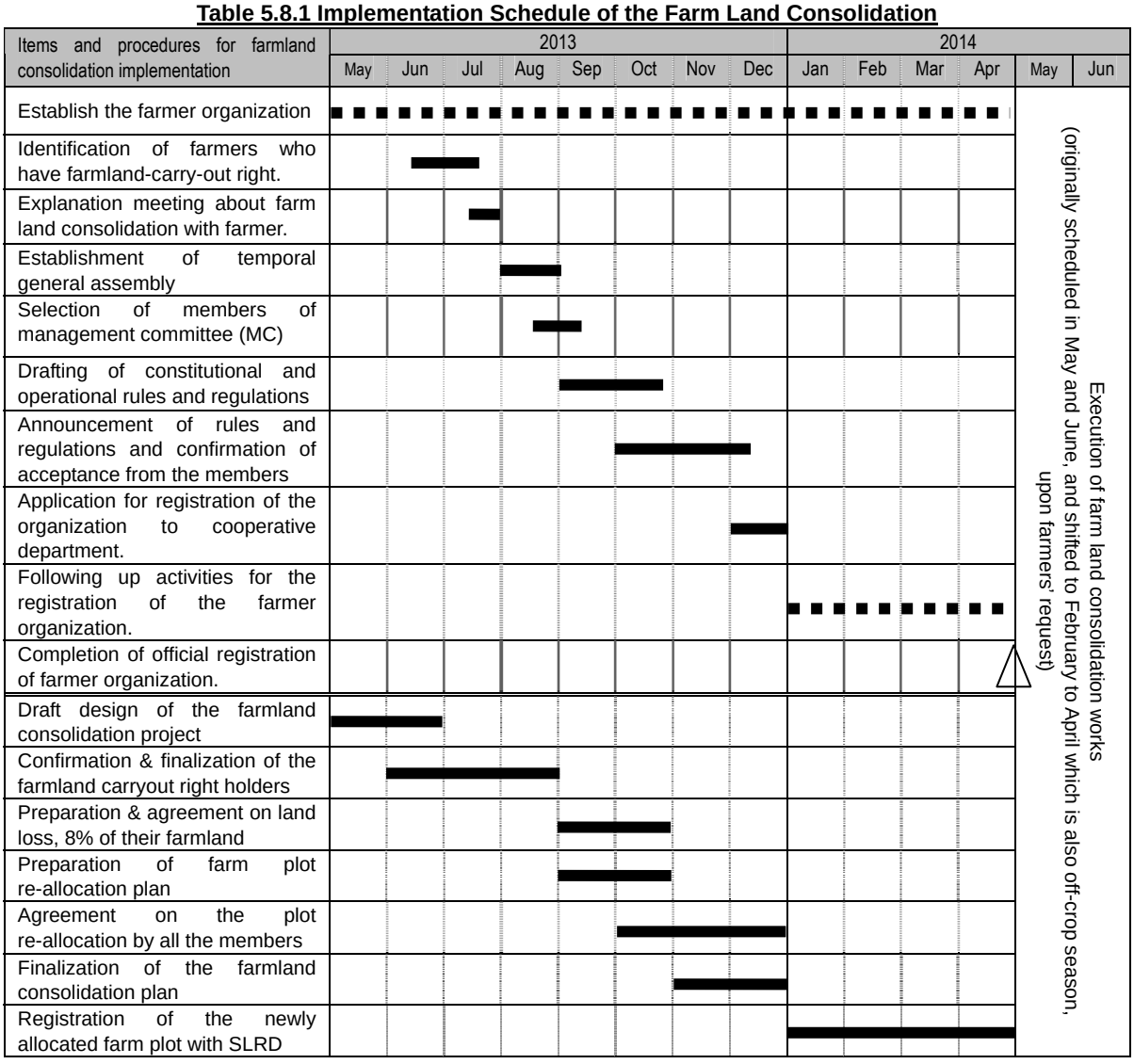
1) ID (Irrigation Department): Planning and designing of farm land consolidation project together with AMD, and execution of farmland consolidation works for the parts of farm roads, irrigation and drainage canals,
2) AMD (Agriculture Mechanization Department): Planning and designing of farm land consolidation project together with ID, and land leveling by using farm machineries (in general, tractors 70HP and 90HP), making plot boundary levees within one-acre standard plot, and first-time harrowing and ploughing for the preparation of cultivation,
3) SLRD (Settlement and Land Record Department): Assistance to farmer origination to establish farm plot reallocation plan, conduct of the farmland area survey upon completion of consolidation works, and issuing of registration for the right of cultivating farmland.
4) DOA (Department of Agriculture): Facilitation and coordination in respective necessary tasks which have to be done between beneficiaries and concerned government departments,
5) CD (Cooperative Department): Assistance to farmers in establishing farmer organization, acceptance of application of registration and issuing of the registration certificate,
6) GAO (General Administration Office): Responsible office for coordination between farmer organization and concerned government departments, and consultation to solve complaints/ grievances from concerned farmers, and
7) Management Committee: Responsible body established under the farmer organization in coordinating and negotiating respective issues with each of the government organizations noted in above 1) to 4).

Upon completion of the farm land consolidation works, farmer organization established will take responsibility of daily O&M of farm road, and irrigation and drainage canals. Furthermore, if a farmer or organization itself has complaints/ grievances, the management committee under the farmer organization takes the responsibility to solve them. If the committee cannot solve the complaints/ grievances, the committee will deliver the claim to the respective government offices.

5.8 Implementation Schedule

Work schedule of the consolidation work including the establishment of farmer organization and plot reallocation is shown below; namely, establishment of management committee to be done till mid September which will be in charge of obtaining agreement on the plot re-allocation; all the process of establishing the farmer organization till the end of December 2013 applying official registration, official registration by April 2014, preparation of farm plot re-allocation plan till the end of October, the agreement on the plan till the end of December 2013, and construction to be done during off-crop season (originally in May and June, and shifted to February to April upon farmers request).

Table 5.8.1 Implementation Schedule of the Farm Land Consolidation



Source: the Survey Team (2013)

5.9 Cost and Fund Source for the Land Acquisition

Each farmer has to release 7.7 % of their farmland for the sake of construction of new farm road, irrigation and drainage canals. Since this piece of land is to be surrendered voluntary by all the farmers, and becomes common property owned by the farmer organization, no compensation cost is required. Instead of losing the 7.7% of the farmland, they are to gain benefit more than that from the land consolidated in a form of; yield increase, reduction of transportation loss, and increase of land value. These profits altogether will be more than what they have to lose; hence on condition that all the farmers agree such arrangement, no compensation cost is required.

5.10 Monitoring Structure and Monitoring Form

The monitoring of land non-substitute surrender is to be carried out through the process of plot re-allocation in order to ensure that the plot re-allocation shall be conducted in accordance with the voluntary agreement and also referring to the plot re-allocation plan. The activities will be closely followed by Cooperative Department and SLRD together with the JICA survey team. It is expected that the likelihood of success and risks could be timely detected and issues arisen should be tried to solve by the management commit calling upon concerned farmers and also supported by Cooperative Department with JICA team.

Table 5.10.1 Recommended Monitoring Format (Responsible Organization: Farmer Organization)

Village name	Farmer Name	Original farmland (acre)	7.7% of farmland (acre)	Remaining farmland (acre)	Original Location	New Location	Agreement date

Note: this form accompanies with a map showing original land plot and land consolidation map where plot No. is indicated.
Source: JICA Survey Team

5.11 Stakeholder Meetings

5.11.1 Overall Progress and Agreements

Till the end of September 2013, farmer meeting has been held 2 times followed by household visit and group meeting as following up activities to those farmers who have not attended the meetings. These 2 times explanation has covered all the farmers additionally by carrying out the follow up visit and small group meeting on the issues of; 1) explanation of the project objective and content, 2) agreement on the consolidation implementation, and 3) agreement on the establishment of farmer organization.

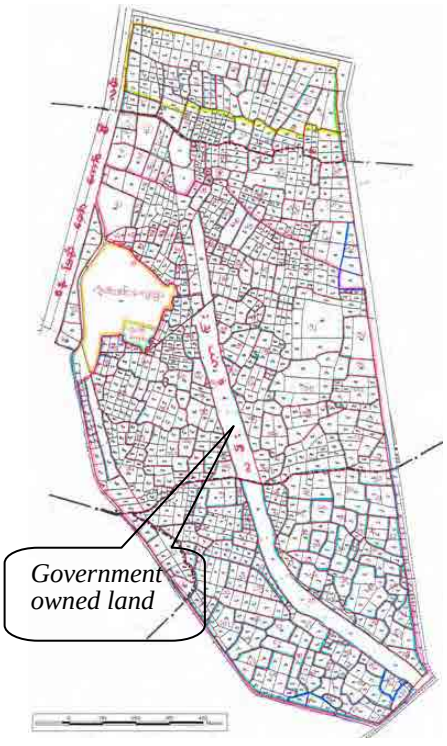


Figure 5.11.1 Government Owned Land

All the 138 farmers have signed 2 times, and the first signature endorses 2 issues of; 1) understanding of the project and 2) the agreement on the implementation of farmland consolidation, and the 2nd signature endorses the agreement on the establishment of farmer organization. Note that though all the farmers have already agreed upon the implementation of the project at the occasion of 1st signature, this agreement was done on the condition that farmers would not necessary surrender a part of their farmlands.

There is a government own land running almost central part of the target consolidation area from north-west down to south-east direction (see the figure left), whose area occupies 28.8 acre. On the other hand, the necessary area for the establishment of farm road and irrigation and drainage canals is estimated at 26.2 acre. It means if the government owned land were used for availing of the land necessary for the construction of farm road and canals, no farmer needs to surrender a part of their farms. In fact, the government land was acquired for the purpose of constructing a high way; however, the plan was already canceled.

Given this situation, the original plan for availing the land for

farm road and canals was to utilize the government owned land. With this plan, most of the famers had once agreed on the land consolidation to be implemented since they do not need to surrender any part of their land. However, 8 farmers who once sold their land for the un-constructed highway claimed that the land be returned otherwise they would not agree on the implementation of land consolidation.

The Nay Pyi Taw City council received this claim and decided to sell back the land to the original famers at the same price at which the land was purchased. The arrangement was announced on August 20, 2013 to the concerned farmers, who once sold the land to the government and are then entitled to get it back. Those 8 farmers who want the land back and had opposed the land consolidation project have changed to the proponent of the project given the announcement.

However, as a matter of fact, the other famers who once agreed on the land consolidation project on condition that no part of their land is required shall be once again explained the land loss, equivalent to about 8% of what they own. This requires another agreement on the project implementation by all the beneficiary farmers. The explanation of the land acquisition has been informed to the farmers through the farmer representatives.

The representatives are the member of the management committee of the farmer organization approved through the 2nd farmer meeting. As of mid October 2013, the representatives, member of the management committee, have started obtaining the new agreement on the land consolidation project clearly showing that there will be 8% loss of the farmland for the construction of farm road and irrigation and drainage canals. This agreement was finally reached by all the farmers on October 24, 2014.

5.11.2 First Farmer Meeting (July 20, 2013)

First farmer meeting was held on 20th July 2013 for the purpose of explaining the project objective and content of the land consolidation works (see Table 5.11.1). Total 83 farmers participated while the rest 55 farmers were absent to the meeting. However, follow-up house visit and a series of small group meetings had finally covered all the concerned 138 farmers. Note that the small group meetings were held on 24th and 25th August 2013.

Table 5.11.1 Outline of 1st Farmer Meeting

Date	20th, Jul, 2013 (Sat)
Obejctives	To understand the project objective, To know the contents of the consolidation works, and To obtain agreement on the project implementation.
Place	Monastery in Shar Taw Village
Participant	83 farmers (see Table 5.11.2). ID: Staff officer, Zabu Thiri Township DOA: District Officer SLRD: Township officer, Zabu Thiri Township Cooperative Department: Regional officer, Nay Pyi Taw Council Region JICA Survey Team

Source JICA Survey Team

Table 5.11.2 Number of Attendant and Absent at 1st Farmer Meeting

No.	Village Tract	Village	No. of Farmers	Attendant	Absent
1	Te Gyi Gone	Gone Min Ein	53	30	23
		Te Gyi Gone	5	4	1
		Shar Taw	16	16	0
2	Ag Zabu	Ag Zabu	24	13	11
3	Ayinlo	Ayinlo	31	15	16
4	Kan Oo	Kan Oo	9	5	4
Total			138	83	55

Note: the absentees of 53 farmers have been covered by following up house visit and small group meetings.
Source JICA Survey Team

At the question and answer session in the meeting, some farmers concerned about farmland area that Nay Pyi Taw city council bought from them to construct a highway. Previously Nay Pyi Taw city had a plan to construct a new road which runs through model farm land area and the purchased land occupies 28.76 acres out of total model farm land 338.2 acres. However, the plan of constructing the road has been already cancelled, and therefore farmers who had sold their farm land want to return the farm land back.

During the meeting time, the farmland purchased by Nay Pyi Taw city was explained to be used for the construction of new farm road, irrigation and drainage canals. The government side and JICA survey team answered these farmers that the area could not be returned to the original farmers but it will be used for the benefit of all the farmers. Throughout this explanation, however, 8 farmers did not agree with the execution of model farm land consolidation project though other farmers had agreed on the implementation of the consolidation work.

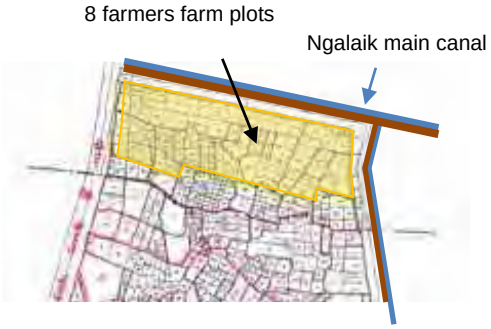


Figure 5.11.2 Farmland Owned by 8 Farmers

The reason why the 8 farmers who are relatives each other did not agree was that at first they want Nay Pyi Taw city to return back their farm land. They think the land was purchased at a lower price than the then-prevalent market price. Also, the 8 farmers have their farmlands at the upper side of the target consolidation area where they can easily access irrigation water and also access the road running beside the Nagalaik main canal (see Figure 5.11.2). Note that there is an intake pipe directly taking water from the irrigation canal, whereby they are not suffering from water shortage at all.

DOA staff explains model farmland consolidation

A scene of the farmer meeting

A scene of question and answer session

Farmer puts his signature on the understanding of the project.

Nay Pyi Taw City council, after receiving the claim from the farmers, decided to return back these farmlands to the original farmers at the same price at which they purchased. Nay Pyi Taw City council had announced the decision to the concerned famers, respective village chairpersons, ID and SLRD on

August 20, 2013. During this explanation, it was also agreed that the village chairpersons are to deliver the information to all the land consolidation target farmers that they have to surrender a part of their land since the government owned land can no longer be used for the common purpose.

5.11.3 Second Farmer Meeting (September 1, 2013)

Second farmer was held on 1st September 2013 to facilitate the establishment of farmer organization as indicated in Table 5.11.3. At the meeting, purpose of establishment of farmer organization, the roles, structure, and the process of the establishment were explained, and agreed to establish the organization. Total 56 farmers participated in the second meeting while the rest 82 farmers were covered by the follow-up house visits and a series of small group meetings.

Table 5.11.3 Outline of 2nd Farmer Meeting

Date	1st September, 2013 (Sun)
Objectives	To understand the objectives, roles and structure of the farmer organization, To understand the process of establishing the farmer organization, and To select the management committee members.
Place	Monastery in Shar Taw Village
Participant	56 farmers (see Table 5.11.4) ID: Sub assistance engineer, Zabu Thiri Township DOA: Township officer, Zabu Thiri Township. SLRD: Township officer, Zabu Thiri Township Cooperative department: Regional officer, Nay Pyi Taw Council Region Zabu Thiri Township: Township officer JICA Survey Team

Source JICA Survey Team

Table 5.11.4 Number of Attendant and Absent at 2nd Farmer Meeting

No.	Village Tract	Village	No. of Farmers	Attendant	Absent
1	Te Gyi Gone	Gone Min Ein	53	25	28
		Te Gyi Gone	5	4	1
		Shar Taw	16	16	0
2	Ag Zabu	Ag Zabu	24	3	21
3	Ayinlo	Ayinlo	31	7	24
4	Kan Oo	Kan Oo	9	1	8
Total			138	56	82

Note: the absentees of 82 farmers have been covered by following up house visit and small group meetings.
Source JICA Survey Team

During the question and answer session, purpose and benefit of establishment farmer organization, contents of activities of farmer organization and assistances for managing farmer organization were discussed as follows:

- ✓ On the purpose of establishment of farmer organization, it was replied as it is to maintain new farm road, irrigation and drainage canals which will be constructed under the model farmland consolidation project.
- ✓ On the benefits of establishment of farmer organization, the farmer organization will be registered as a regal entity in Myanmar; therefore farmer organization can, as a legal entity, request assistances to the concerned government offices depending upon the issue.
- ✓ On the contents of activities of management committee, it was explained that the management committee shall be in charge of obtaining the agreement of the project from all the farmers, will apply registration to the Cooperative Department to have regal entity. After the registration, farmer organization activities will be supervised by the management committee and general assembly should be called if when it is required.
- ✓ On the assistance for farmer organization activities, it was answered that the management committee will request concerned government departments for assistance if necessary.

After the discussions, 16 persons were selected as the member of the management committee. Management committee members were selected from all the villages, to which all the concerned farmers (138 farmers) belong. In fact, the number of management committee member was set proportionally to the number of farmers who belong to each village.

Cooperative Department officer explains the roles of farmer organization

CHAPTER 6 IMPLEMENTATION OF MODEL FARMLAND CONSOLIDATION

6.1 Farm Plot Reallocation Plan

Prior to the commencement of consolidation works, farm plot reallocation plan has to be established and agreed by all the concerned farmers. Farmland consolidation works were implemented from February to March 2014, before which farm plot reallocation plan was therefore completed in December 2013. Farm plot reallocation plan was established by the management committee of farmer organization and that plan was explained to all the concerned farmers by the committee.

6.1.1 Approach and Methodology of Farm Plot Reallocation

In order to generate a farm plot reallocation plan, policy of farm plot reallocation plan has to be prepared first and the farm plot reallocation plan must be prepared in accordance with the plot reallocation policy. From this point of view, JICA survey team has assisted the management committee to prepare for the policy as well as the plot reallocation plan.

To prepare the policy of farm plot reallocation, JICA survey team showed an example conducted in Japan to the management committee. The management committee has, then, discussed and modified in order to meet with actual situation of their farmland. The policy preparation meeting was held on October 30 and 31, 2014. The contents of farm plot reallocation policy are listed below;

- ✓ Allocate a newly constructed plot area, whether whole one-acre area or a part of it, to the original farmer who used to cultivate in that same area as much as possible; namely, keep the same location of their farm lands wherever possible, and
- ✓ If a farmer has more than one farm plot scattered in the project area, collect all the pieces of lands he/she owns, and allocate a newly constructed plot area, whether whole one-acre area or a part of it depending upon the total farm acreage, equivalent to the accumulated farm areas.

There may be many pieces of farmlands less than the smallest unit of one-acre plot owned by individual farmers. To accommodate these smaller farm plots, following measures are taken according to the farmers' preference;

- ✓ Make a ridge, which height is about 20 - 30 cm, to divide the one-acre farm plot into several smaller plots where respective concerned farmers are allocated each smaller unit of farmland according to the original area they had owned, and to know the exact position of each small plot, put such numbers as F3/1, F3/2, F3/3 for farmer-1, farmer-2 and farmer-3 respectively within the one-acre plot 'F3',
- ✓ On condition that all the farmers who have smaller farm plot agree to work collectively, mostly applied in a case of relatives each other, the one acre farm plot can be cultivated by the collective work, and the harvest should be shared according to the size of original farmland, and
- ✓ If a farmer has very small piece of farmland, an arrangement of selling out the small farmland to the neighboring farmer(s) can be made. In this case, a fixed unit price shall be applied to all those farmers who want to sell out.

6.1.2 Agreement on Farm Plot Reallocation

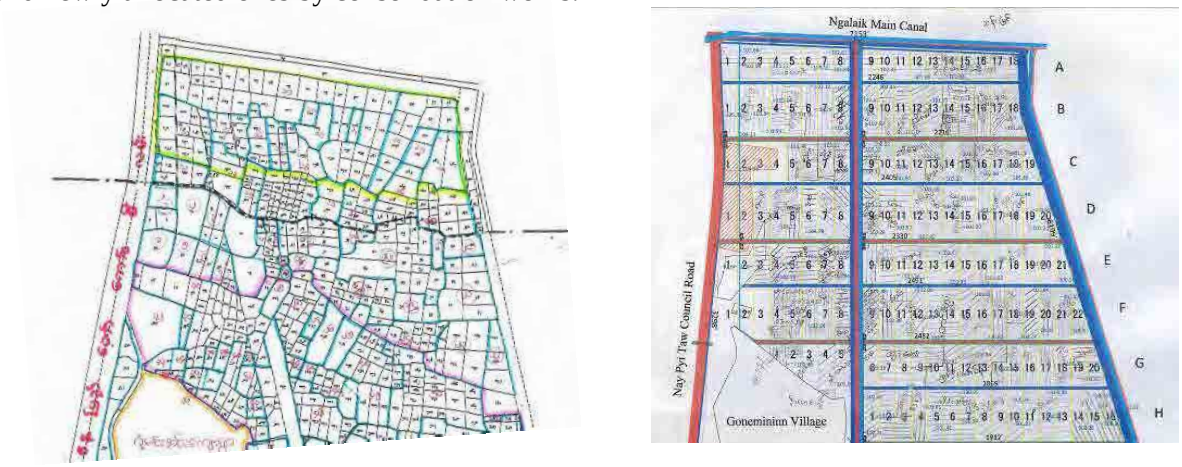
After the policy of farm plot reallocation has been prepared, members of the management committee brought the policy back to his/her village and explained it to all the farmers concerned in the village. The explanation was held on November 1 and 2, 2013, and all the farmers agreed with the policy. In fact, under normal circumstances, general assembly for the explanation should preferably be held; however, the farmers were busy in harvesting during that time. Therefore, the committee decided not to hold the general assembly meeting, and instead the committee members conducted household visit

and small group meeting.

6.1.3 Farm Plot Reallocation Plan

Based on the policy of farm land reallocation plan which was agreed by all the concerned farmers, the management committee has prepared the farm plot reallocation plan under the support from JICA survey team. Preparation of farm plot reallocation plan was in fact first experience for the committee members, so that they felt it was difficult. Therefore, JICA survey team showed them some examples of how to prepare for a farm plot reallocation plan. With the assistance from JICA survey team and SLRD officer, the committee members had completed the farm plot reallocation plan.

To generate a farm plot reallocation plan, 2 kinds of maps are necessary as presented below; left map shows the original farm plots while the right one shows the arrangement of consolidated farm plots by one-acre rectangular plot as the standard. The table below comparatively indicates original farm plots and newly allocated ones by consolidation works:



No	Village Tract	Village	Name	Before						After						Signature
				1	2	3	4	5	Total	1	2	3	4	5	Total	
				Block	Block	Block	Block	Block		Block	Block	Block	Block	Block		
				Plot	Plot	Plot	Plot	Plot	Acre	Plot	Plot	Plot	Plot	Plot	Acre	
				Acre	Acre	Acre	Acre	Acre		Acre	Acre	Acre	Acre	Acre		

Figure 6.1.1 Preparation of Draft Farmland Plot Reallocation

Source: JICA study team (2014)

6.2 Registration of Farm Plot upon Completion of Construction Works

6.2.1 Arrangement on Small Plot Transaction

During the preparation of the draft farm plot reallocation plan, some farmers came to an idea of selling out their farm plot to the farmer(s) who has the neighboring plot especially in case that he/she owns very small plot e.g. less than 0.25 acre. Likewise, some farmers wanted to purchase his/her neighboring plots. There could, therefore, be transaction of farm plots taking place during the time of preparing for the registration. This transaction may take place even sometime after the completion of the consolidation works.

Though the transaction of farm plots, transaction of the right to use farmland in essence, is a private business deal, there should be a fixed unit price applied only to the deals conducted during the preparation of registration. If such deal takes place with different negotiable prices, it may take long time to settle by all the respective farmers. To facilitate the process of registration, there should therefore be a fixed price applied during this preparation stage for the registration.

Under the model farmland consolidation project, unit price of trading the right to use farmland was fixed before carrying out the farm plot registration. JICA survey team hold the meeting with SLRD Zabu Thiri township officers together with the member of management committee on April 7, 2014. Through the discussion amongst 3 parties, the unit price for trading the right to use farmland was set at 3 million kyat per acre.

6.2.2 Registration of Farm Plot

Necessary materials for registration of farm plot are "1) plan-drawing of the project area completed for the construction", "2) completed reallocation list which was already agreed among all the concerned farmers" and "3) completed reallocation map". The management committee has prepared farm plot registration table based on these three materials. SLRD township officer has checked the table of farm plot registration together with plots for each of the farmers.

Table 6.2.1 Confirmation of Place for Farm plot Registration

Village	Village Tract	Farmer Name	Plot number	Acreage	Reduced area	Rest area	After		Number
							Plot number	Acreage	

Source: SLRD Zabu Thiri Township Office, 2014

6.3 Construction Works for Model Farmland Consolidation

6.3.1 Construction Schedule Implemented

Types of work contents are divided into 5 categories; namely, 1) ploughing and harrowing, 2) farm road construction, 3) drainage canal construction, 4) irrigation canal construction and 5) farmland leveling. Earthwork is the major work in the farmland consolidation works and construction of structures is not so big as compared to the earth work. Therefore, construction machineries are mainly used for earthwork, and structures are mainly constructed by man-power.

The construction works started from northern part of the target model farmland area. Having completed the construction of first farm block line, the construction works moved to next south farm block line. These construction works was commenced on February 10, 2014 and completed on April 25, 2014. Table 6.3.1 shows the construction schedule actually implemented:

Table 6.3.1 Implementation of Model Farmland Consolidation

	Month	February			March			April			Days
	Date	10	20	30	40	50	60	70	80	90	
AMD Work	Remove of Levee		■								5
	Ploughing and Harrowing		■	■	■	■					29
	Renewal of Levee					■					5
	Levelling (Rough)						■	■			18
	Levelling (Final)								■	■	18
	Sum										75
ID Work	Main Farm Road		■								8
	Branch Farm Road			■	■						20
	Filling Pavement on Farm Road					■					9
	Irrigation Canal						■	■			19
	Drainage Canal								■	■	19
	Sum										75

Source: JICA Study Team, 2014

6.3.2 Machineries, Materials and Man-power

1) Machineries Deployed

To complete the construction works in two and half months from February to April 2014, which is the off-crop season in the model farmland area, enough numbers of construction machineries were deployed (see table below). The machineries from No.1 to No.8 were used for the construction of farm road, irrigation canal and drainage canals by ID while the machineries from No.9 to No.12 were used for land leveling, ploughing and harrowing by AMD.

Table 6.3.2 Heavy Machineries Deployed for Model Farmland Consolidation Works

No	Machineries Name	Unit	Major Function
1	Dozer Class II	3	• Dozing and compacting soils for the farm road, irrigation and drainage canals
2	Dozer Class III	1	• Dozing and compacting soils for the farm road, irrigation and drainage canals
3	Hydraulic Excavator ($1m^3$)	7	• Earth works for farm road, irrigation and drainage canals • Unload of bricks • Construction of structures, including hoist of heavy materials and machines
4	Mini Backhoe ($0.23m^3$)	4	• Earth works for secondary irrigation canal and drainage canal
5	Dump Truck ($10m^3$)	19	• Transport of materials and aggregates such as sand, cement, brick, etc. from stockyard in ID Regional Office to the site
6	Earth Work Vibration Roller	1	• Earth works for compacting the farm road
7	Water Bowser ($1,200m^3$)	1	• Transport of water for soil compaction
8	Low bed Semi-Trailer Truck	1	• Transport of heavy machineries such as hydraulic excavators, track dozers and vibration rollers
9	Tractor (90 Horse Power) (75 Horse Power)	20 (14) (6)	• Earth works for land leveling, ploughing and harrowing
10	Land Leveler (8 feet with 2 wheel) (10 feet with 2 wheel)	15 (10) (5)	• Earth works for land leveling • Attachment for tractor
11	Plough (4 disks) (7 disks)	12 (5) (7)	• Earth works for ploughing • Attachment for tractor • Removing and making Levee
12	Harrow (16 disks) (18 disks)	4 (2) (2)	• Earth works for harrowing • Attachment for tractor

Source: JICA Study Team, 2014

2) Materials Used

Materials used for the consolidation works are summarized below by item with the quantity. Materials used in large quantity are diesel running the heavy machineries, and brick and cement for structures.

Table 6.3.3 Materials Deployed under Model Farmland Consolidation

Item	Quantity	Unit	Remarks
High Speed Diesel	41,580.00	Gallon	
Sand	474.00	Sud	
Chipping	104.00	Sud	
Brick	553,091.00	Nos	
6” - 9” Stone	230.00	Sud	
Kanker	2,950.00	Sud	
Lime	491.01	Cft	
Hard Wood	12.30	Ton	
Jungle Wood	0.00	Ton	
Binding Wire	3.00	Viss	
Wire Nail	33.80	Viss	
5/8”M.S Rod	0.00	Ton	

Item	Quantity	Unit	Remarks
Small Bamboo	2,557.00	Nos	
Glue	49.50	Bott	
Brush	94.00	Nos	
Thatch	4,900.00	Nos	
Hnee (Bamboo Thread)	82.00	Viss	
6*6 H beam	252.00	Fts	
Control Bar & Gate Leaf	1.00	Nos	
Water Gate	1.00	Rft	
1' Φ P.V.C Pipe	26.00	Rft	
4 " P.V.C pipe	0.00	Rft	
8" Φ P.V.C Pipe	100.00	Rft	
l'-6¨Φ R.C.C Pipe	130.00	Nos	
3 " R.C.C Pipe	16.00	Nos	
Cement	5,223.00	Bags	

Source: JICA Study Team, 2014

3) Man-powers Employed

List of man-powers employed for the farmland consolidation works is shown in Table 6.3.4; casual workers were employed the most, i.e. 15, 839 person-days in total, followed by masonry workers of 3,379 person-days. Carpenter was employed in total 200 person-days.

Table 6.3.4 Employee Deployed under Model Farmland Consolidation

Kinds of Work	Total Unit	Unit	Remarks
Carpenter	200	Person·Day	
Masonry Workers	3,379	Person·Day	
Workers	15,839	Person·Day	

Source: JICA Study Team, 2014

6.3.3 As-build Drawings of Model Farmland Consolidation

When the ID and AMD had almost completed the farm land consolidation works at the 1st week of April, SLRD staff started plane survey for the preparation of as-build plan drawing. The survey started from the 2nd week of April and finished in the 4th week of April including *Thingyan* and Myanmar New Year holidays. Typical drawings for the as-build model farmland consolidation works are shown below:

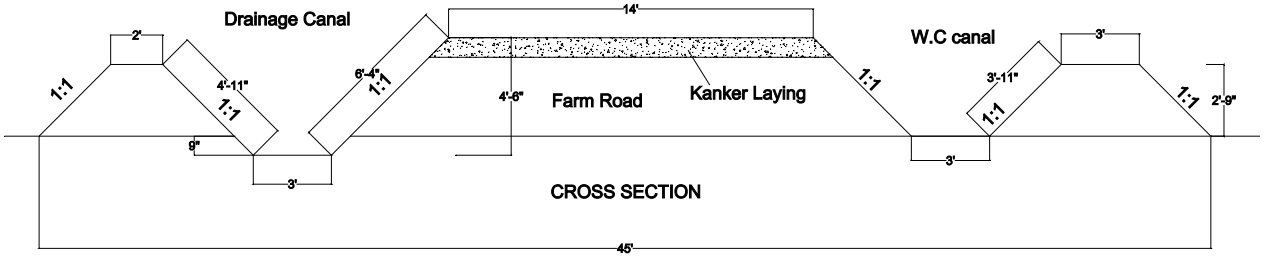


Figure 6.3.1 Cross Section of Main Farm Road, Irrigation and Drainage Canals

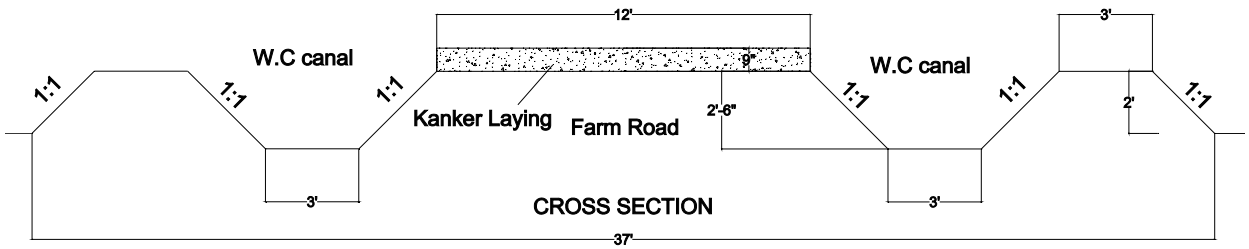


Figure 6.3.2 Cross Section of Lateral Farm Road and Irrigation Canal

Figure 6.3.3 Plan Drawing of Model Farmland Consolidation

6.3.4 Construction Cost

Total cost for the model farmland consolidation is around 561 million Kyats. Of the total cost, diesel, lubricant and grease together come to 184 million Kyat (33%); the construction materials cost 247 Kyat (44%); ploughing and harrowing cost 21 million Kyat (4%); and labor cost 109 million Kyat (19%). Table 6.3.5 shows the model farmland consolidation cost by major category and the breakdown of the cost in Table 6.3.6:

Table 6.3.5 Construction Cost for Model Farmland Consolidation Project

Number	Item	Cost (Kyat)	Cost (Yen)	Percentage
1	Diesel, Lubricant, Grease	184,382,052	19,360,115	33 %
2	Construction Materials	247,363,463	25,973,164	44 %
3	Ploughing, Harrowing	20,760,000	2,179,800	4 %
4	Labor	108,504,165	11,392,937	19 %
Total		**561,009,680**	**58,906,016**	**100 %**

Source: JICA Survey Team (2014). Cost (Yen) is calculated by 1kyat=0.105Yen (JICA Rate, 2014, May)

Table 6.3.6 Breakdown of Construction Cost for Model Farmland Consolidation Project

Category	Item	Cost (Kyat)	Cost (Yen)
1	High Speed Diesel	176,600,000	18,543,000
	Lubricant, Grease	7,782,052	817,115
	Total	184,382,052	19,360,115
2	Sand	18,628,200	1,955,961
	Chipping	12,989,600	1,363,908
	Brick	49,778,190	5,226,710
	6”～9” Stone	20,470,000	2,149,350
	Kanker	44,250,000	4,646,250
	Lime	1,227,525	128,890
	Transportation	2,300,000	241,500
	Hard Wood	9,840,000	1,033,200
	Binding Wire	8,700	914
	Wire Nail	104,780	11,002
	Small Bamboo	639,250	67,121
	Glue	24,750	2,599
	Brush	141,000	14,805
	Thatch	490,000	51,450
	Hnee (Bamboo Thread)	123,000	12,915
	6*6 H beam	3,877,020	407,087
	Transportation	2,010,000	211,050
	Control Bar & Gate Leaf	1,000,000	105,000
	Water Gate	2,100,000	220,500
	1' Φ P.V.C Pipe	780,000	81,900
	8” Φ P.V.C Pipe	750,000	78,750
	Transportation	900,000	94,500
	l’-6¨Φ R.C.C Pipe	7,215,000	757,575
	3 " R.C.C Pipe	2,584,000	271,320
	Cement	33,940,000	3,563,700
	Temporary Hut	6,258,700	657,164
	Machine Repairmen	24,597,748	2,582,764
	Field Use Materials	336,000	35,280
	Total	247,363,463	25,973,164
3	Ploughing	13,840,000	1,453,200
	Harrowing	6,920,000	726,600
	Total	20,760,000	2,179,800
4	Labor	108,504,165	11,392,937
	Total	108,504,165	11,392,937
Grand Total		561,009,680	58,906,016

Source: JICA Survey Team (2014). Cost (Yen) is calculated by 1kyat=0.105Yen (JICA Rate, May 2014)

6.3.5 Monitoring Result for Environmental and Social Consideration

Expected negative environmental impacts are air pollution, water pollution, noise/vibration, working environment including accident, which were identified through scoping and environmental examination. These impacts are, if any, to take place only during the farmland consolidation works phase. Therefore, necessary monitoring was implemented during the construction period. As a result, no negative impact was reported during the farmland consolidation works as summarized below:

Table 6.3.7 Result of Environmental Monitoring during consolidation works

Environmental parameter	Survey point	Monitoring item	Frequency	Responsible organization	Monitoring Result
Air pollution	Residential area near the farmland consolidation works site.	Monitor the complaints from the relevant inhabitants near the site.	Once per week	ID (CON4)	No complaints about air pollution from the relevant inhabitants
	Maintenance of heavy machineries	Check the heavy machineries whether some trouble or damage have happened to the machines or not. If some trouble is found, it should be repaired.	Every day	ID (CON4)	Heavy machineries had been maintained properly every day.
	Water spray	Spray Water during the farmland consolidation works to prevent the dust taking place.	Every day	ID (CON4)	In order to prevent dust arise, water was sprinkled properly every day.
Water pollution	Sedimentation basin	Monitor the quantities of sediment. If the sedimentation basin becomes full with sediment, the sediment should be removed, and brought/spread over the farmlands.	After rain fall in the field.	ID (CON4)	There was rainfall twice during the construction period; however the rainfall was little, and therefore sedimentation did not occur.
Noise and vibration	Residential area near the farmland consolidation works site.	Monitor the complaints from the in habitants near the site.	Once per week	ID (CON4)	No complaints about noise and vibration from the relevant inhabitants
	Maintenance of heavy machineries	Check the heavy machineries whether some trouble or damage are happening to the machines or not. If some trouble is found, it should be repaired.	Every day	ID (CON4)	Heavy machineries had been maintained properly every day.
	Farmland consolidation works time	Do not continue the work near the residential area at night time, from 18:00 to 8:00.	Every day	ID (CON4)	Construction machineries did not work near residential area at night time.
Working environment (Include working safety)/ Accident	Farmland consolidation works area and around the residential area	Check the management/ operation of machineries, vehicle routes and speed.	Every day	ID (CON4)	All the construction machineries were well operated by the operators and they observed the route and speed regulated.
	Maintenance of heavy machineries	Check the heavy machineries whether some trouble or damage take place to the machines or not. If some trouble is found, it should be repaired.	Every day	ID (CON4)	Heavy machineries had been maintained properly every day.
	Access of machineries into the field.	Conduct safety checking during the carrying and carry-out the heavy machine.	First and end time of the farmland consolidation works	ID (CON4)	Safety checking had been conducted during carrying and carrying-out the machines, therefore accident did not occur.
		Conduct safety checking during the	Every day	ID (CON4)	

Environmental parameter	Survey point	Monitoring item	Frequency	Responsible organization	Monitoring Result
		time refueling car accesses to the field.			
	Installation of project sign board	Installation of sign board which explains the farmland consolidation works.	First time of the farmland consolidation works	ID (CON4)	Sign board was installed beside the construction site.

Source: JICA Survey Team (2014)

CHAPTER 7 RECOMMENDATIONS TOWARD FUTURE WORKS

During the process of undertaking the model farmland consolidation project, the JICA Team encountered a number of issues that lead to the recommendations presented below. However, as is the case with continuous processes, these recommendations are by no means exhaustive and may need to be changed or modified, depending upon the prevailing condition. Nevertheless, it is believed that the ones covered here constitute broader issues on which the implementation of the future land consolidation works will have to be pursued:

1) Before executing the farmland consolidation, SLRD should examine the number of concerned farmers, the area of farm plots and their addresses where they live. This information are quite important for obtaining consensus on the project implementation among all the concerned farmers, establishment of farmer organization, preparation of plot reallocation plan and registration of the farm plots. In case this information not completed, successive process will be very much hindered.

2) Consolidation works shall not commence till all the beneficiary farmers have agreed necessary arrangement for the project implementation, e.g. establishment of farmer organization, loss of farmland for the purpose of constructing farm roads and irrigation & drainage canals (so-called non-substitute re-plotting), reallocation of consolidated farm plots, etc. Among issues, loss of farmland and farm plot reallocation are the major issues that the farmers need time to agree and settle.

3) Farmer organization should be established upon making consensus among the concerned farmers. Under the farmer organization, management committee is established by selected farmer representatives. The committee is in charge of taking contact with every farmer and also of arbitration if a problem occurs among farmers for the farmland consolidation. This farmer organization shall be in charge of maintaining such agricultural infrastructure as farm roads and irrigation & canals constructed within their jurisdiction.

4) The benefits accrued from land consolidation should be more than that of the land the farmers are to lose for the construction of farm roads and irrigation & drainage canals, and the ratio of the land loss should preferably be less than 10% of what the farmers own at present. If the ratio of the land loss comes to more than 10%, ID and AMD staff should review the plan and modify the designing of the farm road and canals in order not to lose more than 10% of the farmland.

5) To execute farmland consolidation project, ID, AMD, SLRD, Cooperatives Department, DOA, GAO should participate and assist the farmers. After the farmer organization has been established, management committee of the farmer organization will be in charge of holding general assembly or making consensus among all the famers. In every stage, respective government office should assist the farmer organization through the management committee.

6) Close collaboration and information sharing of respective works is necessary among the concerned government departments. After the farm land consolidation project has started, more than one government department have to discharge respective responsibility at the same time (e.g. designing by ID and AMD, obtaining information for beneficiary farmers and their farm plots by SLRD, registration of farmer organization by Cooperative Department, etc). To keep pace together among the concerned departments, collaboration and information sharing are due required.

7) Environmental examination and social consideration should be carried out prior to the implementation of the farmland consolidation project. All the environmental parameters which may give negative impacts during and after the project implementation should be identified and

monitoring plan thereof shall be established. Monitoring especially during the project implementation phase shall be carried out, and when negative impacts are to occur, necessary measures should be undertaken.

8) Loss of income opportunity during the construction period, if any, should be compensated. To avoid this, the construction should be carried out during off-crop season. In Myanmar, monsoon paddy is the dominant crop, and therefore winter season coming after the monsoon season and/or summer season coming before the monsoon season could be the off-crop season. The construction schedule shall consider these off-crop seasons, or compensation may not be avoided.

9) Any properties, e.g. house, trees, etc. existent within the project area should be compensated, provided that they had been existing before the cut-off date. It is noted that no compensation can be made on the properties constructed after the cut-off date. Cut-off date here means the date when the project is officially announced, e.g. the date stakeholder meeting for the purpose of explaining the project is held or census survey covering the beneficiary farmers is commenced.

10) Complaint-handling mechanism should be established prior to the commencement of the construction woks. Under farmland consolidation project, management committee may receive complaint from colleague farmers, and the committee should at first try to solve the complaint within the farmer organization. If they cannot solve the complaint within them, the management committee will bring the complaint to the concerned government office and claim the staff to solve the complaint.