Democratic Socialist Republic of Sri Lanka
Ministry of Mahaweli Development and Environment

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE PROJECT FOR FORMULATING CASCADE SYSTEM DEVELOPMENT PLAN UNDER NORTH CENTRAL PROVINCE CANAL

FINAL REPORT

MAIN REPORT

May 2018

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.
NTC International Co., Ltd.

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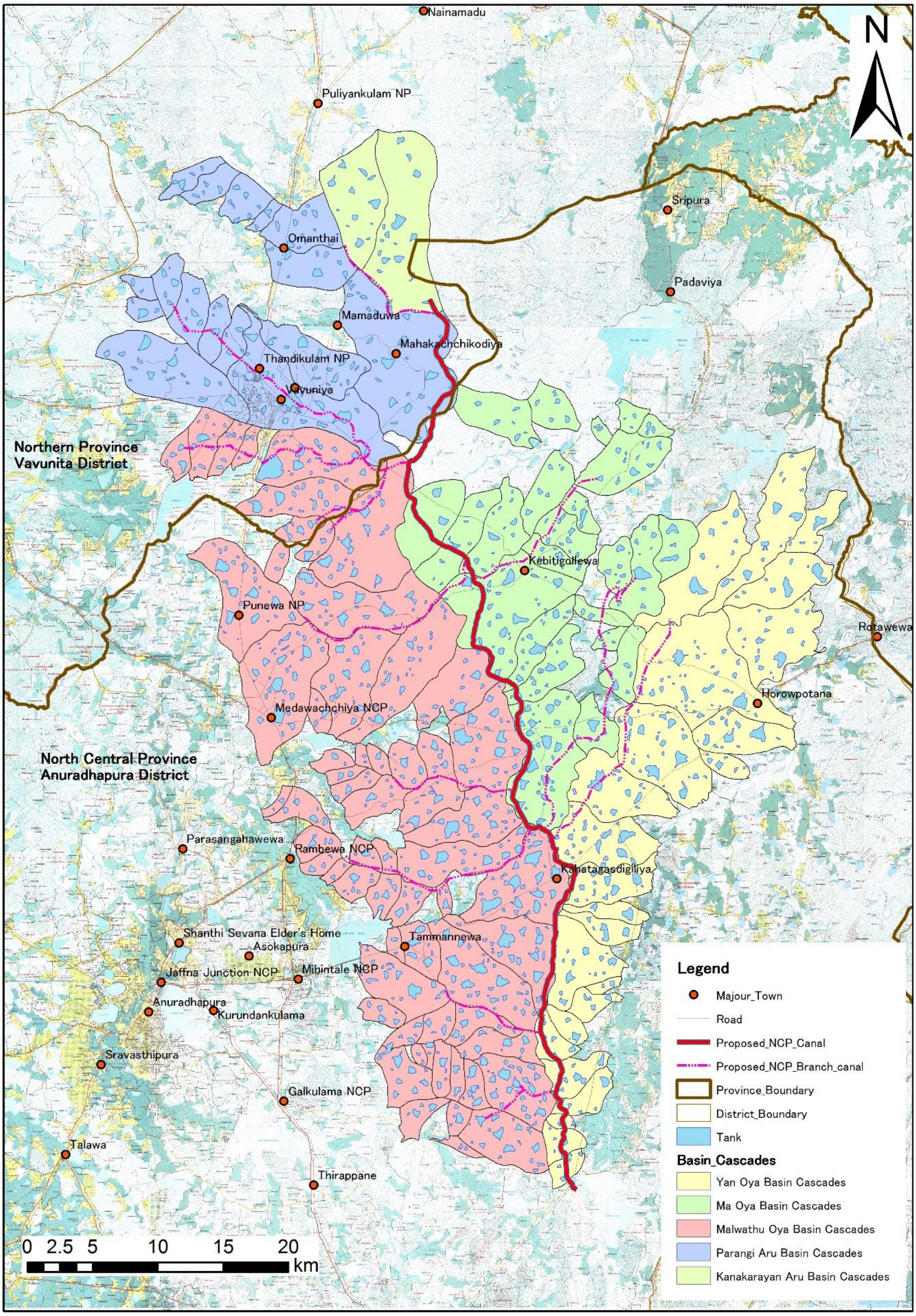


Source : JICA Project Team

Location Map of Project Target Area

Photographs (1/5)

		
1st JCC (20th Jun. 2016)	Kickoff meeting in DOI (16th Jun.2016)	Kickoff meeting in Northern Province (26th Jul. 2016)
		
Kickoff meeting in North Central Province (23rd Jun. 2016)	Meetng with ADB consultant (16th Jun 2016)	Interim progress meeting (15th Sep. 2016)
		
Reservoir in the target area	Tank bund in the target area	Typical Slice Structure
		
Spillway in the target area	Earth canal in the target area	Farm road in the target area
		
Causeway just downstream of the spill way.	Piping hole through the bund	Emergency repair of bund failure behind the intake sluice

Photographs (2/5)

		
Intake sluice under the non-functioning condition by fallen trees.	Overflowing water from the diversion canal.	Detachments by deterioration of the spillway concrete
		
Emergency (temporally) repair work by sandbags	Damaged causeway by flood	Construction of riprap
		
Paddy land under minor irrigation scheme	Papaya Cultivation	Mixed Cropping (Amaranthus,(leafy vegetable), with long bean and onion)
		
Chilli cultivation	Agro-well	Big Onion Cultivation
		
Onion seed production under rain shelter	Cowpea cultivation	Chilli cultivation with sprinkler irrigation system

Photographs (3/5)

		
Milk collecting point	Cattle shed	Chopped grass feeding
		
Milk chilling machine	Field demonstration for fodder cultivation	Milk chilling center
		
Local market (1)	Local market (2)	Field survey to collect tank and cultivation data
		
Field survey with NARO, JIRCAS and SPEC	Discussion with farmers in the field	Meeting with FO
		
Soil sampling for cmpression test for STEIN	Laboratory text for STEIN	Water level logger installed in the sluice

Photographs (4/5)

		
Soil survey	Farm household survey	Market survey
		
Inventory survey for infrastructure	FO meeting for detailed data collection	FGD for agriculture development
		
Field demonstration and verification on traditional paddy cultivation	Demonstration and field day on high value vegetable in CIC (1)	Demonstration and field day on high value vegetable in CIC (2)
		
Field Demonstration and Verification on Silage Making	Demonstration and verification on STEIN Works in Kiulekadawewa	Demonstration and verification on STEIN Works in Navelikulam
		
Evaluation meeting for STEIN work	Tank rehabilitation works in Kiulekadawewa (1)	Tank rehabilitation works in Kiulekadawewa (2)

Photographs (5/5)

		
Construction of link canal in Kiulekadawewa	Tank rehabilitation works in Navelikulam	Irrigation canal rehabilitation works in Navelikulam
		
Construction of link canal in Navelikulam	Telemetering facilities to support water management	Discussion on Uuilization of auto water level recorder
		
Cascade meeting for organizational management	Cascade meeting for water management	JCC meeting
		
Meeting with cascade experts	Training in Japan (1)	Training in Japan (2)
		
Training in Japan (3)	Training in Japan (4)	Training in Japan (5)

Source : JICA Project Team

Summary

Chapter 1 : General

1. "The Project for Formulating Cascade System Development Plan under North Central Province Canal in Sri Lanka (the Project)" was implemented during from July 2016 to April 2018 based on the Record of Discussion made between the Japan International Cooperation Agency (JICA) and the Ministry of Mahaweli Development and Environment (MMDE) of the Government of Sri Lanka (GoSL). The Project aims to formulate of a cascade system development plan to uplift the living standard and increase the income of farmers in the area benefited by the North Central Provincial Canal Project (NCPCP), which is one of the components of the Mahaweli Water Security Investment Program (MWSIP) Phase 2 to be funded by the Asian Development Bank (ADB). The Project targets 128 cascade systems in Anuradhapura and Vavuniya districts located in the arid area of the north-central region of Sri Lanka. Around 128 cascade systems are located over eight District Secretariat (DS) divisions in Anuradhapura District and four DS divisions in Vavuniya District covering five river basins, namely: Malwathu Oya, Yan Oya, Ma Oya, Parangi Aru, and Kanagarayan Aru. The target area includes 1,024 tank irrigation systems of 31,446 ha with 33,515 farm households.

Chapter 2 : National Background

2. Sri Lanka, achieving an average growth rate of 6.4% between 2010-2013, is focusing on long-term strategic and structural development challenges striving to become an upper middle-income country. Although the contribution of the agriculture sector to the national economy has declined over the years, it continues to play a key role in the economy.

3. The Ministry of Agriculture has been conducting programmes of (1) National Food Production Programme, 2016–2018, (2) Yaya 2 (Tract 2) Programme for Paddy Production, (3) Crop Clinics, and (4) Provincial Programmes. The National Food Production Programme 2016-2018 is one of the important government policies in agriculture and irrigation development in the country, which indicates production targets for major crops and describes 14 thrust areas to be addressed. The total budget of the Department of Agriculture (DOA) and Department of Agrarian Development (DAD) amounted to LKR. 16 billion in 2018. The Ministry of Irrigation and Water Resources Management (MIWRM) are is implementing eight major projects for the improvement of agricultural water resources. The total budget of Department of Irrigation (DOI) amounted to LKR. 14 billion as a whole in 2018. The Ministry of Mahaweli Development and Environment (MMDE) has five on-going irrigation development projects under its authority with a total budget of LKR. 45.6 billion for 2018.

Chapter 3 : Present Condition and Issues in the Project Area

4. The population and population density of Anuradhapura District are 860,575 and 119.3 per km^2, while those of Vavuniya are 172,115 and 85.9 per km^2, respectively. About 64% of the population are in the work age between 15 and 59 in both districts. While 91% of Anuradhapura population is Sinhalese, with 8% of Sri Lankan Moor, while 83% of Vavuniya is Tamil. The religion is largely corresponding to their ethnicity. Poverty headcount index in Anuradhapura is higher than that of the national average, while that of Vavuniya is lower. Employment in the agriculture sector counts to 55% in Anuradhapura and 33.8% in Vavuniya. Mean monthly household income in Anuradhapura and Vavuniya is LKR. 33,460 and LKR .43,965, respectively, which are lower than the national average of LKR .45,878. Income from agriculture contributes to 16.5% and 9.3 % of the total income in Anuradhapura and Vavuniya, respectively.

5. The main crop cultivated in the lowland of the project area is paddy while maize, millet, green gram, black gram, cowpea, chilli, onion, and low-country vegetables in the highland in the *Maha* season. The cultivation in the *Yala* season is limited due to insufficient water supply. The yield of paddy is 3.0 ton/ha, it is lower than the national average. The GoSL directly intervenes with the paddy/rice market by setting guaranteed prices and providing opportunity for farmers to sell the product directly to the Paddy Marketing Board (PMB) and Multi- Purpose Cooperative Society (MPCS). In addition, private purchasing is also significantly taking place in the project area. Dedicated Economic Centres (DECs) located near the project area can be accessed by farmers for selling their other field crops (OFCs), vegetables, fruits, and other crops. Agricultural extension service is carried out by the Provincial Department of Agriculture (PDOA) in association with the Department of Agrarian Development (DAD) in the project area. However, the coverage of one extension officer is large; and proper and timely extension services are not provided to the farmer.

6. Livestock is also one of the income sources of farmers in this area. About 11% of the farm households reared cattle and the average cattle holding size is 6.6 livestock unit. Major cattle breeds in the area consist of Indian Crosses, European Crosses, and indigenous. Since the free grazing or tethered grazing system is common in the project area, the average milk production in Anuradhapura area is as low as 2.8 L/cow/day and that of in Vavuniya area is about 1.0 L/cow/day. The Provincial Department of Animal Production and Health (PDAPH) is involved with necessary extension support for livestock farmers in the area.

7. Irrigation facilities of minor schemes in the cascade systems are deteriorated; and rehabilitation is essential. Major deterioration, which needs rehabilitation covers (a) tank bund erosion and the bund covered with thick jungle, (b) intake facilities that include sluice and gates, (c) spillways structure and downstream, (d) eroded causeways, and (e) eroded canal system in downstream. Currently, water management and minor repairs of minor irrigation schemes are generally done by farmer organisations (FOs) and the FOs are technically maintained by the Provincial Directorate of Irrigation (PDI) and DAD, or DAD alone.

8. FOs have been formed and are functioning in the project area on tank basis. FOs should be registered under the Agrarian Development Act No. 46 2000 to receive a legal entity. All the FOs in the project area are registered and assisted by DAD. One of the major functions of FOs is the operation & maintenance (O&M) of irrigation facilities and water allocation within the area as per *Kanna* meeting decision. Majority of the FOs have their own fund through collection of periodical member fee, which is used for minor repairs and maintenance work.

Chapter 4 : Outline and Progress of the North Central Province Canal Project

9. The “Mahaweli Water Security Investment Program (MWSIP)” is currently underway with the financial assistance of ADB. Total financing for the program is about USD $ 675 million and total duration of the MWSIP is about ten years from 2015. The implementation of MWSIP aims to improve the livelihood of the farmers through increase agricultural production and improve the accessibility to better drinking water in the Central, North Central, and North Western provinces through transferring water from the Mahaweli River basin to dry zone. The Project consists of two phases and Phase-1 is on-going. The project components of Phase 1 are: (1) Upper Elahera Canal Project (UEC), (2) North Western Canal Project (NWPC), and (3) Minipe Left Bank Canal Rehabilitation Project (MLBCR), while Phase 2 are: (1) North Central Province Canal Project (NCPCP), (2) Lower Uma Oya Project, (3) Kalinganuwara Pumping Complex, and (4) Randenigala-Kalu Ganga Transfer Canal (RKTC).

10. In 2015, a consortium of the consultants formed the Program Management, Design and Supervision Consultant (PMDSC) for the consultant services to implement Phase-1 components under the ADB funded project. The task of the consultant service includes mainly seven tasks, namely: (1) program management, (2) design review, detailed designs, and preparing contract documents, (3) contract management, construction supervision, commissioning and operation, (4) capacity

development and training implementation, (5) communications and public administration, (6) preparing a strategic environment assessment (SEA), and (7) preparation of Phase 2. For the water balance study, generation of steam flow time series data for daily time step requires stream flow estimation by a rainfall-runoff model, and such generation of stream flow data was not included in the original scope of PMDSC. The development of water balance simulation model has to be completed by July 2016 in the original schedule. However, due to the additional new scope to generate stream flow for daily time step, it was not completed yet, as of April 2018. Moreover, the feasibility study on the North Central Province Canal Project was carried out by the Ministry of Mahaweli Development and Environment (MMDE) and scheduled to be reviewed by the end of 2017. However, due to the delay in collection of the basic data on water balance study, the review of the feasibility study requires some more time in 2018 according to the MMDE.

Chapter 5 : Cascade System Development Concept Under the North Central Province Canal

11. The present economic viability of the cascade agriculture is low and it can be one of the biggest threats for sustainability of the cascade agriculture. The present annual net income from crop production of LKR 140,900 per household is low compared with the secondary and tertiary sectors' income level and it is not attractive for farmers to encourage further investment and intensive agriculture. Due to this situation, farmer loses interest in farming and becomes more dependent on non-farm income. As a result, technologies may not be updated, agriculture productivity may decline, and agriculture, which is the key sector of local economy, may deteriorate.

12. To overcome this situation, the Project proposes to make cascade agriculture an "Economic Entity" to achieve a profitable agriculture with proper utilisation of NCPC water. The profitable agriculture targets net income of more than LKR 500,000 per annum considering the middle- level wage earners at the national level. It is proposed that this can materialise by improving the productivity of ordinal crop; diversify the market-oriented high value crops and varieties; and promote crop and livestock integration. Basic concepts on the development plans on infrastructure, institutional development, agriculture, marketing, and livestock development, are outlined as follows;:

13. The concept of infrastructure development focuses on establishment of firm infrastructure to mitigate flood and drought risk and timely water distribution system amongst cascade systems to ensure an intensive and profitable agriculture in the target area with crop diversification. The Project proposes to rehabilitate existing tank bund and canal system, expansion of spillway capacity, construction of link canal connected between upstream and downstream tank, and establishment of water management supporting system.

14. Institutional setup for NCPC development shall be established through demarcation and adjustment of government's institutional structure, establishment of cascade- level management organisations, and capacity building of existing Farmers Organisations (FOs). Overall management of NCPC shall be materialised by applying government institutional system of concerned irrigation schemes. Cascade- level management organisation is required due to inevitable tasks of cascade-level distribution of water from NCPC. NCPC main canal shall be controlled by MMDE, and sub-watersheds are determined by the branch canal are handled by the Sub-watershed Management Committee (SWMC) authorised by PDI, while the cascades below the tertiary canals are managed by the Cascade Management Organisation supported by DAD and PDI.

15. The Project emphasises on three key aspects for agriculture development, namely: (1) shift to labour saving farm management, (2) develop cultivation and management skills, and (3) ensure fund and quality input to materialise profitable agriculture in the target area. Those are important aspects to promote high value vegetable cultivation, other field crop cultivation, and traditional paddy cultivation. In addition, enhancement of extension system focusing on improvement of information dissemination and communication system amongst the government and non-government stakeholders and improvement of the mobility of the extension officers is proposed.

16. Achievement of profitable agriculture requires market-driven approach for marketing agricultural produce. The marketing development concept underlines improvement of current condition and upgrading or creation of value-added markets in consideration of the factors such as agro-ecological condition, willingness of farmers to challenge the strategy, financial capacity, and organisational capacity in the target areas. Strategies for marketing of paddy focuses on improving efficiency of domestic distribution and promoting traditional rice varieties for high value market. OFC can be marketed by upgrading contract farming as well as increase of production of high demand crops. Vegetable marketing is to be promoted through off season production and sales, upgrading supermarket chain, and creating partnership with the hotel industries.

17. For the livestock development in the cascade development concept, it is required to shift from free grazing system specially using harvested paddy field in the Yala season to stall feeding system in livestock management after the arrival of the NCPC water in the target area. To promote stall feeding system, establishment of feed production and delivery system with utilisation of crop residue, and enhancement of livestock extension system focusing on breeding improvement are necessary.

Chapter 6 : Results of the Detailed Survey

18. In order to supplement the development concept, the Project carried out the detailed survey for selected six model cascade systems. The main survey items covered collection of information in seven categories, namely: (i). Existing Irrigation Facilities and Rural Roads and Rehabilitation Needs, (ii). Flood and Flood Mitigation Measures, (iii) Operation and Maintenance Activities in the cascade System, (iv). Establishment of Simulation Model for Water Distribution, (v). Farm Household Economy and Farming System, (vi). Agriculture Marketing and Post-Harvest, and (vii). Farmers Organisation and Extension Service. The survey methodology included individual interviews, focus group meetings, field survey, farm household survey, questionnaire survey, and collection of data from existing records.

19. The farm household survey covered 1,168 respondents in the six model cascades. The survey revealed that 76% of the heads of households are in the age group of 36 and 65 years. The average monthly households' income in the surveyed area recorded an average of LKR. 32,527, which is lower than the average of the target districts. Monthly households' income consists of income from crop production (50%), off-farm income (34%), and miscellaneous non-farm activities (12%). The income from crop production in the Maha and Yala seasons is estimated at LKR .123,514 and LKR .24,804, respectively. Since the farming does not bring attractive profit, the youth in the village are drawn away from the farming and seeking for off- farm income in the village and township.

20. All the households possess irrigated land under main tank, and 25% of them have irrigated land under other tanks as well. Land ownership for Akkarawela, Chena, and home -garden are 2%, 37%, and 66%, respectively. About 75% of the irrigable lands are owner operated.

21. Paddy is the main crop cultivated in irrigable lands in the surveyed area in the Maha season and about 25% of the Maha extent is cultivated with paddy in the Yala season. The average yield of paddy was found at 4.25 t/ha. OFCs and other seasonal crops are mostly cultivated in highland during the Maha season. Agricultural input supply channel is mainly occupied by private sector suppliers except supply of certified seeds by DAD and DOA.

22. About 65% of the heads of households are engaged fulltime in their own farms. Eighty-eight percent of households depend on hired labour during peak demand. Around 42% of the households reported farm labour scarcity while 32% indicated high labour wage as a constraint. Regarding the production capital, 73% of households invest their own money only since they do not have access to the bank. The farmers who borrowed part of their capital from commercial banks have counted for 17%.

23. The survey results indicated that willingness of farmers for crop diversification is about 14% and 65% in the Maha season and Yala season, respectively. Farmers who are hesitant to diversify crops are in view of unsuitability of soils for crops other than paddy, small- land holding size that could provide rice only for family consumption, inadequate knowledge on cultivating non-paddy crops, and crop damage by wild animals.

24. Cattle rearing and poultry keeping are the main livestock activities in the survey area. The percentage of households engaged in cattle rearing is about 10% and the average herd size is about 9.2 animals per dairy-farmer. Indigenous types of cattle dominate the cattle population and only 29.2% are crossbreds in the survey area. About 50%, 44%, and 6% of dairy farmers in the survey area practised free-grazing, tethered, and stall-fed, respectively. It is reported that the average milk production is 2.4 lit/cow/day and daily total milk production is 845 litres, which is sold mainly to MILCO Company. Poultry keeping households in the area is only about 5.1%.

25. Six model cascade systems covers 67 minor tanks, of which only 3% are in good operational condition and other 3% is abandoned. Bund tops as well as side slops have been eroded having leakages in 16% of the tanks. Only about 40% of tanks are accessible or observable while the balance are covered with vegetation. About 85% of total 72 spillways in 67 tanks are with inadequate capacity and 85% is damaged. There are 135 sluices in 66 tanks, out of which 76% are not working properly due to poor condition of spindle or missing gates. Almost all the canals are earthen and not functioning adequately due to heavy weeds, silting, and damages. Water allocation for farm lands are not in order due to unavailability of farm turnouts. Almost all the farmers attend canal clearing while only 80% attend for bund clearing. In addition to irrigation tanks, 304 agro-wells are functioning in the surveyed area, of which 195 are located in home garden and others are in the command area of the tank or highland.

26. Marketing survey revealed that major crops for sale in the survey area are paddy and maize in the Maha season. Paddy is sold directly or through collectors to PMB and private millers, while other crops are sold to the DEC or weekly Pola (open market). Contract farming system is in operation with four agri-business companies targeting maize and soya in the survey area. Accessibility to qualified seeds, agricultural loans, crop insurance, shortage of labour, and legal support of the contract are observed challenges in contract farming. Marketing potential of traditional rice varieties is increasing and excess demand was observed in Colombo market. Most wholesalers as well as retailers prefer purchasing traditional rice directly from producers. For selling of fruits and vegetables, the survey found the need of launching Hotel-Farmer Partnership. About 65% of the hotels are willing to purchase fruits and vegetables such as cabbage, water melon, cantaloupe melon, cauliflower, and bell pepper provided that price and quality are assured.

27. Organisational functions of FOs are satisfactorily mainly due to strong regulation and support of DAD. Irrigation water sharing within the tank has been established and there are cases that some FOs share water with other tanks. However, conflicts within the tank as well as between tanks have been recorded. Basic maintenances are done with a system already existing for canal cleaning and bund clearing. However, quality may not be up to the standard while major rehabilitation needs are attended by the government. Considering the possibility of establishing a cascade- level organisation, existing situation should be assessed.

Chapter 7 : Field Verification Programme

28. With the aim of verifying feasibility and acceptability of some important components of prepared development plan, verification programmes were implemented covering the issues of (a). Irrigation infrastructure rehabilitation and development for effective usage of irrigation water, (b). FOs to assess the flood risk by themselves and to attend minor repairs, (c). High value vegetable production, (d). Production of high value traditional and new paddy varieties, (e). Improvement of accessibility to quality feed by introducing silage making, and (f). Establishment of cascade management organisation.

29. Verification programme of “irrigation infrastructure rehabilitation and development for effective usage of irrigation water” was implemented to four tanks in Anuradhapura and Vavuniya covering six items, namely,: rehabilitation and improvement of flow capacity of the spillways, rehabilitation of sluice and irrigation canals, construction of link canal, enhancement of tank bund, installation of supporting system for water management, and canal lining with STEIN material. In the farmers’ meeting held after the completion of the construction works, the respective farmers generally accepted the link canal construction and expressed positive idea of utilisation for effective usage of tank water. The technical feasibility of each type of link canal (closed- type and open- type) was also confirmed through verification programme. The support system for water management was tentatively established by installing the auto water- level recorder with telemetering facility. The feasibility of the system was confirmed with PDI officers and FO member.

30. STEIN is a soil hardening agent that has been used in Japan since 1975 for irrigation systems and road construction, and it is recently in been used in Taiwan, East Timor, Indonesia, Malaysia, etc. STEIN was tested through constructing canal sections in three places in the project area. Results indicated that life cycle cost of STEIN is slightly lower than that of concrete with enough strengthening as a canal lining material. However, this required environment clearance of usage of the material and establishment of production and distribution system STEIN in the country for expansion of this technology.

31. Through the verification of flood risk assessment with check sheet and minor repairs by farmers, high motivation and technical ability to attend risk assessment for tank collapse and minor repair work by farmers with proper guidance of government officers are confirmed.

32. Field demonstration for high value vegetables was conducted in 2016/17 Maha and 2017 Yala seasons in CIC farm in Palwehera and Thalawa. Based on the demonstration, four field days were conducted with the participation of 105 farmers and officers. The programme revealed that cauliflower, cabbage, sweet corn, and beet can be cultivated successfully in the project area and farmers were motivated to cultivate those crops. The discussion made after the field demonstration revealed that continuous update of the cultivation skills, procurement of the quality seeds, and credit support are essential. The broccoli, Chinese cabbage, bell pepper, and cantaloupe melon may be tested with appropriate varieties.

33. A field demonstration for high value traditional and new paddy varieties were set in three places in Yala 2017 in cooperation with the Rice Research & Development Institute (RRDI), Bathalagoda. Nearly 30 farmers and field extension officers participated in the programme. Findings and feedback revealed that farmers are keen on cultivating traditional rice due to the growing demand. However, since the present genetic purity of the seeds of traditional varieties in the market is low, arrangement to provide quality seed to the farmers with in collaboration with RRDI is needed.

34. Silage making and application was the main activity focused on verification under the livestock program. Twenty-two farmers were trained, out of which five were supported with silage choppers. Silage making demonstrations were carried out using maize, grass, and crop residues. Milk production of the cows fed with silage was monitored. Verification results indicated that one acre of maize cultivation can maintain two livestock units. Daily milk production can be increased by feeding silage. Since poor sheltering causes high mortality of livestock, stall feeding is recommended. It is significantly expected that the development of livestock components contributes to improve dairy production;, which, also supports paddy and other crops farmers in the drought seasons to get substitute income.

35. Based on the detailed survey results, the outline of the Cascade Management Organisation (CMO) was be proposed; and the possibility of establishing CMOs were assessed. CMO will be formed with the membership of all the FOs under the concerned cascade. CMO management committee will consist of representatives of each FO and tank in the cascade. Relevant government officers will provide necessary supporting services as supporting members of CMO. Regarding the legal

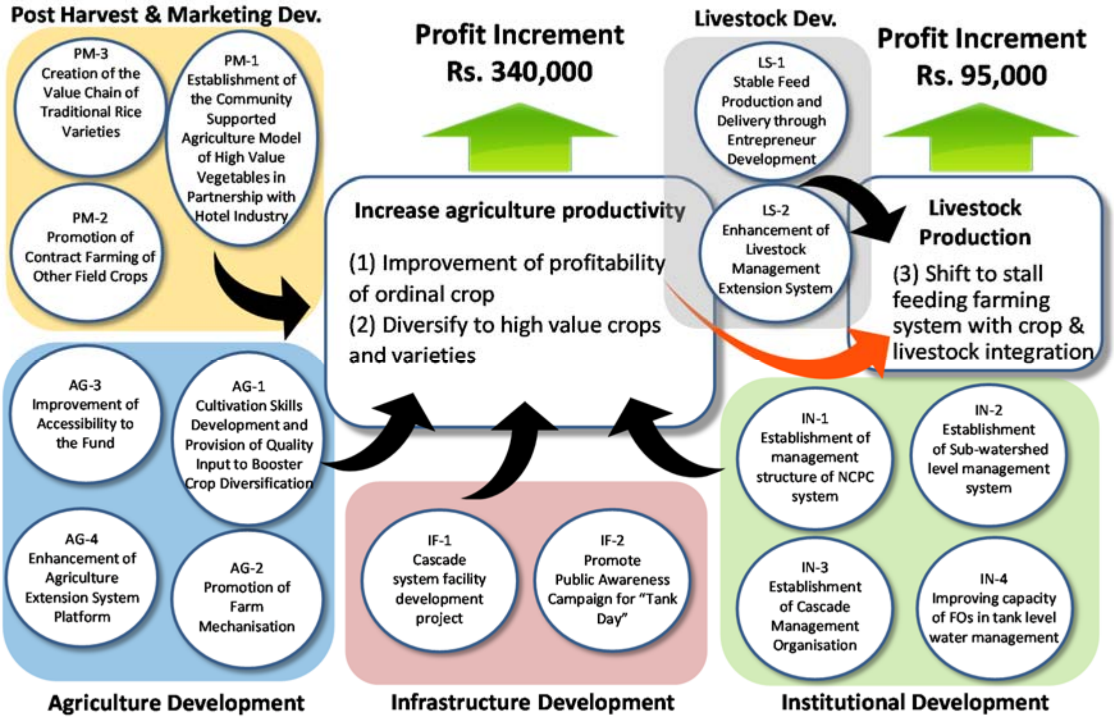
status, CMO can be registered under the Agrarian Development Act, 2000 No. 46, with necessary amendment. Area of authority of CMO will be restricted only for cascade related matters while tank- related issues are managed by relevant FOs. Government agencies involved with CMOs' activities will be DAD, PDI, and DOI (central). Authorisation and supervision of CMOs will remain with DAD while PDI will act on tertiary canal operation and maintenance of cascade- level irrigation facilities. DOI (central) will authorise the medium scheme FOs located in a cascade.

36. CMOs mainly act on cascade- level water distribution to each tank. Based on the water allocation to each tank by CMO, each tank-level FO will decide the cropping plan. Cascade- level water distribution will be operated practically by "Water Master" who will be selected by CMO and appointed by relevant Agrarian Services Committee. Payment for water master to be done through Agrarian Development Council with collected money from member FOs. The O&M of inter- tank irrigation facilities especially Link Canal will be a responsibility of CMO for minor repairs while major rehabilitation to be handled with government assistance.

37. Regarding the possibility of establishing a cascade- level organisation, it was concluded that the establishment of cascade- level organisation is crucial for adequate water management at the cascade; and this is feasible with necessary support. Risk factors in the establishment of CMOs were identified through the verification programme, namely:, difficulty in making consensus with mixed community;, crossing over different ASCs creates difficulty in coordination,; making consensus is difficult with large number of FOs,; coordination may be difficult when FOs joining more than one CMO; and low experience in sharing water. Necessary support is required in the area with the following risk factors: such as (1) cascade crossing over ASC divisions, (2) existence of minority population, (3) cascade with a large number of FOs, (4) FOs covering more than one cascade, (5) lower Bethma practice in current situation, (6) observed existing problems/disputes between FOs, and (7) existence of inactive FOs.

Chapter 8 : Cascade System Development Plan and Proposed Projects

38. Based on the development concept and results of the detailed survey and field verification programmes, the cascade system development plan including infrastructure development plan, institutional development plan, agriculture development plan, post harvest and marketing development plan, livestock development plan is proposed aiming at increment of the income and livelihood of farmers. Totally, 15 necessary actions as a project under the five development plans are proposed with the a total cost of LKR. 36,819 million. The farmers' income from irrigated and non irrigated agriculture and cattle farming will increase from LKR .151,000 to LKR. 587,000 per household with the implementation of 15 projects. In the completion of the crop diversification program in the target area, 14,800 tons of traditional and high-value new paddy, 56,000 tons of condiments (chilli and big onion), 37,000 tons of maize, 31,000 tons of soybean, 2,300 tons of grain legumes (green gram and black gram), and 125,000 tons of vegetables are added to the total production annually. In case of livestock product, milk production volume will reach to 54 million L per annum. The schematic drawing on the proposed 15 projects is shown in the figure below.



Source: JICA Project Team

Schematic Drawing of Structure of Proposed Projects

39. A firm infrastructure is required to achieve intensive agriculture through fair and timely water distribution with proper maintenance. The infrastructure development plan focused on those aspects and proposes two projects, namely: "Cascade System Facility Development Project" and "Promote Communication Campaign for Tank Day". The Cascade System Facility Development Project includes all the civil works for 128 cascade systems such as survey and investigation, headworks, canal system, link and tertiary canal, and farm road, as well as procurement of water-level monitoring systems. While the "Promote Communication Campaign for Tank Day" aims to strengthening proper maintenance of the facilities by promoting joint walk through survey and attending minor repair works with stakeholders once a year. These projects shall be implemented by PDI in NCP and DAD in NP with a budget of LKR .34 billion in total. The construction works shall be implemented in stage-wise dividing the target 128 cascades into five batches. Construction of tertiary canal and link canal with the installation of a water- level monitoring system, which is affected by the design parameters of NCPC main and branch system, will be implemented after the fourth year.

40. The institutional development plan focuses on the establishment of cascade management organisation with proper legal support. Since the institutional development for cascade management needs to be prepared in consideration of the whole NCPC management, the institutional set-ups should be established at different levels of the NCPC, namely:; the main canal, branch canals to tertiary canals, and cascades. From this point of view, the institutional development plan shall consist of the following four components: 1) the establishment of the NCPC main canal management system under the Mahaweli System, 2) the establishment of sub-watershed management system led by the PDI, 3) the establishment of the cascade management organisations with legal entity supported by DAD, and 4) the capacity building of the existing FOs. Institutional set-ups shall be established before the completion of the NCPC physical structures in order to start operation as soon as the irrigation structure is completed. Total budget amounted to nearly LKR .300 million.

41. The agriculture development plan focuses on cultivation skills development, credit access, and farm mechanisation, to meet the required labour and capital for profitable agriculture and to

overcome limited knowledge on irrigated agriculture for other field crops. In addition, it is required to enhance extension service by improving mobility of officers, communication and information management system, and technology transferring system in the area. The project of ‘Cultivation Skills Development and Provision of Quality Input to Boost Crop Diversification’ aims to ensure crop diversification through enhancement of cultivation skills for high-value vegetables, OFCs, and traditional and new variety of paddies and provisions of quality seeds and planting materials. ‘Promotion of mechanisation’ focuses on change of farming management system to suit mechanisation and establishment of local entrepreneurs to supply agricultural machinery services in the area. Increased investment cost of farmers who started cultivation of other crops shall be supported through the project of ‘improvement of accessibility to fund’. Improvement of agricultural extension system shall emphasise the establishment of extension platforms as capacity development of extension officers are covered through other agriculture project. DOA shall be responsible for mechanisation and DAD will handle improvement of fund accessibility project, and the rest will be under the responsibility of PDOA. Total budget proposed for these four projects is LKR.675 million.

42. The post harvest and marketing development focuses on necessary actions to assure the market channel of the production which will be increased due to the augmentation of the water and crop diversification. The marketing plan proposes direct marketing system between farmers and high-end consumers and promote contract farming with agribusiness partners, for which the following projects are proposed;: ‘Establishment of the community supported agriculture model of high-value vegetables in partnership with the hotel industry’, ‘Promotion of contract farming of other field crops’, and ‘Creation of the value chain of traditional rice varieties’. All the projects shall be carried out by PDOA with the a total budget of LKR.1,636 million.

43. The livestock development plan focuses on the aspect of feed production and delivery with breeding improvement since the grazing yard is limited especially in the Yala due to the crop production after arrival of NCPC water to the area. To achieve the production target of milk, three projects are proposed with a total budget of LKR .200 million, namely; (1) stable feed production and delivery through entrepreneur development, and (2) enhancement of livestock management extension system.

44. All the projects are to be commenced in consideration of the arrival of NCPC water. Infrastructure development should be completed before the completion of NCPC; and related management structure and institutional development shall be started well in advance to start the operation soon after the arrival of NCPC water. Agriculture, marketing, and livestock project shall be also be started prior to the completion of NCPC, in order to root and expand transferred technologies to the farmers in the target area.

Chapter 9 : Environment and Social Consideration

45. Environment and social impacts of the proposed cascade development plan were assessed based on the legislation and policies concerning environmental and social considerations in Sri Lanka. Since cascade systems have been traditionally formed with unique ecological system, environmental impacts were assessed in terms of preservation of biodiversity, protection of sensitive areas, reservation of forest area, impacts on wetlands, and influence on cultural and archaeological sites.

46. Potential environmental and social concerns related to NCPCP were identified in the impacts on biodiversity, deforestation of upstream forest areas, salt damage caused by drainage problems, change in social capital and traditional cultivation systems, and increase of in land related issues such as encroachment, fragmentation, and conflicts. The implementation of the proposed development plan may bring significant positive impacts on poverty alleviation, local economy such as employment and livelihood, land use and utilisation of local resources, water use, while minor negative impact may occur in water pollution, soil contamination, biodiversity, topography

and geographic features. Impact on indigenous people and ethnic minorities, mis-distribution of benefit, and damage/local conflict of interest will be highly depending on the project approach.

47. Other issues to be taken into consideration in the implementation of the projects include a) pollution such as water pollution, soil contamination, solid waste, noise and vibration caused by the infrastructure construction, b) land acquisition / involuntary settlement, c) biodiversity, requirement for approval and licences, e) employment of workers and accidents in construction work, f) increased agro-chemicals for crop diversification and expansion of the Yala cultivation, g) increased livestock waste, h) elephant-human conflict and needs for conservation, i) local conflict of interest regarding water distribution such as upstream vs. downstream, power relation of farmers' organisations, ethnic groups, social status, and j) gender.

48. Mitigation measures for addressing the negative impacts that may be relevant to NCPCP are analysed and proposed for environmental and social sustainability of the cascade system and the prosperity of the people in the target area.

Chapter 10 : Recommendations

49. The cascade system development plan was prepared based on the feasibility study results carried out by MMDE in April 2016 and it is necessary to update the proposed plans such as expected cropping calendar and link canal design based on the updated water balance study. In addition, MMDE should incorporate the revised cascade system development plan into the feasibility study on NCPCP for full completion of the planning and design. Therefore, completion of the feasibility study of NCPCP with review results of programme management, design, and supervision of consultant is indispensable for the finalisation of the cascade development plan.

50. Existing minor irrigation tanks under cascades require rehabilitation and upgrading for maximum use of the NCPC water, which are out of scope in the Mahaweli Water Security Investment Programme. To achieve an efficient use of NCPC water in the completion of the NCPCP, it is recommended that the respective departments should initiate the cascade system development plan early in advance.

51. Collaboration with other ongoing related projects shall be important to maximise the benefit of the Project. The Climate Resilience Integrated Water Management Project (CRIWMP) is currently underway with the aim of sustainable development of cascade systems through enhancement of irrigated agriculture. Since most of the activities covered under the Component 01 of CRIWMP are similar to the activities proposed under the cascade system development plan, the lessons learnt from CRIWMP were incorporated to the proposed project of the cascade system development plan. Other than CRIWMP, a special project on minor irrigation development for targeting physical rehabilitation of the tank and irrigation system under DAD is also implemented in the target area. DAD, MMDE, and MIWRM should collaborate for an effective use of fund and experience toward to the implementation of the cascade system development plan.

52. Since NCPC covers a large extent of area involving a huge number of farmers from different areas and different communities, some proposed projects are to be implemented in selected areas or selected farmers to demonstrate as pilot activities. Even though the intensity of benefit from the project shall be highly influenced by the environmental and geographical situation of the area, it is recommended to implement the project activities with a certain strategy in resource allocation, the selection of pilot areas, and the order of executing the activities in consideration of regional balance, economic, and social situations of the area to fairly benefit farmers from different communities.

53. The overall project goal can be achieved through collaboration of all the proposed projects that are implemented by different government departments. Due to such interrelation, arrangement of implementation schedule through close communication between the relevant government agencies is critical. Even though the main implementing agencies are proposed, collaboration and

coordination between all the concerned agencies are necessary for efficient implementation of the total project. It is recommended to consider the establishment of a coordination body to oversee the whole project with clear division of roles between the agencies and coordination structure.

54. In order to create a new sense of unity amongst farmers in the cascade level, the Project recommends implementing any type of development and rehabilitation activities related to agriculture and irrigation. This should be carried out by cascade basis so that it could accelerate the communication and discussion amongst the cascade level which will become the basis of unity. The project proposes to establish a Cascade Management Organisation (CMO) for developing and strengthening unity of farmers at the cascade level and thereby CMO can attend to development activities in the cascade especially for O&M of irrigation facilities.

55. In order to develop the capacity of CMO and supervise its activities, the Project proposes to give technical trainings such as water management and repair of facilities by the Provincial Directorate of Irrigation (PDI) and institutional trainings such as financial and organisation management by DAD considering the present departments' specified mandates and capabilities. Since the two organisations belong to the different government line, it requires additional coordination on budgeting and planning amongst government departments. This can be one of the risks to reduce project efficiency, for which the Project recommends to integrate the functions of present DAD and PDI into one either in the Provincial Council or Central Government.

56. Through the verification programme, advantages of STEIN usage in the irrigation rehabilitation work and quality of equipment of water- level recorder and telemetering facilities of OSASI Technos,. Inc. were confirmed. However, since the distributor of STEIN element in the country is not available and environment clearance is not yet obtained, there is less possibility to expand the technologies for large-scale development activities so far. It is recommended that SPEC Company Ltd. and MMDE collaborate regularly to achieve the environmental certificate immediately and make necessary actions to establish the distribution agent in the country.

57. Under the Project, 15 government officers in the central, provincial, and district levels were trained in Japan to strengthening of the development and management capacity on tank- based irrigation system. The achievements of the training programme were used effectively for the preparation of the cascade system development plan. The achievements in the counterpart training were not limited to the preparation of the cascade system development plan, but they could also be utilised for other works related to irrigation and agriculture development. It is recommended to expand those lessons learnt to other government officers for improvement of government project planning and implementation capacity.

The Project
for
Formulating Cascade System Development Plan
under
North Central Province Canal
in
Democratic Socialist Republic of Sri Lanka

Final Report

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Attachment

Annex

Table Index

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Abbreviations

A/L	Advance Level
ACAD	Assistant Commissioner Agrarian Development
AD	Assistant Director
ADB	Asian Development Bank
ADC	Agrarian Development Councils
ADO	Agrarian Development Officer
AGA	Assistant Government Agent
AI_1	Agricultural Instructor
AI_2	Artificial Insemination
AO	Agricultural Officers
ARPA	Agriculture Research & Development Assistants
ASC	Agrarian Service Center
BC	Branch Canal
CABI	Center for Agricultural Bioscience International
CARE	Humanitarian aid company
CBA	Cost Benefit Analysis
CBO	Community Based Organization
CDO	Cooperative Development Officer
CEB	Ceylon Electricity Board
CEC	Cation Exchange Capacity
CI	Cropping Intensity
CMFO	Cascade Management Farmer Organization
CO3/CO4	Hybrid Napier Variations
CS	Chief Secretary
DAD	Department of Agrarian Development
DAPH	Department of Animal Production and Health
DATC	District Agricultural Training Center
DCC	District Coordination Committee
DD	Deputy Director
DDO	Divineguma Development Officer
DEC	Dedicated Economic Centre
DFR	Draft Final Report
DL	Low Country Dry Zone
DO	Divisional Officer under ASC
DOA	Department of Agriculture
DOI	Department of Irrigation
DOL	Department of land
DRO	Divisional Revenue Officer
DS	Divisional Secretariat
DSM	Digital Surface Model
DSWRPP	Dam Safety and Water Resources Planning Project
EBDI	Export Development Bank of Iran
EIA	Environment Impact Assessment
EIRR	Economic Internal Rate of Return
ERW	Explosive Remnants of War
EU	European Union
FAO	Food and Agriculture Organization
FCMP	Full Cream Milk Powder
FGD	Focus Group Discussion
FHH	Female Headed Household
FMS	Farm Management Society
FO	Farmer Organization
FOB	Free On Board
FR	Final Report
FS	Final Report in September 2015
GA	Government Agent

GAP	Good Agriculture Practice
GCE	General Certificate of Education
GDP	Gross Domestic Product
GIS	Geographic Information System
GIZ	German Society for International Cooperation, Ltd
GN	Grama Niladhari
GND	Grama Niladari Division
GNP	Gross National Product
GOSL	Government of Sri Lanka
GS	Grama Sewaka
GVA	Gross Value Added
GWH	Gigawatt Hour
HARTI	Hector Kobbekaduwa Agrarian Research and Training Institute
HH	House Hold
HIES	Household Income and Expenditure Survey
ICR	Inception Report
ICT	Information and Communications Technology
IDA	International Development Association
IDP	Internally Displaced Person
IL	Low Country Intermediate Zone
IM	Mid Country Intermediate Zone
IMD	Irrigation Management Division
INMAS	Integrated Management of Major Irrigation System
IPHT	Institute of Post-Harvest Technology
IPNS	Integrated Plant Nutrition System
ISTI	In-Service Training Institute
IT	Information Technology
ITI	Industrial Technology Institute
ItR	Interim Report
IU	Up Country Intermediate Zone
IUCN	International Union for Conservation of Nature
IUCN	International Union for Conservation of Nature and Natural Resources
IWMI	International Water Management Institute
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
KFAED	Kuwait Fund for Arab Economic Development
KMTC	Kaluganga-Moragahakanda Transfer Canal
LDI	Livestock Development Instructors
LDO	Land Development Ordinance
LHG	Low Humid Grey
LME	Liquid Milk Equivalent
LTTE	Liberation Tigers of Tamil Eelam
MASL	Mahaweli Authority of Sri Lanka
MCB	Mahaweli Consultancy Bureau
MCM	Million Cubic Meter
MIWRM	Ministry of Irrigation and Water Resource Management
MKDP	Moragahakanda-Kaluganga Development Project
MLBCRP	Minipe Left Bank Canal Rehabilitation Project
MLBCRP	Minipe Left Bank Canal Rehabilitation Project
MLT	Middle level Technician
MMDE	Ministry of Mahaweli Development and Environment
MIWRM	Ministry of Irrigation and Water Resources Management
MOP	Muriate of Potash
MPCS	Multi-Purpose Cooperative Society
MREA	Ministry of Rural Economic Affairs
MSL	Mean Sea Level

MT	Metric ton
MW	Mega Watt
MWSIP	Mahaweli Water Security Investment Program
NAQDA	National Aquatic Resources and Research and Development Agency
NCP	North Central Province
NCPC	North Central Province canal
NCPCP	North Central Province Canal Project
NCRCS	New Comprehensive Rural Credit Scheme
NE	Northeast
NGO	Non-Government Organization
NIRP	National Irrigation Rehabilitation Project
NLDB	National Livestock Development Board
NMAC	National Mine Action Centre
NP	North Province
NPK	Nitrogen Potassium Phosphorus
NPV	Net Present Value
NWPCP	North Western Province Canal Project
NWSDB	National Water Supply and Drainage Board
O&M	Operation and Management
O/L	Ordinary Level
OFC	Other Field Crops
OFID	OPEC Fund for International Development
OPEC	Organization of the Petroleum Exporting Countries
PDAPH	Provincial Departments of Animal Production and Health
PDI	Provincial Director of Irrigation
PDOA	Provincial Director of Agriculture
PIM	Participatory Irrigation Management
PMB	Paddy Marketing Board
PMC	Project Management Committee
PMDSC	Project Management Design and Supervision Consultants
PMU	Project Management Unit
PODIE	People's Organization for Development Import and Export
PR	Progress Report
PRA	Participatory Rural Appraisal
PTWG	Provincial Technical Working Group
QCD	Quality Cost and Delivery
RBE	Reddish Brown Earth
RDO	Rural Development Officer
RDS	Rural Development Society
RNI	Real National Income
RPM	Resident Project Manager
RRDI	Rice Research and Development Institute
SFD	Saudi Fund for Development
SLSI	Sri Lanka Standard Institute
SMO	Subject Matter Officer
SNF	Solid No Fat
SOP	Seasonal Operation Plan
SW	Southwest
SWMC	Sub-watershed Management Committee
TO	Technical Officer
TSP	Triple Super Phosphate
UEC	Upper Elahera Canal
UECP	Upper Elahera Canal Project
UHT	Ultra-High Temperature
UOMDP	Uma Oya Multipurpose Development Project
US	United States
VBA	Visual Basic Application

VS	Veterinary Sargent
WL	Low Country Wet Zone
WM	Mid Country Wet Zone
WMS	Water Management Secretariat
WRB	Water Resource Board
WRDS	Women Rural Development Society
WU	Up Country Wet Zone

Specific Terms of Sri Lanka

Ande	Share Cropping arrangements in which smallholders without animals herd and manage flock on behalf of a larger farmer and in return retain half the offspring
Anicut	A diversion weir to abstract water from a natural channel
Attam	Labour exchange between farmers
Asswedduma	Bunded and puddled (of land for paddy cultivation)
Chena	Slashing, Burning and shifting cultivation
Ganga	River
Grama Niladhari	Village level government officials
Maha	North east monsoon season
Oya/Ara	River
Pola	Weekly fair
Pradeshiya Sabha	Local Elected council (at divisional level)
Purana	Old or Ancient
Shramadana	Self-help / Shared labour
Tank	A reservoir storing water for irrigation
Wewa	Water tank
Yala	South west monsoon season
Yaya	Paddy field

Measurement Units

Area

cm^2	=	Square-centimetre(s)
m^2	=	Square-metre(s)
km^2	=	Square-kilometre(s) (1,000,000 m^2)
ha	=	Hectare(s) (10,000 m^2)
acre	=	Acre(s) (4,046.8 m^2 or 0.40468 ha.)

Length

mm	=	Millimetre(s)
cm	=	Centimetre(s)
m	=	Metre(s)
km	=	Kilometre(s) (1,000 m)

Currency

US$	=	United State Dollars US$1.0 = Yen 108.98 LKR 1.0 = Yen 0.7064 (as of 31st January 2018)
Yen	=	Japanese Yen
LKR	=	Sri Lankan Rupee

Volume

cm^3	=	Cubic-centimetre(s)
m^3	=	Cubic-metre(s)
L	=	Litre(s) (1,000 cm^3)
MCM	=	Million Cubic Metre (s)

Weight

g	=	Gram(s)
kg	=	Kilogram(s) (1,000 gr.)
tonne	=	Metric Tonne(s) (1,000 kg)
t	=	Metric Tonne(s) (in Table)

Time

sec	=	Second(s)
min	=	Minute(s) (60 sec.)
hr	=	Hour(s) (60 min.)

Chapter 1 Introduction

1.1 General

This Final Report on "The Project for Formulating Cascade System Development Plan under North Central Province Canal in Democratic Socialist Republic of Sri Lanka" has been prepared in accordance with the record of discussion following deliberations between the Japan International Cooperation Agency (JICA) and the Ministry of Mahaweli Development and Environment (MMDE) of the Government of Sri Lanka (GoSL). The Final Report describes on the result and activities of the entire project period till February 2018.

1.2 Background and Objectives of the Project

Almost all land area in the North Central and Northern Provinces of Sri Lanka are located in the dry zone, which is characterized by a bi-modal monsoon rainfall pattern coinciding with the wet and dry cultivation seasons, Maha and Yala, respectively. Cascade tank systems consisting of nearly 1,200 small/medium village tanks, developed in the ancient times and still functional, are found scattered in the area. They serve as reservoirs providing water for crop and livestock production which is the mainstay of the rural farming population. Most of the annual rainfall in the dry zone is received during the Maha season, which allows farmers to practice irrigated agriculture in the lowlands and rain-fed agriculture in the highlands. However, during the Yala season, farm activities are highly restricted due to low rainfall and limited water storage in the tanks. This situation has caused these rural areas to lag behind in the national socioeconomic development process.

With financial assistance from the Asian Development Bank (ADB), under the Mahaweli Water Security Investment Programme (MWSIP), GoSL has initiated the North Central Province Canal Project (NCPCP) to divert water to the North Central and Northern provinces with the objective of improving the agricultural productivity and thereby uplift the economic situation in the area. Although the water availability in this area will improve significantly after the implementation of the NCPCP, lack or inadequacies, particularly in the tail-end facilities, may prevent water from reaching the whole command area.

With the supply of water from NCPCP, which is scheduled to be completed by 2024, to establish efficient and fair water distribution in the cascade tank systems, it becomes necessary to prepare a facility implementation plan and an operation and maintenance plan. It also becomes crucial to formulate an agriculture and livelihood development plan in order to contribute towards the uplifting of farmers' socioeconomic status through promotion of new technologies for enhanced farm profitability. Furthermore, improvement of disaster management is inevitable and needs to be addressed focusing on possible incidence of flood damage to tank bunds and structures in the area.

Hence, the main objective of this project is to formulate a cascade system development plan to make the cascade as an economic entity, encompassing rehabilitation and improvement of existing irrigation facilities, water management, irrigation system operation and maintenance, agriculture and livestock development, processing and marketing, and capacity development of relevant communities and service providers. These plans are prepared based on feasibility study report prepared in April 2016 by Mahaweli Consultancy Bureau under MMDE.

1.3 Project Area

The target area of the project covers beneficial area under NCPC located in Anuradhapura and Vavuniya districts in the North Central Province and Northern Province, respectively, which is the arid area of the north-central region of Sri Lanka. The area has been left behind among the Mahaweli Development Programme (MDP) due to high priority on implementation of other area such as System B and System C as well as power supply projects. While other areas covered by the MDP have achieved higher cropping intensity, the area under NCPC remain without significant improvement. Moreover, the project area has larger number of minor irrigations, the cropping intensity of which is lower than that of medium and major irrigation schemes. This indicates that water resources have been limited with reference to the land availability and cropping potential in the area. In addition, necessity of immediate improvement of water availability in the area was highlighted by the severe drought for consecutive seasons in 2016-2018 that deteriorated food production of the area. These situations have given priority on the NCP canal project, and development of NCPC is justified as Moragahakanda and Kalu Ganga head works have been already commenced.

The project specifically targets 128 cascade irrigation systems identified as beneficial cascades under the NCPC through the Feasibility Study. Although the target number of cascade system was agreed at 135 during the detailed planning survey stage based on the intermediate output of the feasibility study, further investigation and analysis of the canal route revealed irrigable area under the NCPC is limited to 128 cascades. Therefore, it was finally decided that 128 cascade systems are to be built based on the final output of the feasibility report.

The 128 cascade systems are spread into five sub-river basins, namely: Malwathu Oya, Yan Oya, Ma Oya, Parangi Aru, and Kanakarayan Aru and covering 12 divisional secretary divisions, namely: Galenbindunuwewa, Horowpothana, Kahatagasdigiliya, Kebithigollewa, Medawachchiya, Mihinthale, Rambewa, Thirappane in Anuradhapura District and Vavuniya, Vavuniya North, Vavuniya South, and Vengalacheddiculam in Vavuniya District. The summary of the target cascade systems is as follows:

Table 1.3.1 Summary of Target Cascade Systems Specified under Pre-FS

River basin	Benefited Cascade System			Benefited Tank		
	Total (Nos.)	**Anuradhapura** (Nos.)	**Vavuniya** (Nos.)	**Total** (Nos.)	**Anuradhapura** (Nos.)	**Vavuniya** (Nos.)
Malwathu Oya	62	58	9	521	469	52
Yan Oya	24	24	0	215	215	0
Ma Oya	24	24	1	198	197	0
Parangi Aru	16	2	16	125	0	125
Kanakarayan Aru	2	1	2	25	0	25
Total	128	109	28	1,084	881	202

Source: Prepared by the JICA Project Team based on the information from the Feasibility Study carried out by the Ministry of Mahaweli Development and Environment

1.4 The JICA Project Team and its Counterpart

The JICA Project Team is composed of 12 experts having different expertise in the field of irrigation and agricultural development. Twenty organisations/departments in GoSL involved in the project nominated their counterpart personnel who will be the focal point of the respective departments and the JICA Project Team. The members of the JICA Project Team and the nominated counterpart personnel are shown in Table 1.4.1 and Table 1.4.2, respectively.

Table 1.4.1 Members of the JICA Project Team

Position	Name
1. Team Leader / Project Planning	Shigeki Yamaoka
2. Sub Leader / Irrigation Facility / Rural Infrastructure / Irrigation and Water Management	Tatsuhiko Hiraiwa
3. Hydrology	Sohei Uematsu
4. Disaster Management / Soil Conservation	Masami Yasunaka
5. Crop Production / Extension	Lalith Devasiri
6. Livestock Production	Aritsune Uehara
7. Post-harvest / Marketing	Akiko Akiyama
8. Farmers Organisation	Ayako Mitsui
9. GIS	Yasutaka Sakamoto Chikara Uchida
10. Cost Estimation / Construction Supervision	Takuya Igawa
11. Environmental and Social Considerations / Conflict Prevention	Miki Morimitsu
12. Coordinator / Support for Crop Production and Extension	Hironori Inoue

Source: JICA Project Team

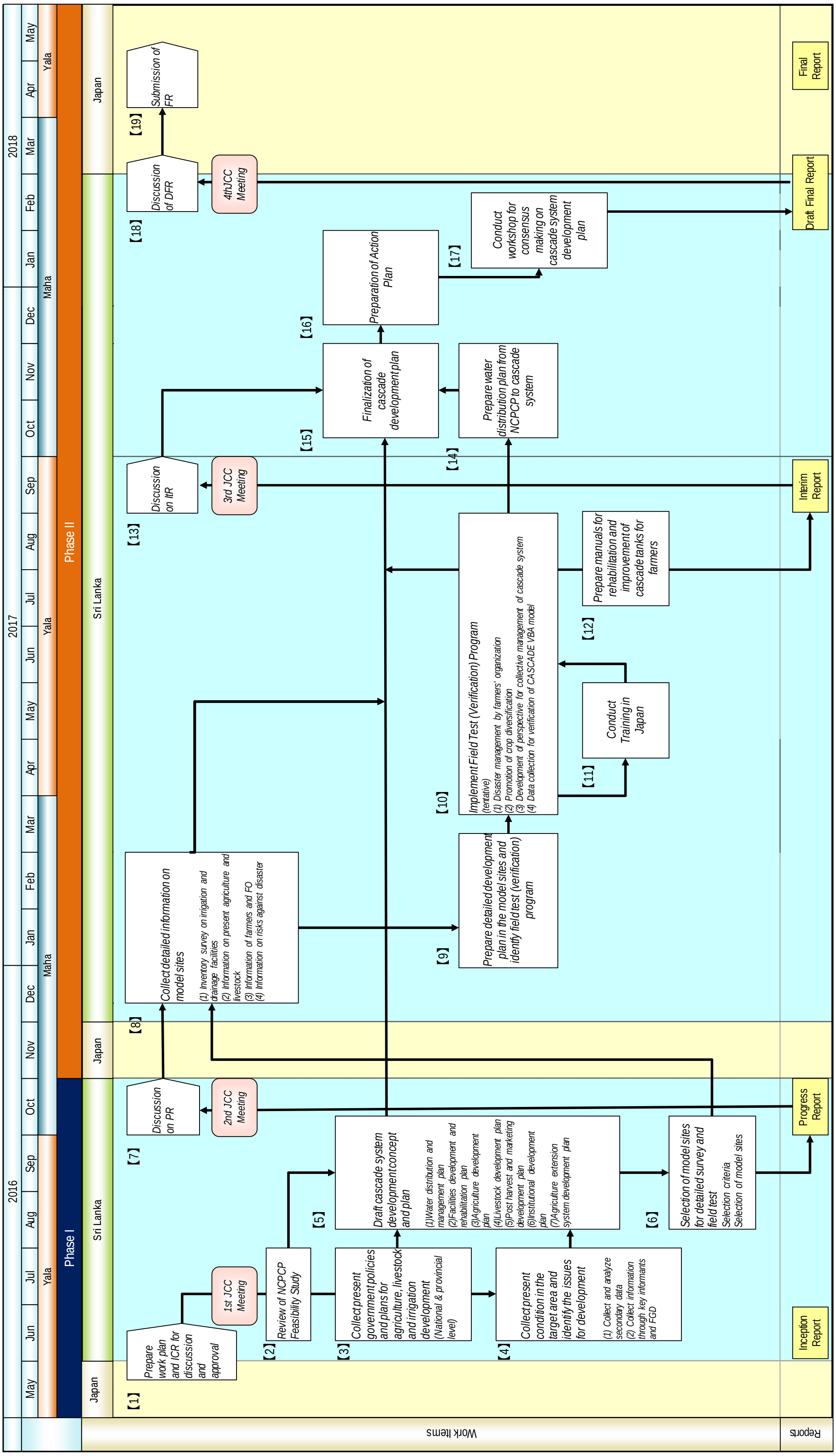
Table 1.4.2 List of Counterpart Personnel (at the beginning of the Project, July 2016)

Ministry / Provincial Council	Department	Counterpart Personnel	
		Name	Position
Ministry of Mahaweli Development and Environment	Ministry	Eng. N.A.Sisira Kumara	Additional Secretary
Ministry of Irrigation and Water Resource Management	Ministry	Eng. S.M.D.L.K. De Alwis	Additional Secretary / Water Resource Management
Ministry of Irrigation and Water Resource Management	Department of Irrigation	Eng. T.P. Alwis	Additional Director General of Irrigation
Ministry of Irrigation and Water Resource Management	Department of Irrigation	Eng. M.W.P. De Silva	Director of Irrigation / Anuradhapura
Ministry of Agriculture	Department of Agriculture	Dr. S.A.S.A. De Silva	Director / Natural Resource Management
Ministry of Agriculture	Department of Agrarian Development	Eng. Prabarth Witharana	Head / Water Management Division
Ministry of Agriculture	Department of Agrarian Development	S.Y.D.A. Somawansa	Assistant Commissioner / Anuradhapura
Ministry of Agriculture	Department of Agrarian Development	R. Vijayakumar	Assistant Commissioner / Vavunia
Ministry of Social Services, Welfare, and Livestock Development	Ministry	Dr. R.P.M. Pathirathna	Additional Secretary
Ministry of Irrigation and Water Resource Management	Department of Irrigation	Eng. P. Rasikaran	Dept. of Irrigation / Vavunia
Provincial Council / NP	Provincial Department of Planning	R. Umakanthan	Deputy Chief Secretary (Planning)
Provincial Council / NCP	Provincial Department of Planning	P.B. Dayarathna	Deputy Chief Secretary (Planning)
Provincial Council / NCP	Provincial Department of Animal Production and Health	Dr. Nihal Wedasingha	Provincial Director
Provincial Council / NP	Provincial Department of Animal Production and Health	Dr. S.Vaseeharan	Provincial Director
Provincial Council / NCP	Provincial Department of Agriculture	Priyanjanie Madana	Provincial Director
Provincial Council / NP	Provincial Department of Agric.	S. Sivakumar	Provincial Director
Provincial Council / NCP	Provincial Department of Irrigation	Eng. H.M.J. Herath	Provincial Director
Provincial Council / NP	Provincial Department of Irrigation	Eng. V.Premakumar	Provincial Director
Provincial Council / NCP	Provincial Department of Cooperative	K. Ravindranathan	Assist. Commissioner
Provincial Council / NP	Provincial Department of Cooperative	K.P.C. Darmathilake	Assist. Commissioner

Source: JICA Project Team

1.5 Work Procedure and Outline

The project will be carried out for 24 months from June 2016 to May 2018. The project is divided into two phases, namely, Phase-1 from June to October 2016 and Phase-2 from December 2016 to May 2018. The objectives of Phase-1 are mainly the drafting of the cascade system development concept and plan, selection of model sites, and preparation of plan for Phase-2 works, while Phase-2 targets the implementation of the detailed survey and development planning in model sites as well as the conduct of field verification programme and finalisation of development plan and action plans. The workflow is shown in the following figure.



Source : JICA Project Team

Figure 1.5.1 Project Work Flow

1.6 Technology Transfer

The technology transfer from the JICA Project Team members to the counterpart personnel was carried out according to the technology transfer plan discussed and agreed upon during the inception meeting as shown in Table 1.6.1.

Table 1.6.1 Technology Transfer Plan

Categories	Content	Method	Target
Formulation of cascade system development plan	(1) Data organisation and analysis with GIS (2) Water resource/hydrological analysis (3) Development potential evaluation and classification of cascade system (4) Environmental social consideration	Discussion and sharing of knowledge through day-to-day communication	Central and Provincial, District-level staff
Cascade level water management and disaster management	(1) Analysis of rainfall and water level relationship (2) Collection and analysis of metrological data for effective water management (3) Preparation of effective water management system (4) Planning of preventive measures for flood protection (5) Rehabilitation and improvement of cascade tanks by farmers	Discussion and sharing of knowledge through day-to-day communication Training in Japan	Provincial and District-level staff
Crop and livestock development	(1) Develop innovation, knowledge, and learning process to assist farmers to adopt and make best use of new technologies and services	Discussion and sharing of knowledge through day-to-day communication	Provincial and District-level staff
Preparation of action plans	(1) Analysis of human resources and budget forecast	Discussion and sharing of knowledge through day-to-day communication	Central and Provincial, District-level staff

Source: JICA Project Team

1.7 Joint Coordination Committee (JCC)

The joint coordination committee (JCC) was established to provide coordination among different departments and to give the necessary guidance to the JICA Project Team for the smooth and effective implementation of the project. The JCC was chaired by the Secretary to the Ministry of Mahaweli Development and Environment, and each related organisation head was nominated as a member of JCC as shown in Table 1.7.1. Five JCC meetings were conducted during the project period, i.e., in June and October 2016, April and October 2017, and February 2018.

Table 1.7.1 Members of the Joint Coordination Committee

Title	Position	Organisation
Chairman	Secretary	Ministry of Mahaweli Development and Environment
Project Coordinator	Additional Secretary	Ministry of Mahaweli Development and Environment
Project Manager	Additional Secretary / Water Resource Management	Ministry of Irrigation and Water Management
Members (Sri Lankan Side)	Secretary	Ministry of Irrigation and Water Management
	Director General	Department of Agriculture
	Commissioner General	Department of Agrarian Development
	Director General	Department of Irrigation
	Director General	Department of Animal Production and Health
	Commissioner General	Department of Cooperative Development
	Conservator General	Department of Forest
	Director General	Department of Wildlife
	Chief Secretary	Provincial Council, Northern Province
	Chief Secretary	Provincial Council, North Central Province

		Other personnel accepted by the chairperson
Members (Japanese Side)	Senior Representative	JICA Sri Lanka Office
	Team Leader	JICA Project Team
		Other personnel assigned by JICA

Source: JICA Project Team

Chapter 2 National Background

2.1 Overview of the National Socioeconomy

2.1.1 Land and Population

Sri Lanka covers a total area of 65,610 km^2 including 2,905 km^2 of inland waters with 1,340 km long coastline. The total population in 2015 was 20.96 million of which, the majority constitutes the rural sector (77%) with 18% in the urban sector and the balance of 5% in the estate sector. The annual population growth rate is 0.9%. Land areas and population densities in the provinces and (selected districts) are shown in Table 2.1.1 below.

Table 2.1.1 Land Area, Population, and Population Densities (2014)

Province and *(District)*	Total Area km^2	Inland Waters km^2	Forests km^2	Land Area km^2	Population '000	Density Persons Per km^2
Western	3,684	91	195	3,593	5,936	1,652
Central	5,674	99	1,402	5,575	2,631	472
Southern	5,544	161	932	5,383	2,532	470
Northern	8,884	594	3,946	8,290	1,085	131
(Vavuniya)	*(1,967)*	*(106)*	*(889)*	*(1,861)*	*(177)*	*(95)*
Eastern	9996	635	3,030	9,361	1,593	170
North Western	7,888	382	1,002	7,506	2,425	323
North Central	10,472	731	3,326	9,741	1,298	133
(Anuradhapura)	*(7,179)*	*(515)*	*(1,979)*	*(6,664)*	*(883)*	*(133)*
Uva	8,500	165	2,000	8,335	1,301	156
Sabaragamuwa	4,968	47	265	4,921	1,970	400
All Island	65,610	2,905	16,598	62,705	20,771	331

Source: Surveyor General's Office and Registrar General's Office, quoted in Economic and Social Statistics of Sri Lanka (2015)

2.1.2 National Economy

The economy of Sri Lanka expanded following the end of the civil war and registered an average growth rate of 6.4% from 2010 to 2013. During this period, the largely rural-based economy of the country shifted towards a more urban-based economy. However, this boom did not last and the gross domestic product (GDP) growth rate for 2013 fell to 3.4% and recovered to 4.5% in 2014. The economy expanded by 4.8% compared to 4.9% in 2014. The negative impact caused by the slowing down of the demand for traditional export markets and the short-term capital outflows due to the strengthening of the US economy was offset to some extent by the lower international commodity prices. Sri Lanka has surpassed the set targets of most of the Millennium Development Goals relating to poverty reduction, gender equality, and education, and ranked 73rd in terms of the Human Development Index in 2014.

Sri Lanka has emerged as a lower middle-income country with a per capita income of USD 3,912 in 2015 and is focusing on long-term strategic and structural development challenges as it strives to become an upper middle-income country. The summary of the national accounts is shown in Table 2.1.2 below.

Table 2.1.2 Summary of National Accounts, 2011-2014

Item	2011	2012	2013	2014 [1]
Gross National Product (GNP) LKR in Million				
GNP at Constant (2002) Prices	2,832.162	2,983,049	3,180,915	3,420.629
GNP at Current Market Prices	6,471,272	7,423665	8,448,144	9,944,608
Gross Domestic Product (GNP) LKR in Million				
GNP at Constant (2002) Prices	2,863,691	3,045,288	3,266,041	3,506,664
GNP at Current Market Prices	6,543,313	7,578,554	8,674,230	9,784,672

Real National Income (RNI) LKR in Million				
RNI at constant (2002) Prices	2,861,259	3,007,151	3,222,506	3,479,471
Economic Growth (in Real Terms) %				
Growth of GDP	8.2	6.3	7.2	7.4
Growth of GNP	8.4	5.3	6.6	7.5
Growth of RNI	7.0	5.1	7.2	8.0
Per Capita Income (current market prices)				
GDP Per Capita LKR	313,542	371,061	421,509	471,074
USD	2,836	2,908	3,265	3,608
GNP Per Capita LKR	310,090	363,478	410,523	459,516
USD	2,805	2,848	3,180	3,520
Expenditure (Current Market Prices) LKR in Million				
Gross Domestic Expenditure	7,495,578	8,614,147	9,500,783	10,621,164
Consumption	5,536,095	6,295,894	6,940,569	7,716,177
Investment	1,959,483	2,318,253	2,560,214	2,904,987
Savings (Current Market Prices) LKR in Million				
Domestic Savings	1,007,218	1,282,660	1,733,661	2,068,496
National Savings	1,448,393	1,816,384	2,236,253	2,641,560
Net Export of Goods and Services				
(Current Market Prices) LKR in Million	-952,265	-1,035,593	-826,553	-836,491
Exports of Goods and Services	1,508,565	1,730,467	1,949,158	2,185,039
Imports of Goods and Services	2,460,830	2,766,060	2,775,711	3,021,530
Factor Income from Abroad (Net)				
(Current Prices) LKR in Million	-72,041	-154,889	-226,086	-240,065

(1) Provisional
Source: Department of Census and Statistics, Central Bank of Sri Lanka (2015)

The sectoral composition of the GDP is shown in Table 2.1.3 below.

Table 2.1.3 Sectoral Composition of GDP (%)

Year	Agriculture	Industry	Services
2012	11.1	30.4	58.6
2013	10.8	31.1	58.1
2014	10.1	32.3	57.6

Source: Central Bank of Sri Lanka

Analysis of the composition of GDP from the agriculture sector shows that the largest contributors are the OFC, fishing and paddy sub-sectors in that order. The provincial GDP of the three sectors are shown in Table 2.1.4 below.

Table 2.1.4 Provincial GDP by Industrial Origin at Current Prices in 2013(1)

(LKR in Million)

Sector/Province		Western	Central	Southern	Northern	Eastern	North West	North Central	Uva	Sabaragamu
Agriculture		**91,965**	**148,885**	**133,227**	**66,630**	**92,846**	**131,060**	**82,589**	**107,981**	**78,452**
a	Tea	5,321	26,316	26,985	-	-	-	-	7,674	22,082
b	Rubber	10,147	949	3,150	-	-	705	-	697	13,171
c	Coconut	14,819	4,854	10,157	2,102	3,278	26,523	5,435	4,531	5,941
d	M. Export C	1,199	4,480	13,851	2	6	301	4	601	3,276
e	Paddy	2,995	5,361	10,895	12,246	27,176	17,467	32,225	9,459	6,618
f	Livestock	9,617	4,017	2,900	6,570	6,513	20,575	5,010	3,466	2,137
g	OFCs	9,581	83,224	20,293	18,427	17,835	24,749	25,535	63,776	15,113
h	Plantation C	2,422	2,568	3,222	168	262	2,177	435	1,032	3,294
i	Forestry	1,828	9,200	1,826	1,391	3,877	7,661	6,863	9,025	4,167
j	Other Crops	2,278	7,312	2,916	2,131	4,826	4,826	2,203	6,165	2,279
k	Fisheries	31,759	603	37,069	23,594	26,075	26,075	2,878	1,556	375
Industry		**1,280,355**	**336,117**	**318,401**	**68,176**	**181,383**	**273,717**	**118,149**	**90,486**	**148,646**

Services		**474,917**	**50,890**	**176,736**	**268,676**	**482,307**	**238,157**	**211,505**	**299,058**
GDP	**3,643,241**	**959,918**	**954,518**	**311,542**	**542,905**	**887,063**	**438,896**	**409,972**	**526,155**
% Contribution	**42.0**	**11.1**	**11.0**	**3.6**	**6.3**	**10.2**	**5.1**	**4.7**	**6.1**

(1) Provisional
Source: Central Bank of Sri Lanka

2.1.3 Agriculture Trade

Total exports showed an increase during the 2005-2014 period with LKR 1,453 billion for 2014. Of this, agricultural exports amount to LKR 364 billion with earnings from export of tea amounting to LKR 212.58 billion. Rubber showed a declining trend while coconut showed an upward movement during the same period.

Table 2.1.5 Selected Exports, 2005–2014 (a)

Item	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014(b)
Agricultural Exports										
Tea (mt'000)	309	327	312	320	290	328	323	320	320	327
Rubber (mt'000)	32	47	51	49	56	52	43	37	24	16
Coconut (Mn nuts)	377	456	457	380	367	251	386	351	379	716
Vegetables (mt)	14,071	11,005	12,761	12,279	15,670	20,994	13,446	10,815	32,737	40,460
Coffee (mt)	131	106	61	86	60	26	10	10	19	57
Cinnanmon (mt)	12,365	12,334	13,400	12,459	12,234	13,682	13,747	14,762	14,148	13,949
Pepper (mt)	8,130	8,191	9,061	6,253	6,580	12,971	5,065	10,532	21,703	8,353
Arecanuts (mt)	3,646	4,465	6,354	6,052	4,017	4,709	5,022	4,369	12,807	32,382
0il seeds (mt)	949	2,059	1,184	315	1,449	9,201	546	3,298	7,036	4,942
Tobacco Raw (mt)	1,598	1,399	1,578	1,278	686	695	708	861	1,142	1,162
Selected Other Exports										
Petroleum Products (mt'000)	274	319	283	310	269	436	589	504	511	398
Textile and Garment (Mn kg)	554	674	768	828	720	758	861	797	923	973
Minerals (c)	4,229	5,077	5,152	5,176	3,018	3,231	3,341	3,094	3,083	3,116
Gems, carats (000)	6,644	8,972	7,459	7,531	7,445	7,345	9,154	9,194	14,393	12,685

(a) From 2007 onwards, categories are reclassified based on the National Import Tariff Guide - 2010
(b) Provisional
(c) Graphite only
Source: Sri Lanka Customs, Central Bank of Sri Lanka

The value of major imports grew steadily over the past years reaching LKR 2,535 billion in 2014 with intermediate goods contributing a major share at LKR 1,488 billion. In the food and drink category under consumer goods, the import costs of milk and milk products, rice, and sugar accounted for LKR 44.3 billion, LKR 36.79 billion, and LKR 33.37 billion, respectively.

Table 2.1.6 Imports by Major Categories, 2005-2014 (a)

Item	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014 (b)
Food and Drinks (mt'000)										
Rice	52	12	88	84	52	126	28	36	23	600
Sugar	418	525	478	571	466	548	606	569	548	520
Milk and Milk Products										
Milk and Milk Food (c)	53	73	66	66	65	76	88	84	69	71
Infant Milk Food (mt)	355	1,866	1,114	1,343	1,442	911	1,756	1,446	1,545	1,172
Fish and Fish Products										
Fish (Dried) (d)	50	50	52	48	49	49	50	41	39	36
Fish (Other)	26	27	35	29	27	34	33	31	40	43
Wheat Grain	864	1,200	952	919	1,026	1,051	1,242	1,084	895	1,179
Medical and Pharma (mt'000)	14	14	88	110	61	558	82	189	122	108
Fertilizer (mt'000)	529	633	569	773	462	649	801	640	600	765
Crude Oil (mt'000)	2,008	2,152	1,968	1,853	1,066	1,819	2,070	1,486	1,743	1,824
Cement (mt'000)	1,460	1,849	2,117	2,004	1,702	2,012	2,584	3,796	4,123	4,363
Transport Equipment (1,000 nos.)										
Motor vehicles (e)	75	65	44	19	3	37	68	103	32	46
Motor cycles	201	209	177	153	112	226	252	186	160	314
Tractors	26	23	23	28	12	18	26	18	13	5

(a) From 2007 onwards, categories are reclassified based on the National Import Tariff Guide - 2010
(b) Provisional
(c) Excluding infant milk food
(d) Including maldive fish, sprats and smoked fish
(e) Including motor cars, vans, lorrie, and busses
Source: Sri Lanka Customs, Central Bank of Sri Lanka

2.1.4 National Food Balance

Food balance sheet is prepared annually by the Department of Census and Statistics reflecting the nutrition status at the national level. It also shows the per capita availability of food.

Table 2.1.7 Summary of Food Balance

Item		'000 mt				Per Capita Availability			
		Production	Gross Import	Available Supply	Food Net	Food g/day	Calories /day	Protein /day	Fats /day
Cereals		4,855.36	522.03	5365.79	3,477.13	469.37	1,627.20	3.30	1.77
Root, Tuber, and Starchy Food		421.87	123.20	545.07	411.61	54.93	71.57	0.60	0.09
Sugar		54.86	538.97	592.90	556.48	75.11	300.34	0.00	0.00
Pulses and Nuts		69.02	161.23	230.25	219.89	29.68	109.04	7,51	1.99
Vegetables (including onion)		1,055.71	184.26	1,221.35	1,109.00	149.70	82.74	3.88	0.54
TVP		4.16	0.48	4.60	4.60	0.62	2.31	0.31	0.02
Fruits		609.81	62.48	643.14	631.93	85.30	86.74	1.09	0.26
Meat		162.05	2.77	164.82	164,82	22.25	27.63	5.50	0.63
Eggs		92,81	0.00	92.81	91.14	12.30	21.38	1.63	1.63
Fish	Fresh	512.84	15.84	507.32	200.34	27.04	35.99	5.28	1.48
	Dried	68.20	37.61	105.81	105.81	14.28	35.01	7.24	0.58
	Canned	1.12	21.84	22.96	22.96	3.10	5.33	0.65	0.03
Milk	Fresh	278.01	0.00	278.01	179.58	24.24	19.90	0.85	1.34
	W. Dried	11.61	89.91	101.85	101.23	13.66	67.80	3.52	3.65
	Condensed	7.34	0.02	7.40	7.40	1.00	3.25	0.07	0.09
	Milk Food (Yoghurt, etc.)	10.48	0.03	10.51	10.51	1.42	0.85	0.06	0.00
Fat and Oil (including coconut)		939.42	18.54	917.54	755.15	101.92	366.34	3.03	34.76
Total		9134.67	1779.21	10,803.13	8,049.76	1,085.92	2,863.42	75.53	48.84

Note: Estimated mid-year population: 20,579,000
(1): (Production + Imports) – (Change in Stock + Exports)
(2): Quantity set apart for seed, animal feed, waste and manufacturing are excluded
Source: Department of Census and Statistics

Domestic agriculture meets around 75% of the country's food requirement, although there is potential to produce the entire requirement within the country in terms of OFCs such as gram, potato, chilli, and big onion. Per capita availability of food commodities increased marginally in 2015 from 2014. The food balance sheet with regard to major food commodities is shown in Table 2.1.8 below.

Table 2.1.8 Food Balance Sheet: Major Food Commodities

Item	Unit	2014			2015		
		Production	Imports	Per Capita Availability (kg/yr)	Production	Imports	Per Capita Availability (kg/yr)
Rice	mt'000	2,367	600	143	3,373	286	175
Maize	mt'000	241	99	16	261	79	16
Wheat	mt'000	-	1,179	57	-	1,208	58
Big Onion	mt'000	101	151	12	89	210	14
Sugar	mt'000	52	520	28	56	624	32
Potato	mt'000	83	118	10	97	142	11
Fresh Fish	mt'000	535	21	27	520	34	26
Cow Milk	Mil Let.	273	-	13	305	-	15
Coconut oil	mt'000	45	6	2	53	6	3

Note: 1 mt of paddy = 0.7 mt of rice
Source: Department of Census and Statistics and Sri Lanka Customs

2.2 Overview of Agriculture Sector in Sri Lanka

The agriculture sector constitutes five subsectors comprising of plantation crops (tea, rubber, coconut and minor export crops), field crops (paddy and OFCs including vegetables and fruits), livestock, fisheries and forests. The contribution of the agriculture sector to the national economy tends to decline over the years compared to the industry and service sectors. However, the sector continues to play a key role in the economy as the most important source of employment and livelihood for the majority of the Sri Lankan population. The gross national income by industrial origin is shown in Table 2.2.1 below.

Table 2.2.1 Gross National Income by Industrial Origin at Constant (2010) Prices

Economic Activity/Year	2010	2011	2012	2013	2014(C)	2015(C)
Agriculture, Forestry and Fishing	544,914	569,954	592,443	611,676	641,493	676,899
1. Growing of Cereals (Except Rice)	10,548	10,593	12,521	14,307	14,927	15,077
2. Growing of Rice	60,086	70,205	62,289	65,607	61,022	75,219
3. Growing of Vegetables	47,704	52,349	51,244	54,153	55,307	69,060
4. Growing of Sugar Cone, Tobacco, and Other Non-perennial Crops	2,442	2,142	2,254	2,441	2,286	1,954
5. Growing of Fruits	36,610	37,791	38,248	37,385	40,889	47,629
6. Growing of Oleaginous Fruits (Coconut, King Coconut, Oil Palm)	60,231	57,110	62,201	53,424	64,159	67,439
7. Growing of Tea (Green Leaves)	72,208	71,769	72,100	74,734	73,946	72,027
8. Growing of Other Beverage Crops (Coffee, Cocoa, etc.)	1,295	1,287	1,319	1,321	1,538	1,259
9. Growing of Spices, Aromatic, Drug, and Pharmaceutical Crops	28,468	28,147	44,426	50,833	57,509	58,278
10. Growing of Rubber	44,411	45,956	44,249	37,987	28,689	25,777
11. Growing of Other Perennial Crops	14,496	14,666	15,167	14,344	15,392	15,829
12. Animal Production	27,230	26,359	29,511	36,599	47,954	51,782
13. Plant Propagation and Support Activities to Agriculture	8,533	8,436	9,105	9,183	9,767	9,781
14. Forestry and Logging	43,339	42,505	38,188	43,044	47,451	48,333
15. Marine Fishing and Marine Aquaculture	77,579	89,575	97,063	103,879	106,585	104,952
16. Fresh Water Fishing and Fresh Water Aquaculture	9,737	11,065	12,560	12,435	14,072	12,501
Industries	1,708,867	1,866,947	2,035,601	2,119,080	2,194,167	2,259,223
Services	3,504,323	3,817,155	4,245,461	4,405,644	4,634,805	4,881,273
Equals Gross Value Added (GVA) at Basic Price	5,758,104	6,254,056	6,873,506	7,136,401	7,470,465	7,817,394
Taxes less Subsidies on Products	655,564	698,664	715,011	709,801	758,521	805,431
Equals Gross Domestic Product (GDP) at Market Price	6,413,668	6,952,720	7,588,517	7,846,202	8,228,986	8,622,825
Net Primary Income from Rest of the World	-69,776	-67,488	-134,946	-184,198	-189,495	-196,496
Gross National Income at Market Price	6,343,892	6,885,232	7,453,571	7,662,004	8,039,492	8,426,330

(c) Provisional
Source: Department of Census and Statistics

The performance of selected crops and crop categories are briefly discussed below.

Paddy is the major field crop and, like OFCs, vegetables and fruits, is almost exclusively cultivated by the smallholders in the rural areas. Land area under paddy and the productivity have increased greatly over the past few decades as a result of irrigation rehabilitation, construction of new irrigation infrastructure, and modernization of agriculture. Between 1960 and 2015, the extent of paddy lands increased from 91,000 ha to 1 million ha and production from 0.17 million mt to 4.8 million mt while the average yield increased from 1.88 t/ha to 4.4 t/ha. Government intervention in the form of guaranteed paddy purchase price, fertiliser subsidy, and purchase of stocks by the Paddy Marketing Board (PMB) contributed to the significant increase in the paddy sector in 2015. The production is equivalent to 3.3 mt of rice and is stated to be adequate to meet the rice demand of the country for 17 months.

Production of other field crops increased, collectively, by 6.8% to 362,452 mt in 2015 from 339,495 mt in 2014. Compared to expanded outputs of maize, finger millet, soybean, groundnut and potato in 2015, production of cowpea, big onion, red onion, and chilli recorded negative growth. It is estimated that the production of maize, cowpea, and groundnut exceeded the estimated domestic requirement in 2015 aided by the third season cultivation of legume crops.

Vegetable production in 2015 is recorded as 1.9 million mt with the domestic retail prices ranging between LKR 70 and LKR 306 per kg. During the year, 26 million kg of vegetables, valued at LKR 4.1 million, were exported. Meanwhile, the post-harvest losses of vegetables have been estimated at around 30-40% of the total production.

Production of fruits recorded a growth of 15.6% in 2015 with avocado, melon, and guava making significant contributions. During the year, 33 million kg of fruits worth LKR 5,173 were exported while 45 million kg of fresh fruits, including apples, oranges, mandarins, and grapes valued at LKR 5,637 were imported to the country. Like with vegetables, the post-harvest losses are estimated at around 30-40%.

Plantation crop of tea and rubber production recorded decreases in the past few years due to the decline in the international market prices. Tea covers 203,000 ha of land area and is grown in the low, mid, and up country wet zone of Sri Lanka. The sector is dominated by smallholders who account for 73% of the total tea production. The tea industry is currently experiencing a decline in output prices and the high cost of production and low productivity have resulted in low profitability posing a challenge in its sustainability.

Rubber is grown primarily in the low and mid country wet zones and covers a land area of 135,000 ha. The production decline in rubber is attributed to low prices, high cost of production, poor management, and overaged trees. Production in 2015 recorded 88,570, a reduction of 10% from the previous year.

Coconut is grown in all parts of the country, but the main producing areas are the coconut triangle with Gampaha, Kurunegala, and Puttalam at the apices and the coastal belt of the country. It covers a total land area of 455,000 ha and recorded the highest production surpassing 3,000 million nuts since 2000.

The main livestock products in Sri Lanka are milk, meat, and eggs. Animal power used in crop cultivation has virtually been completely replaced by farm machinery. However, the industry continues to play an important role in the rural economy by supplementing farm incomes. Livestock is spread in all regions of the country with concentrations in certain areas as determined by cultural, marketing, and agro-climatic conditions.

2.3 Agriculture-related Development Plan and Programmes

2.3.1 Mandate of the Key Ministries

Formulation and implementation of policies and programs related to agriculture development come under the purview of several government ministries. The key ministries involved are the Ministry of Agriculture, Ministry of Rural Economic Affairs, Ministry of Irrigation and Water Resources Management, and the ministry of Mahaweli Development and Environment. The functions of the respective ministries are executed through several departments and statutory boards/institutions established for the purpose. Key functions and the executing agencies under the ministries are summarized below.

Table 2.3.1 Key Functions and Executing bodies of the Ministries

Ministry	Key Functions	Departments	Statutory Bodies/Institutions
Agriculture	• Agricultural diversification and production improvement • Promotion of the use of organic fertilizer, • Administration of Soil Conservation Act, Felling of Trees (Control) Act, Seed Act, Pesticide Act, • Regulation of Fertilizer Act and Plant Protection Ordinance • Agricultural education, research and extension, • Undertaking activities related to paddy lands • High-tech agriculture. • Postharvest technology. • Agricultural enterprise development.	• Department of Agriculture (DoA). • Department of Agrarian Development (DAD)	• Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) • Sri Lanka Council for Agricultural Policy • Institute of Post-Harvest Technology • National Food Promotion Board • Pulses and Grain Research and Production Authority • Agriculture and Agrarian Insurance Board • National Fertilizer Secretariat • Ceylon Fertilizer Co. Ltd • Colombo Commercial Fertilizer Co. • Janatha Fertilizer Enterprises Ltd. • Lanka Phosphate Co. Ltd.

Rural Economic Affairs	• Regional and Rural economic development policies and strategies • Rural infrastructure and small enterprises • Facilities to enhance production in the livestock sector • Animal welfare activities and related matters • Promotion, propagation and development of livestock products • Popularization of livestock breeding methods for upgrading animal population in the sector • Protection of livestock against diseases and quarantine work	• Department of Animal Production and Health	•Paddy Marketing Board (PMB) •Rural Resuscitation Fund •Janadiriya Fund (Gramodaya Mandala Fund) •National livestock Development Board •Kiriya/Milk Industries of Lanka (Pvt) Ltd. •Milk Industries Lanka Ltd. •Mahaweli Livestock Enterprise Ltd.
Irrigation and Water Resources Management	• Irrigation reservoirs • Water resources management • Promotion, construction, operation, redevelopment and management of Irrigation Schemes • Drainage and flood Protection Schemes • Prevention of the pollution of revers, sreams and other watercourses • Rain water harvesting • Engeneering consultancy services and construction • Administration of Water Resources Board Act	• Department of Irrigation	• Water Resources Board • Riverine Bamboo Project
Mahaweli Development and Environment	• Implementation of Mahaweli Development Program • Compensation to Mahaweli farmers • Preservation of environment for present and future generations • Formulation and effective implementation of programs to combat pollution of the environment • Prevention of marine pollution and urban solid waste management • Protection and conservation of forest, fauna and flora • Promotion of commercial forestry to meet timber requirement of the country • Regulation and promotion of the Gem and Jewelry Industry • Coast conservation and protection	• Department of Forest • Department of Coast Conservation and Coastal Resources Management	• Mahaweli Authority of Sri Lanka • Central Environment Authority • Marine Environment Protection Authority • National Gem and Jewelry Authority • Gem and Jewelry Research Institute • State Timber Corporation • Central Engineering Consultancy Bureau • Geological Survey and Mines Bureau

Source : JICA Project Team

2.3.2 Ongoing Programmes under the Ministry of Agriculture

(1) National Food Production Programme, 2016–2018

The programme was launched in October 2015 with the view to attain self-sufficiency in selected agricultural commodities, curtail import of food items, adopt environment-friendly production methods, and enhance the producer income level. Other major objectives include proper management of food buffer stocks and establishment of a proper coordination mechanism among all stakeholders involved in the programme to make it part and parcel of daily life of people including school children, farmers' organisations, and civil organisations. Endorsed as the Wadduwa Declaration by the Ministers of Agriculture of the Central and Provincial governments, and implemented by a Presidential Task Force, the programme treats food production under the development of food crops, livestock, home gardens, and fisheries sectors. For effective implementation of the activities identified for enhancement of food production and agricultural development, 14 trust areas along with the strategies have been identified. The trust area on institutional coordination of the programme specifies establishment of seven monitoring committees at the national, provincial, and divisional levels. It is envisaged that all the objectives pertaining to food production identified in the programme are achieved within the three-year period.

Table 2.3.2 Main Trust Areas of National Food Production Programme

1	Input management	8	Traditional knowledge and practices
2	Empowerment of farmers	9	Research and technology development
3	Marketing	10	Consumer health and satisfaction
4	Natural resource management and adaptation to climatic change	11	Development of irrigation infrastructure facilities
5	State-Private sector partnership	12	Legal and regulation framework
6	Youth and women participation	13	Food security
7	Knowledge management	14	Institutional coordination

Source: National Food Production Programme

Under the trust area of institutional coordination, the programme envisions the establishment of monitoring committees. The national monitoring committee is headed by His Excellency, the President. Other committees will function as International Institutional Task Force and at ministerial, provincial, district, divisional, and rural levels.

Production goals and development activities are identified for each commodity in the programme. Among them, the targets and activities of selected commodities are shown in Table 2.3.3, Table 2.3.4 and Table 2.3.5 below.

Table 2.3.3 Production Target and Activities for Major Crops

Crop	Production Targets					Activities
	Items	2015	2016	2017	2018	
Paddy	Requirement (mil mt)	3.0	3.25	3.3	3.5	Yaya 2 Programme Introduction of water, weed, and nutrition management systems. Introduction of suitable varieties and technologies for rice-based products. Improving rice quality for traditional and special foods. Reclamation of areas abandoned due to bio-stresses. Promotion of traditional paddy in low country wet zone. Introduce rotational system to issue certified seeds among four farmer groups in community for self-seed production for three seasons.
	Target (mil mt)	4.6	5.0	5.1	5.4	
	Extent (mil ha)	1.1	1.1	1.1	1.1	
	Productivity (mt/ha)	4.1	4.5	4.7	5.0	
Maize	Requirement (1000 mt)	400	410	420	480	Increase extent in Yala season and productivity in Maha season. Produce local hybrid seeds and popularise usage. Mechanisation to reduce cost of production: seeder, weeder, harvester. Soil conservation to minimise erosion. Improve soil fertility by crop rotations and sun hemp cultivation. Introduce price control. Establish agro-wells with water pumps and tubes.
	Target (1000 mt)	240	330	400	480	
	Extent (1000 ha)	80	87	97	110	
	Productivity (mt/ha)	4.0	4.2	4.5	5	
Green Gram	Requirement (1000 mt)	26	24.8	26.0	25.0	Increase production through 3rd season cultivation. Establish green gram villages. Introduction of decortication machinery and establish storage facilities. Establish purchasing units for green gram villages.
	Target (1000 mt)	26	27.3	28.6	30.1	
	Extent (1000 ha)	24	25	26	25	
	Productivity (mt/ha)	1.1	1.1	1.1	1.2	
Soybean	Requirement (1000 mt)	200	225	230	280	Identify and popularise new varieties. Introduce certified seeds and profitable marketing mechanism. Promote a sustainable community-based seed production programme. Initiate research activities. Introduce mechanisation. Popularise trade agreements with buyers. Establish agro-wells and supply irrigation hose and water pumps.
	Target (1000 mt)	23	28	43	84	
	Extent (1000 ha)	15	20.5	25,5	42	
	Productivity (mt/ha)	1.5	1.5	2.0	2.0	
Big Onion	Requirement (1000 mt)	235	240	245	250	Extend cultivation in new areas area from 300 ha to 1,000 ha. Breeding, production, and distribution of seeds of high yielding varieties. Introduce storage technologies to extend keeping period for up to 4 months. Establish seed production villages to produce 50,000 kg. Promote year-round production in identified off-season growing areas.
	Target (1000 mt)	104	129	142	148	
	Extent (1000 ha)	6.5	6.8	7.1	7.4	
	Productivity (mt/ha)	16	19	20	20	
Red Onion	Requirement (1000 mt)	90	100	105	110	Expand area of new cultivation from 200 ha to 800 ha. Establish late Maha cultivation (late November to December) in Jaffna and Mannar to minimise shortage during this period. Promote use of true seeds to reduce production costs.
	Target (1000 mt)	85	90	105	110	
	Extent (1000 ha)	6.2	6.5	6.8	7.0	

	Productivity (mt/ha)	12	14	15	16	Increase production of true seeds from 2,000 kg to 15,000 kg. Promote use of organic fertiliser and micro-irrigation for increased yield.
Chilli (Dried)	Requirement (1000 mt)	50	51	52	60	Establish chilli producing villages and promote brand production. Increase true seed availability through seed production programme. Popularise cultivation in home gardens. Establish fixed market price. Make consumers aware of toxic contamination in imported chilli. Promote sprinklers to control leaf curl and leaf folding diseases. Construct agro-wells with provisions (water pump and supply pipes).
	Target (1000 mt)	9.2	15	25	30	
	Extent (1000 ha)	14	17	25	30	
	Productivity (mt/ha)	0.6	0.9	1.0	1.0	
Ground nut	Requirement (1000 mt)	26	27	28	29	Extend cultivation in new areas. Establish groundnut farmer organisations and supply machinery. Establish certified seed and self-seed production programmes. Train all stakeholders on forward trade agreements. Promote efficient/effective irrigation practices and fertility management. Conduct research to develop new need-based varieties.
	Target (1000 mt)	21.5	23.0	26.2	28.8	
	Extent (1000 ha)	12.6	12.8	13.8	14.8	
	Productivity (mt/ha)	1.7	1.8	1.9	1.9	

Source: National Food Production Programme

Table 2.3.4 Production Target and Activities for Vegetable and Fruits

	Vegetables	**Fruits**
Per Capita Consumption (g/day)	114	100
Recommended (g/day)	200	200
Annual Requirement (mt)	1,500,000	-
Cultivated Extent 2014 (ha)	84,844	135,000
Production 2014 (mt)	1,011,683	916,527
Targeted Extent 2018 (ha)	103,083	150,000
Targeted Production (mt)	1,415,350	1,300,000
Activities	Promote year round cultivation. Promote cultivation under rain shelters. Reduce post-harvest losses to 10%. Promote eco-friendly cultivation practices. Promote post-harvest technologies for value addition.	Increase availability of productive high quality plants. Establish off season cultivation zones in non-traditional area. Establish commercial farms and processing centres. Introduce modern management techniques, GAP, and pest control. Expand foreign market opportunities for mass producers.

Source: National Food Production Programme

Table 2.3.5 Production Target and Activities for Milk and Mutton

	Milk	**Mutton**
Recommended (g/day)	100 ml/day	-
Annual Requirement	750 mil litres	2,185 mt
Production 2014 (mt)	334 mil litres	1,800 mt
Targeted Production	450 mil litres	2,100 mt
Activities	Establish district level zones for integration of farmers in small/medium scale dairying. Empower 9,000 medium scale farm units. Establish 100 medium scale farms and increase productivity. Promote cattle feed production in districts Strengthen extension service. Establish medium scale processing plants Establish buffalo farms.	Supply 500 Jamunapuri goats annually for breeding. Supply 1,000 hybrid goats annually for hybridization. Strengthen 500 small scale goat farms Enhance knowledge and skills of beneficiaries.

Source: National Food Production Programme

(2) Yaya 2 (Tract 2) Programme for Paddy Production

Launched as an extension of the Yaya 1 Programme and the Granary Project, the Yaya 2 Programme aims to increase national productivity of paddy from the present 4.3 t/ha to 5.3 t/ha and to enhance product quality. The programme incorporates a package of technical recommendations comprising several components including proper land preparation, selection of good quality seeds, improvement of soil fertility, methods of crop establishment, increasing cropping intensities, promoting crop diversification and post-harvest operations combined with integrated water management, pest management, and weed management.

(3) Crop Clinics

Crop clinics were introduced in Sri Lanka in 2010 and the service was extended to cover Anuradhapura District in 2013. They serve as centres where farmers bring samples of diseased plants for examination and diagnosis for advice and solutions. The main objective is to promote pest and disease management through natural and least harmful methods while minimising the use of pesticides and reducing the costs of production.

Crop clinic is a collaborative programme of research, extension, and training and involves the Plant Protection Centre of the Department of Agriculture (DOA), the Provincial DOA (PDOA), Department of Agrarian Development (DAD) and the Centre for Agricultural Bioscience International (CABI), an international non-profit organisation who initiated the approach.

The crop clinic committee consists of members known as plant doctors and includes the agricultural instructors (AIs) and Agrarian Research and Production Assistants (ARPAs) of the range, subject matter officers (SMOs) of the PDOA, and AIs of other district ranges. Researchers from DOA and the Deputy Director Extension may also participate as members as required. The AIs are required to follow three residential training modules conducted by the Plant Protection Centre of the DOA for certification as plant doctors. The locations, dates, and times for holding the crop clinics are agreed upon by consensus of all stakeholders and are usually conducted once a month.

(4) Provincial Programmes

Provincial level research, extension, and training are decided at the pre-seasonal Provincial Technical Working Group (PTWG) meetings held under the chairpersonship of PDOA and members comprising of the deputy directors (DDs) and assistant directors (ADs) of both provincial and interprovincial, AIs, concerned researchers of DOA, and farmers' representatives. Progress achieved in the previous season, work plan for the next season, and other related issues are discussed and the research, extension and training needs for the forthcoming crop season are identified. The collective decisions made at these sessions are presented at the cultivation meetings held at the field level to assist in the formulation of tank-wise cultivation calendars under the guidance of the respective Development Officers (DOs) of DAD. Based on available resources, the nature of the innovation promoted, and targeted farmer group, the AIs under the guidance of the segment AD select and apply extension techniques for technology transfer.

(5) Annual Budget of MOA

The annual budget of the Department of Agriculture (DOA) and Department of Agrarian Development (DAD) are summarised in the following Tables.

Table 2.3.6 Annual Budget of DOA

Category	Amount LKR '000		
	2016	2017	2018 (Estimate)
Total Expenditure	5,549,530	6,057,732	7,215,637
Recurrent	4,184,224	4,572,614	5,282,043
Capital	1,365306	1,485,117	1,933,650
Total Financing	5,549,530	6,057,732	7,215,637
Domestic	5,476,313	5,965,473	7,144,693
Foreign	73,217	92,256	71,000

Source: Budget Estimates 2018

Table 2.3.7 Annual Budget of DAD

Category	Amount LKR '000		
	2016	2017	2018 (Estimate)
Total Expenditure	7,590,322	9,133,856	9,004,100
Recurrent	6,676,100	6,752,170	6,827,600
Capital	914,222	2,381,686	2,176,500
Total Financing	7,590,322	9,133,856	9,004,100
Domestic	7,590,322	9,133,856	9,004,100
Foreign	-	-	-

Source: Budget Estimates 2018

2.3.3 Ongoing Programmes under the Ministry of Rural Economic Affairs

There are three important agencies under the Ministry of Social Services, Welfare, and Livestock Development. They are the Department of Animal Production and Health (DAPH), National Livestock Development Board (NLDB) and Milco (Pvt) Ltd. DAPH is the apex government institution responsible for providing the leadership in the technical functions of animal health, animal breeding, livestock research, and human resources development for livestock development activities. The task of the NLDB is to issue the requirement of breeding animals continuously to farms with the objective of making the country self-sufficient in livestock and dairy products. Meanwhile, Milco acts as the marketing arm of the ministry. In order to increase the supply of livestock products as well as to support livestock farmers, the projects and programmes in Table 2.3.8 are carried out through these three agencies.

Table 2.3.8 Ongoing Programmes under the Ministry of Rural Economic Affairs

No.	Programme/Project	
Ministry of Rural Economic Affairs		
1	Facilitation and Promotion of Liquid Milk Consumption	Procurement activities are in the process to purchase chilling tanks worth LKR 30 million for the Milco (Pvt) Ltd.
2	Establishment of Animal Breeder Farms	Commitments have been made for LKR 27 million in addition to the above value and settlement documents are being received at the time of review.
3	Medium-Term Livestock Development Programme – "Uthuru Wasanthaya"	Commitments of LKR 36.5 million have been made in addition to the above value under the medium-term livestock development project and settlement documents are being received at the time of review.
4	Importation of Dairy Animals	Activities of the project of importation of dairy animals are almost completed and settlement of LKR 1,096.35 million has been done by the General Treasury.
5	Development of Small and Medium Scale Poultry Farming System	Commitments have been made for LKR15.6 million in addition to the above value and settlement documents are being received at the time of review.
6	Swine Industry Development	Commitments have been made for LKR10 million in addition to the above value and settlement documents are being received at the time of review.
7	Modernisation of Processing Factories of Milco (Pvt) Ltd	Bills of LKR 1322.73 million have been sent.
8	Skills Sector Development Programme	Relevant procurement activities are being completed by the Department of Animal Production and Health in Peradeniya and settlement documents are being received.
9	Importation of 20,000 Dairy Animals (Australia)	Projects are being re-designed under the priorities of the present government
10	Construction of 12 Mini Dairies	
Department of Animal Production and Health		
1	Prevention of Communicable Diseases	333,812 animals were vaccinated against foot and mouth diseases; 59,477 animals against Black Quarter; and 1,218 animals against Brucellosis
2	Improvement of the Breed of Animals and Breeding of Animals	Insemination is carried out using sperm of high breed cattle for multiplication of hybrid cattle and buffalo population to increase the local milk production.
3	Rearing of Baby Cows/Heifers	Increasing the number of heifers within the country suitable for breeding thereby increasing the local milk production.

4	Establishment of Milk Technology Testing Unit Attached to the Livestock Research Institution	Supply of analytical and advisory services, providing laboratory facilities and conducting field investigation, and conducting of training are the main achievements of this project.
5	Mastitis Controlling Programme	Reducing the rate of spreading Mastitis from 30% to 1% thereby enhancing productivity up to 25%.
6	Goat Breeding Farms	Two goat breeding farms are in operation under the department at Imbuldanda and Thelahera to meet the demand for high breed goat.
7	Swine Insemination Unit	At the Livestock Training Centre at Kotedeniyawa, a swine insemination unit was in operation where cooled sperm doses are produced.
8	Preventing Bird Flu from Entering into the Country	The Livestock Research Institution has expanded its diagnostic facilities. In addition, staff of the DAPH have been trained on preventing and eradicating of bird flu.
9	Strengthening of Animal Quarantine and Testing Service	Subjecting imported hybrid chicks into quarantine procedure and improving healthiness of export-oriented ornamental fish farming.
10	Skills Development, Education, and Training	Imparting knowledge and disseminating information on modern technology on livestock farming for the benefit of small and medium scale entrepreneurs who are already engaged in animal husbandry.
11	Registration of Poultry Farms	Controlling the spread of communicable diseases, conducting technological supportive programmes, and maintaining quality of animal production.
12	Identification of Animals and Establishment of a Central Data System	Up-to-date earmarks fixed on to 87,236 animals.
13	Improvement of Service Delivery Systems of Veterinary Officers of the Government	Out of six veterinary offices, two offices have been completed by the end of the period under review. 40% of the construction of the remaining four offices have been completed.
National Livestock Development Board		
1	Development of Ridiyagama Farm	Dairy farms at Ambalantota and Rediyagama have been modernized to international standards to enable breeding of European Cattle and for having higher output of milk production under the second phase of the Sri Lanka Dairy Farm Development Project.
2	Development of Dairy Farming within the Coconut Triangle	Baby heifers bred from animals imported from Australia for distribution among upcountry farms under the first stage of the Sri Lanka Dairy Farm Development Project.
3	Development of Cattle Breeding	2,000 semen bits of Jersey species and 4,000 semen bits of Friesian species were imported from Sweden.
4	Pasture Land Development	2,800 kg of high quality seed grass were imported from Australia.
5	Development of Swine Industry	In order to meet the shortage of breeding pigs, parental generation was imported from Canada.
6	Introduction of New Animal Varieties	New animal species “Kalukum, rabbits, ducks, village cocks, Jaffna local sheep, and Japanese quaul” were introduced.
7	Development Activities of the Buffalo Breeding Farms	Animal farm in Polonnaruwa is to be developed as Buffalo Breeding Farm. Accordingly, the number of female buffaloes is expected to be increased up to 1,000.
8	Introducing Yoghurt Manufacturing Plant	Introduce yoghurt manufacturing plant at Marandawila Farm to meet the increasing demand.
9	Establishment of the Milk Pasteurization Unit	Introduce a milk pasteurization unit for Weerawila Farm
10	Introducing Milk Toffee Manufacturing Plant	Introduce a milk toffee manufacturing plant for Oyamaduwa / Parasangaswewa Farm.
11	Production of Animal Feed	A new animal feed plant is to be installed at Weerawila Farm.
12	Installation of Meat Processing Plant	Meat processing plant at Martin Farm is in progress.
13	Rearing of Cattle for Meat	500 cattle each were reared for meat in Marandawila, Rukattana, and Polonthalava farms.

Source: Prepared by the JICA Project Team based on the information from the Ministry of Social Services, Welfare, and Livestock

The annual budget of development project under the Ministry of Rural Economic Affairs is shown in the following Table 2.3.9:

Table 2.3.9 Annual Budget of Ministry of Rural Economic Affairs

Category	Amount LKR '000		
	2016	2017	2018 (Estimate)
Total Expenditure	1,008,627	1,147,210	1,705,700
Recurrent	498,146	515,710	540,700
Capital	510,480	626,500	1,165,000
Total Financing	1,008,627	1,147,210	1,705,700
Domestic	1,008,627	1,147,210	1,705,700
Foreign	-	-	-

Source: Department of Animal Production and Health

2.3.4 Ongoing Programmes under the Ministry of Irrigation and Water Resources Management

(1) Polonnaruwa District / Kaudulla Stage I - Extension of Canal up to Damsopura Tank

The total estimated cost of the Kaudulla Canal Extension Project, Stage-01 is LKR 369 million and it will feed the Damsopura Tank and thereby supply irrigation water for 749 ha of existing lands with 939 farmer families.

(2) Kurunegala and Polonnaruwa Districts / Deduruoya Reservoir Project

The project has started initial activities in 2005 and 98% of the work has been completed. The total estimated cost of the project is LKR 13.5 billion. Reservoir capacity is about 75 MCM and it will provide irrigation facilities for 11,500 farmer families to cultivate 6,115 ha of existing lands and 4,817 ha of new lands.

(3) Kurunegala District / Augmentation of Mahagalgamuwa Tank

The Mahagalgamuwa Tank Capacity Improvement Project has started in 2013 to secure irrigation water supply for 567 ha of existing irrigable land The project's total estimated cost is LKR 500 million and 2,000 farmer families will receive the benefits.

(4) Ampara District / Kalugal Oya Reservoir Project

The main purpose of the project is to provide water for cultivation of land directly upstream of the Navakiri Tank resulting in an increase in cropping intensity and production. Over 1,000 farmer families will benefit through an assured supply of water for cultivating 600 ha of paddy in "Maha" and "Yala" seasons. The reservoir capacity is 10 MCM and the total estimated cost of the project is LKR 1.87 billion.

Educating and training the farmers under the project have also been planned to enhance the capacity of farmers' organisation for efficient operation and maintenance of the irrigation scheme. Providing the water requirement for domestic purposes is also planned. Improvement of inland fishing and livestock farming has also been planned as means of additional income to the farmer families.

(5) Ampara District / Rambukkanoya Reservoir Project

The Rambukkanoya Reservoir Project will benefit 2,300 farmer families providing irrigation water for 1,471 ha of land. In addition to irrigation infrastructure which includes 75 MCM capacity reservoir and canal network, it is intended to provide other infrastructure improvements that would reinforce and enhance the benefits from the irrigation development under the project. Also, the project has planned to improve health facilities, education facilities, marketing facilities, internal road network, and access roads connecting the project area to major towns. In addition, it is expected to provide a pipe-born water supply system. Total estimated cost of the project is LKR 4.74 billion.

(6) Badulla District / Morana Reservoir Project

Implementation of this project will ease the irrigation difficulties faced by the 2,800 farmer families for cultivating 1,600 ha in the Nagadeepa Irrigation Scheme. In addition, about 1,000 farmer families will be benefitted as a result of providing water for additional 810 ha of new lands. Total estimated cost of the project is LKR 1.7 billion.

(7) Anuradhapura and Trincomalee Districts / Yan Oya Project

Yan Oya Reservoir Project will enhance agricultural production and inland fishery by providing irrigation water for 7,900 ha of existing land and 1,500 ha of new land. Total estimated cost of the project is LKR 34 billion (part of the cost is borne by China) and planned date of completion is end of 2020. The project would be capable of solving water problems for areas in the North Central Province including Kebithigollewa, Padaviya, Welioya, and Medawchchiya.

(8) Anuradhapura District / Ellepothana Anicut

The Ellepothana Anicut Project covers the construction of an anicut across the Yan Oya with two canals feeding water to several minor irrigation tanks benefitting about 1,300 farmer families engaged in paddy cultivation. Also, the project expects, with the development of irrigation facilities, to help elevate the water table of surrounding areas providing easy access to drinking water from the ground. Total estimated cost of the project is LKR 296 million and the planned time of completion is at the end of 2019.

(9) Annual Budget of DOI

The annual budget of the Department of Irrigation (DOI) is summarised in the following Table 2.3.10:

Table 2.3.10 Annual Budget of DOI

Category	Amount LKR '000		
	2016	2017	2018 (Estimate)
Total Expenditure	13,223,111	14,909,183	14,090,870
Recurrent	2,869,116	3,280,055	3,115,670
Capital	10,353,995	11,629,128	10,975,200
Total Financing	13,223,111	14,909,183	14,090,870
Domestic	13,223,111	14,909,183	14,090,870
Foreign	-	-	-

Source: Budget Estimate 2016, National Budget Department

2.3.5 Ongoing Programmes under the Ministry of Mahaweli Development and Environment

(1) Uma Oya Multipurpose Development Project (UOMDP)

Diversion of 145 MCM of excess water from Uma Oya in Mahaweli Basin into Kirindi Oya basin is expected through a series of reservoirs and tunnels under the project. The project plans to provide irrigation facilities to around 4,500 ha of new lands and to around 1,500 ha of existing lands in Moneragala District. Provision of 30 MCM of drinking and industrial water requirement in Hambantota and Monaragala districts is also planned. Construction of underground power station will generate 231 GWh of electricity through an underground power station with an installed capacity of 120 MW. The project also envisages providing drinking water requirements of Bandarawela and Atampitiya areas in Badulla District.

The project commenced in March 2010 with the financial assistance from the Export Development Bank of Iran (EBDI) and partial contribution of the Government of Sri Lanka (GoSL).

The total estimated cost of the project including cost of downstream development works amounts to USD 529,059,198 plus LKR 15,474,250,000. Out of the foreign cost, a sum of USD 450,000,000 was to be made available by EBDI while the balance of USD 79,059,198 was to be funded by GoSL. Out of the local cost, LKR 9,352,500,000 is for the downstream development works in Kirindi Oya basin. All works are in progress and the target date of completion of the headworks is on 31 December 2017.

The downstream development works in Kirindi Oya basin, which include the development of irrigation infrastructure in Moneragala District to utilise water diverted from Uma Oya through the underground powerhouse at Alikota Ara, are also in progress. The total estimated cost is LKR 9,352 million for the works and it will provide irrigation facilities for 4,500 ha of new lands and 1,500 ha of existing lands at the end of the project completion in 2018.

(2) Dam Safety and Water Resources Planning Project (DSWRPP)

The project was initiated with the overall objective of establishing long-term sustainable arrangements for operation and maintenance of large dams and improving water resources planning.

Project activities mainly focused on improving dam safety and operational efficiency, upgrading and modernising the existing hydro-meteorological information systems, and providing technical assistance for developing national water use plans.

The original project commenced in June 2008 and the planned completion date was June 2013. However, based on the findings and recommendations of the project mid-term review, the project was extended for another two years up to June 2015. The total estimated project cost including contingencies was LKR 8,187.35 million (USD 71.66), out of which, LKR 7,538.14 million was financed by the International Development Association (IDA)-World Bank (WB) and LKR 649.21 million was contributed by GoSL.

With the completion of the original project activities, in response to a request made by GoSL, WB has provided additional financing of USD 83 million for the second phase of DSWRPP. In addition, GoSL provided USD 1.5 million to cover additional project management cost. Under the second phase of the project, works for 30 dams and establishment of 50 stations for hydro-meteorological information systems are in progress.

(3) Moragahakanda-Kaluganga Development Project (MKDP)

The Moragahakanda-Kaluganga Development Project (MKDP) started its activities in January 2007 with the aim of increasing agricultural production of the country while providing irrigation water to 82,000 ha of dry lands and drinking water for the people in the area. The project will generate 25 MW of hydropower and open up around 5,000 ha of new lands for agriculture.

The main benefits expected from the project include: increase in agricultural production by 123,000 tonnes annually, increase in fish production by 4,700 tonnes annually, annual cost saving due to hydropower station of around LKR 330 million, enhancement of eco-tourism, reduction of flood damages in Manampitiya and Somawathiya areas, and infrastructure development in new settlement and existing villages and towns. Main elements of the project include the Moragahakanda Reservoir headworks with 25 MW powerhouse, Kaluganga Reservoir headworks, land acquisition and resettlement of the affected families (around 3,000 families), social and irrigation infrastructure development in downstream areas under the Kaluganga Reservoir (4,000 ha – System F) and Kaudulla left bank canal extension areas (2,000 ha – System D), implementation of environment mitigation activities, improvement of agriculture productivity, and water utilisation through the demonstrated model farms.

The total expected cost is USD 557.4 million and it is financed by Saudi Fund for Development (SFD), Kuwait Fund for Arab Economic Development (KFAED), OPEC Fund for International Development (OFID), and GoSL local fund. The expected date of project completion is December 2018.

(4) Mahaweli Water Security Investment Programme (MWSIP)

MWSIP commenced activities after agreements were signed by the Asian Development Bank (ADB) and the Ministry of Finance in September 2015. It will support the North Central Province Canal Programme (NCPCP) that will complete outstanding investments of the Mahaweli Development Programme. The main financial assistance is provided by ADB amounting to USD 453 million with USD 114 million co-financing and USD 108 million government contribution.

The programme will be implemented over ten years from 2015 to 2024. The programme comprises three main projects, namely: Upper Elahera Canal Project (UECP), North Western Province Canal Project (NWPCP), and Minipe Left Bank Canal Rehabilitation Project (MLBCRP),

In addition, assistance of the investment programme is in place for the preparation of Phase 2 projects. The Phase 2 projects will develop additional transfer canals and reservoirs which will finally result to having additional diversion of Mahaweli water to feed additional existing reservoirs in the North Central Province. Hoping for a financial assistance from ADB, the government plans to implement Phase 2 from 2018 to 2030. Phase 2 projects may consist of Kalinganuwara Pumping Complex Project, Lower Uma Oya Reservoir Project, Randenigala – Kalu Ganga Transfer Canal Project, and North Central Province Canal Project.

(5) Climate Resilience Integrated Water Management Project (CRIWMP)

The CRIWMP is currently underway with the aim of strengthening the resilience of smallholder farmers in the dry zone of Sri Lanka through improved water management to enhance lives and livelihoods. The project is implemented from 2017 to 2024 with the financial assistance of UNDP about USD 38.1 million under Green Climate Fund (GCF) and with the co-financing of US$ 14 million from GOSL.

The project has three main components, one of which is Upgrading Village Irrigation Systems. The project encompassed approximately 325 Village tanks in about 30 cascades located in three river basins namely Mee Oya, Malwthu Oya and Yan Oya. Rehabilitation of irrigation facilities, restoration of water sheds, introduction of climate-smart ecological agriculture, improvement of marketing, preparation of cascade level climate resilience water management plan, preparation of operation and maintenance plan with FOs and enhancement of ASC capacities have been identified as main activities under this component. The component 2 of the CRIWMP includes improvement of access to safe drinking water for vulnerable communities and the 3rd component focuses on strengthening climate and hydrological observation and forecast and water management systems to enhance capacity of smallholder farmers against droughts and floods.

Basically the area covered under CRIWMP are different from that of the Cascade System Development Plan.

(6) Annual Budget of MMDE

The annual budget of MMDE from 2016 to 2018 (estimated) is summarized below.

Table 2.3.11 Annual Budget of MMDE

Category	Amount LKR '000		
	2016	2017	2018 (Estimate)
Total Expenditure	45,780,124	58,019,783	45,611,154
Recurrent	5,269,680	5,274,042	5,464,404
Capital	40,510,443	52,745,741	40,146,750
Total Financing	45,780,124	58,019,783	45,611,154
Domestic	30,023,711	36,716,652	31,837,624
Foreign	15,756,413	21,303,130	13,773,530

Source: Budget Estimate 2016, National Budget Department

Chapter 3 Present Conditions and Issues in Project Area

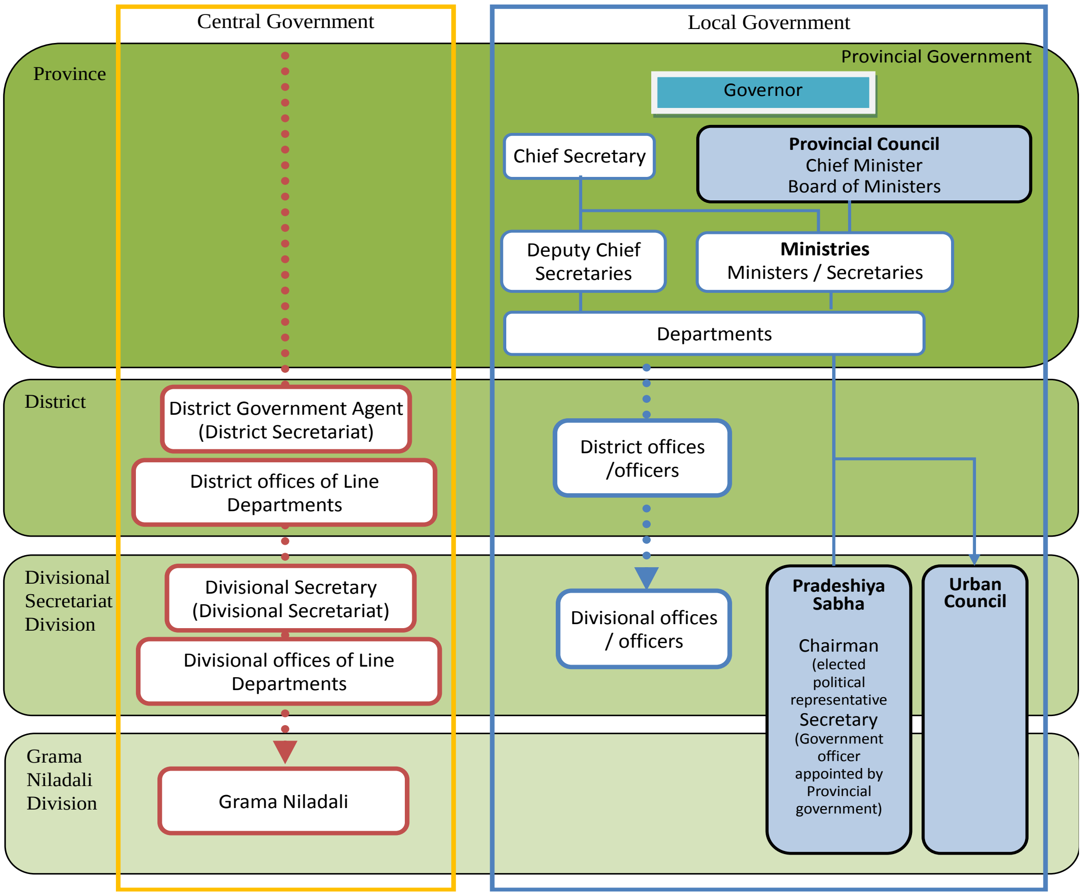
3.1 Local Administration System of Sri Lanka and Project Area

The two governance systems, namely, central government system and local government system, are operational in parallel with the local administration. The following section describes the relevant structures of the central government and local government in the local administration.

3.1.1 Existing Setup and Budget of the Local Administration

The local administrative structure in Sri Lanka has four levels, namely: province, district, division/local authority, and *Grama Niladhari (GN)*. The functions of the two systems of the central government and local government overlap at the district and division levels in some cases and demarcation of roles is often intertwined.

The following is the local government system of the North Central Provincial (NCP) Government:



Source: *JICA Project Team*

Figure 3.1.1 Structure of Local Administration

There are two lines of administration below the province level, namely, central government and local government. At the provincial level, the provincial government is the main governing body and there is no central government administrative structure at the provincial level. At the district level, a district government agent (GA) is appointed by the central government to handle district administration with the district offices of each line department of the central government. The provincial government has its office or officers at the district level, although it is not applied for all departments. At the Divisional Secretariat Division (DS Division), the divisional secretary, appointed as central government administrator with the line department offices, manages the divisional level administration. Field officers of the provincial government are assigned at the DS level attached to the divisional secretary. *Grama Niladhari(GN)* is the lowest administration body of the central government.

Local governments are functioning at two levels. At the provincial level, the provincial council is the government legislative body. Provincial council comprises ministers, a chief minister, and board of ministers consisting of four ministers. There council members are political representatives, while the governor of the province is appointed by the president with the consent of the chief minister. The provincial government has ministries and departments as administrative body. The names and numbers of the provincial ministries and departments vary by province.

At the lower level under the provincial council, there are municipal council at the municipal area, urban council at the urban area, and Pradeshiya Sabha (PS) at the rural area as local government bodies. Boundaries of the Pradeshiya Sabha are different from the DS Division, which is generally larger than the GN Division and smaller than the DS Division. Currently, the central government reviews the boundaries of the Pradeshiya Sabha.

The number of district secretariat, divisional secretariat, GN, and local authorities in the Northern Province and North Central Province is shown in table below.

Table 3.1.1 Local Administration in the Project Area

Province	District Secretariat	Divisional Secretariat (Nos.)	Grama Niladhari (Nos.)	Urban / Municipal Council (Nos.)	Pradeshiya Sabha (Nos.)	Agrarian Service Centre (ASC) (Nos.)
Northern	Jaffna	14	467	4	13	15
	Kilinochchi	4	95	0	3	8
	Mannar	5	160	1	4	12
	Vavunia	5	107	1	4	8
	Mullaitivu	5	127	0	4	1
	Subtotal	**33**	**956**	**7**	**28**	**45**
North Central	Anuradhapura	22	694	1	18	42
	Polonnaruwa	7	295	0	7	9
	Subtotal	**29**	**989**	**1**	**25**	**51**
Total		**63**	**1,910**	**7**	**50**	**96**

Source: 'District Statistical Handbook' of each district, and 'Statistical Information 2015 Northern Provincial Council' Office of the Deputy Chief Secretary Planning Norther Provincial Council

The outline of the major local administration bodies is described below.

(1) Provincial Councils

The provincial council is the legislative body of the provincial government with a chief minister and board of ministers consisting of four other ministers. The chief secretary's office is the focal point of provincial administration. The chief secretary, the chief administrative officer of the provincial government, is appointed by the president with the concurrence of the chief minister of the province.

Under the chief secretary, there are 13 secretaries, five ministerial secretaries, five deputy chief secretaries, secretary to the council, governor secretary, and secretary of public service commission. Ministerial secretaries are assigned under the chief secretary working for each ministry. The chief secretary is supported by five deputy chief secretaries with different duties, namely: planning, finance, engineering, administration, and training.

There are five ministries in the provincial council that is defined by the Provincial Councils Act No. 42 of 1987. The subjects and demarcation of the ministries differ in different provinces. The main provincial subjects and functions are organized under the following respective provincial ministries:

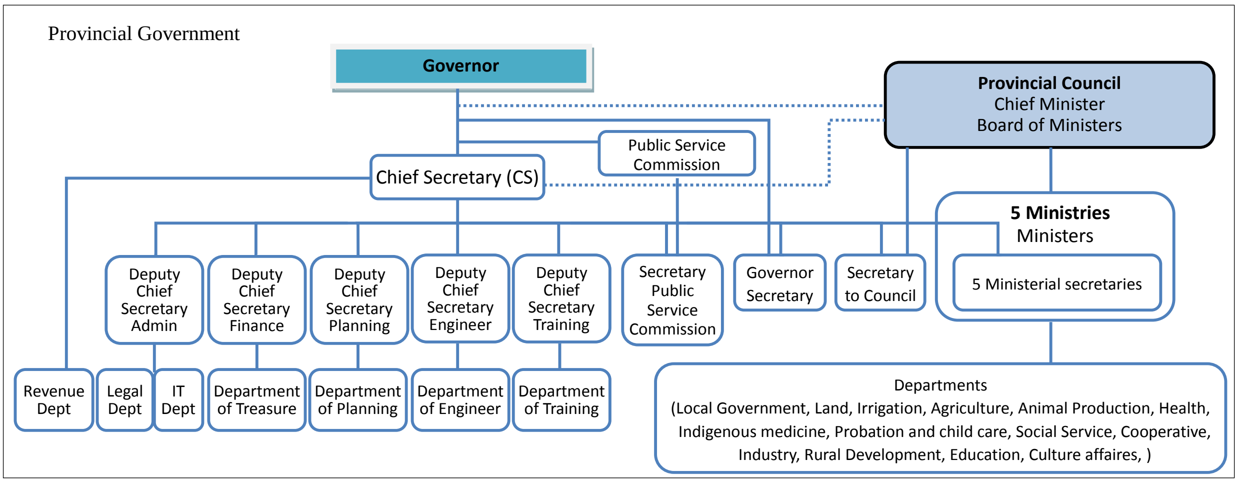
Table 3.1.2 Ministries in the Target Provincial Governments

Province	Ministries
North Central Province	Chief Ministry; Ministry of Law and Order, Finance and Planning, Local Government, Provincial Roads, Development, Rural Infrastructure Facilities and Special Projects, Tourism, Education, Information Technology, and Cultural Affairs
	Ministry of Agriculture, Agro Products Marketing, Animal Production, Animal Health, Fisheries, and Housing Affairs

	Ministry of Health, Indigenous Medicine, Social Welfare, Probation and Childcare, Environmental and Provincial Council Affairs
	Ministry of Transport, Sports, Youth Affairs, Cooperative, Trade, and Food and Industrial Development
	Ministry of Irrigation, Provincial Land, Provincial Irrigation, Rural Development and Women Affairs
Northern Province	Chief Minister's Ministry; Ministry of Finance and Planning, Law and Order, Lands, Electricity, Housing and Construction, Industries and Enterprise Promotion, Tourism, Local Government and Provincial Administration
	Ministry of Education, Cultural Affairs, Sports and Youth Affairs
	Ministry of Health and Indigenous Medicine, Social Services and Rehabilitation, Probation, and Childcare Service and Women's Affairs
	Ministry of Agriculture and Agrarian Services, Animal Husbandry, Irrigation, Water Supply, Food Supply and Distribution, Environment, and Cooperative Development
	Ministry of Fisheries, Transport, Trade and Commerce, Rural Development, Road Development, and Motor Traffic

Source: JICA Project Team prepared from the data from the provincial governments

There are 15 departments in the provincial government of the North Central Province and 18 in the Northern Province under the respective ministries. In addition to the departments under the ministries, there are few departments, namely: Department of Provincial Revenue, Legal, IT, Engineering, Planning and Monitoring, Provincial Treasury, and Personnel/Training, which are directly attached to the chief secretary's office/secretariat accountable to each concerned deputy chief secretary. The structure of the North Central Province's government, as an example, is shown in the following Figure 3.1.2.



Source: JICA Project Team

Figure 3.1.2 Structure of Provincial Government of North Central Province

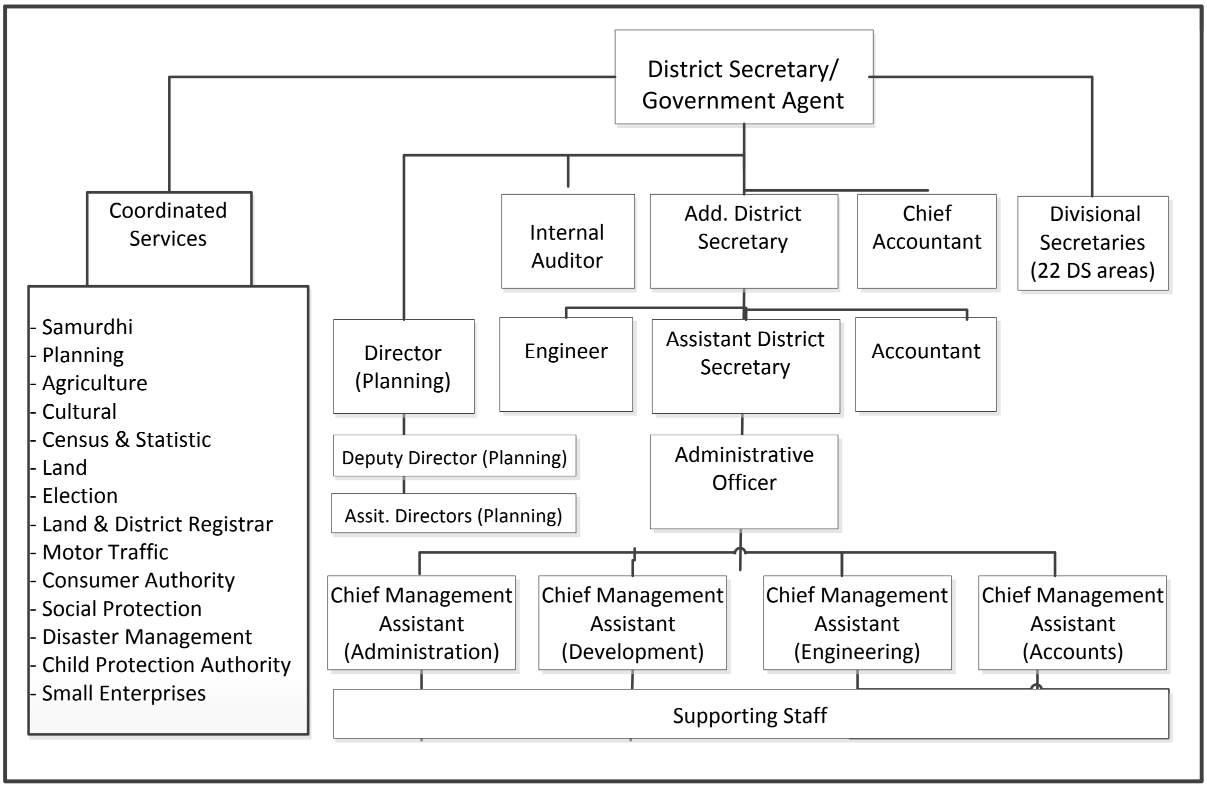
Even though the provincial government has administrative service at the district level, its district offices and officers are limited. For the North Central Province, only the Department of Education, Health, and Cooperative Development have district offices and regional directors in the districts. Other departments assign district officers.

At the divisional secretariat level, provincial departments appoint field officers of each line department who are provincial government officers while they are attached to and functionally working directly under the divisional secretary of the central government.

(2) District Secretariat

The present district administration system has been established according to the Administrative District Act No. 22 of 1955 in which the district came to be recognized as the pivotal unit of administration. The district secretariat is the main district administrative agency of the central government under the Ministry of Internal Administration. Since 1987 after amendment of constitution, the province came to the forefront of the sub-national administration.

The district secretariat is headed by the Government Agent (GA) (district secretary) with the assistance of the additional district secretary and assistant district secretary. Other staffs who are supporting the implementation of work of the district secretariat is indicated in the organisation structure below.



Source: JICA Project Team

Figure 3.1.3 Structure of District Secretariat

The district administration is mainly responsible for coordinating provincial and central programme implementation at the district level; whereas, implementation of programmes and delivery of services have been further decentralised to the division level administration. Supervising the work of the divisional secretariats is one of its main functions. The major functions are summarised as follows:

- Coordination of government activities and functions delegated by law through officers and organisation at village divisional and district levels,
- Acting as an agent to other ministries, departments, and statutory boards,
- Collection of revenue and financial management and accounting of allocated funds,
- Implementation of decentralised budget programme,
- Monitoring various foreign-funded projects and directing towards the accepted development policies, and
- Assisting the provincial council in its activities.

The district secretaries also function as secretaries of various coordinating committees in the districts such as the district coordinating committee (DCC), district planning committee, district agriculture committee, district environmental committee, district security committee, and the district land use committee. As secretaries of the DCC, they also have crucial voices in the allocation and monitoring of the decentralised budget and major government programmes. Provincial directors or district level officers of the provincial government participate in the DCC to represent the provincial government for district level execution of their duty.

(3) Divisional Secretariat (DS)

The Divisional Secretariat Division (DS Division, former AGA division) is the implementation and operational base within the existing decentralisation framework. The DSs are headed by divisional secretaries who were called divisional revenue officers (DROs)/assistant government agents (AGAs) in the past. After the 13th Amendment of the Constitution came into force, management tasks, staff, and equipment moved from the district level to the DS. This major change was effected by the Transfer of Powers (Divisional Secretaries) Act No. 58 of 1992 which provided for the transfer of powers, functions, and duties exercised, performed, and discharged by the GAs under the various laws to the DSs.

The main functions of the DS include revenue collection, civil registration, issuing of permits and certificate, implementation of the Samurdhi programme, operating social welfare and benefits, land administration, operation of the divisional planning units, data collection, coordination of rural development societies and small industries, and implementation of various government development initiatives.

DS is the central point of divisional level administration. The DS office has different divisions, namely: administrative division, social service division, planning division, accounts division, registrar division, and pension division. The approved staffs of DSs are around 100 including GN. Several other officers from the central and provincial ministries are attached to the DS.

Table 3.1.3 List of DS Division and the Number of GN Division in the Target Districts

	Anuradhapura District			Vavuniya District		
S/N	Name of Divisional Secretariat	No. of GN Division	Project Target	Name of Divisional Secretariat	No. of GN Division	Project Target
1	Medawachchiya	37	○	Vavuniya North	20	○
2	Galenbindunuwewa	41	○	Vavuniya South	20	○
3	Galnewa	30		Vavuniya	42	○
4	Horowpothana	38	○	Vengalacheddikulam	20	
5	Ipalogama	32				
6	Kahatagasdigiliya	40	○			
7	Kebethigollewa	26	○			
8	Kekirawa	53				
9	Mahawilachchiya	17				
10	Mihinthale	25	○			
11	Nachchaduwa	19				
12	Nochchiyagama	36				
13	Nuwaragampalatha Central	40				
14	Nuwaragampalatha East	29				
15	Padaviya	15				
16	Palagala	35				
17	Palugaswewa	16				
18	Rajanganaya	21				
19	Rambewa	38	○			
20	Thalawa	39				
21	Thambuttegama	26				
22	Thirappane	41	○			

Source: 'District Statistical Handbook' of Anuradhapura District, and 'Statistical Information 2015 Northern Provincial Council' Office of the Deputy Chief Secretary Planning Northern Provincial Council

(4) Grama Niladhari (GN) Division (Grama Sewaka (GS) Division)

The *Grama Niladhari (GN)* Division is the lowest administrative level, commonly consisting of several villages that range from one up to 20. The population of a GN Division varies depending on the size of the area and some GNs have populations exceeding 10,000 while the small ones have less than 100. There is one GN officer, a government administrator, in-charge of each GN Division. The GN is appointed by the central government after passing a competitive examination. Most GNs are selected from the respective GN Division itself and continue to be posted there, sometimes up to ten years. The GN maintains various statistical records, including registry of births and deaths, exercises police duties, and provides emergency relief assistance.

Apart from the GN, there are development officers and Divinaguma[1] officers (former Samurdhi development officers) at the GN Division. The Divinaguma officers are responsible for selecting which families are entitled to food stamps and for distributing such.

(5) Local Authority

Municipal council, town council, and Pradeshiya Sabha are local authorities under the provincial council. Even though these local governments are under the control of the Department of Local Government of the provincial government, they are operated under a different act from the provincial council, i.e.: Pradeshiya Sabhas Act (No. 15 of 1987) and Municipal Council and Urban Council Ordinance No. 10 of Act 1981. They have an independent finance and financial system even though they have financial allocation from the provincial council.

There are one municipal council and 18 Pradeshiya Sabhas in Anuradhapura and one urban council and four Pradeshiya Sabhas in Vavuniya District. It is noted that there are two separate Pradeshiya Sabhas in Vavuniya South where there is a large Sinhalese community in the Tamil population.

3.1.2 Water Resource Management Structure and Relevant Legislation of Sri Lanka and Actual Application in the Project Area

(1) Legislation Regarding Water Resource Management

Currently, the following four major laws principally define the necessary legal endorsement for irrigation management in Sri Lanka:

- Irrigation Ordinance Principal Enactment (Chapter 453, Act No. 48 of 1968)
- Irrigation Amendment Act No. 23 of 1983
- Irrigation Amendment Act No. 13 of 1994
- Agrarian Development Act No. 46 of 2000

Irrigation Ordinance is the primary law base of the current irrigation-related legislation which has been amended with the execution of different related laws. The management system has also been changed through the government policy since the government has executed the policy of "Irrigation Management Transfer", which means the transfer of all or a part of management functions and authority from the government to irrigation water users (generally, farmers).

In addition to the above laws, the Mahaweli Authority Act No. 23 1979, which covers 25 important acts including the Irrigation Ordinance, defines irrigation matters in the area of authority handled by the Mahaweli Authority of Sri Lanka. The 13th Amendment to the constitution, with devolution of power to the provincial councils, also brought change in the legal framework related to irrigation works in the country. However, the responsibilities between the provincial council and the central government have not been explained clearly in the constitution and these changes have not been included in the Irrigation Ordinance nor in its amendments.

The following discusses the major laws governing the irrigation management in the country:

(a) Irrigation Ordinance

The first irrigation ordinance of the country, passed in 1856, was described as an ordinance to facilitate revival and enforcement of the abolished ancient customs of irrigation and paddy cultivation. The original Irrigation Ordinance has been amended and overtaken by recently issued acts and ordinances. In 1968, all issues are recompiled as Irrigation Ordinance No. 48 of 1968, which is referred to as the "Principal Enactment" of Irrigation Ordinance and still valid with subsequent amendments such as Act No. 23 of 1983, Act No. 34 of 1990, and Act No. 13 of 1994. The amendment of Irrigation Act No. 13 of 1994 was issued to provide legal backing for the new concepts in participatory management, which introduced farmers' organisation (FO) replacing the cultivation committees defined in the former act.

[1] Government's poverty alleviation programme of uplifting livelihood, name of which has been changed from Janasaviya to Samurdhi, and then to Divinaguma as the same project in each implementing period of the government at the time. However, it is currently again in the transitional period after the generation of the current government established in 2015. The cabinet approved a memorandum to amend the Divinaguma Act No. 01 of 2013 to replace the name Divinaguma with Samurdhi.

The major acts that influenced the Irrigation Ordinance are the Paddy Lands Act No. 01 of 1958, Agricultural Productivity Act of 1972, and the Agricultural Land Law of 1973. With the passage of the Paddy Lands Act No. 01 of 1958, the Department of Agrarian Services was established. Afterwards, the Agrarian Services Act of 1979 replaced the Agricultural Productivity Act of 1972 and the Agricultural Land Law of 1973. The Agrarian Services Act of 1979 was amended in 1991 to provide prospects for the establishment of FO and to grant them powers regarding cultivation and irrigation matters. The Agrarian Services Act of 1979 was repealed with the introduction of the Agrarian Development Act No. 46 of 2000, which is in force at present.

(b) Agrarian Development Act

The Agrarian Development Act No. 46 of 2000 defines the power of the FO as: “Every tank, dam, canal, watercourse, embankment reservation or other irrigation works, within the area of authority of farmers organisation, shall be subject to the supervision of that farmers organisation”. The Commissioner General of Agrarian Development has been empowered fully under the act for the protection of all irrigation works.

Part VIII, General Provision of the Agrarian Development Act states the provision that the Agrarian Development Act prevails over any other written laws. It describes that, “The provisions of this act shall have effect notwithstanding anything to the contrary in any other written law. Accordingly, in the event of any conflict or inconsistency between the provisions of this act and such other law, the provisions of this act shall prevail.” Regarding irrigation works, almost similar issues are covered in both the Agrarian Development Act and the Irrigation Ordinance. In case of irrigation offence, such as damage to irrigation structures, actions can be taken under both acts, through magistrate court or agrarian tribunal. Furthermore, regarding the authority for the irrigation activities, the Commissioner General of Agrarian Development has been empowered also by the Irrigation Ordinance No. 48 of 1968, in addition to the power given by the Agrarian Development Act. Accordingly, “the Commissioner General of Agrarian Development is responsible for the general supervision and control of government agents in the exercise and discharge of the powers and duties conferred and imposed upon them by the Irrigation Ordinance”. Such authority given to the Commissioner General of Agrarian Development is debatable while having separate leading agencies for irrigation works in the country.

(2) Government Structure for the Water Resource Management Sector

There are several government agencies at the national level involved in the water sector at different degrees and in different fields including agricultural, industrial, and domestic water, as well as hydropower. In addition, there are several agencies in the provincial government and in the lower administrative division of the central government. The following table summarises the major agencies with their roles in agriculture-related water administration:

Table 3.1.4 Summary of Government Agencies for Water Resource Management

Level	Agency	Roles
National	Ministry of Irrigation and Water Resource Management (MIWRM)	Responsible for irrigation development policy.
	Ministry of Mahaweli Development and Environment	Responsible for implementation of water policy for plan and distribution of available water resource for hydropower and irrigation.
	Department of Irrigation (DOI) under MIWRM	Responsible for planning, designing, construction, operation, and management of all major and medium irrigation schemes, and works related to flood control, drainage, and salinity extrusion.
	Irrigation Management Division (IMD) in the MIWRM	Established in 1984 to implement the programme for Integrated Management of Major Irrigation System (INMAS). The major objective is to maximise productivity of land and water resource of major irrigation schemes by organising farmers. This division is appointed directly under the secretary of the Ministry of Interior (MoI) having independent programmes and decision-making. IMD is in-charge of all soft components of major irrigation schemes including social aspects, institutional development, operation and maintenance (O&M), and capacity building of

		PMC/FOs, while DOI handles technical issues.
	National Water Supply and Drainage Board (NWSDB)	Responsible for domestic and industrial water supply, providing safe drinking water, and facilitating the provision of sanitation.
	Water Resource Board (WRB)	Established in 1966 under Act No. 29 of 1964, as an advisory body to the minister on all matters concerning the control and utilization of water resources. The amended act in 1999 emphasises the role of WRB in matters pertaining to groundwater resources.
	Department of Agriculture (DOA)	In relation to water management, DOA is responsible for protecting catchment from deterioration and pollution under the Soil Conservation Acts No. 25 of 1951 and 24 of 1996, Plant Protection Act No. 35 of 1999, Control of Pesticides Acts No. 33 of 1980 and No. 6 of 1994.
	Department of Agrarian Development (DAD)	Running in accordance with the Agrarian Development Act No. 46. of 2000. Apart from its function regarding utilisation of agricultural land, it is responsible in making regulation on registration and functioning of FOs and their execution. DAD is responsible for managing minor irrigation schemes. The Water Management Division of the department is in-charge of execution of programmes for protection and conservation of all minor irrigation systems through increasing the productivity and proper management of those minor irrigation systems, accomplishing the responsibilities under Part 7 “Irrigation Work and the Management of Irrigation Water” of the Agrarian Development Act.
Province	Provincial Department of Irrigation	Established in each province under the 13th Amendment of the Constitution of Sri Lanka. - Construction and rehabilitation of irrigation schemes and canals within the province, - Development of skills and awareness of farmer organisations on water management, - Collecting data and conducting basic investigations on irrigation projects, and - Locating hazards to the irrigation system by floods and other disasters and introducing remedies.

Source: JICA Project Team with reference to IUCN (2015) Institutional Framework for Integrated Water Resources Management: Kapiriggama Cascade. IUCN programme on Restoring Traditional Cascading Tank Systems Technical Note # 4. and information from each agency and information from offices of the concerned authority

The following table indicates the roles of the authorities in irrigation management defined in the relevant laws:

Table 3.1.5 Roles of the Relevant Authorities in Irrigation Management

Authority	Roles and Powers
Director General of Irrigation	・ Representation of the District Agricultural Committee and the Advisory Committee of major irrigation schemes. ・ Represent project management committee (PMC) of major irrigation schemes. ・ Express opinion on defective maintenance of minor irrigation work connected with major irrigation works. ・ Prepare scheme of annual maintenance in consultation with GA. ・ Authorisation of use of any mechanical appliances for deriving benefits from major irrigation works.
GA	Powers of the government agents still continue in the Irrigation Ordinance and these powers now have been transferred to divisional secretaries under the “Transfer of Powers to Divisional Secretaries Act No. 58 of 1992”. ・ Impose irrigation rates for lands benefited by irrigation water ・ Act as the chairman of the District Agricultural Committee ・ Chair the Advisory Committee in major irrigation schemes except the schemes where Project Management Committees have been appointed. ・ Approve the decisions taken by the cultivators regarding cultivation practices and irrigation maintenance. ・ Approval of resolutions relating to minor irrigation work. ・ Prepare proposals for construction and maintenance of irrigation work. ・ Incur expenses in carrying out operations necessary for the maintenance of any irrigation work and charge such expenditure to relevant cultivators. ・ Impose “irrigation rates” for lands benefited by special mechanical appliances or any other special supply. ・ Take action against person who obstructs or encroaches upon any irrigation works and recover the expenses incurred in effecting the removal of any obstruction or encroachment.

	・ Take steps to arrange arbitration against dispute related to irrigation works. ・ Seizing lands, crops, produce, and movables where default is made in the payment of any payment under the Irrigation Ordinance.
Commissioner General of Agrarian Development	The Commissioner General of Agrarian Development is empowered under both Agrarian Development Act and Irrigation Ordinance. ・ Responsible for the general supervision and control of government agents in the exercise and discharge of the powers and duties conferred and imposed upon them. ・ Take action to evict persons who fail to act in accordance with the decision taken by the Agrarian Development Council. ・ Where an agricultural land is not being cultivated, owner cultivator or occupier could be kept under the commissioner general's supervision order. ・ May decide if a certain land is paddy land or not. ・ The commissioner general and his officers have the power to inspect agricultural lands to find out the purpose for which such land is used. ・ Issue permission to a person, who uses a paddy land for a purpose other than agricultural cultivation and for obtaining mineral resources in a paddy land. ・ Registration of FOs, examination of their accounts, and cancellation of registration of FOs. ・ Deal with magistrate's court on recovery of acreage tax. ・ Setting out of auditing procedures for Agrarian Development Councils and Federations. ・ Prevent misuse of FOs, Farmers Federations, or Agrarian Development Councils. ・ Issue written permission for digging any well or constructing any well or maintaining any well for the purpose of cultivation. ・ Interfere with cultivation rights of owner cultivator or occupier.

Source: JICA Project Team

(3) Irrigation Management Systems of Different Schemes

For irrigation schemes, competent authority and management system of major and medium schemes are different from those of minor schemes. The following table summarises the structure of the irrigation management for different schemes:

Table 3.1.6 Structure of Irrigation Management System

	Mahaweli Scheme (The area where specified by MMDE)	**Major Schemes** (Command area is above 400 ha)	**Medium Schemes** (Command area is less than 400 ha and above 80 ha)	**Minor Schemes** (Command area is less than 80 ha)
Decision-making Body for Management	Water panel meeting (national and district level) consisting of Resident Project Manager (RPM), Director of DOI, NWSDB, CEB, GA, DS, line departments, FO representatives	PMC (Project Manager, FO representatives, representatives of line departments)	PMC (Project Manager, FO representatives, representatives of line departments)	Farmers Organisations (FOs)
Competent Authority of the Management Body	Mahaweli Authority of Sri Lanka (MASL)	Irrigation Managemenr Division (IMD) under MIWRM (54 schemes) DOI (49 schemes)	DOI	DAD
Competent Authority for Technical Issues	Mahaweli Authority of Sri Lanka (MASL)	DOI	DOI	PDI DAD
Legislation	Mahaweli Authority of Sri Lanka Act (No. 23 of 1979)	Irrigation Ordinance and subsequent amendment	Irrigation Ordinance and subsequent amendment	Agrarian Development Act No. 46 of 2000

Source: JICA Project Team

(a) Mahaweli Systems

Mahaweli Systems are handled by MASL. Mahaweli systems are managed by the Resident Project Manager (RPM) of the system. Since Mahaweli Systems are generally not independent and many schemes are linked, the water management secretariat in the MASL takes decisions on seasonal water issues in the Water Panel Meeting considering all systems; the Water Panel Meeting at the national level is the highest decision-making of the water distribution and management of Mahaweli Systems, where RPM, Director of DOI, NWSDB, CEB, GA, DS, line departments, and FO representatives participate. Water Panel Meeting is conducted every season to decide water distribution in each system organised by the water management secretariat and chaired by the director-general of MASL. The decision of Water Panel Meeting is discussed with farmers in the Project Coordinating Committee meetings in the respective systems and is finalised for the implementation with minor changes, if necessary. The Project Coordinating Committee meetings held in each system to decide seasonal water issues and agricultural calendar is taken as Kanna meetings for Mahaweli System. The Project Coordinating Committee of a Mahaweli System (Kanna meeting for Mahaweli System) is chaired by RPM with participation of farmer representatives, other relevant officials from MASL, and relevant departments. Apart from the main Kanna meeting at the system level, Kanna meetings at field level are also held depending on the administrative setup of the system.

(b) Major and Medium Irrigation Schemes

The major and medium irrigation schemes out of the Mahaweli Systems are jointly managed by both government authorities and FOs through the Project Management Committees (PMCs) as defined in the Irrigation (amendment) Act No. 13 of 1994. PMCs consist of representatives of FOs (should be more than 50% of the total membership of PMC), a project manager appointed by the secretary of MIWRM, and representatives of relevant government departments such as irrigation, land, agrarian development, agriculture and cooperative development. The main duty of the PMC is to provide the necessary coordination for all project management activities.

District meetings are conducted in each district for management of water in the district reflecting the decisions of PMCs of major and medium schemes within the district. The district meetings are organised by the director of Irrigation chaired by GA, with participation from relevant department, and FO representatives. Decision in the district meetings are brought to the national level Water Panel Meeting represented by GA.

PMC has the authority to setup Sub-Project Management Committees in order to have better coordination for the project level management. Decisions taken in a Kanna meeting at PMC are regarded as legally valid and violation of such decisions is a punishable offence as per Section 96 of the Irrigation Ordinance.

The DOI of the central government is in charge of any technical management of the major and medium irrigation schemes, while the Irrigation Management Division (IMD) directly under MIWRM, being independent from bureaucracy of the ministry, handles the soft component of the major irrigation schemes. Currently, IMD handles 54 major schemes out of 103 in the country. The remaining 49 schemes are managed by DOI. FOs of both major and medium schemes are registered under DAD while the decision-making structure under the concerned authority depending on the scheme is under DOI or IMD programme.

Medium irrigations are mainly handled by DOI, while some medium irrigation is under the provincial government. Medium irrigation is managed by PMC in the same way as major irrigation, though the PMCs are handled and supported by DOI.

(c) Minor Irrigation Schemes

Minor irrigation schemes are basically managed by FOs with the support of competent government authorities such as PDI and DAD. The 13th Amendment of the constitution of Sri Lanka has provided for the establishment of provincial councils with the devolution of responsibility that includes provincial irrigation schemes. Although the 13th Amendment defines that minor irrigation schemes are to be handed over to provincial councils, situations differ in different provinces. Concerning technical maintenance of irrigation, minor irrigations are managed by both Provincial Department of Irrigation (PDI) and DAD. According to the 13th amendment of constitution, PDI in responsible on maintenance, repair and rehabilitation of minor irrigation, while DAD is in charge of protection of minor irrigation scheme as per the Agrarian Development Act of 2000. Institutional issues and management of irrigation schemes are handled by DAD as indicated by the Act. The principal decision-making of the minor irrigation is made in Kanna meetings of each FO, which is chaired by DO[2], and authorised by the assistant commissioner of DAD.

(d) Ground Situation in the Project Area

Complicated situation has been observed as different legislations state different legal provisions to different authorities. Even though the act is a strong law, the actual situation on the ground has been adjusted to the realistic practice. Under Section No. 86 of the Agrarian Development Act, the power to hold Kanna meeting is not specified, be it for minor irrigation schemes or major irrigation schemes and it is open for owner cultivators and occupiers of agricultural lands under any type of schemes. Accordingly, if required, a Kanna meeting of a major irrigation scheme could also be held under the Agrarian Development Act. However, practically, no such incident has been recorded so far.

The operation of the management system of minor irrigation schemes also differs in different provinces. In Anuradhapura, even though the minor irrigation schemes are locally managed by FOs, they are technically maintained by PDI and DAD. Since the FOs are responsible for maintaining minor irrigation facilities, all capacity development support and programmes are conducted by DAD that is responsible for the development of FOs. Both PDI and DAD have budget for the rehabilitation of minor irrigation schemes and each executes its programme individually, although there are some coordination at the field level. In Vavuniya, both technical and institutional management and maintenance of minor irrigation are under the authority of DAD, while FOs are still responsible for managing the irrigation facilities.

The Department of Agriculture (DOA) was the sole provider of agricultural extension services at the national level until devolution of the extension function from the central government to the provincial governments in 1989. Since then, the extension activities of the DOA at the field level has been confined to the interprovincial irrigation and land development projects. However, the DOA continues to provide the backup for provincial agricultural extension through a network of institutions covering different agro-ecological regions island-wide. The interprovincial projects include schemes within a province that has been initiated by the state utilizing water from rivers flowing through more than one province and schemes where the command areas fall within two or more provinces such as the Mahaweli Development Project.

3.1.3 Agriculture Extension Structure of Sri Lanka and Situation of the Project Area

(1) Department of Agriculture (DOA)

The activities of DOA are focused on (i) maintaining and increasing productivity of the food crops sector, (ii) enhancing the income and living condition of the farmer, and (iii) making food available to the consumer at affordable prices. Besides extension in interprovincial areas, the main functions of DOA consist of (i) research on food crops, (ii) production of seed and planting materials, and (iii) provision of regulatory services relating to plant quarantine, soil conservation, and pesticides.

For this purpose, DOA operates a network of institutions covering different agro-ecological regions, island-wide, which includes (i) three research institutes (Rice Research and Development Institute, Field Crop Research and Development Institute, and Horticultural Crops Research and Development Institute), (ii) six technical service centres (Seed Certification and Plant Protection Centre, Seed and Planting Material Development Centre, Extension and Training Centre, Socioeconomics and Planning Centre, Natural Resource Management Centre, Progress Monitoring and Evaluation Unit), and (iii) three support service divisions (Engineering, Finance, and Administration)

At the district level, the interprovincial extension offices are headed by assistant directors (ADs) and are assisted by a team of subject matter officers (SMOs) and segment agricultural officers (AOs) who are supported by agricultural instructors (AIs) placed at ranges as field level officers.

[2] Although it is stated in the Agrarian Development Act that the Kanna meeting is chaired by the chairman of FO, it has been practically chaired by DOs in-charge.

(2) Provincial Department of Agriculture (PDOA)

In areas lying outside the interprovincial projects, extension services to the farming communities are provided by the Provincial Department of Agriculture (PDOA) under the Provincial Ministry of Agriculture (PMOA) of the provincial administration.

The PDOA is headed by the director (D/PDOA) and is assisted by the deputy directors (DDs) on extension, training, and administration, and the SMOs. Anuradhapura District is divided into three segments, each headed by an AD and a total of 21 AIs working in ranges as frontline extension workers. In Vavunia District, agricultural extension functions are under the purview of the DD who reports to the D/PDOA in the office located in Jaffna. Although provision exists for two segment ADs in Vavunia, the posts remain vacant at the moment. DD is assisted by an office AD, three SMOs and in the field, by nine AIs placed in ranges. The range AIs in the project area works from the respective Agrarian Service Centres (ASCs). The coverage of farmers served by each AI averages to about 4.800.

In addition to extension, PDOA is vested with related duties of national interest, namely: (i) coordination and collaboration of national extension programmes, (ii) supporting the extension system by collection, management, and dissemination of information, (iii) training of extension staff, agricultural entrepreneurs, and farmers, and (iv) engaging in the provision of vocational and technical education on agriculture to the youth. In this regard, it works in close collaboration with the central DOA.

Table 3.1.7 Segment and Range-wise Distribution of Extension Services

AD Segment	DS Division	ASC	No. of AI Ranges	No. of GN Div.	No. of H/H	No. H/H per AI
Thirappane	Galenbindunuwewa	Yakalla	1	9	3,141	3,141
		Sivalakulama	1	5	3,241	3,241
	Thirappane	Thirappane	2	29	6,474	3,237
		Mariyakadawela	1	12	3,176	3,176
	Mihinthale	Mihinthale	2	25	10,482	5,241
Kahatagasdigiliya	Kahatagasdigiliya	Konwewa	1	12	4,040	4,040
		Ratmalgahawewa	1	7	2,250	2,250
		Kahatagasdigiliya	1	21	4,499	4,499
	Kebethigollewa	Kebethigollewa	1	26	7,650	7,650
	Horowpothana	Parangiyawadiya	1	6	1,755	1,755
		Horowpothana	1	22	7,038	7,038
		Kapugollewa	1	10	3,107	3,107
Anuradhapura	Rambewa	Rambewa	1	18	6,855	6,855
		Kallanchiya	2	20	5,641	2,820
	Medawachchiya	Punewa	1	9	3,836	3,836
		Ethakada	1	10	4,161	4,161
		Medawachchiya	2	18	8,123	4,061
	Vavunia	Kovilkulam	1	9	6,541	6,541
		Omanthai	1	9	2,152	2,152
		Pampaimadu	1	10	6,681	8,139
	Vavunia South	Ulukkulam	1		1,414	1,414
		Madukanda	1	17	3,521	3,521
	Vavunia North	Nedunkerny	1	11	1,786	1,786
		Kanagarayankulam	1	9	2,191	2,191
	Vengalacheddikulam	Cheddikulam	2	20	7,406	3,703

Source: Prepared by the JICA Project Team based on the information of DAD

Training component in extension service is provided by the training centre located in the two districts. In Anuradhapura District, training needs of both the technical officers and the farmers are catered to by the In-Service Training Institute (ISTI) located in Mahailuppallama. The District Agricultural Training Centre (DATC) in Vavunia serves the training needs of the farmers while officer training is conducted at the ISTI in Kilinochchi. All training institutes are equipped with lecture halls, demonstration farms, and residential facilities. Depending on the course modules and target groups, resource persons from within the province and researchers and field officers, mainly from the central DOA, are engaged to conduct training sessions.

(3) Department of Agrarian Development (DAD)

DAD assists the agricultural extension services through its provincial and district offices. The Development Officers (DOs), who head the Agrarian Service Centres, are placed under the Assistant Commissioners of Agrarian Development who in turn report to the Deputy Commissioners of the provinces. Agricultural Research and Production Assistants (ARPAs) are the field level officers working under the DOs and are allocated to the GN Division. Each GN Division may be served by 1-3 ARPAs. Under the Agrarian Development Act, 2000, the territories of the ARPA are specified in the Government Gazette of December 9, 2011. According to the guidelines issued by the commissioner general of DAD, the ARPAs are required to work with the range AIs on extension-related activities for three days a week. Except for few ARPAs in the predominantly Sinhalese South Vavunia DS Division, positions in most areas in Vavunia District remain vacant.

3.1.4 Livestock Extension Structure of Sri Lanka and Situation of the Project Area

Technical leadership on many aspects of livestock development including research, extension, animal health management, and breeding services such as artificial insemination inputs for the dairy sector is provided by the Department of Animal Production and Health (DAPH) which is the principal state organisation functioning under the Ministry of Social Services, Welfare, and Livestock. However, for the livestock development, being a devolved subject under the constitution of Sri Lanka, nine Provincial Departments of Animal Production and Health (PDAPH) implement livestock development programmes, through its network of 257 veterinary offices located in the nine provinces.

The National Livestock Development Board (NLDB), which is a statutory board under the Ministry of Social Services, Welfare, and Livestock, is the custodian of state farms. It is primarily responsible for maintaining nucleus herds of livestock species and for supplying improved livestock, both males as well as females, to interested farmers. It is also engaged in the promotion of liquid milk by establishing fresh milk outlets at strategic locations for the popularisation of fresh milk consumption in the country.

Constitutional changes with the 13th Amendment in 1987 devolve some of the activities of the DAPH to the PDAPH. The PDAPH is permitted to carry out the following activities:

- Breeding
- Animal health-related
- Livestock development programmes
- Farmer training
- Extension

These are supported by the technical leadership and information, biological (vaccines, drugs, curd culture, and semen), training of trainers, and research and diagnostics provided by the central DAPH.

The Northern and North Central provinces are headed by a provincial director of Animal Production and Health. They are assisted by assistant directors at district levels. The Vavunia District has four veterinary ranges: Kanagarayamkulam, Vavunia, Cheddikkulam, and Vavunia South. Whereas, the Anuradhapura District has 23 veterinary ranges: C.N.P, E.N.P, Eppawala, Galenbindunuwewa, Galnewa, Galkiriyagama, Horowpothana, Kahatagasdigiliya, Kebithigollama, Kekirawa, Mahailluppallama, Medawachchiya, Mihinthale, Nochchiyagama, Nachchaduwa, Padawiya, Palugaswewa, Rajanganaya, Rambewa, Thambuththegama, Thirappane, Welioya, and Willachchiya. These veterinary surgeons are assisted by Livestock Development Instructors (LDI) in implementing field development programmes, breeding, and vaccinations. It is observed that the interaction of officers in the PDAPH and relevant departments (agriculture, irrigation, etc.) is at a minimal level. This can be a major disadvantage.

The delivery of livestock services is emerging as an important priority area for enhancing and optimising livestock production and management of the livestock. It would be acceptable to say that the current extension strategy is adequate to maintain status quo in the livestock sector. However, the recent advances in the animal husbandry sector have increased the demand for various livestock services like:

- Competent animal breeding activity
- Feed and fodder production to support periods of feed scarcity
- Day to day animal health care
- Sustainable approaches to the prevention and control of endemic, trans-boundary, emerging, and zoonotic diseases
- To improve public health
- Marketing
- Livestock extension service

Which are now provided by the range veterinary surgeon and their extension staff comprising of one, two, or three livestock development officers. Yet, the rapidly transforming systems, especially in the dairy sector, demand a different approach. A major limitation is that this system is unable to bridge the gap between farmers' expectations and services provided. A system such as the commodity-based extension approach that had a marked effect on the Sri Lanka poultry industry since the late 1980s could make a major change in the milk production effort of the government.
Therefore, the challenge is that with increases in the demand for livestock products, it has created an opportunity for the predominant smallholder farming community. However, smallholders remain particularly vulnerable to the continuing threat of animal diseases. In addition, the importance of livestock to farming household welfare is still under-recognized. Furthermore, the livestock production extension faces an additional institutional problem of being marginal to both agricultural extension and animal health services. Hence, the success of the proposed interventions of this project is greatly dependent on a commodity-based dedicated extension service.

3.2 Demographic and Socio-economic Situation of the Project Area

3.2.1 Population

The project's target DS Division covers about 2.1% of the total population of Sri Lanka. Most of the population in the target area live in rural area. Urban population is observed only in Mihintale and Vavuniya DS Division in the target area. Around 94.1% of Anuradhapura District and 79.8% of Vavuniya District live in rural area. Sex ratio of the population does not show exceptional tendency apart from Vavuniya North DS Division where male population is higher than female population, while female is majority in other target areas as well as in the national average. Population density varies by DS Division in the target area. Details of the population, sex ratio, rate by sector, and population density of the target areas are shown in table below.

Table 3.2.1 Population Rate by Sex and Sector, and Population Density (2012)

Target	Total		Male	Female	Urban	Rural	Population Density
	(nos.)	(%)	(%)	(%)	(%)	(%)	(per km^2)
Anuradhapura District Target DS Division							
Kebithigollewa	22,325	100%	49.7%	50.3%	0.0%	100.0%	36.5
Kahatagasdigiliya	40,339	100%	48.1%	51.9%	0.0%	100.0%	110.0
Horowpothana	36,990	100%	49.3%	50.7%	0.0%	100.0%	43.7
Rambewa	36,782	100%	48.6%	51.4%	0.0%	100.0%	121.1
Medawachchiya	46,906	100%	48.1%	51.9%	0.0%	100.0%	95.3
Mihinthale	35,293	100%	47.4%	52.7%	5.1%	94.9%	150.2
Thirappane	27,044	100%	49.4%	50.6%	0.0%	100.0%	96.9
Galenbindunuwewa	46,992	100%	49.0%	51.0%	0.0%	100.0%	163.1
Anuradhapura District Total	860,575	100%	48.8%	51.2%	5.9%	94.1%	119.3
North Central Province Total	1,266,663	100%	49.0%	51.0%	4.0%	96.0%	118.8
Vavuniya District Target DS Division							
Vavuniya North	11,578	100%	51.7%	48.3%	0.0%	100.0%	15.2
Vavuniya South	13,118	100%	49.2%	50.8%	0.0%	100.0%	64.7

Vavuniya	117,533	100%	48.6%	51.4%	29.6%	70.4%	186.7
Vengalacheddikulam	29,886	100%	50.5%	49.5%	0.0%	100.0%	72.7
Vavuniya District Total	172,115	100%	49.2%	50.8%	20.2%	79.8%	85.9
Northern Province Total	1,061,315	100%	48.1%	51.9%	16.7%	83.3%	119.5
National Total*	20,359,439	100%	48.4%	51.6%	18.2%	77.4%	310.3

*Note: *1 The remaining 4.4% at the national level is in estate.*
Source: Census of Population and Housing 2012, Department of Census and Statistics. Area data from GIS data

Examining the age-wise population, no significant difference has been observed in terms of the rate of the working age group. The following table indicates the population by age groups in the target areas:

Table 3.2.2 Population by Age Group (2012)

Target Area	Below 15		between 15 and 59		Over 60	
Anuradhapura District Target DS Division						
Kebithigollewa	6,465	29.0%	14,019	62.8%	1,841	8.2%
Kahatagasdigiliya	12,103	30.0%	24,850	61.6%	3,386	8.4%
Horowpothana	11,444	30.9%	22,934	62.0%	2,612	7.1%
Rambewa	10,593	28.8%	23,059	62.7%	3,130	8.5%
Medawachchiya	13,317	28.4%	29,963	63.9%	3,626	7.7%
Mihinthale	9,087	25.7%	23,325	66.1%	2,881	8.2%
Thirappane	6,868	25.4%	17,517	64.8%	2,659	9.8%
Galenbindunuwewa	12,674	27.0%	29,516	62.8%	4,802	10.2%
Anuradhapura District Total	230,911	26.8%	550,844	64.0%	78,820	9.2%
North Central Province Total	337,001	26.6%	810,905	64.0%	118,757	9.4%
Vavuniya District Target DS Division						
Vavuniya North	3,489	30.1%	7,195	62.1%	894	7.7%
Vavuniya South	3,338	25.4%	8,649	65.9%	1,131	8.6%
Vavuniya	31,038	26.4%	75,547	64.3%	10,948	9.3%
Vengalacheddikulam	9,128	30.5%	18,746	62.7%	2,012	6.7%
Vavuniya District Total	46,993	27.3%	110,137	64.0%	14,985	8.7%
Northern Province Total	283,882	26.7%	651,933	61.4%	125,500	11.8%
National Total	**5,131,666**	**25.2%**	**12,707,200**	**62.4%**	**2,520,573**	**12.4%**

Source: Census of Population and Housing, 2012

3.2.2 Ethnic Balance and Religion

According to the Population Census 2012, 75% of the entire national population is Sinhalese. Although the second majority were the Tamil people (Sri Lankan Tamil and Indian Tamil), they only occupy 15.3% of the population. However, the ethnic balance differs from region to region and a remarkable difference is observed in the distribution of ethnic groups between Anuradhapura and Vavuniya districts. While Sinhalese comprise more than 90% of the population and Tamil population makes up only 0.6% in Anuradhapura District, Tamils are a majority in Vavuniya District where only 10% of the population is Sinhalese. Vavuniya District has a remarkable variation within the district. Vavuniya South DS Division has 96.1% of Sinhalese population while the other DS Division in Vavuniya District has only 5% or less of Sinhalese. Percentage share of population by ethnicity in the target DS Division in comparison with the district total, provincial total, and national total is shown in the following table:

Table 3.2.3 Percentage Share of Population by Ethnicity of the Target DS Divisions (2012)

		All Ethnic Groups		Sinhalese	Tamil	Sri Lanka Moor	Other
Anuradhapura District Target DS Division							
1	Kebithigollewa	22,325	100%	90.5%	0.2%	9.3%	0.0%
2	Kahatagasdigiliya	40,339	100%	79.2%	0.5%	20.3%	0.0%
3	Horowpothana	36,990	100%	73.2%	0.3%	26.5%	0.0%

4	Rambewa	36,782	100%	84.4%	0.2%	15.4%	0.0%
5	Medawachchiya	46,906	100%	93.4%	0.6%	5.9%	0.1%
6	Mihinthale	35,293	100%	94.4%	0.3%	4.6%	0.7%
7	Thirappane	27,044	100%	93.6%	0.3%	6.1%	0.0%
8	Galenbindunuwewa	46,992	100%	96.9%	0.1%	2.9%	0.0%
Anuradhapura District Total		860,575	100%	91.0%	0.6%	8.2%	0.2%
North Central Province Total		1,266,663	100%	90.9%	1.0%	8.0%	0.2%
Vavuniya District Target DS Division							
1	Vavuniya North	11,578	100%	5.0%	94.7%	0.1%	0.2%
2	Vavuniya South	13,118	100%	96.1%	3.8%	0.0%	0.1%
3	Vavuniya	117,533	100%	2.8%	93.0%	4.2%	0.1%
4	Vengalacheddikulam	29,886	100%	2.3%	74.8%	22.9%	0.0%
Vavuniya District Total		172,115	100%	10.0%	83.2%	6.8%	0.1%
Northern Province Total		1,061,315	100%	3.0%	93.8%	3.1%	0.1%
National Total		20,359,439	100%	74.9%	15.3%	9.3%	0.5%

Note: Other includes Burgher, Malay, Sri Lanka Chetty, and Bharatha
Source: Census of Population and Housing 2012, Department of Census and Statistics

The religion of people is largely corresponding to their ethnicity. Most of the Sinhalese populations are Buddhist and a significant portion of the Tamil populations are Hindu. Relatively larger Muslim populations are observed in Kahatagasdigiliya, Horowpothana, and Rambewa DS divisions in Anuradhapura District and Vengalacheddikulam DS Division in Vavuniya District. The following table indicates the distribution of religion in the target DS Division in comparison with the district total, provincial total, and national total:

Table 3.2.4 Percentage Share of Population by Religion of the Target DS Divisions (2012)

		All religion		Buddhist	Hindu	Islam	Roman Catholic	Other
Anuradhapura District Target DS Division								
1	Kebithigollewa	22,325	100%	90.4%	0.1%	9.3%	0.1%	0.1%
2	Kahatagasdigiliya	40,339	100%	78.8%	0.4%	20.3%	0.3%	0.3%
3	Horowpothana	36,990	100%	72.9%	0.1%	26.6%	0.2%	0.2%
4	Rambewa	36,782	100%	84.0%	0.1%	15.5%	0.4%	0.1%
5	Medawachchiya	46,906	100%	92.9%	0.2%	6.2%	0.5%	0.2%
6	Mihinthale	35,293	100%	93.6%	0.2%	4.8%	0.9%	0.4%
7	Thirappane	27,044	100%	90.8%	0.2%	6.1%	2.7%	0.2%
8	Galenbindunuwewa	46,992	100%	96.7%	0.1%	3.0%	0.1%	0.1%
Anuradhapura District Total		860,575	100%	90.1%	0.4%	8.3%	0.8%	0.4%
North Central Province Total		1,266,663	100%	90.0%	0.8%	8.0%	0.8%	0.4%
Vavuniya District Target DS Division								
1	Vavuniya North	11,578	100%	4.9%	89.5%	0.1%	2.7%	2.8%
2	Vavuniya South	13,118	100%	95.5%	2.5%	0.1%	1.6%	0.3%
3	Vavuniya	117,533	100%	2.6%	78.3%	4.3%	8.7%	6.1%
4	Vengalacheddikulam	29,886	100%	2.2%	55.8%	23.1%	15.3%	3.6%
Vavuniya District Total		172,115	100%	9.8%	69.4%	7.0%	8.9%	5.0%
Northern Province Total		1,061,315	100%	2.9%	74.3%	3.1%	15.5%	4.2%
National Total		20,359,439	100%	70.1%	12.6%	9.7%	6.2%	1.5%

Source: Census of Population and Housing 2012, Department of Census and Statistics

3.2.3 Poverty

Poverty status is determined by comparing the monthly real per capita expenditure with the set official poverty line. If the per capita monthly real expenditure is less than the value of the official poverty line, then that individual is considered to be in poverty. According to Sri Lanka's official national poverty line, a person is identified as being poor in the 2012/13 HIES if his or her real per capita consumption expenditure falls below LKR 3,624 per month, which is equivalent to about USD 1.50 in 2005 purchasing power parity term. Table 3.2.5 shows the poverty headcount index that presents the percentage share of the total population of people who live under the poverty line by DS Division in the target area.

Poverty headcount index in Anuradhapura District is higher than that of the national average, while Vavuniya District total shows lower rate than the national average. Most of the target DS Divisions in Anuradhapura District has higher index than the national average of 6.7% except Mihinthale and Galenbindunuwewa. In Vavuniya District, the poverty index is significantly higher in Vavuniya North DS Division, while the other two target DS Divisions have figures lower than the national average. As a whole, it can be said that a comparatively large share of the people in the project area are living under the poverty line.

Table 3.2.5 Poverty Index and the Number of People below Poverty Line (2015)

		Estimated Headcount Index (%)	People Below Poverty Line (nos.)
Anuradhapura District Target DS Division			
1	Kebithigollewa	10.20%	2,167
2	Kahatagasdigiliya	8.97%	3,457
3	Horowpothana	10.01%	3,536
4	Rambewa	8.56%	3,017
5	Medawachchiya	8.08%	3,599
6	Mihinthale	5.68%	1,810
7	Thirappane	8.11%	2,105
8	Galenbindunuwewa	6.66%	2,997
Anuradhapura District Total		7.60%	63,097
North Central Province Total			88,789
Vavuniya District Target DS Division			
1	Vavuniya North	10.74%	1,176
2	Vavuniya South	4.86%	604
3	Vavuniya	5.41%	6,139
4	Vengalacheddikulam	9.45%	2,717
Vavuniya District Total*		3.40%	5,629
Northern Province Total			113,511
National Total		6.70%	1,339,000**

Note: The disparity in figure of Vavuniya District can be due to wide confidence interval due to small sample size of the study*
*Note**: Rounded figure*
Source: Department of Census and Statistics, 'The Spatial Distribution of Poverty in Sri Lanka' August 2015, Poverty Global Practice, World Bank Group

3.2.4 Employment

The Sri Lanka Labour Force Survey was designed to measure the levels and trends of employment, unemployment, and labour force in Sri Lanka.

The definition of the categories stated in the Sri Lanka Labour Force Survey are as follows. All persons above 15 years old are identified as working age population. This population consists of two groups, namely, economically active and inactive. The economically active population or the labour force comprises all persons of working age who are either “employed” or “unemployed” during the reference period. The employed includes persons who worked as paid employees, employers, own account workers, or contributing family workers. Persons available and/or looking for work, and who did not work and took steps to find a job during the last four weeks and ready to accept a job given a work opportunity within the next two weeks are said to be unemployed. Persons who were neither working nor available/looking for work are classified as “not in the labour force” (economically inactive). Persons are not in the labour force for such reasons as fulltime care of the household, fulltime students, retired or old age, infirmed or disabled, or are not interested in working for one reason or another. The following table shows the labour force status in the target area by DS Divisions.

Table 3.2.6 Labour Force Status of the Household Population, 15 Years of Age and Over in the Target Area (2012)

	Population of 15 Years of Age and Over		Labour Force				Not in Labour Force	
			Total		Employed	Unemployed		
	(Nos.)	(%)	(Nos.)	(%)	(%)	(%)	(Nos.)	(%)
Anuradhapura District Target DS Division								
Target DS Division								
Kebithigollewa	15,860	100%	9,110	57.4%	95.6%	4.4%	6,750	42.6%
Kahatagasdigiliya	28,236	100%	15,348	54.4%	95.8%	4.2%	12,888	45.6%
Horowpothana	25,546	100%	14,643	57.3%	97.1%	2.9%	10,903	42.7%
Rambewa	26,189	100%	14,048	53.6%	93.8%	6.2%	12,141	46.4%
Medawachchiya	33,589	100%	19,255	57.3%	95.8%	4.2%	14,334	42.7%
Mihinthale	26,206	100%	12,816	48.9%	94.7%	5.3%	13,390	51.1%
Thirappane	20,176	100%	11,707	58.0%	95.2%	4.8%	8,469	42.0%
Galenbindunuwewa	34,318	100%	19,150	55.8%	96.1%	3.9%	15,168	44.2%
Anuradhapura District Total	629,664	100%	353,004	56.1%	95.4%	4.6%	276,660	43.9%
North Central Province Total	929,662	100%	509,797	54.8%	95.1%	4.9%	419,865	45.2%
Vavuniya District Target DS Division								
Vavuniya North	8,089	100%	4,294	53.1%	92.4%	7.6%	3,795	46.9%
Vavuniya South	9,780	100%	5,525	56.5%	92.4%	7.6%	4,255	43.5%
Vavuniya	86,495	100%	40,720	47.1%	90.0%	10.0%	45,775	52.9%
Vengalacheddikulam	20,758	100%	10,471	50.4%	69.0%	31.0%	10,287	49.6%
Vavuniya District Total	125,122	100%	61,010	48.8%	86.7%	13.3%	64,112	51.2%
Northern Province Total	777,433	100%	350,431	45.1%	88.7%	11.3%	427,002	54.9%
National Total*	15,227,773	100%	7,857,370	51.6%	93.4%	6.6%	7,370,403	48.4%

Source: Census of Population and Housing 2012, Department of Census and Statistics

According to the table, Mihinthale and Vavuniya DS Divisions have lower labour force rates, which are lower than both provincial and national averages. Unemployment is much higher in Vavuniya District, the average of which is raised because of the exceptionally high rate in Vengalacheddikulam DS Division.

Updated data of 2014 is available at the district level as shown in Table 3.2.7 below. A remarkable feature in comparison with the data of 2012 is observed in the Northern Province and Vavuniya District whose rates of unemployed decreased tremendously from 11.3% to 5.3% and from 13.3% to 3.9%, respectively.

Table 3.2.7 Labour Force Status of the Household Population, 15 Years of Age and Over in the Target Area (2014)

	Population of 15 Years of Age and Over		Labour Force				Not in Labour Force	
			Total		Employed	Unemployed		
	(Nos.)	(%)	(Nos.)	(%)	(%)	(%)	(Nos.)	(%)
Anuradhapura District Total	635,612	100%	395,873	62.3%	96.9%	3.1%	239,739	37.7%
NCP Total	945,025	100%	560,784	59.3%	96.7%	3.3%	384,241	40.7%
Vavuniya District Total	120,978	100%	64,164	53.0%	96.1%	3.9%	56,814	47.0%
NP Total	808,673	100%	372,706	46.1%	94.7%	5.3%	435,968	53.9%
National Total*	16,531,768	100%	8,804,548	53.3%	95.7%	4.3%	7,727,220	46.7%

Source: Labour Force Survey - Annual Report 2014, Department of Census and Statistics

According to the Annual Bulletin 2014 of the labour force survey, reported labour force participation rate is 53.3%. About 65.1% of the economically active population are males while the majority of economically inactive population (74.8%) are females.

The employed population is further divided into the major industrial sectors. The following Table 3.2.8 shows employment by major industry groups by district in the target provinces:

Table 3.2.8 Employment by Major Industry Group in the Target Area (2014)

	Total		Agriculture		Industry		Service	
	(Nos.)	(%)	(Nos.)	(%)	(Nos.)	(%)	(Nos.)	(%)
Anuradhapura District	383,664	100%	210,907	55.0%	52,448	13.7%	120,309	31.4%
Polonnaruwa District	158,816	100%	68,258	43.0%	29,606	18.6%	60,951	38.4%
North Central Province	542,480	100%	279,165	51.5%	82,054	15.1%	181,260	33.4%
Vavuniya District	61,643	100%	20,856	33.8%	15,063	24.4%	25,725	41.7%
Jaffna District	201,662	100%	51,955	25.8%	48,194	23.9%	101,513	50.3%
Mannar District	28,185	100%	11,013	39.1%	3,158	11.2%	14,014	49.7%
Mullaitivu District	27,561	100%	12,305	44.6%	6,129	22.2%	9,127	33.1%
Kilinochchi District	33,816	100%	13,133	38.8%	7,594	22.5%	13,089	38.7%
Northern Province	352,867	100%	109,262	31.0%	80,138	22.7%	163,468	46.3%
National Total	8,423,994	100%	2,399,629	28.5%	2,229,810	26.5%	3,794,554	45.0%

Source: Labour Force Survey - Annual Report 2014, Department of Census and Statistics

Population engaged in agriculture is high in Anuradhapura District which accounts for 55.0% of the employed population. In Vavuniya District, 33.8% of the employed population is engaged in agriculture, which is slightly higher than the national average of 28.5%.

The rate of farmer population among the whole working age population is analysed by DS Division as shown in the following Table 3.2.9:

Table 3.2.9 Rate of Farmer Population or Farm Families in the Target DS Divisions

Anuradhapura		Vavuniya	
Target DS Division	**Rate of Farmer Population*1**	**Target DS Division**	**Rate of Farm Family*2**
Kebithigollewa	34.8%	Vavuniya North	20.9%
Kahatagasdigiliya	45.1%	Vavuniya South	27.1%
Horowpothana	70.2%	Vavuniya	47.6%
Rambewa	47.4%	Vengalacheddikulam	23.4%
Medawachchiya	18.3%		
Mihinthale	11.6%		
Thirappane	52.3%		
Galenbindunuwewa	41.2%		

*Note: *1 The number of population whose primary occupation is agriculture divided by the population of age 15 and over.*
**2 The number of farm family divided by the total household*
Source: Calculated from the data of population, household, occupation and the number of farm families from the following data source: (Anuradhapura: Data from DS offices, Vavuniya: Resource Profile and Statistical of Vavuniya District, 2015)

The above table implies that there is a remarkable disparity in the rate of farmer population or farm families even within districts. The largest farmer population is seen in Horowpothana DS Division that accounts for 70% of the population with age of 15 and above, while the smallest is 11.6% in Mihinthale DS Division. In Vavuniya District, Vavuniya DS Division has higher rate of farm family compared to other DS Divisions. Analysing the GN Division-wise data, there are some GN Divisions with no farmers as primary occupation according to the occupation data collected from each DS Division.

3.2.5 Household Income

Table 3.2.10 shows the mean and median of household income, Gini coefficient of mean income, per capita income, income of income receivers (monthly mean and median), the number of income receivers, and household size by province and by district in the target areas. It can be said that the distribution of the data is skewed to the right judging from the disparity between the mean and the median income, which means there are possibly a few households with significantly large income. Both mean income and median income are higher in Vavuniya District than in Anuradhapura District. However, the Gini coefficient is much higher in Vavuniya District compared to that in Anuradhapura District. This indicates higher inequity is observed in Vavuniya District. The similar tendency is noted between Northern Province and North Central Province. Gini coefficient of Anuradhapura District as well as of North Central Province is much lower than the national figure.

Table 3.2.10 Monthly Income of Household, Per Capita, and Receiver's Income, Number of Income Receivers, and Household Size by Province and District

	Mean Household Income (LKR)	Median Household Income (LKR)	Gini Coefficient of Mean Household Income	Mean Per Capita Income (LKR)	Median Per Capita Income (LKR)	Income Receivers Mean Income (LKR)	Income Receivers Median Income (LKR)	Average Number of Income Receivers (Nos.)	Average HH Size (Nos.)
District									
Anuradhapura	35,460	29,689	0.37	9,673	7,829	21,671	16,000	1.6	3.7
Vavuniya	43,965	30,967	0.45	11,360	7,833	24,405	17,000	1.8	3.9
Province									
North Central	36,632	29,707	0.39	9,877	7,824	21,848	15,930	1.7	3.7
Northern	34,286	23,571	0.48	8,339	5,540	18,916	12,692	1.8	4.1
National									
Sri Lanka	45,878	30,814	0.48	11,819	7,881	25,963	16,667	1.8	3.9

Source: Household Income and Expenditure Survey 2012/13, Department of Census and Statistics

The following Table 3.2.11 shows the percentages of households with income below LKR 5,000 in each target division in Anuradhapura. Higher percentage of low-income households is observed in Kahatagasdigiliya and Kebithigollewa DS Divisions followed by Galenbindunuwewa DS Division, of which more than 40% of the households receive less than LKR 5,000 of income. The lowest is Mihinthale DS Division with the rate of 21.9%.

Table 3.2.11 Percentage of Household with Income Below LKR 5,000 in the Target DS Division in Anuradhapura

DS Division	% of HH with Income Below LKR 5,000
Kebithigollewa	43.2%
Medawachchiya	30.3%
Rambewa	30.2%
Horowpothana	38.0%
Galenbindunuwewa	40.2%
Kahatagasdigiliya	44.0%
Thirappane	21.3%
Mihinthale	21.9%
Anuradapura Total	31.9%

Source: Prepared by the JICA Project Team based on the information from Resource Profile of GN Divisions prepared at each DS with adjustment due to different categorization of income range

Even though the disparity of income level amongst DS Divisions is not huge, the disparity is significant amongst GN divisions. The lowest rate of the household with income below LKR 5,000 is 0% and the highest is 83%. The following Table 3.2.12 shows the GN Divisions with the largest and smallest rates of household with income below LKR 5,000 in Anuradhapura District.

Table 3.2.12 List of GN Divisions with Largest and Smallest Percentage of Household with Income Below LKR 5,000 in the Target DS Division in Anuradhapura, 2012/13

Largest 10 GN Divisions				Smallest 10 GN Divisions			
DS Division	**GN Code**	**GN Division**	**% of HH With Income Below LKR 5,000**	**DS Division**	**GN Code**	**GN Division**	**% of HH With Income Below LKR 5,000**
Kahatagasdigiliya	201	Kokmaduwa	66%	Galenbindunuwewa	182	Sivalakulama	0%
Kahatagasdigiliya	221	Mahawewa	67%	Mihinthale	72	Nuwarawewa	0%
Galenbindunuwewa	178	Ellawewa	67%	Galenbindunuwewa	197	Konwewa	0%
Kahatagasdigiliya	228	Nelugollakada	68%	Medawachchiya	574	Kirigalwewa	0%
Kahatagasdigiliya	219	Punchi Halmillewa	69%	Galenbindunuwewa	182	21 Colony East	3%
Kahatagasdigiliya	223	Gonumeru Wewa	73%	Mihinthale	72	Maradankulama	3%
Horowpothana	149	Parangiyawadiya	74%	Kahatagasdigiliya	197	Ellawewa	4%
Thirappane	534	Aluth Punchikulama	76%	Kebithigollewa	574	Gonumeriyawa	5%
Kahatagasdigiliya	231	Kahatagasdigiliya East	83%	Thirappane	182	Alisthana	5%
Kebithigollewa	32	Kurulugama	83%	Mihinthale	72	Kurundankulama	6%

Source: Prepared by the JICA Project Team based on the information from Resource Profile of GN Divisions prepared at each DS with adjustment due to different categorization of income range

Income is divided into monetary income and non-monetary income. Based on the Household Income and Expenditure Survey 2012/13 report, monetary income includes income from wages and salaries, agricultural activities (seasonal and non-seasonal crops), non-agricultural activities, and other cash income (which includes pension payments, disability payments, Samurdhi, local and foreign transfers, windfall income such as lottery wins, compensations, etc.). The non-monetary income is the estimated value of goods and services received in kind and consumed within the survey reference period. This value is composed of homegrown fruits and vegetables, firewood, home-consumed quantities of the product of agricultural activities, and other goods or concession values received from employer or other parties. Estimated rental values of owner-occupied housing units or freely occupied housing units are also included under non-monetary income. Examining the sources of income in the target districts in comparison with each provincial average and national average, it is discovered that the total monetary income accounts for 85% to 89% of the total mean household income. Wage and salaries are the largest source of monetary income, which comprise between 28% and 35% of the total average income. Only 16.5% and 9.3% of income in Anuradhapura and Vavuniya, respectively, comes from agricultural activities.

Table 3.2.13 Percentage of Main Sources of Average Monthly Household Income by Province and District, 2012/13

Sector/ Province/ District	Mean Household Income (%)	Total Monetary Income (%)	Wages/ Salaries (%)	Agricultural Activities (%)	Non-agricultural Activities (%)	Other Cash Income (%)	Non-monetary Income* (%)
District							
Anuradhapura	100.0	85.4	30.5	16.5	9.9	28.4	14.6
Vavuniya	100.0	87.2	35.0	9.3	9.7	33.2	12.8
Province							
North Central	100.0	85.5	28.4	15.3	11.2	30.7	14.5
Northern	100.0	89.2	35.5	7.8	19.6	26.3	10.8
National							
Sri Lanka	100.0	85.7	35.2	11.4	17.4	21.7	14.3

*Note: *Non-monetary income includes income in kind and estimated rent value of own occupied housing unit*
Source: Household Income and Expenditure Survey 2012/13, Department of Census and Statistics

3.2.6 Household Expenditure

According to the following Table 3.2.14, the average household expenditures in Anuradhapura and Vavuniya districts are LKR 31,959 and LKR 44,486, respectively. In comparison with the provincial average and national average, the average expenditure of Vavuniya is much higher than the provincial average (LKR 34,562) and the national average (LKR 41,444). According to the Household Income and Expenditure Survey 2012/13 report, Vavuniya District has the fourth highest expenditure in the country while Anuradhapura is eighth from the lowest. The Gini coefficients of the mean household expenditure in Anuradhapura and Vavuniya are 0.35 and 0.39, respectively, while the national average is 0.4

Table 3.2.14 Monthly Expenditure of Household, Per Capita, in the Target Area

	Mean Household Expenditure (LKR)	Median Household Expenditure (LKR)	Gini Coefficient of Mean Household Expenditure	Mean Per Capita Expenditure (LKR)	Median Per Capita Expenditure (LKR)
District					
Anuradhapura District	31,959	25,578	0.35	8,718	6,743
Vavuniya District	44,486	33,503	0.39	11,494	8,485
Province					
North Central Province	33,935	27,217	0.35	9,150	7,014
Northern Province	34,562	26,414	0.37	8,406	6,360
National					
Sri Lanka	41,444	30,701	0.40	10,677	7,757

Source: Household Income and Expenditure Survey 2012/13, Department of Census and Statistics

Table 3.2.15 shows the average monthly household expenditures on food and drink, and on non-food items by province and by district. Household food expenditure is contributed by all the expenditure on food and drink excluding liquor, drug, and tobacco. Compared with the entire country's figure (LKR 15,651), Anuradhapura District has only LKR 12,941 for food expenditure, while Vavuniya shows higher food expenditure of LKR 17,019. Assessing the percentages of food expenditure in the total average expenditure, the disparity is less amongst Anuradhapura, Vavuniya District, North Central Province, and National, which is between 38% and 40 %, whereas Northern Province has higher rate of food expenditure (48%).

Table 3.2.15 Average Monthly Household Expenditures on Food and on Non-Food Items in the Target Area (2009-2010)

Sector/Province/ District	Mean Household Expenditure (LKR)	Mean Household Expenditure (%)	Food Expenditure (LKR)	Food Expenditure (%)	Non-Food Expenditure (LKR)	Non-Food Expenditure (%)
District						
Anuradhapura	31,959	100.0	12,941	40%	19,019	60%
Vavuniya	44,486	100.0	17,019	38%	27,467	62%
Province						
North Central	33,935	100.0	13,292	39%	20,643	61%
Northern	34,562	100.0	16,443	48%	18,119	52%
National						
Sri Lanka	41,444	100.0	15,651	38%	25,793	62%

Source: Household Income and Expenditure Survey 2012/13, Department of Census and Statistics

3.2.7 Education

Literacy rate is a key indicator to measure the level of reading and writing ability of persons in a country. The definition of literate person is given as: "A person who can both read and write and understand a short statement is considered as literate". According to the Census of 2012, literacy rate of the population aged ten years and above in Anuradhapura District stands at 95.7%. The corresponding rates for males and females are 97.0% and 94.6% respectively. The literacy rate in Vavuniya is 97.1% with corresponding rates of 98% and 96.2% for males and females, respectively. Both districts show an average literacy rate that is either the same or higher than the national average.

Table 3.2.16 Literacy Rate by Sex in Target Districts

	Population Aged Ten Years and Above	Both Sexes	Male	Female
Anuradhapura District Total	698,281	95.7%	97.0%	94.6%
North Central Province Total	1,029,994	95.7%	96.9%	94.6%
Vavuniya District Total	141,135	97.1%	98.0%	96.2%
Northern Province Total	876,354	95.4%	96.6%	94.3%
National Total	16,867,825	95.7%	96.9%	94.6%

Source: Census of Population and Housing, 2012

Table 3.2.17 shows the percentage distribution of population (five years and over) by level of educational attainment by DS Division in the target area in comparison with the concerned provinces and national average. Percentages of those who passed primary (including those who are studying in grade 1 at the time of the census) and those who passed secondary are 25.2% and 46.1% in Anuradhapura and 26.1% and 43.0% in Vavuniya District, respectively. These figures show that majority of the population completed secondary level education. The percentage shares of people with no schooling in Anuradhapura District and Vavuniya District are 3.4% and 3.0%, respectively, which are slightly lower than the national average. However, the values by DS Divisions range from 2.4% to 5.1%. No significant difference is observed except some reasonably remarkable characteristics such as relatively higher attainment of "Passed General Certificate of Education (GCE) Advanced Level (A/L)" and "Degree and above" in Vavuniya and Mihinthale DS divisions.

Table 3.2.17 Percentage Distribution of Population by Level of Education in Target Districts

		Total	Primary (%)	Secondary (%)	G.C.E. (O/L)* (%)	G.C.E. (A/L)* (%)	Degree and Above (%)	No Schooling (%)
Anuradhapura District Target DS Division								
1	Kebithigollewa	19,964	27.1%	48.7%	11.9%	6.1%	1.1%	5.1%
2	Kahatagasdigiliya	35,961	27.1%	45.5%	14.9%	7.6%	1.3%	3.6%
3	Horowpothana	32,616	30.9%	48.7%	10.5%	5.3%	0.8%	3.7%
4	Rambewa	32,931	27.6%	48.0%	13.7%	6.3%	1.0%	3.4%
5	Medawachchiya	41,883	26.0%	48.1%	14.1%	7.3%	1.0%	3.5%
6	Mihinthale	32,013	20.9%	42.1%	16.0%	16.2%	2.2%	2.7%
7	Thirappane	24,391	26.1%	44.7%	16.3%	8.3%	1.5%	3.1%
8	Galenbindunuwewa	42,096	26.9%	45.7%	13.9%	8.4%	1.5%	3.6%
Anuradhapura District Total		774,771	25.2%	46.1%	14.5%	9.1%	1.7%	3.4%
NCP Total		1,142,012	25.6%	46.6%	14.1%	8.6%	1.5%	3.5%
Vavuniya District Target DS Division								
1	Vavuniya North	10,310	32.5%	38.7%	17.7%	7.5%	1.2%	2.4%
2	Vavuniya South	11,883	25.0%	48.1%	14.9%	8.2%	1.2%	2.7%
3	Vavuniya	107,728	24.2%	42.8%	16.7%	10.2%	3.1%	2.9%
4	Vengalacheddikulam	26,868	31.9%	43.2%	14.6%	6.2%	0.7%	3.4%
Vavuniya District Total		156,789	26.1%	43.0%	16.3%	9.2%	2.4%	3.0%
Northern Province Total		971,208	26.5%	44.5%	15.3%	9.2%	2.5%	1.9%
National Total		18,615,577	23.6%	40.7%	17.0%	12.3%	2.7%	3.8%

Note: "Passed General Certificate of Education (GCE) Ordinal Level (O/L)" and "Passed GCE Advanced Level (A/L)"
Source: Census of Population and Housing, 2012

3.2.8 Gender

(1) Gender Equality in Sri Lanka

The constitution of Sri Lanka guarantees equal rights without discrimination on sex, and Sri Lankan women are in better position than other Asian countries' counterpart in terms of gender equality. According to the Human Development Report 2015, Sri Lanka ranked 73rd out of 188 countries in gender inequality index[3], which is mainly due to achieving gender equality in all levels in education. The Sri Lanka National Census 2012 reported that 51.5% of the total population of 20,271,464 were women, but the labour force participation rate of women stayed as low as 35.5%, while the men participation rate was 64.5%[4]. The country has yet to introduce laws and regulations to mainstream women's rights in national legislations[5]. Also, the national machineries of Sri Lanka, including the current one - Ministry of Women and Child Affairs - have depended its effectiveness on its personnel's quality, not on the institutional set-up[6]. Sri Lanka still has a long way to go in achieving international standard in gender equality.

(2) Gender Situation in Project Area

(a) Labour Force Participation

In Anuradhapura District, both female and male participate in economic activities as labour force at much higher rate than the national average. In particular, female marked 45.7% as compared to the national average of 34.7%. On the contrary, in Vavuniya District, female participation rate is 32.4%, which is very close to the national average in 2014.

Rates of employed women and men population in the agriculture sector were 63.2% and 49.8%, respectively, in Anuradhapura District in 2014, while the country averages were 31.9 % and 26.7%. In Vavuniya District, the rates were 39.3% and 31.2%, respectively. In both districts in the project area as well as in whole country, women outnumber men in the agriculture labour force.

Table 3.2.18 Labour Force Participation Rate by Gender (% Involvement)

	Sector	Female	Male
National Average	All Sector	34.7	74.6
	Agriculture	31.9	26.7
Anuradhapura District	All Sector	45.7	81.4
	Agriculture	63.2	49.8
Vavuniya District	All Sector	32.4	77.0
	Agriculture	39.3	31.2

Source: Sri Lanka Labour Force Survey Annual Report - 2014, Department of Census and Statistics

(b) Women's Role and Decision-making in Irrigation Paddy Production

Women play significant roles in agriculture in Sri Lanka. These women's roles are determined based on social and cultural norms and practices as well as family situation. Table 3.2.19 shows examples of tasks that both women and men of different religions undertake in irrigated paddy production in Vavuniya District. Women are more involved in farming activities that require manual labour or daily attention in general. Sinhalese women are more involved than Tamils and Muslims in farming activities in terms of activities and numbers. Some argue that the overall workload of women engaged in paddy production is heavier than men's since women are also involved in most of the domestic activities.

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[3] For example, Thai ranked 93rd, Philippines 115th, India 130th, and Nepal 145th.

[4] Sri Lanka Labour Force Statistics Quarterly Bulletin, Sri Lanka Labour Force Survey, Fourth Quarter 2015

[5] The National Committee on Women appointed under the Charter in 1993 formulated a draft for a Bill of Women's Rights and developed a National Plan of Action for Women with state and non-state participation. But during the last two decades, the draft bill and amendments have not been accepted and published as official documents. (Country Gender Assessment Sri Lanka, An Update, ADB, GIZ, German Cooperation, 2015)

[6] Country Gender Assessment Sri Lanka, An Update, ADB, GIZ, German Cooperation, 2015

It is also recognized that the conflict that lasted almost three decades has also affected women's roles and positions in rural areas, i.e., flexible situation during the war period allowed women to be engaged more actively in other economic activities[7].

Table 3.2.19 Gender Differences in Paddy Farming Activities (% Involvement)

Activities	Sinhalese		Tamil		Muslim	
	Male	Female	Male	Female	Male	Female
Branch irrigation channel cleaning	58.9	41.1	83.7	16.3	97.6	2.4
Bund making	70.7	29.3	100	0	96.9	3.1
Ploughing and levelling by machines	100	0	100	0	100	0
Hand levelling	58.8	41.2	98.8	1.2	97.1	2.9
Making drainage system	71.7	28.3	98.8	1.2	97.3	2.7
Preparation of paddy for sowing	46.4	53.6	48.4	51.6	50	50
Sowing seeds	100	0	100	0	100	0
Gap filling	26.7	73.3	34.9	65.1	0	100
Irrigation	55.4	44.6	88.3	11.7	90.7	9.3
Arraying the inputs to the field	65.2	34.8	94.9	5.1	100	0
Applying weedicides, pesticides and fertiliser	81-92.8	7.2-19	100	0	100	0
Manual harvesting	50.4	49.6	67.2	32.8	91.3	8.7
Packaging	91.1	8.9	100	0	100	0

Note: Although this study is from the experiences based on the major tank irrigation farming system, information could be useful to analyse the minor tank systems in the area.
Source: Prepared by the JICA Project Team, based on "Mapping Out Gender Dynamics in Paddy Farming: A Case Study of Pavatkulam Major Irrigation Scheme in Vavuniya District in Sri Lanka", T. Jeyaruba, et.al. Tropical Agricultural Research Vol. 24 (4): 380- 390 (2013).

When it comes to decision-making in paddy farming, men take a major role in Tamil and Muslim families, while men and women together make decisions in Sinhalese families.

Table 3.2.20 Ethnic Groups and Decision-making Power (%) on Paddy Farming

	Ethnicity	Male	Female	Both
Paddy Farming	Sinhalese	11	6	83
	Tamil	43	9	48
	Muslim	73	0	27

Source: Prepared by the JICA Project Team based on the Study by T. Jeyaruba, et.al. (2013)

(c) Female-Headed Households (FHHs)

There are quite few FHHs in both Anuradhapura and Vavuniya districts. Table 3.2.21 below shows the numbers of FHHs in both districts.

Table 3.2.21 Female-Headed Households

	Anuradhapura District	Vavuniya District
Female-Headed Households	60,730	9,905
Total Households	170,626	41,894
Ratio (%)	26.2 %	23.6 %

Source: Prepared by the JICA Project Team based on the Sri Lanka Census of Population and Household 2012, Department of Census and Statistics

Both districts have more FHHs than the national average of 23.0%. One study indicates that the majority of FHHs was due to the conflict in Kebithigllewa Division, one of the project target divisions in Anuradhapura District[8]. In Vavuniya District, even higher percentages of FHHs are war widows. According to the DOs in both Anuradhapura and Vavuniya districts, FHHs are particularly vulnerable,

7 *"Rural Women in Sri Lanka's Post-conflict Rural Economy"*, Centre for Women's Research Sri Lanka, 2006
8 *"A Report on the Status of Female Heads of Households and their Access to Economic, Social and Cultural Rights: Anuradhapura District"*, Focus Women, 2015

and often it is very difficult for these FHHs to continue farming as some of the farming tasks were traditionally undertaken by males, as shown in Table 3.2.21 above, and female farmers lack skills or machines to undertake these tasks. Some even give up farming and rent out their farmland.

(d) Female Participation in the Development Activities

Participation of women in development activities and decision-making processes tends to be still low in rural Sri Lanka due to some of the following constraints: 1) the lack of capacity (knowledge and skills) in order to participate; 2) cultural and social background; and 3) limited information and opportunities given to them. Women themselves lack understanding of the importance of participation in the activities, leadership, and correct mind set. Participation in meetings or activities is considered “obligation” rather than “entitlement”, and only one person from the household attends, in many cases, a man who has decision-making power in the family. If the woman is the head of the household, she would attend, but just to be there and to watch the discussion takes place in order to fulfill obligation or avoid risk[9], and follow the decisions. In addition, information about activities is often transmitted only to the head of the households (generally men). In order to encourage women’s participation in the project activities and incorporate their ideas and opinions into the development plans, it is essential to pay special attention to their needs and requests. It is also important to facilitate recognising women's ability and to stimulate gender awareness amongst local communities as part of the project activities.

3.2.9 Internally Displaced Persons (IDPs) or Returnees

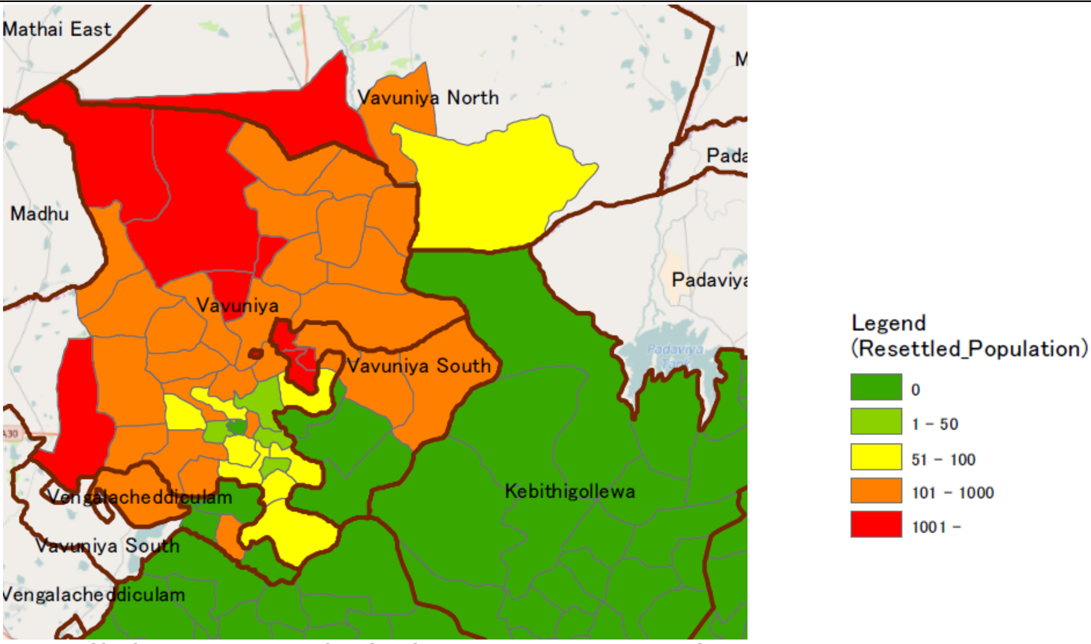
(1) Resettled Farmers

Between 1983 and 2009, over a million people were displaced by the conflict in Sri Lanka. Soon after the cessation of the conflict in 2009, two government-led resettlement programmes called “Vadakkin Vasantham” (Northern Spring) and “Nagenahira Navodaya” (Eastern Revival) were started with strong initiative from the former president, Mahinda Rajapaksa, in order to facilitate rapid resettlement of displaced persons. The programmes assisted IDPs to return to their places quickly and safely, and provided them with housing, sanitation and water facilities, education, as well as livelihood support programme.

As of end of June 2016, seven years after the cessation of the conflict, the majority of IDPs, including those who were from Vavuniya District, have returned to their original places or relocated to other areas[10]. According to the Vavuniya District Secretariat, a total number of 68,037 resettlers (16,966 families) returned to their homes since 2009 and received Vadakkin Vasantham assistance. It should be noted that displaced and resettled people were not only Tamils. The majority of the resettled people in Vavuniya South Division were Sinhalese. Figure 3.2.1 below shows the distribution of resettlers at the GN level.

[9] *“An Assessment of Female Participation in Minor Tank Irrigation System in Sri Lanka”*, IWMI and Univeristy of Twente, 2001

[10] Only 66 families, 97 displaced persons, are still at the Poon Dhodam Walfare Centre in Vavuniya District. These people are originally from other districts and do not have their own land. They are soon going to resettle in two locations in Vavuniya District. By Planning Department, Vavuniya District Secretariat.



Source: Prepared by the JICA Project Team based on the Vavuniya District Secretariat document

Figure 3.2.1 Resettled Population in Project Target GNs in Vavuniya District

Among these resettlers, there are some ex-LTTE combatants who have received rehabilitation/reintegration assistance and came back to their communities. According to one of the DOs in Vavuniya Division, these ex-LTTE combatants may have had difficulty to gain back respect in their communities, but they are doing fine now and may need further psychological support programme.

Conflict-affected farmers exist in Anuradhapura District as well. People who lived or villages located near the boundaries between LTTE-controlled areas and government-controlled areas were subject to receive regular attacks by the LTTE during the conflict in the North Central Province. The Kebithigollewa Division, especially Yakawewa, Halmillawetiya, Kanugahawewa, Herathhalmillewa and Thammennawa GNs were most affected by the conflict in Anuradhapura District. About 200 people were killed or gone missing between 2000 and 2009, and many people, a majority of them were farmers, were frequently displaced for some time throughout the conflict era.

By June 2016, about two thirds of displaced farmers have returned to their original location. Due to the government assistance programmes for resettlement, they are not facing any particular problem in farming at present[11].

(2) Abandoned Tank and Unkempt Farmland Issues

During the three-decade conflict period, part of Vavuniya District was identified as “high-security zone” and controlled by the Sri Lankan military. Farmers were forced to move out from their homes and become IDPs. In those areas, some command areas/paddy fields and tanks were left unmaintained for a long time and vegetation around them overgrew, and/or military bunkers and dunks were created in their paddy field. Many tanks were abandoned. The number of abandoned tanks may be more than its current number[12].

As mentioned above, it is believed that majority of the IDPs have returned/resettled to their place of origin in Vavuniya District. However, in reality, only around 40-45% of farmers returned, the other 30% of farmers commute to their land every day only for farming, and the rest of 20-25% have given up farming and rent out their farmland to other farmers[13]. Even the returnee farmers have not recovered their farmland 100% as they have difficulty to clear their paddy field (remove trees and

[11] Interview with DO of Kebithigollawe ASC.

[12] Interview with DOs of Omanthai, Pampaimadu,and Madukanda ASCs, and the manager of SEED (Non-Governmental Organisation (NGO) that has been assisting resettlers in Vavuniya District).

[13] Omanthai and Pampaimadu ASC-covered villages.

bushes or bunkers) and make it usable, because heavy machines are not available in the area. In these areas, recovering the command areas is necessary in addition to renovation of tanks.

Another issue related to land is risk from the remaining landmines. Many landmines were laid in Vavuniya District during the conflict, especially in the "high-security zone". As of April 2016, both Anuradhapura and Vavuniya districts remain contaminated with landmines and explosive remnants of war (ERW) although the remaining hazardous areas have been dramatically decreased since the operation started. National Mine Action Centre (NMAC) estimated that a total of 54 km^2 remains to be processed in the ten districts in the North and East provinces. Table 3.2.22 shows the current situation of mine clearance in Anuradhapura and Vavuniya districts.

Table 3.2.22 Mine Clearance Situation in Anuradhapura and Vavuniya Districts

	Before NTS*		After NTS
	Number of Hazardous Areas	Area (km^2)	
Vavuniya	99	6,444,291	On-going
Anuradhapura	21	1,154,672	On-going

Note: NTS is a survey method reviewing and collecting all available information and analysing the situation. The NTS allows confirmed hazardous areas to be demarcated and areas outside of this are released for resettlement. Priority for mine clearance was given to the residential areas in villages identified for resettlement, in order to keep pace with and support the government's resettlement plans. There is a possibility that farmland is still contaminated with mines/ERW.*
Source: Sri Lanka Mine Action Strategy 2016 -2020, Ministry of Prison Reforms, Rehabilitation, Resettlement, and Hindu Religious Affairs (2016).

Even if the areas are declared as "cleared area" by the government, it is not certain that all landmines and ERW were completely removed because some farmlands still remain overgrown and the bunkers made in the paddy fields during wartime have been left untouched. In addition, it is possible that frequent floods washed down the remaining landmines to other locations. There were incidents in Mullative District that un-removed landmines or ERW exploded and farmers got injured during farming activities in the "cleaned area"[14]. Enough precaution should be taken when conducting activities in the area.

3.3 Farming System in Rural Society of Sri Lanka

Farming system in a rural society in Sri Lanka is characterised by complex land use systems and labour use patterns. The following describes the land ownership, agriculture land use system, and labour use pattern commonly observed in rural Sri Lanka:

3.3.1 Land Ownership and Land Use System

There are several types of land use systems applied in Sri Lanka. There are several different land ownerships as shown in the following Table 3.3.1:

Table 3.3.1 Land Tenure Systems in the Project Area

	Type of Ownership	Description
1	Freehold lands	These are private lands with freehold land titles. The owner of these lands can sell or transfer them at his disposal
2	'Praveni' Lands	Praveni lands are also private freehold lands but ownerships of lands are passed down from parents to the children
3	Lands with LDO permits	LDO permits are given as grants from the government under the Land Development Ordinance of the country. Ownership of these lands can be transferred only to husband/wife, children, or to blood relatives. Furthermore, the lands with LDO permits can be subdivided subject to limitations in the grant and be given to children or blood relatives
4	Lands with Jaya Boomi/Swarna Boomi titles	These lands are given as state grants under certain conditions of the State Land Development Ordinance and cannot be sold, mortgaged, or disposed. However, they can be transferred to another person with the approval of the Divisional Secretary of the area.

[14] Interview with a former JICA Project Team member in Mullative District.

5	Lands with annual permits	Annual permits for agricultural lands are given on temporary basis subject to conditions by the Divisional Secretary or the Deputy Land Commissioner.
6	Leased lands	The user of the land pays a rental to the owner for an agreed period.
7	Mortgaged lands	This a legal agreement that conveys the conditional right of ownership of the land by its owner to a lender as a security of a loan. If the owner fails to pay the loan back within the agreed period, the title is transferred to the lender.
8	Encroached lands	Crown lands used illegally.

Source: JICA Project Team

For agriculture land use, there are joint ownership and single ownership. Although single ownership is more popular in Sri Lanka, diversified and complex joint ownership of land still exists. Joint ownership of land is called "*Havul*". Under joint ownership, no single person has sole ownership of the land property, and is instead shared by some individual farmers. Thus, any decision concerning the jointly owned land needs to be agreed by all the owners, and no one can make any decision without mutual agreement of the joint owners. Table 3.3.2 below summarises the characteristics of the various types of the joint ownership system.

Table 3.3.2 Types of Ownership and Land Use System

	Land Use System	Description
1	'Thattumaru' System (Tenancy Rotation)	Under this system, when there is more than one owner for a particular agricultural land, each of the shareholder ('Pangukaraya') would take turns in cultivating the whole extent of the land. If a shareholder for some reason does not cultivate the land when it is his turn, he has to wait for several seasons for his turn again. This system is disappearing today as a result of unity among family members
2	'Kattimaru'System (Benefit Rotation)	This system is practised when several land parcels are owned by several people but not in equal soil fertility or productivity. In this situation, to maintain an equitable distribution of both fertile and infertile or barren land, the farmers shift from one parcel of land to another every season on a rotational basis so that all shareholders would have a turn on all parcels. This system is disappearing recently.
3	'Bethma' System (Situtational Cropping)	'Bethma' is a practice that temporally redistributes plots of paddy fields amongst all the farmers belonging to a tank in a part of the command area during drought periods when there is no adequate water available in the tank to cultivate the entire command area. All decisions pertaining to land distribution are taken by the respective farmer organisations.
4	'Ande'System (Tenant Farming)	When a land owner is unable to cultivate his land by himself and gets it cultivated by some other person (tenant farmer) called 'Ande'. The Ande farmer or tenant farmer has to give a portion of his harvest to the landowner in each cultivated season. Paddy land owners cannot change the tenant farmers at their disposal as tenant farmers are secured under the Paddy Land Act of 1958.

Source: JICA Project Team

Although the practises of joint ownership of farmland and tenant farming are still observed, they are presently not very common. Recognition and understanding of land ownership are essential in planning equitable water distribution and cultivation patterns. Land ownership may affect membership and entitlement for particular service.

3.3.2 Labour Use Pattern

Several types of labour use patterns can also be observed in Sri Lanka. The labour use pattern present in a community may vary depending on the custom, season, availability of labour, and type of crops of each area. The following Table 3.3.3 shows the types of labour use patterns:

Table 3.3.3 Types of Labour Use Patterns

Type of Labour Use Pattern		Description
(a)	Exchange of labour with responsibility (*Attam* labour)	*Attam* is the traditional term used for exchange of labour. This kind of labour concept is unique to Sri Lanka. In the village level, when some work is to be done, neighbours communicate, mutually agree, and do the work.
(b)	Shared labour on group basis (*Kaiya* labour)	*Kaiya* labour is similar to *attam* labour. The landowner invites other people to participate or help in harvesting his paddy lands. Whoever is available and willing to work comes to help the landowner on an agreed date. All the participants eat specially prepared meals on that day. This is also called *kaiya*.

Type of Labour Use Pattern		Description
(c)	Informal contract (Ad hoc labour)	Ad hoc labour is an informal type of labour. Anyone who is available to work may just meet a labour supplier without any prearrangement and agree immediately to provide the labour necessary on a given date.
(d)	Formal agreement (Contract labour)	A contract labour is informally organized by a labour supplier. The labour supplier discusses and agrees with a labour demander to do specific work for a specific price. The labour supplier is responsible for finishing the specific work in an agreed period of time. The labour supplier hires labourers from a labour market to finish the work as agreed, with profit.
(e)	Hired labour	Hired labour is open market labour. Workers come to an agreement with those who hire and decide to supply their labour at an agreed wage. The wage is decided on an hourly or daily basis or for a specified duration. Most of this kind of labour is seasonal type hired labour, meaning labour is hired only for the peak days of the cultivation season. It is necessary to note that some of the hired workers in the informal labour market migrate to the urban sector in the off-season and work there until the next cultivation season.
(f)	Family labour	Members of peasant families themselves provide necessary labour for their own farm. If their labour is not enough, they hire outside workers or utilise some type of labour described above.

Source: Adapted from the Final Report of The Preparatory Survey on The Project for Improvement of Agricultural Production and Productivity in Dry Zone Areas in Democratic Socialist Republic of Sri Lanka with original source of "Land and Labour Use Pattern of Paddy Farming Practices in Sri Lanla Peasant Farm Sector" (Lal Thilakarathne et.al, Gifu University, Res. Bull. Fac. Age. Gifu Univ. (62) :33-43. 1997)

Although the abovementioned labour use patterns had been commonly practised before, these types of labour use patterns such as *attam* labour have become increasingly rare at present. Hired labour and family labour are the more popular labour patterns which can be observed in the field currently. One of the common reasons pointed out in the entire country for the diminishing trend of mutual cooperation in farming in rural society is modernisation and unification of the farming system during the colonial era.

In addition, there are different types of labours in terms of their origin and skills. The following Table 3.3.4 summarises the types of labours commonly adopted in the project area:

Table 3.3.4 Types of Labour

	Type of labour	Description
1.	Agricultural labourers within the area	They are involved in agricultural farming activities during the cultivation season and very often they are skilled in those practices.
2.	Agricultural labourers coming from out side	They come from other areas of the country during the cultivation season.
3.	Non-agricultural labourers	Skilled or unskilled labour engaged in other than farming activities.

Source: JICA Project Team

3.4 Land Use of the Project Area

According to the 1:50,000 topographic data officially available in Sri Lanka, land use in the project area is dominated by forest and scrub land with a share of more than 50%. The shares of paddy and home garden are nearly 21% and 8%, respectively as shown in Table 3.4.1.

In addition to the 1:50,000 map, a topographic map with the scale of 10,000 was collected from the Survey Department of Sri Lanka for detailed understanding of the current situation of land use in the study area. The differences between the land use at the scale of 50,000 and 10,000 were confirmed.

The topographic map with the scale of 50,000 shows a situation that has not been updated, while the old land use has been prepared from 2001 to 2009. Topographic map with the scale of 10,000 shows a situation with an updated land use using the satellite images taken in 2013 and 2014. There are still parts based on satellite images taken in 2010. However, it is determined that it can be used for the current situation of the study area because there are many ranges using satellite images taken in 2013 and 2014.

Therefore, by comparing the land use area in the maps of both scales, it was possible to confirm the change of the paddy, garden, water area, and forest, which is required in the study.

Paddy land use area was increased by about 140 km^2. Its ratio has increased from about 21% to about

28%. Garden area was increased by about 50 km^2 and its land use area ratio has increased from about 8% to about 11%. Water area shows a little increase of about 10 km^2. Forest was reduced by about 130 km^2 and its previous ratio of more than 50% decreased to about 45%.

Table 3.4.1 Land Use Area Comparison in the Topographic Map

Land use 1:50,000	Land use 1:10,000	1:50,000 Area (km^2)	1:50,000 Rate (%)	1:10,000 Area (km^2)	1:10,000 Rate (%)
Home Garden	Homesteads/Garden	165.22	8.44	215.27	10.99
River	All water area	167.23	8.54	174.32	8.90
Canal - Abandoned					
Tank with Bund - Working					
Tank with Bund - Abandoned					
Water Hole					
Ela					
Paddy	Paddy	406.16	20.74	546.12	27.89
	Paddy-abandoned				
Forest/ Scrub land	Dense Forest	1016.13	51.90	884.93	45.19
	Open Forest				
	Forest-Unclassified				
	Grassland				
	Mixed tree and other perennial crop				
	Scrub land				
Other Plantation	Forest Plantation	2.80	0.14	96.14	4.91
	Sparsely used cropland				
	Other cultivation				
	Coconut				
	Rubber				
Chena		144.76	7.39	0.30	0.02
Others		55.73	2.84	40.98	2.09
Total		1958.05	100.00	1958.06	100.00

Source: Prepared by the JICA Project Team based on the data collected from the Survey Department of Sri Lanka

3.5 Agro-ecological Zone

Sri Lanka exhibits a wide range of agro-ecological states reflecting variations in the topography, climate, and soil conditions. Most of the island's surface consists of plains between 30 and 200 meters above sea level. In the southwest, ridges and valleys rise gradually to merge with the central highlands. In the southeast, the land is relatively level and the transition from the plain to the central highlands is abrupt. The flat plains in the north and east are dissected by long narrow ridges running from the central highlands.

3.5.1 Agro-climatic Zones

Rainfall forms and seasons are determined by monsoonal, convectional, and cyclonic systems with the south-central highland region and to a lesser extent, the insularity of the country modifying the efficiency and the special distribution pattern. The rainfall experienced in Sri Lanka during the 12-month period (rainfall year) is divided into four seasons, namely: Southwest (SW) and Northeast (NE) monsoon seasons (Yala and Maha, respectively) and two inter-monsoon seasons. The NE monsoon is the main source of rainfall in the dry zone and lasts from late October/early November to late December/early January. During this period, most dry zone stations receive 45–55% of the total annual rainfall. The rainfall in the pre-NE monsoon is caused by cyclonic activity and provides another 20–25% of the rainfall. Thus, about 65–75% of the rainfall is concentrated in a period of less than four months. Although occasional heavy showers occur in late March and early April, the seasonality of rainfall is so marked that 3-4 months of drought is common in normal years.

Table 3.5.1 Elevation and Rainfall of Different Climatic Zones

Country (Code Letter)	Altitude (m above MSL)	Zone (Code letter)	Annual Rainfall (mm)
Low (L)	< 300	Wet (W)	> 2,500
Mid (M)	300 – 900	Intermediate (I)	1,500 – 2,500
Up (U)	>900	Dry (D)	<1,500

Source : Department of Agriculture

Based on annual rainfall distribution, Sri Lanka is divided into three major climatic zones, namely: wet, intermediate, and dry zones. Using the monthly rainfall and elevation, the country is further divided into seven agro-climatic zones (WL, WM, WU, IL, IM, IU, and DL).

3.5.2 Agro-ecological Regions

The agro-ecological zones are further divided into 24 agro-ecological regions and 46 sub-regions. Thus, the low country dry zone (LD) is divided into five regions designated as 1 - 5 based primarily on the nature of soil and into six sub-regions based on the degree of wetness designated by a lower case letter a – f. In the project area, the agro-ecological conditions are described as DL 1_b and DL 1_e and are briefly described below.

3.5.3 Agro-ecological Sub-regions DL 1_b and DL 1_e

The land terrain is mainly undulating and the slope varies from 0–8%. The main soil groups are the Reddish Brown Earth (RBE) occurring in higher slopes and Low Humic Gley (LHG) in the flat valley bottoms. Annual rainfall is more than 900 mm and the mean temperature is 30^0C. The daytime relative humidity ranges from 50% to 75% while the night-time values may exceed 90%. Major land use in the two sub-regions includes rain-fed upland crops, paddy, scrub, mixed home gardens, and forests.

3.6 Soils

Fourteen great soil groups are found in Sri Lanka of which RBE and LHG soils are the dominant groups found in the project area. They occur in a catenary sequence with RBEs occupying the well-drained upper slopes and imperfectly drained middle slopes of the typically undulating landscape while the LHGs are found in the low valley bottoms. The main characteristics of these soils are described below.

3.6.1 Reddish Brown Earths

The colour of the topsoil is reddish brown when dry and turns to dark reddish brown when wet. They occupy slopes ranging from 2% to 8%, about 1.0-1.2 m deep and have a subsoil horizon with high proportion of gravel of varying depth. This gravel layer is composed of a mixture of quartz, ironstone, and iron-manganese nodules. Soil texture may vary from sandy loam to sandy clay. The soils are extremely hard when dry and friable to firm when wet. Soil reaction is slightly acid to neutral. Base saturation level varies from 60% to 80%. They are low in P but reasonably high in K. The water holding capacity is low at 100-140 mm/m depth of soil and releases the moisture at low tension. The steady infiltration rate ranges from 1 to 5 cm/hr. The percolation rates can remain high even after many years of continuous puddling as in growing of paddy. Organic carbon content is low and is in the range of 1-2%. Soils are suitable for a range of crops, both annual and perennials, and are best used for rain-fed agriculture or for farming under well controlled irrigation.

3.6.2 Low Humic Gley Soils

Developed from colluvial deposits, the soils are characterised by wetness of gleying throughout the profile. Soils are deep, moderately fine textured, occupy slopes ranging from 0 to 2%, and are extremely hard when dry and sticky when wet. Drainage is poor and base saturation of subsoil is 90-100%. Soil reaction is moderately alkaline and the water percolation rate of these soils remains at 2.4 mm/day even after 6-10 years of continuous cultivation of paddy with puddling. They also have a high CEC and are more suitable for paddy, but OCFs can be grown with proper irrigation.

3.7 Surface Water and Groundwater Resources

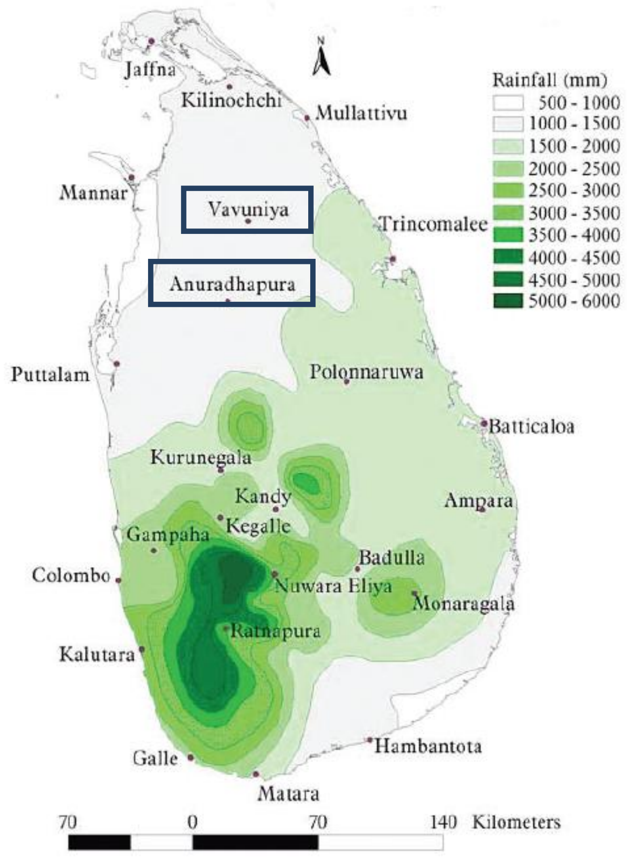
3.7.1 Surface Water Resources of the Project Area

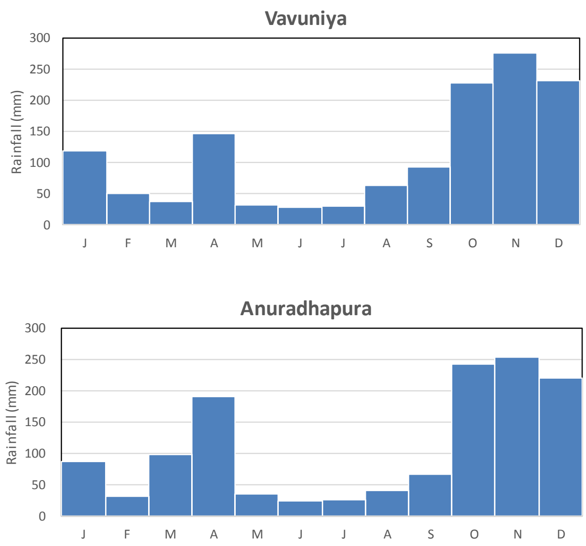
(1) Climate & Rainfall

The island of the Sri Lanka belongs to the tropical monsoon climate zone and is influenced by two monsoons. The rainfall pattern is strongly influenced by the direction of these monsoons, i.e. the southwest monsoon pouring rainfall in the southwest part of Sri Lanka from May to September, while the northeast monsoon pours rainfall in central part and arid area of north and northeast part of Sri Lanka from December to February.

The climate of Sri Lanka is further subdivided to three zones, i.e. the wet zone, intermediate zone, and dry zone depending on the amount of annual rainfall. Wet zone is the area where annual rainfall has more than 2,000 mm, and dry zone is defined where the annual evaporation exceeds the annual rainfall. Intermediate zone is the area between wet and dry zone. The annual rainfall of the country is shown in Figure 3.7.1.

The project area laid on Anuradhapura and Vavuniya districts where has the climate category of dry zone. As shown in the figure the area limited annual rainfall between from 1000 to 1500 mm.





Source: Irrigation Department.

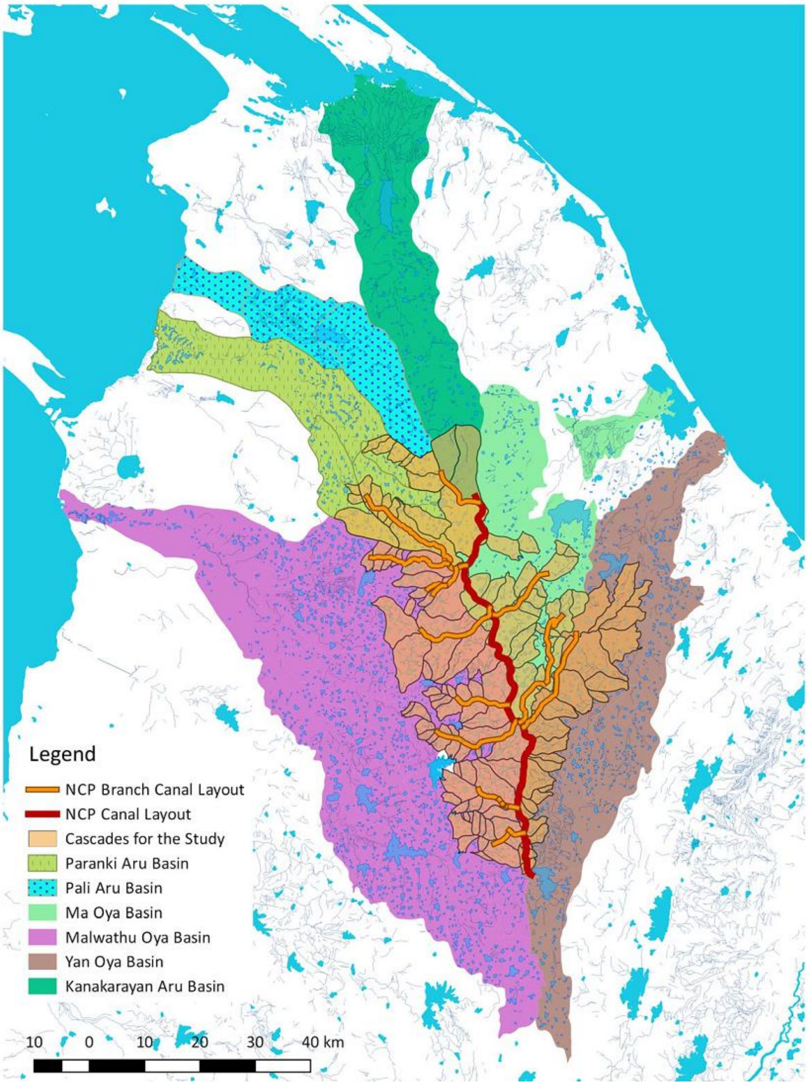
Source: Premarathe et al; "Country Pasture/Forage Resource Profile, Sri Lanka"2006, FAO.

Figure 3.7.1 Average Annual Rainfall (1961 - 1990)

Figure 3.7.1 also shows the bar chart of mean monthly rainfall of Anuradhapura and Vavuniya measured from the year 2001 to 2010. The two charts indicates that the two region has distinct dry season from May to September.

(2) Surface Water

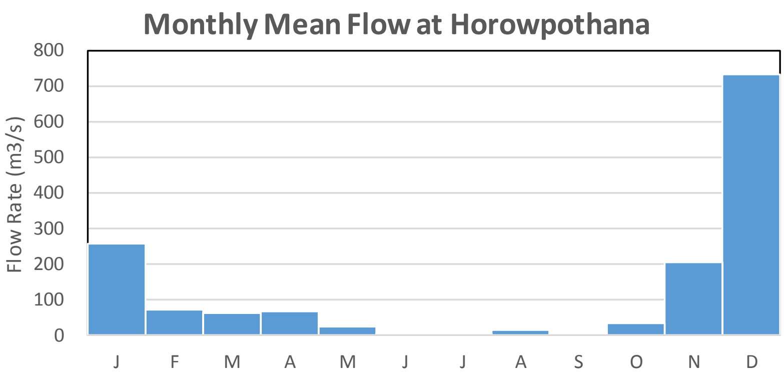
The target cascade area are laid over six river basins namely, Malwathu Oya, Paranki Aru, Pali Aru, Kanakarayan Aru, Ma Oya and Yan Oya. The layout of the six river basins are shown in Figure 3.7.2.



Source: JICA Project Tem

Figure 3.7.2 River Basins in the Project Area

The river stream flow in the project area is only measured at Horowrpothana. The monthly mean stream flow measured at Horowpothana from the year 2001 to 2010 is shown in Figure 3.7.3.



Source: Irrigation Department

Figure 3.7.3 Monthly Mean Flow at Horowpothana

As shown in the figure, the river water during the dry season is almost dried up. Thus tank system that had been developed over the project area, is important for supply irrigation, and domestic water during the dry season.

3.7.2 Groundwater Resources in Sri Lanka

Rainfall is the major source of supply of freshwater in Sri Lanka. Rainfall precipitates on the earth surface and percolates into the underground by gravity. The groundwater is stored through circulation. Water seeps on the land surface. The water-bearing capacity depends on the formation (rock and soil).

Groundwater is mainly used for small-scale irrigation and for industrial use. There are several types of shallow and deep groundwater aquifers. These types have been identified based on the study conducted over the past 50 years. Each of these aquifers has clear characteristics. Shallow aquifers carry out an important role in providing domestic supplies from traditional wells with depths between 6 m and 9 m. The shallow aquifers are discharging water to rivers and other water bodies during low flow periods. Their region in the country is densely populated and intensively cultivated.

The general description and characteristics of each of the seven types of aquifers are shown in Table 3.7.1.

Table 3.7.1 Groundwater Aquifers in Sri Lanka

Type	Characteristics
T1	[Shallow Karstic Limestone Aquifers] The shallow aquifers of Jaffna peninsula are found in channels and cavities (karsts) in Miocene limestone. A large volume of rainwater and other surface water infiltrates into these spaces during the rainy periods. Of this amount, about 50% eventually drains to sea outlets, while the remainder becomes the most intensively utilized groundwater resources in the country, mainly for agriculture and domestic purposes. Thickness of the freshwater bodies ranges from 20 m to 30 m below the ground level in the Puttur, Pannikudduwan, and Urali areas. The groundwater table is located at 0 m to 3 m below ground level. The conductivity is very high.
T2	[Coastal Sand Aquifers] Shallow and moderately developed aquifers are found in unconsolidated sands, which occur along a major part of the country's coastline. These aquifers consist of 'lenses' of freshwater floating above saline water. The volume of freshwater in these aquifers usually expands during the rainy season and contracts during the dry season, with fluctuating brackish and saline boundaries. Infiltration rate and lateral movement of water through these sand aquifers are relatively high.
T3	[Deep Confined Aquifers] A number of distinct and confined aquifers exist mainly in the limestone formation of the northwestern and northern coastal plains. These are relatively deep aquifers and have relatively high recharge rates. The limestone is highly faulted and segregates the aquifer into a series of isolated blocks forming a number of groundwater basins. Confined aquifers of Vanathavillu and the Mannar-Mulunkavil basins are examples of this nature, and 30 m to 40 m deep tube wells yield around 3 litre per second to 10 litre per second. This aquifer dips towards the sea and the depth of the aquifer is around 70 m to 90 m in some places close to the sea.
T4	[Laterite Aquifers] The laterite or 'kabook' of southwestern Sri Lanka has considerable water-holding capacity, depending on local depths. Because of the high infiltration rate of the upland higher-level laterite, the groundwater drains off quickly into the adjacent board valleys. The groundwater in these lower valleys is being used by small and medium scale enterprises. Enhanced nitrate levels have been observed from some of the domestic wells around Colombo and regional suburbs. The deeper aquifers that occur below the laterite aquifers have close interconnections.
T5	[Alluvial Aquifers] A number of rivers and streams, which cross the coastal plains, have associated alluvial aquifers, particularly along their lower reaches. Rivers, such as the Mi Oya, Deduru Oya, Kelami Ganga, and Mahaweli Ganga, have significant alluvial aquifers. These aquifers are generally shallow and are directly connected to the surface water in the rivers or streams. Even in periods of low surface flow, these alluvial aquifers are therefore quickly recharged and constitute a considerable source of water. Groundwater withdrawals will have a corresponding impact on river flow; and contamination of either surface water or groundwater will affect the other.
T6	[Shallow Regolith Aquifers] The shallow regolith (weathered and residual overburden) aquifer is mainly confined to narrow inland valley systems of the undulating mantled plain landscape located within the hard metamorphic rock regions, especially in the north-central and north-western regions of the country. The thickness of the aquifers can vary from site to site in proportion and scale, and is usually not more than 12 m, with the shallow water table within 6 m to 8 m, fluctuating widely from season to season.
T7	[Deep Fractured Zone Aquifers] Throughout several parts of the metamorphic hard rock areas in each of the climatic zones, deep aquifers can be found. These are present in joints, fractures, and are therefore discontinuous and sporadic, and be exploited only through deep tube wells.

Source: The National Atlas of Sri Lanka, Second Edition 2007, Survey Department, Sri Lanka

3.8 Agricultural Production

3.8.1 Agricultural Land Use of the Project Area

Each cascade system consists of a series of small tanks connected by link canals. The tanks may not have adequate catchment area due to excessive deforestation for chena cultivation and settlements. During the rainy season, the excess water from the upper tanks spills over to the next down the cascade. Irrigation water is usually drawn down the sluices located on either side of the bund along distribution canals on the contour to irrigate the lands at the lower elevation. Taken as a whole, the agricultural land use in the cascade system can be examined under two categories, namely: the irrigated lands and the rain-fed lands.

(1) Irrigated Lands

(a) Command Area

Lands for which irrigation water is supplied through the distribution canals lies within the irrigation command area. Most of these lands have slopes of less than 2% and occupy the valley bottoms. The predominant major soil group is the low humic gley (LHG) soils and has been traditionally cultivated with paddy. However, the extent cultivated is dependent on the rainfall received during the Maha season and the amount of water retained in the tanks for Yala cultivation season. In a normal year, the entire command area may be cultivated with paddy during the Maha season, but cultivation at best is possible only in a part of the area during the Yala season; and in general, the extent varies between 20%–30%. Thus, a maximum cropping intensity of about 130% can be expected in the command area.

A movement towards crop diversification is observed in the project area during the Yala season, though the extent never exceeded 5% of the command area. This is seen in few instances where Bethma form of land tenure is in operation when the stored water in the tank is inadequate for paddy cultivation. Blocks of land (liyaddas) are selected and 1 m wide planting beds are raised for flood irrigation in the furrows.
Assisted by the extension workers, some farmers have already tried out a mid-season or third season cultivation of green gram and black gram on Maha stubble when adequate water is available in the tank at the end of the season for at least three water issues.

(b) Lift Irrigated Area

Agro-wells are used extensively in the project area and are constructed in all categories of rain-fed lands. These include the areas adjacent to and/or below the command area lying at slightly higher elevations, chenas, and home gardens. However, it has been noted that agro-wells were often constructed without adequate assessment of the hydro-ecological properties of the aquifer, yield potential, and rational siting of the wells. They are typically 6.0 m in diameter, dug by hand and/or mechanical excavator to a depth of 6–8 m, and are recommended to be spaced 200 m apart. The walls of the well are lined with brick and top 1–2 m plastered with cement. Farmers use 50 mm pump and 50 mm flexible hose for direct surface irrigation or drip/sprinkler irrigation. Each well holds adequate water soon after the Maha rains and possible to cultivate 0.2 – 0.4 ha during the January-April period. Six hours of continuous pumping is possible during this time. If the precipitation in the inter-monsoonal period is low, cultivation after May will be severely restricted; and pumping hours reduced to four hours as the recovery rate of the well is low. The cost of construction of an agro-well is estimated at LKR 200,000 of which, up to 50% was borne by the state as grants through funds received from various donor agencies. OFCs, condiments (chilli and onion), and vegetables are the main crops grown; but semi-permanent crops such as papaya and banana are also being introduced. Though the list is incomplete, wells located within the project area in Anuradhapura District, presented in Table 3.8.1, shows that at least 867 (over 10%) of the wells were abandoned; and on average, each operating well irrigates an area of about 0.5 ha.

Table 3.8.1 Agro-wells in the Project Area (Anuradhapura District)

DS Division	No. in Use	No. of Abandoned Wells	Ext. Irrigated (ha)
Rambewa	409	143	746
Thirappane	1,520	301	635
Medawachchiya	1,845	335	863
Kahatagasdigiliya	1,362	88	1,024
Horowpothana	1,732	-	749
Mihinthale	1,080	-	
Galenbindunuwewa	1,036	-	416
Kebithigollewa	-	-	-
Total	8,984	867	4,423

Source: Resource Profiles

(2) Rain-fed Area

Cropped area under rain-fed category can be divided into two classes as follows:

(a) Paddy Lands

These lands border the irrigated paddy fields and occupy the upper slopes on either side of the main distributary canals from the tank and the lands that lie just below the command area converging towards the drainage stream or link canal feeding the next tank in the cascade. Some of these lands were converted for cultivation under lift irrigation. However, the major area is being cultivated under rain-fed paddy and maize during the Maha season. These lands mostly occupy the transitional area between the well-drained reddish-brown earth (RBE) soils in the upper slopes and the poorly drained LHGs in the valley bottoms and are classified as imperfectly drained RBEs. Though the percolation rate of the soil is high, these lands are cultivated with paddy during the Maha season since precipitation in a normal year is adequate to raise a good crop. Land areas located at higher slopes are being increasingly diversified to maize and to some extent to other field crops (OFCs), grain legumes in particular, and vegetables.

(b) Home Gardens

Home gardens are located in the highlands; and in many instances, were originally chena lands where farmers have now established their permanent residences. Extents, in general, are in excess of 0.4 ha and, besides the homestead, are used extensively for mixed cropping. Most of the permanent crops such as coconuts and fruits as well as seasonal vegetables and ornamental plants (floriculture) are grown in home gardens.

(c) Chena

These are the highland and are located adjoining the forest on state lands. Originally, these lands formed a part of the shifting cultivation system, but due to the gradual dwindling of lands available for shifting the chenas have become permanent holdings, often with homesteads. Permanent and seasonal crops are grown in these areas.

3.8.2 Cropped Area and Crop Production in the Project Area

The project area is located in the agro-ecological regions $DL1_b$ and $DL1_e$, and has suitable conditions for growing of seasonal crops during the Maha season. However, during the dry Yala season, supplementary irrigation is necessary to raise crops successfully. A range of crops is cultivated in the area which includes cereals, OFCs, vegetables, tuber crops, and fruit crops. Crop yields showed wide seasonal variations which may have been caused by the irregular weather conditions experienced during the past few years.

(1) Cereals

(a) Paddy

During the Maha season, paddy is cultivated in the irrigated command area as well as in rain-fed uplands. However, during the Yala season, rainfall alone is insufficient to raise a successful crop without supplementary irrigation, and cultivation is restricted to the command area of the tank. Since full storage capacities of the tanks are rarely reached during the season, cultivation is limited and averages around 20%–30% of the total command area. The average yield of 2.9 t/ha recorded for the project area is below the national average of 4.2 t/ha. Summary of cropped areas, production, and the yields reported for the cascade areas within the project area in Anuradhapura and Vavuniya districts at the Divisional Secretariat (DS) level is presented in Table 3.8.2. Low crop intensity and low yield are one of major issue in agriculture in the area.

Table 3.8.2 Cropped Area, Production, and Yield of Paddy

DS Division	Maha Irrigated			Maha Rain-fed			Yala Irrigated		
	ha	mt	mt/ha	ha	mt	mt/ha	ha	mt	mt/ha
Kebithigollewa	757	2,162	2.8	137	247	1.8	452	1,250	2.8
Medawachchiya	1,543	5,926	3.8	272	564	2.0	182	332	1.8
Rambewa	2,208	5,375	2.4	859	1,606	1.9	625	2,722	4.3
Horowpothana	5,639	9,914	1.7	4,243	5,092	1.2	1,568	2,152	1.4
Galenbindunuwewa	3,180	7,611	2.4	1,682	5,381	3.2	1,591	2,627	1.6
Kahatagasdigiliya	4,858	15,994	3.3	1,477	3,711	2.5	1,477	3,711	2.5
Thirappane	2,485	8,275	3.3	778	2,479	3.2	1,350	4,534	3.3
Mihinthale	2,178	8,650	4.0	416	1,649	3.9	1,618	5,010	3.0
Vavuniya	6,432	26,181	4.0	1,496	4,483	3.0	3,150	11,866	3.7
Vavuniya South	1,699	7,271	4.3	349	1,049	3.0	1,163	4,711	4.0
Vavuniya North	103	424	4.1	24	74	3.0	50	195	3.9
Chetti Kullam	140	574	4.1	33	100	3.0	68	263	3.8
Total	31,222	98,329	3.1	11,766	26,437	2.2	13,630	42,959	3.1

Source: Resource Profiles

(b) Maize

Next to paddy, maize is the most important cereal crop cultivated in the project area. Supported by the private sector interventions, the extent cultivated in the project area increased significantly in the last few years. However, cultivation is mostly confined to rain-fed highland areas during the Maha season. During the 2016 Yala season, a promotional programme was launched by the provincial Department of Agriculture (DOA) (Anuradhapura), under which 5,000 ha of the command areas under minor tanks were planted with maize. However, due to unexpected heavy rains experienced during 2016 Yala, 90% of the planted area was destroyed and farmers quickly reverted back to paddy cultivation. Cultivation of maize in Vavuniya District is not as well spread as in Anuradhapura, mainly due to less private sector activity in the region. It should be noted that the available data does not distinguish the cultivated area of maize into minor or medium/major irrigation schemes. Finger millet is cultivated mainly during the Maha season in the highlands, but the recorded cropped areas are negligible. Extents cultivated, production, and the yields of maize in the project area are presented in Table 3.8.3. Yields recorded for the project area are on par with the national productivity level of 4 t/ha.

Table 3.8.3 Cropped Area, Production, and Yield of Maize

DS Division	Maha			Yala		
	ha	mt	mt/ha	ha	mt	mt/ha
Kebethigollewa	67	60	0.9	78	86	1.1
Medawachchiya	98	258	2.6	5	2	0.4
Rambewa	0	0	0.0	0	0	0.0
Horowpothana	2,856	5,921	2.0	348	335	0.9
Galenbindunuwewa	6,036	26,350	4.3	452	1,555	3.4
Kahatagasdigiliya	2,494	9,168	3.6	95	479	5.0
Thirappane	2,275	13,721	6.0	12	66	5.5
Mihintale	1,281	6,809	5.3	111	602	5.4
Vavuniya	71	393	5.5	15	42	2.8
Vavuniya South	61	251	4.1	5	14	2.8
Vavuniya North	8	33	4.1	2	5	2.5

Cheddiculam	2	8	4.0	1	3	3.0
Total	15,249	62,972	4.1	1,124	3,187	2.8

Source: Resource Profiles

(c) Finger Millet

The project area is renowned for production of finger millet. However, the GN level data appears to be underestimated. The total area under the crop is stated as 333 ha and is cultivated almost exclusively during the Maha season as a rain-fed crop. The total annual production is shown as 529 t at an average yield of 1.6 t/ha.

(2) Other Field Crops (OFCs)

The available crop data for the project area shows that 19,600 ha are cultivated with OFCs during the Maha season and 4,460 ha during the Yala season. These include the grain legumes and condiments. However, the available records do not separate them out into specific areas of cultivation as to major or minor tank areas or whether they are raised as irrigated or rain-fed crops. It, therefore, presumed that the area covers the totality of GN area; and the entire extent of OFCs during the Maha season is cultivated under rain-fed conditions in the highlands while in the Yala season, it is grown under irrigated conditions in the parts of command areas and in lift irrigated areas in the highlands.

(a) Grain Legumes

The grain legumes cultivated in the project area include black gram, soybean, and cowpea green gram, of which land area under soybean and black gram has been more than 3,600 ha (73%). Productivity levels of all the legumes are comparable to those given in the National Food Production Programme 2016–2018 and crop enterprise budgets of DOA. It would appear that production of grain legumes is undertaken by farmers in the innovator and early adopter categories who are better placed to apply the recommended technologies and reap the full benefits.

(b) Condiments

Condiments include chilli, big onion, and red onions. GN level records include big onion and chilli. Production figures for chilli are given in terms of green chilli or dried chilli, and a common conversion rate of four to one was applied in presenting the production and yield data. The productivity of chilli and big onion falls far short of the figures quoted in National Food Production Programme 2016–2018 and crop enterprise budgets of DOA. The seasonal and annual crop production and yields of the crops under the three crop categories in the project area are shown in Table 3.8.4.

Table 3.8.4 Cropped Area, Production, and Yield of OFCs

Crop Category	Crop	Maha Season			Yala Season			Total Annual		
		Extent (ha)	Product (t)	Yield (t/ha)	Extent (ha)	Product (t)	Yield (t/ha)	Extent (ha)	Product (t)	Yield (t/ha)
Grain legumes	Green gram	433	534	1.23	76	148	1.94	509	682	1.34
	Black gram	1,655	2,427	1.46	26	102	3.92	1,681	2,529	1.50
	Soybean	527	1,890	3.58	1,398	3,792	2.71	1,925	5,682	2.95
	Cowpea	603	761	1.26	173	177	1.02	776	938	1.21
Coarse cereals	Maize	15,250	62,285	4.08	1,123	3,190	2.84	16,373	65,475	3.99
	Finger millet	331	527	1.59	2	2	1.00	333	529	1.59
Condiments	Chilli (green)	583	3,454	5.92	716	3,760	5.25	1,299	7,214	5.55
	Big onion	217	1,463	6.74	947	11,833	12.59	1,164	13,296	11.42
Total		19,599			4,461			24,060		

Source: Resource Profiles 2014/15

(3) Vegetables, Fruits, Root and Tuber Crops

Data on these three categories are not included in the GN level records in a consistent manner making it difficult to grasp either the extents or production levels. Except for a minor land extent under vegetables in the command area during the Yala season, all other crops are raised in lift irrigated and rain-fed areas.

Papaya and banana are cultivated in the highlands under lift irrigation and most other crops are confined to home gardens. There is a concerted effort to promote planting of fruit crops in the highlands as suitable conditions prevail for successful cultivation. Based on field observation and incomplete records, the crops grown in the project area are listed in Table 3.8.5.

Table 3.8.5 Crops Grown in the Project Area

Vegetables	Tomato, bitter gourd, snake gourd, luffa, pumpkin, cucumber, eggplant, okra, capsicum, and long bean
Fruits	Banana, papaya, wood-apple, orange, mango, pomegranate, cashew, guava, passion fruit, watermelon, and Jak
Root and tubers	Cassava and sweet potato

Source: JICA Project Team

3.8.3 Farm Input Supply

Following the liberalisation of the economy in 1977, the role of the government organisations and agencies in the supply of agricultural inputs gradually declined, allowing active involvement of the private sector. Consequently, private sector organisations have consolidated their position as the main suppliers while the government obligations are focused on the production of seeds and planting materials and regulatory functions.

(1) Seed and Planting Material

The National Seed Policy, approved in 1996, pursued the establishment of a viable seed industry; and for this purpose, the Seed Act No. 22 of 2003 was enacted. It sought to promote and supply good quality seed and planting material for economically important crops, maintain buffer stocks, implement seed security regulations, plant quarantine, and certification. The Seed and Planting Material Development Centre of DOA supplies basic seeds to seed producers, coordinates seed supply from government seed farms, and provides seed certification services.

(a) Sources of Seeds and Planting Materials

Farm level seeds and planting materials supply may originate from informal or formal supply sources. About 15%–20% of the farmers in the project area depend on informal supply sources for their seed paddy which is self-produced from their previous crops or are either borrowed or purchased from fellow farmers. The formal supply mechanism operates through DOA and other commercial seed producers. The seed supplied in the formal system are certified for genetic and physical purity as well as the germinability. The total annual seed paddy requirement of the project area is estimated to be about 5,000 tonnes.

With the exception of chilli and maize, nearly all OFC seeds are procured by farmers through the informal system. In the case of maize, hybrid varieties are predominant in the project area and the seeds are supplied to contract farmers by traders and private companies, the cost of which is deducted at the time of purchase of the produce. Vegetable seeds, on the other hand, originate mainly from formal supply system where all the exotic and hybrid seeds used by the farmers are imported by the private sector.

(b) Seed Production

Production of basic seeds of DOA-recommended varieties is carried out in the DOA seed production farms, while certified/standard seed production is undertaken by both public and private sectors. The DOA provides seeds to farmers in the project area from Mahailluppallama and Pelwehera seed farms which produce paddy and OFC/vegetable seeds, respectively. The seed farms also operate a system of contract farming for seed production under which seed farmers in Yakakka and Galenbindunuwewa DS Divisions in Anuradhapura cultivated 8 ha of cowpea in 2015.

The seed farm located in Vavuniya produces a variety of seeds and planting materials which includes paddy, fruits, and vegetables. The main items produced in 2015 were seed paddy (26 mt), and seedlings of chilli (67,000), eggplant (51,000), papaya (23,000), tomato (30,000), and capsicum (9,000).

The provincial DOA of Anuradhapura and Vavuniya has been promoting informal production of seed paddy among farmers. During the 2015 Maha season, 97 farmers in the project area cultivated 38 ha (0.4 ha each) to produce the target 155 tonnes of DOA certified seed paddy. In addition, two-kilogram packs of seed paddy were distributed among farmers for self-production of seeds for the next season.

(c) Seed Delivery

The government seed farms do not operate a dealer network and the farmers are required to procure their seed paddy requirements directly from the farm. The maximum quantity of seed paddy that can be purchased from the farm is limited to 40 kg. The private seed producers have their dealer networks and it includes the agrarian service centres (ASCs).

(2) Fertiliser

The Government of Sri Lanka (GoSL) introduced the national agriculture policy in 1995, focused on the following aspects:

1. Promote production and utilisation of organic manure and bio-fertilisers, and gradually reduce the use of chemical fertilisers through integrated plant nutrition systems (IPNS);

2. Ensure timely availability of chemical fertilisers in significant quantities, while providing soil and plant testing facilities for their rational use through site specific fertiliser application;

3. Promote application of straight fertilisers; and

4. Promote manufacturing fertilisers using locally available raw materials.

The fertiliser subsidy scheme, introduced in 2005, continued until the end of 2015 when it was replaced by a new system from Yala in 2016. Under the previous system, fertilisers were supplied through ASCs of the Department of Agrarian Development (DAD) on highly subsidised rate up to 2 ha of paddy lands based on the recommendations of Rice Research Institute of DOA.

The subsidy given for other crops grown in paddy fields was based on the recommendation given to rice crop under rain-fed conditions and were priced at LKR 350 per 50 kg pack. For highland crops, straight fertilisers were sold at LKR 1,200 per 50 kg pack and were made available through private dealers. Accordingly, the quantities of fertilisers issued under the subsidy scheme are shown in Table 3.8.6.

Table 3.8.6 Fertilisers Supplied Under the Subsidy Scheme (2015)

Anuradhapura District				Vavuniya District			
DS Division	**Urea (mt)**	**T.S.P (mt)**	**M.O.P (mt)**	**DS Division**	**Urea (mt)**	**T.S.P (mt)**	**M.O.P (mt)**
Mihintale	904	227	252	Vavuniya	1,647	480	537
Kebithigollewa	1,426	293	291	Vavuniya South	891	216	276
Medawachchiya	1,824	452	500	Vavuniya North	711	177	197
Rambewa	2,240	524	614				
Kahatagasdigiliya	2,084	567	619				
Horowpathana	2,379	482	479				
Thirappane	1,209	305	325				
Galenbindunawewa	2,690	647	725				
	14,756	3,497	3,805		3,249	873	1,010

Source: Fertiliser Secretariat (Anuradhapura and Vavuniya)

Under the new subsidy scheme, farmers are provided with LKR 25,000 per season per hectare up to a maximum of 2 ha for cultivation of paddy and/or other seasonal crops. Farmers could purchase urea, triple superphosphate (TSP), and muriate of potash (MOP) form the respective ASCs or private dealers at a maximum price of LKR 2,500 per 50 kg bag.

(3) Plant Protection Products and Marketing

The Control of Pesticide Act No. 33 of 1980 and Control of Pesticide (Amendment) Act 1994 were enacted to regulate the imports, packing, labelling, storage, formulation, transport, sale, and their use in the country. Registrar of pesticide of the DOA is the licensing authority of pesticides.

(a) Pesticide Use

Recent farmer surveys in the Vavuniya District reveal that majority of the farmers (60%) apply their own past experience in the selection of pesticides to use for controlling pests in their crops. Twenty-three percent of the farmers sought advice from fellow farmers while 7% depended on the recommendation of pesticide dealers. Only 10% of the farmers resorted to obtain guidance from extension personnel. The trend appears to be similar in the project area of Anuradhapura as well.

(b) Pesticide Marketing

Private sector distribution system of pesticides is well established and there is a smooth flow of material from the importer through the dealer network to the farmers. Pesticide dealers (owner and/or assistant) are required to register themselves with DOA, following a one year part-time course conducted by DOA. Pesticides are made available to farmers through private dealers operating in all the ASC areas in the project area.

(c) Farm Machinery

Nearly all field operations in paddy cultivation are mechanised except for bund making and cleaning. Four-wheeled or Two-wheeled tractors, 42% and 58% respectively, are used exclusively for plowing by farmers and use of draft animals have disappeared completely. Combine harvesters are used by 88% of the farmers while the balance resort to reapers coupled with two-wheeled tractors or manual harvesting. Thresher machines are used for grain separation. There is no serious shortage of machinery for field operations at present.

(4) Agricultural Credit

(a) New Comprehensive Rural Credit Scheme (NCRCS) of the Central Bank

Agricultural credit plays a crucial role in facilitating farmers in purchasing production inputs. ‘Sarusara’ or New Comprehensive Rural Credit Scheme (NCRCS) operated by the Central Bank through public banks has disbursed the highest amount of agricultural loans to farmers in Anuradhapura District amounting to 19% of the total in 2015. The repayment period for loans is 70 days and at an annual interest rate of 7%. A mutual collateral among three farmers and the deed of the farm land (not as a mortgage) are required by the lending bank for granting of the loan. The loan structure of the NCRCS is shown in Table 3.8.7.

Table 3.8.7 Land Extents and Loan Amounts Under NCRCS

Crop	Min. Land Extent (ac)	Max. Land Extent (ac)	Loan Amt. (LKR/ac)
Paddy irrigated	0.250	10	30,000
Paddy rain-fed	0.250	10	32,000
Maize	0.125	10	34,000
Finger millet	0.125	10	19,000
Chilli	0.125	02	88,000
Big onion	0.125	02	140,000
Cowpea/black gram	0.125	05	21,000
Green gram	0.125	05	27,000
Soybean	0.125	05	22,000
Eggplant	0.125	05	60,000
Capsicum	0.125	05	112,000

Source: Central Bank Report (2015)

(b) Govi Shakthi Scheme of Bank of Ceylon

The scheme operated by the Bank of Ceylon grants loans for construction of traditional paddy storage structure (LKR 10,000) and for purchase of farm equipment and equipment at two levels of up to LKR 500,000 and up to LKR 1.5 million. Loan recovery period of five years and an interest rate of 10% is applicable. Similar schemes are also operated by other private and public banks as well.

(c) Agrarian Banks (Govijana Banks) of DAD

Agrarian Banks of the DAD, established as a pilot project under the sponsorship of Ministry of Agriculture in 1998, aims to fulfil loan requirements and promote savings of farmers whose main income source is based on agriculture. The operations come under the purview of the Commissioner General of DAD and administered through the Deputy/Assistant Commissioners at district level and the

Divisional Officers at the ASC level. The banks functions from nearly all ASCs in the target area and several loan schemes are implemented which cover agriculture, harvesting, crop protection, agricultural machinery, special projects, home gardening, farmer pension and packing materials.

(d) Loan Administration

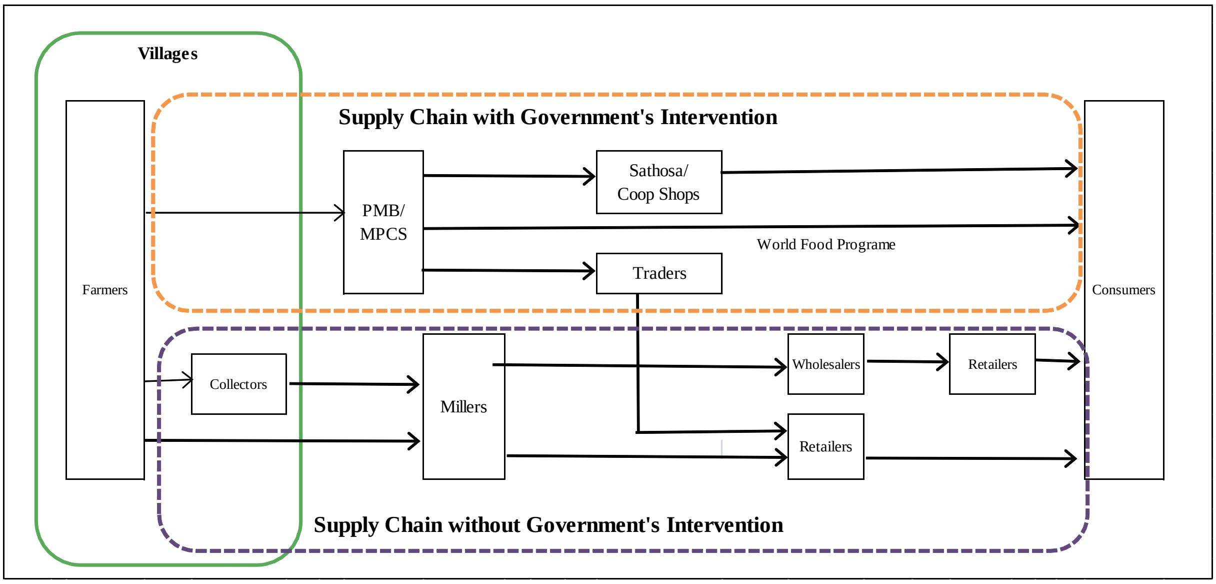
Credit worthiness of the farmers in general is low because of the increasing trend in the default ratio. Of the agricultural loans disbursed recipients in Anuradhapura district through participating lending agencies under the CSRCS in 2016, 50 % remains as non-performing loans. Crop failure due to adverse weather conditions over the past seasons may have contributed to this situation.

The performance of the Agrarian Banks tended to be inconsistent. The fund availability for disbursement and the number of loan beneficiaries varied widely among the ASCs. The loan administration is generally assigned to an ARPA attached to the ASC, but the required resource base for handling large numbers of loan seekers for a wide range of crops are lacking at the ASC level.

3.8.4 Agriculture Logistics and Marketing

(1) Overview: Supply Chain of Major Crops

Figure 3.8.1 shows the supply chain of key crops in the target area. The supply chain of food crops is divided into two main channels: paddy/rice and the others. The GoSL directly intervenes with the paddy/rice market by setting a guaranteed price. Paddy Marketing Board (PMB) or Multi-Purpose Cooperative Society (MPCS) purchases paddy directly from farmers at a guaranteed price.



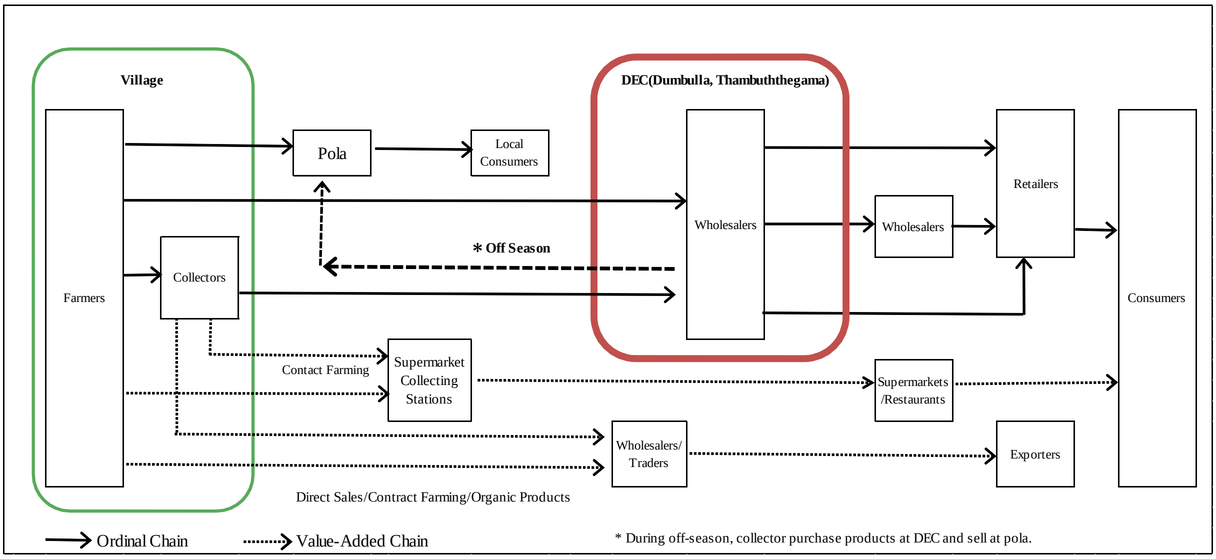
Source: JICA Project Team

Figure 3.8.1 Supply Chain of Paddy/Rice

The supply chain of the other crops including OFC, vegetables, and fruits without intensive government's intervention, is divided into two categories: an ordinal, domestic chain and a newly emerged, value-added chain (Figure 3.8.2). Boutiques are the smallest conventional marketing system at the village level where farmers sell their surplus to neighbours in his/her community or on roadside. Pola, a weekly market or village fair, is a key nexus where farmers or collectors directly transact with nearby consumers in a production area. The dedicated economic centre (DEC), a public wholesale market, is another key arena where farmers or collectors transact their produce with a broader range of distributors. Out of the 13 DECs, Thambuththegama DEC (in Anuradhapura District, North Central Province (NCP)) and Dumbulla DEC (in Matale District, Central Province) are accessible from the target area. In particular, the Dumbulla DEC is located at the centre of the country and functions as a central nexus of produce from all over the nation.

In the value-added chain, private retailers, typically major supermarket franchises such as Cargill Food City or APRICO, play a new and influential role in purchasing crops directly from farmers or collectors at its own collecting stations. Private wholesalers or traders (exporters) purchase produce, especially for feed crops and organic fruits, directly from farmers.

The next section describes the detailed marketing situation of each crop.



Note: Boutiques are not described on the figure, since it is more conventional or informal transaction in a community level.
Source: JICA Project Team

Figure 3.8.2 Supply Chain of Other Food Crops

(2) Paddy/Rice

(a) High Self-sufficient Rate with Government's Market Intervention

The rice self-sufficiency rate in Sri Lanka reached 90% in the early 1980s, and since then has remained above 80%. Despite this achievement, the GoSL continuously protects rice farmers through market intervention and a package of production subsidy. The PMB, as a key player in market intervention, purchases 2,000 kg of paddy per farmer every harvesting season at a guaranteed price. The MPCS also purchases paddy directly from farmers at the guaranteed price. The MPCS, however, changes its volume of paddy to be purchased every year, following the governmental budget and mandate. In 2014/2015, the MPCS was not allowed to purchase a single paddy in the Anuradhapura District. The MPCS, according to one of its officers, functions as a supplement purchasing body when stock of paddy at the PMB are in excess. The guaranteed price is determined annually by the cabinet, and the recent prices show higher figures (Table 3.8.8). With such governmental support, farmers prefer to cultivate paddy during Maha rain season as well as Yala season if water is available (Table 3.8.9), which results in high dependency on paddy cultivation and delay in crop diversification

Table 3.8.8 Comparison of Market and Guaranteed Prices in 2014 and 2015

	Ordinal Market 2014		Guaranteed Price 2014		Ordinal Market 2015		Guaranteed Price 2015	
Harvest Season	**Short**	**Long**	**Short**	**Long**	**Short**	**Long**	**Short**	**Long**
February	36	33.63	45	35	36.75	32.88	45	50
August	40.75	39.75	45	35	40.47	28.59	45	50
Average	38.375	36.69	45	35	38.61	30.735	45	50

Source: Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI)

Table 3.8.9 ASC-wise Cultivated Crops in Maha and Yala

	Maha Season		Yala Season	
District (No. of ASC*)	**Paddy**	**OFC**	**Paddy**	**OFC**
Anuradhapura District (14 ASCs)	14	11	6	5
Vavuniya District (6 ASCs)	6	1	14	3

**JICA Project Team interviewed 14 ASCs in Anuradhapura District and 6 ASCs in Vavuniya District.*
Source: JICA Project Team

(b) Lower Farm-gate Price at Harvest Season

Although the guaranteed price secures 2,000 kg paddy/season, farmers have to bear a lower price during, February and August harvesting seasons. According to the Institute of Post-Harvest Technology (IPHT), typically, small-scale farmers store approximately 30% or 590 kg for self-consumption after selling to the PMB and thereupon sell 70% or 2,350 kg paddy to millers (or via collectors) immediately after harvesting at the lowest price of the year, to pay for their production cost.

(c) Lack of Quality Control Yet High Value Varieties are Popular

In 1984, the Sri Lanka Standard Institute introduced a grading system for rice (i.e. SLSI grading system) with four grades for raw rice (Table 3.8.10). Recent study shows that in 2012, only 11% of raw rice available in the local market are of export quality (Premium and Grade-1 in SLSI grading system). Supposing that the country aims to export rice, therefore, all stages of production, post-harvest, and storage need to be significantly improved.

Table 3.8.10 Sri Lanka Standard for Raw Milled Rice

Characteristics	Premium	Grade-1	Grade-2	Grade-3
Moisture (% by mass, max)	14.0	14.0	14.0	14.0
Foreign matters (% by mass, max)	0.2	0.5	1.0	1.5
Type mixtures (% by mass, max)	Nil	2.0	6.0	10.0
Damaged grains (% by mass, max)	Nil	1.0	2.0	4.0
Broken grains (%by mass, max)	10.0	20.0	35.0	45.0
Paddy seeds (grains/kg)	Nil	10.0	30.0	50.0

Source: K.B. Palipane "Milling and quality improvement in rice "(IPHT)

While certain improved varieties occupy majority of the paddy land in the country, such as Bg352 (covering 19.3% of total land distribution), Bg 300 (11.5 %), At 358 (11.5 %), and 362 (11.3 %), recently, traditional varieties like the Pachchaperumal and Suwandel are being demanded in the urban market typically among health-conscious consumers, and sold at a higher price.

(d) Summary of Paddy/Rice Marketing

Table 3.8.11 summarises key facts and the potential of paddy/rice marketing in Sri Lanka. Assuming that the paddy/rice market of the country has already passed the stage of self-sufficiency, the next stage is to improve the efficiency of domestic distribution in order to enhance food security in the country.

Off-season sales contribute to the efficiency of domestic distribution as well as increase farmer's gate price since it fulfils the rice-shortage period. Improvement in storage management is also a key.

Apart from food security, high-valued paddy, such as traditional varieties, enables farmers to increase their profits without an increase in total production of paddy since those varieties normally have longer production time with less yield.

Table 3.8.11 Key Facts and Possible Solutions in Paddy/Rice Marketing

Key Facts	Possible Solutions
・ High self-sufficiency rate (>80%) ・ Intensive market intervention by the government ・ Lower farm-gate price during harvesting seasons ・ Lack of quality control ・ High demand of traditional varieties among those who consider health and environmental conservation	・ Encourage off-season sale to overcome lower prices during harvesting seasons ・ Introduce high-value varieties for high-end consumers

Source: JICA Project Team

(3) Other Field Crops

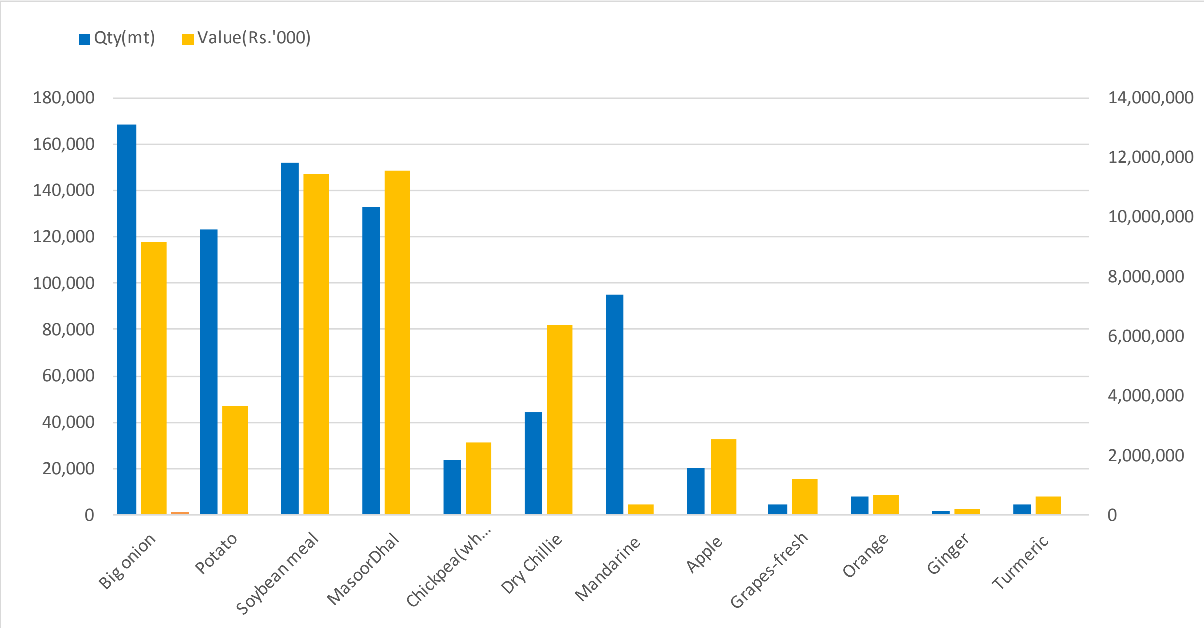
(a) Lack of Domestic Production

Sri Lanka spent approximately LKR 50.2 billion for importation of food items in 2013, despite the fact that major import substitutions such as grain legumes (millet, green gram, black gram, soybean, cowpea), and condiments (big onion, chillies) and oil seed can be produced locally. However, to enhance not only the food security of the nation but also income generation of the target farmers, there has been recent appeal to increase the local production of these "imported" crops.

In particular, a few traders semi-monopolises the market of grain legumes and supply the import substations to DEC and other wholesale markets. Producers need to access the established market in order to ride on the channels until the market is more privatised to small-scales.

In the case of condiments and oil seed, on the other hand, local supply shows a serious shortage during off-season, which in turn cause the prices of those crops to skyrocket. The price advantage needs to be well considered in selecting a variety and deciding the timing of harvest.

For durable OFCs, including maize and soybean, proper post-harvest management, i.e. drying, package, and storing, enables farmers to sell off-season sales.



Source: Food and Agriculture Organisation of the United Nations Statistics Division (FAOSTAT)

Figure 3.8.3 Importation of Crops in 2013

(b) Increase in Contract Farming of Feed Crops but Necessity in a Proper Regulation

Recently, contract farming of some OFCs, especially maize has increased. The CIC Agri-business, a seed and fertiliser company, for example, sets up 20 collecting stations and annually purchases 2,500 mt maize for animal feed through contract farming, only in Anuradhapura District. The annual price is negotiated prior to cultivation, and extension officers provide inputs and training to the contracted farmers.

While the newly emerged contract farming has potential to expand farmers' marketing channels, the contract can cause troubles. For instance, a CIC officer complained that in many cases products do not meet the required quality for the feed processing. The DOA officers in Vauniya District also mentioned that there are a number of rifts between farmers and buyers in contract farming mainly due to prices. Typically, farmers refuse to sell their produce to contracted buyers when market price during a harvest season is higher than that of the contracted price.

(c) Summary of OFC's Marketing

Table 3.8.12 summarises key facts and potential of other field crops' marketing. Most OFCs are currently imported. However, it is highly recommended to be produced domestically in order to reduce the expense of foreign exchange. Grain legumes can be a target to make a linkage with major grain traders since the market is already structured. Condiments and oil seed, on the other hand, functions well in ordinal markets, from farmers to DEC (via collectors). Farmers, therefore, can increase their production and sell ordinal channels. Finally, feed crops such as soybean, millet, and maize have specific channels through large-scale processors such as CIC Agribusiness. It is therefore advantageous for farmers to have a network or contract with those buyers. The government backups the promotion through developing a regulatory system of contracts.

Table 3.8.12 Key Facts and Possible Solutions in OFC Marketing

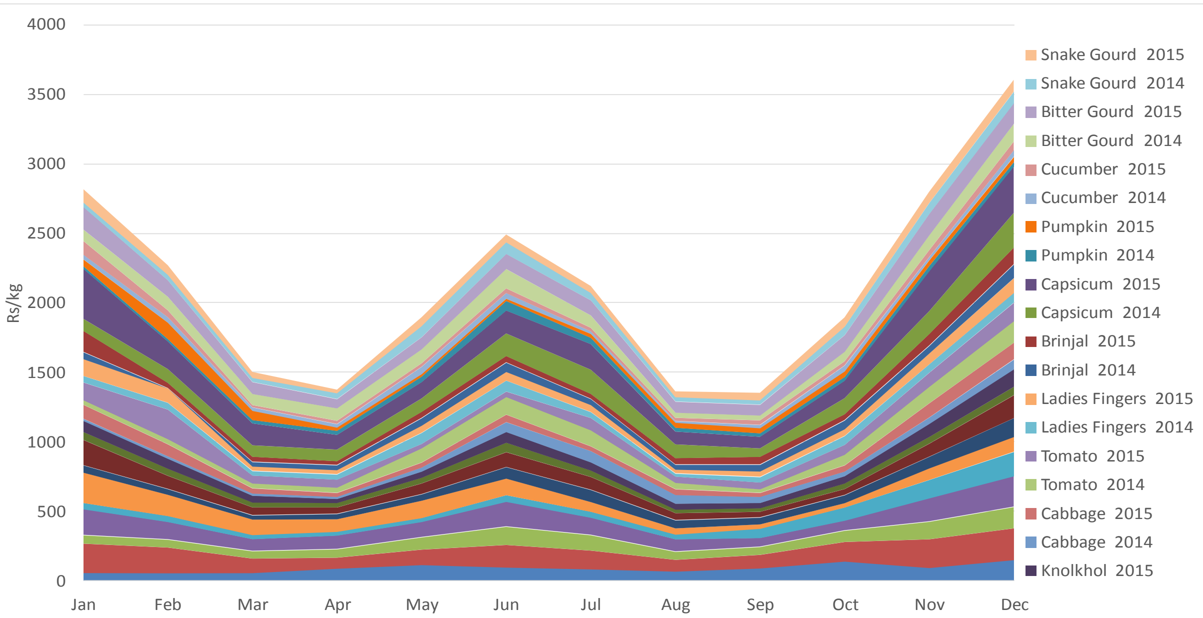
Key Facts	Possible Solutions
・ Lack of domestic production ・ Monopolised supply of grain legumes ・ Increase in contract farming of feed crops and necessity in a proper regulation	・ For grain legumes, establish linkage of farmers and major buyers (food trading company) ・ For condiments and oil seed, increase production and provide post-harvest training for farmers ・ For feed crops, make a linkage of farmers and buyers for contract farming and develop regulatory system of contracts/agreements

Source: JICA Project Team

(4) Vegetables

(a) Clear Price Seasonality

Prices of vegetables in Sri Lanka show clear seasonality. As Figure 3.8.4 indicates, wholesale prices of most vegetables drop during two high seasons, namely March-April and August-September. On the contrary, the local market faces a lack of supply and the prices of vegetables skyrocket during off-seasons between October and February, and between May and July. In the case of Rambewa Pola (a weekly rural market) located in the Northeastern Anuradhapura District, most vegetables including those exported are not carried from this local area, but from Dumbulla, Thanbhuththegama, Kandy, and even Colombo during off-seasons and the price of those vegetables are by far higher. The survey in the project site indicates that most farmers who harvest vegetables during Yala season, between June and August, sell them at DEC, not at Pola (Table 3.8.13). In other words, rural consumers at production areas pay the transaction cost of long distance distribution.



Source: HARTI

Figure 3.8.4 Wholesale Price of Key Vegetables in 2014 and 2015

Table 3.8.13 Selling Routes of Vegetables in the Project Area

District（Number of Answers）	Directly to DEC	DEC via Collectors	Traders
Anuradhapura（16）	12	2	0
Vavyunia（6）	1	2	1

Note: Surveyed at 14 ASCs in Anuradhapura District and 6 ASCs in Vavuniya District
Source: JICA Project Team

(b) High Valued Chain by Supermarkets

Apart from the ordinal market, supermarket franchises create a higher value channel for farmers. Unlike OFCs, they normally do not contract with producers. Instead, they establish a network of farmers. For instance, Cargills Food City, a supermarket franchise run by Cargills (Ceylon) PLC, set ten collecting stations in major production areas and its extension officers at each station provide an ID code called "Traceability ID" to those who are willing to participate in Cargills' network. Prior to bringing their produce to a collecting centre, farmers communicate with the officer in order to confirm the demand and prices, normally LKR 15/kg higher than the market price. Both Cargills and farmers have no obligation to transact with them. Farmers show their products and sell them to DECs or other wholesale markets if Cargill refuses to purchase them or farmers find a better price elsewhere.

(c) Low Quality Awareness and Potential of Value Added Market

Awareness of the quality standards of fresh vegetables is still limited. One of the largest supermarket chain, Cargill Food City, has its own quality standard of vegetables including size, shape, and colour, but not pesticide residue and taste (sweetness, sourness, and ripeness). Supermarkets are mainly concerned with transportation damage or loss as mentioned in 3.8.5(3)(c). Proper post-harvest training can improve the quality of the produce and guide farmers to match market preference.

(d) Summary of Vegetable Marketing

Table 3.8.14 summarises key facts and possible solutions in vegetable marketing. In the ordinal chain, current vegetable market indicates that farmers are able to take price advantage in off-season sales. Off-season sales also benefit rural consumers who otherwise pay the transaction cost of a long distance chain. Ambitious farmers can challenge these prices at high valued markets through supermarket chains, for instance. The future programme support will link willing farmers and buyers at high-end markets in order to upgrade the quality of the vegetable market.

Furthermore, the partnership between hotels/restaurants and farmers has high potential. In particular, Anuradhapura is one of the major touristic areas that has a number of historical heritages. To maximise the locational advantage, producers and hotels can mutually develop the qualified food-chain in order to enhance not only both parties' profits but also its regional development.

Table 3.8.14 Summary of Key Facts and Possible Solutions in Vegetable Marketing

Key Facts	Possible Solutions
・ Clear price seasonality ・ Low awareness of quality ・ Potential in value added markets	・ Encourage off-season production and sale ・ Linkage of farmers and buyers (supermarkets) ・ Partnership between hotel industries and producers and create a high-valued chain and enhance the regional tourism

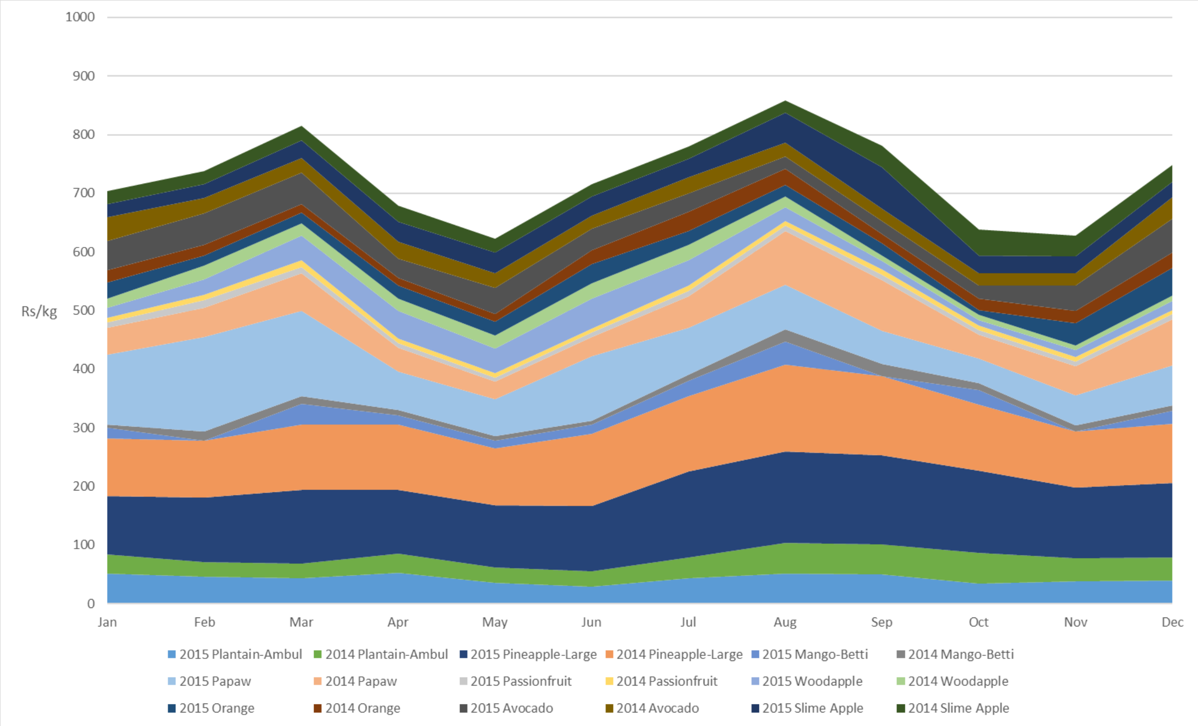
Source: JICA Project Team

(5) Fruits

(a) Clear Price Seasonality and Necessity of Increase in Domestic Production

Fruits and vegetables have a similar marketing structure. The price of fruits fluctuates seasonally (Figure 3.8.5). The supply chain also shapes a similar route from farmers to Pola or DEC (via collectors) as the ordinal chain, and farmers or collectors to supermarket or wholesalers as a value added chain.

Moreover, the government promotes production of fruits through the Food Production National Programme (2016-2018). The programme aims to increase its intake up to 200 g per capita per day, against current intake at 100 g per capita per day ("Food Production National Programme 2016-2018" Presidential Task Force on National Food Production). Under these conditions, domestic production of fruits can be encouraged with the consideration of price seasonality.



Source: HARTI

Figure 3.8.5 Wholesale Price of Key Fruits in 2014 and 2015

(b) Potential for Export

In Sri Lanka, some fruits are exported mainly for Middle East and European Union (EU) countries. For Middle Eastern countries, mango, papaya, and pineapple are major produces, while banana and mango goes to EU countries (Table 3.8.15). At present, the exporting countries are mostly where Sri Lanka expatriates.

Table 3.8.15 Exports of Fresh Fruits in 2012/2013

	2012			2013		
Crop	Quantity (mt)	Value (LKR in thousands)	Free On Board (FOB) Price (LKR/kg)	Quantity (mt)	Value (LKR in thousands)	FOB Price (LKR/kg)
Banana	14,415	687,949	47.72	19,358	1,062,855	54.91
Papaya	1,187	98,922	83.33	1644	150,352	91
Pineapple	346	48,586	140.42	1,270	208,370	164
Orange	207	31,589	152.60	12	1,251	104.25
Cashew nuts	145	170,240	1,174.06	50	76,866	1537.32
Guava	95	15,046	158.37	18	2,888	160.44
Strawberries	73	35,972	492.76	67	48	717.42
Lemon	48	4,187	87.22	282	19,564	69.38

Source: Socio Economic and Planning Centre -DOA

In addition, the market of organic fruits for exports has functioned as a niche market, creating a value added market in Sri Lanka since 1980s. Organic agri-business has two types: plantation companies and companies that organise small farmer groups. Plantation companies, based in Colombo or plantation areas, export tea and spices while the other companies organise small-scale farmers to export tropical fruits to EU countries. For instance, in Anuradhapura, Tropical Health Food (Pvt) Ltd. and Lanka Organics (Pvt) Ltd. organise small-scale farmers to gain a group organic certificate (Development of Organic Farming and Its Mechanism in Sri Lanka, Kohmoto Daichi, 2006). In Vavuniya District, a company called PODIE Spices organises small farmers and assists them to gain a group certification of organic products.

(c) Summary of Fruits Marketing

Fruits marketing can target both ordinal and value-added chain. For the ordinal chain, domestic production is encouraged to increase in order to meet future demand growth in a mid to long-term range. For the value-added market, on the other hand, export and organic products for export can be scoped. Furthermore, a new value-added chain for vegetables can be increased through the tie-up of hotels/restaurants and farmers has high potential.

Table 3.8.16 Key Facts and Possible Solutions in Fruits Marketing

Key Facts	Possible Solutions
・ Clear price seasonality ・ Promotion of fruits consumption by the government ・ Potential in value added markets (supermarket, export, organic, and hotels)	・ Encourage production in order to fulfil future demand increase ・ Make a linkage of farmers and buyers, in particular organic products for export ・ Partnership between hotel industries and producers and create a high-valued chain and enhance the regional tourism

Source: JICA Project Team

3.8.5 Post Harvest

(1) Paddy/Rice

(a) High Post-harvest Loss During Storage

Improvement of on-farm, small-scale and medium-scale storage techniques, and facilities is extremely important both in terms of rice quality improvement and post-harvest losses. A study conducted by IPHT shows that about 5% of the total paddy production stored by farmers and 3% at commercial level storage are lost due to inferior storage conditions. Clearly, the lack of proper storage facilities and adoption of improper storage techniques by farmers, processors, and traders are leading to qualitative and quantitative losses.

(b) Low Quality of Milling

The rice mills in the country can be categorised mainly into two forms, namely custom and commercial mills. The custom mills are small-scale mills located in villages that farmers hire to mill paddy for their self-consumption. The commercial mills, on the other hand, mill paddy purchased from the farmers and thereafter, sell the rice in the open market. The commercial level mills can be further categorised into three levels according to their scale of production: small-scale, medium-scale, and large-scale.

The low quality paddy used for milling is one of the reasons why the quality of rice is low. Very often, rice millers purchase low quality paddy and when it is milled, the quality of rice (discolouration, bad odour, and breakage) evidently becomes low. Furthermore, farmers are also compelled to sell their produce soon after harvesting without drying and proper cleaning at a cheaper price at the farm itself to pay for the cost of production.

Table 3.8.17 Rice Mills in DS Divisions in Anuradhapura District (Tentative)

DS Division	Custom Mills (<1,000 kg/day)	Small-scale Mills (1,000-5,000 kg/day)	Medium-scale Mills (5,000-25,000 kg/day)	Large-scale Mills (>25,000 kg/day)
Medawachchiya	111	1	0	0
Horowpothana	69	7	10	0
Galenbindunuwewa	7	0	0	0
Kahatagasdigiliya	NA	NA	NA	NA
Kebithigollewa	41	6	0	0
Mihinthale	44	0	0	0
Rambewa	80	1	0	0
Thirappane	67	5	0	0

Source: Resource profile Anuradhapura -2014 and planning divisions of DS offices.

Table 3.8.18 Summary of Key Facts and Possible Solution in Paddy/Rice Processing

Key Facts	Possible Solutions
・ High post-harvest losses ・ Poor quality of paddy used for milling ・ Insufficient post-harvesting of farmers	・ Awareness, motivation, and training for farmers, collectors, and processors. ・ Increase in availability of credit facilities and other incentives such as importation of milling machinery and equipment

Source: JICA Project Team

(2) Other Field Crops (OFCs)

Due to the difficulties faced by farmers in storing produce, farmers opt to sell their produce shortly after harvest instead. As such, actual problems regarding the storage of pulses and maize were not observed during this survey although IPHT and the Farm Machinery Research Centre of DOA have developed several small-scale machineries for the value addition of other field crops at domestic level.

Table 3.8.19 Summary of Key Facts and Possible Solution in OFC

Key facts	Possible Solutions
・ Lack of storage facilities ・ Lack of grading system	・ Development of indices for grading ・ Promotion of value added products

Source: JICA Project Team

(3) Vegetables and Fruits

(a) High Post-harvest Losses

A considerable volume of fruits and vegetables produced in the area go to waste throughout the handling chain, where the level of waste vary between 20%-46%.

Table 3.8.20 Post-Harvest Losses of Fruits and Vegetables Throughout the Handling Chain

Crop	Post-harvest Loss (%)				
	Producer	Collector	Wholesaler	Retailer	Total
Fruits					
Banana	2	4	8	6	20
Papaya	6	10	20	10	46
Pineapple	2	4	8	4	18
Lime	4	8	16	12	40
Avocado	2	12	5	22	41
Vegetables					
Beans	4	6	13	7	30
Carrot	3	6	12	4	25
Leeks	5	6	12	7	30
Cabbage	4	7	9	5	25
Tomato	5	10	15	10	40
Okra	3	10	13	20	46
Egg plant	2	5	6	7	20
Capsicum	6	7	10	12	35

Source: Food Research Unit, DOA, Peradeniya

(b) Improper Harvesting Stage

The timing of harvesting fruit and vegetables, when it is at proper maturity, is important in reducing the post-harvest losses and improving sale price. Through training and extension, proper determination of maturity for each fruit and vegetable can enhance the knowledge and skills of farmers; thus, avoiding over ripened or immature produce.

Through training and extension, maturity indices for some fruits and vegetables as determined by IPHT and Industrial Technology Institute (ITI) in Sri Lanka are presented in Table 3.8.21.

Table 3.8.21 Main Induces for Fruits and Vegetables

Crop	Maturity Index	Remarks
Fruits		
Mango	・ Shape of the fruit ・ Fruit colour ・ Outer cover appearance ・ Flow rate of milk in the fruit	・ Shoulders move up ・ Changes from green to yellow ・ Gloss disappears ・ Reduced
Guava	・ Fruit colour	・ From dark green to light green
Banana	・ Fruit shape	・ Lines around the fruit disappears and fruit become plump
Vegetables		
Tomato	・ Colour of the fruit size ・ Size	・ Green to light pink ・ Fully developed
Cucumber	・ Formation of the fruit ・ Size and colour of the fruit	・ Well formed ・ Medium size and dark green
Okura	・ Tenderness and the size of the pod	・ Young tender pods

Source: IPHT (Anuradhapura)

(c) Improper Transportation

The study of IPHT states that post-harvest process indicated that around 75% of total post-harvest losses occur during transportation. The main causes of post-harvest losses in transportation are as follows:

- Transportation in poly sack bags,
- Tight packing and over loading,
- Compression damage during stacking, and
- Heat build-up during transportation and rough handling in loading and unloading.

The Ministry of Cooperatives and Internal Trade (currently, Ministry of Rural Economic Affairs) enforced in 2011 a regulation to use plastic crates in transportation of fruits and vegetables with the purpose of reducing the post-harvest losses. Nevertheless, it has been unsuccessful due to the protests of the farmers and traders who claim that the proposed system has many disadvantages for them. However, the collecting centres of the supermarkets use plastic crates for transporting fruits and vegetables.
Storage facilities for vegetables and fruits are not available in the project area and in the Dambulla DEC.

Table 3.8.22 Summary of Key Facts and Possible Solution in Fruits and Vegetable

Key Facts	Possible Solutions
・ High post-harvest losses : Improper harvesting stage : Improper transportation	・ Awareness, motivation, and training for stakeholders for appropriate harvest and post-harvest techniques ・ Development of quality standards ・ Establishment of village level centres for sorting, grading, and packing in specific areas of production ・ Encourage private sector to invest on storage facilities with cold storage

Source: JICA Project Team

3.8.6 Agriculture Processing

Secondary processing of agricultural products is traditionally carried at a village level as dried foods, powdered spices, legumes, and cereal flour. With this background, the IPHT has developed technologies to create added-value to rice and other legumes based products such as rice noodles and rice ice cream in a small-scale. However, this kind of secondary processing or other value added products is not observed in the project area.

Besides, some small-scale processing businesses have emerged lately. For instance, Dasini Dehydration Centre is one of a few places where locally produced fruits and vegetable are processed. It is located in Pubudupura, Anuradhapura and mainly engages in dehydrating fruits and vegetables collected from 50 contacted farmers. The dehydrated products are supplied to private companies who use them as raw materials for their products such as medicine or herbal tea. For instance, dehydrated drumstick leaves are bought by a leading company to make capsules. The prices given to farmers are always higher than that of in the prevailing market.

As another example, Mahaweli Authority of Sri Lanka has initiated a programme for farmers' organisations to get involved in business activities. Under this programme, a farmers' organisation is running a sales outlet in Thambuttegama Town. In this outlet, fresh fruit juice and farmer produce such as indigenous rice are sold.

Left: Dasini Dehydration center

Above: Juice Stand run by Famer's Organization iin Thambuttegama Town.

Source: JICA Project Team

However, most processing business are taken over by middle-scale, or large-scale private companies which also export their processed products (Table 3.8.23).

Table 3.8.23 Agro-based Processing Companies for Exports in Sri Lanka (2016)

Type of Processed Product	No. of Companies
Fresh fruits and vegetables	21
Dried fruits and vegetables	16
Fruit juice and cordials	01
Jam and jellies	02
Pickles	13
Fruit pulps	01
Canned fruits and vegetables	11

Source: Global Suppliers on line & Export Development Board

Table 3.8.24 Summary of Key Facts and Possible Solution in Agriculture Processing

Key Facts	Possible Solutions
･ Lack of processed products promotion ･ Emergence of small-scale agri-businesses ･ Major processors are middle-scale and large-scale export enterprises	･ Encourage farmers level of processing ･ Make a linkage with major processors

Source: JICA Project Team

3.8.7 Market Facilities

(1) Storage Facilities

Like the rest of the country, the lack of storage facilities especially for paddy has been a major problem encountered by the farmers in the project area. Paddy farmers are unable to sell their produce at a reasonable price due to this limitation. The storage facilities available at the PMB is not adequate to cater to all the purchases from farmers

Table 3.8.25 The storage facilities available with Paddy Marketing Board(PMB)

D.S.Division	No.of Warehouses	Storage Capacity (Mt)
Anuradhapura District		
Galenbindunawewa	1	1000
Horowpothana	2	1000, 2000
Kahatagasdigiliya	1	1000
Kebithigollewa	1	1000
Medawachchiya	1	2000
Mihinthale	0	0
Rambewa	1	1200
Thirappane	0	0
Vavuniya District		
Vavuniya	3	2000, 1000, 1000
Vavuniya (South)	1	1045
Vavuniya (North)	1	1045

Source: Paddy Marketing Board Anuradhapura and Kilinochichi

(2) Market Places

The weekly market or ‘Pola’ is the traditional market place for selling agricultural produce of farmers. It has a pivotal role in circulating rural sector products within the village areas as well as close by urban areas. Since the opening of the Sri Lankan economy in 1977 and the the opening up of areas into urban sector, expansion of transport services and mobility, the marketing system was changed in favour of outside products rather than rural produce. As a result, it can be observed that most of the agricultural produces sold at the Pola are from outside of the local areas, especially during off-season. In many of the Polas the majority of the traders sell vegetables, fruits, grains bought either from Dambulla or Thambuttegama Dedicated Economic centers. Moreover farmers in the villages and the collectors also are compelled to sell their produce in these DEC even though they are located far away from the village.

Table 3.8.26 Village fairs (Pola) in Anuradhapura

DS Division	GN.Division (GN Code)	Location	Conducting day	No.of Traders
Horowpothana	Horowpothana (128)	Horowpothana Town	Saturday	300
Thirappane	Kada Weediya ,Thirappane (532)	Thirappane Town	Wednesday	13
Kahatagasdigiliya	Kahatagasdigiliya -West (232)	Kahatagasdigiliya Town	Monday	300-350
Kebithigollewa	Kebithigollewa (18) Wahalkada- D4 (40)	Kebithigollewa Town Wahalkada Colony	Sunday Sunday	300 125
Rambewa	Rambewa Town (100) Pihimbiyagollewa (81)	Rambewa Town Pihimbiyagollewa	Thursday Tuesday	315 28
Mihinthale	Mihintalaya(577)	Mihintalaya Town	Wednesday	430
Galenbindunawewa	Galenbindunawewa (162)	Galenbindunawewa Town	Tuesday	414
Medawachchiya	Medawachchiya -West (67)	Near Medawachchiya Road Block	Friday	200

Source: Department of local government, Anuradhapura

Table 3.8.27 Summary of key facts and possible solution in market facilities

Key Facts	Possible Solutions
・ Lack of storage facilities with proper standards ・ Pola functions changed to an end of supply chains from a pivotal role of rural products	・ Intervention of public and private sector to establish storage facilities at village level ・ Increase in supply of vegetables and fruits in Pola

Source: JICA Project Team

3.8.8 Cost and Profit per Crop

Since field level data for computation of crop budgets is not available, the following presentation is based on the published data by Socioeconomic and Planning Centre of DOA. The variable costs in crop production are analysed under three main components, namely input costs, machinery costs, and labour costs.

(1) Cost of Inputs

The main costs the farmer has to bear for purchase of production inputs are the costs of seeds, fertilisers, and pesticides.

(a) Seed and Planting Material

Seed paddy, when secured from formal supply sources, are priced at LKR 77.50/kg for samba varieties and LKR 72.50/kg for other varieties. Big onion farmers use seeds of both local and foreign origin. Locally produced seeds are priced at LKR 15,000/kg and is favoured by the farmers because of the superior quality and high yield potential. The imported seeds, on the other hand costs about LKR 5,000/kg and farmers are compelled to use them because of the scarcity of locally produced seeds in the market.

(b) Fertilisers

Fertiliser was supplied to farmers at a subsidised rate of LKR 7/kg until 2015. Since 2015, the prices for all straight fertilisers (N-P-K) have risen to LKR 50/kg. The recommended quantities of the fertilisers under different growing conditions are shown in Table 3.8.28.

Table 3.8.28 Fertiliser Recommendations Under Different Growing Conditions

Growing Condition	Urea (kg)	S. Phosphate (kg)	MOP (kg)
Major irrigation	215	50	55
Minor irrigation	190	50	55
Rain-fed	165	35	45

Source: Fertiliser Secretariat (Anuradhapura and Vavuniya)

(c) Pesticides

Types and quantities of pesticides (insecticides, fungicides, and herbicides) used by farmers varied depending on the crop, intensity of damage, and application of pesticide; therefore, the cost component is highest in chilli followed by big onion.

(d) Cost of Machinery

Majority of the farmers have mechanised field operations in paddy production, land preparation in OFCs, and vegetable production. Innovator and early adopter categories, and to some extent the early majority category of farmers, possessed their own machinery and earned an additional income from hiring them to other farmers.

Table 3.8.29 Rates for Hiring Farm Machinery

Operation	Machine	Hiring Charge (LKR)
Plowing	Four-wheeled tractor	20,000/ha
	Two-wheeled tractor	19,000/ha
Harvesting	Combine harvester	25,000/ha
Threshing	Thresher	3,000/hr
Spraying	Power sprayer	1,000/hr

Source: Provincial DOA (Anuradhaura)

(e) Cost of Labour

Cost of labour is the highest component in the total production cost of all crops. It represents 60% of the production cost of high value crops such as chilli, big onion, red onion, and capsicum. Thus, the selection of crops by farmers is to some extent influenced by the availability of family labour for farm work. The situation is further aggravated by increasing trend in the labour wage rates. The labour wage of LKR 1000 per man day in 2015 has shot up to LKR 1,200 – 1,300 per man day with food and refreshments by 2016. This indicates a growing labour demand in the area and labour shortages can be expected in the future.

(2) Gross and Net Returns

Cost of production, yield, price, and gross and net income from selected OFCs are presented in Table 3.8.30. Imputed costs related to farmers, contribution in the form of farm labour and machinery has been included in the computation of the costs of production. A significant reduction in the cost of production is expected when the imputed costs are excluded. High production cost results in low profitability of agriculture in the area.

Table 3.8.30 Cost of Production, Yield, and Income of OFCs

Crop Category	Crop	Cost of Production (LKR/ha)			Total Cost (LKR)	Yield (kg/ha)	Price (LKR/kg)	Income (LKR/ha)	
		Inputs	Machine	Labour				Gross	Net
Grain legumes	Green gram	23,323	20,377	116,090	159,790	1,482	160	237,120	77,340
	Black gram	16,312	24,700	72,865	113,877	1,358	160	217,280	103,403
	Soybean	20,254	27,170	128,440	175,864	2,964	100	296,400	120,536
	Cowpea	28,333	14,820	101,270	144,423	1.630	142	231,488	87,065
Coarse cereals	Maize	32,016	26,243	79,040	137,299	6422	35	224,770	87,471
	Finger millet	6,422	1,235	118,560	126,217	2,470	95	234,650	108,433
Oil seeds	Groundnut	35,116	17,290	130,910	183,316	2,470	169	417,430	234,114
	Sesame	10,082	17,290	74,100	101,472	1,050	160	168,000	66,528
Condiments	Chilli (dried)	74,087	17,290	259,350	350,727	8,645	100	864,500	513,773
	Big onions	158,739	69,086	442,130	669,955	24,700	72	1,778.400	1,108,445
	Red onion	307,868	31,045	201,552	540,465	11,856	75	889,200	348,735

Source: Crop Enterprise Budgets 2015 (DOA)

A frequent reference is made to high value crops which are known to have a high net return per unit of land compared with staples and other widely grown crops. Produce of high value crops generally have a high market value and are emerging and expanding to cater local niche markets as well as global markets. In the project area, chilli, big onion, and selected vegetables can be recognised as high value crops since they record the highest net return per unit area cultivated.

Even though high dependency on paddy cultivation and lower rate of crop diversification is identified as causes of low profitability, high labour cost and lack of labour may hinder cultivation of these crops that are more labour intensive than paddy.

3.8.9 Summary of Issues to be Addressed in Agriculture Production and Marketing

Analysing from the abovementioned situations of cropping patterns, crop production, processing and marketing, the following issues are identified as constraints of agriculture development. First of all, efficiency of agriculture production is low due to the small cultivation land per household. Low availability of water results in low crop intensity and low yield of the major crop together with lack of quality seeds. On the other hand, cultivation of the other crops with lower water requirement is limited due to high intervention of government in rice marketing and fertiliser subsidy. Moreover, lack of quality seeds and seedlings, lack of cultivation data, poor extension service and lack of fund for agriculture input limit cultivation of OFC, vegetables, and fruits. Inadequate post-harvesting management and marketing also hinder production of OFC, vegetable and fruits. The issues to be addressed in agriculture production and marketing are summarised as follows.

- High production cost / high agriculture labour fee / lack of agriculture labour
- High dependency of the rice farming / delay in crop diversification due to active intervention by government in rice market and/or fertilizer subsidy scheme

- Low crop intensity in tank command area and pump irrigation area / low yield of paddy / lack of irrigation water
- Small cultivation land per household under tank command area due to division of the land over generations
- Flood damage in tank command area especially maize
- Lack of quality seed and seedlings
- Lack of fund for profitable agriculture and default
- Lack of cultivation data for OFC, vegetable and fruits and poor extension services
- Low quality of product (rice and vegetable) / low quality of paddy processing / low attention against the quality
- Poor agriculture processing skills / inadequate promotion of agriculture processing / lack of OFC processed product / no grading system
- Low farm gate price / inadequate storage facilities / oligopoly by major trading companies in OFC market
- Big processing and transportation loss

3.9 Livestock Production

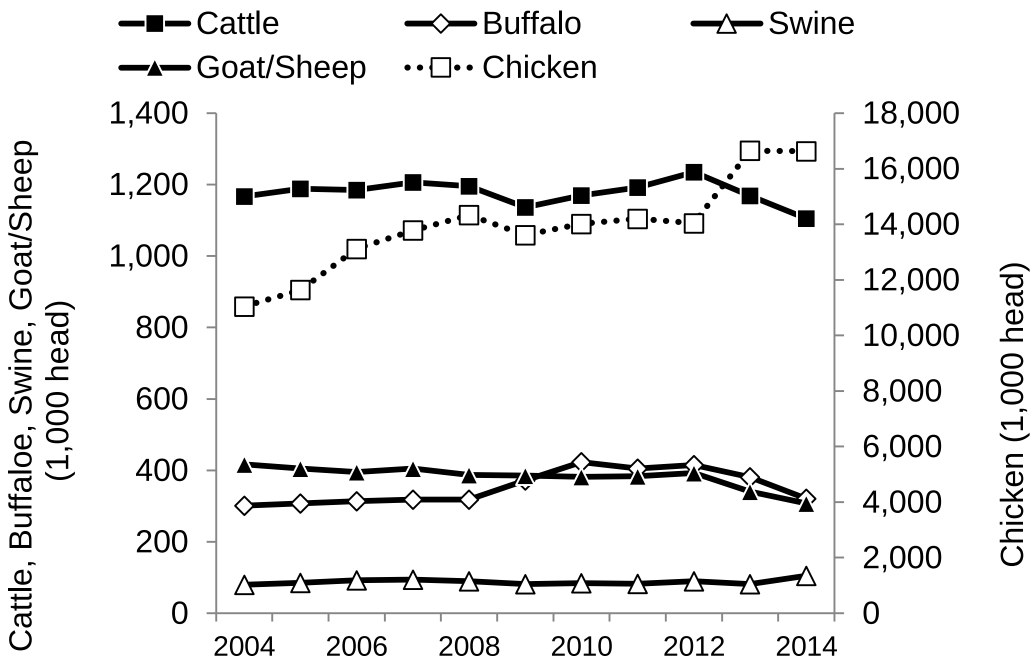
3.9.1 Overview of Livestock Production in Sri Lanka and the Project Area

The livestock sector as a sub-sector of the agriculture sector contributed 0.6% of Sri Lanka's GDP in 2015. The majority of around one million families employed in the livestock sector are rural families. Growth achieved in the livestock sector makes a considerable contribution towards the enhancement of the economy of the rural people.

Sri Lanka has a total land area of 65,610 km^2. Of this, around 2 million ha or 30% is agricultural land. Almost 75% of the agricultural land is under smallholdings and the balance is under estates. The number of smallholdings is estimated at about 1.8 million and of this, 90% are less than 2 ha in extent. About 78% of smallholdings are solely devoted to crop production, 21% in crops and livestock mix farming, and 1% solely to livestock. Even though the livestock sector has traditionally been highly integrated with rural agriculture, it is still considered as informal sector. This sector consists of the following five subsections: cattle, buffalo, goat/sheep, swine, and poultry.

The smallholder farming sector maintains the majority (90%) of the large and small ruminants. However, any interventions in to the ruminant system should not disturb the main farming activity, i.e., rice and crop farming.

Livestock populations in 2015 are 1.20 million cattles, 0.38 million buffalos, 0.36 million goats and sheep, 0.09 million pigs, and 12.26 million chickens. The population of chicken has been increasing for the past ten years. However, the other livestock population are decreasing as shown in Figure 3.9.1.



Source: DAPH (2016)

Figure 3.9.1 Livestock Population in Sri Lanka

Livestock are raised under different environments which are defined in agroclimatic zones. Based on the rainfall pattern and altitude, the country is divided into three main agroecological zones, namely: low country, mid country, and hill country. The low and mid country regions are again divided into a wet zone, an intermediate zone, and a dry zone.

Dairy sector is the most important of all livestock sub-sectors. This is primarily because of the influence it can make on the rural economy. Sri Lanka imports around 65,000 mt of dairy commodities, mainly full cream milk powder (FCMP), and dairy development is therefore seen as an instrument to replace this large volume of imported commodities and to generate rural employment. Unlike with pigs and poultry, where certain religious and socio-cultural sentiments are seen in promoting the development of such species, dairying is acceptable to all ethnic groups and religious sectors.

The domestic milk production only constitutes about 17% of the requirement and the rest is imported. The import bill on dairy commodities is around USD 400 million. The government attention is most focused on the dairy sub-sector to develop this sector into a ‘local industry’. The government policy on dairy development aimed at producing 50% of country’s requirement of milk by the year 2015. Priority is therefore given for the dairy development in public sector investment programmes and several incentives offered to the private sector to engage in dairy sector.

The dairy sector is predominantly based on small holders keeping two to five cows and their followers in most of the agro-ecological regions except the dry zone. In the dry zone, the herds tend to be large, though the animals are mostly of the indigenous types with poor milk yields. There are two alternatives in the development programmes, first is to increase productivity of the existing dairy farmers and the second is by attracting new farmers and increasing the number of farmer holdings in dairy production. This will benefit new farmers and also increase national production.

About 70% of the contribution to livestock sub-sector in Sri Lanka comes from chicken meat and eggs. With the current purchasing levels of consumers, the industry is capable of producing all local requirements of chicken meat and eggs. Chicken meat and eggs are becoming relatively cheap compared to other animal products; thus, making these products the most consumed animal protein sources in the average Sri Lankan diets. Chicken meat and eggs are available throughout the country, in supermarket chains in the main cities up to small retail shops in rural areas. Current per capita availability of chicken meat and eggs is estimated to be 4.8 kg and 57 eggs, respectively.

From being a backyard type of an industry, poultry industry of Sri Lanka has developed into a commercial industry over the past three decades. In early 1950s, the GoSL launched a programme to upgrade local indigenous poultry population in the country. Since then, this sector has shown a phenomenal growth, most prominently in the broiler sector, mainly due to active participation of the private sector. The industry today is in the hands of the private sector; the role of the state being confined mostly for implementation of poultry health management programmes, research, and policy development for further consolidation of the industry.

(1) Livestock in Sri Lanka

(a) Cattle

Cattle farming is generally distributed throughout all the agroclimatic zones of the country. In the hill and mid country regions and in Jaffna peninsula, cattle are kept primarily for milk. In the low country wet zones and in the coconut triangle, cattle and buffaloes form an integral part of paddy production in providing draught for haulage, in weed control and provision of manure in the coconut lands, and also in milk production. In the dry zones, these species are regarded more as a source on insurance by most of the farmers, where they provide a store of wealth and access to liquid cash by way of animal sales for meat. In areas where facilities for milk and dairy value additions exist, marketing milk from these animals is also becoming an important source of income.

(b) Buffalo

Buffalo keeping is principally for heavy works in paddy cultivations especially in small terraces cultivations. Some farmers keep these animals for their own power needs and buffalo keeping is seen in all rice growing areas; but Jaffana, Killinochchi, and Mannar are exceptions with only few buffaloes. Some farmers keep buffaloes for milk. Buffalo milk is generally converted to curd which has a high demand locally, and is a type of milk production mostly seen in semi-urban areas.

(c) Goat/Sheep

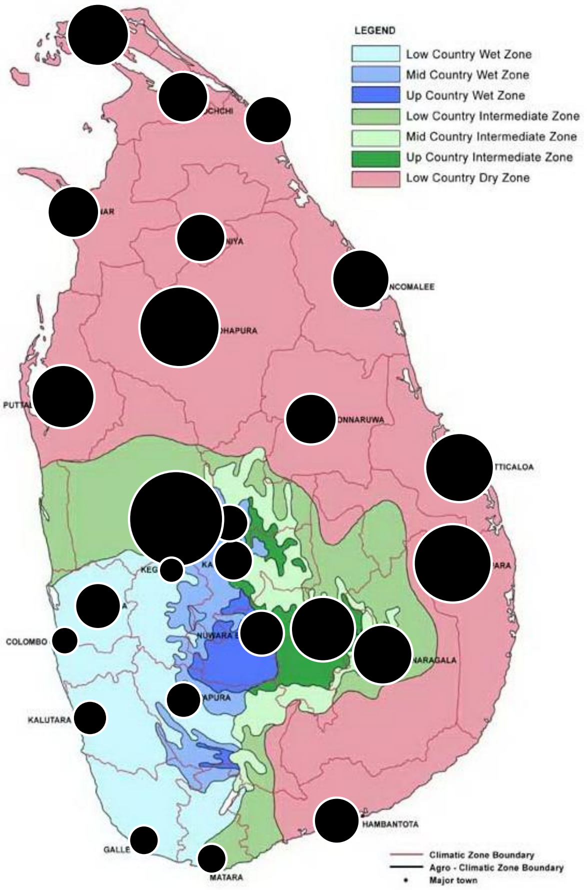
Goat keeping is popular among dry zone areas of the country and are kept for meat, depending to great extent on the common property resources of these areas for their feed. Indigenous type of goats is the predominant type of goats kept in these areas. Rearing goats for milk purposes is becoming popular around urban areas.

(d) Swine

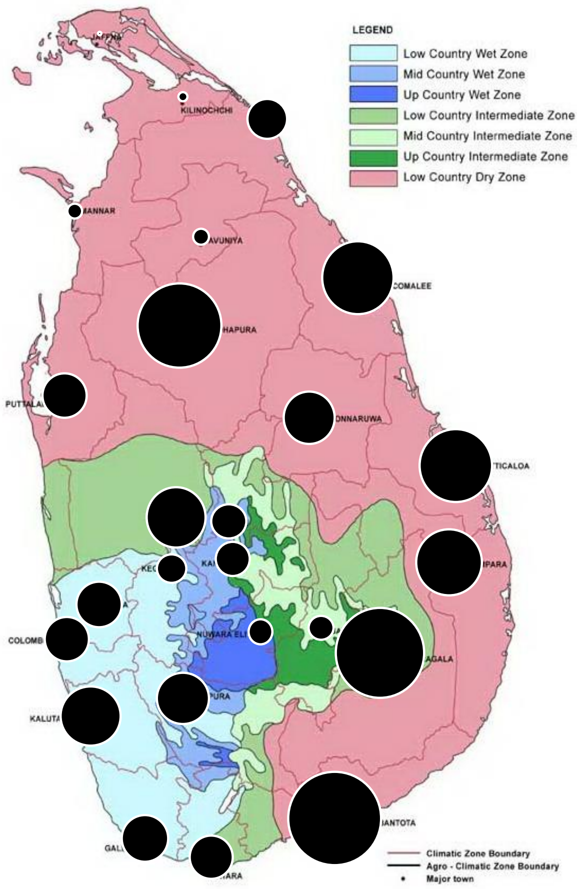
Pig keeping is done both in intensive and extensive systems. In the extensive system, only one to two pigs are kept and the operation is predominantly of a subsistence nature practised mostly by small farmers. The commercially oriented farmers keep the pigs under the intensive system and fattening and or breeding is done more systematically. Western and northwestern coastal belt is identified as the particular area in majority of pigs.

(e) Poultry

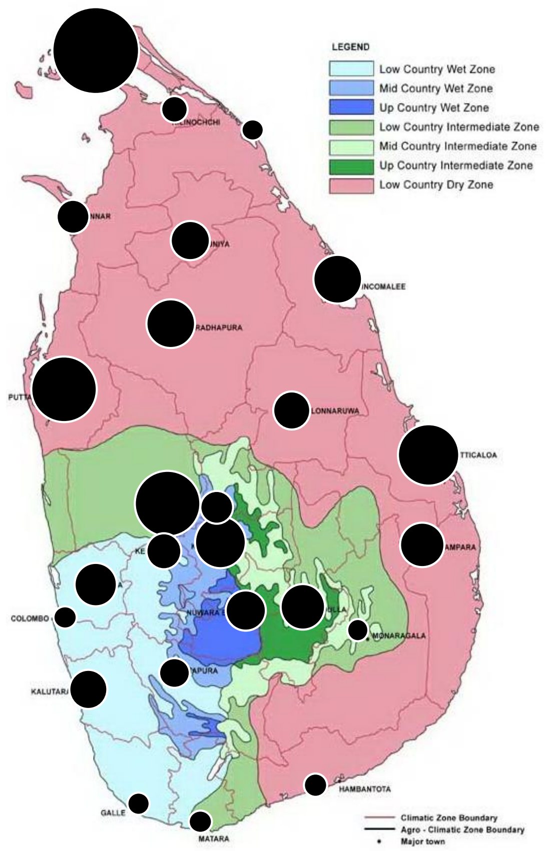
Poultry keeping is more predominant in the western coastal areas. This phenomenon seems to be related to socio-cultural practices of the people living in these areas. The poultry sector can be divided into family and commercial poultry sectors. The commercial poultry sector has an oligopoly market structure controlled by large operators. This group controls the replacement broiler chick market, feed market, feed raw material market, processing, and marketing. Availability of broiler meat is assured by the marketing strategies of these entrepreneurs. Broiler meat has been projected as a formal marketable product, whereas the other meats are considered low quality informal product.



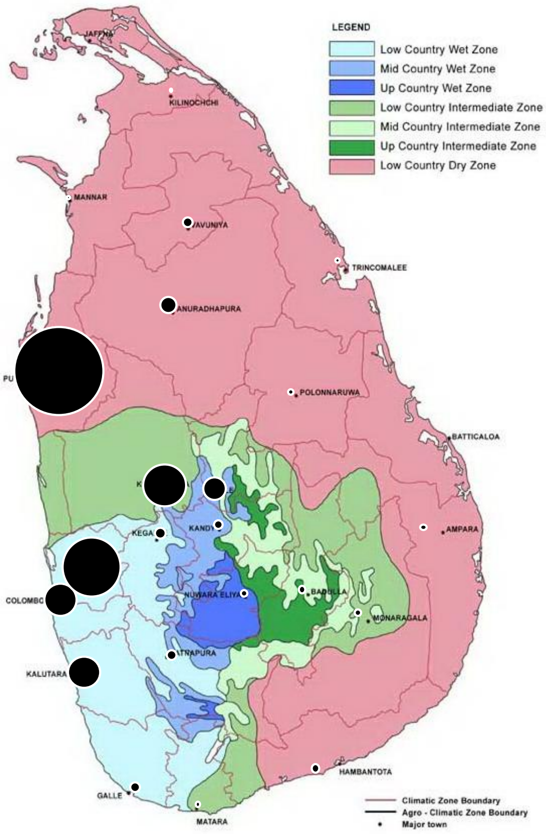
(1) Cattle



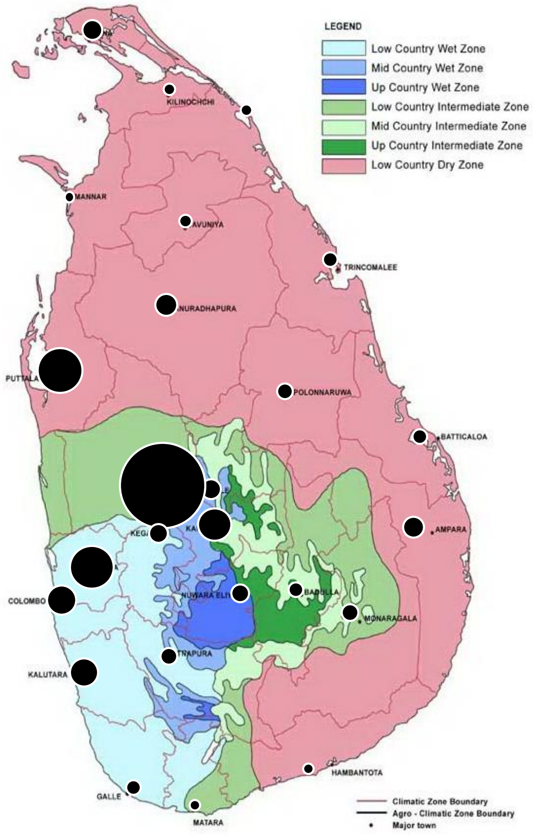
(2) Buffalo



(3) Goat / Sheep



(4) Swine



(5) Poultry

Source: Department of Animal Production and Health (DAPH)

Figure 3.9.2 Livestock Population Distribution in Sri Lanka

(2) Livestock in North Central and Northern Region

Livestock population in the North Central Region (Anuradhapura) and Northern Region (Vavuniya) are shown in Table 3.9.1. Livestock population in Anuradhapura tends to decrease for all animals. The population of cattle, buffalo, swine, goat/sheep, and chicken in 2015 when the number of livestock in 2009 was 100 were 67, 67, 37, 47, 72 respectively. In Vavuniya, livestock population tends to increase; and the population of cattle, buffalo, swine, goat/sheep, and chicken in 2015 when the number of livestock in 2009 was 100 were 101, 150, 126, 82, 107 respectively. The change of population of cattle in Vavuniya is large but this is considered as temporally in statistics.

Table 3.9.1 Livestock Population in North Central and Northern Regions

District	Livestock	2009	2010	2011	2012	2013	2014	2015
Anuradhapura	Cattle	146,500	140,850	133,320	134,870	121,740	97,940	97,580
	Buffalo	54,770	62,160	54,590	53,280	48,610	33,140	36,830
	Swine	5,920	6,450	3,795	4,020	3,040	1,680	2,170
	Goat/Sheep	37,480	36,785	30,740	32,090	21,750	15,440	17,460
	Chicken	589,680	534,880	588,000	582,330	572,620	427,420	426,440
Vavuniya	Cattle	42,970	61,320	87,720	94,540	64,950	36,630	43,600
	Buffalo	1,190	2,370	2,490	2,410	3,510	1,270	1,780
	Swine	390	195	185	190	200	590	490
	Goat/Sheep	12,450	10,045	11,525	14,240	11,810	10,100	10,210
	Chicken	125,550	147,890	138,710	145,710	164,240	127,930	134,770

Source: Department of Animal Production and Health (DAPH)

(3) Other Related Livestock Sector

(a) Fish – Duck – Rice Integration

Among the sources of protein intake of people in Sri Lanka, fish is the most important animal protein; fish products fulfil 53% of the animal protein. Furthermore, fish as the cheapest source of protein is a solution for the malnutrition problem. In 2015, the marine fish production was 334,390 mt, while inland fish production was reported to be 50,220 mt. Per capita fish consumption was 44.6 g/day in 2015. However, the Medical Research Institute of Sri Lanka recommends 60 g/day. To achieve this target, the Ministry of Fisheries and Aquatic Resources Development aimed to increase the national fish production up to 685,700 mt and double the contribution of inland fisheries.

Fish and duck integration is most common in the South Asian Region. Fishpond being a semi-closed biological system with several aquatic animals and plants, provides an excellent disease-free environment for the ducks. In turn, ducks eat harmful insects and weeds averting the use of chemical pesticides and manual weeding in the rice field. Ducks get nutritious diet from eating insects and weeds in rice fields. The droplets of ducks act as natural fertiliser to rice crop preventing the use of chemical fertilisers. Duck also help in aerating the pond water, along with bottom racking.

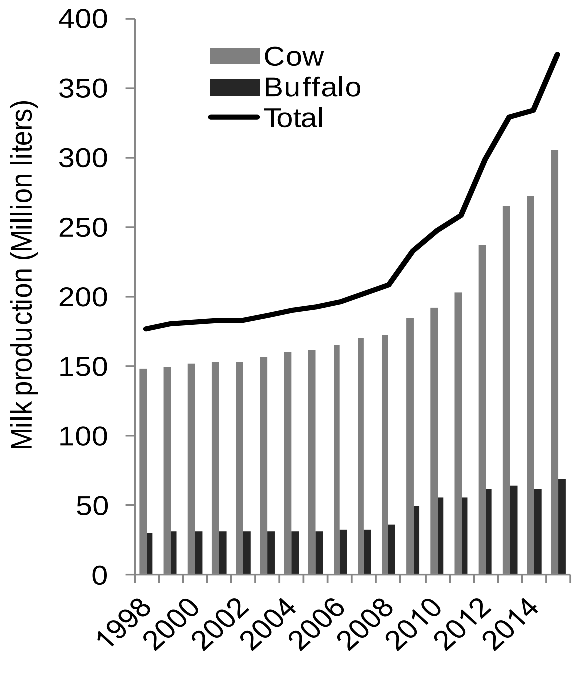
(b) Bee Keeping

There is a big demand for bee honey in Sri Lanka. The traditional uses of honey in healthcare stretch back into antiquity. The use of honey in medications for diabetes is mentioned in Ayurveda since ancient times. In various localities, patients suffering from diabetes mellitus use honey in place of sugar. Bee honey is beneficial for diabetic patients in two ways. Some cosmetic applications of bee honey are face wash, facial cleansing scrub, facial to improve smoothness, pimples, cracked lips, lotion for dry patches of skin, hair lustre, and conditioner.

Hives are best located in back gardens away from footpaths and other activity areas around homes. It is important to place the hive in a spot that is reliably well-drained, away from draughts, and where the bees can receive sunshine all day. In addition, bee keeping is environment friendly because it is an industry that utilise natural resource. In order to develop bee keeping, environmental conservation is the most important.

3.9.2 Milk and Dairy Production of Sri Lanka

The milk production has been a traditional industry which survived thousands of years. The national requirement is 740 million L. However, the estimated annual milk production in the country is 350 million L and is produced in all districts. The GoSL is expected to increase dairy production by 20% in 2018 whereby reducing import bill on milk powder. Annual milk production in Sri Lanka is has been increasing during the past ten years. However, the national cattle and buffalo population have been decreasing; increase in milk production may be accelerated by strengthening of milk collection network. The districts with a significant milk production are Kurunegala, Badulla, Anuradhapura, and Nuwara-Eliya. Of the total milk that is available, the volume of milk entering the formal milk market annually is around 150 million L and the



Source: DAPH

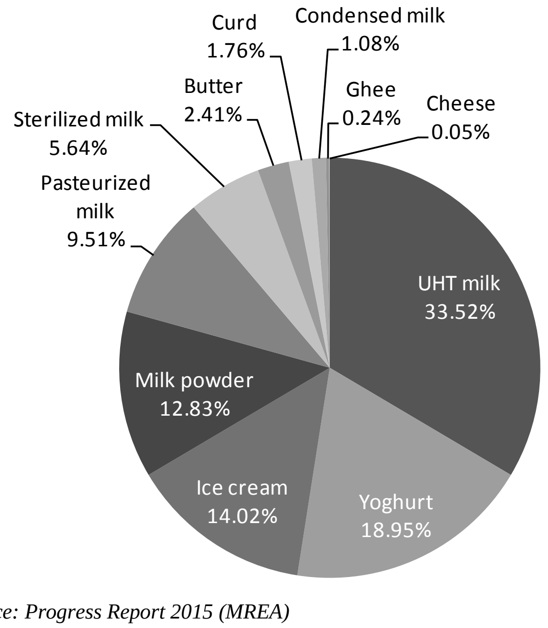
Figure 3.9.3 Annual Milk Production

rest is channelled via informal routes and consumed domestically. With the pressure on land for pasture production, the main milk production areas have recently been shifted from the mid and upcountry to the Northwest and North Central provinces.

Average farm-gate price per litre of milk increased from LKR 33.68 in 2010 to LKR 61.00 in 2015. Average cost of production of one litre of milk in up-country and mid-country in 2015 was recorded at LKR 32.31 under intensive management systems (DAPH). Form of powdered milk out of milk and milk products imported was 84.37%, which had 1.5% of fat. Imported dairy products amounted to 86,327.48 mt in 2015, an increase of 21.5% over the corresponding figure of 71,026.84 mt in 2014 (Department of Customs). Out of the total dairy products imported into the country in 2015, FCMP amounted to 72,487.82 mt, which was an increase of 21% when compared with 59,927.32 mt in 2014. Similarly, imported non-fat milk powder at 9,271.19 mt in 2015 showed an increase of 28% from the 2014 imported volume of 7,243.99 mt. However, total import bill on dairy products reduced to LKR 34 billion in 2015 because of the decrease in milk prices in the world market. International market prices of whole milk powder showed a decrease towards the end of the year. Total availability of milk and milk products in the country was 1,018.03 million L of liquid milk equivalent (LME) (domestic production and imports); and the per-capita availability recorded in 2015 was 133.03 mL/day.

The milk powder producing plant at Ambewela is now operating at maximum capacity, but is not capable to handle the supply during the annual high yielding period of milk; in view of production losses and breakdowns of old machinery and equipment installed over 40 years ago. Accordingly, it is expected to increase the production capacity of Digana, Ambewela, and Polonnaruwa factories. This factory modernisation project which commenced with the modernisation work at the Plonnaruwa Factory in 2013 was due to be completed by the first quarter of 2016. At present, all modernisation work at the Polonnaruwa Factory was completed and production has commenced, while 95% of modernisation at Digana and 70% at Ambewela factories has been completed.

The major milk based products of Milco in 2014 were 33.52% ultra-high temperature (UHT) processing milk, 18.95% yoghurt, 14.02% ice cream, and 12.83% milk powder.



Source: Progress Report 2015 (MREA)

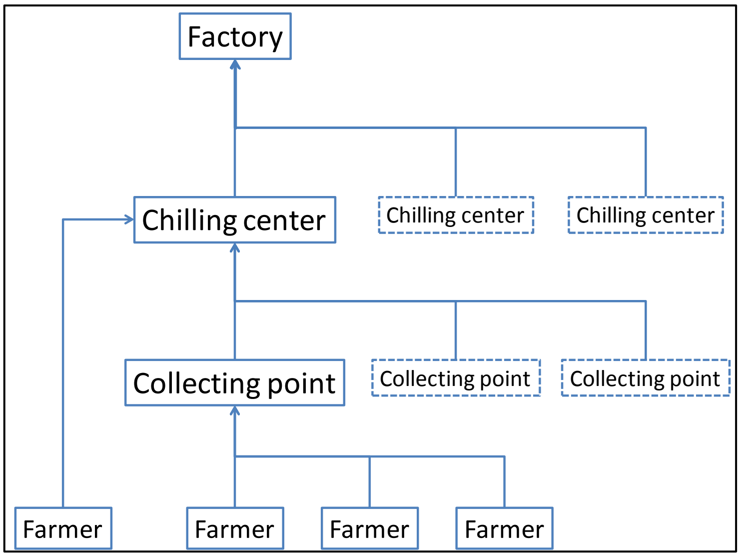
Figure 3.9.4 Milk-based Products (Milco 2015)

3.9.3 Milk Collecting System and Marketing in the Project Area in Relation to the National Situation

(1) Milk Collecting System

Milk collecting system is constituted from collecting point and chilling centre. Milk collecting point is the primary formal collection point, with a sufficient number of milk producers to ensure a minimum milk collection of about 100 L per day. The milk collecting points are managed by the milk processing company and operated by each farmer organisation. The main function of the collecting point is receiving milk from farmers and forwarding the milk to the chilling centre.

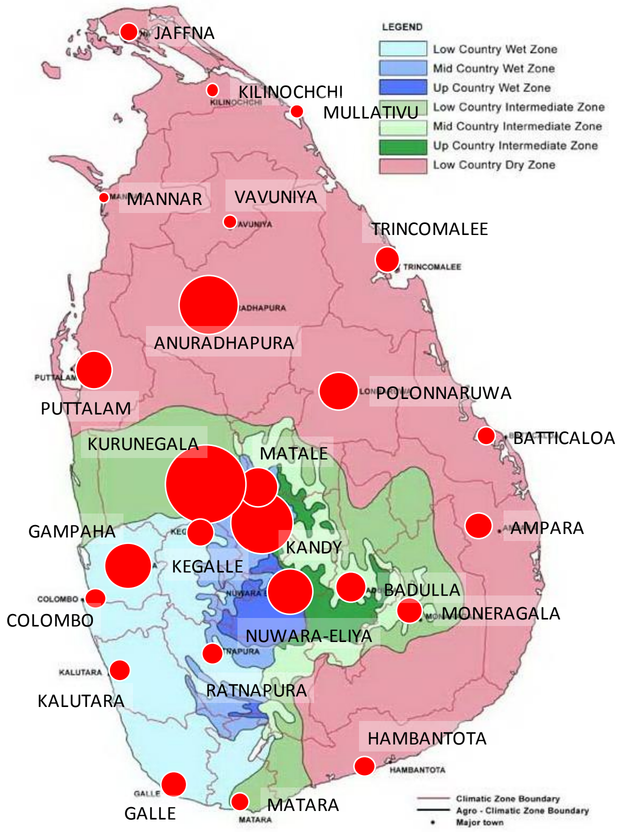
The farmers bring the milk to the milk collecting point every morning by themselves. The collecting point records "milk yield" "milk purity (lactometer)", "solid no fat (SNF)", "fat", "milk unit price", and "total price" of each farmer. Milk unit price will be decided by the SNF and fat. Collected milk is kept in larger milk cans numbered at each collecting point. The milk cans are transferred to the chilling centre by truck from the chilling centre. Chilling centre has cooling facilities to keep fresh milk until pick up by milk processing company. Chilling centre also test fat, SNF, and milk purity of milk sample of each collecting point. Some farmers who can get high yield of milk will bring their milk directly to the chilling centre.



Source: JICA Project Team

Figure 3.9.5 Milk Collecting System

Number of milk chilling centres in the year totalled up to 287. Milk collection in the country showed a moderate progress in 2015. The amount of milk collected by the 12 main milk processors in the formal milk market in the year amounted to 218.44 million L, which is an increase of 1.16% over the 2014 volume of 215.93 million L. The highest milk collection from a single district was recorded from Nuwara Eliya, contributing to 24% of the total collection; while more than 50% of milk was collected from the Central and Northwestern provinces. Number of milk chilling centres in the year totalled up to 287.



Source: DAPH

Figure 3.9.6 Number of Milk Collecting Centres in Sri Lanka

(2) Milk Market

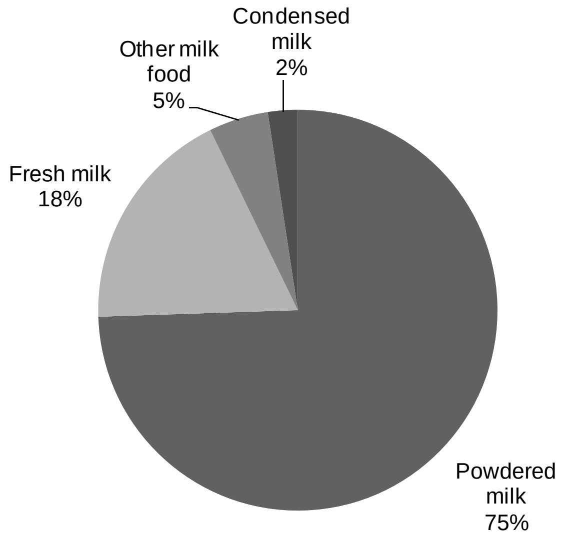
Milk market in Sri Lanka is complex and varied. There are individual farmers who sell milk directly to processors, consumers, hotels, cafeterias, and other sales outlets. The major milk processing companies extend their operations to procure fresh milk locally to cater to developing market segments such as liquid milk, both pasteurised and sterilised milk, flavoured milk curd, and yoghurt. Moreover, locally procured milk is used in processes such as ice cream making and mixed/flavoured drinking milk products. A number of other private sector processors are involved in the milk processing industry. Some of them are extremely small.

Institutionally, marketing of milk is through contribution of private and public sector organisations working with each other. The major involvement by the government is with “Milco (Pvt) Ltd”, which is engaged in milk collection from major farming areas. It also processes fresh milk, marketing it under the brand “Highland”. The formal private sector stakeholders have milk powder and other processed milk product imports as their primary line of business, except Nestle, which undertook substantial milk powder processing operation based on locally procured milk.

Milco (Pvt) Ltd. is a subsidiary company wholly owned by the government, coming under the purview of the Ministry of Social Services, Welfare, and Livestock. The company is engaged in milk collection, processing, and marketing of processed dairy products; and hold a market share of about 54% of total milk collected in the formal market. Milk collection is done by nearly 2,000 farmer managed societies (FMSs) spread throughout the country and established by this company.

Of the private sector agencies involved in livestock activities, Nestle’ Lanka Ltd. is a major player and is a subsidiary of Nestle’. It is the second largest milk processor next to Milco (Pvt) Ltd. and is engaged in producing a wide variety of dairy products including FCMP. Palawatte Dairy Industies, Kotmale Dairy Products, Lucky Lanka Dairies (Pvt) Ltd, Lanka Milk Foods (Pvt) Ltd, and Fonterra Brands (Pvt) Ltd are the other players with sizeable milk processing engagement. Also, there are several medium-scale and small-scale private sector organisations and cooperatives involved in milk collection and milk processing in the country.

Within the total milk products, 75% of total consumption is powdered milk as shown in Figure 3.9.7.



Source: Department of Census and Statistics (2016)

Figure 3.9.7 Milk per Capita Availability

(3) Milk Collecting System in Anuradhapura by Milco Co. Ltd.

One FMS belongs to a collecting point that started in 2008 with eight members and milk production was at 30 L/day. In 2016, there are 60 members (out of which about 30 are women) in this FMS, and milk production is at 330 L/day. The oldest farmer has 20 years of experience in dairy farming and has 4 L/day/head of milk production capacity. The highest milk production is 25 L/day from five cows. Grazing and cut grass feeding are the major animal feed. Some farmers cultivate CO3 type grass. Farmers request sugar grace (sorghum) and maize seeds to Milco. Farmers want to have high lactating cows because the average daily milk production is 6~7 L/head. Farmers want to milk twice a day (morning and evening), but they can only milk in the morning because of lack of chilling facilities in the collecting point. Farmers need more milk cans. Also, they need animal shed. Training is important. Some farmers want to know how to learn manual milking. Dairy farming is much more profitable than crop production; because when crop production is bad, they can still get income from milk. Some farmers' income depends only dairy farming because of lack of land for cropping. The problem to expand dairy farming is breeding. Farmers receive milk fee every 15 days. Seventeen farmers get their income solely from livestock, while eight farmers are highly dependent on livestock. One farmer gets his income solely from cropping. Twelve farmers are contracted by Nestle Co. Ltd Out of the 340 families in the village, 72 families are engaged with dairy farming.

One chilling centre collects milk at 4,500 L/day from 28 FMSs. There is one FMS beside the chilling centre with 40 members. The highest farmer's milk yield is 30 L/day from five cows. No one have grass chopper and animal shed. Grazing is the only feed resource. One farmer cultivates CO3. To expand dairy farming, equipment and facility such as grass chopper and animal shed should be introduced.

Figure 3.9.8 shows images of the milk collecting point and chilling centre in Anuradhapura.

Collecting Point

Account Book (Collecting Point)

Chilling Centre

Account Book (Chilling Centre)

Milk Quality Test (Chilling Centre)

Cooling Facility (Chilling Centre)

Source: JICA Project Team

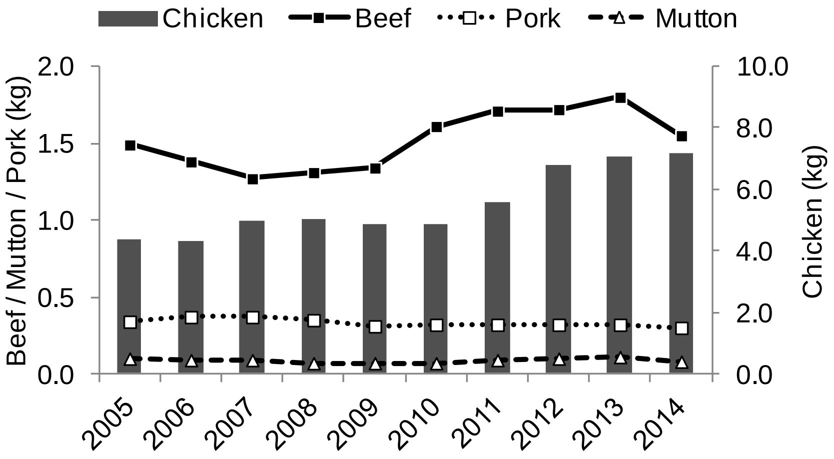
Figure 3.9.8 Milk Collecting Point and Chilling Centre in Anuradhapura

3.9.4 Meat Production in Sri Lanka

The Food and Agriculture Organisation of the United Nations (FAO) data indicates that the average dietary energy supply in Sri Lanka increased by 18.6% from 1990 to 2014. However, the contribution by food of cereal, roots, and tubers origin is –3.3% during the same period. This indicates that there is an increased contribution by food from animal origin, fish, and fruits. The average protein supply during this period increased by 18.8% and the contribution by foods of animal origin to this was 36.4%.

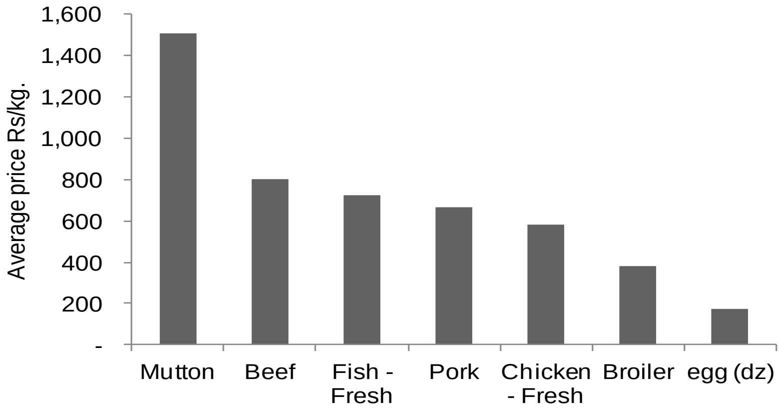
Figure 3.9.9 indicates that pork production has been maintaining the supply levels closer to the consumer demand; and therefore, the average retail price is manageable to most income levels.

Whereas, beef is maintaining a higher supply level than pork but price is higher than pork. This may be due to the fact that beef supply is lower than the actual demand. This point can be further illustrated by the mutton sector[15]. It could be safely said that high mutton prices are mainly due to the reason that the supply of mutton is just a fraction of the demand by consumers. Hence, to correct this situation, more beef and substantial amount of mutton should be supplied to the market.



Source: Department of Census and Statistics (2016)

Figure 3.9.9 Annual Growth Rate of Meat Supply



Source: Department of Census and Statistics (2016)

Figure 3.9.10 Average Retail Price of Meat

Figure 3.9.9 indicates that broiler meat seems to be the most popular meat in Sri Lanka. Furthermore, average retail price of meat shows a slow growth for mutton, beef, and pork as compared to broiler meat. The popular argument for the slow growth of these meats is given as sociological reasons. The reduction of cattle, buffalo, and goat populations may have resulted from non-availability of feed due to the restriction on grazing lands and land fragmentation. This may be the causes that may have contributed to the negative growth in mutton and beef. Mutton production dropped from 14,000 tonnes in 1970 to 5,805 tonnes in 2013. Whereas, beef production in 1970 was 36,881 tonnes and came down to 29,332 tonnes in 2013, while pork production increased from 1,339 tonnes to 1,540 tonnes during the same period. The average price of chicken, pork, beef, and mutton as of June 2016 are LKR 380, LKR 665.00, LKR 803.33, and LKR 1,508.33, respectively (Department of Census and Statistics). This shows that the demand for beef and mutton is high but the supply is low.

However, the availability of broiler meat is assured by the marketing strategies of the poultry industry. This market can be considered an oligopoly controlled by large operators. This meat market cannot be penetrated by smallholders, as this group controls the replacement broiler chick market, feed market, feed raw material market, processing, and marketing. They keep their margins high by resorting to

[15] *The word of "mutton" is commonly used for goat meat in Sri Lanka*

various marketing tactics even though there is a control price. This group maintains a huge stock of frozen meat to prevent any penetration into this market.

Furthermore, it is a false presumption if we believe that consumers prefer chicken meat over other meats. Broiler meat has been projected as a formal market product, whereas the other meats are considered a low quality informal product. It is proposed that slaughter of broilers is more humane than the other farm livestock due to its state of the art processing facilities. Other livestock is slaughtered mostly in a government facility, that is not properly maintained and open to outside elements.

The growth and decline in meat consumption is usually discussed under the multi-ethnic and multicultural nature of the Sri Lankan population. This presumption may not be accurate as we are only dealing with meat availability data. It can be argued that mutton and beef retail prices will decrease with higher supply of these meats to the market. This argument can be further confirmed by the fact that 90% in the farm animal population is chicken, 8.0% is cattle and buffalo, 1.7% is goats, and only 0.4% is swine at one point of time, as we do not consider the six batches per year in the broiler population.

So it is correct to say that low supply of mutton, pork and beef can be a major factor for high price as well as the low consumption of these meats, where sociological factors to play a minor role. Hence, rapid increase in the meat supply from cattle, buffalo, and goat may have a major impact on consumption of these meats as experienced in the poultry sector. In fact, replacing a sizable part of chicken meat by large ruminant, small ruminants, and porcine meat will not only support the environmental aspect, it will also reduce the utilisation of crops as poultry feed.

3.9.5 Livestock Breeding and Management in the Project Area in Relation to the National Situation

The relative distribution of crossbred dairy cattle is the highest in the mid-country and up-country, as well as in the wet lowlands near Colombo. This can be attributed to the temperate climate conducive to the health and performance of improved breeds. However, the harsh conditions in the dry zone may require an animal that can survive these conditions and produce reasonable milk quantity. Mahaweli Project developed a crossbred with Jersey and Sahiwal that still thrive under these conditions and produce around 10-12 L of milk. It was observed that subsequent use of jersey semen on the Jersey X Sahiwal cross, may have changed the genotype conducive to these conditions. The animal now demands better management condition which the farmers are unable to provide. This needs to be corrected soon for better results. Furthermore, breeding conditions can further be improved in both cattle and buffaloes by providing good quality studs for natural mating. A good artificial insemination (AI) system is in place and requires small changes for further improvement, since there seems to be a gap between farmer expectation and what is offered.

Deep frozen semen is produced at *Kundasale* and *Polonnaruwa* artificial insemination centres for cattle, buffalo, and goat. In addition, field AI programmes are facilitated by supplying semen of specific genetic merits imported from other sources. Semen sexed for female offspring is also supplied to the provinces on demand. The national AI programmes is a division of animal breeding. Two goat breeding farms located at *Thelahara* and *Imbulandanda* maintain nucleus flocks of *Jamunapari* goat and generally issued stud goats for breeding purpose.

Table 3.9.2 Production of Dairy Cattle Semen (No. of Doses)

Species / Breed	AI Centre – Kundasale	AI Centre – Polonnaruwa
Friesian	145,697	7,318
Australian Friesian Sahiwal (AFS)	67,890	1,150
Sahiwali	-	22,030
Jersey	116,843	-
Total	330,430	30,984

Source: DAPH

Five hundred doses Jersey semen were imported in 2015 while tendering is in progress to import 5,000 doses of *Giro-lando* and 10,000 doses of *Sahiwal* semen.

There are few crossbred dairy cattle; some are already introduced, some are products of experimental AI, and some are produced with the use of cross-bred studs.. Most crossbred dairy cattle are found in irrigated areas, with some imported from mid-country and up-country, suggesting that the demand for upgrading is not being met through official channels. AI is severely constrained by open herd management practices, so upgrading happens through use of studs. Animal loaning is an important mechanism for herd development and expansion.

As mentioned before, continuous usage of Bos Taurus semen on these crossbreds without a culling and selection programme has made subsequent generations a liability to the mixed farming system in these areas, since they require better management as well as high quality feed, both concentrates and roughages, than what is provided to indigenous breeds to maintain higher production levels throughout the lactation. In addition to this, there is a marked decline in the number of calves born in their lifetime and a considerable decline from expected total lifetime milk production. Delayed age of first calving not only increases the generation interval but also increases the number of heifers to be maintained in the herd. Hence, the growth in per cow milk production from generation to generation increases at a much slower rate or became static.

Sri Lankan cattle population census (Census and Statistics, 2003) showed that only 18% of the total cattle population are cows in milk production industry. In fact, the 1982 census (Census and Statistics, 1982) too showed that only 18% of the cattle population are milking cows. This indicates that the condition has not improved during the past 20 years. This means that Sri Lanka maintains a large number of unproductive cattle; this will create an unwanted pressure on the feed and water resource bases.

3.9.6 Food Supply for Livestock in the Project Area in Relation to the National Situation

(1) Feed Supply

For farm animals, traditional feed is not produced directly by farmers. These are smallholder farmers with limited land and use this resource to produce human food only. However, traditional crop residue, low-grade grains, and pulses are offered to livestock. These animals are allowed to graze in vast marginal land known as grazing lands. Sometimes they are tethered in the farmstead. The first priority is crop cultivation; and livestock is considered a subsidiary activity. This limits resource usage such as land for fodder cultivation. The non-availability of quality pasture/fodder and shortage of improved grass (pasture seeds) and lands for grass cultivation is considered one of the major bottlenecks in livestock production. The most indispensable and basic input for efficient dairy production is good quality fodder. Present dairy industry in Sri Lanka primarily depends on natural pasture and fodder found on roadside, ravines, tank banks, and uncultivated public and private lands. Very few farmers grow pasture and fodder for feeding their animals.

In the dry zone, rice straw is the most substantial material for forage conservation. Cattle are fed with this fodder, but milk yields are low when feeding rice straw combined with supplements. Urea treatment of rice straw is an easy option to improve the digestibility. At Ridiyigama Farm, ensiling chopped fodder sorghum in surface bunkers is practised.

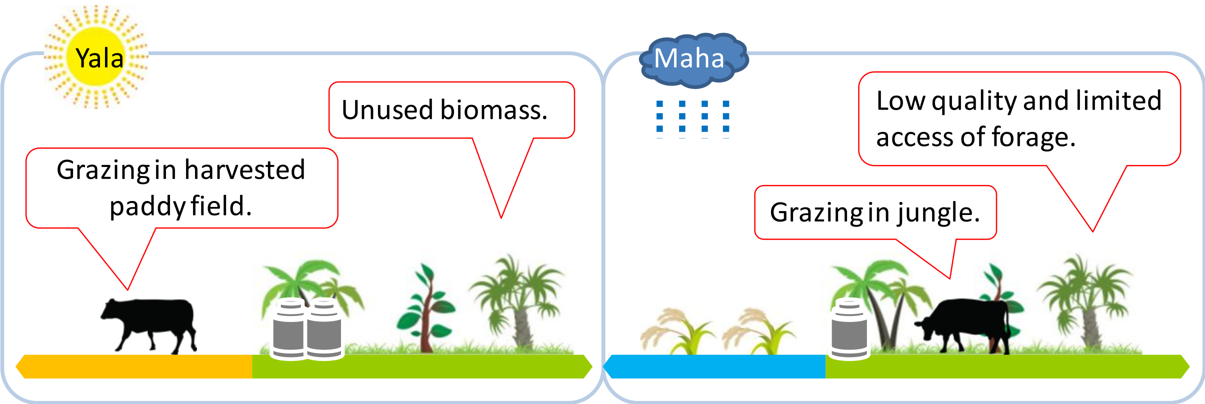
Sri Lanka annually needs 400,000 mt of fodder. About 250,000 mt out of this is locally manufactured while the balance is imported. Since profits of a smallholder livestock operation are largely dependent on the cost of feed, the use of expensive concentrate feed must be kept to minimum level. Green forage (grass, fodder, and tree fodder) is the cheaper source of nutrients for crop livestock farm. The efficient production of green forages is therefore an essential feature towards maximisation of production from crop livestock farm. Hybrid Napier var. CO3 is widely used for cattle feeding in Sri Lanka. Sorghum and maize are two of the most important plants grown for fodder production in Sri Lanka.

Strong extension programmes are required to change the mind-set of the farming community to use new technology needed to conserve forages. In addition to this, at the onset, a substantial assistance programme has to be organised to support this activity.

(2) Grazing System in Dry Zone

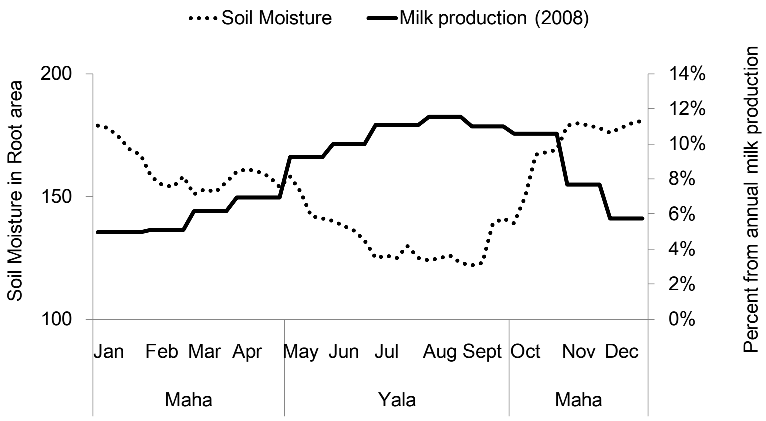
Cattle and buffaloes graze for most of the year on paddy lands, tank bunds, and scrub jungle. During dry season (Yala: usually May to September) the animals moved to paddy lands after harvest. During rainy season (Maha: usually October to April), the animals may be moved to some distance to scrub jungle. There is almost no use of concentrations and little use of crop residues.

During the rainy season, milk production is low and access to feed resources is limited. Lack of good quality feed year around is a major constraint to profitable smallholder dairy production. This is a primary result of pressure on land and competing opportunities for labour, which restrict the supply of fodder to many dairy herds.



Source: JICA Project Team

Figure 3.9.11 Grazing System in Dry Zone



Source: DAPH

Figure 3.9.12 Monthly Percent Milk Production

The feeding calendar is specifically for livestock in the dry zone. At the commencement of the Maha season, the cattle are initially restricted to paddock areas since farmers barely have time to attend to them with the initiation of land preparation. However, after the land preparation is over, these animals are then herded to marginal areas where they are able to graze freely. These marginal areas are neglected pasture land with small amount of vegetation. However, they get more feed than when they were restricted to paddocks. Livestock products are the main outputs of these scrublands, grasslands, and sparsely used croplands; and continue to be the fastest growing agricultural subsector in the dry zone. These are marginal lands with very poor soil profiles and dearth of water. Hence, to produce food crops, a substantial expenditure will be required. These areas are not utilised for any other sector such as food crop production but for grazing livestock during the cropping seasons.

Table 3.9.3 Feeding Calendar

Month	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Land	Maha - 100% cultivable land							Yala - 55% cultivable land				
Activity	Rice planting and growing				Rice Harvest			Rice planting and growing			Rice harvest	
Cattle movement	Village	Migration to inaccessible/marginal lands						Village	Restricted grazing in uncultivated dry crop land			
Grazing area	Restricted grazing crop land	Stubble consumption in overgrazed pasture land					Grazing in uncultivated moist crop land		Grazing in uncultivated dry crop land and water shortage			Restricted grazing crop land
Residue usage	Crop residue wasted	Grass and fodder residue wasted in crop cultivation area			Crop residue wasted			Crop residue available for consumption	Depleted crop residue		Crop residue wasted	
Weeks	40-43	44-47	48-52	1-4	5-8	9-12	13-17	18-21	22-25	26-30	31-34	35-39

Source: JICA Project Team

In the dry zone, communal grazing areas are dominant which are shared by wildlife and cattle. A non-negligible aspect is wild elephants moving through the dry zone, often along very old tracks. This raises a conflict between agricultural activities and wildlife protection. The natural grasslands are multifunctional with importance for livestock, wildlife use, and other domestic uses, each of which generates marketed and non-marketed outputs. Researchers and policy makers should pay much more attention to extract these uses and outputs, integrating the fundamental, social, and socioeconomic issues into the design and implementation of development interventions through a multidisciplinary manner. The key policy question is how to increase total land productivity in a sustainable way while minimising degradation.

(3) Other Feed Resources

(a) Crop by Products

There is potential in improving the nutritional value of milling by-products since milling residues are vital resource for increased dairy production.

The main by-products suitable for cattle feed produced are rice-bran, coconuts poonac, and brewers grain. The dairy sector, however, has to compete with alternative usage, like poultry and pig industry, fertiliser, and industrial activities like distilleries.

Rice bran, coconuts poonac, and molasses are the main sources of concentrates used in dairy production to supplement the generally poor quality (low nutrient density) fodder basal diets. It has been estimated that there are 70-90,000 tonnes of rice bran produced annually. One-hundred kilogram of paddy rice will generate approximately 5 to 10 kg of bran. The annual production of rice in Sri Lanka is 3,380,780 mt. However much of this is wasted mainly due to inefficient methods of milling that do not separate the rice hulls, which have virtually no nutritional value, from the valuable bran. As a result, only 25,000 t of rice bran is suitable for animal feed.

(b) Feed Supplementation Blocks (Leaf Meal Block)

Feed supplementation blocks, as its name implies, is used to supply nutrients to ruminants in countries like Sri Lanka since they are largely dependent on fibrous feeds – mainly crop residue and low quality pasture deficient in nutrients. It is traditional to provide conventional feeds such as cereals, oil cakes, and meals to ruminants. The major constraints in providing these conventional feeds are the costs incurred and availability. A leaf meal block developed by the Faculty of Agriculture, University of Peradeniya could be an ideal non-conventional feed resource for the cascade system ruminant populations. They have recommended two formulas: 75% Gliricidia + 25% coconut poonac and 75% Gliricidia + 12.5% coconut poonac+ 12.5 rice bran. This could be modified with grasses and other ingredients available in the cascade areas.

(c) Hydroponic Fodder

This is the process of growing fodder without the use of soil. This system reduces the use of water and land. Hydroponic fodder production requires only about 2%-3% of water used under field conditions to produce the same amount of fodder. Fodder produced hydroponically has short growth period of five to six days (poultry); and does not require high-quality arable land, but only a small piece of land is required - three times more dry matter from the same area. Hydroponic fodder will be used for family poultry sector and milk goat programme. This will allow women to handle these and develop both into economic entities.

(d) Water Plants

There are possibilities to use some water plants for animal feed like Azolla. Azolla is an aquatic floating fern found in still or slow moving water bodies. It easily grows in wild and can grow under controlled condition. It can be easily produced in large quantity required as green manure in both the seasons – Maha and Yala. The nitrogen-fixing capability of Azolla has led to Azolla being widely used as a biofertiliser, especially in parts of Southeast Asia. Azolla can be used with hydroponic fodder for poultry to further improve its quality. During the Maha season, Azolla can be grown in the paddy fields; and during Yala season, it can be grown in tanks to prevent evaporation. Azolla can also be grown within home gardens.

3.9.7 Overall Issues in the Livestock Sector Development

Considering recent socioeconomic situation of livestock in Sri Lanka, dairy is the priority sector to contribute to rural development. To earn profitable farming by livestock, increasing milk production should be focused on. To achieve high milk production, introducing intensive or semi-intensive farming is important. “Feeding”, “breeding”, and “capacity building” are target activities.

(1) Feeding

- The non-availability of quality pasture/fodder and shortage of improved grass and lands for grass cultivation are considered as the major bottlenecks in livestock production.
- During rainy season, milk produced may fall as low quality and access to feed resources is limited.
- Improving feed processing by chopping grass or milling by-products is a vital resource for increased dairy production.
- Green forage (grass, fodder, and tree fodder) is a cheaper source of nutrients for crop livestock farm.

(2) Breeding

- Sri Lanka maintains a large number of unproductive cattle; this will create an unwanted pressure on feed and water resource bases.
- The relative distribution of crossbred dairy cattle is highest in the mid-country and up-country. This can be attributed to the temperate climate conducive to health and performance of improved breeds.
- The animal now demands better management condition which the farmers are unable to provide.

(3) Capacity Building

- This is a transition period from cattle keeper to dairy farmer. Training is important to promote dairy farming.
- Intensive farming including feed processing, forage cultivation, and adapting new animal breed are the main contents of training.
- Both trainers and farmers are target trainees.

3.10 Irrigation and Rural Infrastructure

3.10.1 Present Condition and Issues in Major and Minor Irrigation Schemes

Irrigation development is Sri Lanka began way back 2,500 years ago. Initially, irrigation development started with small village tanks and simple canal systems. Later, tanks are developed so that river flow in shallow valleys could be intercepted to build large reservoirs. Water flowing down perennial rivers is diverted by weirs (*anicut*) and conveyed through long canals to be stored in large reservoirs at appropriate locations to irrigate large areas of farmland in dry zones. However, most of these irrigation systems were abandoned after 13th century with the shift of kingdoms and drift of population towards southwest. During the 19th century, some of the tanks such as Kalawewa Tank, Tissawewa Tank, and Kantale Tank were restored. In 1952, Gal Oya, a large multipurpose scheme, was launched and finished in the 1960s by the Mahaweli Project, the largest multipurpose scheme. The Mahaweli Project envisaged the development of 365,000 ha of irrigable lands in dry zone. In addition to Mahaweli Scheme, there are 542 major and medium irrigation schemes and 24,199 working minor irrigation schemes in Sri Lanka. The extent of the command area in each major or medium schemes exceeds 80 ha (200 ac) while the extent of each minor scheme is less than 80 ha.

District-wise distribution of major and medium schemes is shown in Table 3.10.1. Of the total 542 major and medium schemes, 322 are reservoir; 112 are anicut; 96 are drainage, flood protection, and salt water exclusion; and 12 are lift irrigation schemes.

The project area is located in Anuradhapura and Vavuniya districts. There are 87 schemes including 84 reservoir schemes, two anicut schemes, and one lift irrigation scheme in Anuradhapura district. In Vavuniya District, there are 24 schemes including 23 reservoir schemes and one anicut scheme.

Table 3.10.1 District-wise Distribution of Major and Medium Schemes

(Unit: no.)

District		Reservoir Schemes	Anicut Schemes	Drainage, Flood Protection, and Salt Water Exclusion Schemes	Lift Irrigation Schemes	Total
1	Ampara	22	3	2	-	27
2	Anuradhapura	87	2	-	1	90
3	Badulla	9	8	-	-	17
4	Batticaloa	21	1	16	-	38
5	Colombo	2	-	3	-	5
6	Galle	1	3	10	-	14
7	Gampaha	-	10	16	-	26
8	Hambantota	17	23	15	-	55
9	Jaffna	-	-	18	1	19
10	Kalutara	1	1	5	-	7
11	Kandy	1	5	-	-	6
12	Kegalle	-	-	-	-	-
13	Kilinochchi	8	-	-	-	8
14	Kurunegala	15	6	-	-	21
15	Mannar	10	2	-	-	12
16	Matale	6	2	-	2	10
17	Matara	6	7	7	-	20
18	Monaragala	17	11	-	-	28
19	Mullaitivu	19	-	1	5	25
20	Nuwara Eliya	-	8	-	-	8
21	Polonnaruwa	11	6	-	3	20
22	Puttalam	22	4	3	-	29
23	Ratnapura	1	7	-	-	8
24	Trincomalee	23	2	-	-	25
25	Vavuniya	23	1	-	-	24
Total		322	112	96	12	542

Source: The National Atlas of Sri Lanka, Second Edition 2007, Survey Department, Sri Lanka

District-wise distribution of minor schemes is shown in Table 3.10.2. Of the total 24,199 major schemes, 11,257 are tank and 12,942 are anicut

There are 2,341 schemes including 2,333 tank schemes and eight anicut schemes in Anuradhapura District. In Vavuniya District, there are 465 schemes including 453 tank schemes and 12 anicut schemes.

Table 3.10.2 District-wise Distribution of Minor Schemes

(Unit: no.)

	District	Tank	Anicut	Total
1	Ampara	181	46	227
2	Anuradhapura	2,333	8	2,341
3	Badulla	259	3,623	3,882
4	Batticaloa	132	4	136
5	Colombo	3	210	213
6	Galle	-	504	504
7	Gampaha	24	395	419
8	Hambantota	446	32	478
9	Jaffna	771	-	771
10	Kalutara	6	401	407
11	Kandy	86	1,586	1,672
12	Kegalle	7	806	813
13	Kilinochchi	224	-	224
14	Kurunegala	4,192	657	4,849
15	Mannar	61	3	64
16	Matale	278	759	1,037
17	Matara	24	825	849
18	Monaragala	285	325	610
19	Mullaitivu	129	3	132
20	Nuwara Eliya	54	1,113	1,167
21	Polonnaruwa	79	131	210
22	Puttalam	743	63	806
23	Ratnapura	59	1,436	1,495
24	Trincomalee	428	-	428
25	Vavuniya	453	12	465
Total		11,257	12,942	24,199

Source: The National Atlas of Sri Lanka, Second Edition 2007, Survey Department, Sri Lanka

The Project targets 128 cascades including 109 in Anuradhapura District and 28 in Vavuniya District. 'Cascade' is a small watershed located upstream of a major watershed. The cascade is defined and fixed by the GoSL, not divided or integrated. A total of 1,247 tanks are located in 128 cascades. The tanks include mainly minor schemes and a part of the tanks are medium schemes. River basin-wise distribution of cascades and tanks is shown in Table 3.10.3. Detailed cascade lists are attached in Attachment 3. About a half of the cascade number are located in Malwathu Oya basin.

Table 3.10.3 River Basin-wise Distribution of Cascades and Tanks

River Basin	No. of Cascade	No. of Tanks
Malwathu Oya	62	620
Yan Oya	24	240
Ma Oya	24	212
Prangi Aru	26	146
Kanakarayan Aru	2	29
Total	128	1,247

Source: Prepared by JICA Project Team

Irrigation water flows from upper tanks to lower tanks by using spill-out drainage in the cascade. However, irrigation water management is basically isolated from the upper and lower tanks, and managed by farmers under the tank command area. Flood management is also isolated.

Tank irrigation systems are almost the same for the 128 cascades. The system is gravity irrigation and consists of tank reservoirs, tank bunds, sluices, spillways, causeways, main canals, and farmland. The main crop is paddy and there are no field canals. Irrigation water is distributed to paddy field using plot-to-plot irrigation system. Present conditions and issues regarding irrigation facilities are shown in Table 3.10.4.

Table 3.10.4 Present Conditions and Issues of Irrigation Facilities

Facilities		Photographs	Present Conditions and Issues
Tank	Bund		[Erosion] Tank bunds are partly eroded due to heavy rainfall and wave action. Some eroded slope are deep and expands to left and right sides. Tank bund strength may be decreased by erosion action. The tank bunds need repairs such as reshaping and reinforcement like ripraps.
			[Jungle] Tank bunds are covered by trees and weeds like jungle. Especially tanks in Vavuniya District, vegetation is high in density because of being abandoned during the conflict. Vegetation affects water management and facility maintenance activities as well as strength of tank bunds. The tank bunds need vegetation clearing and appropriate maintenance like regular weed removal.
	Sluice		[Deterioration] Sluices (intake facilities) consist of concrete structures and gates. Concrete structures and gates are deteriorated because of being used for long periods. Especially gates made from metal are heavily deteriorated due to short lifespan. Aside from deterioration, some of the concrete structures of sluices are leaning. The sluices need full-scale rehabilitation and replacement.
	Spillway		[Erosion and Deterioration and Capacity Shortage] Spillways are generally concrete structures. The concrete is deteriorated because of being used for long periods. Runoff during Maha season is spilled-out through the spillway to drainage. The downstream of the spillway is eroded because of high velocity of the flow. Capacity of some of spillway are short. The spillway and tank bunds are damaged. Spillways need full-scale rehabilitation and improvement of capacity.
			[Temporary and Simple Structure] Some of tanks have temporary spillway made of sandbags or simple spillway like concrete pipes. Temporary or simple structures are difficult to use for flood management. Flood damage may happen. New spillways should be constructed to prevent flood damage.
	Causeway		[Erosion] Some of tanks have causeways instead of spillways to spill out excess water. Causeways are eroded due to earthen structures and its capacity may be short. Causeways need reconstruction: use concrete and appropriate dimension to drain flood.

	Reservoir		[Silting] Silting in reservoirs is generally increasing due to flow carrying earth and sand from catchment. Silting decreases reservoir capacity to store irrigation and flood water. Reservoirs need desilting and prevention of flow of earth and sand.
Canal			[Low Irrigation Efficiency] Canals are located downstream of sluices and distribute irrigation water to paddy field. Almost all canals are earthen structures with heavy weeds. Irrigation efficiency is very low due to leakage and percolation. Canals need to be rehabilitated from earth to concrete lining to improve irrigation efficiency and maintenance works.
Farmland			[Jungle] Farmland is mainly used to cultivate paddy in the project area. Especially in Vavuniya, tanks and farmland were abandoned during the conflict period. Although most farmers are already back to their villages, a part of farmland is still heavily vegetated. Farmland needs to be rid vegetation such trees, heavy weeds, and their roots; and be leveled.

Source: Prepared by JICA Project Team

Farmers have cultivation meetings called Kanna meeting to decide the regulations regarding irrigation water management and irrigation facility maintenance. Kanna meetings make the highest decision among farmers. Farmers have to obey the decided regulation at the meeting. The regulation includes punishment for persons who violate cultivation meeting decisions. DAD prepares the form of Kanna meeting records. Main items of Kanna meeting based on the form are shown in Table 3.10.5.

Table 3.10.5 Main Items of Kanna Meeting

Water Management		**Facility Maintenance**	
Items	Contents	Items	Contents
Paddy cultivation	Sowing: from to (dates)	Clearing tank bund	First clearing: before (dates)
	Planting: from to (dates)		Second clearing: before (dates)
Other field crops	Land preparation: from to (dates)	Clearing canals	First clearing: before (dates)
	Planting: from to (dates)		Second clearing: before (dates)
Water issues	For nurseries, water is either issued or not		Third clearing: before (dates)
	For land preparation, water is either issued or not	Maintenance of irrigation structures	Maintenance work to be done
	Water distribution is on rotation or continuous		Time frame (before)
	First and last date of water issue		

Source: Prepared by JICA Project Team

3.10.2 Present Condition and Issues on Rural Road in the Project Area in comparison with Other Area in Sri Lanka

The inventoried length of road network in Sri Lanka was 96,346 km in 2001. This includes 11,760 km of national roads, 15,743 km of provincial roads, and 68,843 km of other roads. The road density is 1.47 km/km^2 for the whole nation. Provincial-wise road length and density are shown in Table 3.10.6.

Table 3.10.6 Provincial-wise Road Length and Density

Privince	Road Length (km)				Land Area	Road Density (km/km^2)			
	National	Provincial	Other	Total	(km^2)	National	Provincial	Other	Total
Western	1,544	1,830	9,635	13,009	3,684	0.42	0.50	2.62	3.53
Central	1,707	2,097	8,256	12,060	5,674	0.30	0.37	1.46	2.13
Southern	1,320	1,695	5,839	8,854	5,544	0.24	0.31	1.05	1.60
Northern & Eastern	2,405	2,698	12,856	17,959	18,880	0.13	0.14	0.68	0.95
North Western	1,275	2,142	11,866	15,283	7,888	0.16	0.27	1.50	1.94
North Central	1,160	2,406	9,306	12,872	10,472	0.11	0.23	0.89	1.23
Sabaragamuwa	1,103	800	4,956	6,859	4,968	0.22	0.16	1.00	1.38
Uva	1,246	2,075	6,129	9,450	8,500	0.15	0.24	0.72	1.11
Total	11,760	15,743	68,843	96,346	65,610	0.18	0.24	1.05	1.47

Source: Road Development Authority, Ministry of Provincial Councils and Local Government (2001)

Total length of road network in Vavuniya and Anurdhapura is 11,280 km. This includes 837 km of national roads, 911 km of provincial roads, and 9,532 km of other roads. The road density is 1.22 km/km^2. District-wise road length and density are shown in Table 3.10.7.

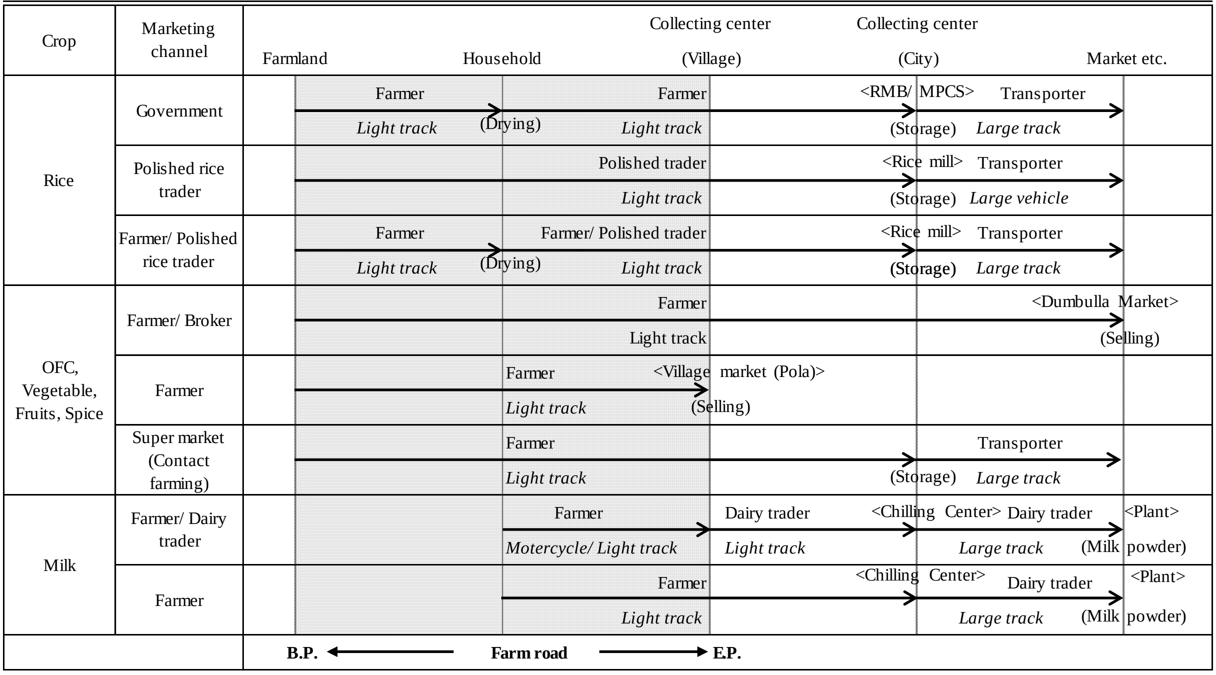
Table 3.10.7 District-wise Road Length and Density

District	Road Length (km)				Land Area	Road Density (km/km^2)			
	National	Provincial	Other	Total	(km^2)	National	Provincial	Other	Total
Vauniya	188	116	1,888	2,192	2,004	0.09	0.06	0.94	1.09
Anuradhapura	649	795	7,644	9,088	7,212	0.09	0.11	1.06	1.26
Total	837	911	9,532	11,280	9,216	0.09	0.10	1.03	1.22

Source: Department of Statistic

There are national road, provincial road, and other roads in the Project area. The target roads of the project is one (hereinafter referred to as farm road) of the three roads in the target cascades. The farm roads are used to transport agricultural products, manage the irrigation water, and maintain the irrigation facilities.

Figure 3.10.1 shows the farm road range in the project area in view of agricultural production distribution by crops. The farm road ranges are from farmland and households to the collecting centre in the village. There are three marketing channels (government, polished rice trader, and farmer) for rice; three channels (farmer, broker, and supermarket) for OFC, vegetable, fruits, and spice; and two channels (farmer and dairy trader) for milk. All of those channels are transported using road, and modes are by motorcycle or light track.

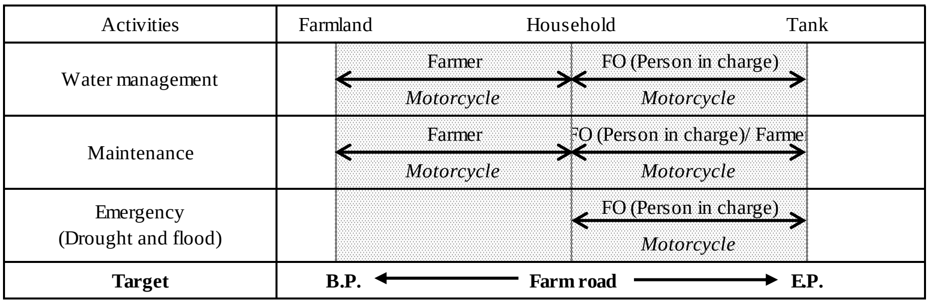


Remarks: PMB; Paddy Marketing Board, MPCS; Multipurpose Corporative Sociaty

Source: Prepared by JICA Project Team

Figure 3.10.1 Agricultural Production Distribution and Farm Road

Figure 3.10.2 shows the farm road range in the project area in view of activities regarding the irrigation water management, irrigation facility maintenance, and emergency (draught and flood). The farm road ranges are from farmland and households to tanks. All activities are done by the famers' organisation (FO) and/or farmers using the road. The mode of transportation is motorcycle.



Source: Prepared by JICA Project Team

Figure 3.10.2 Water Management, Maintenance, and Emergency Activities; and Farm Road

There are so many farm roads in the project area. Some of them are unpaved. Therefore, erosion and damage happened. It is difficult to use such farm roads during rainy season. Those roads have low transportation efficiency. Farm roads need to be paved and repair works for damaged section.

3.11 Community-based Organisation

3.11.1 Overview of Community-based Organisations (CBOs)

Several types of community-based organisations (CBOs) can be observed in the rural areas of Sri Lanka. Primary objective of CBOs is to improve the quality of life of the people in the communities through mutual help and collective action of the members, although main activities may differ from CBO to CBO. Usually, the main objective and focus of a CBO is stated in its constitution enacted when it was established. Some CBOs are initiated by government schemes with legal registrations to or being formally recognized by a particular government department. There are few CBOs originating from the customary and cultural community, such as Death Donation Societies, and later recognized by the government. CBOs are registered under respective departments according to their purpose and functions as well as the schemes through which the CBOs were established. If the CBOs are intending to undertake any contract work with external fund, including government fund, the CBOs should be registered under the DS office.

Generally, farmers in rural villages belong to several CBOs with different purposes. One can even have memberships in several farmers' organisations as long as he/she owns or cultivates tenant lands scattered over the command area of different tanks. This leads to the situation that there are overlaps of membership and CBOs are closely related to each other.

Amongst the CBOs shown in Table 3.11.1 of the subsequent page, the following types of CBOs are related to agriculture and livestock activities:

i) Farmers' Organisation (FO),
ii) Rural Development Society (RDS)/Women Rural Development Societies (WRDS),
iii) Divinaguma CBO (Samurudhi Society), and
iv) Cooperative Societies

Table 3.11.1 Summary of Major CBOs in the Target Area

CBO	Types	Legislative base	Competent Authority	Registration	Field officers in charge (allocation)	Government support	Scale	Structure	Membership	Major Activities
Farmers' Organisations (FO)	Farmers' Organisations (FO) *(for Minor irrigation Schemes)*	Agrarian Development Act, No.46 of 2000	Department of Agrarian Service (Central Government)	Department of Agrarian Service (Central Government)	1 ARPA per ARPA division (lots of vacancy in Vavuniya)	- supply of fertilizer substitutes - supposet water management (organising Kanna meetings) - Contracting works - Training programmes	1 FO per 1 minor tank (some FOs cover 2-3 tanks)	- FOs a federated to Agrarian Development Council at ASC level and further to District Federation	- Land owners or tenants in the area - Minimum of 25 members	- Water management (monitoring, operation and maintenance of irrigation facilities, contract work for minor repair), - Agriculture activities (decision making and formulation of cultivation calendar, cropping plan etc)
Rural Development Society (RDS)	Rural Development Society (RDS)	Circular No. A/C/3/1/1 18.09.1978 amended on 31.10.1978	Provincial Department of Rural Development	DS office	One Rural Development Officer (RDO) is assigned at each DS office	- Dahami Niwahana (improving house environment), - Gamdora Abiyasa (cultural activities) - Srama Abimana Niwasa (low cost housing) - Liya Saviya (sawing training) - Infrastructure improvement (e.g. culvert repair, filling road surface, construction of library, etc): - Contract work of less than 2 million (Even tough the RDSs are entitled to carry out contract of irrigation related works, there is no many cases where RDS take up the irrigation works) *Basically all the programmes are implemented with community participation (labour contribution)	The concept is one RDS per village, though the number of the RDS vary by GN division. (average 1-2 RDS per GN Division)	- RDSs are federated into Divisional Society at DS level as a roof of the RDSs - RDSs have several different sub-committees depending on their activities and issues to be handled	Not specified	- Sramadhana (communal work). - Rural credit (RDS fund from their savings) - Small business - Religious activities, - Social services such as running clinic - Forest planting - Helping poor - Implementing special programme for the disabled.
	Women Rural Development Society (WRDS)									- Some WRDS have small business activities
Cooperative society	Multi Purpose Cooperative Society (MPCS)	Co-operative Societies Act No.5 of 1972 Amended Act No. 32 of 1983 Amended Act No.11 of 1992 (Each Provincial Council further issue Co-operative Society Statute)	Provincial Department of Cooperatives	Provincial Department of Cooperatives	1 Cooperative development officer is appointed to each MPCS.	- Auditing, monitoring and supervision of the Cooperatives. - Cooperative fund as revolving fund (every cooperative deposit 10% of their profit) - Infrastructure support (e.g. rice mill), - Training programmes (e.g. cooperative governance, auditing, banking, administration, etc) - The Department intervene when the cooperative face problem such as bankrupt and management problem such as misuse. The Department appoint an officer to correct their management.	1 in DS Division	- The department is planning to form Divisional level Agriculture Cooperatives and District level Agriculture Cooperatives	- Minimum of 10 members	Purchasing and selling paddy (authorised by the government), running rice mills (4 in the District).
	Agricultural				For other cooperatives, 1 Cooperative officer look after 5-10 cooperatives.		Not specified			Depending on the purposes of each coorerative
	Inland Fishery									
	Livestock/milk product									
	Thrift & credit									
	Other									
Divineguma CBO*	Divineguma CBO*	Circulars issued by the Samurudhi Authority	Divineguma District office	Divineguma District office (need to registere to DS office if it is to undertake contracting work)	A Divineguma Officer (Samurudhi Officer) is appointed in each GN division under Divineguma Manager attached to DS office	- Livelihood improvement programs (individual support) - Social development programmes: establishment of infrastructure, skill development trainings, scholarships	- 1-2 CBO per GN division - 15-20 CBO per Divineguma Banking Society	- 54 Banking Societies with 952 Divineguma CBOs under them - each Divineguma CBO has small groups under it	Samurudhi beneficiaries, poor families with income under Rs.3,500, women headed families, and handicapped people	- Implementing Divineguma Programmes. - For banking society: deciding loan beneficiaries, monitor repayment etc - Normal activities: arranging Suramadhana (communal works), deciding beneficiaries, and conducting monthly meetings - undertaking small contacting works
Others	Death Donation Society	Welfare Societies	N/A	DS office	N/A	N/A	Village level community	N/A	N/A	- Organising welfare activities such as funerales - Collecting membership fee and provide credit to the members
	Seed Production Goups		Interprovincial Department of Agriculture	Interprovincial Department of Agriculture	Agriculture Instructor (AI)	- Original funds are provided by the Department - Currently operated only under major irrigation schemes.	5 acres of land for seed production		Not specified	- production of seeds of paddy, onions, maize, etc.

* former Samurudhi Society

Source: JICA Project Team

Details of the CBOs are described in the following section.

3.11.2 Farmers' Organisation (FO)

FOs are observed and functioning in every Gramma Niladhari (GN) Division on irrigation tank basis throughout the country. Most of the farmers cultivating the irrigated land are members of FOs. FOs are mainly undertaking irrigation management and agricultural activities in their respective areas. With legal authority and strong support from the Department of Agrarian Development, FOs have been firmly entrenched in rural societies in the project area. The following subsections describe the overview of the FOs and specific situation of the FOs in the project area.

(1) Background and Basic Feature

Organisations registered under the Agrarian Development Act No.46 of 2000 are called Farmers' Organisations. FOs were first given legal recognition under the amended Agrarian Service Act No.4 of 1991, which states the purpose of an FO in Clause 33 (4). Following the legal recognition, capacity-building of FOs has received particular emphasis. FOs were further encouraged to act independently under the Participatory Irrigation Management (PIM) programmes that started in 1998.

According to the Agrarian Service Act No.4 of 1991, the original objectives of the FOs are: formulation and implementation of the agricultural program for the area, undertaking village-level construction work and repairs of irrigation facilities, marketing of produce and distribution of seed, fertilizer and agrochemicals, and promotion of cooperation and coordination of the agricultural activities between the government organisation and farmers of the area.

FOs' by-laws, which define their specific rules and functions, are prepared in accordance with the Agrarian Development Act of 2000. Part V of the Agrarian Development Act, No.46 of 2000 prescribes the institutional regulation, rights, and duties of an FO. The overview of an FO is summarised in Table 3.11.2.

Table 3.11.2 Overview of FO

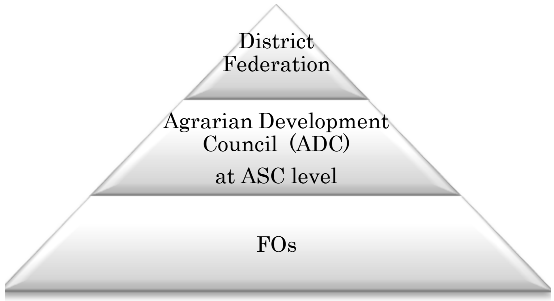
Legal status	"Irrigation Ordinance No.48, 1968" and its subsequent amendment, "Irrigation (Amendment) Act No.13 of 1994" and the "Agrarian Development Act, No.46 of 2000" define the legal provisions of Farmers' Organisations that have authority to make rules and decide on irrigation management
Establishment	One or more FO(s) may be established for any area determined by the Commissioner-General. (FO can be formed even without a tank to be maintained as FOs have functions other than irrigation management.) An FO shall consist of persons who are eligible to be members. Each FO must include at least 25 owners or tenants of land, or one-fourth of all owners or tenants of land in the area. <u>Procedure for establishment</u> FOs must register with the Commissioner of Agrarian Service. The financial viability of the FO is a requirement for registration. The FO should run for one year before registration to be judged on its validity and sustainability as an FO. Notice of Registration is published in the Official Gazette.
Membership	1. Membership Every person whose livelihood is agriculture shall be eligible for membership, if: (a) he is a citizen of Sri Lanka, (b) he is not less than 16 years of age, (c) he is a resident of the area under the authority of the Farmers' Organisation in which he is seeking membership or he has been engaged in agricultural activities in that area for a period exceeding two years. Any family member (both wife and husband) can become a member of an FO. 2. Associate Membership Can be obtained by: (a) an owner or occupier of agricultural land within the area of authority of the FO, whose main livelihood is not agriculture, or (b) any person who is engaged in any production relating to agriculture or in the marketing of agricultural produce or goods. Associate members do not have voting rights. Eligibility of associate members is the same as that of general members. 3. Observer Persons not eligible for enrolment as members of an FO as stated above, shall be eligible for enrolment as observers.

General meeting	General meeting of the members of the FO shall be called every year. When an FO fails to convene a general meeting at least once in two years, the Agrarian Development Council of that area shall have the power to convene such meeting. Meetings shall not be deemed to be validly constituted unless there is present at such meetings at least one fourth of the total number of owner cultivators or occupiers of agricultural land in the area of the FO.
Examination of accounting	The funds of an FO shall be deposited in an account in a prescribed bank. The Commissioner-General or a representative, authorized generally or specifically, shall be entitled to examine the accounts of every FO. These have authority on the withdrawal of fund from FO's bank account; thus, approval from the Department of Agrarian Development (DAD) is required to withdraw the bank savings of FO.
Internal structure	Every FO shall elect its own office bearers. Regulation may be made on the manner of election of office bearers and their terms of office, removal or resignation of committee members, filling up of vacancies, enrolment of members, recovery of membership fee, manner of transaction of business at meetings of the organisations, functions of the organisations, maintenance of the accounts of the organisation and audit of such accounts. FOs encourage members to organise small groups to carry on agricultural activities.
Rights	A registered FO can engage in the supply of goods and services relating to agriculture. Every tank, dam, canal, water course, embankment reservation or other irrigation work within the area is subject to the supervision of that FO, and regulation of supervision shall be made and exercised by the FO. FOs that have taken over the operation and maintenance of a distribution system can request that lands in their area of jurisdiction be exempted from the payment of irrigation taxes. Registered FOs are eligible to undertake contract work with value less than two million.
Financing	Sources of income are: - revenue from the collection of water charges imposed on members, the rate of which can be decided in each FO, - deposits from members, - profit from contracting works, - loans or advances from prescribed bank or state institutions, - acquiring, holding, taking or giving on lease or hire, mortgage, pledge, selling or disposing of any movable or immovable property.
Government role	The government, through the Commissioner of Agrarian Services, adopts regulations on the election of office bearers of registered FOs, on procedures for the transaction of business and on the powers of FOs, and is responsible for auditing all accounts maintained by FOs. DAD supports FO in registration, sustaining, providing training programmes for FO leaders, and supervising activities. Kanna meetings of FOs are conducted with participation of the concerned DO and are authorised by GA.

Source: JICA Project Team based on the information from DAD

(2) Structure of FOs

An FO has its management body of elected office bearers. Office bearers of an FO consist of the president, vice president, secretary, vice secretary, treasurer, and several board members. Apart from, or in combination with the annual general meetings, Kanna meetings (cultivation planning meetings) are organised at the beginning of every season at each FO called for by a Divisional Officer (DO) of DAD and participated by the concerned Agrarian Research and Production Assistant (ARPA). Kanna meetings for minor irrigation schemes are authorised by the Assistant Commissioners of DAD, and decisions in the Kanna meetings have legal power.



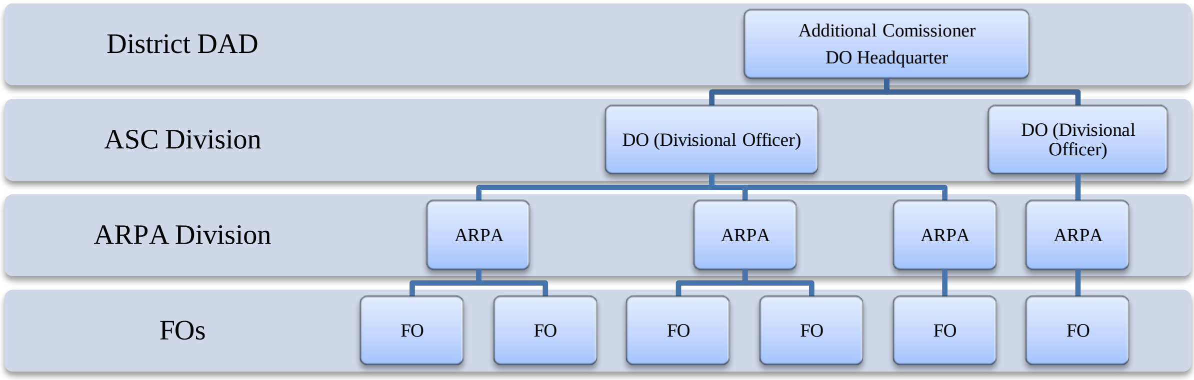
Source: JICA Project Team

Figure 3.11.1 Structure of FO Federations

An FO is generally established for each minor tank or some small tanks combined. FOs are federated at larger areas as shown in Figure 3.11.1. Based on the regulation determined in the Agrarian Development Act, Agrarian Development Councils (ADCs) are formed at the Agrarian Service Centre (ASC) level, which is smaller than DS divisions' boundaries. ADCs, consisting of the officials of FOs in the same ASC division, have meeting once a month. Issues discussed in the ADC meetings include reporting of problems and issues in each FO, decision making on seed and fertilizer distribution, and conflict resolution. Furthermore, FOs are federated at the district level. District federation meetings are conducted once in three months called for by the Assistant Commissioners. District federation consists of chairmen of the ADCs. In Vavuniya, even though the system itself has been existingfor a long time, it has not been functioning, and the committee meetings were resumed only recently.

(3) Government Structure in Support of FOs

FOs are registered under the authority of DAD under the Ministry of Agrarian Service and Wildlife. An Assistant Commissioner Agrarian Development (ACAD) is assigned in each district as the head of the district DAD. Activities of the FOs are monitored mainly by the ASC under the district DAD. A Divisional Officer (DO) / Agrarian Development Officer (ADO) is appointed at each ASC to manage ASC. ASC divisions are divided into several ARPA divisions and an ARPA is appointed at each ARPA division to work on field to support and monitor FO's activities. In addition, there are DOs attached to ASC, who are sometimes attached to the DS office working for ASC. The following is the structure of DAD for FO support:



Source: JICA Project Team

Figure 3.11.2 Structure of DAD for FO Support

In Anuradhapura District, there are 42 ASC divisions and 675 ARPA divisions, where at least one ARPA officer is appointed in each ARPA division. In Vavuniya District, there are eight ASCs: three in Vavuniya DS, two in Vavuniya South, two in Vavuniya North and two in Vengalacheddikulam, wherein six are covered by the NCPCP project. ARPA divisions in Vavuniya District are on the process of reorganisation and not yet finalized. The DAD Vavuniya is requesting the government to establish 102 ARPA divisions that would correspond to GN divisions (there are 102 GN divisions in Vavuniya District). There are currently only 18 ARPAs appointed in Vavuniya for 235 FOs that include FOs in major and medium irrigations.

Table 3.11.3 presents the number of ASC, ARPA divisions, officers in charge and FOs in the target area within the two districts. The figures of ARPA divisions for Vavuniya District are those before reformation.

Table 3.11.3 Number of ARPA Divisions and ARPA Officers in Charge in the Target DS Divisions

DS Name	ASC Name	No. of ARPA Division	No. of ARPA Officers	No. of FOs	No. of FO per ARPA Officer
Anuradhapura District					
Kebithigollewa	Kebithigollewa	26	23	75	3.26
Kahatagasdigiliya	Kahatagasdigiliya	20	20	40	2.00
	Rathmalgahawewa	7	7	20	2.86
	Koonwewa	12	10	30	3.00
Horowpathana	Horowpathana	22	20	70	3.50
	Parangiya wadiya	6	5	34	6.80
	Kapugollewa	10	5	26	5.20
Rambewa	Rambewa	18	13	56	4.31
	Kallanchiya	20	18	52	2.89
Medawachchiya	Medawachchiya	16	15	46	3.07
	Punewa	9	8	29	3.63
	Ethakada	10	7	26	3.71

Mihinthale	Mihinthale	20	19	60	3.16
Thirappane	Thirappane	29	27	50	1.85
	Muriya Kadawala	12	11	19	1.73
Galenbindunuwewa	Galenbindunuwewa	27	26	84	3.23
	Shiwalakulama	5	5	20	4.00
	Yakalla	9	9	23	2.56
Vavuniya District					
Vavuniya	Kovikulam	19	4	29	7.25
	Pampaimadu	13	1	40	40.00
	Omanthai	10	1	30	30.00
Vavniya South	Madu kanda	12	5	31	6.20
	Uluk kulam	8	4	15	3.75
Vavuniya North	Nedunkeni	11	0	19	n/a
	Kanakarajan Kulam	9	1	19	19.00
Vengalacheddikulam	Vengalacheddikulam	-	2	42	21.00

Source: JICA Project Team based on the data collected from each ASC

It is obvious that ARPAs are understaffed in Vavuniya District, especially in Pampaimadu, Omanthai, Nedunkeni, and Kanakarajan Kulam ASCs. Although there were many more ARPAs appointed before, majority of them were Sinhalese who were not competent enough to work on the fields of Tamil communities. Therefore, in Tamil-dominated areas, such as Vavuniya and Vavuniya North, the current situation is worse than in the others. The Department is planning to recruit ARPAs who are suitable for the field situation (i.e., Tamil officers for Tamil communities) once the ARPA divisions are finalized by the government.

(4) Government Structure for Irrigation Management by FOs

In Anuradhapura District, technical authority of minor irrigation is under the Provincial Department of Irrigation (PDI). The operation and maintenance (O&M) works with budget below LKR 2 million are undertaken by FOs, with technical support from the PDI, through contract agreement with FOs. Complicated works are done by PDI through private contractor even if the contract amount is below LKR 2 million. Meanwhile, all the trainings and capacity building related to the O&M are conducted by DAD. Both departments have separate budget for maintenance works of minor irrigation schemes. Demarcation of works and areas are arranged between the department at DS level as well as District Coordination Committees.

In Vavuniya District, all the minor irrigation schemes are managed under DAD. Under DAD Vavuniya, there are two TOs and three work supervisors (additional four are to be recruited this year) for O&M of irrigation-related facilities, apart from the abovementioned ARPAs covering all the four DS divisions. Each work supervisor is expected to handle four to five works (rehabilitation work/contract work), and when the work increases, the department recruits some additional staffs. Minor repair with cost of less than two million rupees is to be done by FOs through contract between the department and the FO, with technical support by TOs. However, most of the FOs sublet the work to other contractors. If the FO carries out the work by themselves, they can obtain profit of 15-20% of the contract amount (5% of the contract amount is retained for maintenance work).

(5) Water Management and O&M of Tanks by FOs

One of the major functions of FOs is O&M of irrigation facilities. Maintenance fund for irrigation facilities has been established through a government order in 2011. Maintenance fund is collected by farmers on the basis of their landholdings (acre-wise). The rate of the contribution is decided by each FO. Minor repair of the tanks and canals is taken cared of by each FO with this maintenance fund through technical support by the Technical Officers (TOs). Maintenance fund is deposited to the FO’s bank account, which can be withdrawn with the approval of DAD. In Vavuniya, 20 tanks were repaired with the maintenance fund during the flood in 2015. In the case of Vavuniya, contribution of the maintenance fund is generally from fines, mainly due to the sanction for the non-contributing members. DAD will stop support for agricultural input to the land (such as LKR 5,000/acre as subsidy for fertilizer, which is given only to the farmers registered as FO members) which stimulates incentive to pay for the maintenance fund. Sanction is imposed not on the farmer but on the field because the farmer who is not willing to pay tends to lease the land if his/her support from the government is withheld for the sanction.

For the labour contribution, the law and government circular mention that all the members must clear tank bund, repair damage, and clean canal before the onset of a season. Those who are not able to contribute labour can substitute with payment for labour.

Water allocation and management of water distribution from the concerned tanks are decided and managed by FOs in Kanna meetings, as explained in the previous section. Kanna meetings are currently conducted at each FO, organised and chaired by DO (GA chairs the meeting for tanks under major and medium irrigation). Decisions in the Kanna meetings have legal power and FOs are responsible to comply with the decisions and plans confirmed in the Kanna meeting. A water master (also called 'irrigation secretary' or '*Jala palaka'* in Sinhala) is appointed at each tank to take care of the regulation of water distribution with paid salary by FO. The payment, either in cash or in kind, to the water master is decided in each FO.

(6) Situation of FO in the Survey Area

This section summarises the basic situation of the FOs in the target ASC divisions. The information was collected from all the FOs registered under the ASC that cover any part of the target area (with some missing responses). This means that the FOs that are not in the target areas are included as long as they are registered under the target ASC divisions. The answers to the questionnaires were received from the 18 target ASC divisions out of a total of 42 in Anuradhapura, and six target ASC divisions out of a total of nine in Vavuniya. The following table is the summary of the results from the questionnaire survey.

Table 3.11.4 Basic Data of FOs in the Target ASC Divisions

Item		Anuradhapura				Vavuniya			
Total Number of FO responded			735				163		
Total Number of FO members			56,485				12,640		
Average number of members	Total		79.1	Max	399		84.3	Max	365
				Min	12			Min	6
	Male		56.6				59.1		
	Female		23.1				27.3		
Sub-committees	Irrigation Development Committee	Yes (Nos.)	49	(%)	7%	Yes (Nos.)	1	(%)	1%
		No (Nos.)	591	(%)	80%	No (Nos.)	155	(%)	95%
	Other sub-committee	Yes (Nos.)	91	(%)	12%	Yes (Nos.)	20	(%)	12%
		No (Nos.)	532	(%)	72%	No (Nos.)	139	(%)	85%
No. of tanks under the FO		Average (Nos.)	2.37	Max	17	Average (Nos.)	3.01	Max	17
				Min	1			Min	1
Contract work for rehabilitation of irrigation structure for last 2 years		Yes (Nos.)	119	(%)	16%	Yes (Nos.)	29	(%)	18%
		No (Nos.)	506	(%)	69%	No (Nos.)	127	(%)	78%
Water management	Appointed water master	Yes (Nos.)	627	(%)	85%	Yes (Nos.)	145	(%)	89%
		No (Nos.)	51	(%)	7%	No (Nos.)	11	(%)	7%
	Whether the water master is paid	Yes (Nos.)	507	(%)	69%	Yes (Nos.)	141	(%)	87%
		No (Nos.)	199	(%)	27%	No (Nos.)	15	(%)	9%
	Mode of payment to water master	In cash (Nos.)	92	(%)	13%	In cash (Nos.)	119	(%)	73%
		In kind (Nos.)	401	(%)	55%	In kind (Nos.)	18	(%)	11%
Kanna meetings	Frequency	Seasonally (Nos.)	458	(%)	62%	Seasonally (Nos.)	119	(%)	73%
		Yearly (Nos.)	15	(%)	2%	Yearly (Nos.)	1	(%)	1%
		Needs basis (Nos.)	88	(%)	12%	Needs basis (Nos.)	37	(%)	23%
	No. of meetings conducted last year	Average (Nos.)	2.67			Average (Nos.)	2.17		
	% of attendance	Average (%)	52%			Average (%)	59%		
Committee	Frequency	Seasonally	32	(%)	4%	Seasonally	58	(%)	36%

meeting		(Nos.)				(Nos.)			
		Yearly (Nos.)	16	(%)	2%	Yearly (Nos.)	5	(%)	3%
		Needs basis (Nos.)	489	(%)	67%	Needs basis (Nos.)	24	(%)	15%
	No. of meetings conducted last year	Average (Nos.)	3.19	Max	13	Average (Nos.)	3.64	Max	12
				Min	1			Min	1
	% of attendance	Average (%)	66%			Average (%)	45%		
Last election of office bearers		2016 (Nos.)	108	(%)	15%	2016 (Nos.)	30	(%)	18%
		2015 (Nos.)	356	(%)	48%	2015 (Nos.)	44	(%)	27%
		2014 (Nos.)	101	(%)	14%	2014 (Nos.)	15	(%)	9%
		2013 (Nos.)	24	(%)	3%	2013 (Nos.)	5	(%)	3%
		before 2012 (Nos.)	31	(%)	4%	before 2012 (Nos.)	13	(%)	8%
Membership fee	No. of FO collecting membership fee	Yes (Nos.)	520	(%)	71%	Yes (Nos.)	116	(%)	71%
	Period of fee collection	Yearly (Nos.)	260	(%)	35%	Yearly (Nos.)	107	(%)	66%
		Monthly (Nos.)	94	(%)	13%	Monthly (Nos.)	2	(%)	1%
Financial situation	Cash on hand (LKR)	Average (LKR)	7,993			Average (LKR)	9,739		
	Bank Balance (LKR)	Average (LKR)	154,641			Average (LKR)	246,496		
	Financial record	Yes (Nos.)	477	(%)	65%	Yes (Nos.)	100	(%)	61%
		No (Nos.)	145	(%)	20%	No (Nos.)	18	(%)	11%

Note: Percentage is calculated out of the total number of FOs that responded to the questionnaire
Source: JICA Project Team based on the questionnaire to the FOs under the target ASCs

The average number of members in one FO is around 80, of which about 70% are males. Some farmers have membership in several FOs.. On the average, an FO manages about three tanks, with one as the minimum and the maximum is 17.

About 15% of the FOs have a sub-committee to manage specific issues including irrigation management, which is legally mentioned in the Agrarian Development Act. In Anuradhapura, Provincial Director of Irrigation (PDI) started establishing Irrigation Development Committees in FOs as there has been a gap between FO that is under the authority of DAD and PDI. This is reflected in the higher percentage of the FOs that have irrigation management committees in Anuradhapura than that in Vavuniya. Regarding current situation of maintenance of the irrigation facilities, only 16% in Anuradhapura and 18% in Vavuniya have undertaken contract work for irrigation related facilities in the last two years.

Water management of nearly 90% of FOs are handled by water masters appointed by the FOs who take care of regulation of water distribution. Most of them are paid either in cash or in kind. While majority of the FOs in Anuradhapura pay water masters in kind, those in Vavuniya pay in cash. Management and allocation of water are discussed and decided in Kanna meetings, which are conducted seasonally in most of the FOs, while some FOs conduct them based on their needs. Since the average number of the Kanna meetings conducted in the last year is more than two in both districts, FOs that conduct Kanna meetings based on need seem to organise more Kanna meetings compared to those who conduct meetings only seasonally. Average participation rate at the Kanna meetings is more than 50%.

Committee meetings of the FOs are conducted more than three times a year, on the average, and ranging from a minimum of once to a maximum of 13 times. There are some FOs that have not conducted election of officials since 2012 or before, while majority have elected the current officials between 2015 and 2016.

About 70% of the FOs are collecting membership fees, whether monthly or annually, and more than 60% of FOs are maintaining financial records.

In Vavuniya, the situation of FOs is influenced by the specific context of Vavuniya in terms of ethnicity of the population and the decades of the conflict. First, as mentioned above, the number of ARPAs who support FOs is significantly limited in Vavuniya. According to the Assistant

Commissioner of DAD Vavuniya, this adversely influenced as most of the FOs in Vavuniya is functioning well partly because FOs are skilled to take role of ARPA in the absence of ARPA, such as record filing. Second, regarding ethnic co-existence, although there are a few mixed FOs whose membership consists of different ethnic groups, they do not have any problem, according to DAD and ASC officers. It was mentioned that the caste is a more serious issue in the management of FOs rather than ethnicity. Members of high caste groups are normally dominant in terms of position, even through democratic election. The third issue is abandoned tanks. There have been registered FOs in abandoned area/abandoned tank before the war period, while some new FOs were formed and registered during the National Irrigation Rehabilitation Project (NIRP). Even though the FOs in the abandoned areas have not been functioning for nearly 30 years, they still have members who have previous experience on FO management.

(7) Possibility to Undertake the Project Activities

FOs are the major actors as defined in the Agrarian Development Act. Most irrigation-related projects have been implemented through the FOs and many minor maintenance works have been conducted through contracting with the FOs. However, it should be noted that most of the contracted works with the FOs have been further sublet to other agencies, such as private contractors, even though it is not officially allowed. This situation has been occurring due to different reasons such as lack of capacity of FOs, and political interference to the contracting works. Therefore, it shall be inevitable to support the capacity development of FOs for proper participatory maintenance by the FO members even of the FOs that have been undertaking contracting works.

It seems FOs have been well maintained with support of DADs through ARPAs. Their functions in agriculture-related activities such as distribution of subsidised fertiliser and cultivation planning through Kanna meetings are the robust elements for the functions of FOs.

3.11.3 Rural Development Society (RDS)/Women Rural Development Societies (WRDS)

RDS and WRDS were established under Circular No. A/C/3/1/1 (dated September 18, 1978) by the Director of the Department of Rural Development (amended on October 31, 1978), and are commonly observed throughout the country. The activities of RDS/WRDS cover social development of rural area.

(1) Background and Basic Features

Rural development activities initially started with the government initiative in the 1940s under the Department of Commerce and Industries. In 1947, 70 Rural Service Centres (RSCs) were established to promote rural development activities. Since the establishment of the Rural Development Department in 1947, rural development activities have been carried out by the RDS formulated in each village in the country in order to function as the focal point to coordinate all the rural development activities at the village level. In line with the 13th Amendment to the 1978 Constitution, Provincial Council took over the responsibility of rural development in its coverage area taking charge of registration and monitoring of RDS.

The main objective of the RDS is to improve the socioeconomic condition by upgrading the condition of living of the village people through livelihood support such as revolving fund activities, income generation activities, skills development and vocational training programme, capacity development programme, and improvement of infrastructure facilities. Major activities undertaken by the RDSs are Shramadhana (communal work), rural credit through RDS fund from their savings, small business, religious activities, social services such as running a clinic, forest planting, helping the poor, and implementing special programme for the disabled.

Table 3.11.5 shows the overview of the institutional regulations of RDS/WRDS.

Table 3.11.5 Overview of RDS/WRDS

Registration	The secretary of the organisation shall forward two copies of following documents through GN to Rural Development Officer or RDO (GN shall certify the number of families in the area of authority of RDS/WRDS). After perusal of all the documents by RDO, it will be forwarded to DS with RDO's recommendation. DS will take action to certify and register at the DS office.
Membership	Requirements for membership in a society are: a) being a citizen of Sri Lanka b) being a permanent resident of the area of authority of the RDS/WRDS c) not less than 16 years of age d) no membership in another RDS/WRDS e) he/she is a member of a small group f) membership fee has been paid with the application form
Meetings	i) Initial meeting: announced by GN, participation of RDO, and at least 40% of families in the village ii) Small group meetings: to be held weekly iii) Working committee: Meetings are held weekly or as needed. iv) General meeting: Meetings should be held at least once in two months v) Annual progress review meetings: progress of the work done and planning are discussed. vi) Meetings for electing office bearers: Within the first three months after two years of initial meeting or meeting for electing office bearers. Either GN or RDO should participate.
Executive Committee	At the inaugural and annual general meeting of once in two years of the society, the following office bearers shall be elected, either unanimously or by voting: a) President, b) Secretary, c) Finance manager , d) Vice president, e) Assistant secretary
Finance	The society's funds are collected through the following sources: membership fee (monthly LKR 5.00, which can be increased with the approval of the secretary of the provincial rural development), savings by members, grants, donations, interests, loans, and other income All the money should be deposited in a savings account in any bank decided at the general meeting of the society. Also, cash withdrawal should be signed by the finance manager and president/secretary and on behalf of the government RDO and DS/Assistant DS.
Government Role	The Rural Development Officer, District Rural Development Officer, and Divisional Secretary of the area are entitled to advise every society and its members as for the development activities and rights of the societies.

Source: Constitution of RDS, Department of Rural Development, NCP

(2) Organisation and Functions of RDS/WRDS

RDSs have several different sub-groups depending on their activities and issues to be handled. For the upward connection, RDSs are federated into Divisional Society at the DS level as the umbrella of the RDSs.

With the aim of motivating members on savings and fulfilling urgent financial needs, the society should operate and maintain rural development revolving fund, for which the interest rate for the loans obtained from this fund should not exceed that of estate banks. Credit facilities from the revolving fund should be provided only for agricultural activities, small industries, small business animal husbandry and for urgent needs. Limits of the credit facilities could be decided at the general meeting.

Registered RDS/WRDS are allowed to undertake contract works. If any society hopes to do contracts, it should be discussed at the general meeting after signing the relevant agreement. The contract can be implemented with the decision arrived at the general meeting. All the details regarding contract payments and transactions should be relayed to the working committee and monthly income-expenditure report should be prepared and forwarded to DS through RDO. In any case, sub-contracts of the contracted works are prohibited. From the contract payments, 1% and 4% should be credited to the Divisional Rural Development Society and the WRDS/RDS Society Fund, respectively.

(3) Government Structure in Support of RDS/WRDS

RDSs are registered at DS office under the authority of the Provincial Department of Rural Development. One RDO, under the Director of Provincial Department of Rural Development, is assigned at each DS office as a divisional level advisor for the society. Officers of the Ministry of Rural Development, DS, and RDO have the power to inspect all books and records and provide necessary guidance for organisational management and development activities. Activities of RDS/WRDS are monitored by the RDOs.

The department provides livelihood support activities, such as support to small business, poultry rearing, cultivation, cattle/goat rearing, fishing, food production and so on by revolving loan fund to society members. Major programmes supported by the department are as follows:

- Dahami Niwahana (improving house environment),
- Gamdora Abiyasa (cultural activities)
- Srama Abimana Niwasa (low cost housing)
- Liya Saviya (sawing training)
- Infrastructure improvement with contract work of less than 2 million

All the programmes are implemented basically with community participation through labour contribution.

(4) Situation of RDS/WRDS in the Survey Area

Table 3.11.6 shows the number of RDS and WRDS in the target area by DS Division. According to the data from the Provincial Department of Rural Development, there are 710 RDSs registered in Anuradhapura District, and 512 in Vavuniya District. Although the concept of the RDS is one RDS per village, the number of the RDS varies by GN Division depending on the size of the GN Division. In general, 1 to 2 RDS(s) are functioning in each GN Division.

Table 3.11.6 Number of RDS and WRDS in the Target Area

DS Division	RDS (nos.)	WRDS (nos.)	Sub-total (nos.)	DS Division	RDS (nos.)	WRDS (nos.)	Sub-total (nos.)
Anuradhapura District				*Vavuniya District*			
Mihinthale	42	-	42	Vavuniya	156	113	269
Horowpathana	21	-	21	Vavuniya North	36	37	73
Rambewa	38	-	38	Vavuniya South	35	40	75
Medawachchiya	41	-	41	Vengalachessikulam	50	45	95
Thirappane	36	-	36				
Kebithigollewa	26	-	26				
Galenbindunuwewa	40	-	40				
Kahatagasdigiliya	24	-	24				
Sub-total	**268**	**-**	**268**	Sub-total	**276**	**247**	**512**
District total	**710**	**-**	**710**	District total	**276**	**247**	**512**

Source: Vavuniya: Statistical Information 2015, Northern Provincial Council, Resource Profile & Statistical of Vavuniya District 2015, and Data from DS office,
Anuradhapura: Provincial Department of Rural Development

While there is no specific differentiation between RDS and WRDS in the North Central Province (NCP), Northern Pronvince (NP) has special focus on WRDS. Almost the same number of RDSs and WRDSs are functioning in NP. More than 90% of the RDSs engaged in the revolving loan is WRDS. Some WRDSs have small business activities. In NP, there are women development centres at divisional level, which are the focal institutions for skills development training such as for dress making, handicraft, beauty culture, and home science. This situation in NP might be a result of activities of NGOs and international organisations in NP that focused on women's social participation and income generation during the internal conflict period.

(5) Possibility and Adequacy as CBO to Undertake the Project Activities

RDSs are undertaking infrastructure improvement through contracting works such as culvert repair, filling road surface, construction of library and so on. Even though the RDSs are entitled to carry out contract of irrigation-related works, it is rare for RDSs to take up irrigation works. In consideration of the purpose and background of the organisations, it seems more reasonable to consider FOs as counterpart organisations for purely agriculture-related project activities in the field. However, as for the rural infrastructure development projects such as the construction of farm access roads, RDS/WRDS may be more appropriate to undertake the responsibility than FOs, although the situation may depend on the community.

3.11.4 Divinaguma CBO (Samurdhi Society)

Divinaguma CBOs are basically the group of Samurdhi beneficiaries in the government scheme of Divinaguma Programmes, which cover one-third of the entire population of Sri Lanka. Divinaguma CBOs are operating in every GN Division throughout the country. Most of the members of Divinaguma CBOs are also members of other organisations such as RDSs and FOs.

(1) Background and Basic Feature

Divinaguma CBOs are established to succeed the former Samurdhi Societies. Samurdhi Societies were established through the Samurdhi Programme launched by the Government in 1994. The main purpose of the Samurdhi Programme was to ensure the participation of the poor in the production process by increasing access to resources for self-employment, enhancing their health and nutritional status as well as improving rural infrastructure. It also attempts to enhance the capacity of the poor to take initiatives to improve the quality of life of their family through sustained provision of technical, managerial, and financial support based on a consultative process. Samurdhi Programme has been replaced by the succeeding government with the Divinaguma Programme. Divinaguma CBOs were established under Number 1 Divinaguma Development Act of 2013, under the Ministry of Social Service (currently the Minister of Social Empowerment and Welfare).

The followingTable 3.11.7 shows the basic feature of Divinaguma CBOs:

Table 3.11.7 Overview of Divinaguma CBO

Establishment	Every village has Divinaguma societies. Therefore, one Gramma Niladari division can have a number of Divinaguma societies based on the number of village under one Gramma Niladari division.
Registration	Divinaguma CBOs are currently registered under the Divinaguma District Office.
Membership	The minimum number of members is 25 and there is no maximum. Members of the Divinaguma CBOs are Samurdhi beneficiaries, and any low income person (with income under LKR 3,500), women headed families, and handicapped people. This means that it is open for non Samurdhi beneficiaries as well. Those who are eligible can join the five-member-small-group after discussing with the Samurdhi Development Officer of the concerned GN Division. The person can obtain the membership through the small group.
Meetings	Monthly Committee Meeting
Executive Committee	An executive committee is selected by the members in the general meeting. The executive committee members are as follows: Chairman, vice chairman, secretary, vice secretary, treasurer, and 6 committee members; one internal auditor is also elected by the committee.
Capital and Financial Activities	A member of the Divinaguma society is eligible to get loan facilities to enhance his income generation activities. Everyone in the society should be a member of a small group. A small group has five members. If one member applies for a loan, the other four members are taken as guarantors. The applicant should have a savings account and share account at the Divinaguma bank and the share account balance should be equal or more than 10% of the loan amount. A member can get up to LKR 1,000,000 loan based on its need. The loan interest rate varies between 4% and 12% yearly.
Government Role	The Divinaguma society is directly supervised by the Divinaguma Development Officer (DDO) at the Gramma Niladari division. DDOs help members get loan for income-generation activities. The Divinaguma Manager at the bank also monitors the activities of the members at the field level. At the Divisional Secretariat level, the Divinaguma headquarters manager and divisional secretary are responsible for the proper implementation of the loan activities. They have monthly progress review meetings to monitor the loan progress at the Divisional Secretariat level.

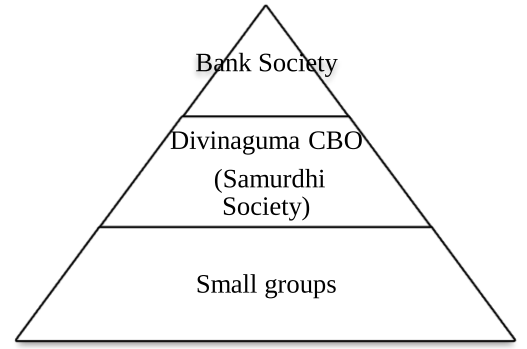
Source: JICA Project Team based on the information from the District Divinaguma Office, Anuradhapura

(2) Organisation and of Divinaguma CBOs

Divinaguma CBOs have been functioning in the Divinaguma (Samurdhi) banking system that is illustrated in Figure 3.11.3. Samurdhi beneficiary families, defined as those with income under LKR 3,500, are gathered to form small groups of five families who mutually help each other. The village society, so-called Samurdhi Society, is the society which is formed by bringing small groups together for the purpose of carrying out development work in the village.

The Divinaguma Banking Society, as the Board of Management of the Samurdhi Bank, has been established at the zonal level consisting of presidents of the village societies. One to two banking societies are operating in each DS division, which means at least one banking society is formed in every 15-20 GN divisions.

The main function of the banking society is to provide loans and social insurance to the Samurdhi beneficiaries and other poor families (although the focus is Samurdhi beneficiaries). The bank is managed and run by the government. Samurdhi funds for Samurdhi beneficiaries are also deposited through the bank account of the beneficiaries.



Source: JICA Project Team

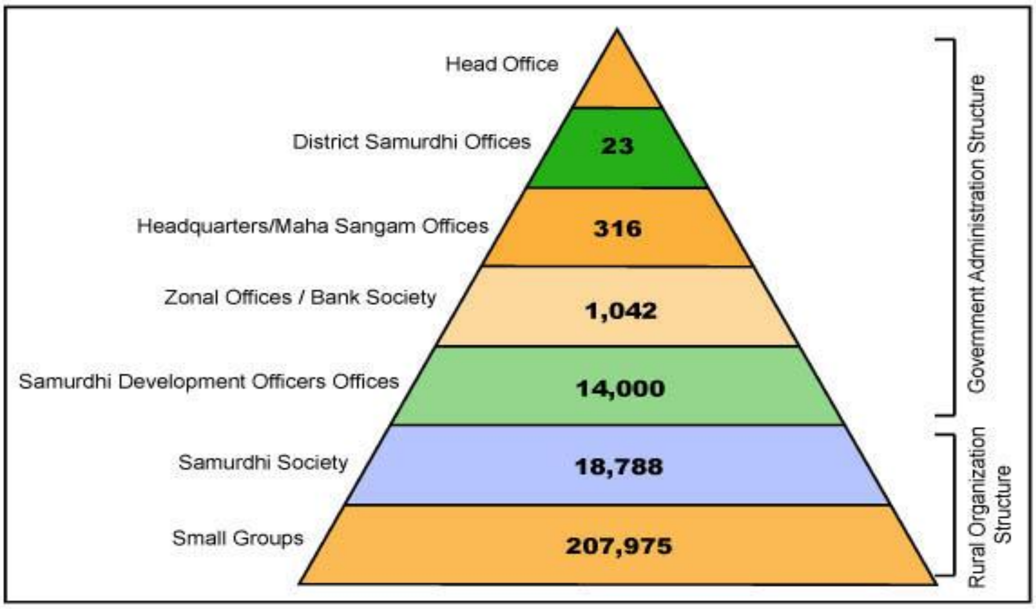
Figure 3.11.3 Structure of Banking Society through Divinaguma CBO

Normal activities conducted by the Divinaguma CBOs/Samurdhi Societies are arranging Suramadhana (communal works), deciding beneficiaries, and conducting monthly meetings. Although the Samurdhi societies were functioning merely for the banking society with the main roles of deciding loan beneficiaries and monitoring repayment, the government is currently developing them as registered CBOs for further activities and associating them with other departments and NGOs.

(3) Government Structure in Support of Divinaguma Programme

Divinaguma CBOs are under the authority of the Department of Divinaguma Development under the Ministry of Social Empowerment and Welfare. At the field level, one or two Divinaguma Development Officer(s) (Samurudhi Officer) are appointed in each GN Division to support and facilitate the CBO activities and to collect information regarding Samurdhi beneficiaries.

The government structure of the Divinaguma Programme is as shown in the following Figure 3.11.4:



Source: Department of Divinaguma Development
http://www.samurdhi.gov.lk/web/index.php?option=com_content&view=article&id=83&Itemid=91&lang=en

Figure 3.11.4 Structure of Divinaguma Programme

(4) Situation of Divinaguma CBOs in the Survey Area

The following Table 3.11.8 shows the number of Divinaguma CBOs in the target area:

Table 3.11.8 Number of Divinaguma CBOs in the Target Areas

DS Division	No. of Divinaguma CBO	DS Division	No. of Divinaguma CBO
Anuradhapura District		***Vavuniya District***	
Mihinthale	65	Vavuniya	201
Horowpathana	79	Vavuniya North	48
Rambewa	72	Vavuniya South	49
Medawachchiya	87	Vengalachessikulam	98
Thirappane	61		
Kebithigollewa	46		
Galenbindunuwewa	132		
Kahatagasdigiliya	94		
Sub-total	**636**	**Sub total**	**396**

Source: District Divinaguma Office of Vavuniya and Anuradhapura District

Livelihood improvement programmes are offered to the Divinaguma CBOs, even though the support is provided to individual families. The programmes fund agriculture, livestock, fishery, and marketing activities. Individual proposals are collected at the GN Division and each proposal is evaluated for funding. This system was introduced in the current year learning from the failures of previous procedures. Several social development programmes are conducted to enhance the capacities of the beneficiaries, which include establishment of infrastructure such as housing and toilets, enhancement of social infrastructure by providing skills development trainings such as handicraft training and polytechnic training to improve livelihood, and providing scholarships.

The major programmes offered by the Department of Divinaguma Development are listed in Table 3.11.9.

Table 3.11.9 Major Programmes on Divinaguma Development

Division	Programme / Support
Agriculture	Promotion of special projects for agro productions, and local food crop cultivation Coordination of small-scale plantation crop cultivators through line institutions Asweddumization of paddy field left fallow Home gardening development project Post harvest technology and processing projects
Animal Husbandry and Fisheries Programme	Milk cow programme, erection of cattle sheds, by-products of milk Establishment of bio gas units and processing of bio gas units Goat keeping projects, pig-keeping projects, poultry-keeping projects Minor fishing year projects, making tanks for ornamental fish Dryfish, Jaadi and maldive fish projects Milk sales and milk collection projects
Industrial Development	Development of small-scale industrial projects. Development of mining villages Development of model industrial villages
Sales and Service	Promotion of Samurdhi domestic sales outlets, rice sales, mobile trading, saloons, restaurant / catering services, servicing vehicles, beauty therapy, domestic services, child care centres, and communication centres
Banking and Financial	Providing loan facilities Promotion of saving
Maha Sangam	Organisation of training courses for livelihood development Compilation of project reports Coordination of support services Maintenance of data system
Social Development	“Diriya Piyasa” housing programme Model villages programme Programs on children and child care

Source: Department of Divinaguma Development

(5) Possibility and Adequacy as CBO to Undertake the Project Activities

Most of the Divinaguma programmes have been provided to individuals through the Divinaguma CBOs. However, the current phase of the Divinaguma scheme intends to develop Divinaguma CBOs to take up collective activities. Divinaguma CBOs are currently registered under the Divinaguma District office. To develop their activities, the Divinaguma District office encourages the Divinaguma CBOs to register under DS offices so that they can take up contacting works (recent legislation defines that any CBO should be registered under DS offices to undertake contracting works). Although they have not taken any contract works so far, it is expected that Divinaguma CBOs undertake minor infrastructure improvement contracts. Since their skill to manage contract works is not well developed yet, they are not encouraged to undertake major contracts.

3.11.5 Cooperative Societies

The Department of Cooperative Development defines cooperative society as "an independent entrepreneurial organisation democratically controlled and aims to achieve common economic, social and cultural needs of a group of individuals voluntarily gathered together and enjoying collective ownership". There are several types of cooperative societies in the country such as credit cooperative societies, agriculture cooperative societies, livestock cooperative society, industrial cooperative societies, fisheries cooperative societies, school cooperative societies, and multipurpose cooperative societies (MPCS). Cooperative societies have the following unique characteristics:

- being an independent organisation;
- a group of individuals that voluntarily and collectively come together;
- collective ownership of members;
- common expectations and needs shared among the members; and
- entrepreneurship with democratic management.

(1) Background and Basic Feature

Cooperative societies in Sri Lanka have a long history which can be traced back to the beginning of the 20th century when the first cooperative credit society was formulated in 1906. With the enactment of the first Cooperative Act in 1911, only credit societies were allowed to be registered under the act. Subsequent amendments of the Cooperative Act have made it possible to establish other types of cooperative societies. In 1930, the Department of Cooperative Development was separated from the Agriculture Department and became an independent institution. In the 1980s, the responsibility for cooperative societies' activities was devolved to provincial councils.

Cooperative societies are regulated under the Cooperative Societies Law No. 5 of 1972 issued by the central government, which is amended by Cooperative Societies Amendment Act No. 32 of 1983 and No.11 of 1992. Each province further prepares Cooperative Society Statutes which are consistent with the law.

The following Table 3.11.10 provides an overview of Cooperative Societies:

Table 3.11.10 Overview of Cooperative Societies

Establishment	Will become eligible to apply for registration after fulfilling basic qualifications to commence a cooperative society by directly getting together a group of people (minimum of 10 persons) to achieve their objectives and who have engaged in cooperative activities for at least six months prior to the registration. For Primary Societies, the minimum number of members is ten. Regarding Secondary Societies, the Primary Societies (minimum of three) which are established based on the needs of the members could join together to form a secondary society with the view of establishing a cooperative society.
Registration	Application document is submitted and the society complies with the provision defined in the statute that: - the activity in which the society proposes to engage is economically viable, - its proposed by-laws are not contrary to the statute.

Membership	Requirements for membership in a society are: (a) residing or employed or owning immovable property within the area of operation of the society, (b) be over 18 years old (except for school cooperative societies). Other criteria for membership shall be specified in the provisions of the by-laws.
Meetings and Organisation	Meetings and organisational structure of the cooperative society are defined in the by-laws. The by-laws is the internal law of a cooperative society. The by-laws gets legal authority after registration by the Registrar of Cooperative Societies subsequent to the approval in the general meeting of the society.
Financing	Cooperative Societies may be financed through the following: - Conducting their business in compliance with the objective of the society and with the development plan approved in the general meeting. - Supplying goods on credit on a formal agreement. - Receiving deposits and loans under the conditions prescribed by its by-laws.
Government Role	Services provided by the department after registration are: advising and supervising by cooperative development officers, provision of basic financial management advice required for good governance, support on development management, personnel management and legal affairs, solving disputes and investigations, giving guidance, recommendations, and advice for the projects designed to achieve the objectives, registering cooperative societies, and conducting audit.

Source: Cooperative Society Statute No. 5 of 2009 of the North Central Province Provincial Council

(2) Government Structure in Support of Cooperative Societies

Cooperative societies are under the control of the Provincial Department of Cooperative Development, and registered directly under the department.

Statutory functions of the Department of Cooperative Development are:

- to register and develop cooperative societies,
- to conduct general audit inspections on the cooperative societies,
- to improve knowledge, practices, and entrepreneurship of the members of cooperative societies,
- to provide guidance and assistance for the organisation, registration, expansion, and strengthening of cooperative societies,
- to maintain the level of cooperative entrepreneurship by acting as an intermediary by expanding knowledge through education and training, providing management consultancy service, and acting as a coordinator between international and national cooperative organisations, and
- to cancel the registration of and dissolve defunct societies and to take action to liquidate such societies.

The Commissioner of Cooperative Development, appointed by the Governor of the province, is given the authority of auditing cooperative societies on the basis of the annual work plan under the Cooperative Societies Act No. 05 of 1972. The department intervenes when a cooperative faces problems such as bankruptcy, management problem, and misuse of funds by appointing an officer to resolve its management. The commissioner's decision has strong power, which cannot be challenged even by the court.

Cooperative Development Officers (CDOs) under the District Assistant Commissioner of Cooperative Development of the area are entitled to advise every society. CDOs are assigned by the provincial government as field officers to support registered cooperative societies. In the case of North Central Province, one CDO is appointed to each MPCS. For other cooperatives, one officer looks after five to ten cooperatives. Although the cooperative societies are under the supervision of the department, they can have their own constitutions as long as they comply with the act and statutes.

The Commissioner of Cooperative Development administers the established fund named 'Cooperative Development Fund'. Each cooperative society contributes 10% of its annual net profit to the fund, which is used as a revolving fund to support the activities of the cooperative societies.

(3) Situation of Cooperative Societies in the Survey Area

Major cooperatives are MPCSs and Thrift and Benefit Cooperative Societies. The situation of the cooperatives varies. While some agriculture-related cooperative societies are functioning in Vavuniya

District, there are no active cooperatives that have agriculture-related activities in the target area of Anuradhapura. Table 3.11.11 below shows the number of cooperative societies in the target area.

Table 3.11.11 Number of Cooperative Societies in the Target Areas

DS Division	MPCS	Agricultural	Inland Fishery	Livestock/Milk Product	Thrift & Credit	Other
Anuradhapura District (Target DS Divisions)						
Kebithigollewa	1	-	-	-	-	-
Medawachchiya	1	-	-	-	2	-
Rambewa	1	-	-	-	1	-
Kahatagasdigiliya	1	-	-	-	3	-
Horowpothana	-	-	-	-	-	1
Galenbindunuwewa	1	-	1	-	4	-
Mihinthale	-	1	1	-	3	5
Thirappane	1	-	-	-	1	-
Anuradhapura Total	**17**	**4**	**7**	**3**	**80**	**13**
Vavuniya District						
Vavuniya	1	6	2	4	75	9
Vavuniya North	1	3	1	1	40	-
Vavuniya South	1	3	4	2	10	-
Vengalachessikulam	1	1	6	2	15	-
Vavuniya Total	**4**	**13**	**13**	**9**	**140**	**9**

Source: Data from Department of Cooperative NCP, and Resource Profile and Statistical of Vavuniya District 2015

MPCS is the major organisation whose schemes, such as the promotion of paddy marketing by supporting the establishment of rice mills, are directly supported by the deparmtent. Although MPCSs have some agriculture-related activities such as operating rice mills, and organising skills development activities with support from the department, collective marketing activities are not common.

In North Central Province, the Provincial Department of Cooperative is trying to promote agricultural activities of the cooperatives, as cooperatives have advantages in purchasing and bargaining power compared to other community organisations such as farmers' organisations. The department also plans to organise divisional level cooperatives as well as district level cooperatives.

With respect to dairy activities, milk collection is mainly operated by dairy companies such as Nestle, Milco, Cargiles, Anchor, CIC Dairies, and Elephant House, some of which organise separate dairy farmers' societies for their own business. In Vavuniya, milk is collected through the network of livestock farmers' group.

3.11.6 Other Relevant Community-based Organisations Functioning in the Project Area

(1) Farmer Managed Society (FMS)

Farmer Managed Societies (FMSs) are dairy farmers' societies introduced and formed by Milco (Pvt) Ltd., a government-owned dairy company. Although FMSs are not registered under any government authority, they are recognized by and registered under Milco. An FMS who supplies milk to Milco consists of 50 to 70 dairy farmers; the minimum number of members to form an FMS is 10 members. Criteria to become a member of FMS are: being dairy farmer, supplying milk to Milco, and to attend FMS monthly meetings. Both men and women can be members. There are some FMSs consisting only of women. Milco collects milk through FMS. The secretary of the FMS collects milk from members with the equipment provided by Milco and the milk collection vehicle of the company collects milk from each FMS and transports it to the chilling centre. There are 13 chilling centres of Milco in Anuradhapura District and Vavuniya District. FMSs are federated at the unit of chilling centre, which consists of 20 to 60 FMSs. Federations consist of the FMS presidents as FMS representatives. Chilling centres are managed by the FMS federation, with support of facilities and some financial allowance[16]

[16] Milco supports operational cost through fixed allowance of LKR15,000 per chilling centre and LKR 0.5/litre of milk collected, which

by Milco. Each FMS has a bank account where the payment is to be deposited based on the record (payment sheet) maintained by the FMS, and the FMS distributes the payment to each member. FMSs are audited by outside private bodies. Milco also provides trainings on an FMS basis. A remarkable benefit of being a member of the FMS is the Farmer Social Security Fund for members. Members credit LKR 0.25/litre of milk sold and Milco deposits LKR 0.5/litre for the milk supplied by the member. There are 18 categories of benefit from the fund, such as hospital cost, support for children, and so on. The benefit is only for the members who supply milk only to Milco. Although the members can still supply milk to other agencies, they cannot receive benefits of the security fund if they supply to other agencies.

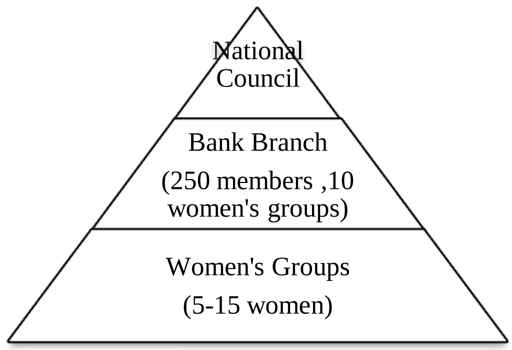
As an organisation, the FMS elects office bearers such as president and secretary in its annual general meetings with the participation of Milco officers, and a veterinary officer is also invited. Major activities conducted by FMSs are collection of milk, monitoring of quality of milk through sample test conducted daily in the chilling centre, managing finance and payment of the members, and conducting monthly meetings to share problems faced by the members and to refer the issues to Milco extension officers as well as to veterinary officers. Some are organising social activities among members such as internal loaning. There are some FMSs undertaking processing of milk production although they are very few.

Even though the FMS is not registered under government authority, government departments are also utilising the society in their programme through Milco. More than half of the total dairy farmers who produce milk are members of the FMSs judging from the rate of supply of milk to Milco through FMS. In the case of the FMS in Galenbindunuwewa DS Division in Anuradhapura, about 25% of the members are totally dependent on livestock for their livelihood, and majority are daily farmers whose main income is from dairy product. Even though most of them, except a few landless farmers, cultivate paddy and other crops, their income from crops are neither stable nor sufficient.

(2) Women Bank

The Women Bank registered under the Cooperative Act is also functioning in the North Central Province, although mainly in Polonnaruwa District.

The Women Bank is a cooperative society registered initially as the ‘Colombo District Women’s Thrift and Credit Cooperative Society Ltd’ in 1991 under the Cooperative Societies Law No.5 of Sri Lanka. With the need of expanding its activities in many parts of the country, the Women Bank was restructured in 1998 and re-registered as ‘Sri Lanka Women’s Development Service Cooperative Society (Women’s Bank) Ltd. It has been developed as a national level cooperative society, built, owned and operated by poor women to serve themselves with their own resources pooling together.



Source: JICA Project Team

Figure 3.11.5 Structure of Women Bank

The Women Bank has around 25,000 low-income members operating in 16 administrative districts in Sri Lanka. It has 55 branches in 6 districts that serve about 15,000 members through around 1,400 groups, whereas in other ten districts, it has mobilised around 10,000 poor women into about 800 groups. The Women Bank provides loans ranging from LKR 250 to LKR 300,000 to its members. The bank also provides other services such as insurance scheme, children savings programme, welfare fund, death donation scheme, human resource development programme, education fund, and health care service.

The management structure of the Women Bank is as shown in Figure 3.11.5. Women’s groups, having members of 5 to 15 poor women living near each other, mobilise their own savings and use them to

amounts to nearly LKR 90,000 per chilling centre per month.

provide small loans to their fellow group members, enabling them to meet many of their urgent day-to-day needs. Bank branch is formed by pooling 10 or more women's groups living at a reasonable distance which can be managed by all the groups. Average size of a bank branch consists of 250 members. They maintain their own sets of books of accounts and prepare periodical financial statements. The Women Bank has the National Council and the National Executive Council at the national level. The National Council is responsible for making policy decisions and for all monitoring and coordinating functions of the bank branches.

3.11.7 Summary of Present Situation and Issues in Community-based Organisation

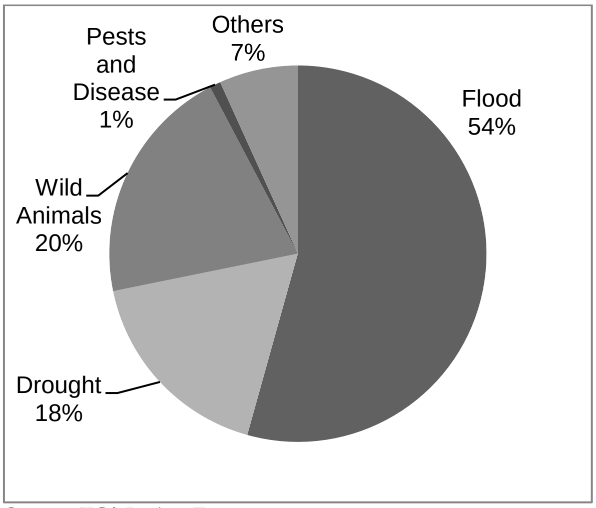
The present condition and issues on the community-based organisation are summarised as follows.

- There is no cascade level organisation.
- There have been several attempts to establish cascade management committees, most of which could not sustain their functions.
- Functioning to a certain extent under close intervention and monitoring by DO/Agrarian Research and Production Assistant (ARPA)
- Discipline has been maintained due to strong interference/penalty of DAD.
- FOs are under the control of DAD, while maintenance of minor tanks are under responsibility of PDI in Anuradhapura. In Vavuniya, the competent authority on both maintenance and FOs are DAD.
- Major agriculture activities are collective decision (e.g. cultivation calendar and cropping plan), but not collective activities.
- Even though they are entitled to conduct agriculture related activities, not many are doing activities further than tank management and distribution of agriculture input supplied/subsidised by the government.
- Regarding marketing, FOs play a role on communication and sharing information.
- Several government agencies manage different schemes with different systems.
- Mahaweli systems are managed by the Mahaweli Authority of Sri Lanka (MASL), while other major and medium systems are under central irrigation department, and minor schemes are handled by DAD and the provincial government.

3.12 Disaster and Prevention Measures

3.12.1 Damage to Agriculture Products

According to a report by the Disaster Management Centre of the Ministry of Disaster Management, floods, followed by droughts, have the most serious impact on the livelihoods of the people in Sri Lanka. It is reported that floods and droughts affected approximately 3,000,000 and 2,000,000 people, respectively, over three decades from 1974 to 2004. They are followed by tsunami, which affected about 1,000,000 people, and cyclones, which affected 300,000 people. Although these statistics show how much impact these disasters have had on people's livelihoods and social infrastructure, they do not indicate how much damage they have caused to agriculture and rural areas. Needless to say, natural disasters can cause damage to agriculture and rural areas. The climate of the Northern and North Central Provinces, like that of Sri Lanka as a whole, is characterised by distinctive wet and



Source: JICA Project Team

Figure 3.12.1 Crop Damages in the Northern Province

dry seasons (the wet season, also known as the Maha season, occurs from October to January, and the dry season, also known as the Yala season, occurs from May to August). This climate typically causes torrential rains (floods) during the wet season and heat damage to crops (droughts) during the dry season. These two kinds of disasters are two sides of the same coin as they are both attributed to the amount of rainfall during the rainy season.

A drought occurs when there is less rainfall than normal during the rainy season, but this hazard can be dealt with in a systematic way because farmers can just give up planting crops when they expect that a drought will occur. Therefore, in general, there are no statistics on drought damage, such as the area of affected farmland and the amount of damage to agriculture.

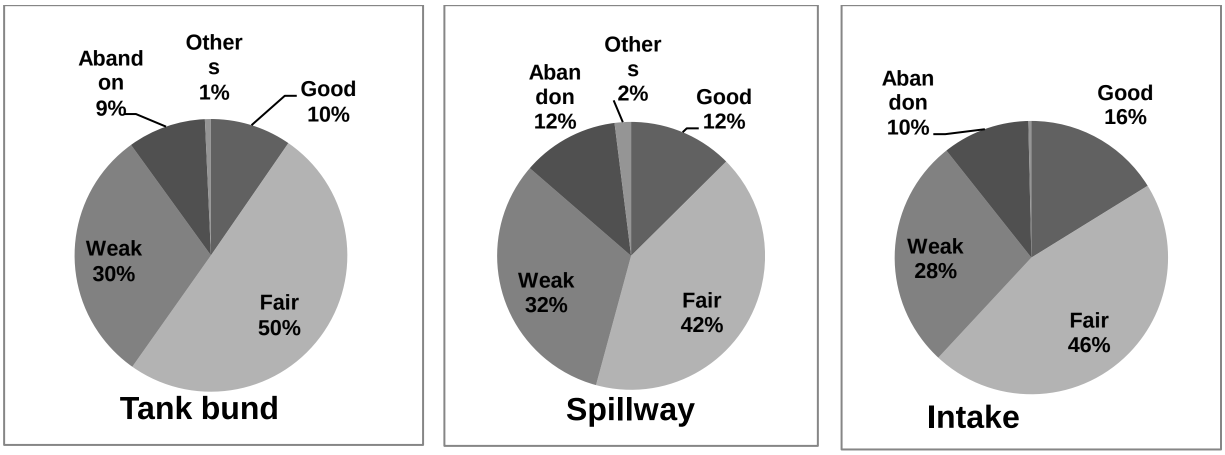
Figure 3.12.1 shows the main causes of damage to agriculture according to a survey of the conditions of irrigation tanks in the Northern Province (Vavuniya District)[17]. The "damage to agriculture" here means damage to rice crops grown with tank irrigation. Out of 585 tanks, this pie chart represents a total of 428 tanks that have been damaged. Because the survey included multiple-response questions, some subjects suggested multiple causes for the damage. While flood damage accounts for a majority, drought and wild animals' damage account for 18% and 20%, respectively. Most of the wild animals' damage here is caused by elephants trampling the fields.

Although there are no similar statistics for the North Central Province, the region is also likely to show a similar tendency, except for a slight decline in the damage caused by elephants.

3.12.2 Damage to Irrigation Tanks

Cascade tanks for irrigation in rural areas also suffered from floods. The report[18] referred to in Figure 3.12.1 also included a survey of the conditions of irrigation tanks. The stability of the performance of individual parts of irrigation tanks is shown in Figure 3.12.2.

The figure illustrates the conditions of tank bunds and supplementary structures (spillways and intake facilities). The responses of "good", "fair", "weak", "abandon" account for almost the same proportions in all parts. This indicates that all parts have been equally damaged by floods, although some tanks may be partially damaged and become entirely unusable.



Source: JICA Project Team

Figure 3.12.2 Conditions of Irrigation Tanks in the Northern Province

As for irrigation canals, "good" accounts for 7%, "fair" for 34%, "weak" for 44%, "abandon" for 13% and "others (collapsed by floods)" for 2%. In the case of irrigation canals, as compared to the body and supplementary parts of irrigation tanks, the ratio of "good conditions" and "bad conditions" is reversed ("bad conditions" accounts for approximately 60%). The reason why irrigation canals are so

17 Department of Agrarian Development, Ministry of Agriculture : Data Book for Village Irrigation Schemes of Sri Lanka, Vavuniya District (Draft) (2016)

18 Department of Agrarian Development, Ministry of Agriculture : Data Book for Village Irrigation Schemes of Sri Lanka, Vavuniya District (Draft) (2016)

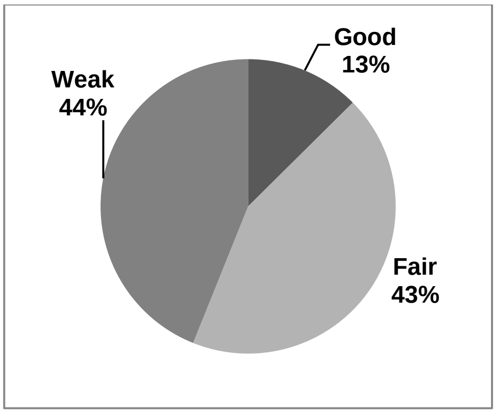
vulnerable is because most of them are unlined earth canals. The description "abandon" means the structure is presently unused due to various causes.

Figure 3.12.3 shows the conditions of irrigation tanks according to a survey in the North Central Province[19]. There are a total of 2,316 tanks. Because of differences in the survey items between the Northern Province and North Central Province, it is impossible to compare the conditions of irrigation tanks between the two provinces from the same points of view. Figure 3.12.3, however, indicates the overall conditions of the irrigation tanks. The stability of the performance of the irrigation tanks of the North Central Province is similar to that of the Northern Province, with the sum of "good" and "fair" accounting for 56% and "weak" accounting for 44%.

Figure 3.12.4 shows the statistics on the proportion of irrigation tanks functioning properly according to the same report referred to in Figure 3.12.3. Those that are being used normally account for 53%; those that are out of use (abandoned) account for 40%; and the irrigation tanks and their downstream paddy fields that are not being used account for 7%.

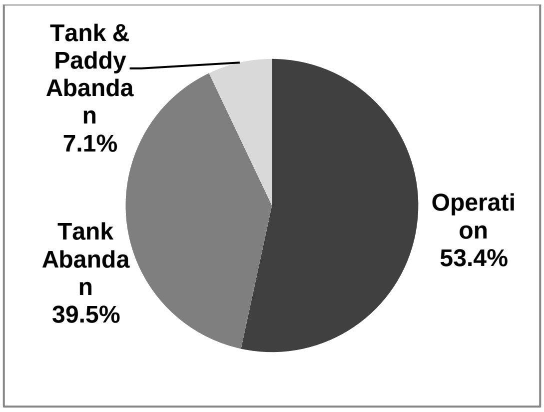
A comparison of the statistics on the conditions and usage of irrigation tanks shows that even in the case of tanks kept in a "good" condition (representing 13%), 3% of the tanks and paddy fields are abandoned. In the case of tanks kept in a "fair" condition (representing 43%), 18% of the tanks and paddy fields are abandoned. In the case of tanks left in a "weak" condition (representing 44%), 24% of the tanks and paddy fields are abandoned. Irrigation tanks and irrigated fields may have been abandoned not only because they suffer from irreparable damage due to flooding but also because of human and social reasons.

A cascade tank system is a system where water resources from small watersheds are temporarily stored in individual tanks and used for agricultural purposes at the maximum efficiency by circulating surface and underground water. Covering an entire watershed from upstream to downstream, this system is managed by multiple farmer organisations. They are interconnected with water resources, but this does not necessarily mean that they are well coordinated with each other. In particular, when a



Source: JICA Project Team

Figure 3.12.3 Conditions of Irrigation in the North Central Province



Source: JICA Project Team

Figure 3.12.4 Usage of Irrigation Tanks in the North Central Province

drought occurs, water does not always reach downstream tanks. In this case, the downstream farmers who cannot carry out agricultural activities will be forced to relocate leaving their tanks abandoned. Thus, quite a few tanks have been unusable due to the lack of coordination and disputes amongst farmers.

In particular, in the Northern Province, farmers were evacuated from rural areas during the conflict (from 1983 to 2009). Some irrigation tanks were damaged during the evacuation, and they are still abandoned because the farmers have not returned, or the damaged tanks have remained unrepaired.

Taking the heavy rain at the end of 2014 as an example, the actual flood damage is described below.

[19] Department of Agrarian Development, Ministry of Agriculture : Data Book for Village Irrigation Schemes of Sri Lanka, Anuradhapura District (Draft) (2016)

When torrential rains hit Sri Lanka in 2014, Anuradhapura had 469.8 mm and 830.5 mm of rainfall in November and December, respectively. These figures are a record high for Anuradhapura, whose annual average precipitation is approximately 1,250 mm.

The floods triggered by this heavy rain affected a total of 285 irrigation tanks (67 breached and 218 damaged) in the North Central Province. The floods also devastated 12,300 acres of farmland and affected more than 6,900 households of farmers. Rice production was estimated to decline by 34,250 tonnes[20].

Source: H.M.Jayantha Herath：Rehabilitation of Minor Irrigation Flood Damages 2014/2015, Presentation (2015)

Figure 3.12.5 Tank Disaster due to the 2014 Torrential Rains (Left: tank breach, Right: spill collapse)

3.12.3 Damage to Agro Roads and Irrigation Canals

Agricultural infrastructure, such as agro roads and irrigation canals, is also susceptible to floods. According to a report of damage to individual DS divisions in the North Central Province caused by the torrential rains in 2014, a total of 321 km of agro roads and a total of 708 km of irrigation canals were damaged by the floods.

In the case of agro roads, the structure called causeway is especially vulnerable. It is a structure located at the point of intersection of an irrigation canal or natural channel and agro road, composed of conduits for water to flow through and a pathway lower than the roads on its both sides, and made of stones or concrete (See Figure 3.12.6).

When flood occurs, a large amount of fast-flowing water will flow through the conduits of causeways, and they will suffer damage due to overflow, scouring, or water pressure strengthened by the floodwater with debris.

Source: JICA Project Team

Figure 3.12.6 Causeway Susceptible to Flooding

3.12.4 Prevention Measures

(1) Concepts of Prevention

The magnitude and frequency of floods vary depending on the precipitation during the Maha season. Either way, floods occur as frequently as every two to three years, resulting in severe damage to

[20] Provincial Irrigation Department：Status Report of 2014/2015 Flood, Minor Irrigation Schemes, North Central Province (2015)

agricultural facilities, such as irrigation tanks, agro roads, and canals. The basic policy of disaster control measures is to repair the damaged structures before the next Maha season.

These rehabilitation works are undertaken by the district offices of the Department of Agrarian Development of the Ministry of Agriculture or the Provincial Department of Irrigation. The rehabilitation costs are funded from (i) the annual budget of provincial governments, (ii) the special budget of provincial governments, (iii) the budget of the central government, (iv) the resources of international organisations, or (v) the resources of NGOs in the order in which they are applied for. These funds are disbursed after applications are reviewed and verified. Therefore, when many facilities are damaged by floods, quite a few repair works cannot be completed before the next Maha season.

In the field, farmers' organisations make emergency repairs to damaged facilities to restore their minimum required functions. Still, large-scale rehabilitation works, such as the repairs of breached bunds, cannot start until they are funded.

The following issues[4)] should be taken into account in flood control measures:

- Changes in the intensity of rainfall due to global climate change
- Deterioration of the strength of the tank bunds that have not been rehabilitated
- Inadequate discharge capacity of old spillway structures
- Lack of operation and maintenance of drainage canals
- Inconsistent development of roads and other infrastructures
- Blockade of spillway and drainage channels due to human activities
- Encroachment into tanks (tank beds) and drainage channels

The concepts of countermeasures to tackle the abovementioned issues are described as follows:

(i) Strengthen the tank bunds that have not been rehabilitated
(ii) Redesign the spillways by taking into account the overall water catchment area
(iii) Regular maintenance of the spill-tail channels and drainage channels
(iv) Remove obstructions from the spillway and drainage channels
(v) Prevent unauthorized entry and interference into the water catchment area

The countermeasures (i) and (ii) can be achieved by systematically funding the rehabilitation and upgrading works for tank structures. The countermeasures (iii) to (v) should be further discussed at Kanna meetings and other occasions because the situation can be improved by raising awareness of farmers' organisations that use and manage tanks and cascade tank systems.

(2) Prevention Measures

A typical flood control measure is to repair the damaged facilities. For example, possible damage to irrigation tanks would be breach of bunds, seepage/piping, sliding of embankments, and damage to intake facilities and spillways. Moreover, agro roads and canals are sometimes washed away or damaged in part or in whole. In the case of such damage, the affected facilities should be restored, one by one, to their original condition by following the budget execution procedures mentioned in above. When a spillway is damaged, it is not only recovered but sometimes also redesigned to enhance its discharge capacity. However, when a tank is breached, only the damaged part is repaired. At this time, especially in the case of minor systems such as cascade tank systems, the embankment is not reconstructed in a fundamental way even if the entire tank bund has deteriorated.

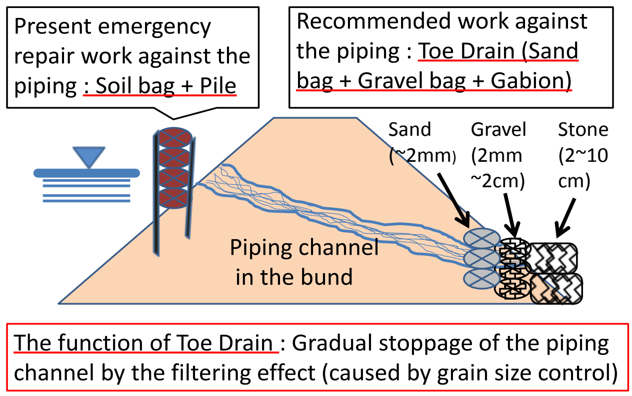
Farmers' organisations are typically the first responders in the rehabilitation after floods. In most cases, they make emergency repairs using piles and sandbags. Figure 3.12.7 (left photo) shows that the embankment with piping holes has been enclosed on the upstream side with sandbags to prevent erosion caused by water seepage. Figure 3.12.7 (right photo) shows an example of repair of a damaged spillway. Because many of the damaged facilities are repaired for emergency use and not prepared for floods in the next Maha season, they become even more vulnerable to floods.

Source: JICA Project Team

Figure 3.12.7 Examples of Emergency Repair Works (Left: Bund Piping, Right: Spill Collapse)

Piping of an irrigation tank is a phenomenon wherein seepage water makes flow channels from the upstream bund surface to the downstream lower surface. The piping channels in the bund are gradually eroded by the concentrated water flow or the water head pressure. This phenomenon is a progressive failure; therefore, it often results in the breach of bund.

The method of emergency repair is usually making a guard for the upstream side piping hole (Figure 3.12.7 (left)) and filling in the downstream hole using soil bags. Because of the possibility of failure again at the same portion, the construction of toe drain is recommended in the repair of the downstream piping hole. Figure 3.12.8 shows the toe drain. Toe drain exercises the filtering effect to soil particle flowing in the piping holes. As a result, the piping holes are plugged gradually. When this happens, it is better to make a choice of repair method that can strengthen the tank bund and facilities.



Source: JICA Project Team

Figure 3.12.8 Prevention Measures against Piping (Toe Drain)

An issue of the prevention measures is the absence of a comprehensive perspective essential to understand the whole area of a cascade system interconnected with surface and underground water. Although many previous studies examined the balance of water in a single cascade system, none of them analysed the system from a flood prevention perspective to identify its weak points. In other words, which part of the system fails to work properly and impairs the safety of the whole system has not been examined.

A reasonable decision can be made on the priority of repairs, repair methods, and sizes by assessing the disaster control function of the entire cascading tank system based on the understanding of water flow through the whole system, rather than by focusing on repairs of individual structures.

Chapter 4 Outline and Progress of North Central Province Canal Project

4.1 Outline and Progress of "Mahaweli Water Security Investment Programme"

The Mahaweli Water Security Investment Programme (MWSIP) is in progress with financial assistance from the Asian Development Bank (ADB). The total financing for the investment programme is under a USD 675 million multi-tranche financing facility which consists of USD 453 million ADB contribution, USD 114 million co-financing, and USD 108 million Government of Sri Lanka (GoSL) contribution. The total duration of the investment program is about ten years starting from 2015. The MWSIP includes Phase 1 of the two-phased North Central Province Canal Programme (NCPCP) that will complete the remaining investments of the Mahaweli Development Program (MDP). The GoSL has identified three main projects under the Phase 1 to be completed with ADB financial assistance.

The Upper Elahera Canal Project (UECP)

The UECP includes two components, namely, “Kaluganga – Moragahakanda Transfer Canal” and “Upper Elahera Canal”. After completion of the first component, it will transfer water from Kalu Ganga and Moragahakanda through a 9 km-canal which will pass through an 8 km-tunnel. The second component, Upper Elahera Canal (UEC), will connect the Moragahakanda Reservoir to existing reservoirs, namely, Huruluwewa, Manankattiya, Eruwewa, and Mahakanadarawa covering 82 km of canals, including a 26 km-tunnel.

The North Western Province Canal Project (NWPCP)

A total length of 96 km of new and upgraded canals (including a 940 m-tunnel) and two new 25 m tall earthen dams will be constructed under the NWPCP. The two dams will impound water to form Mahakithula and Mahakirula reservoirs. It will transfer water from the Dambulu Oya River and the existing Nalanda and Wemedilla reservoirs and finally, it will facilitate existing irrigation and water supply reservoirs.

Minipe Left Bank Canal Rehabilitation Project (MLBCRP)

The project has identified three main work items: (i) heightening the headwork’s weir by 3.5 m and increase upstream capacity, (ii) construction of new intake gates to the left bank canal and emergency spill weirs to both left and right bank canals, and (iii) rehabilitation of the 74 km Minipe left bank canal to ensure water supply to farmers.

In addition, assistance from the investment program is in place for the preparation of Phase 2 projects. The Phase 2 projects will develop additional transfer canals and reservoirs which will finally result to additional diversion of Mahaweli water to feed additional existing reservoirs in the North Central Province. Hoping for financial assistance from ADB, the government plans to implement Phase 2 from 2018-2030. Phase 2 projects may consist of Kalinganuwara Pumping Complex Project, Lower Uma Oya Reservoir Project, Randenigala – Kalu Ganga Transfer Canal Project, and North Central Province Canal Project.

It is envisaged that the impact of the MWSIP will improve agricultural production in the areas of North Central, Central, North Western, and Eastern provinces and achieve sustainable economic growth.

Currently, the activities of MWSIP are in progress and its program management unit (PMU) has been established with necessary facilities and staff in the Mahaweli Authority of Sri Lanka (MASL) located at 493, T.B. Jayah Mawatha, Colombo 10. The PMU was set up and the project management design and supervision consultants (PMDSC) were mobilised. Under the MWSIP, there are several contract-packages for construction work and some are ready to be awarded to contractors, while some are in the preparatory stage.

4.2 Proposed North Central Province Canal Project Under the Feasibility Study

4.2.1 Water Balance Study

For the NCPCP, the water balance study was carried out in two levels, namely, basin level and cascade level. Both levels were studied by Mahaweli Consultancy Bureau (MCB). Basin level study provides information on water distribution to different subcomponents of the project, including NCPC, while cascade level water balance study provides information on irrigation requirements and its variation with time. The water balance study was done by allocating Mahaweli water in almost 100,000 ha of existing and proposed irrigable area and drinking water requirements up to 2040 among six river basins in Northern and North Central provinces under NCPCP.

(1) Water Balance Study at the Basin Level

The Mahaweli water distribution under NCPCP and its conceptual framework, which formed the basis of the water balance study at river basin level, can be described as follows:

(a) Reception Area

The North Central Province (NCP) and Northern Province (NP) areas will become the reception area for UEC diversion. The main river basins identified under the reception zone are Malwathu Oya, Parangi Aru/Pali Aru, Kanagarayan Aru, Ma Oya, and Yan Oya basins which cover 56,350 ha of existing irrigable area under major and minor tank systems with Akathimuppu tank and giant tank systems. In addition to the NCPCP area, it makes the total irrigable area beyond UEC to 99,640 ha with significant number of existing and proposed medium to large irrigation systems in the peripheral area extending irrigable lands. Each river basin can be divided into major and minor systems as shown in Table 4.2.1.

Table 4.2.1 Basin-wise Major and Minor Systems

Malwathu Oya		Yan Oya		Ma Oya		Parangi/Pali Aru		Kanagarayan Aru	
Major	Minor	Major	Minor	Major	Minor	Major	Minor	Major	Minor
Nachchaduwa	CRMAL1	Huruluwewa	CRY1	Padaviya	CRMA	Kurai tank	CRPAR1	Iranamadu	CRKA
Mahawilachchiya	CRMAL2	Brahmanayagama	CRY2	Kiul Oya		Peraru	CRPAR2		
Mahakanadarawa	CRMAL3		CRY3			Upper Parangi	CRPLA		
Pavatkulama	CRMAL4					Pali Aru			
Lower Malwathu Oya	CRMAL5					Vavunikulam			

Source: Feasibility Study of NCPC, Contract No.MIWRM/AGR/Consult/2013/48

(b) Domestic Water Supply Demand

Drinking water demand in NP and NCP has been increasing rapidly due to unavailability of potable water and health issues of current available water. According to National Water Supply and Drainage Board's computation based on population to be served as of 2011, 120L/day per person including commercial, industrial and non-recoverable usage of water has been added. Therefore, this supply of drinking and commercial water requirement to the NCP area could also be considered as an equitable distribution of water among each river basin. Water for drinking under NCPCP is given a higher priority over irrigation.

(c) Hydrology

The NCPC Project envisages supplying irrigation and domestic water to five river basins in the Central Province in Sri Lanka. Out of several rainfall stations in and around the NCPCP area, 19 rainfall stations were considered to be the most representative of rainfall in NCPCPareas. Missing data were filled through regression analysis using groups of stations situated in close proximity; the weighted average rainfall over each river basin were computed.

(d) Methodology

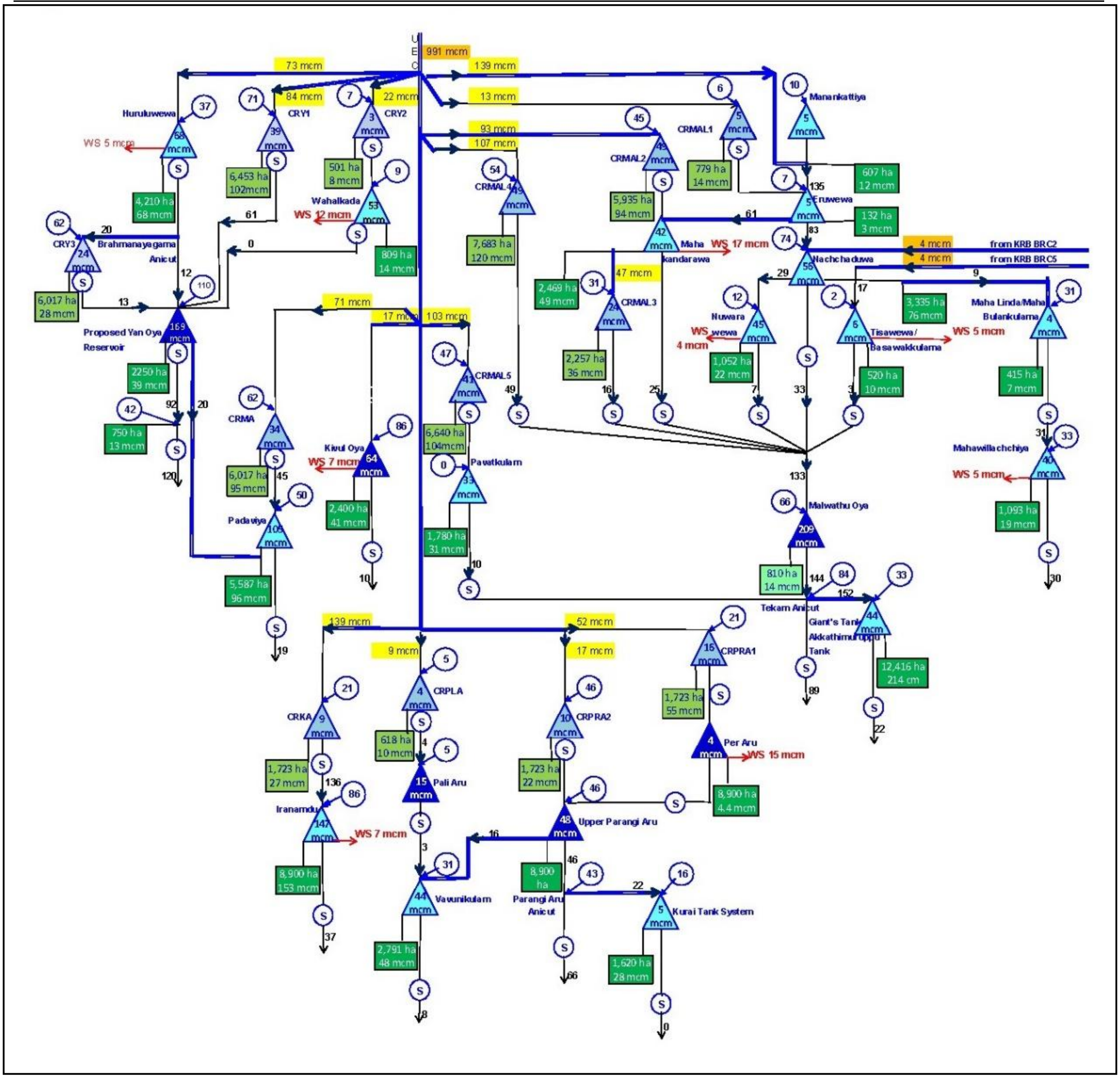
The NCPCP area is represented in a mathematical model via a network of nodes and channels and it's depicted. In addition to the future configuration of the NCPCP area, the main parameters of the conveyance system, irrigation systems, regulatory reservoirs, system characteristics, all constraints, minimum and maximum conveyance capacities of the channels, reservoir parameters, irrigation and water supply demands, and inflows to the reservoirs are incorporated to the computer model for the purpose of evaluating the results based on system performance for past 40 years. Complete water balance study was carried out using ARSP computer model, which is a general multipurpose and multi-reservoir computer model. A series of simulation runs were carried out. The three levels of reliability criteria adopted are the following:

- 5% Yala deficit allowed in 20% of the simulation period,
- 10% of Yala deficit in 10% of time, and
- 20% of Yala total in 5% of time.

Ultimately, the water allocation to different river basins under average hydrologic situation would be done by adjusting the duty of the water for 180% cultivations, and by cutting down the irrigation extents by same proportions in the case of dry hydrologic situation.

(e) Results of the Simulation

Several trial simulation runs were carried out and the results of selected simulation runs were obtained. The simulation results were presented based on reliability criteria, diversions, reservoir spillages, and water supply demands. According to results, 130 ha/MCM during Maha and 100 ha/MCM during Yala will be required to fully satisfy the minor tank system, while 120 ha/mcm in Maha and 90 ha/mcm in Yala will be required to fully satisfy the major tank system. These totals to about 1,020 MCM. There will be corresponding rise in water availability from 180 mm to 305 mm for Malwathu Oya, Kanagarayan Aru, Ma Oya, and Yan Oya, and from 180 mm to 250 mm for Parangi Aru and Pali Aru basins.



Source: Feasibility Study of NCPC, Contract No.MIWRM/AGR/Consult/2013/48

Figure 4.2.1 Schematic Diagram of Water Balance Simulation by MCB Consultant

Table 4.2.2 Cascades an Yala Reliability by MCB Consultant

Scheme	Yala Issue	Maha Issue	Yala 5%	Yala 10%	Yala 20%	Maha 5%	Maha 10%	Maha 20%	Yala Reliability
Manankattiya	7	5		0			0		100%
Eruwewa	1	1		0			0		100%
Mahakandarawa	27	22	3	3	2		0		95%
Thuruwila	2	3							100%
Nachchaduwa	47	28	4	4	2		0		95%
Nuwarawewa	14	9	3	3	1		0		98%
Tis'wa/Basa'ma	5	5	3	2	1		0		98%
Pro Malwathu Oya	7	7	3	3	2		0		95%
TEKKAM ANICUT LB/RB	110	104	4	4	3	4	4	3	93%
Pavatkulam	16	15	3	3	1		0		98%
CRMAL1	8	6		0			0		100%
CRMAL2	48	46	2	0	0		0		100%
CRMAL3	18	17	3	3	2		0		95%
CRMAL4	61	59	3	1	0		0		100%
CRMAL5	53	51		0			0		100%
Maha Bulan/Linda	4	3	3	3	1		0		98%
Maha Willachchiya	10	9	8	8	8	3	2	1	80%
Per Aru	2	2	7	6	5	2	2	2	88%
Kurai Tank System	14	13	3	3	2	2	2	1	95%
CRPAR1	28	27	5	4	1	2	2	1	98%
CRPAR2	11	11	2	2	1	3	1	0	98%
Pali Aru									100%
Vaunilulam	25	23	7	6	4	5	5	2	90%
CRPLA	5	5		0		1	1	0	100%
Iranamadu	79	74	7	5	5		0		88%
CRKA	14	13	2	2	1		0		98%
Kivul Oya	21	20	15	15	13	4	2	2	68%
Padaviya	50	47	5	3	3	3	2	1	93%
CRMA	48	46	5	3	1	2	1	0	98%
Huruluwewa	40	28	3	3	1		0		98%
Wahalkadawewa	7	7	2	2	2	5	5	2	95%
Brahmanayagama	14	14	4	3	2		0		95%
Yan Oya Reservoir	20	19	6	5	4	1	1	1	90%
Yan Oya Anicut	7	6	5	5	2	1	1	1	95%
CRY1	52	50	3	2	1	1	1	0	98%
CRY2	4	4		0		3	2	0	100%

Source: Feasibility Study of NCPC, Contract No.MIWRM/AGR/Consult/2013/48

(2) Water Balance Study at the Basin Level by JICA Project Team

(a) General

According to the water balance study conducted by MCB consultant, the water supplied from UEC is further allocated to the downstream area beyond the NCPCP boundary as shown in Figure 4.2.1. The project team assumes that the same amount of water is allocated to the downstream of NCPCP.
Then, the water balance study was conducted for the targeted cascades without combining the cascades, the water balance of each cascade is simulated.

(b) Methodology

The procedure of the water balance simulation is as follows;
- The result of water balance simulation done by MCB consultant is extracted for aggregated cascades such as CRMAL1 or CRY1.
- The duration of simulation is 40 years which is same as the MCB consultant's study.
- The water balance simulation for target cascades are conducted within each of aggregated cascades models.
- The dependability of water supply is assessed based on the same reliability criteria employed by MCB consultant's study.

(c) Result

The reliability of the water supply of NCPCP is assessed for all of the targeted cascades. The result of the reliability of all cascades are shown in Table 4.2.3, Table 4.2.4 and Figure 4.2.2. As shown in the table and figure, the reliability of the water supply is not even among cascades. There are some low reliability cascades in Malwatu Oya basin. Especially, the cascades in the lower weli oya basin have low reliability from 5% to 69%. Parangi aru and Kanagarayan aru shows high reliability as shown in the table.

Table 4.2.3 Cascades an Yala Reliability (1/2)

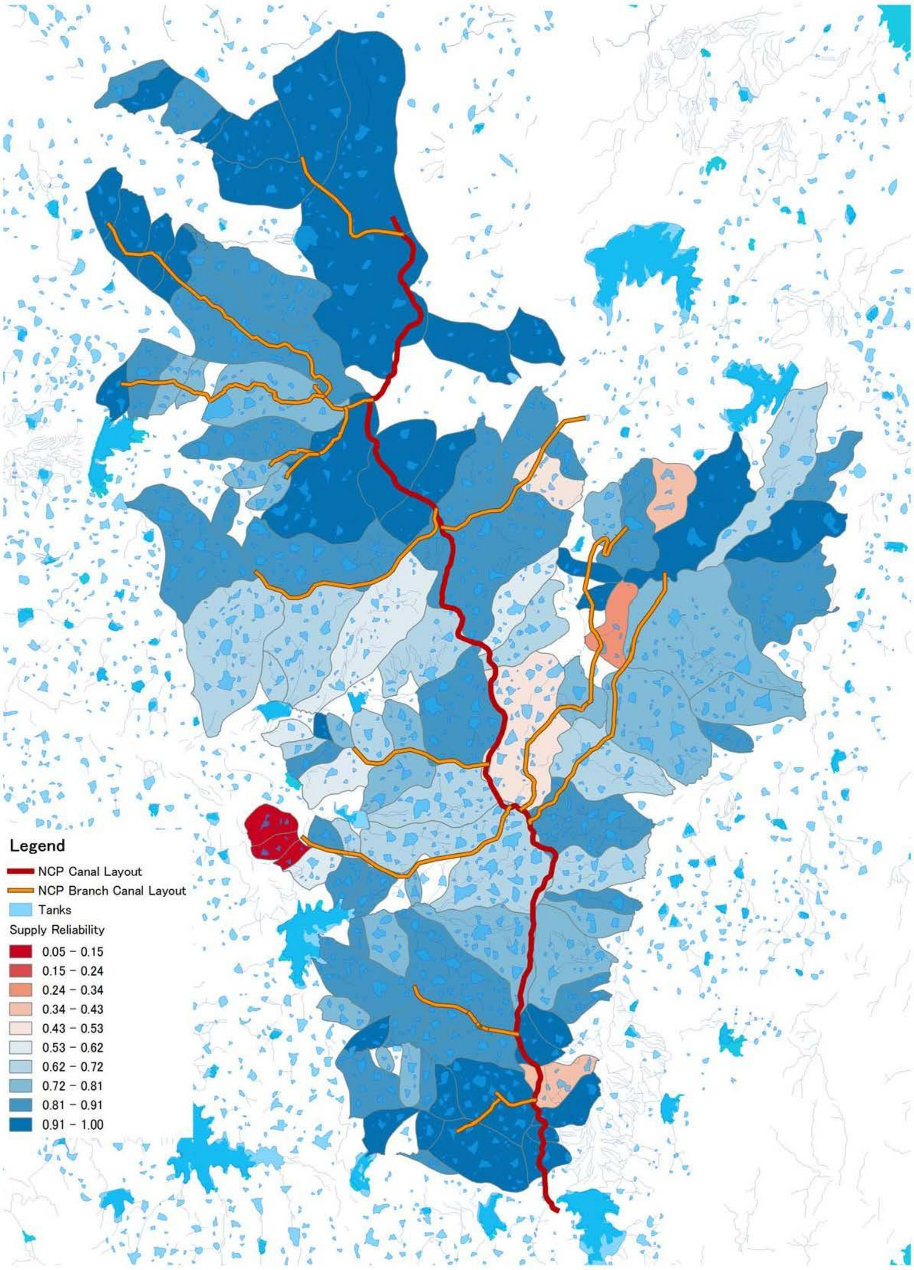
River basin	Sub water shed	Cascade	Symbol	Scheme	Number of Failure						Yala Reliability
					Maha			Yala			
					5%	10%	20%	5%	10%	20%	
Malwathu Oya	Maminiya oya	Siwala kulam	9/MAL2	CRMAL 1	0	0	0	1	0	2	95%
		Bora Wewa	11/MAL2	CRMAL 1	0	0	0	1	1	3	92%
		Pairimaduwa Wewa	12/MAL2	CRMAL 1	0	0	0	0	1	2	95%
		Galwaduwagama	10/MAL2	CRMAL 1	8	10	6	0	2	6	85%
	Upper Kanadara oya	Abagaha wewa	12/MAL4	CRMAL 2	0	0	0	0	1	2	95%
		Periya kulam	11/MAL4	CRMAL 2	0	0	0	1	1	3	92%
		Kon wewa	10/MAL4	CRMAL 2	8	10	6	0	2	6	85%
		Pahala halmillewa	9/MAL4	CRMAL 2	1	0	0	1	3	8	79%
		Tharanogolllawa	8/MAL4	CRMAL 2	1	1	2	0	1	12	69%
		Siyabalabedigaswewa	7/MAL4	CRMAL 2	1	0	0	0	9	9	77%
		Mahagal kulam	6/MAL4	CRMAL 2	0	0	0	0	1	5	87%
		Ichchan kulam	13/MAL4	CRMAL 2	0	0	0	2	2	4	90%
		Katukaliyawa	14/MAL4	CRMAL 2	0	1	0	0	1	5	87%
		Kasamaduwa	15/MAL4	CRMAL 2	0	0	0	2	1	4	90%
		Ittiktiya	16/MAL4	CRMAL 2	1	0	0	0	3	3	92%
		Galmaduwa	17/MAL4	CRMAL 2	0	1	0	1	4	8	79%
		Palugas wewa	18/MAL4	CRMAL 2	0	0	0	0	2	4	90%
	Upper weli oya	Mekechchawa	3/MAL5	CRMAL 2	0	2	0	1	5	7	82%
		Abagahawela	2/MAL5	CRMAL 2	0	2	0	1	3	8	79%
		Ethawetuna wewa	1/MAL5	CRMAL 2	0	0	0	0	0	4	90%
		Ella wewa	4/MAL5	CRMAL 2	0	2	0	0	4	9	77%
		Ranpathwila wewa	5/MAL5	CRMAL 2	0	3	1	0	2	12	69%
		Kukulawa wewa	6/MAL5	CRMAL 2	1	2	0	1	3	9	77%
		Konketupothana	7/MAL5	CRMAL 2	2	0	0	2	0	5	87%
		Gekarawa wewa	8/MAL5	CRMAL 2	0	0	0	0	1	5	87%
	Lower weli oya	Kongollawewa	8/MAL12	CRMAL 3	6	6	6	4	1	15	62%
		Nika wewa	10/MAL12	CRMAL 3	1	7	25	0	3	34	13%
		Hammillewa	9/MAL12	CRMAL 3	4	9	21	1	0	37	5%
		Kuda wewa_1	11/MAL12	CRMAL 3	2	5	25	0	2	35	10%
		Rathmalgaha wewa	12/MAL12	CRMAL 3	4	2	3	3	1	12	69%
		Kudagama wewa_1	13/MAL12	CRMAL 3	3	6	20	0	4	33	15%
	Kudahathu oya	Tibiri wewa	3/MAL6	CRMAL 4	1	2	1	1	1	12	69%
		Gonawa Ihala wewa	2/MAL6	CRMAL 4	3	2	0	2	7	12	69%
		Gonawa wewa	1/MAL6	CRMAL 4	0	1	0	0	5	6	85%
		Kapirilgama wewa	4/MAL6	CRMAL 4	1	2	1	1	3	12	69%
		Siyabalagaswewa	5/MAL6	CRMAL 4	3	1	0	0	1	11	72%
		Thalgaha	6/MAL6	CRMAL 4	0	2	0	2	4	15	62%
		Walketu wewa	7/MAL6	CRMAL 4	1	0	1	1	1	6	85%
		Dumminnegama	8/MAL6	CRMAL 4	0	4	0	1	5	12	69%
		Lidawewa	2/MAL7	CRMAL 4	3	2	0	3	4	15	62%
	Sangili kanadara oya	Pihibiyagollawa	7/MAL7	CRMAL 4	0	2	0	0	1	5	87%
		Kirimetiyawa	6/MAL7	CRMAL 4	1	0	1	0	3	9	77%
		Ralapanawa	5/MAL7	CRMAL 4	2	2	0	0	1	12	69%
		Kardan kulam	4/MAL7	CRMAL 4	3	1	0	0	5	11	72%
		Diulgas Wewa	3/MAL7	CRMAL 4	0	0	0	0	0	0	100%
		Galwiragollewa	8/MAL7	CRMAL 4	1	2	0	0	7	12	69%
		Kirigollewa	9/MAL7	CRMAL 4	1	2	0	3	4	15	62%
		Kudagama wewa_2	10/MAL7	CRMAL 4	2	3	0	1	7	12	69%
		Kuda wewa_2	11/MAL7	CRMAL 4	2	3	0	1	7	12	69%
		Madawachchiya Wewa	12/MAL7	CRMAL 4	2	2	0	0	1	12	69%
	Boo oya	Parana halmillewa	4/MAL8	CRMAL 5	1	1	1	3	2	6	85%
		Kidewaran kulam	5/MAL9	CRMAL 5	0	2	2	3	2	7	82%
		Thibiri wewa	3/MAL8	CRMAL 5	3	0	0	0	1	5	87%
		Tammnennakanda	6/MAL8	CRMAL 5	1	1	2	0	2	11	72%
		Alagalla	7/MAL8	CRMAL 5	1	3	1	1	0	10	74%
		Nochchikulam	8/MAL8	CRMAL 5	1	2	0	0	3	7	82%
		Aluth halmillewa	5/MAL8	CRMAL 5	0	0	0	0	1	1	97%
		Irataperiya Kulam	9/MAL8	CRMAL 5	1	3	2	0	2	11	72%
		Kurundan kulam	10/MAL8	CRMAL 5	6	11	4	18	6	8	79%
		Kandapuran kulam	11/MAL8	CRMAL 5	9	13	4	17	7	8	79%
		Karuweppan kulam	12/MAL8	CRMAL 5	0	3	0	1	1	7	82%
		Suduventapulavu	13/MAL8	CRMAL 5	1	0	0	1	1	3	92%

Source: Prepared by JICA Project Team based on Feasibility Study of NCPC, Contract No.MIWRM/AGR/Consult/2013/48

Table 4.2.4 Cascades an Yala Reliability (2/2)

River basin	Sub water shed	Cascade	Symbol	Scheme	Number of Failure						Yala Reliability
					Maha			Yala			
					5%	10%	20%	5%	10%	20%	
Yan oya	Upper yan oya	Ihalagal kulam	10Y/2	CRY 1	0	1	0	7	3	9	77%
		Eluwan kulama	9/Y2	CRY 1	0	0	0	1	1	3	92%
		Meegaswewa	8/Y2	CRY 1	0	0	1	1	1	3	92%
		Kannimaduwa wewa	7/Y2	CRY 1	0	0	0	3	1	2	95%
		Pahala nittawa	6/Y2	CRY 1	5	4	6	3	7	25	36%
		Puliyan kulam	5/Y2	CRY 1	0	0	0	0	1	0	100%
		Ella wewa	4/Y2	CRY 1	0	1	0	0	1	3	92%
		Olukolagala wewa	3/Y2	CRY 1	0	0	2	3	2	5	87%
		Punchihammillawa	2/Y2	CRY 1	0	1	2	1	3	6	85%
		Mahakirimetiyawa	1/Y2	CRY 1	0	1	2	2	3	9	77%
	Upper middle yan oya	Hettuwewa	7/Y4	CRY 1	2	2	2	4	2	9	77%
		Kon wewa	6/Y4	CRY 1	1	1	1	0	1	6	85%
		Ithalwatuna wewa	5/Y4	CRY 1	1	3	2	3	2	14	64%
		Maha hammillewa	4/Y4	CRY 1	2	2	1	2	2	7	82%
		Moragahadigiliya	3/Y4	CRY 1	0	2	2	1	2	12	69%
		Pemorakewa	2/Y4	CRY 1	1	1	2	2	2	11	72%
		Patanaya	1/Y4	CRY 1	0	1	2	2	2	6	85%
	Middle yan oya	Nilla wewa	2/Y5	CRY 1	2	1	2	5	4	11	72%
		Rathmala wewa	4/Y5	CRY 1	1	2	2	5	2	10	74%
		Ralapanawa	1/Y5	CRY 1	0	1	0	1	0	4	90%
	Lower middle yan oya	Hammillawa	1/Y6	CRY 2	0	0	0	0	0	0	100%
		Dutu wewa	5/Y6	CRY 1	0	0	0	1	0	3	92%
		Kapugollewa ela	2/Y6	CRY 1	2	2	2	6	1	14	64%
		Wagollakada	3/Y6	CRY 1	0	0	1	0	0	4	90%
Ma oya	Mora oya	Maha wewalkadawala	9/MA1	CRMA	1	3	5	0	5	19	51%
		Walahawidda wewa	10/MA1	CRMA	3	1	2	1	11	8	79%
		Ulpathagama wewa	11/MA1	CRMA	5	6	5	2	7	28	28%
		Ulpotha	12/MA1	CRMA	1	0	0	3	3	1	97%
		Kiriketu wewa	13/MA1	CRMA	0	0	0	1	0	0	100%
		Mahatikka wewa	15/MA1	CRMA	0	1	1	0	4	6	85%
		Elapattewa	14/MA1	CRMA	2	1	2	2	10	8	79%
		Gallewa wewa	16/MA1	CRMA	4	4	4	5	7	23	41%
		Ihala thammennawa	8/MA1	CRMA	0	5	2	4	10	12	69%
		Kiulekada wewa	7/MA1	CRMA	1	4	4	2	3	17	56%
		Ayiyatige wewa	6/MA1	CRMA	3	0	2	3	8	7	82%
		Palupuliyam kulama	5/MA1	CRMA	0	1	1	3	0	5	87%
		Ithalwiddawa wewa	4/MA1	CRMA	2	5	2	4	11	20	49%
		Mahanettiyawa	3/MA1	CRMA	0	1	1	0	3	5	87%
		Olugaskada	2/MA1	CRMA	1	1	1	3	13	7	82%
		Sinhaya ulpotha	10/MA2	CRMA	3	1	2	1	11	8	79%
		Pahala herath mamillewa	1/MA1	CRMA	3	4	6	1	3	26	33%
	Mukunu oya	Kunchuttuwa	7/MA2	CRMA	1	0	1	1	5	5	87%
		Puliyan kulama	8/MA2	CRMA	0	1	0	6	5	6	85%
		Maha ralapanawa	6/MA2	CRMA	1	0	0	4	2	3	92%
		Migakada wewa	5/MA2	CRMA	0	0	0	2	3	1	97%
		Viharahalmillawa	2/MA2	CRMA	0	0	0	1	2	1	97%
		Nikawewa	1/MA2	CRMA	0	0	0	0	0	0	100%
Parangi aru	Upper parangi aru / peru aru	Puthuk kulam	5/PAR1	CRPAR 1	1	1	0	0	0	4	90%
		Putuk kulam	4/PAR1	CRPAR 1	0	0	0	0	0	0	100%
		Periya kulam	3/PAR1	CRPAR 1	0	0	0	0	0	0	100%
		Kollamutamadu kulam	2/PAR1	CRPAR 1	0	0	0	0	0	0	100%
		Chinna kulam	1/PAR1	CRPAR 1	0	0	0	0	2	1	97%
		Parandikallu	6/PAR1	CRPAR 1	1	2	0	1	2	4	90%
	Periyakattu aru	Periyakada	6/PAR4	CRPAR 1	2	0	0	2	2	1	97%
		Kidachchuri	7/PAR4	CRPAR 1	0	0	0	0	0	0	100%
		Mullaik kulam	8/PAR4	CRPAR 1	0	0	0	3	1	0	100%
	Thurumpamddi aru	Karunkalisinna kulam	7/PAR1	CRPAR 1	0	0	0	0	2	0	100%
		Marutan kulam	3/PAR2	CRPAR 2	0	0	4	3	3	3	92%
		Naveli Kulam	4/PAR2	CRPAR 2	1	2	1	0	2	3	92%
		Kasawapulaiyan kulam	5/PAR2	CRPAR 2	0	0	0	0	0	0	100%
		Alankulam	6/PAR2	CRPAR 2	0	1	3	2	2	4	90%
		Podun kulam	7/PAR2	CRPAR 2	0	0	0	0	0	0	100%
		Palaimoddalk kulam	8/PAR2	CRPAR 2	2	1	0	1	1	4	90%
Kanagarayanaru	Upper kanakarayan aru	Chamalan kulam	7/MGA1	CRKA	0	0	0	0	0	0	100%
		Periyapuliyan kulam	6/MGA1	CRKA	0	0	0	0	0	0	100%

Source: Prepared by JICA Project Team based on Feasibility Study of NCPC, Contract No.MIWRM/AGR/Consult/2013/48



Source: Prepared by JICA Project Team based on Feasibility Study of NCPC, Contract No.MIWRM/AGR/Consult/2013/48

Figure 4.2.2 Reliability of Water Supply of Cascades under NCPCP

(3) Water Balance Study at the Cascade Level

The main objectives of the water balance study at the micro-catchment level were to estimate the irrigation requirement and its variation with time, and to confirm whether the additional inflow from NCPC would enable the village tanks to perform satisfactorily to achieve the desired cropping intensity. For this study, Mahaweli Consultancy Bureau (MCB) used Pihimbiyagollewa cascade. Monthly inflow to the micro-catchment was estimated based on the diversions calculated in the basin level study. Since the Yala season is the critical season, the assessment was carried out for it.

(a) Crop Water Requirements and Irrigation Requirements

Crop water requirements and irrigation requirements were calculated using the CROPWAT and CLIMWAT models with a few assumptions. Crops which will be cultivated during the Yala season are paddy in three staggers with 30%, pulses with 20%, maize with 20% and vegetable with 30%.. The crop intensity of Yala is 80%.

(b) Results of the Cascade Level Water Balance Study

The study conducted for the Yala season found the following:

- Local inflows and NCPC diversions are sufficient to sustain the expected cropping intensity, based on the crop diversification assumed in the river basin level water balance study;
- Tank water levels become low during June and July; and during those months, the supply from NCPC should be reliable and water management at the cascade level has to be well attended; and
- Release of water from the upstream tanks to downstream tanks, even when they are below spill level, is important to absorb the inflow from NCPC, especially towards the end of the season.

4.2.2 Design of NCPC and Irrigation Water Management Plan

(1) Main Canal

The trace begins at the end of UEC and ends at Rambaiveddiyakulam. The trace lies on the ridge to feed the maximum possible area, and was designed to minimise filling for canal bunds, minimise the environmental and social damage, and limit excavations. The total length of the canal trace is 82.3 km. The canal trace lies in three depression reaches having a total length of 5.7 km where an average fill of around 5.0 m is required. To avoid large earth fill sections, these reaches were provided with aqueducts.

NCPC is a lined open canal. A side slope of 1:1.5 was selected for normal cut sections, and for deep cut sections side slopes, 1:1.25 was selected. Longitudinal slope was determined by topography and energy head required for the flow of water.

- Generally, a velocity of 0.6–0.9 m/s is sufficient to prevent silting, when the silt load is small.
- A slope of 1/10,000 will provide a velocity of approximately 1 m/s.
- In NCPC, the silt load is small, as most local stream flow bypass the canal.
- Adopting a mild slope is useful to make the elevation drop.

The main features of the canal described above are summarised in Table 4.2.5.

Table 4.2.5 Design Parameters of NCPC

Parameter	Value
Design discharge	35 m^3/s
Bed width	6 m
n value	0.015 (for concrete)
Side slope	Normal sections: 1 vertical to 1.5 horizontal Deep cut sections: 4 vertical to 1 horizontal Milder canal slope are proposed at animal escapes
Bed gradient	Normal cut sections: 1/10,000; deep cut sections: 1/6,700
Full supply depth	Normal cut sections: 3.15 m; deep cut sections: 3.95 m
Free board	Lined freeboard: 0.7 m; unlined freeboard: 0.7 m
Canal banks	5.3 m-wide road on one side and 3.0 m-wide maintenance road on the uphill side (in non-forest reaches)
Aqueduct Type-A	No. of bays: 2; width of a bay: 3.90 m; bed slope: 1/1,700; wall thickness: 300 mm
Aqueduct Type-B	No. of bays: 2; width of a bay: 3.50 m; bed slope: 1/1,000; wall thickness: 300 mm

Source: Feasibility Study of NCPC, Contract No. MIWRM/AGR/Consult/2013/48

(2) Main Canal Structures and Locations

A summary of the structures is shown in Table 4.2.6.

Table 4.2.6 Details of Canal Structures in NCPC

Structure	Total Number
Road crossings	43
Drainage over crossings	60
Drainage under crossings	18
Drainage siphon under crossings	21
Turnouts	30
Gated cross regulators	3
Labyrinth weir type cross regulators	5
Level crossings	2
Drop structures	3
Aqueducts	3
Sluice outlet to Kanakarayan Aru	1

Source: Feasibility Study of NCPC, Contract No. MIWRM/AGR/Consult/2013/48

For NCP, the following cross regulator types were considered:

- Gated cross regulators with a linear axis,
- Labyrinth weirs with gates, and
- Piano-key weirs.

Out of the above, gated cross regulators with a linear axis requires readily available labour for operation and easy access. The labyrinth weir minimises the fluctuation of water level and limits the use of labour to pre-determined canal operations at low flows. Although piano-key weir is similar to labyrinth weir in minimising the water level fluctuations, incorporating gates to the weir is difficult. Accordingly, gated labyrinth weir was adopted for the cross regulator.

(3) Branch Canal

Irrigation water is diverted at cross regulators and/or at turnout to the branch canals and/or direct outlet canals to the cascade systems. The branch canals are designed to be supplied continuously, to avoid large cross sections. Under the present feasibility study report, the NCPC is intended to feed target cascade system through ten main branch canals and 30 direct outlet canals.

There are six branch canals (BC-1, BC-2, BC-4, BC-5, BC-6, and BC-8) and ten direct input canals from NCPC for cascades in Malwathu Oya, while one branch canal (BC-8) supplies water for both cascades in Malwathu Oya and the Parangi Aru River basin. Other than the common branch canal, another branch canal (BC-9) is feeding water for cascades in the Parangi Aru River basin from NCPC. For feeding cascades in the Yan Oya River basin, there are ten direct input canals and one branch canal (BC-3.1), while cascades in the Ma Oya River basin are fed by ten direct input canals and two branch canals (BC-3.2 & BC-7) from NCPC.

Branch canal locations are decided in the feasibility study but the design parameters are not decided yet. Design parameter of each branch canal will be decided in the cascade-wise water balance study.

(4) Overall Water Management Plan

The concrete water management plan was not proposed in the feasibility study. However, the following concepts were described in the report:

- Broad-crested weirs calibrated gauge posts are proposed at main cross regulators and at the branch canals.
- Measurement of basic weather parameters such as rainfall and temperature will be useful in irrigation planning and real-time operations. Setting up of weather stations with facilities to measure basic weather parameters is recommended at the sub-watershed level or at appropriate level. The weather stations to be set up under the NCPC Project are managed by the farmers' organisation (FO) in collaboration with schools, etc.
- Water allocation from NCPC to village tank cascades will follow the bulk water allocation concept. Water will be issued from the upstream tank when a specified water level is reached, and an outlet will be provided for this purpose. The amount and timing will be decided through a water balance analysis, which is to be conducted at the detailed design stage. An irrigation schedule will be prepared to regulate the water issues in an equitable manner.

- Irrigation water distribution will have to be planned at micro-watershed and cascade levels in the future, due to augmentation of water supplies from NCPC. Existing tank-based FOs will be strengthened and improved institutional framework will be developed to carry out new responsibilities.
- The irrigation schedule divides the canal into two sections (rotation 1 and 2), and provides for a weekly rotation among the direct turnouts. This arrangement will enable the managers to close down a section of the canal in case of an extreme dry situation. The branch canals are designed to be supplied continuously, to void large cross sections;
- Quantity of water issued to tank cascades, their timing and other precise details cannot be decided at this stage. Information provided by the river basin level water balance study regarding the monthly water releases from the UEC was used as guidance for the feasibility study.

4.2.3 Agriculture Development Plan

(1) Agriculture (Crops), Livestock, Marketing, and Agricultural Extension Plan

The agricultural development plan examines six inter-related components, namely, a) crop production, b) livestock production, c) aquaculture production, d) marketing, e) agricultural extension, and f) environment conservation and protection. The components are presented in two sub-sections and are summarised in Table 4.2.7.

Table 4.2.7 Agriculture (Crops), Livestock, Marketing, and Agricultural Extension Plan

No.	Item	Aim	Activity	Approach
i	Paddy	Increase paddy yield by 10% to 15% in year 1 of the project	Application of strategies and recommendations	Extension and training support to FOs
ii	Other field crops (OFC), vegetables, and fruits	Increase income from low and sparsely used crop lands (28,000 ha to produce 89,000 mt)	Active promotion of diversification	Demonstrations in presently irrigated lands
iii	Irrigated sugarcane	70,000 ha to produce 50% of national sugar requirement	Install processing plant	Investigations in land identified in Horowpothana
iv	Improved irrigation technology	Water-saving and increased productivity and cropping intensity	Use of sprinklers for onion, chilli, and vegetables in the highlands during the Yala season	Promotion
v	Agro-wells	Supplementary irrigation	Irrigation of high value crops during the Yala season	Promotion
vi	Low-cost green houses	Year round high value crop, and big onion and other crop seed production	Introduction of green houses	Demonstrations in selected locations
vii	Highland crops and homesteads	Stabilise seasonally cultivated *chenas* by growing permanent tree crops with underplanting	Establish permanent tree crops underplanted with fodders and grasses	
viii	Horticulture	Take advantage of the high potential for horticultural crops	Promotion of home gardens by provision of quality planting material	Training on pruning and post-harvest technologies, management, and marketing
ix	Livestock production	Improve the livestock production	Organised management, cattle sheds, and stall feeding	Training and establishing links with extension services for AI
x	Inland fisheries	Utilisation of stored water in the tanks collected through the year	Form groups within FOs to carry out related activities and provide boats/nets	Technical guidance of NAQDA Training
xi	Agricultural marketing	Improve farm gate prices due to seasonal gluts and reduction of stakeholders in the market chain	Promotion of post-harvest technologies to improve product quality, establish collecting centres and packing houses.	Training
xii	Agricultural extension	Advancement of the extension system with special attention to the role of women in the farm	Promote agricultural resource management, records-keeping, adopting production technologies,	Seasonal training programs, field tours to other regions,

		(nursery management, processing, storage, and marketing of produce)	skills development, managing post-harvest operations, and marketing of produce. Close collaboration with relevant departments/organisations	demonstrations, field days, and skills development programs
xiii	Capacity building of FOs and local institutions	Strengthening and empowering FOs	Facilitate FOs' involvement in water management, extension, input supply, market linkage building, enterprise development, and agricultural planning	Training

Source: Feasibility Study of NCPC, Contract No. MIWRM/AGR/Consult/2013/48

The cropping pattern, under crop groups of other field crops (OFCs), vegetables and fruits, along with livestock and fisheries, is recommended with minor variations between the Vavunyia and Anuradhapura districts.

Table 4.2.8 Recommended Agriculture Production

Low land	OFC	Vegetables	Fruits	Livestock	Fisheries	Other
Rice	Chilli Maize Kurakkan Green gram Black gram Big Onion	Bitter gourd Capsicum Egg plant Cauliflower Shallot Onion	Mango Papaya Melon Banana Guava Pomegranate Lime	Dairy cattle Buffalo Goat Poultry	Carp	

Source: Feasibility Study of NCPC, Contract No. MIWRM/AGR/Consult/2013/48

Vavuniya District: Cultivation of ground nut, red onion and sesame under OFCs, cabbage under vegetables, and grapes under fruits is recommended.
Anuradhapura District: Fresh water prawn under fisheries and sugarcane under others are recommended.

(2) Environment Enrichment and Improved Land Management

Nearly half of the length of the canal lies in forest habitats. Actions will be taken to carry out the project work with minimum impact to the surrounding habitats by enrichment, restoration or reforestation with indigenous tree/shrub species to enhance diversity, and connectivity among habitats. The areas include the following:

- Left and right banks beyond the canal roadways;
- Areas degraded due to obstruction activities;
- agricultural lands, open lands, and home gardens after construction work is completed;
- Canal banks; and
- Degraded forest covers in catchment areas of small tanks.

The need for an EIA that addresses likely environmental problems such as human-elephant conflicts with appropriate solutions as well as an extended cost-benefit analysis (CBA) on a detailed project design before project implementation are emphasised.
Since lands within the water catchment area are not controlled by the Forest Department, the tendency for exploitation of the forest lands for timber, and encroachment by the community are high. To address the constraints and issues in the NCPC beneficiary area, a participatory environmental conservation and protection approach is proposed. The following aspects are highlighted:

- Management of land resources with forest cover, agroforestry, grasslands, and crop lands in a sustainable manner, rather than reforestation of land selected for conservation;
- Checking soil erosion through construction of contour bunds, silt traps, and biological hedges in both the farmers' lands and crown lands is stressed; and
- Demarcation of a mandatory 100 m to 150 m-wide conservation belt on either sides of the NCPC.

Based on the findings from the Pihimbiyagllewa survey and the prevailing condition in the project area, the following recommendations are made:

- Demarcation, reforestation, and conservation of illegally deforested, abandoned and encroached tank beds, tank reservations, waterways and drainages by the Forest Department and irrigation institutes through community participation;

- Conducting awareness training, establishing plant nurseries, and tree planting campaigns for the community including school children;
- Establishment of agroforestry in *chena* lands and home gardens for timber and firewood implemented by farmers in collaboration with the Department of Agriculture (DOA) and Forest Department; and
- Promotion of non-destructive use of forest resources for small-scale women's enterprises (bee-keeping, etc.) and ecotourism.

4.2.4 Cascade System Development and Management

(1) Model Cascade Study

The beneficiary area of NCPC comprises about 1,100 small tanks contained in 131 tank cascades. The feasibility study selected Pihimbiyagollewa cascade as a model cascade to carry out the necessary studies and surveys for cascade development planning such as socio-economic survey and problem analysis, soil-based land classification, agriculture production, and future water distribution and management.

As a result of detailed studies and surveys in the model site, the f development concepts, discussed in the succeeding subsections, were proposed.

(2) Water Distribution and Irrigation Infrastructure Development

To safely store and distribute the additional water resources throughout the project area, structural improvements are necessary in beneficiary tanks including their sluices, spillways, and tail canal. Water management with proper water allocation plan is needed to divert water to the village tanks from the NCPC. The irrigation schedule prepared to regulate water will enable the distribution of water in an equitable manner in cascade tanks in appropriate amounts and timing.

Through walk-through surveys and topographical surveys, existing link canals and feeder canals were identified and additional needs were proposed. Irrigation water distribution will have to be planned at micro-watershed and cascade level in the future. Currently, tank-based FOs will be strengthened and the institutional framework with new responsibilities will be improved. According to the survey carried out to identify rehabilitation needs of the cascade, the major findings are as follows:

- Due to shrub growth along spillways, tail canals, and feeder canals, water conveyance is reduced, endangering tank bunds and reducing irrigation water supply.
- Due to slope erosion, leakages in tank bunds intensified; and due to silting, tank capacities are reduced.
- Some spillways are incorrectly located, resulting in spill waters destroying agricultural lands. Also, due to inadequate capacity of existing culverts, spill water passes through rural roads.
- Drainage canals have to be improved for better flood management and prevent any waterlogging in the future.
- Several rural roads require gravelling, clearing vegetation on the sides, and improvement of drainage structures.
- Some sluices have to be re-built with gate arrangements. Most of the sluices are working, but require improvement in the approaches, which hinder operation during high water levels.

According to the water balance study that is currently being updated, the water allocation to the NCPC is planned on a monthly basis. Water allocation to the cascades and micro-catchments was made per command area basis, and a micro-catchment level water balance study was carried out with reference to the results of the NCPC water balance study. The objective was to assess whether water allocation from NCPC is sufficient to achieve the planned cropping intensity of 1.8, and it was found that this target is achievable. However, since the NCPC water balance study is being updated, new tank to tank linkages were identified. Also through a pipeline system, water will be distributed for home gardens and sparsely cropped lands.

Moreover, installation of weather stations at sub-watershed level is recommended for efficient water supply operations. Community participation in the management of such stations is required to make their operation cost-effective, and necessary technology transfer should be made.

(3) Associated Infrastructure Development

(a) Agricultural Roads

Agricultural road network is in a very poor condition at present. Improving the network will provide many benefits such as easier mobility of agricultural machinery and agricultural produce, and reduction in the cost of production. Improvements to be carried out include grading and gravelling.

(b) Offices/Buildings Required for Improved Public Agricultural Services Delivery

The community requires offices and buildings for organised agricultural activities and storage of agricultural produce. The planned buildings include the following:

- Community centres (one for each Grama Niladhari (GN) Division); existing community centres will be improved, and
- Storage facilities will be developed at GN division levels, and will be combined with milk collection centres.

(4) Improving Integrated Management

(a) Institutional Arrangement During the Project

A committee chaired by the divisional secretary will oversee and coordinate the implementation of the programme. The committee will comprise representatives from the following: Irrigation Department (ID), Provincial ID, DOA, the Department of Agrarian Development (DAD), and the sectors of fisheries, livestock, and farmers.

(b) Institutional Arrangement During Operation Period

Community-based approach can serve as an important vehicle to build social capital and enhance the capacity for collective action at the local level. Empowerment of the poor, in particular, women has proven to be a very powerful instrument in promoting better opportunities for productive investments and expanding access to income-generating activities and markets in the poorest rural areas.

The project will make optimum use of existing community-based organisations, to improve the institutional framework. A cascade management committee will be formed during the project period, considering that water management decisions have to be made at cascade level after augmentation of the water resources. The committee will make decisions about the cropping pattern, irrigation schedule, transfer of water from tank to tank, and others. It will comprise of the president, secretary, and water manager (*Yaya Niyojitha*) of each tank level FO. The committee will elect or select a president and a secretary for cascade level committee. This organisational set up will be further refined during the detailed designed stage.

The project proposes to form a sub-watershed (sub-basin) level committee to manage agricultural development and water management interventions. A project manager at the sub-watershed level is proposed to coordinate agriculture-related activities including coordination with the private and public sectors. Details are provided in the Cascade Development Plan.

It is required to develop a strong out-grower network and formulate an agricultural credit program. Many farmers are in debt due to crop failures resulting from either frequent or occasional droughts. Moreover, the economy suffered for a long period due to the civil unrest in this area. It is thus necessary to provide bank loan facilities to farmers. To ensure socio-economic development in this area, the project will see to it that the community is introduced to formal banking systems with its assortment of financial services.

The FOs will play a role in the provision of agricultural inputs, and will link up with milk producers' societies, fisheries, and women's societies who are required to increase productivity.

4.2.5 Project Cost and Cost-Benefit Analysis

(1) Project Cost

Table 4.2.9 provides the cost of the main project components.

Table 4.2.9 Cost of Main Project Components

Item No.	Description of Contract Package	Estimated Cost without VAT (LKR in millions)
1	Construction of NCPC from 0+000 km to 89+000 km	20,105
2	Construction of NCP branch canal (length=182.0 km)	13,775
3	Construction of Brahmanayagama Anicut and 32 km long feeder canal	1,922
4	Cascade development cost in NCPC area	15,653
5	Resettlement cost	375
Total		51,830

Source: Contract No. MIWRM/AGR/CONSULT/2013/48, Final Report Volume 1 Main Report

The NCPC and diversions to Yan Oya basin were made possible by several associated projects including the UEC. Therefore, a realistic comparison of costs and benefits of the project is not possible by isolating the components in this feasibility study. A CBA was carried out for the entire NCPC Project, and its results are summarised below.

The NCPC Project, in a broader perspective, includes the following components:

- The conveyance route from Randenigala Reservoir to Kaluganga Reservoir,
- The link route from Kaluganga Reservoir to Morgahakanda Reservoir,
- The UEC from Morgahakanda Reservoir to the outlets of Manankattiya – Mahakanadarawa irrigation system,
- The Huruluwewa – Yan Oya Anicut system and the conveyance of additional water to Mhakanadarawa and Nachchaduwa – Nuwarawewa systems,
- The NCPC starting the end of the UEC (Yalkalla) to Chemamadukulam,
- Pumping complex at Kalinganuwara and Angamedila, and
- NWP canal starting from the downstream of Bowatenne to irrigation systems in Mi Oya and Hakwatuna Oya irrigation systems.

In the area to be benefited by the broader NCPC Project, the cultivation is mostly carried out during the Maha season. After the completion of the NCPC project, about 80,000 ha in the project area will be benefitted by being able to cultivate during the Yala season too. When considering only NCPC (from Yakalla to Chememadukulam), 33,000 ha will be benefitted.

(2) Methodology Used in the CBA

The CBA of the project was conducted in two parts:

- A comprehensive analysis of the economic benefits up to 30 years of project period, quantified in terms of the financial and economic value of the output including value-added, indirect benefits, and employment; and
- Finding the internal rates of return (IRR) on economic and financial terms, the net present values (NPV), and the cost/benefit ratios with sensitivity analysis.

Table 4.2.10 Economic Investment Cost of NCPC Project (2015-2029)

(Constant mid-2014 prices)

Investment Cost Items	Construction Period	LKR in billions	% total
PHASE 1		71.3	35
Minipe Left Bank Canal Rehabilitation	2015-2019	2.8	1
North Western Province Canal	2015-2022	15.1	8
UEC and KMTC	2015-2024	46.3	23
Other	2016-2024	7.0	3
PHASE 2		130.4	65
Kalinganuwara Pumping Station	2015-2019	24.9	12
Other Phase 2 Investments	2029-2029	105.4	52

Source: ADB, based on MCB

The total estimated capital construction cost of the project, which is LKR 201,700 million, will be spent over the first ten years of the project.

The NCPC Project will divert about 1,200 MCM per year; and this will be allocated to hydropower, domestic uses, and agriculture. The benefits include the following:

- Yield increase in existing paddy land through agricultural extension,
- Supply water to cultivate non-cultivated lands during the Yala season,
- OFC cultivation,
- Cultivation of sugar cane, and
- Provision of drinking water and hydro-power generation.

A 30-year cash flow was used to analyse the project costs and benefits. Over the 30-year cash flow, the financial and economic NPVs were calculated in LKR terms using discount rates 8%, 10% and 12%.

(3) Results of the CBA

According to the Technical Assistance Consultant's Report of the ADB, at present, cropping intensities (Cls) in existing cultivated areas are suppressed mainly because of persistent shortage of irrigation water. Records of the MASL indicate that cropping intensities are about 50% lower during Yala than Maha. At present, the average cropping intensity of the agricultural benefit is 1.42. This means that about (1.42*232,500 ha) 331,000 ha is harvested on an annual basis. Upon completion of the project in 2030, the Cl will increase to 1.86. As a result, and taking into account the impact of climate change, the harvested area will increase by about 107,000 ha, with an annual agricultural production increase of over 1 million tonnes.

The increase in the value of farm gate output over the 30-year cash flow within the command area is calculated as follows: the value of output (i.e., gross farm revenue) increases from LKR 11 billion to LKR 18 billion annually through yield increase in existing paddy lands. The OFC cultivation, increased paddy production, and increased sugar cultivation will result to an increase of the total annual farm gate value of agricultural production by more than LKR 23 billion.

The NCPC Project will provide a range of benefits including economic, social, and environmental benefits. Benefits include improvement to farmers' living conditions and improved domestic water supply. Increase in secondary productions and services market expansion resulting from the increased primary agricultural productions and increased employment opportunities (which are estimated to be approximately 40,000) are some of them.

The CBA at the farm gate level shows that the project will have net economic benefits. The NPV is LKR 755 billion (in 2014 rate) over 30 years. The benefit-cost ratios from the sensitivity analysis shows are 2.11, 1.73, and 1/49 at discount rates of 8%, 10%, and 12%, respectively. The NPV increased to LKR 80,025 million at discount rate 10% . At 10% economic IRR, the project is considered satisfactory. Hence, it can be concluded that the NCPC Project is feasible from both financial and economic viewpoints.

Chapter 5 Cascade System Development Concept Under North Central Province Canal

5.1 Overall Concept

5.1.1 General

Cascade systems in the north central region were developed to function principally as paddy growing area under the distinctive agro-ecological characteristics leading to a unique way of life among the farming communities who inhabit the villages. The total extent cultivated in both Anuradhapura and Vavuniya districts during the 2014/15 Maha season is about 62,587 ha which included 32,222 ha of irrigated paddy and 11,766 ha, 15,249 ha, 3,218 ha of paddy, maize and pulses, respectively under rain-fed conditions. A minor extent of rain-fed was also grown. Compared to the Maha season, the extent cultivated during the subsequent Yala season was significantly lower due to scarcity of water. During the 2015 Yala season, only 18,092 ha were cultivated which is 29% of the total asweddumized extent. The above 2 seasons can be considered as a production year with normal rainfall distribution. It is therefore apparent that the average extent cultivated by a farmer during the Yala season is low and accordingly his farm income is less as cultivation is virtually restricted to irrigated paddy.
Data pertaining to selected cascades reveal that the average total landholding is 1.80 ha per household and the cultivated areas were 1.8 ha and 0.26 ha in the Maha and Yala seasons, respectively. The present seasonal cropped extents and net profit realized per household are shown in Table 5.1.1.

Table 5.1.1 Present Typical Agriculture per Household in Target Area

Crop	Cultivation Type	Extent (ha)		Net Profit (LKR)	
		Maha	Yala	Maha	Yala
Paddy	Irrigated	0.95	0.25	52,500	13,700
	Rain-fed	0.135	-	6,500	-
Coarse grains	Irrigated	-	-	-	-
	Rain-fed	0.352	-	27,300	-
Legumes	Irrigated	-	-	-	-
	Rain-fed	0.042	-	6.200	-
Condiments	Irrigated	-	-	-	-
	Rain-fed	0.017	-	3,500	-
Vegetables	Irrigated	-	-	-	-
	Rain-fed	0.004	0.005	900	2,700
Mixed Crops (1)	Irrigated	-	-	-	-
	Rain-fed	0.3	-	20,100	7,500
Total		1.80	0.26	117,000	23,900

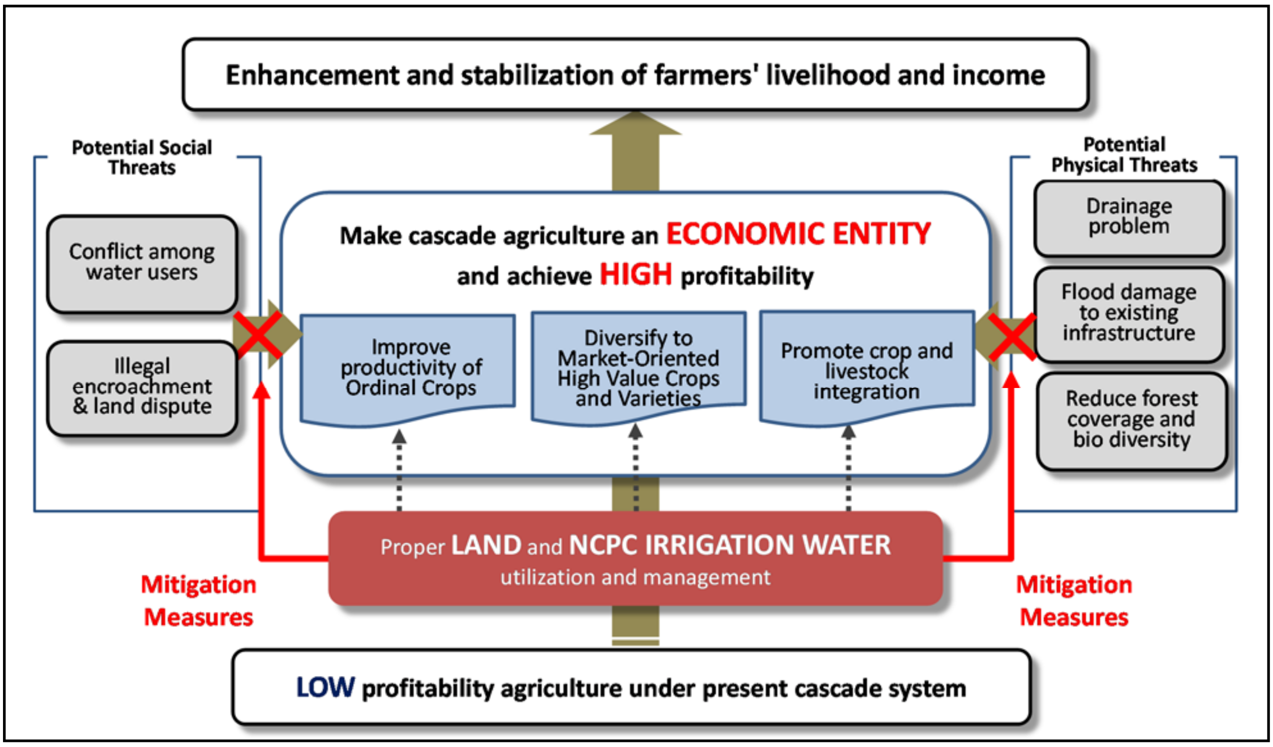
Note : (1)Mixed crops refer to permanent and seasonal crops cultivated in the home garden
Source: JICA Project Team prepared based on detailed survey data

Table 5.1.1 shows that the profit from an average farm-holding is LKR 117,000 and LKR 23,900 during the Maha and Yala seasons, respectively. The figures indicate the present agricultural situation does not generate adequate net farm income to farmers for further farm investment to initiate intensive agriculture. These conditions have caused them to lose interest in farming and be more dependent on non-farm income sources. As a result, the technologies may not be updated leading to decline in crop productivity and deterioration of the farm earnings which is a key contributor to the local economy.

In order to arrest this decline and to improve the present farming situation, the project envisage to transform the cascade agriculture from one of subsistence to operate as an “economic entity” in a sustainable manner to enhance and stabilize farmers’ income through efficient utilization and management of the farm resources. land and irrigation water from NCPC. Though the availability of irrigation water may increase cropping intensities, simple augmentation will not bring enough profit to the farmers. In order to make the cascade agriculture an “economic entity” appropriate qualitative changes are indispensable.
Figure 5.1.1 shows the basic concept for cascade system development. Although the NCPC is

expected to bring economic benefits to the target cascade systems, social and physical threats may also appear at the same time. Conflicts among water users in the same cascade system may occur due to introduction of water sharing among tanks. Illegal encroachment and land dispute may be accelerated due to the increment of value of the land. Forest conservation may be reduced, the drainage problem may increase due to rise of water table in the land and the damage to tanks and irrigation facilities due to floods may increase.

The project addresses and mitigates these potential threats by proposing a proper development concept of water distribution and management, and facility for institutional development. The conceptual idea of each plan is described in the following section.



Source: JICA Project Team

Figure 5.1.1 Basic Concept for Cascade System Development

5.1.2 Concept for Profitable Agriculture

Table 5.1.1 shows that the annual net income from crop production per household is LKR 140,900. This represents a monthly income of LKR 11,774 which is far below that of average income of middle level employees in the public service (National Salaries Commission: 2016) or the monthly expenses of the rural sector in the region (Dept. of Census and Statistics: 2016). It is envisaged that the cascade agriculture, which hitherto remained totally dependent on seasonal rainfall, will greatly benefit with the release of irrigation water from NCPC. The planned improvement of the irrigation infrastructure, water management and adoption of crop production technologies are expected to bring about significant changes in the rural economy. Some of the outcomes envisioned with project conditions are listed below.

i) Assured water supply for crop production in both seasons;
ii) Increased cropping intensity since cultivation is possible during the Yala season and possibly a mid-season;
iii) Reduced crop water stresses in the growing period leading to higher productivity and profitability
iv) Create new job opportunities for the youth
v) Rising of the ground water level of the cascade areas leading to higher recovery rates of Agro-wells due to retention of water over extended periods leading to:
    - Possible extension of cultivation period in the lift irrigated areas thereby allowing farmers to benefit from price advantage during the off-peak production periods,
    - Increase in the volume of vegetative biomass availability in the area as fodder for stall

feeding of cattle.

- Possible establishment of horticultural crops with deep root system in the rain-fed areas.

Though the advantages accrued under the project conditions are many, some drawbacks may arise with regard the following;

i) Reduction in the free grazing area for ruminants as a consequence of;
   - Diminished extents in the tank bed area since full supply level will be maintained over extended periods,
   - Decreased extents of fallow land areas in the irrigated fields due to increased cropping intensities;

ii) If the desired crop diversification is not adopted by the farmers, it will pose some threats in relation to;
   - Possible over-production of ordinal crops leading to decline in product prices and farm profitability,
   - Reduction in the cropping intensity in the Yala season due to high consumptive use of paddy.
   - Only marginal increase in the farm income would be realized

The project proposes qualitative changes to the present agriculture such as (1) increase in the productivity of ordinal crops, (2) diversification to market oriented high-value crops and crop varieties and (3) crop/livestock integration as major strategies for profitable agriculture. It is envisaged that the increase in farm income would enhance welfare of household members and boost up farmers esteem. This would lead to emergence of cascade agriculture as profit generating professional enterprise thereby attracting the youth who avert taking up farming as a carrier and tend to seek off-farm employment. The concept of profitable agriculture is advanced based on presumption that the farmers' net income level should equal or exceed that of middle level wage earners at the national level. If the income derived from rain-fed agriculture is maintained at a constant level of LKR 74,700, a substantial increase in the present profitability level of LKR 66,200 from irrigated farmland would be required. Considering the present wage of middle level earners at the national level of LKR 500,000 per annum, to achieve the status of an "economic entity", a minimum annual profit margin of LKR 500,000 per average household is targeted.

Profitable agriculture cannot be materialized without appropriate market strategies. Such operational marketing systems are more common in major irrigation schemes than in the minor schemes. In the, case major schemes such as Hurulu Wewa and System H, many success stories of contract farming supported by assured quantity and variety of products are observed. Through promotion of market oriented crops in the cascade system, the production volumes could be increased to attract private sector buyers engaged in major agribusiness and processing industries. Such transactions could be strengthened through contract/contact farming systems.

5.2 Basic Concept for Infrastructure Development

5.2.1 Water Distribution and Management

(1) Equitable Water Allocation to the Cascade System

The water balance of NCPC was studied by the Mahaweli Consultancy Bureau (MCB) and was compiled in the final report (hereinafter called "Pre-FS report") in September 2015. The water balance of NCPC in the Pre-FS report considered the water flow through Upper Elahara Canal (UEC) and considered further water allocation to the areas outside NCPC such as Malwatu Oya, or Iranamadu reservoir. According to the Pre-FS report, inflow to NCPC from UEC is shown in Figure 5.2.2. Since NCPC is a part of the large water balance system, it is responsible to release water for beneficial use in the downstream areas of NCPC. With this concept, the water balance study of NCPC was again conducted in detail for the selected cascades as described in Section 4.2.1.

As described in the previous chapter, the North Central Province Canal Project (NCPCP) under the Mahaweli Water Security Investment Programme is a national project with large government investment. The newly developed water resources should be distributed in an equitable manner among target beneficiaries. Then, the project assumes the following water distribution concepts:

a. As "equitable share" concept is simple and can be accepted in Sri Lanka, this concept is employed as the distribution policy of NCPC.

b. According to the equitable share, water is simply distributed proportionally to the irrigable area held by each cascade.

c. Equitable share does not consider inflow within the cascade catchment area, nor the effective rainfall in a cascade.

Thus, the water conveyed by UEC is further distributed by the equation:

$$Q_{dist\_irr\_area} = Q_{irr\_block} \times \frac{Area_{irr\_area}}{Area_{schem\_irr\_block}}$$

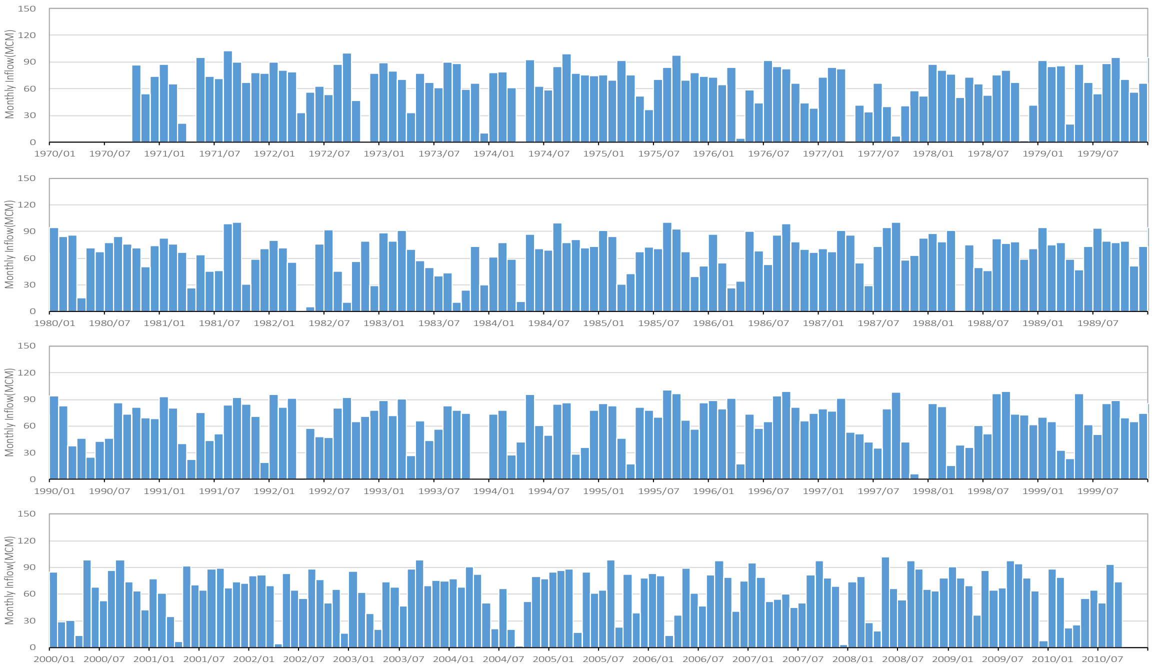
Where, $Q_{dist\_irr\_area}$ is the distributed water for irrigation area, Q_{irr_block} is the water allocated for the irrigation block, $Area_{irr\_area}$ is the irrigable area in a cascade, and $Area_{schem\_irr\_block}$ is the scheme irrigation area.

There are two considerable types of water distribution system, namely, supply-oriented and demand-oriented water allocation. Since there is not enough regulating capacity/facilities before NCPC or between Moragahakanda and the cascade system, the proposed distribution from upstream to the cascade system is supply-oriented water allocation. The project proposed the irrigable area based on the equitable water allocation to the cascade system.

Source: http://www.pref.niigata.lg.jp/kashiwazaki_nogyo

Figure 5.2.1 Jet Flow Distributon

The water conveyance from NCPC to cascade system will be through a branch canal. The branch canal distributes water to the tertiary canal at the division work. If the division discharge from the main system to the sub-system is more than 20% of the total flow discharge, the bifurcation, as a diversion structure, may divert constantly based on the proportion of the crest width.



Source: Pre-FS report

Figure 5.2.2 Inflow to NCPC from UEC

(2) Water Distribution Within the Cascade System

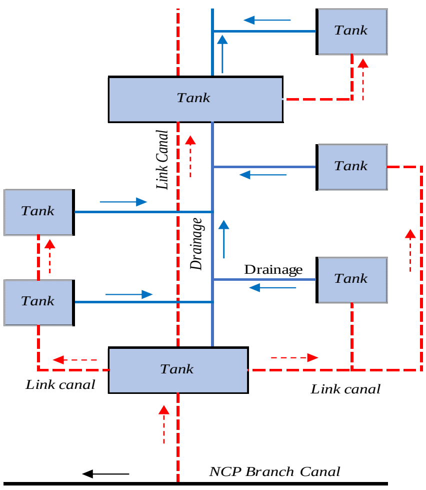
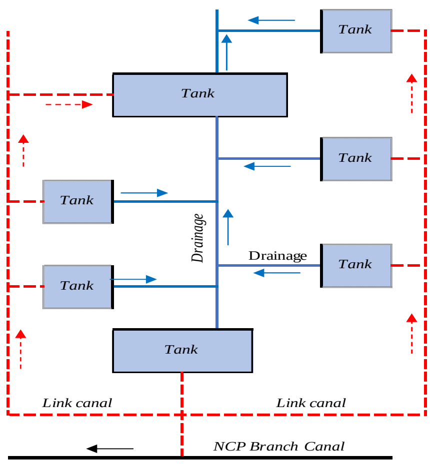
After distribution of irrigation water from the branch canal to the cascade system, two water distribution methods can be considered, namely, Option A and Option B. Option A supplies the NCPC water from the branch canal to several tanks located in the upstream of the cascade system and distributes the irrigation water to the downstream tanks as spilled water and/or return flow through the existing cascade system. Although Option A minimises the project cost, over usage of irrigation water in the upstream tank may cause unfair distribution of irrigation water amongst cascade beneficiaries. Option B supplies water to beneficiary tanks through connected link canal directly from the branch canal to every tank. Although Option B raises construction cost, it may ensure the equitable share of irrigation water amongst cascade beneficiaries. The pros and cons of the both options are summarised as follows.

Option A: The irrigation water diverted from the division works of NCP Branch Canal is distributed to the upper most tanks (there are in case of multiple tanks as the upper most tank). The irrigation water flows from an upper tank to a lower tank by using head difference between tanks. Pipeline and open channel are considered as distribution types. The distribution type will be selected based on the conditions (topographic, land acquisition, design flow quantity etc.).

Option B: The irrigation water diverted from the division works of NCP Branch Canal is directly distributed to each tank. The irrigation water flows from the division works of NCP Branch Canal to each tank by using head difference between the division works and tanks. Pipeline is considered as a distribution type based on topographic conditions.

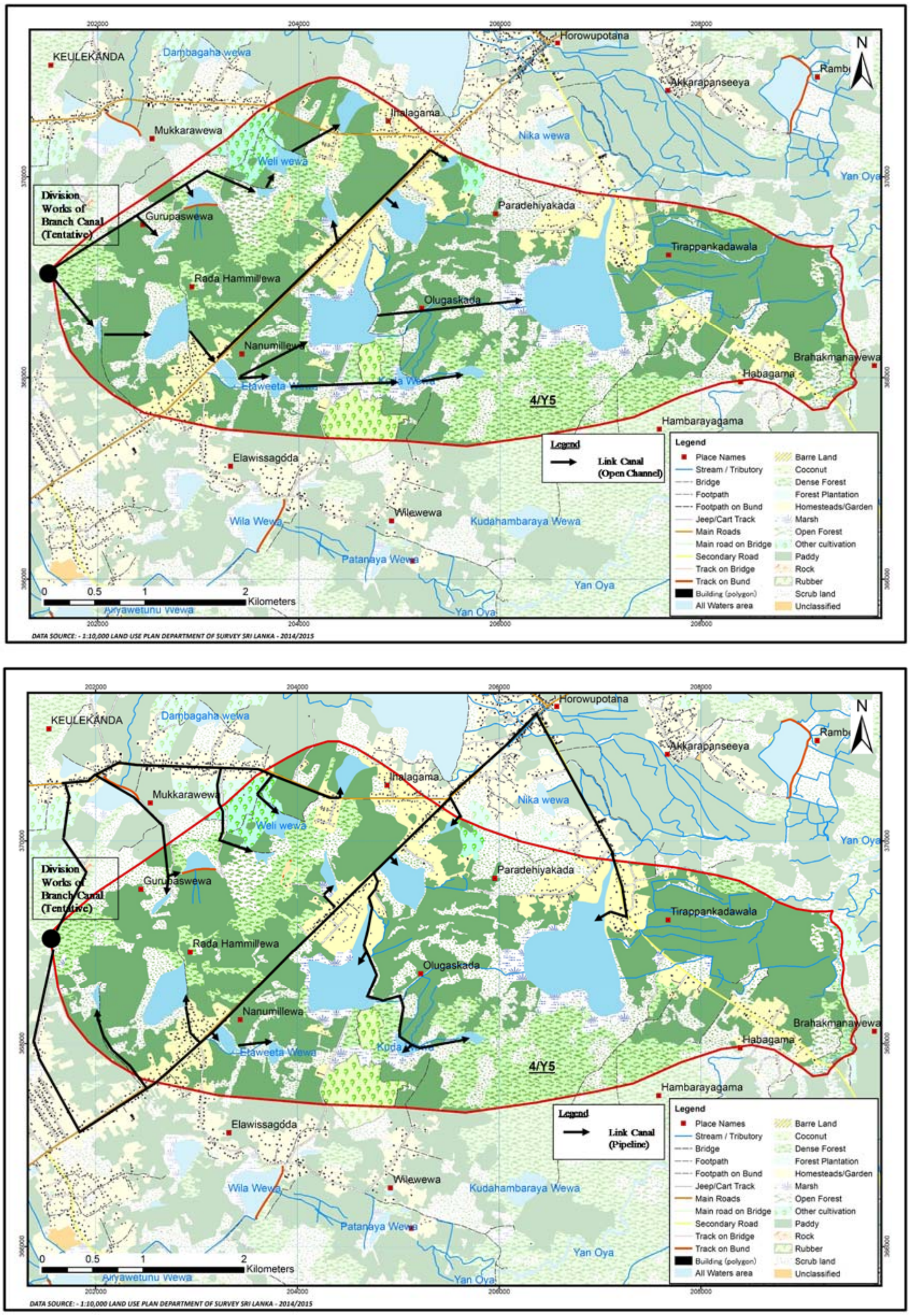
By using the regulating function of the tank, both options can allocate irrigation water based on the demand within a tank command area, though the water distribution system of both options from branch canal to cascade is supply-oriented water management., Considering the construction and maintenance cost of the system, the option A was selected for the water distribution system.

The schematic drawings of Option A and Option B and proposed canal layout for the model case (Ratamala Wewa, Yan Oya basin) are shown in Figure 5.2.3 and Figure 5.2.4, respectively.

Option	Option A	Option B
Concept	Water distribution from an upper tank to a lower tank	Water distribution from division works of NCP Branch Canal to each tank
Image		
Water management	Supply-oriented water control	Supply-oriented water control
Distribution quantity	Optimisation of quantity based on irrigation area based equitable distribution	Optimisation of quantity based on irrigation area based equitable distribution
Distribution Canal type	Pipeline or Open channel (basically constructed under existing canal or paddy field)	Pipeline (basically constructed under existing road)
Construction cost	Low	High (Length of canals is longer than Option A. Refer to Figure 5.3.4)
Maintenance cost	Low	High (due to long canal length)
Evaluation	**Selected**	—

Source: Prepared by the JICA Project Team

Figure 5.2.3 Water Distribution in Cascade for Both Options



Source: JICA Project Team

Figure 5.2.4 Layout Plan of Both Options (4/Y5_Ratamala Wewa)

5.2.2 Facilities Rehabilitation/Development and Management

Although necessary facilities to utilise the NCPC irrigation water effectively are varied based on the water allocation concept such as Option A and Option B as described in the previous sections, the common conceptual ideas for facilities development and rehabilitation plan are described in this section.

(1) Firm Facilities to Ensure Irrigation Water and Prevent Flood Damage

With the allocation of the irrigation water from NCPC, the present farming became an intensive irrigated agriculture; and investment from farmers may increase aiming for high profit. To support the intensive farming, firm facilities to ensure irrigation water as well as to mitigate drought and flood risks are needed. Especially, the risk of flooding is considered to increase due to the augmentation of available water resources after NCPC construction.

The Provincial Director of Irrigation (PDI) and the Department of Agrarian Development (DAD) attend some maintenance or rehabilitation works on tank bund and/or related structure every year with their available fund. However, since PDI and DAD cover a number of tanks in Anuradhapura and Vavuniya districts and available fund does not meet actual needs in many cases, the present irrigation and drainage facilities including farm road are still not in good condition. Comparing the two districts, the condition of the facilities is worse in Vavuniya District and land development with vegetation clearing is needed more in Vavuniya District.

The proposed facilities construction and rehabilitation plan is summarised in Table 5.2.1.

Table 5.2.1 Facility Construction and Rehabilitation Plan

Facilities		Rehabilitation and/or Construction Plan
Tank	Bund	(1) Formation of upstream and downstream slopes, and provide riprap protection if required (2) Filling of breached, eroded, and leaked section and construction of toe drain if needed
	Inlet sluice	(1) Reinstallation of inlet gates and/or rehabilitation or reconstruction of inlet and outlet structure (2) Installation of water level measuring staff gage and installation of measuring devices in the outlet
	Spillway	(1) Rehabilitation of eroded downstream bed and both side slopes of the spillway (2) Placing gabions or stones to prevent erosion (3) Expansion of width of the spillway (4) Installation of gate on the spillway (5) Construction of emergency spillway
	Reservoir	(1) Removal of weed (2) Desilting of tank bed, if needed
Irrigation and drainage canal	(1) Formation of canal embankment and concrete lining in some section (2) Construction or rehabilitation of canal structure	

Source: JICA Project Team

Since small-scale tank irrigation schemes are scattered around the target area and the government's technical support cannot be delivered on time, empowerment of the farmers' organisation (FO) to take necessary roles in the operation and maintenance of the irrigation scheme is important. The FO should identify the risk of collapse of the facilities especially the tank bund, and enable them to attend to the works or manage the works by themselves. By looking at the model case in Hyogo Prefecture in Japan, the prefectural government prepares the manuals for FO for them to attend to the seasonal or emergency maintenance works.

(2) Facilities to Support Proper Water Distribution, Management, and Monitoring

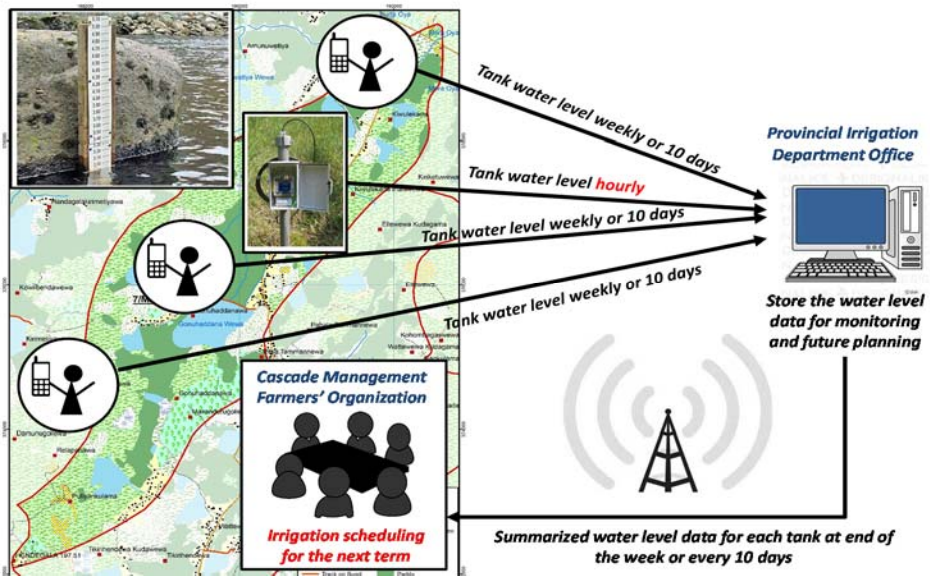
(a) Construction of Tertiary Canals and Link Canals

The project proposes to construct tertiary canals from the branch canal either to each tank or several uppermost tanks in the cascade system. The present water flow amongst tanks is either through paddy field or drainage canal downstream of the spillway. Although such water transmission system contributes in recharging the groundwater and maintaining the natural environment and ecosystem of the cascade system, newly created water resources should be shared amongst the beneficiaries on an equitable manner as much as possible without significant time lag. The project proposes to construct tank-to-tank link canals in some cases where time lag is big.

(b) Establish Water Management Supporting System

An appropriate water management to effectively supply the necessary water to irrigation demand is one of the most important issues to achieve high productivity in cascade agriculture. However, movement of water resources in the cascade system is affected by several unpredictable factors such as rainfall, seepage from the tank, evaporation, return flow from upper scheme, and so on. It is therefore important to note that effective water management should be planned and implemented in a short-term basis such as weekly or ten days as much as possible, with observed data in the field such as water level. The Project proposes to establish the tank water level acquiring system to be utilised for planning and implementation of better water management by cascade management organisation.

As shown in Figure 5.2.5, it is proposed to acquire the tank water level with two kinds of method, namely, by visual observation and automatic reader with telemetering equipment. Most of the tank water level proposed to be collected through visual observation and sent through hand phone. However, the tank in which more accurate information is needed such as upper most tank, is isolated or having high risks against flood, requires automatic reader with telemetering equipment. Transmitted data is preserved in the server installed at PID Office in Anuradhapura and DAD Office in Vavuniya then send to cascade management organisation to make the water distribution plan. The Project targets to develop such a system in PDOI and DAD office.



Source: JICA Project Team

Figure 5.2.5 Concept for Water Management Supporting System

(3) Improve Mobility to Support Agriculture Production and Market as well as O&M of Irrigation Related Facilities

Since the cropping intensity of this area will increase with the NCPCP, it is necessary to improve road conditions to facilitate effective trade between producers and buyers. In addition, it is necessary to manage closely the irrigation water and facility maintenance. Therefore, the roads amongst the tanks in the cascade will be important. The components of the works include the formation of the road pavement and construction of side drains, culverts, and causeways in some cases.

5.3 Basic Concept for Institutional Development

The most crucial issue in institutional development with regard to NCPC development is establishment of a cascade management organisation. The institutional development plan focuses on water management and following the cultivation planning with allocated water. Table 5.3.1 summarises the current situation and proposed direction of the plan.

Table 5.3.1 Summary of Institutional Development Strategy

Current Situation	Issues to be Considered	Strategy/Approach
Government's Institutional Structure for NCP Cascade Management		
・ Several government agencies manage different schemes with different systems. ・ Mahaweli systems are managed by the Mahaweli Authority of Sri Lanka (MASL), while other major and medium systems are under central irrigation department, and minor schemes are handled by DAD and the provincial government	・ Different stakeholders at different levels will be involved, since the NCPC will connect to Mahaweli system and minor schemes ・ Clear and feasible demarcation of roles and responsibilities among relevant government agencies is required.	・ Clarification of responsible agencies for different parts of NCPC from the Mahaweli system to the minor tanks. ・ Existing systems shall be applied with necessary amendment and adjustment at different level of the system according to the demarcated responsibilities of the concerned government agencies. ・ Branch canal and tertiary canal shall be delegated to the provincial council while the NCP main canal is under MASL, and cascades and below will follow minor scheme systems.
Cascade Management		
・ Not existing ・ There have been several attempts to establish cascade management committees, most of which could not sustain their functions.	・ Lack of felt needs by farmers of cascade level management ・ Needs from technical point of view and how much it can be attractive and acceptable for the farmers ・ Identification of possible constraints in establishment of cascade management ・ Roles of cascade level management bodies shall be clarified	・ Clarification of the objective specifically in consideration of water distribution from NCPC ・ Involvement of farmers from the designing to change mindset of farmers on the concept of cascade ・ Coordination body between cascade and NCP main canal shall be also established ・ Countermeasures against possible constraints shall be proposed for feasible operation of cascade management ・ Cascade level management bodies shall be responsible for cascade level water distribution and supervision of crop planning with available NCP water
FO Capacity Building for Management of Minor Tanks Under the Cascade		
・ Functioning to a certain extent under close intervention and monitoring by DO/Agrarian Research and Production Assistant (ARPA)	・ Not sufficient O&M initiatives and contribution	・ Strengthen periodical maintenance activities in collaboration with cascade management through skill development
・ The level of capacity, functionality, and activeness differ with different FOs. ・ Discipline has been maintained due to strong interference/penalty of DAD.	・ *Collaboration between FOs will be inevitable to manage cascade*	・ Interrelation between FOs will be improved and learning from other FOs shall be encouraged through establishment of cascade level management system
・ FOs are under the control of DAD, while maintenance of minor tanks are under responsibility of PDI in Anuradhapura. ・ In Vavuniya, the competent authority on both maintenance and FOs are DAD.	・ Cooperation/demarcation between the competent authorities (DAD and PDI) are not clear, and situation differs by district ・	・ Since the introduction of the NCPC water brings more complicated situation of the division of roles between stakeholders, clear demarcation shall be agreed among them.
・ Major agriculture activities are collective decision (e.g. cultivation calendar and cropping plan), but not collective activities. ・ Even though they are entitled to conduct agriculture related activities, not many are doing activities further than tank management and distribution of agriculture input supplied/subsidised by the government. ・ Regarding marketing, FOs play a role on communication and sharing information.	・ Kanna meetings and strong tie through the water resource can be used for planning agricultural activities in the area (e.g. diversification or shift from paddy to OFC). Since decision in the Kanna meeting has strong juristic power, farmers will be forced to follow. ・ The NCP water will create more complicated situation in cultivation activities because of different water distribution.	・ Cultivation plan discussed in Kanna meetings of FOs should be adjusted with the water availability at the cascade through cascade level management. ・ Since the water availability will be influenced by higher level decision of Mahaweli system, coordination in all levels (FOs, cascade, NCPC, Mahaweli system) shall be established. ・ Through cascade level planning of cropping patterns, collective marketing at cascade level can be promoted.

Source: JICA Project Team

5.3.1 Community Organisation for Cascade Management

Cascade systems originated within the community and were practised over many generations. Presently, even though individual tanks are managed by concerned FOs, there is neither specific management with particular organisation at the cascade level nor a sense of unity amongst farmers at the cascade level. Even though several attempts have been made to establish the management system of cascade, after the traditional system was abolished, no definite management system was introduced. Feasible cascade management system shall be proposed through analysis of the past experiences and presently established relevant systems like FOs.

(1) Background and Learning from Preceding Projects on Cascade Development

Cascade system was originally managed as a whole by a community. Managing and maintaining individual tanks have had a number of negative consequences, including the inundation on upstream paddy fields, shortage of water in downstream tanks, development of salinity, and the risk of chain breaching. One of the reasons for these consequences is the lack of proper technical guidance for the planning and management of water resources viewing the tank cascade system as a whole[1]. Community organisations for cascade management have been proposed and attempted by different agencies such as CARE, North Central Province - Participatory Rural Development Project (NCP-PRDP), and International Union for the Conservation of Nature and Natural Resources (IUCN). However, these efforts were limited to the planning phase and the organisations did not sustain their functions. Major issue analysed as the reason of limited sustainability of the organisation is the failure to address the needs of the concerned farmers on cascade level management. Some approach emphasised the preservation of the traditional total ecosystem of the cascade system, which seems to be insufficient to unite farmers from different tanks. Even though the cascade management bodies were positioned under the coordination committees with concerned government officers, lack of legal recognition and authority seems to have resulted in weak sustainability of the cascade management bodies.

(2) Rationale of Introducing a System for Cascade Management

Basic feature and situation of the NCPC project fundamentally differ from the past experiences of cascade management. The significant difference is the improvement of water availability through distribution of water from NCPC. This creates inevitable task in cascade management of distributing water flowing into the upstream tanks then to the whole cascade. Therefore, need of introducing management system at the cascade level is obvious. However, viability of the system will highly depend on the approach of introducing the system.

A new system can be introduced in different ways depending on the situation of the ongoing system as well as social structures. The typical approaches are, 1) newly introducing a system as an independent system, 2) integrating the new system into the existing system, 3) introducing the new system by changing the existing system. The best approach depends on the current situation of the existing relevant system. Where the existing system is not functioning, introduction of the new separate system can be relatively simple, and changing the existing system shall not face much resistance. On the contrary, where the existing system is functioning, a new system introduced through the first approach will create controversy with the existing system. Alteration of the existing system is also difficult as change of mind and behaviour of people on the existing system is difficult where the existing system is deeply rooted in people's life. Since the existing system of the minor tanks in the target area is functioning to a decent extent, it is the best to integrate cascade management system into the existing system with minimum interference on the existing system. The basic approach of institutional building of cascade shall be proposed from the farmers acceptability and legal and administrative integration into the existing system.

[1] IUCN (2015). Project Implementation Plan. *IUCN programme on Restoring Traditional Cascading Tank Systems Technical Note # 1.* Colombo: IUCN, International Union for Conservation of Nature, Colombo, Sri Lanka & Government of Sri Lanka. ivi + 34 pp.

(3) Prerequisite for Cascade Management

Focusing on the above aspects, the following outline of the management system is proposed. Learning from the past experiences, existing systems, and situation of the proposed water distribution from NCPC, the following needs to be assured as preconditions or issues to be emphasised to establish a cascade management system, which should be confirmed and agreed before formation of the cascade management organisation:

- Clarification of government agencies in charge of each part of the system, which include water and structures from Mahaweli system, within the NCPC, from NCPC to cascades, and within the cascades.
- Roles of government and administrative strategies: Fundamental position of the government to facilitate cascade management by establishing administrative and legislative set-up shall be respecting existing habits and culture, protecting their rights, and fulfil emerging needs for the cascade management.
- Making changes on the concept of cascade tank: In the current cascade situation, only the spilled water flows into downstream tanks. However, once the water is delivered from NCPC, water flown into the upmost tanks should be purposely released to the downstream tanks based on the agreed water amount by controlling facilities. Therefore, systematic cascade level management is necessary.
- Assessment of felt needs by farmers of cascade level management for distribution of water that is purposely delivered to the cascade: Realistic management should be proposed from both technical point of view and farmers' view considering how much it can be attractive and acceptable for the farmers. To develop the needs and ownership of the farmers, it should assure involvement of farmers from the design, and by consulting them on how they want water to be distributed, where to construct canal, what kind of facilities to allocate water, and so on.

(4) Outline of the Institutional Development for Cascade Management

(a) Objective of Cascade Level Management

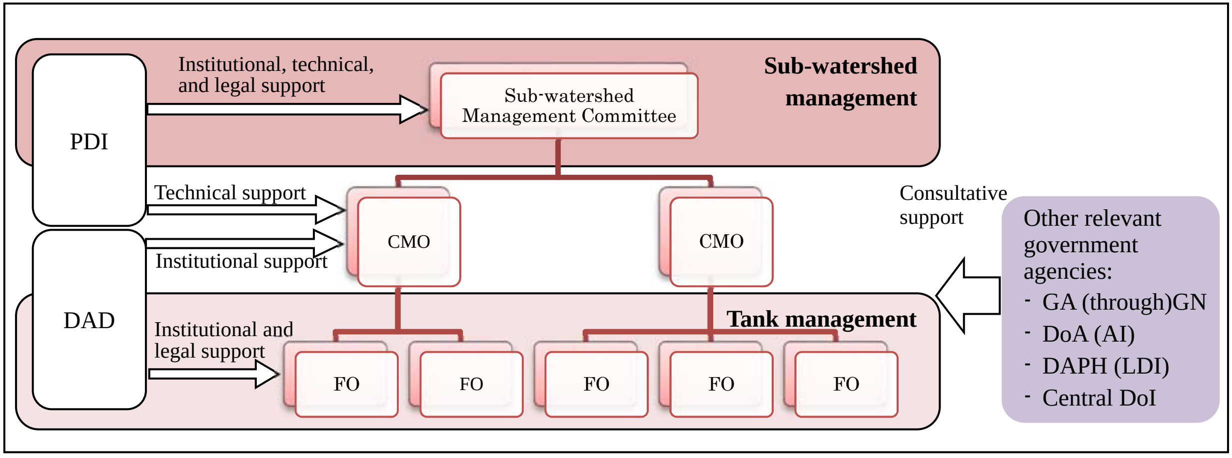
The objective of establishing cascade level management shall be as defined below:

> *"To develop and sustain agriculture related activities of the community within the cascade system by managing water delivered from NCPC to be distributed fairly, equally, and effectively; and by maintaining the inter-tank facilities of the cascade system."*

In order to execute the above objectives, establishment of a cascade level management body with the tentatively proposed name of Cascade Management Organisation (CMO), and relevant coordination bodies, shall be inevitable.

(b) Organisational Structure of the Cascade Management

The CMO shall be a cascade level federation of FOs consisting of representatives from each FO and tank. The CMO shall be coordinated by the Sub-watershed Management Committee (SWMC) that shall be formed at the branch canal level (sub-watershed), by which water distribution to each cascade shall be managed based on the water availability from the NCP main canal. The proposed structure of the cascade related bodies is shown in Figure 5.3.1.



Source: JICA Project Team

Figure 5.3.1 Proposed Structure of CMO

The CMO, as a community organisation, shall have its by-laws that define the rule for cascade management within the concerned cascade, complying with the governing law. Since the CMO shall be a community organisation having similar function and roles as FOs, the Agrarian Development Act shall be applied as its legislative setting with necessary amendment. In this sense, CMO shall be registered to DAD under the Agrarian Development Act, and the commissioner general shall be in-charge of supervising the functions and activities of the CMOs. In the same way as minor schemes, PDI shall be in-charge of technical maintenance of the cascade level irrigation facilities. Other relevant government agencies such as Central Department of Irrigation that is in charge of medium irrigation in the cascades, Department of Agriculture (DOA), Department of Animal Production and Health (DAPH), and administrative line agencies shall provide consultative support for relevant issues of their responsibilities.

The government agency responsible for the branch canal shall be in charge of the SWMC, regarding which, it is proposed, as discussed below, to delegate the management of the branch canal and tertiary canal to PDI.

(c) Expected Roles of CMO

The major role of the CMO is fair and effective distribution of water from NCPC. To address maximum benefit of the distributed water, the CMO shall take responsibility on coordinating relevant issues. The expected roles of the CMO are as follows:

- Making rules on water distribution and management of cascade level irrigation facilities;
- Planning of water allocation to each tank based on the water requirement and equity(assessing the amount of water to be delivered to each tank, order, and schedule of releasing water);
- Compiling crop plan of each FO/tank to assess in compliance with water availability and to endorse;
- Monitoring water distribution;
- Coordinating periodical maintenance of inter-tank facilities;
- Cascade level flood management (maintenance during normal period and rules in case of flood);
- Collection of contribution from each FO and management of their fund;
- Assigning a water controller;
- Maintaining compliance to the rules and agreed issues regarding cascade.
- Supporting the relevant authorities in watershed management, reservation of the area around irrigation facilities, and maintenance of eco system of cascade area by regulating unnecessary encroaching.

5.3.2 Position and Area of Function of Cascade Management Within the NCPC System

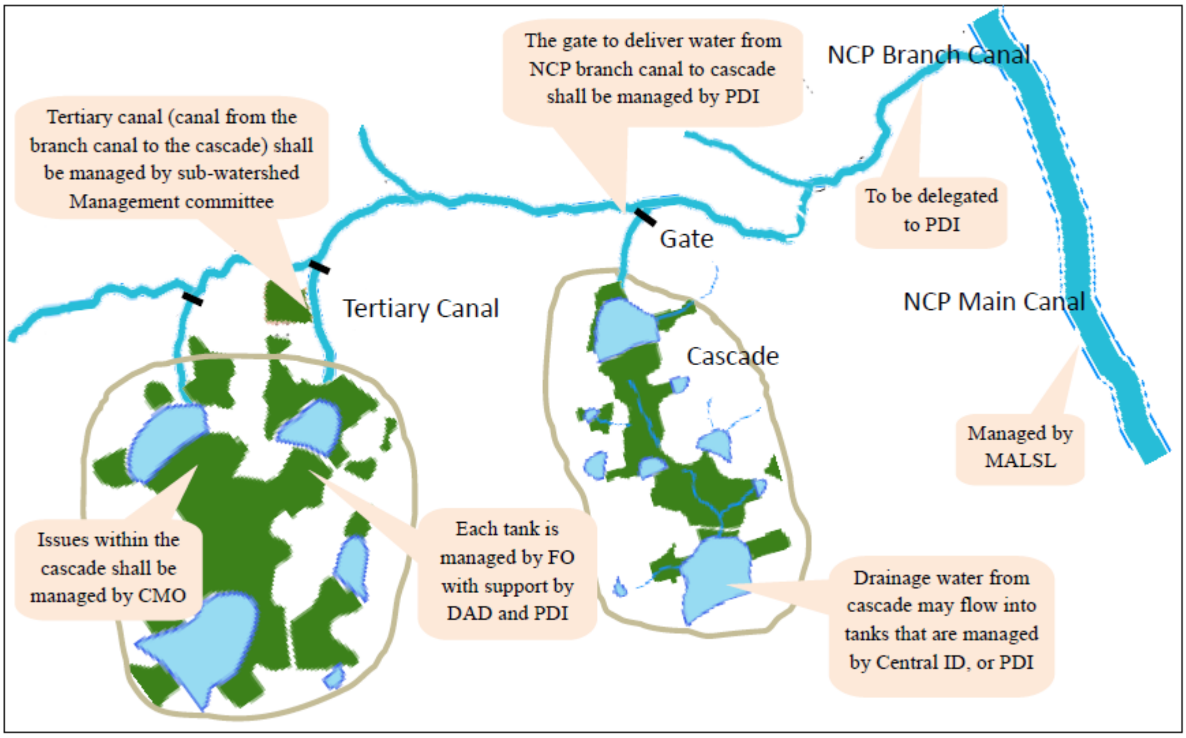
(1) Demarcation of Rules and Responsibilities of Government Agencies in the NCPC System

The proposed cascade system with water flown from NCPC has complicated features, as it involves several different stakeholders at different levels. For example, since the NCPC water will be diverted from the Mahaweli system, the whole project might be taken as a part of the Mahaweli system. Meanwhile, the competent authority of NCPC for its operation differ by the division of the canal system, as the system involve major tank of Mahaweli system to community-managed minor tanks, which are managed by different government authorities. Consequently, demarcation of the relevant authorities is critical for smooth operation of the NCPC system including the cascades. Moreover, as it is highly recommended to integrate the cascade system into the existing system, it is practical to apply the currently functioning system to the cascade management as much as possible.

In consideration of the possible division of authority proposed in the section 5.8.1, different irrigation management systems shall be applied at different levels of the system. The main canal of NCPC shall be governed by the rules of the Mahaweli system. Branch canal and tertiary canal including water regulation at the gate from branch canal to cascades can be delegated to PDI. And the issues below tertiary canal shall be managed by applying the irrigation management system of minor schemes.

As recommended in the final report of the feasibility study of NCPC, the water distribution mechanism from the Mahaweli system to the cascade can be summarised as follows:

- As per the current management of Mahaweli schemes, water distribution from Mahaweli system to NCPC shall be decided by the water management panel (WMP) of the Mahaweli system through their seasonal operation plan.
- The water management secretariat (WMS) of MASL prepares a seasonal operation plan (SOP) based on the results of its simulation studies for the coming irrigation season, by using the data on initial storages of Randenigala, Kotmale and other relevant data.
- The SOP will be presented to the WMP, for review and consent. After any necessary amendments are made, WMS will decide on the water allocation to the NCPC, as a component of the allocation plan for the entire Mahaweli-benefited area.
- The decisions will be informed to the sub-watershed level committee and sub-watershed management committee shall allocate water to each cascade in proportionate bulk water issue basis.
- The cascade representatives to the sub-watershed management committee will inform the cascade management organisation regarding the water allocation to each cascade. The cascade management organisation will decide on water allocation to tanks from the NCPC, at its meeting prior to the season, giving consideration to the water available in the tank at the beginning of the season.
- The tank level FOs will decide on cultivation extents and crops at their respective cultivation meetings, prior to the start of the season.

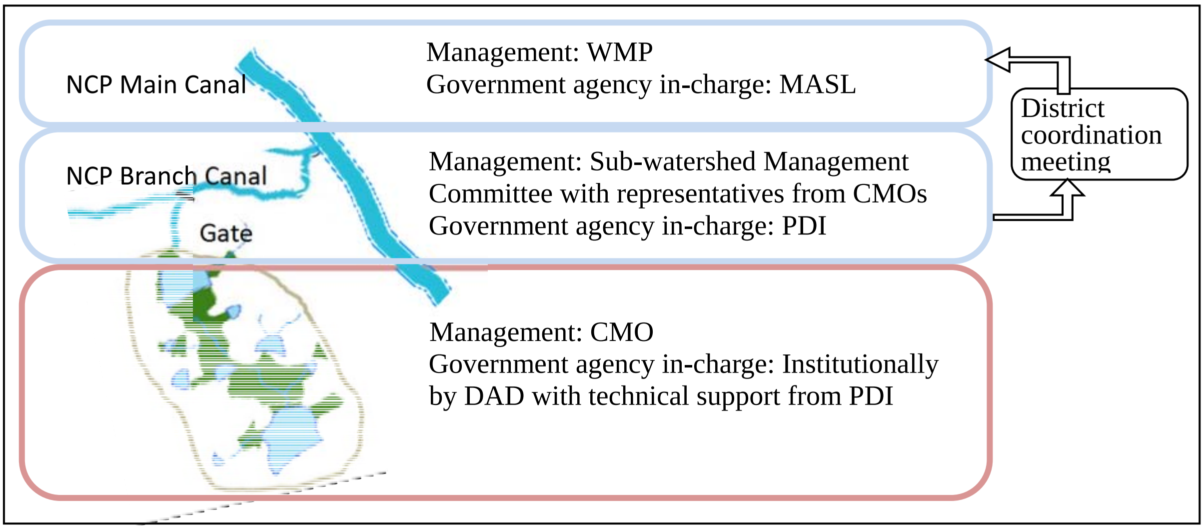


Source: JICA Project Team

Figure 5.3.2 Proposed Division of Roles Amongst Different Stakeholders

Applying this process of water distribution, what is crucial will be the coordination between the relevant authorities from the Mahaweli management system to the cascade management that adopt the minor scheme management system. Possible coordination will be PMC or district coordination meeting of the major schemes. As proposed in the feasibility study report, a coordination body at the sub-watershed level (branch canal level) shall be formed as SWMC. A government representative such as Divisional Officer (DO) and technical officers in charge of each cascade shall participate in the SWMC and in the district coordination meetings of the major irrigation where all the irrigation management issues shall be discussed, decision of which shall be presented in the discussion for Mahaweli water panel meetings.

Applying different management systems at different levels, the management of the NCP main canal, branch and tertiary canals, and the cascade level management shall be summarised as shown in Figure 5.3.3.



Source: JICA Project Team

Figure 5.3.3 Summary of Management of NCPC and Cascade

Based on the above proposed principle of management, the roles of each government agency can be defined as shown in Table 5.3.2.

Table 5.3.2 Expected Roles of the Government Agencies

Agency	Role/Authority
MASL	・ Authority on any facility related issues of the main canal ・ Authority on water distribution from NCPC, in consideration of water requirement from each branch canal in collaboration with Central DOI ・ Controlling the gate from NCPC to branch canal.
Central DOI	・ Authority on water distribution from NCPC, in consideration of water requirement from each branch canal in collaboration with MASL ・ Coordinating with DAD as FOs of some medium tanks that are included in some cascades are supervised by the central DoI ・ Being in charge of the existing district coordination meeting, which will coordinate all the irrigation water distribution within the district, and the decision of which shall be presented in the WMP
PDI	・ Being in charge of water distribution from branch canal to tertiary canal ・ Having authority on repair and maintenance of the irrigation structures from branch canal to tertiary canal, system from the NCPC to cascade and link canals within the cascade ・ Support on repair and maintenance of inter-tank irrigation facilities within cascades. ・ Engineers or his representatives will provide technical advices and participate in the CMO meeting ・ Organising and chairing the SWMC meeting and present the decision of the SWMC
DAD	・ The CMO shall be registered under DAD, as FOs under cascade system are. ・ Facilitate formation of CMO and encourage FOs in functionalising the CMO. ・ The DO, with support from ARPA, is the officer-in-charge of the water management and crop related decision, at the cascade level. ・ Coordinate technical issues with PDI and ID/MASL. ・ To be authorised to resolve conflicts between FOs within the cascades.
DS/GN	・ Participate in the meeting as required. ・ Support resolving conflicts between FOs within the cascade.

Source: JICA Project Team

(2) Legal Provision for CMO

Legal provision is crucial for stabilising the functions of the CMO and for its sustainability as per observed in FO system defined in the Agrarian Development Act and medium and major irrigation systems governed by the Irrigation Ordinance. It is essential to seek the possibility of providing legal authorisation to the cascade management system within the current laws.

Since the cascade is basically managed by concerned FOs, CMO shall be registered under DAD in the similar way as the FOs. DAD has already started process of legalising the cascade level management organisation through amendment of Agrarian Development Act No.46 of 2000, in which establishment of cascade level management body with assigned authority is mentioned. Therefore, it is highly likely for the CMO to be legally authorised in near future.

Legal authorisation is one of the strength of the currently working system. Decisions made in Kanna meetings have legal power endorsed by GA as defined in the Agrarian Development Act. Decisions in the general meeting/executive meeting of CMO should be authorised with similar legal power. Once the minor tanks are connected with NCPC, the decision of FOs' Kanna meeting should comply the decision of higher water management bodies such as water panel, SWMC, and CMO. Therefore, it is proposed to integrate the authorisation of CMO decision in the current legal procedure by making it compulsory to take approval of CMO in the process of legal endorsement of FOs' Kanna meeting.

Table 5.3.3 indicates the proposed status of CMO in comparison with the current systems for minor and major schemes.

Table 5.3.3 Proposed Status of the CMO in Comparison with Existing Systems for Minor and Major Schemes

Schemes	Minor Scheme	*Cascade (Proposed)*	Major Scheme
Institutional support	DAD	*DAD (registered under DAD)*	MASL, DOI, and Irrigation Management Division (IMD)
Technical support	PDI and DAD	*PDI up to tertiary canals, and PDI*	MASL (Mahaweli area) and

		and DAD within the cascade	DOI (major scheme outside Mahaweli area)
Management decision-making body	FO	*CMO at cascade level and SWMC at sub-watershed (branch canal) level*	PMCs
Legal provision	Agrarian Development Act No.46 of 2000	*CMO can be legally recognised under the Agrarian Development Act, and SWMCs can be taken as a similar legal body as PMC of major irrigation governed by the irrigation ordinance. The SWMC of the NCP sub-watershed may require new statute by the provincial government*	'Mahaweli Act' (Mahaweli system) 'Irrigation ordinance' (other major schemes)
Decision making system (meetings)	Kanna meeting	*Cascade level meeting prevails over the Kanna meetings of each FO, but complies with the decision by the district coordination meeting and water panel meeting of the Mahaweli system.* *Kanna meeting decision of each FO will be endorsed by GA only after approval from CMO.*	Decision at district meeting and water panel meeting prevail over the Kanna meetings (for the area that depends on the Mahaweli system)
Meetings chaired by	FO chairman with support of DO	*The CMO chairman with support of DO with delegated power from the DAD assistant commissioner.*	Residential project manager (RPM) for Mahaweli meetings Government agent (GA) for district meetings
Authorisation of Kanna meetings	Assistant commissioner, DAD	*Assistant commissioner with delegated power of DAD*	RPM for Mahaweli systems GA for other major schemes

Source: JICA Project Team

(3) Demarcation and Relation between FOs and CMO

CMO shall be integrated into the currently functioning FO systems. CMO will have right to manage total cascade irrigation system and relater natural resources in the area under the cascade, with guidance and approval from the relevant authorities. CMOs shall fundamentally take charge of issues related with cascade and coordination of FOs under the cascade, while any tank-based issues remain under control of the FOs. However, CMO can intervene management of each FO in case of the issue affecting the management of cascade system. For example, the decision of the FOs related to water management including crop plan shall be interfered by CMO from the perspective of water distribution. Legally endorsed Kanna meeting decisions of each FO in the current system should be approved by CMO before legal endorsement.

(4) Demarcation of Roles in Maintenance of Cascade

Management of the cascade including maintenance of cascade shall be basically delegated to CMO. However, the relevant authorities also take responsibilities in maintenance of the structures. CMO is responsible in maintaining inter-tank facilities such as link canal and structures to send water between tanks, while maintenance of each tank remain under responsibility of each FO While CMO take responsibility of dairy maintenance of the inter-tank facilities and minor repair of the structure with their own fund, PDI shall take responsibility in supporting major rehabilitation of the inter-tank facilities based on the request from CMO. The division of roles in maintenance of the cascade facilities are shown below.

Table 5.3.4 Division of Roles in Maintenance of Cascade Facilities

	Inter-tank Facilities	Tank-based Facilities
Routine maintenance (such as jungle clearing, cleaning of canal, periodical monitoring etc.	CMO	FO
Minor repair	CMO	FO
Support on major rehabilitation	PDI	DAD/PDI

Source: JICA Project Team

5.4 Basic Concept for Agriculture Development

5.4.1 Improvement of Productivity of Ordinal Crops

Since the national self-sufficiency in paddy has already been achieved, the present priority would be to sustain and stabilize the production level of in the target area. In years of normal rainfall distribution, the target area makes a contribution of nearly 3.5% to the total national rice production. Present average productivity of the crop has remained around 4.15 mt/ha which is far below that of 6.5 mt/ha reported in the major irrigation schemes. With an assured water supply and improved crop husbandry supported by strengthened extension services, it is expected that the average paddy yield in the project area would reach 5.75 mt/ha.

Table 5.4.1 Present and Expected Crop Yield (mt/ha)

Crop (Irrigated)	Present Yield	Expected Yield	Crop (Irrigated)	Present Yield	Expected Yield
Paddy	4.15	5.75	Maize	5.66	6.50
Green gram	1.10	1.50	Chilli	5.50	8.75
Black gram	1.23	1.37	Big Onion	21.58	25.00
Soybean	2.50	3.00	Cabbage	n.a	40.00
Groundnut	1.70	2.50	Eggplant	n.a	21.25

Source: Prepared by JICA Project Team based on Cost of Cultivation 2014 Yala, DOA

Other crops in the project area include OFCs and traditional or low country vegetables which are cultivated in the Maha crops under rain-fed crops in the highlands. A minor area is cultivated in the Yala season under lift irrigation off agro-wells. Three crop groups of ordinal category under OFCs are the coarse grains (maize), grain legumes (green gram, black gram and cowpea) oil seeds (groundnut and soybean) and the condiments (chilli and big onions). Of these, the condiments, chili and big onions are high value crops. As with paddy, a large gap is observed between the productivity of these rain-fed crops and their projected yields under irrigation. As shown in Table 5.4.1, the yield levels are achievable with assured irrigation water combined with an effective extension service. The land extents for cultivation of OFCs and vegetables would however depend largely on factors such as willingness and ability of individual farmers, land suitability, crop water requirement, capital investment, farm labour, national deficit in supply and demand, marketing and relative crop income level.

5.4.2 Diversify to Market-Oriented High Value Crops and Varieties

(1) High-value Vegetables for High-end Markets

Consistent data on the production of vegetables in the project area is not available. However, it is observed that a fair quantity is being produced and marketed. Profits generated from cultivation of few vegetables such as capsicum, bitter gourd, and tomato in particular, are high and compare well with high-value condiments such as chilli and onions. Most of the other vegetables produced in the area yield net returns that are equal to or marginally higher than grain legumes and coarse grains showing little relative advantage. However, high perishability associated with seasonal market gluts and weak market channels have discouraged most farmers from taking up cultivation of vegetables.

Introduction of new vegetable crops and varieties is proposed for the project. These include bell peppers, tomato (cluster and cherry), cabbage, cauliflower, sweetcorn amongst others. Those crops give high net return from unit area of land. For instance, cabbage and tomato gives net income of LKR 675,000 and 780,000 respectively per hectare, whereas many local vegetable give lesser income (Eg. Eggplant gives only LKR 230,000/ha).

(2) Introduction of New and Traditional Paddy Varieties

There are niche markets already established for new and traditional varieties of paddy, and the demand is increasing. These paddy types command high market prices, and the feasibility of introducing area-specific varieties as branded products from the area needs to be examined. It is suggested that newly introduced paddy varieties would be cultivated within the area identified for irrigated paddy.

The paddy varieties currently cultivated can be broadly grouped as ‘samba’ and ‘nadu’, based on the shape of grain. They may be brown or white grained and processed for the market as par-boiled or raw rice. The common types cultivated in the project area are red nadu, white nadu, and white samba; and they reach the consumer as samba, keeri samba, red samba, nadu, and red nadu. Samba types have higher market price and are being purchased by the Paddy Marketing Board at a fixed price of LKR 41 per kg while others are priced at LKR 38. Rice types such as keeri samba sell at much higher prices and enjoy a ready market amongst private sector buyers.

In order to obtain the price advantage, feasibility of extending the land area cultivated in the project area under the samba types will be examined and promoted.

New varieties of paddy are bred and released by the Rice Research and Development Institute (RRDI) of DOA.

In addition, 16 cultivars of traditional paddy are presently in different agro -ecological zones in minor extents. Of these, Pachchaperumal, Kaluheenti, Soodurusamba, Murungakayan, and Suwandel are more common. Feasibility of introducing traditional paddy varieties and new high value varieties suitable for the area will be undertaken in collaboration with RRDI.

5.4.3 Key Aspects for Improvement of Crop Productivity

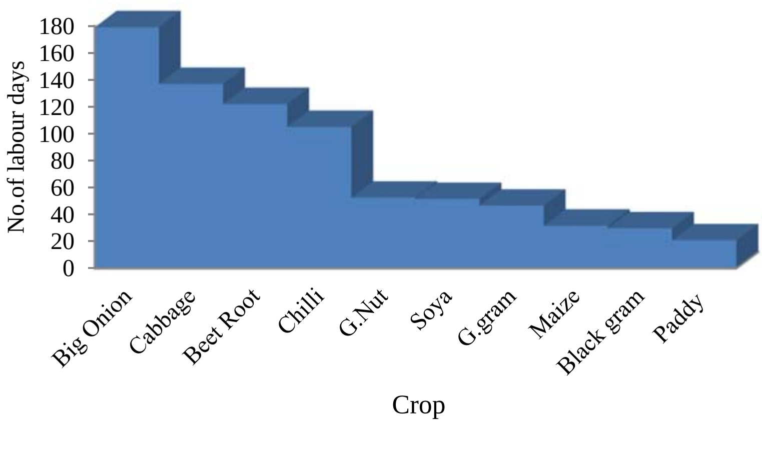
(1) Shift to Labour Saving Farm Management

The shift in the population from the agricultural to non agricultural sectors focuses on two major issues on future crop diversification programme namely increment of production cost and the shortage of labour force. The shortage of labour is outstanding even at present especially during the planting and harvesting time.

If we look at the farmers in the target area, it was revealed that their children are not ready to engage in agriculture and they rather like to go in new avenues of employment with no drudgery. It shows the evidence of shift in the population from the agricultural to non agricultural sectors and may create further severe shortage of agricultural labour.

On the other hand it can be observed a marked reduction during recent 40 years in the use of labour in paddy cultivation due to mechanization of operations on land preparation, harvesting and threshing which demand more labour. The used labour has been declined from 61 in 1970s to 21 in 2010s. This is one of the typical examples for productivity improvement through mechanisation.

Similar results can be obtained in other field crop cultivation which requires more labour if appropriate machinery are introduced. If not farmers will adhere in paddy cultivation which need less labour instead of other crops. Seeding, weeding and harvesting are the major components that demand more labour in other crop cultivation. There are number of farm machineries that can be used for those purposes (such as highland seeders, transplanters, bed making machines, inter-cultivators, plant bed polythene laying devices ,harvesters etc.)are now available in the country. Since these machineries are being introduced to the country from recent years it needs more time to popularize them among farmers. Project will take a special focus on promoting machinery among farmers for other crops cultivation



Source-Socio Economics and Planning Centre (DOA)

Figure 5.4.1 Labour Requirements for Cultivation of One Acre of Crops at Present

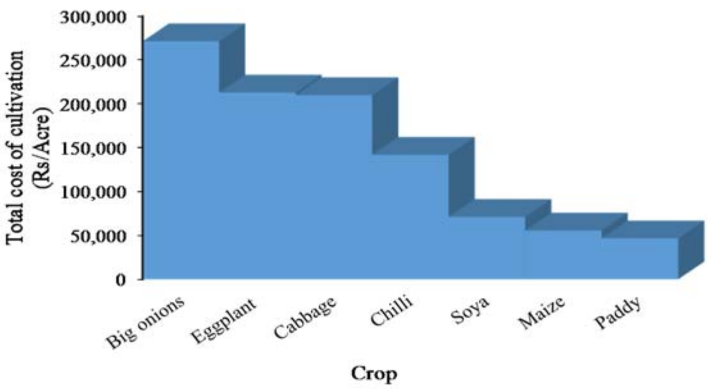
Paddy is the lowest labour demanding crop among other crops and hence it will be not easy to compete with paddy in crop diversification unless labour saving techniques such as use of machinery are adopted. The use of appropriate farm machinery in the production chain will make farming more efficient and enable to diversify cropping by growing more crops.

(2) Cultivation and Management Skills Development

By side of the farm mechanisation, the incubation or capacity development of farm manager is important. From the past to date the agricultural extension programmes have been concerned with the process of disseminating technical information on the farm production. In fact this process has not shown any significant impact on the profitability in farming and enhancing their livelihoods. The declining trend of farm profitability is making the farmers to move away from commercial agriculture and limit their farming only for subsistence. This is one of the reason for poor involvement in youths in farm activities. Many of farm household in the target area are depending on the non farm income and only half of farmers are full time basis. Their average age is over 50 and they may face the difficulty to adopt new technologies needed in agriculture diversification after receiving the irrigation water from NCPC. The farmers should become good producer as well as better manager of farm mechanisation, contract farming and agriculture marketing having both skills of crop management and entrepreneurial skills. Well planned educational programmes on building the farm management and entrepreneurial skills especially tailor made to the youths are imperative in the implementation of the project.

(3) Ensure Fund and Quality Input

While crop farming remains the key economic activity in the project area and nearly 50 % farmers having their primary income from cultivation. Majority of the farmers invest their own money in cultivation and only some are totally or partially dependent on commercial banks. Although majority of farmers can afford to invest their own money for cultivation at present, they require a substantial input of capital for transformation from present comparatively low cost paddy based agriculture to diversified market based agriculture. The total cost incurred in cultivation of selected crops are given in the table below.



Source-DOA

Figure 5.4.2 Cost of Production per Crop

In order to develop fund availability, necessary measures such as (1) use of extension officers to educate the farmers on formal lending sources and management of funds effectively, (2) linking with value chain companies to provide credit and inputs such as seeds with involving in contract farming system and (3) promotion of livestock integration that will provide supplementary income for increased savings for investment in agriculture are needed. In addition, quality input especially seed is needed. It is necessary to strengthening and cooperate with private sectors to encourage quality seed importation and production are needed.

5.4.4 Improvement of Agricultural Extension System

The DOAs are vested with duties relating to programs of national interest which include implementation of National Food Program: 2016–2018, Yaya (Tract 2) paddy program, seed paddy production program and crop clinics program. Provincial programs on training of other needs of the farmers are identified at the Provincial Technical Working Groups meetings (PTWG) and conducted on a seasonal basis. Some of the basic issues relating to improvement of the extension services are highlighted below.

The average service area or Range of an AI is extensive with a large number of farm households to serve. Group and community based extension approaches are examined to expand extension outreach as well as to achieve cost effectiveness. In this regard, Farmer to Farmer (F2F) extension approach to complement the existing extension system is recommenderd and its adaptation to accelerate the agricultural development in the target area appears feasible under the existing kinship patterns observed in the village level communities in the cascade system. F2F system is widely applied in African and South American countries and is not totally new to Sri Lanka. In fact, a study on Adoption of Integrated Farming Concept through Farmer-to-Farmer Extension Approach in Dry Zone of Sri Lanka by M Suchira Suranga et al (2011) concludes that farmer training and capacity building has been effective in technology transfer with the lead farmers benefiting the most. F2F extension system is a community based approach and is described as provision of training by farmers to farmers through systematic utilization of community leadership and informal communication to strengthen information flow and enhance agricultural production. It strives to empower farmers as change agents for improving livelihood of their communities. The system does not aim to substitute the services by the extension workers but rather complement the services provided to the farmers. The basic steps in the establishment of a formal F2F system involves, (a) formation of organized farmer groups in the communities, (b) selection of innovative farmers as lead Farmers (LFs), (c) identifying specific roles of LFs, and initial training of the LFs on technical aspects, extension methods and communication skills followed up by periodic follow up training. The selection of LFs should be made based on set criteria in consultation of the community or group members and their role may include training and advising other farmers, monitoring, contracts, 0rganizing meetings and demonstrations. The selection of LFs should be made based on set criteria in consultation of the community or group members and their role may include training and advising other farmers, monitoring, contracts, 0rganizing meetings and demonstrations. The services of the LFs in the F2F extension system are provided essentially on a voluntary basis, though there are instances where they are rewarded for good performance with gifts in kind or cash.

Agricultural development involves many contributors from the state and private sector. They include service providers in extension, input supply, machinery and equipment supply, produce marketing, etc. who are active in some areas in the target area. A pluralistic approach to extension where all concerned parties work in collaboration is deemed appropriate for development of the sector.

Lack of a proper communication system to exchange data and information between the center, sectors, ranges, farmer organizations and individual farmers is noted as a weakness that hampers work progress.

5.5 Basic Concept for Post Harvest and Marketing Development

5.5.1 Market-Driven Approach toward Profitable Agriculture

The market-driven approach, which puts priority on consumers' preference, begins with the identification of target consumers. The level of quality required by target consumers is thereafter determined, and the necessary cost to achieve that level of quality is appraised. Noting that "delivery" or the transportation of such goods from producers to consumers, which indicates the time, volume, location, and method, is taken into account as it directly influences the optimisation of cost and quality. On this basis, the concept of the post-harvest and marketing development is formulated to increase agricultural profit for the beneficiaries at target cascades applying the following two strategies for each crop category:

- To improve current conditions, and
- To upgrade or create value-added markets.

For the selection of a strategy, the following factors must be thoroughly considered: 1. agroecological condition, 2. willingness of farmers to challenge the strategy, 3. financial capacity, and 4.

organisational capacity in the target areas. These factors, once validated, will facilitate the creation of value-added markets and/or upgrade existing ones.

Once each target cascade has chosen a strategy or a combination of strategies (e.g., create value-added markets for paddy/rice and improve domestic distribution for vegetables), participants need to identify the targeted consumers and consider quality, cost, and delivery (QCD). Ideally, the government needs to support the cost for risk hedge, especially at the initial stage of implementation since most small-scale farmers have difficulty in the initial financial investment, and adjustments in the process of conversion from one crop to others, or conventional to organic farming may cause a decrease in production. Table 5.5.1 summarises the development strategy for selected crops.

Table 5.5.1 Post-Harvest and Marketing Development Plan

<table>
<tr><th>Current Condition</th><th colspan="2">Development Strategy</th></tr>
<tr><td colspan="3">Paddy/Rice: Food Security and Value Addition for Domestic Market</td></tr>
<tr><td rowspan="2">・ High self-sufficient rate (>80%)
・ Government's market intervention
・ Low farm-gate price at harvesting season
・ High post-harvest loss during storage and processing
・ Lack of quality control
・ Potential of value addition</td><td colspan="2">[Improvement of Current Conditions]
Improve efficiency of domestic distribution, and increase farmers' profit through off-season sale</td></tr>
<tr><td colspan="2">[Promotion of High Value Market]
Promote traditional rice varieties for high-end consumers</td></tr>
<tr><td colspan="3">OFC: Import Substitution</td></tr>
<tr><td rowspan="3">・ Lack of domestic production and monopolised supply of grain legumes
・ Increase in contract faming of feed crops, but with proper regulation</td><td rowspan="2">[Improvement of Current Conditions]
・ Encourage production and increase farmers' profit</td><td>Grain legumes</td></tr>
<tr><td>Condiments・Oil Seed</td></tr>
<tr><td>[Promotion of High Value Market]
・ Upgrade contract farming of feed crops with major buyers</td><td>Maize and soya</td></tr>
<tr><td colspan="3">Vegetables: Stable Supply to the Local Market and Value-Addition</td></tr>
<tr><td rowspan="2">・ Clear price seasonality
・ Low awareness of quality
・ High post-harvest loss
・ High potential of high value markets</td><td colspan="2">[Improvement of Current Conditions]
Improve domestic distribution to through off-season production and sales</td></tr>
<tr><td colspan="2">[Promotion of High Value Market]
Upgrade and create high-value chains
・ Upgrade supermarket chain
・ Create partnerships with the hotel industry</td></tr>
</table>

Source: JICA Project Team

5.5.2 Paddy/Rice

Table 5.5.2 shows the two strategies for paddy/rice.

Table 5.5.2 Strategy for Paddy/Rice Marketing of its QCD

Strategy	Consumers	Quality	Cost	Delivery
[Improvement of Current Conditions] Improve efficiency of domestic distribution and increase farmers' profit through off-season sale	Leading Millers	Improved varieties	Postharvest, storage	Off-season
[Promotion of High-Value Market] Promote traditional rice varieties for high-end consumers	Directly to high-end consumers	Traditional rice varieties, package	Transaction, production, and post-harvest,	Sales on order

Source: JICA Project Team

A decrease in the seasonal gap in the supply of paddy/rice is one of the measures to improve the efficiency of domestic distribution which in turn improves food security in Sri Lanka. The government, ultimately, is in charge of managing the equitable distribution of staple food, since its management centres on the food security of the nation. Off-season sales contribute to optimise yearly supply/demand, as well as open opportunities for farmers to take advantage of market prices. In this manner, off-season sales also promote food security and improve farmers’ income.

High-value varieties are one of the options to upgrade paddy/rice market in Sri Lanka without having to increase its production. As mentioned in Section 3.(2) (c), a niche and high-value market of traditional varieties has emerged and the demand has drastically been increasing among the health conscious consumers in urban areas (See Chapter 6.8.4). Given this newly emerged market and the limited volume of consumers, marketing strategy has to design a QCD to respond precisely to the preference of those high-end consumers. For this reason, direct and order-managed system, utilising ICT is recommended.

5.5.3 Other Field Crops

Table 5.5.3 shows the two strategies for OFCs.

Table 5.5.3 Strategy for OFCs Marketing of its QCD

Strategy	Crop	Target Consumers	Quality	Cost	Delivery
[Improvement of Current Conditions] Encourage production and increase farmers' profit	Grain Legumes	Major wholesalers or traders	Varieties	Production	Sale on order
	Condiments	Local consumers (Pola) and wholesalers (dedicated economic centre: DEC)	Varieties	Production, post-harvest, and storage	On and off-season
[Promotion of High-Value Market] Upgrade contract farming of feed crops with major buyers	Maize and soybean)	Contract farming to leading agribusiness companies	On order	Production, transaction	Sales on order

Source: JICA Project Team

Unlike paddy/rice, OFCs are highly recommended to increase domestic production and reduce the expense of foreign exchange.

The market of grain legumes is semi-monopolised by a few major wholesalers and traders. For this reason, new producers of grain legumes need to make a linkage with those major buyers and design QCD of their produces to meet the buyers' requirements. On the other hand, the market of condiments and potato freely functions in the ordinal chain (from farmers, via collectors, to DEC), so farmers are able to enjoy the "seller's market", with some considerations on varieties and off-season sales for durable crops.

The market of maize and soya recently emerged and major agribusiness companies promote its cultivation through contract farming. The new channel allows farmers to secure incomes with a package of support from contractors. For animal feed crops, the support needs to focus on the following transactions:

5.5.4 Vegetables

Table 5.5.4 shows the two strategies for vegetables. The recommend type of vegetable should be assessed through detailed survey and verification study.

Table 5.5.4 Strategy for Vegetable Marketing of its QCD

Strategy	Target Consumers	Quality	Cost	Delivery
[Improvement of Current Conditions] Improve efficiency of domestic distribution	Local consumers (Pola)	Varieties	Production, post-harvest, and transportation	Off-season
[Promotion of High-Value Market] Upgrade and create high-value chains ・ Upgrade supermarket chain ・ Create partnerships with the hotel industry	Directly to supermarket	On order	Production, post-harvest, and transaction	On/off-season
	High-end tourist/consumers			Sales on order

Source: JICA Project Team

Farmers are able to maximise sale price during off-season since the prices of vegetables show a clear seasonality. The target markets during off-seasons are ordinal channels, in particular, Pola. During off-seasons, when seller's prices are higher, farmers are able to earn sufficient profits by selling even at Pola, not at DEC, considering transportation cost. Moreover, the off-season sales at Pola contributes to local consumers, who otherwise pay higher prices of vegetables carried from a distant market.

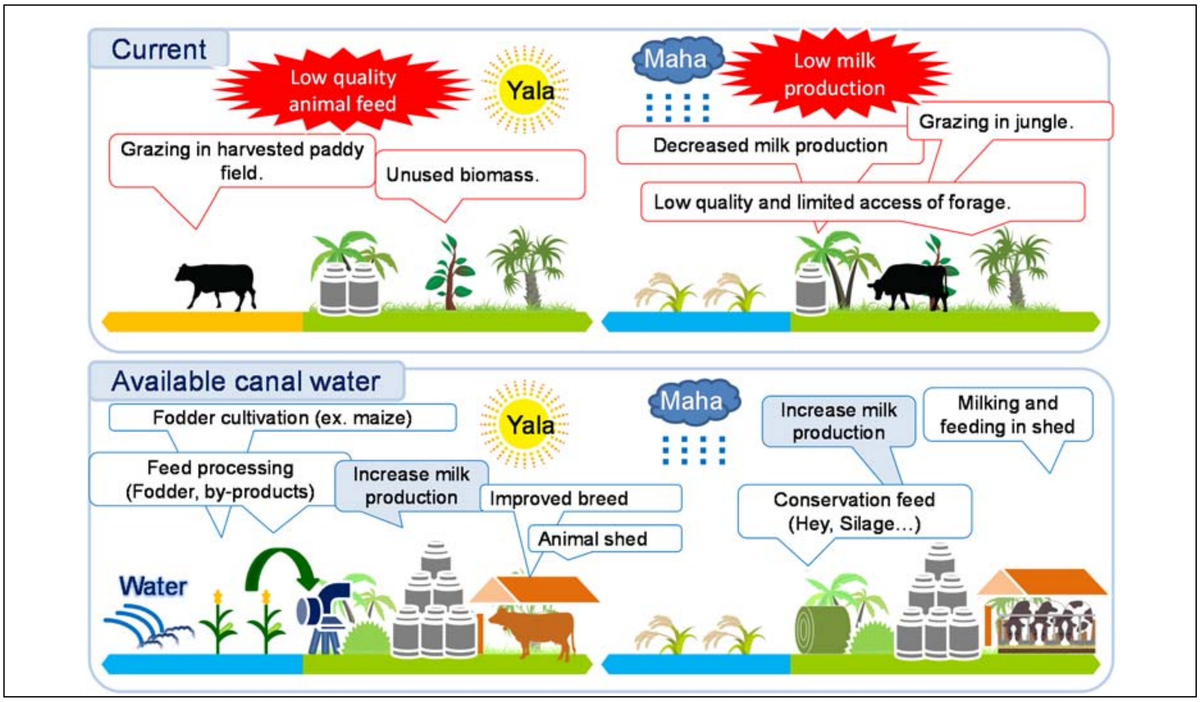
Apart from the ordinal channels, vegetable producers have opportunities to increase their profit through high-value produces. Supermarkets are one of the candidates for the new channels. Supermarkets purchase vegetables at a higher price than ordinal markets if the products meet their prescribed quality standards. In addition, the cooperation of the agricultural sector and the tourist industry can create a new high-value chain. The JICA Project Team had a discussion with executive members of the Anuradhapura Tourism and Hoteliers Association and agreed that the agricultural and tourist sectors should work together to enhance the regional industry as a whole. The result of the detail survey on high valued vegetables supports its potential (Chapter 6.8.5). As an initial trial, some large-scale hotels plan to establish a partnership with a selected cascade village, with the hotel as a direct buyer and farmers will develop a direct, localised food system. The hotel-village partnership can be a flagship venture to form a new market-trend for regional development.

5.6 Basic Concept for Livestock Development

Keeping livestock is an important risk reduction strategy; and livestock is a noteworthy provider of nutrients, an important capital asset and an important source of income for smallholders. Ruminant livestock provides an important complement to rice farming-based livelihoods in Sri Lanka and can increase incomes of crop-livestock farmers. At this moment, there is an interest in dairy farming in the crop farming sector, especially from the youth, due to its high income generation potential that can offset losses due to crop failures and market variability. The significant reason is that landless and farmers with limited land can also participate in dairy farming due to its high flexibility. Furthermore, demand for animal products such as milk is increasing with the rapid economic growth in the country. During the past several decades, a slow transition was observed from meat to milk type farms or from cattle keepers to dairy farmers. However, with the increase of fresh milk purchasing price, there seems to be a real urgency to the farmer for a rapid transition of this system.

5.6.1 Livestock Farming System after Arrival of NCPCP Water

Figure 5.6.1 depicts the management process currently followed in the existing farming system on top; and the transformation that can occur with interventions after the availability of extra water, and its outcome on the bottom.



Source: JICA Project Team

Figure 5.6.1 Characterisation of the Livestock Farming System into Two-cultivation Seasons, Pre and Post NCPCP Water Arrival

The top left section signifies the practice of farmers during dry spell, where farmers allow cattle, buffalo, and goats to graze in uncultivated paddy fields with poor quality annual and perennial grasses and crop residue. The top right section signifies the livestock during rainy season. The farmers find it difficult to attend to their livestock because they are too busy with cultivation activities. Hence, they will either be sent to remote areas for grazing or kept tethered in one place throughout the cultivation period. In both these situations, due to inadequate feed and water, the production is below the potential of these animals and will not recover even with good management.

The lower section signifies fodder utilisation for livestock post NCPCP water. The NCPCP water allows to cultivate fodder such as maize, sorghum, and some hybrid grass during dry spell. The figure indicates the use of fodder processing so that farmers will be able to stall-feed their livestock easily. During this short period, they have time to prepare silage. This will prolong the storage of fodder since silage has a long shelf life. These can be fed during the time when feed is unavailable or when the farmer is too busy with crop cultivation. Livestock now gets good quality feed throughout the year. In order to perform the effect of feed processing, it is necessary to introduce the suitable breed type. In other words, this figure depicts the transformation of the extensive-subsistence level cattle farming to the semi-intensive livestock management system with small interventions and a paradigm shift.

5.6.2 Improvement to Integrated Livestock Farming

The most important issue to increase milk production is to provide appropriate feed resource. In order to provide feed resource, fodder cultivation and feed processing are necessary to be introduced. The farming system practised by the current mixed farming sector is not helpful to the nutrition of dairy cattle. They harvest naturally available grasses but there is no tradition to cultivate fodder and pasture. The problems observed in this situation are that the shelf life of these harvested grasses is limited to one or two days and they have poor nutritive quality. Therefore, the basic strategy mentioned is to use crop-residue or cultivate fodder and then to process these to increase shelf life. In order to sustain the practice of fodder cultivation and feed processing, it is needed to consider setting up small enterprise of feed processing by an FO.

It is necessary to manage suitable type of breed to obtain the effects of feed conservation. However, artificial insemination (AI) provision is unsatisfactory with irregularities like delay of pregnancy. Therefore, good quality males should be made available for natural mating. Such males are comparatively larger than the locally available crossbreds and are sought by people for beef. The basic strategy requested by the farmers, according to their experience, is to develop a Sahiwal X Jersey crossbred that is ideal for dry zone climatic conditions. These changes will allow a rapid transition of the farming system with very small interventions.

Proper capacity building program is necessary for a smooth transition from extensive livestock farming to intensive or semi-intensive livestock farming. Capacity building of trainers and farmers is one of the actions taken to improve the productivity of dairy farming.

Chapter 6 Result of Detailed Survey

6.1 General

Chapter 6 describes the result of the detailed survey which includes various information to build the Cascade System Development Plan based on the development concept written in Chapter 5. The information has basically two types of data, namely; field data, which is mainly collected through detailed survey in the selected six cascade systems, and cross cutting data.

The items and methodology for survey are summarised in Table 6.1.1 hereinafter.

Table 6.1.1 Summary of Detailed Planning Survey

Category	Survey Item	Methodology
Existing Irrigation Facilities and Rural Road and Rehabilitation Needs	Design standard for tank and irrigation works, procurement and cost norms	Individual interview survey / Existing data collection
	Inventory of existing infrastructure (tank, canal and rural road)	Field survey
	Topographic and geographical survey data on the facilities which are to be rehabilitated as pilot activities	- do -
	Infrastructure rehabilitation and development needs	Farmer Organisation (FO) meeting / Focus Group Discussion (FGD)
Flood and Flood Mitigation Measure	Rainfall and fluctuation of the tank water level	Field survey
	Capacity of the existing spillway and condition of the downstream of the spillway	- do -
	Present flood prevention measures and monitoring activities of FO	- do -
Operation and Maintenance Activities in the Cascade System	Present water utilisation and management of FO	FO meeting / FGD
	Present facilities maintenance activities of FO	- do -
	Government supporting system for irrigation development	Individual interview survey
	Expected Operation and Maintenance (O&M) of irrigation water and facilities after receiving NCPC water	FO meeting / FGD Farm household survey
Establishment of Simulation Model for Water Distribution	Rainfall data	Field survey
	Fluctuation of the tank water level	- do -
	Evaporation	- do -
Farm Household Economy and Farming System	Household income	Farm household survey
	Land use and soil type	Field survey by local consultant
	Water utilisation	Farm household survey
	Paddy production	- do -
	Other field crops (OFC) production	- do -
	Livestock	- do -
	Post-harvest and marketing	- do -
	Social environment	- do -
	Gender	- do -
	Organisational activities	- do -
Agriculture Marketing and Post Harvest	Market information and distribution chain on high value rice	Questionnaire survey in Colombo
	Market demand on high value vegetable	Questionnaire survey in hotel industries in Anuradhapura
	Present contract and contract farming system	Interview survey
	Demand on organic vegetable, fresh fruits and processed fruits product	Questionnaire survey
Farmers' Organisation and	Government extension system	Interview survey of government officers

Extension Services	Organisational structure of FO	FO meeting / FGD Collect data through existing records
	Regulations and rules of management of FO	- do -
	Financial status and related activities of FO	- do -
	Other cooperative activities and operational rules	- do -

Source: JICA Project Team

6.2 Selection of Model Cascade System

6.2.1 Preparation of Cascade-based Information

The cascade-based information is not available except for geographical-related information. Since socio-economic, agriculture, and livestock are available basically in divisional secretariat (DS), *Grama Niladhari* (GN) based, and/or Agrarian Service Centre (ASC) level, the project made necessary assumption for the preparation of the cascade-based data from those to capture the characteristics of each cascade system.

Table 6.2.1 summarises the data source for preparation of cascade system level data.

Table 6.2.1 Data Used for Preparation of Cascade-based Information

Categories of Data	Data	Data Unit	Main Data Source	Remarks
Socio-economic	Population	GN	Statistic Office under District Secretariat of Anuradhapura Census of 2012 for Vavuniya	
	Age group	GN	- do -	
	Farmer population	GN	Occupation data from GN profile by target DS obtained from the statistic office under District Secretariat of Anuradhapura 'Resource Profile and Statistical Data of Vavuniya District 2015'	The number of farmers whose primary occupation is farming for Anuradhapura, calculated from farm families in each ASC.
	Sumurudhi population	GN	Data from each DS	
Land data	Area	Cascade	1:50,000 map from survey department	
	Gradient	Cascade	Digital surface model (DSM) data (5 m) purchased from NTT data communications	
	Land use	Cascade	1:50,000 map from survey department	
Irrigation and hydrology	Number of tanks	Cascade	Feasibility Study Report on North Central Province Canal (NCPC) Project, Mahaweli Consultancy Bureau (MCB) September 2015	
	Number of beneficiary tank under NCPC	Cascade	- do -	
	Tank active storage	Cascade	- do -	
	Irrigable area	Cascade	- do -	
	Surface runoff	Cascade	- do -	
	Allocation from NCPC	Cascade	- do -	
Agriculture and livestock	Paddy production and area	GN	Resource profiles of Anuradhapura and data from Provincial DOA in Vavuniya	
	OFC production and area	GN	- do -	
	Milk production	DS	Department of Animal Production and Health; Ministry of Rural Economic Affairs	
	Number of livestock	DS	- do -	

Source: JICA Project Team

6.2.2 Classification of Cascade System

After the arrangement of the cascade level data, the project categorised the 128 target cascade systems into eight groups based on the following aspects:

(1) Vulnerability Against Drought

The vulnerability against drought was assessed based on the water balance study with the North Central Province Canal (NCPC) project condition. Each cascade system water balance study was carried out with the following equation in a ten-day interval.

Tank storage = (NCPC inflow + runoff from residual catchment) – (irrigation release + evaporation from tank surface)

- NCPC inflow: (respective irrigation block monthly inflow) x (cascade irrigable area) / (irrigation block total irrigable area)
- Runoff from residual catchment: (respective irrigation block monthly runoff) x (cascade irrigable area) / (irrigation block total irrigable area)
- Irrigation release: Same data of Mahaweli Consultancy Bureau (MCB) study report applied for cascade water demand
- Evaporation: (Tank surface area) x (daily evaporation rate)
- Seepage and return flow within cascade system is not considered

The data for 30 years from 1979 to 2009 that were used for the study and the number of total failure in *Yala*, which was the deficit of a particular year, was more than 20% of the total demand in *Yala*, was counted. If the number of failure was high, the project marked the cascade system as highly vulnerable against drought. The 128 cascade systems were divided into two groups of “high vulnerability against drought” and “low vulnerability against drought”. The number of failure of each cascade system is shown in the attached “Cascade System Data Based for Selection of Model Sites”.

(2) Vulnerability Against Flood

The vulnerability against flood was assessed using two aspects, namely; storage capacity against runoff and gradient of the cascade system. Those two aspects were assessed with the following methodologies and gave equal weight for scoring.

Storage capacity against runoff = (average runoff in December) / (the ratio of the sum of active storage of the tanks available in the cascade system)

Gradient of cascade system = (area which have more than 5% gradient) / (total cascade area)

(3) Farm Management System

The farming system was assessed using three aspects, namely; technologies, potential, and readiness. With equal weight scoring of the three aspects, the 128 cascade systems were classified into “advanced farm management system cascade” and “moderate farm management system cascade”.

Each aspect was assessed using the following factors:

Technologies:

The present technologies for crop diversification and integration of the crop and livestock were considered. Both technologies were assessed with the ratio of OFC cultivated land against total arable land and with milk production per farm population, respectively.

Potential:

The potential of agriculture is assessed with two criteria, namely; landholding size and rate of population under the age of 15.

Readiness:

The readiness is assessed with the rate of farmer population in total work force and rate of Sumrudhi household against total population.

The project gave equal weight to each factor and gave scores to 128 cascade systems. The project marked the high scoring group as “advanced farm management system cascade” and the low scoring group as “moderate farm management system cascade”.

6.2.3 Preparation of Shortlist for Model Sites

After categorizing the 128 cascade systems into eight categories with the above three factors, the project selected two cascade systems from each category for preparation of the shortlist of candidate model sites. The selection was made considering the number of tanks available in the cascade system, area of the cascade system, number of farmers, and gap between available tank and benefit tank under North Central Province Canal Project (NCPCP). The project set the following screening criteria shown in Table 6.2.2 and identified the average cascade system for each category.

Table 6.2.2 Screening Criteria for Preparation of Shortlist

Item	Screening Criteria
Number of tanks	Between 6 and 14
Cascade area	Deviation should be less than 100
Number of farmers	Between 50 and 800
Gap between available tank number and beneficiary tank number under NCPCP	Less than 4

Source: JICA Project Team

If the screened cascade systems are more than two, the cascade system that has the smallest deviation in the area will be selected. The result of the screening is shown in the attached “Cascade System Database for Selection of Model Sites” and the shortlisted cascade systems for model sites are summarised in Table 6.2.3.

Table 6.2.3 Shortlisted Cascade System

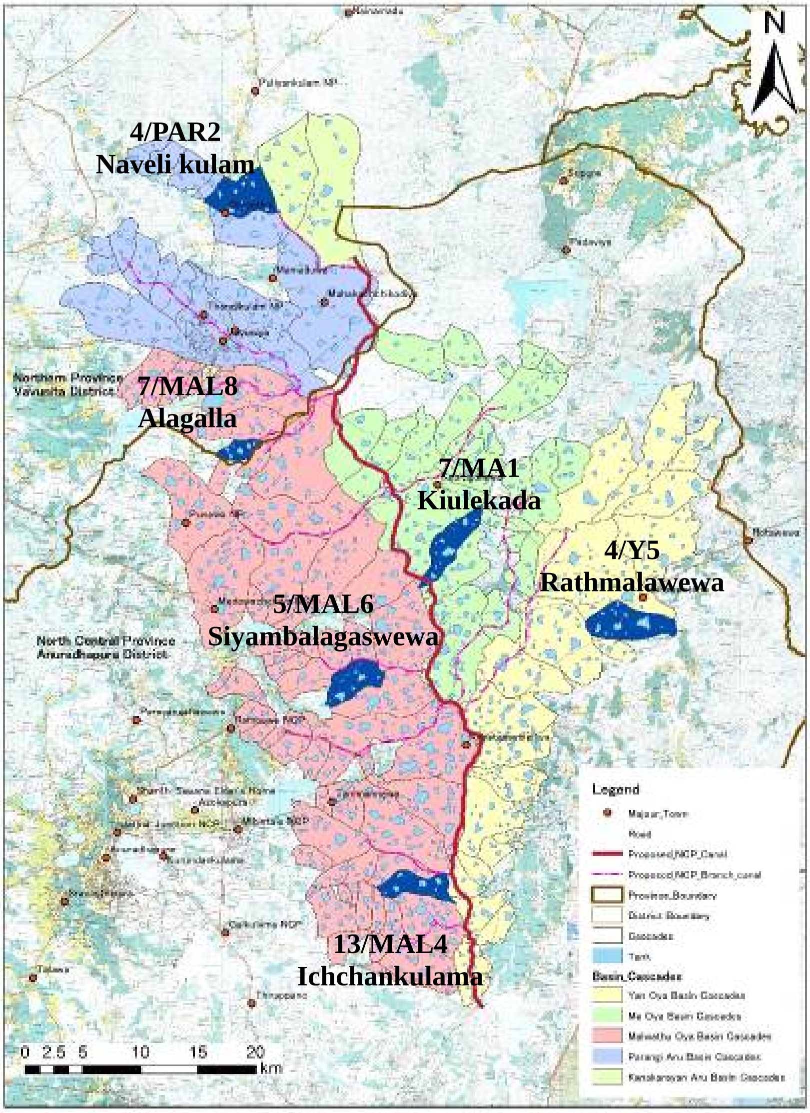
Symbol	Name of Cascade System	District	River Basin	ASC Covered
13/MAL4	Ichchankulama	Anuradhapura	Malwathu Oya	Gelenbindunuwewa
14/MA1	Elapattewa	Anuradhapura	Ma Oya	Kebithigollewa
7/MA2	Maha Ralapanawa	Anuradhapura	Ma Oya	Kebithigollewa
6/MA2	Maha Ralapanawa	Anuradhapura	Ma Oya	Kebithigollewa
3/Y4	Galkandegama	Anuradhapura	Yan Oya	Horowpothana
7/MA1	Kiwulkada	Anuradhapura	Ma Oya	Kebithigollewa
5/MAL6	Kendewa	Anuradhapura	Malwathu Oya	Medawachchiya
8/MA1	Tammennawa	Anuradhapura	Ma Oya	Kebithigollewa
6/MAL6	Talgehewa	Anuradhapura	Malwathu Oya	Kallanchiya
4/Y5	Olugaskada	Anuradhapura	Yan Oya	Horowpothana
5/MAL7	Relpanawa	Anuradhapura	Malwathu Oya	Medawachchiya/ Kallanchiya
7/MAL8	Alagalla	Vavuniya	Malwathu Oya	Kovilkulam/Madukanda
2/MAL5	Seeppululama	Anuradhapura	Malwathu Oya	Mihinthale
1/PAR1	Chinnakulam	Vavuniya	Parangi Aru	Pampaimadu
4/PAR2	Omanthai	Vavuniya	Parangi Aru	Omanthai
9/MAL4	Indigollewa	Anuradhapura	Malwathu Oya	Mihinthale
8/MAL8	Nochchikulama	Vavuniya	Malwathu Oya	Kovilkulam

Source: JICA Project Team

6.2.4 Conduct Interview Survey and Selection of Model Sites

The interview survey for the Agricultural Service Centre (ASC) staff for shortlisted cascade system was carried out to confirm the representativeness as a model and activeness of the farmers’ organisation (FO).

Based on the result of the interview survey, considering the regional balance including district and river basin, ethnicity, and ASC covered, the following six cascade systems, namely; Naveli kulam, Alagalla, Kiulekada, Rathmalawewa, Siyambalagaswewa, and Ichchankulama were selected. The location of these cascades are shown in Figure 6.2.1.



Source: JICA Project Team

Figure 6.2.1 Location of Model Sites for Phase-2 Activities

6.3 Existing Irrigation Facilities and Rural Road and Rehabilitation Needs

6.3.1 General

The inventory data on existing irrigation facilities including tanks and canal and rural road for the selected six cascade systems were collected in the field. The survey was carried out by the JICA Project Team from January to May 2017. The inventory data was used for understanding the present condition of the cascade infrastructure system for infrastructure rehabilitation and/or development planning and cost estimation. The outline of the inventory survey is shown in Table 6.3.1.

Table 6.3.1 Outlie of Inventory Survey for Present Infrastructure

Items	Description
Target Scheme	68 tanks irrigation schemes: Ichchankulama: 9 tanks, Siyambalagaswewa: 10 tanks, Rathmalawewa: 15 tanks, Kiulekada 13 tanks, Alagalla: 5 tanks, Naveli kulam: 16 tanks
Survey Items	(1) Tank bund length, height, up and down stream slope, and condition (erosion, leakage, etc.) (2) Tank related structures such as spillway and inlet sluice's number, dimension, and conditions (3) Canal length, type, and dimension and related structure's (turnout, drop, etc.) number and condition (4) Rural road, location, length, and condition

Source: JICA Project Team

In addition to the infrastructure inventory data for six cascade systems, the design criteria, cost norm and standard procedure for irrigation rehabilitation/development works in the provincial, Department of Agrarian Development (DAD) and central-funded project were collected as described hereinafter.

6.3.2 Design Criteria, Rates, and Tender Formats

Design criteria and rates and bidding formats for the rehabilitation works were collected from North Central Provincial Irrigation Department and DAD, Vavuniya as shown in Table 6.3.2.

Table 6.3.2 List of Design Criteria and Rates and Tender Formats

No.	Name	Publication	Purpose
1	Technical Guidelines for Irrigation Works	Eng. A.J. P. PONRAJAH	Planning and design
2	Approved rates for irrigation and drainage works year 2016	RDI Office Anuradhapura Region	Cost estimation
3	Rate Summary of 2017	Department of Agrarian Development (DAD), Vavuniya	Cost estimation
4	Standard bidding document procurement of works	Institute for Construction Training and Development	Bidding
5	Specifications for irrigation and drainage and land drainage works	Construction Industry Development Authority	Bidding

Source: JICA Project Team

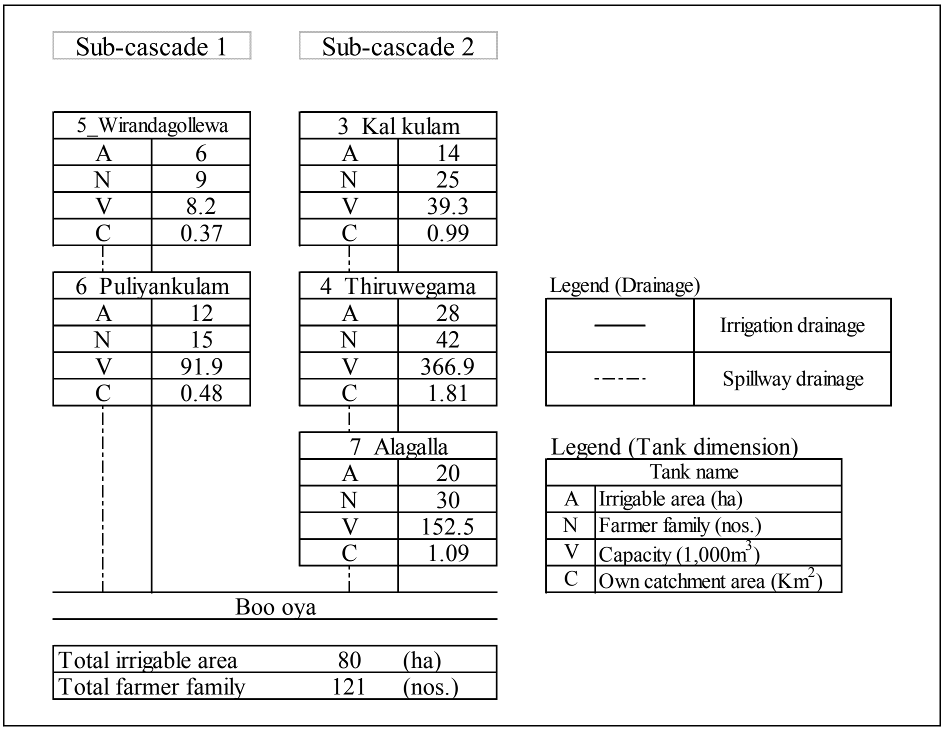
6.3.3 Present Condition of Cascade Infrastructure

(1) Drainage Diagram

The cascade consists of several subcatchments, namely, subcascades. Each subcascade has several irrigation schemes. Those tanks are interlinked by a natural stream. Water spills from the upstream tank during the *Maha* season and flows to downstream tank. The irrigation water issued to upper command area returns to the tank located downstream.

(a) Alagalla Cascade

In Alagalla Cascade, there are five existing irrigation schemes. The drainage diagram of the cascade is shown in Figure 6.3.1.

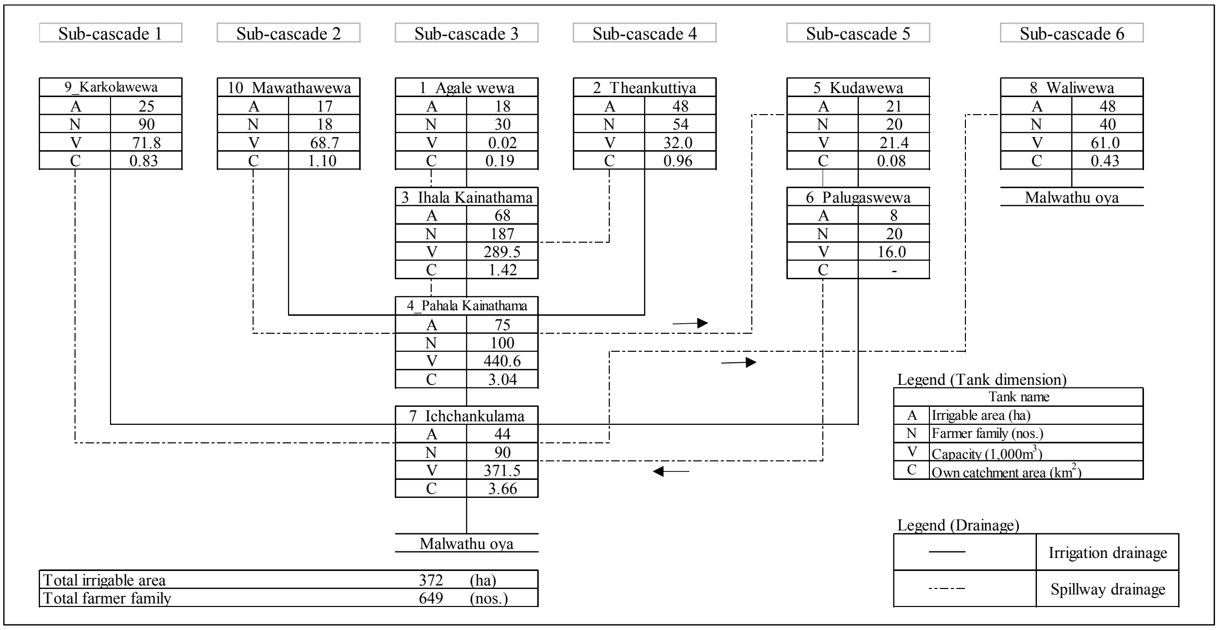


Source: JICA Project Team

Figure 6.3.1 Drainage Diagram of Alagalla Cascade

(b) Ichchankulama Cascade

In Ichchankulama Cascade, there are ten existing irrigation schemes. The drainage diagram of the cascade is shown in Figure 6.3.2.

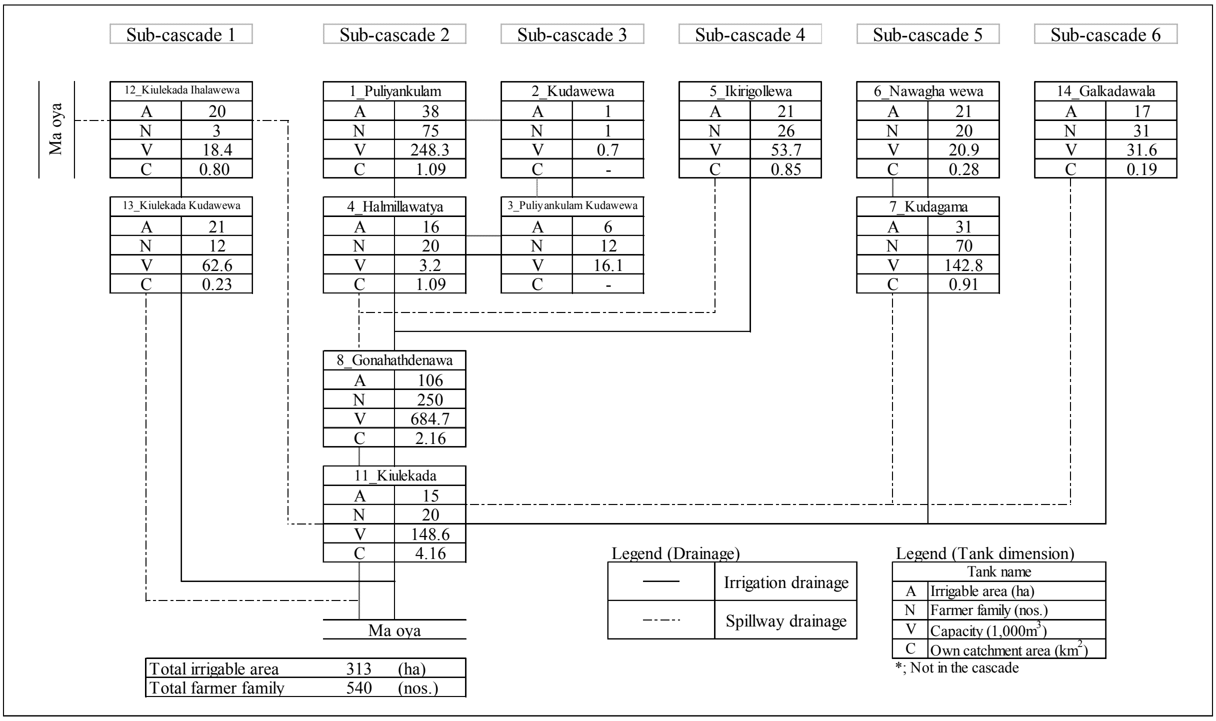


Source: JICA Project Team

Figure 6.3.2 Drainage Diagram of Ichchankulama Cascade

(c) Kiulekada Cascade

In Kiulekada Cascade, there are 12 existing irrigation schemes. The drainage diagram of the cascade is shown in Figure 6.3.3.

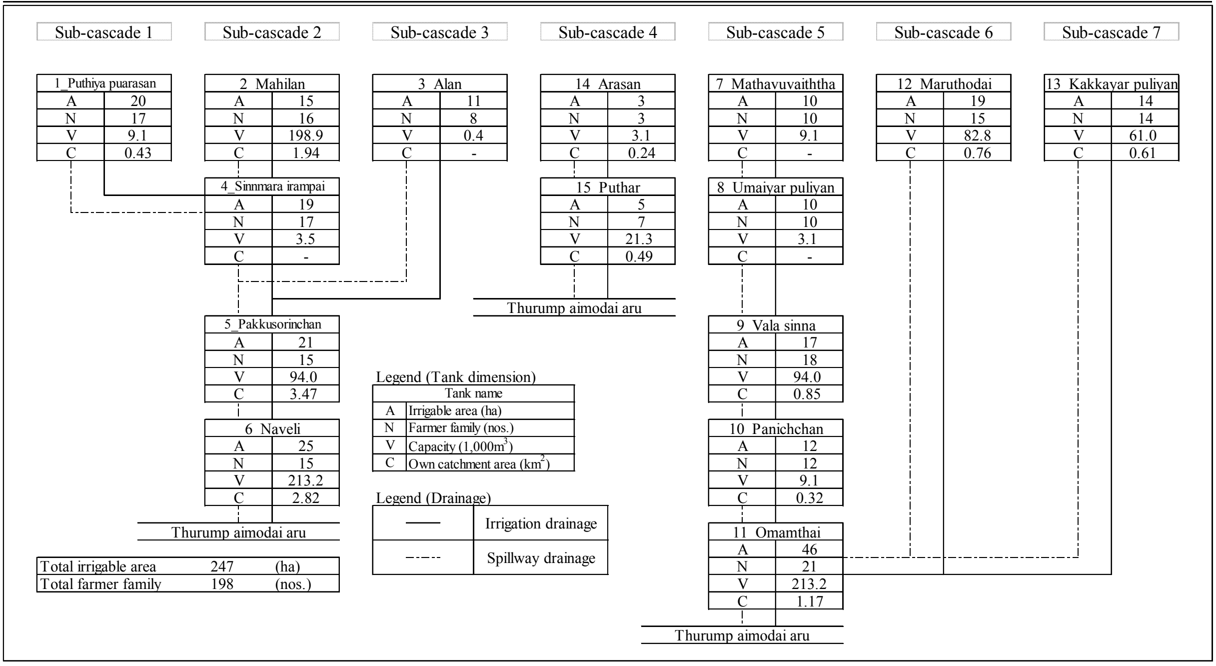


Source: JICA Project Team

Figure 6.3.3 Drainage Diagram of Kiulekada Cascade

(d) Naveli kulam Cascade

In Naveli kulam Cascade, there are 15 existing irrigation schemes. The drainage diagram of the cascade is shown in Figure 6.3.4.

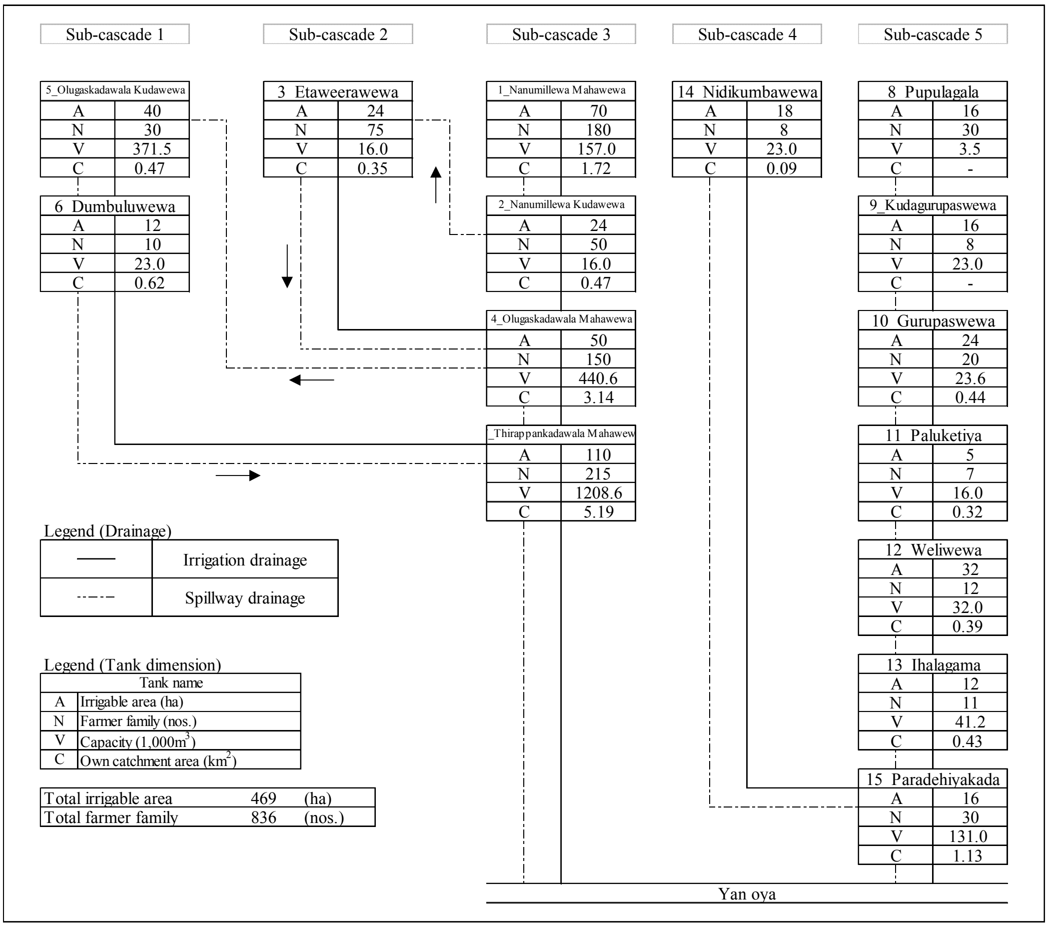


Source: JICA Project Team

Figure 6.3.4 Drainage Diagram of Naveli kulam Cascade

(e) Rathmalawewa Cascade

In Rathmalawewa Cascade, there are 15 existing irrigation schemes. The drainage diagram of the cascade is shown in Figure 6.3.5.

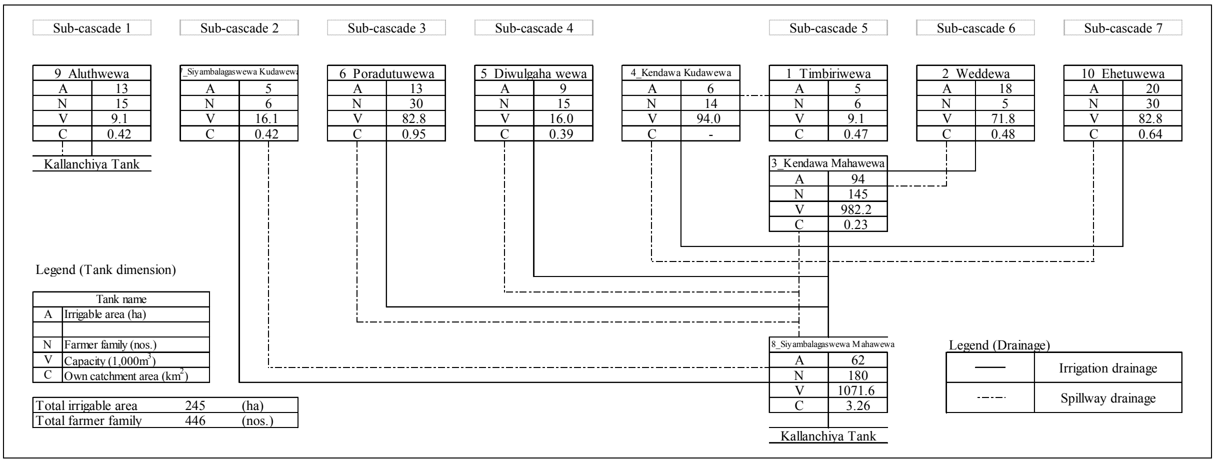


Source: JICA Project Team

Figure 6.3.5 Drainage Diagram of Rathmalawewa Cascade

(f) Siyambalagaswewa Cascade

In Siyambalagaswewa Cascade, there are ten existing irrigation schemes. The drainage diagram of the cascade is shown in Figure 6.3.6.



Source: JICA Project Team

Figure 6.3.6 Drainage Diagram of Siyambalagaswewa Cascade

(2) Existing Irrigation Facilities and Rural Road

Irrigation facilities in the cascade such as tanks, irrigation canals, and rural road, are maintained by the FO under the technical guidance of the Provincial Department of Irrigation, North Central Province (NCP) or DAD.

Whilst the number of structure is basically one per tank, there are several tanks with two or more spillways so that the flood water can flow safely downstream. Each irrigation scheme has two or three irrigation canals to feed water in the fields as shown in Table 6.3.3 to Table 6.3.8.

Table 6.3.3 List of Facilities of Alagalla Cascade

No.	Tank	Tank Bund (m)	Spillway (m)	Sluice (nos.)	Canal (m)	Farm Road (m)
1	Kal kulam	490	14	2	720	200
2	Thiruwegama	591	5	4	573	500
3	Wirandagollewa	470	20	2	412	550
4	Puliyankulam	625	19	2	1,030	650
5	Alagalla	685	46	2	1,725	1,500
Total		2,861	104	12	4,460	3,400

Source: JICA Project Team

Table 6.3.4 List of Facilities of Ichchankulama Cascade

No.	Tank	Tank Bund (m)	Spillway (m)	Sluice (nos.)	Canal (m)	Farm Road (m)
1	Agale wewa	290	0	0	0	0
2	Theankuttiya	650	13	2	1,548	250
3	Ihala Kainathama	1,040	42	3	2,899	450
4	Pahala Kainathama	970	30	4	3,388	2,437
5	Kudawewa	591	5	3	573	0
6	Palugas wewa	540	16	2	365	0
7	Ichchankulama	855	122	4	3,135	0
8	Weliwewa	1,050	82	3	1,405	2,500
9	Karkolawewa	850	35	4	1,875	1,000
10	Mawathawewa	480	8	2	960	0
Total		7,316	353	27	16,148	6,637

Source: JICA Project Team

Table 6.3.5 List of Facilities of Kiulekada Cascade

No.	Tank	Tank Bund (m)	Spillway (m)	Sluice (nos.)	Canal (m)	Farm Road (m)
1	Puliyankulam	730	18	3	1,700	1,000
2	Kudawewa	150	10	0	50	1,200
3	Puliyankulam Kudawewa	320	15	1	60	0
4	Halmillawatya	332	33	2	731	1,000
5	Ikirigollewa	482	17	3	932	0
6	Nawagha wewa	364	10	2	476	2,000
7	Kudagama	890	30	3	3,140	1,500
8	Gonahathdenawa	1,515	54	3	9,520	3,250
10	Kiulekada	933	44	2	1,655	0
11	Kiulekada Ihalawewa	583	38	2	697	2,000
12	Kiulekada Kudawewa	614	11	2	807	200
13	Galkadawala	490	10	2	583	1,500
Total		7,403	290	25	20,351	13,650

Source: JICA Project Team

Table 6.3.6 List of Facilities of Naveli kulam Cascade

No.	Tank	Tank Bund (m)	Spillway (m)	Sluice (nos.)	Canal (m)	Farm Road (m)
1	Puthiya puarasan kulam	940	25	2	2,720	0
2	Mahilan kulam	720	50	2	1,490	1,500
3	Alan kulam	940	0	1	270	0
4	Sinnmara irampai kulam	460	30	1	2,100	0
5	Pakkusorinchan	765	30	2	3,130	1,500
6	Naveli kulam	930	30	2	2,065	1,500
7	Mathavuvaiththa kulam	384	16	2	620	0
8	Umaiyar puliyan kulam	420	40	2	890	1,000
9	Vala sinna kulam	500	19	2	825	0
10	Panichchan kulam	375	5	2	997	0
11	Omanthai kulam	765	30	2	2,130	1,500
12	Maruthodai kulam	706	14	1	600	0
13	Kakkayar puliyan kulam	428	15	2	990	0
14	Arasan kulam	190	20	1	150	200
15	Puthar kulam	510	20	2	680	0
Total		9,033	344	26	19,657	7,200

Source: JICA Project Team

Table 6.3.7 List of Facilities of Rathmalawewa Cascade

No.	Tank	Tank Bund (m)	Spillway (m)	Sluice (nos.)	Canal (m)	Farm Road (m)
1	Nanumillewa Mahawewa	675	30	2	1,750	0
2	Nanumillewa Kudawewa	670	20	2	1,025	2,500
3	Etaweerawewa	475	4	1	650	1,500
4	Olugaskadawala Mahawewa	520	16	2	4,480	0
5	Olugaskadawala Kudawewa	620	20	2	3,070	0
6	Dumbuluwewa	330	20	1	600	0
7	Thirappankadawala Mahawewa	1,820	60	2	7,580	0
8	Pupulagala	410	13	2	470	0
9	Kudagurupaswewa	330	17	1	20	0
10	Gurupaswewa	500	25	2	1,150	0
11	Paluketiya	205	12	1	180	0
12	Weliwewa	520	13	2	1,360	0
13	Ihalagama	500	10	1	575	0
14	Nidikumbawewa	690	15	1	440	0
15	Paradehiyakada	670	11	1	1,350	0
Total		8,935	286	23	24,700	4,000

Source: JICA Project Team

Table 6.3.8 List of Facilities of Siyambalagaswewa Cascade

No.	Tank	Tank Bund (m)	Spillway (m)	Sluice (nos.)	Canal (m)	Farm Road (m)
1	Timbiriwewa	210	12	1	20	0
2	Weddewa	545	30	1	880	0
3	Kendewa Mahawewa	700	16	2	210	0
4	Kendewa Kudawewa	1,880	40	2	3,830	2,500
5	Diwulgaha wewa	390	16	3	260	0
6	Poradutuwewa	800	19	3	1,610	0
7	Siyambalagaswewa Kudawewa	500	9	1	120	0
8	Siyambalagaswewa Mahawewa	1,000	45	2	3,915	0
9	Aluthwewa	300	9	1	415	0
10	Ehetuwewa	480	22	2	900	1,500
Total		6,805	218	18	12,160	4,000

Source: JICA Project Team

Based on the results of the inventory survey, present conditions and issues in the existing irrigation facilities are summarised as shown in Table 6.3.9.

Table 6.3.9 Summary of Present Conditions and Issues on Cascade Infrastructure

No.	Facility	Present Conditions and Issues
1	Tank Bund	**[Present Conditions]**: General: Out of the 66 tanks in the model cascade system, only two tanks (3%) are kept in good condition. The others are deteriorated as described below. There are two tanks, which have been abandoned due to breach of their tank bunds. Erosion: In the 61 tanks, uneven elevation at their bund top and/or side slope erosion was observed due to insufficient maintenance works for a long period. Lowering of the bund top elevation may lead to adverse condition against high water level during flood period. Furthermore, erosion of the side slope on the tank bund may cause seepage on the bund slope, and consequent piping on the tank bund. Leakage: There were 11 tanks, in which leakage was observed on the tank bunds. Heavy Vegetation: Out of the 66 tanks, 52 tanks are covered with jungle, out of which there are 27 tanks with heavy jungle. This situation makes it difficult to access the tank bund and identify the defects of the facilities during the patrol of the farmers. **[Issues]**: In most of the tank bunds, jungle clearing and reshaping would be conducted including filling and compaction. The tanks, where water leakage was observed on the bund slope, were to be enhanced with provision of clay cut-off wall or other measurement to arrest the leakage.
2	Spillway	**[Present Conditions]**: Based on the criteria proposed by the JICA Project Team, probable flood discharge was estimated to evaluate adequacy of capacities of spillway in the tanks. Out of the 72 spillways provided in the 67 tanks, 57 spillways (79%) have insufficient capacity to flow flood water safely downstream of the tanks. Likewise, 62 spillways (85%) are damaged caused by lack of maintenance works for a long period. The damages include crack of wing wall of the structures, erosion or scouring of apron. There are 18 tanks, having natural spillways, out of which eight tanks are located in Naveli kulam Cascade. There are several tanks, where flood water was inundated at the downstream of the spillways during flood period as dense jungle along expected water course made it difficult for flood water to flow smoothly downstream. Furthermore, in the several tanks, spilled flow damages the irrigation canal. It was observed that several spillways were raised by sand bags to increase the storage capacity of the tank, that may threaten the safety of the tank bunds. **[Issues]**: Based on the flood water analysis, length of spillways should be examined and extended to enhance the safety of the tank bunds against probable flood, if required. The damaged spillways are required to be rehabilitated or repaired as per current condition of the structures.

3	Sluice	**[Present Conditions]**: Sluices consist of gates and concrete structures, which malfunctioned because of the insufficient maintenance over a long period. Out of the 133 sluices in the 67 tanks, 102 gates (77%) are not functioning because of their lack of gate itself and/or damage of spindle. 96 (72%) tower/wall structures were damaged and have difficulty in accessing without a passageway. **[Issues]**: Gates and concrete in damaged sluices are to be rehabilitated or replaced for smooth water distribution to irrigation canals.
4	Canal	**[Present Conditions]**: Canals, most of which are earth lined ones, are not functioning well due to heavy weeds and silting. Generally, as there is no structure on the canal to allocate irrigation water to farm plots, farmers are obliged to break canal bund to feed water to their farm plots. In several cases, as elevation of water at abstraction point is lower than that at the farm land, farmers raise water level with stop log or sand bags, that may cause overtopping of water over the canal bund, and subsequent damage of the canals. **[Issues]**: Aiming at appropriate water distribution to each farm plot, irrigation canal would be rehabilitated or improved with adequate design water level and with provision of related structure, such as farm turnouts (FTOs).
5	Farm Road	**[Present Conditions]**: Most roads are damaged due to the lack of maintenance over long periods. **[Issues]**: The damaged roads are required to be improved with pavement.

Source: JICA Project Team

6.3.4 Development Needs Observed

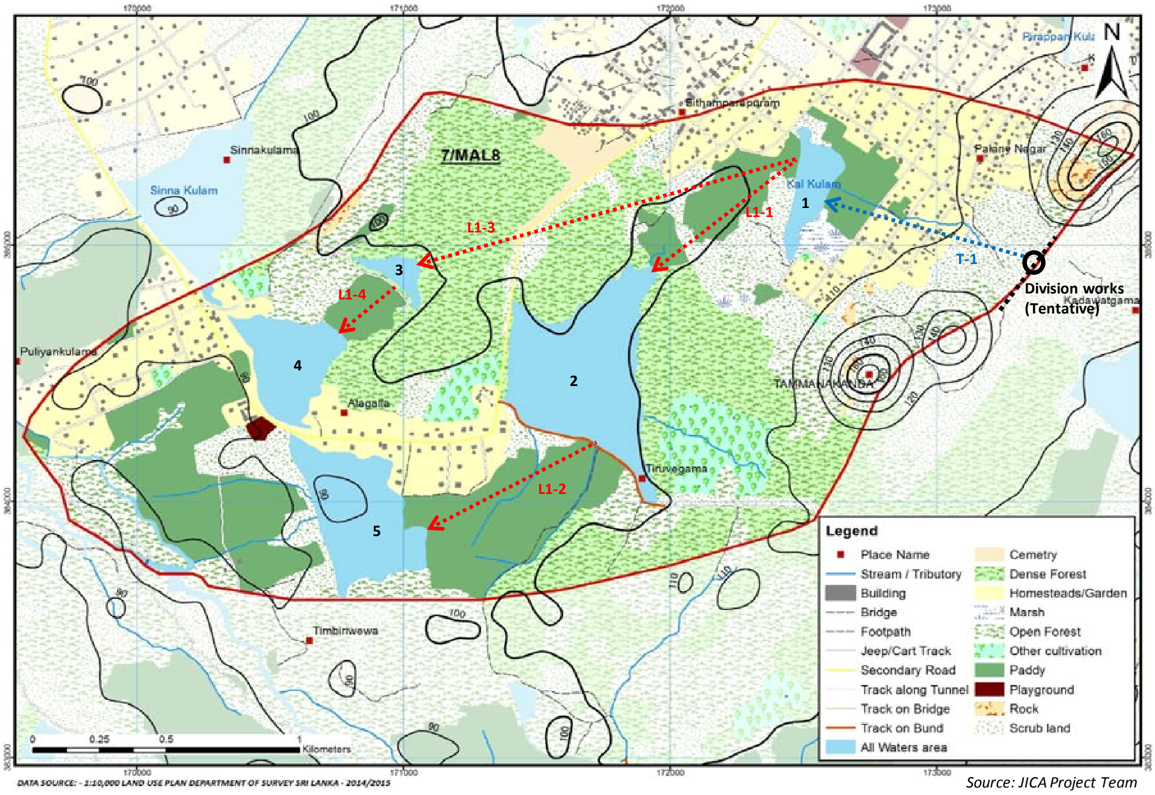
(1) Considerable Water Distribution Plan after NCPC Construction

The water distribution plan described in Section 5.3.2 has two options, namely; Option A and B. Option A supplies the NCPC water from the branch canal to several tanks located in the upstream of the cascade system and distributes the irrigation water to the downstream tanks with link canals. Adopting Option A, water distribution plan was prepared for each tank in the cascade system, regarding the upstream tank as a buffer for the water distribution.

The maximum monthly water flow as per the pre-feasibility study report was applied to determine water allocation for each cascade. Then, the allocated water is to be distributed to each tank proportionally according to command area of the particular tank by tertiary canals and link canals.

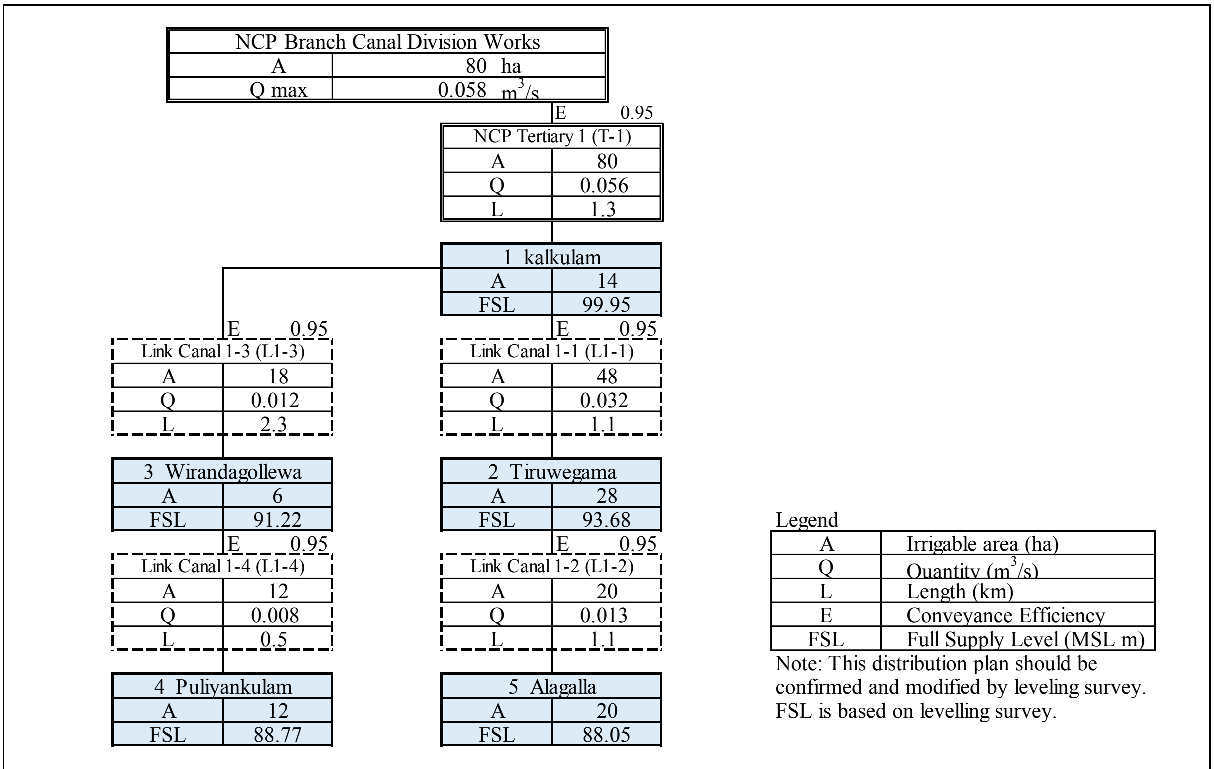
Although location of off-takes on the main/branch canals is not finalised yet, it is tentatively put at the most elevated area under the cascade. Tertiary canals are proposed to convey water from the off-take to the most upstream tanks of the subcascade. Alignment of the tertiary canals was determined based on elevation obtained from the topographical maps.

Link canals will be constructed to convey water from upstream tank to downstream tank in the cascade system. Under Kiulekada and Alagalla cascades, based on the elevation of the downstream sill level of the tanks and crest elevation of the spillway obtained from levelling survey, the link canals were preliminarily planned. Gradient in the cascades, ranging from 1/200 to 1/350, enables distributed water to flow downstream through the pipeline system. Meanwhile, in the other four cascades, alignment of the link canal was studied and decided on the basis of elevation obtained from the topographical maps. Layout of the tertiary canal and link canals is indicated in Figure 6.3.7.



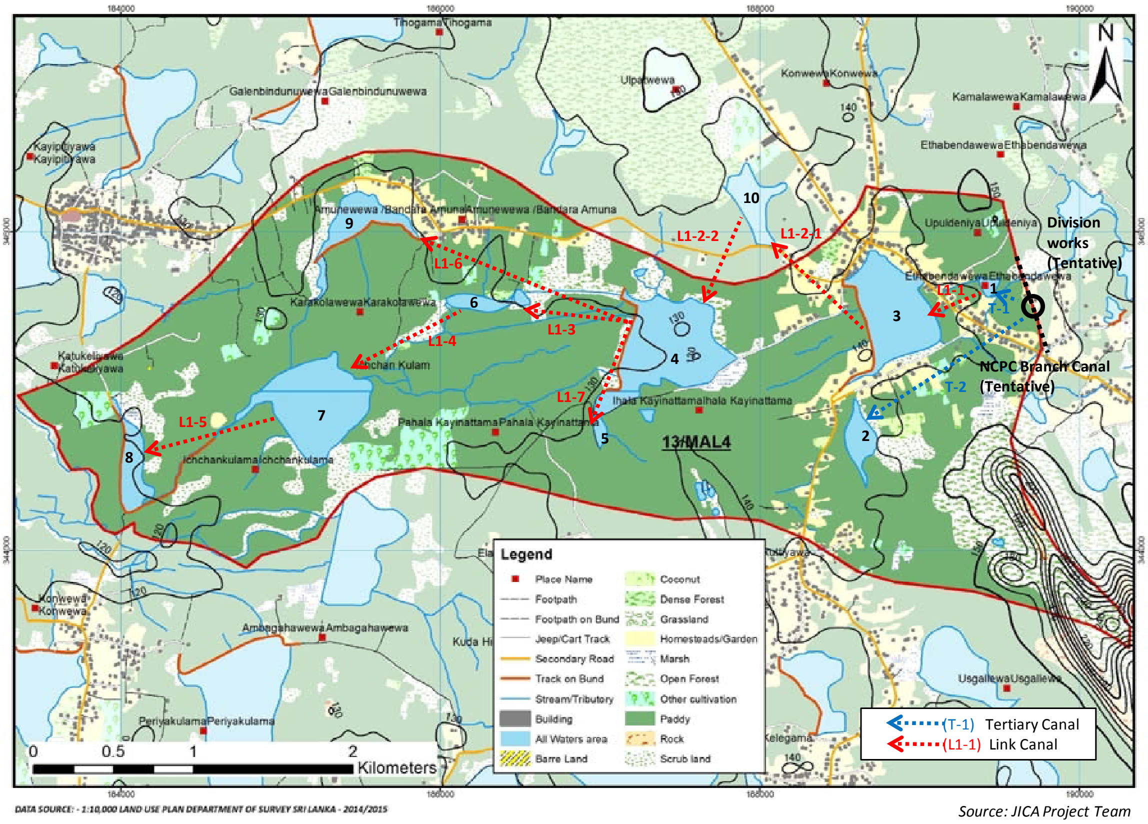
Source: JICA Project Team (Map data: 1: 10,000 Land Use Plan Development of Survey Sri Lanka 2014/2015

Figure 6.3.7 Distribution Plan of Alagalla Cascade



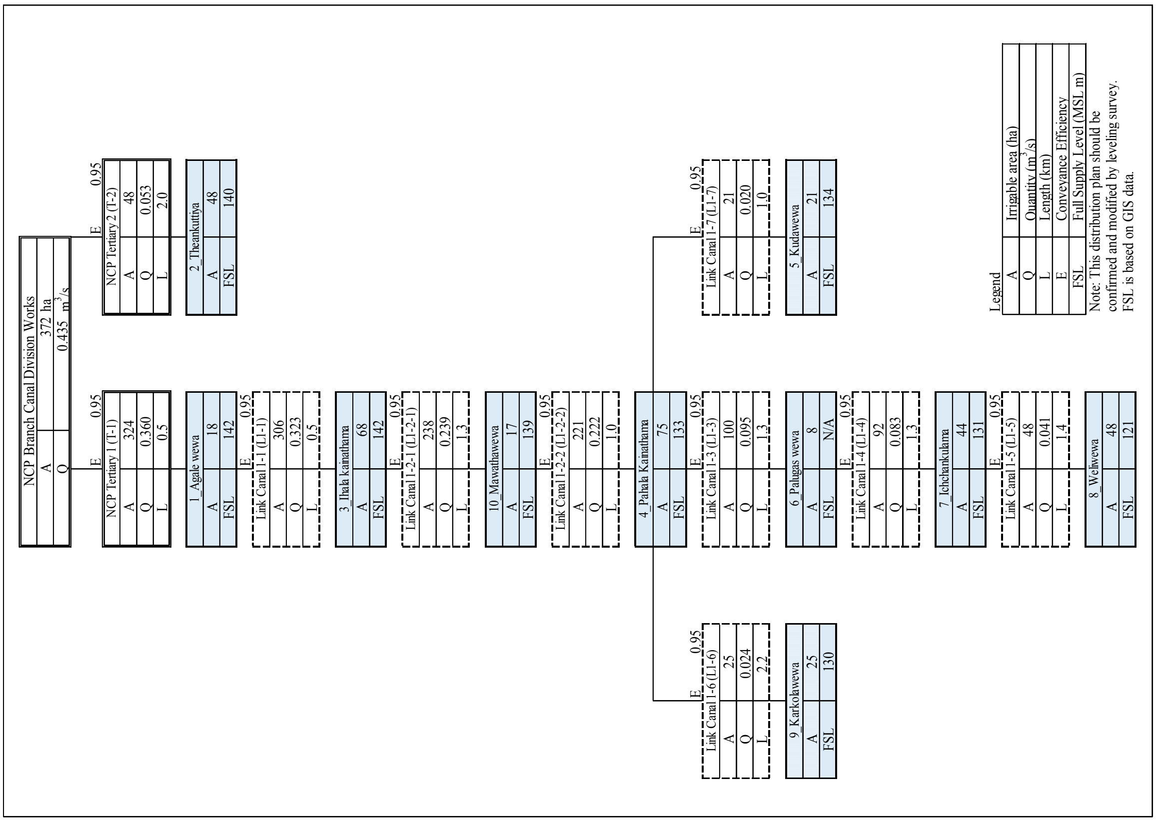
Source: JICA Project Team

Figure 6.3.8 Distribution Diagram of Alagalla Cascade



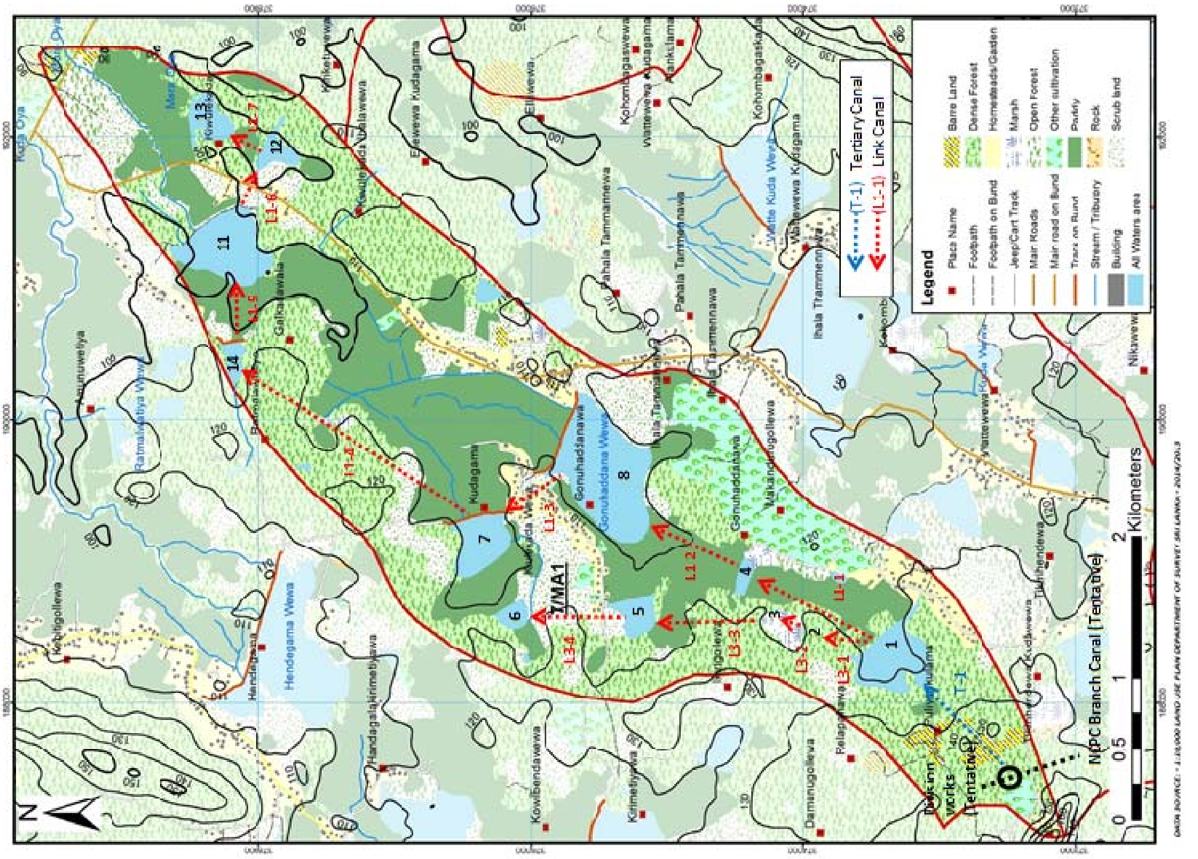
Source: JICA Project Team (Map data: 1: 10,000 Land Use Plan Development of Survey Sri Lanka 2014/2015

Figure 6.3.9 Distribution Plan of Ichchankulama Cascade



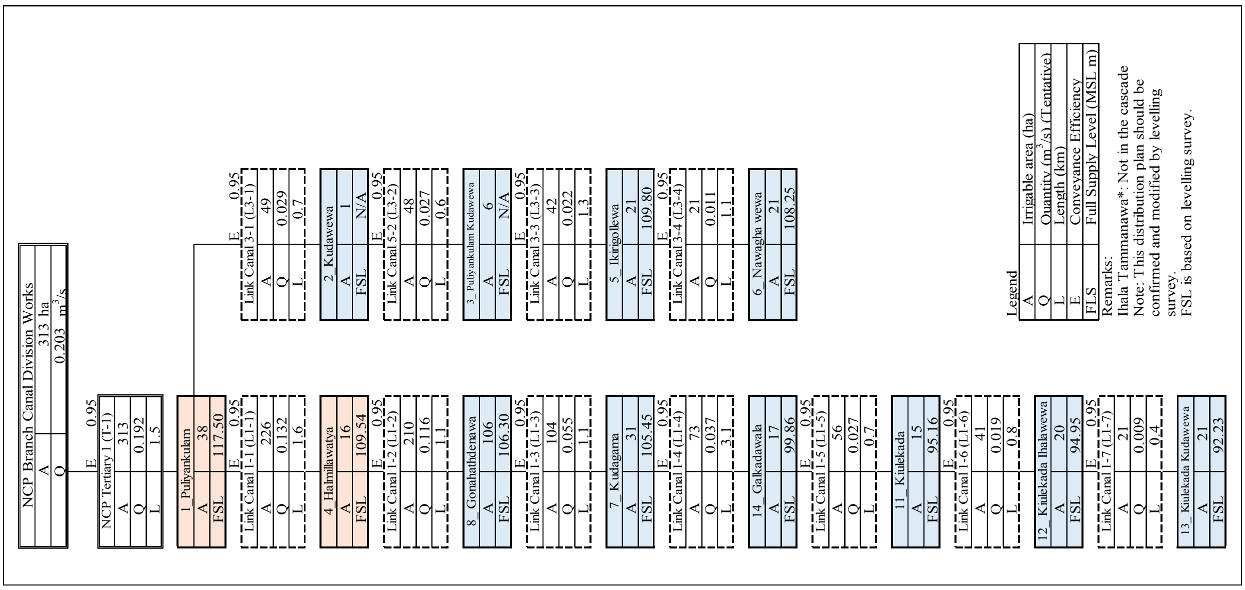
Source: JICA Project Team

Figure 6.3.10 Distribution Diagram of Ichchankulama Cascade



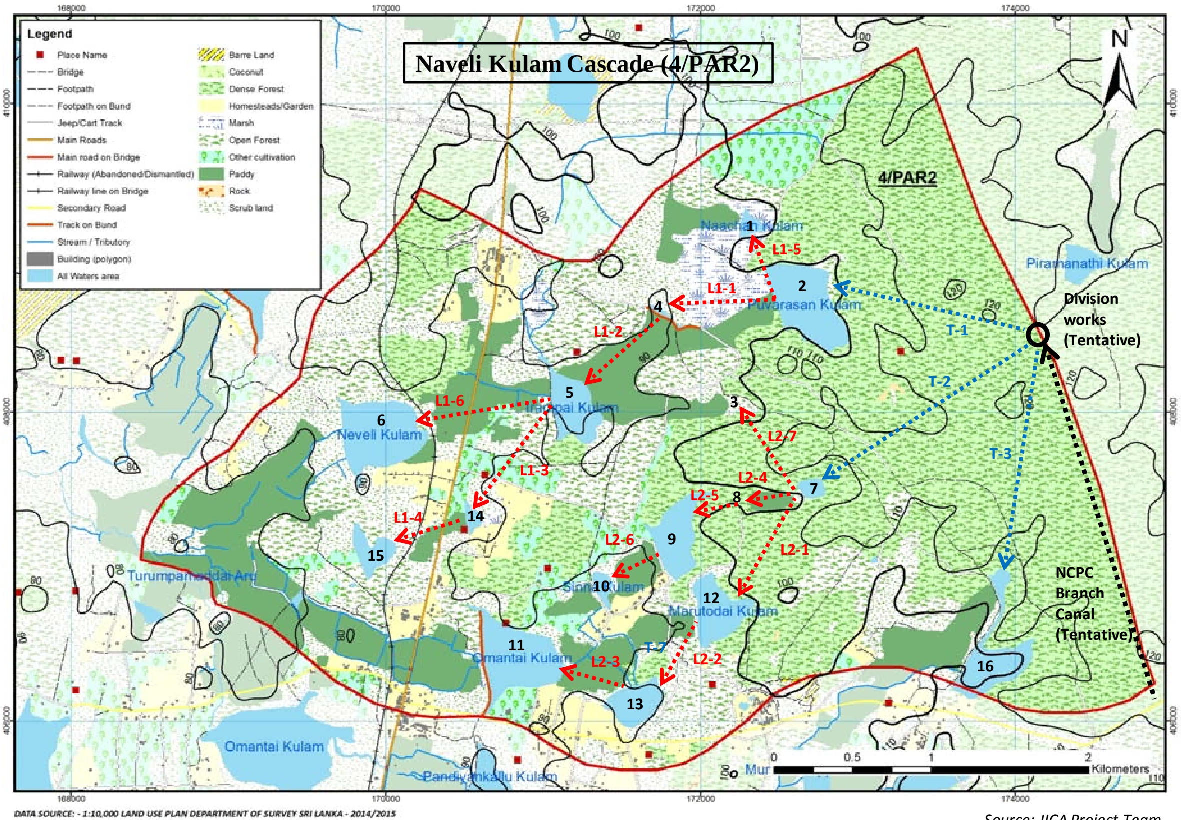
Source: JICA Project Team

Figure 6.3.11 Distribution Plan of Kiulekada Cascade



Source: JICA Project Team

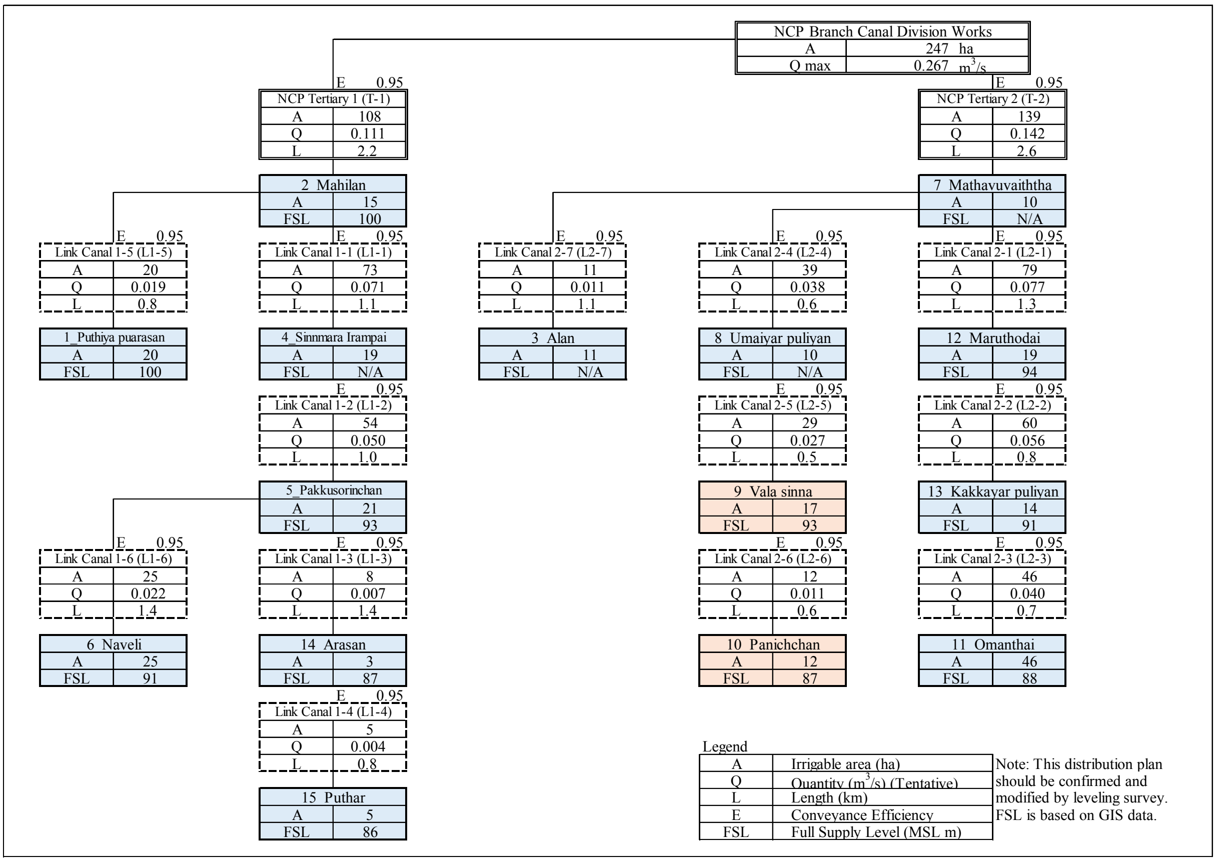
Figure 6.3.12 Distribution Diagram of Kiulekada Cascade



Source: JICA Project Team (Map data: 1: 10,000 Land Use Plan Development of Survey Sri Lanka 2014/2015

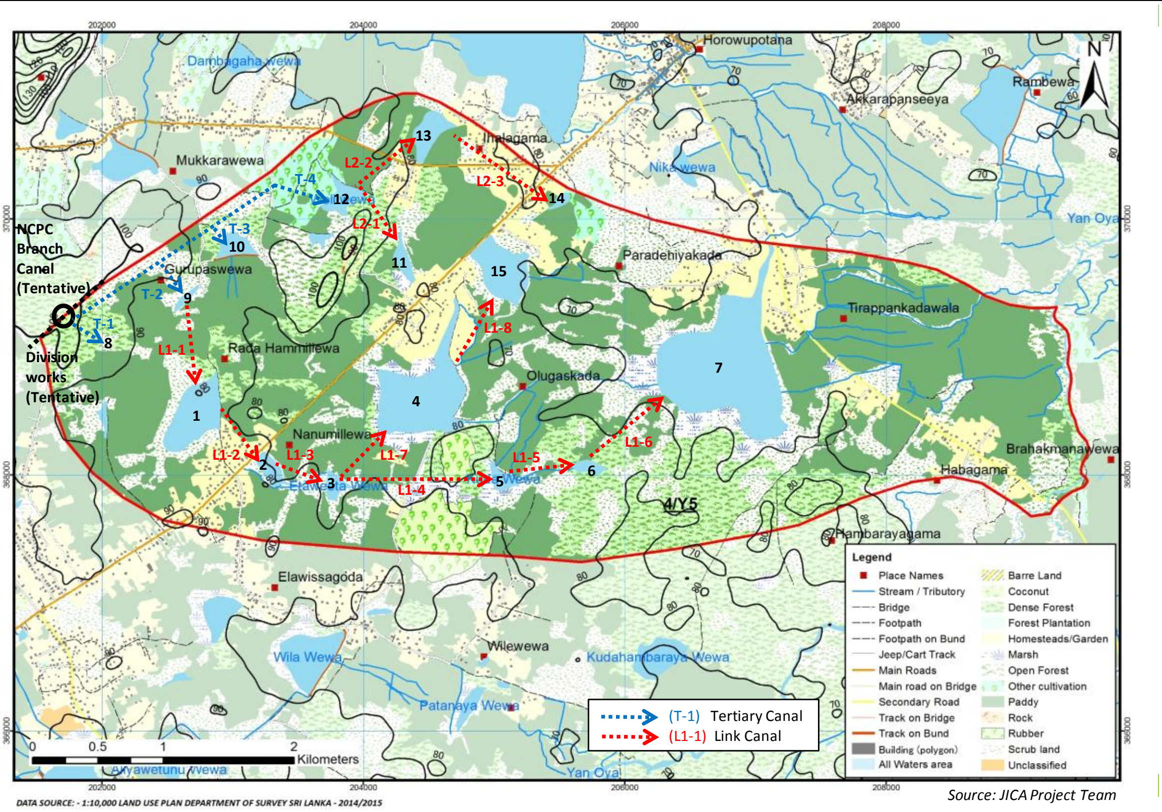
Source: JICA Project Team

Figure 6.3.13 Distribution Plan of Naveli kulam Cascade



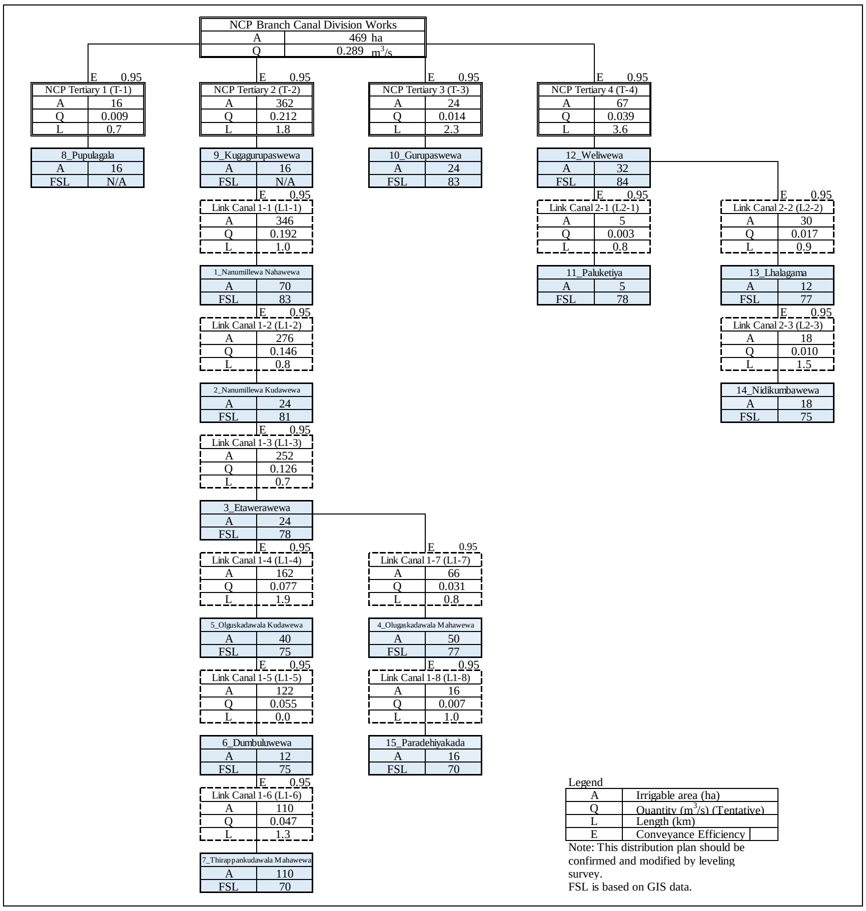
Source: JICA Project Team

Figure 6.3.14 Distribution Diagram of Naveli kulam Cascade



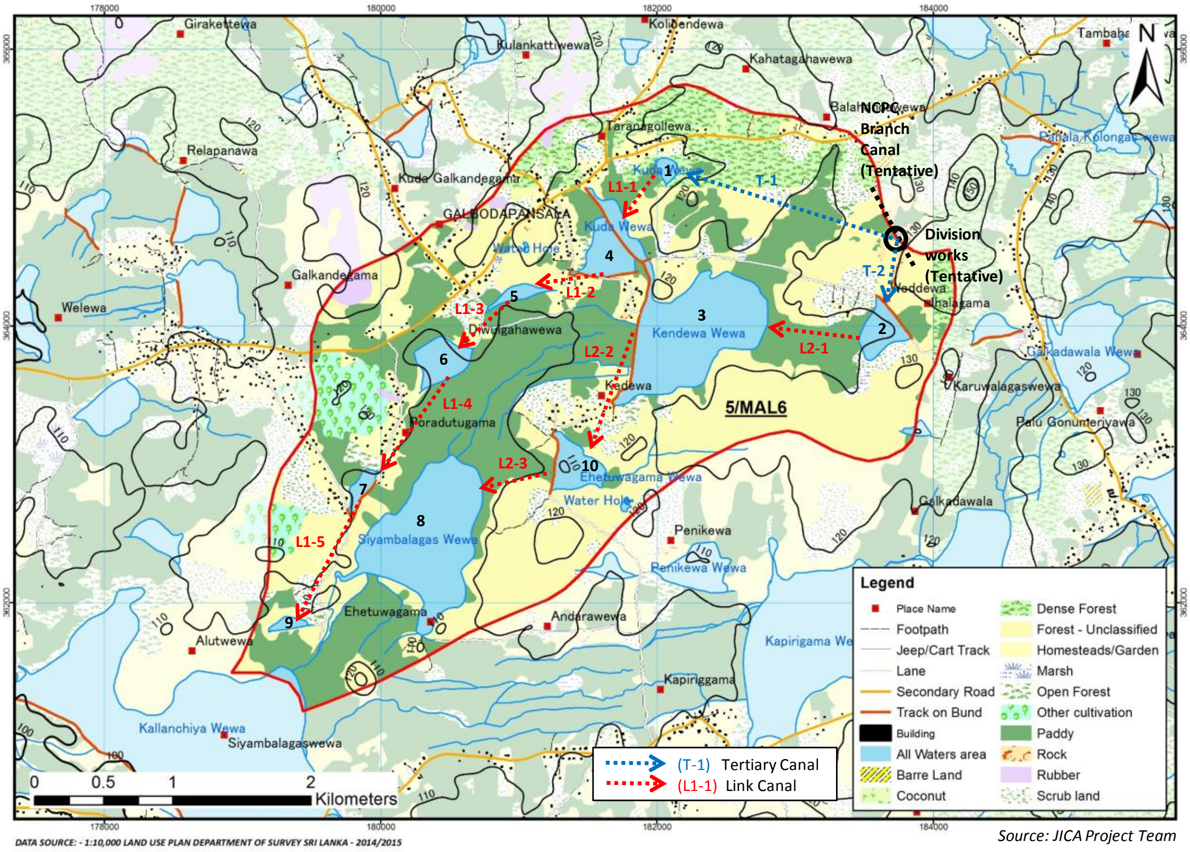
Source: JICA Project Team (Map data: 1: 10,000 Land Use Plan Development of Survey Sri Lanka 2014/2015

Figure 6.3.15 Distribution Plan of Rathmalawewa Cascade



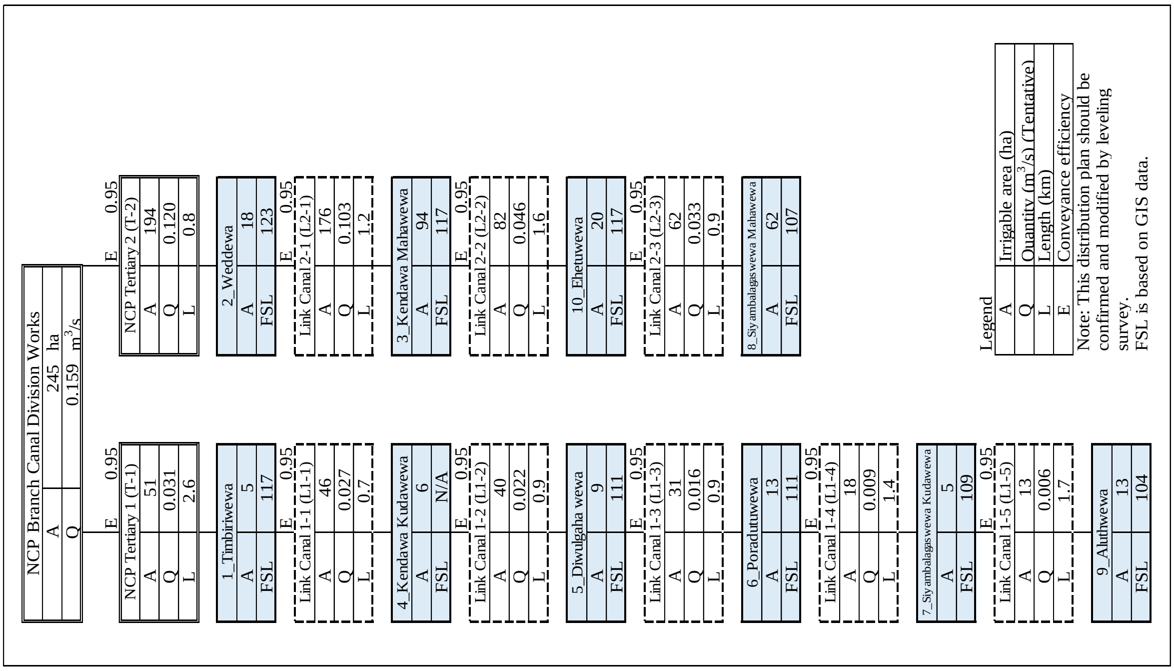
Source: JICA Project Team

Figure 6.3.16 Distribution Diagram of Rathmalawewa Cascade



Source: JICA Project Team (Map data: 1: 10,000 Land Use Plan Development of Survey Sri Lanka 2014/2015

Figure 6.3.17 Distribution Plan of Siyambalagaswewa Cascade



Source: JICA Project Team

Figure 6.3.18 Distribution Diagram of Siyambalagaswewa Cascade

(2) Rehabilitation Needs and Considerable Rehabilitation Plan

To achieve proper water distribution and consequent sustainable irrigation scheme management and market-oriented farming, based on the field investigation, construction/rehabilitation plan for infrastructure is prepared, which consists of rehabilitation of tanks, irrigation canals and construction of the tertiary canals and link canals.

Rehabilitation work of the tanks covers tank bund forming, repair/reconstruction of sluices, improvement of spillway and provision of bathing steps as shown in Table 6.3.11 to Table 6.3.16. Capacities to flow flood water at the spillways are enhanced based on the flood analysis conducted under the Project.

Irrigation canals are improved with trapezoidal earth canals and related structures, such as farm turnout and drops. Those facilities will enable farmers to conduct proper and efficient water distribution at the field level. Improvement of the farm road is partially proposed so that agricultural inputs and products can be transported effectively from the field to the main road.

Those rehabilitation plans are consistent with the farmers' requests as shown in Table 6.3.10.

Table 6.3.10 Needs on Rehabilitation Raised by the FOs

Cascade	Needs
Alagalla	・ Additional sluice is required.
Ichchankulama	・ Canal system should be improved as inappropriate canal system disturbs water distribution. ・ Water overflow due to inappropriate canal system should be avoided with improvement of the irrigation facilities. ・ Sluice problem should be solved. ・ Spillway is not in good condition. ・ Access roads need to be improved. ・ The facilities, such as bund, sluice, spillway, canal, farm roads should be rehabilitated. ・ Desilting is necessary
Kiulekada	・ Tank bund, sluice, canals, and spillways should be rehabilitated. ・ Desilting of the tank is to be conducted. ・ Tank bund should be raised to increase tank capacity.
Naveli kulam	・ The irrigation canals to be improved or constructed to cultivate OFC. ・ The irrigation system is to be improved to decrease water wastages. ・ The facilities are to be repaired as it is difficult to send water due to some damage on the facilities. ・ Tank bund should be raised to increase capacity
Rathmalawewa	・ As spilled water flows into some paddy fields, the farmers want to relocate the spillway ・ Although there are two sluice canals, both have no proper canal system (earthwork). As soil is sandy, canals are washed out every year. ・ Sluice does not function properly. ・ Lotus leaves cover the tanks. ・ Tank bund is damaged and needs rehabilitation ・ Repairs are required in bund, sluice, spillway, canals, and farm access roads ・ Desilting of tank is necessary
Siyambalagaswewa	・ Tank bund, sluice, canals, and spillway are to be rehabilitated ・ Desilting of the tanks is necessary ・ Damages in sluice, canal, and tank bund are to be repaired ・ Facilities, such as drainage system, canal, spillway, sluice gate, bund, bathing steps, and agriculture road, are to be rehabilitated or improved.

Source: JICA Project Team

As for the tertiary canals, taking into consideration topography in the area, pipeline system is adopted. The canals are to connect off-takes on the main/branch canals of the NCPC to the most upstream tanks in the cascade.

Likewise, the link canals with pipeline system are introduced to convey irrigation water from upstream tank to downstream tank, aiming at utilising the augmented irrigation water efficiently.

Table 6.3.11 Rehabilitation Plan of Alagalla Cascade

Tank		Headworks				Canal System			Farm Road
No.	Name	Tank Bund (m)	Spillway (m)	Sluice (Nos.)	Bathing Step (Nos.)	Irrigation Canal (m)	Link Canal (km)	Tertiary Canal (km)	(m)
1	Kal kulam	490	16	2	1	930	3.4	1.3	200
2	Thiruwegama	600	30	4	1	580	1.1	0.0	0
3	Wirandagollewa	470	37	2	1	420	0.5	0.0	550
4	Puliyankulam	630	34	2	1	1,030	0.0	0.0	0
5	Alagalla	690	35	2	1	1,750	0.0	0.0	0
Total		2,880	152	12	5	4,710	5.0	1.3	750

Source: JICA Project Team

Table 6.3.12 Rehabilitation Plan of Ichchankulama Cascade

Tank		Headworks				Canal System			Farm Road
No.	Name	Tank Bund (m)	Spillway (m)	Sluice (Nos.)	Bathing Step (Nos.)	Irrigation Canal (m)	Link Canal (km)	Tertiary Canal (km)	(m)
1	Agale wewa	290	13	1	1	0	0.5	0.5	0
2	Theankuttiya	650	27	2	1	1,550	0.0	2.0	250
3	Ihala Kainathama	1,040	40	3	1	2,910	1.3	0.0	450
4	Pahala Kainathama	970	64	4	1	3,400	4.5	0.0	2,440
5	Kudawewa	600	5	4	1	580	0.0	0.0	0
6	Palugas wewa	540	17	2	1	370	1.3	0.0	0
7	Ichchankulama	890	91	4	1	3,170	1.4	0.0	0
8	Waliwewa	1,050	84	3	1	1,410	0.0	0.0	2,500
9	Karkolawewa	850	34	4	1	1,880	0.0	0.0	1,000
10	Mawathawewa	480	60	2	1	960	1.0	0.0	0
Total		7,360	435	29	10	16,230	10.0	2.5	6,640

Source: JICA Project Team

Table 6.3.13 Rehabilitation Plan of Kiulekada Cascade

Tank		Headworks				Canal System			Farm Road
No.	Name	Tank Bund (m)	Spillway (m)	Sluice (Nos.)	Bathing Step (Nos.)	Irrigation Canal (m)	Link Canal (km)	Tertiary Canal (km)	(m)
1	Puliyankulam	730	28	3	1	1,710	2.3	1.5	1,000
2	Kudawewa	150	2	1	1	50	0.6	0.0	1,200
3	Puliyankulam Kudawewa	320	11	1	1	60	1.3	0.0	0
4	Halmillawatya	340	34	2	1	740	1.1	0.0	1,000
5	Ikirigollewa	490	31	3	1	940	1.1	0.0	0
6	Nawagha wewa	370	15	2	1	480	0.0	0.0	2,000
7	Kudagama	370	44	3	1	3,140	3.1	0.0	1,500
8	Gonahathdenawa	1,520	56	3	1	9,520	2.4	0.0	3,250
10	Kiulekada	940	64	2	1	1,660	0.8	0.0	0
11	Kiulekada Ihalawewa	590	35	2	1	700	0.4	0.0	2,000
12	Kiulekada Kudawewa	620	10	2	1	810	0.0	0.0	200
13	Galkadawala	490	9	2	1	590	0.7	0.0	200
Total		6,930	339	26	12	20,400	13.8	1.5	12,350

Source: JICA Project Team

Table 6.3.14 Rehabilitation Plan of Naveli kulam Cascade

Tank		Headworks				Canal System			Farm Road
No.	Name	Tank Bund (m)	Spillway (m)	Sluice (Nos.)	Bathing Step (Nos.)	Irrigation Canal (m)	Link Canal (km)	Tertiary Canal (km)	(m)
1	Puthiya puarasan kulam	940	6	2	1	2,720	0.0	0.0	0
2	Mahilan kulam	720	25	2	1	1,490	1.9	2.2	1,500
3	Alan kulam	940	22	1	1	270	0.0	0.0	0
4	Sinnmara Trampai	460	37	2	1	2,100	1.0	0.0	0
5	Pakkusirinchan kulam	770	42	2	1	3,130	2.8	0.0	1,500
6	Naveli kulam	930	44	2	1	2,070	0.0	0.0	1,500

7	Mathavuvaiththa kulam	390	20	2	1	620	3.0	2.6	0
8	Umaiyar puliyan kulam	420	20	2	1	890	0.5	0.0	1,000
9	Vala sinna kulam	500	19	2	1	830	0.6	0.0	0
10	Panichchan kulam	380	25	2	1	1,010	0.0	0.0	0
11	Omanthai kulam	770	37	2	1	2,130	0.0	0.0	1,500
12	Maruthodai kulam	710	11	2	1	600	0.8	0.0	0
13	Kakkayar puliyan kulam	430	31	2	1	1,000	0.7	0.0	0
14	Arasan	190	8	1	1	150	0.8	0.0	200
15	Puthar kulam	510	15	2	1	680	0.0	0.0	0
Total		9,060	362	28	15	19,690	12.1	4.8	7,200

Source: JICA Project Team

Table 6.3.15 Rehabilitation Plan of Rathmalawewa Cascade

Tank		Headworks				Canal System			Farm Road
No.	Name	Tank Bund (m)	Spillway (m)	Sluice (Nos.)	Bathing Step (Nos.)	Irrigation Canal (m)	Link Canal (km)	Tertiary Canal (km)	(m)
1	Nanumillewa Mahawewa	680	65	2	1	1,750	0.8	0.0	0
2	Nanumillewa Kudawewa	670	40	2	1	1,030	0.7	0.0	2,500
3	Etaweerawewa	480	40	1	1	650	2.7	0.0	1,500
4	Olugaskadawala Mahawewa	520	75	2	1	4,480	1.0	0.0	0
5	Olugaskadawala Kudawewa	620	75	4	1	3,070	0.8	0.0	0
6	Dumbuluwewa	330	36	1	1	600	1.3	0.0	0
7	Thirappankadawala Mahawewa	1,820	98	2	1	7,580	0.0	0.0	0
8	Pupulagala	410	27	2	1	500	0.0	0.7	0
9	Kudagurupaswewa	330	32	1	1	120	1.0	1.8	0
10	Gurupaswewa	500	21	4	1	1,150	0.0	2.3	0
11	Paluketiya	210	23	1	1	180	0.0	0.0	0
12	Weliwewa	520	32	2	1	1,400	1.9	3.6	0
13	Ihalagama	500	43	1	1	580	1.5	0.0	0
14	Nidikumbawewa	690	6	1	1	440	0.0	0.0	0
15	Paradehiyakada	670	39	1	1	1,350	0.0	0.0	0
Total		8,950	689	27	15	24,880	11.7	8.4	4,000

Source: JICA Project Team

Table 6.3.16 Rehabilitation Plan of Siyambalagaswewa Cascade

Tank		Headworks				Canal System			Farm Road
No.	Name	Tank Bund (m)	Spillway (m)	Sluice (Nos.)	Bathing Step (Nos.)	Irrigation Canal (m)	Link Canal (km)	Tertiary Canal (km)	(m)
1	Timbiriwewa	210	28	1	1	20	0.7	2.6	0
2	Weddewa	550	20	1	1	880	1.2	0.8	0
3	Kendewa Mahawewa	700	82	2	1	550	1.6	0.0	0
4	Kendewa Kudawewa	1,880	15	2	1	3,530	0.9	0.0	2,500
5	Diwulgaha wewa	390	16	3	1	260	0.9	0.0	0
6	Poradutuwewa	800	43	3	1	1,610	1.4	0.0	0
7	Siyambalagaswewa Kudawewa	500	14	1	1	120	1.7	0.0	0
8	Siyambalagaswewa Mahawewa	1,000	117	2	1	3,920	0.0	0.0	0
9	Aluthwewa	300	19	1	1	420	0.0	0.0	0
10	Ehetuwewa	480	27	2	1	900	0.9	0.0	1,500
Total		6,810	381	18	10	12,210	9.3	3.4	4,000

Source: JICA Project Team

6.4 Flood and Flood Mitigation Measure

6.4.1 Methodology of Estimation of Flood Discharge

(1) General

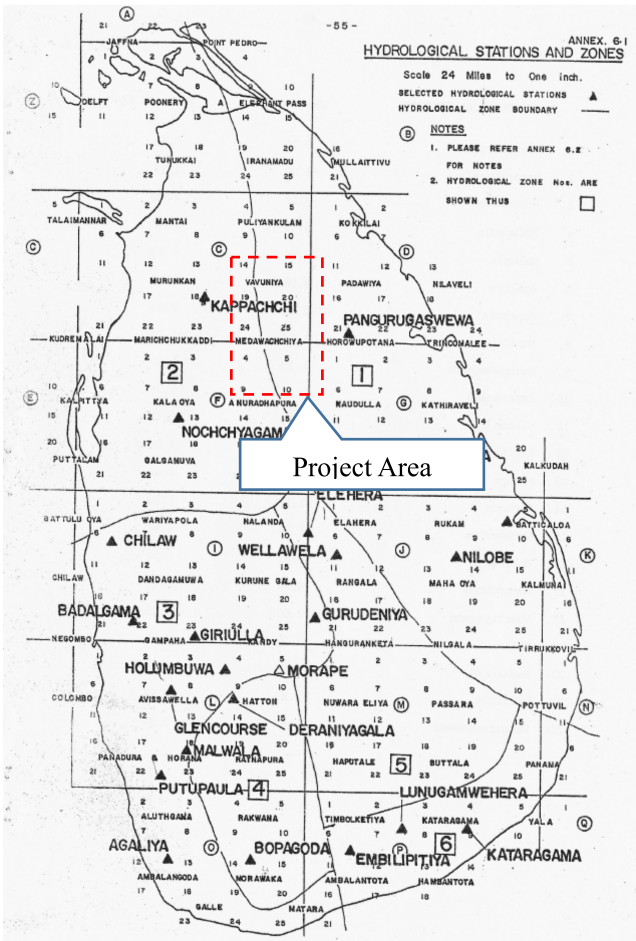
By the request of the counterpart, the study for flood discharge estimation follows the Sri Lankan technical standard named "Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah. The guidelines stipulate the methodology of hydrological analysis, design of spillway, bund, and sluice.

(2) Safety Level

The return period of the flood discharge for the spillway design of a small-scale tank is 25 years, whereas for the medium-scale tank, the return period is 50 years. Most of the tanks in the selected six cascades are categorised as a small tank.

(3) Climate Zone

According to the guideline, the country of Sri Lanka is divided into six hydrological zones as shown in Figure 6.4.1. The project area falls under Zone 1 and Zone 2.



Source: "Technical Guidelines for Irrigation Works (1989)" by A.J.P. Ponrajah

Figure 6.4.1 Hydrological Zone in the Irrigation Guidelines

(4) Rainfall Intensity

The rainfall intensity is given in the guideline corresponding to the climate zone and return period. The cumulative rainfall depth for the 24-hour storm presented in the guideline is shown in Table 6.4.1

Table 6.4.1 Probable Rainfall Depth for 24-hour Storm Presented in Irrigation Guideline

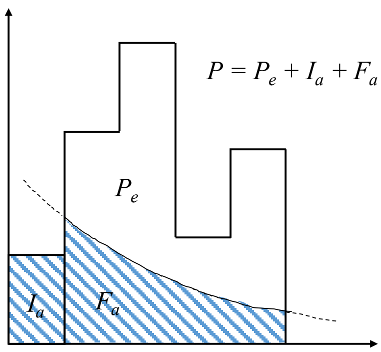
Unit: inches

Hours	2	4	6	8	10	12	14	16	18	20	22	24
100 Year Storm												
Zone 1	8.20	9.50	9.80	10.20	10.50	10.80	11.20	11.50	11.90	12.20	12.60	12.90
Zone 2	7.60	8.50	8.90	9.40	9.80	10.30	10.70	11.10	11.60	12.00	12.40	12.90
Zone 3	7.00	7.80	7.90	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80
Zone 4	5.50	8.30	9.50	10.20	10.80	11.50	12.70	13.00	13.50	14.10	14.80	15.30
Zone 5	4.30	5.40	6.20	6.90	7.50	8.00	8.50	8.90	9.30	9.70	9.80	10.20
Zone 6	7.00	9.40	9.80	10.20	10.50	10.80	11.20	11.60	12.00	12.30	12.60	12.80
Zone 7	6.50	10.50	12.00	14.50	16.00	17.00	19.50	20.50	21.50	22.50	23.00	23.50
50 Year Storm												
Zone 1	7.30	8.40	8.70	9.10	9.40	9.70	9.90	10.20	10.50	10.80	11.10	11.40
Zone 2	6.60	7.50	7.90	8.30	8.70	9.20	9.60	10.00	10.40	10.80	11.20	11.60
Zone 3	6.30	7.00	7.20	7.30	7.40	7.50	7.60	7.80	7.90	8.00	8.10	8.20
Zone 4	5.00	7.20	7.50	9.30	9.80	10.40	10.90	11.50	12.10	12.60	13.30	13.80
Zone 5	3.80	4.90	5.60	6.20	6.70	7.10	7.50	7.90	8.30	8.60	9.00	9.30
Zone 6	6.40	8.50	9.00	9.20	9.50	10.00	10.20	10.50	10.80	11.00	11.40	11.50
Zone 7	6.00	9.20	11.40	13.00	14.30	15.50	16.50	17.40	18.20	18.90	19.50	20.30
25 Year Storm												
Zone 1	6.40	7.30	7.60	7.90	8.10	8.40	8.70	9.00	9.20	9.50	9.80	10.00
Zone 2	5.90	6.80	7.10	7.40	7.80	8.10	8.40	8.70	9.10	9.40	9.70	10.10
Zone 3	5.50	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00	7.00	7.00	7.10
Zone 4	4.50	6.80	7.80	8.30	8.80	9.30	9.80	10.30	10.80	11.30	11.80	12.30
Zone 5	3.50	4.40	5.00	5.50	5.90	6.30	6.60	6.90	7.20	7.50	7.80	8.10
Zone 6	5.70	7.50	8.00	8.30	8.60	8.80	9.10	9.50	9.70	10.00	10.20	10.40
Zone 7	5.00	8.00	8.80	11.20	12.10	13.00	14.00	14.70	15.80	16.70	17.70	18.40

Ref: Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

(5) Rainfall Loss

Rainfall loss is the loss of the initial rainfall due to absorption by the dry soil and infiltration to the ground. In the guideline, rainfall loss is not mentioned, but it has to be considered. In the study, the rainfall loss is calculated by the Soil Conservation Services (SCS) method.



Source: "Applied Hydrology" Ven Te Chow, et al.

Figure 6.4.2 Rainfall Loss by SCS Method

The rainfall after deduction of rainfall loss is calculated by the following equation:

$$P_e = \frac{(P - I_a)^2}{P - I_a + S}$$

The rainfall after deduction of rainfall loss is called "rainfall excess." "*Pe*" in the above equation is the rainfall excess, "*P*" is the total rainfall, "*Ia*" is initial loss, "*Fa*" is infiltration loss, and "*S*" is the potential maximum retention. By using the above equation, the rainfall loss of the project area is calculated from 30% to 40% to the total rainfall. The details of the equation are presented in "Engineer Manual, Flood Run Off Analysis" of US Army Corps of Engineers.

(6) Flood Hydrograph

(a) Method to Derivation of Flood Hydrograph

In the guideline, Snyder unit hydrograph is introduced. The coefficients of the Snyder's unit hydrograph are proposed based on the closest hydrological station, and the shape of the unit hydrograph is developed which may fit the Sri Lankan's hydrological characteristics.

(b) Equation for Estimation of Peak Flow

The equation of unit peak flow of the flood hydrograph by Snyder's method is shown below.

$$q_p = \frac{640 \times C_p \times A}{t_p}$$

Where, q_p is unit peak flow, t_p is basin lag, A is basin area in square mile, C_p is coefficient that vary according to the physical characteristics of catchment. "t_p" is expressed by the following equation.

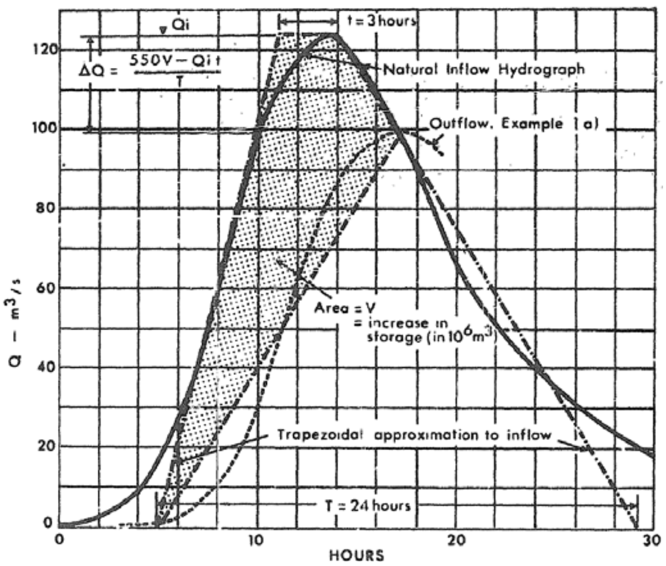
$$t_p = C_t(L \cdot L_C)^{0.3}$$

Where, L is length of the longest river course of catchment in miles, and L_c is length from the point of interest to the point on the river course closest to the centroid of the catchment in miles.

C_t and C_p are given to the closest hydrological stations.

(c) Flood Routing

The inflow of the flood flow will be released from the spillway but a part of the inflow will be stored in the reservoir. The guideline recommends to use the method developed by J.H. West (Journal of Hydrology, 23-1974). The method uses simple graphical solution to estimate the flood discharge through spillway. The graphic solution assumes inflow as trapezoid, and outflow is assumed to be an isosceles triangle. The fore slope and rear slope of the trapezoid are drawn to fit the tangent of the hydrograph.



Source: J.H. West "Flood Control in Reservoirs and Storage Pounds-A Discussion," Journal of Hydrology, 23 (1974) 67-71

Figure 6.4.3 Flood Routing by J.H. West Method

According to the guideline, the peak outflow is estimated by the following equation:

$$q_d = \frac{555.5V_d - q_{in}}{T}$$

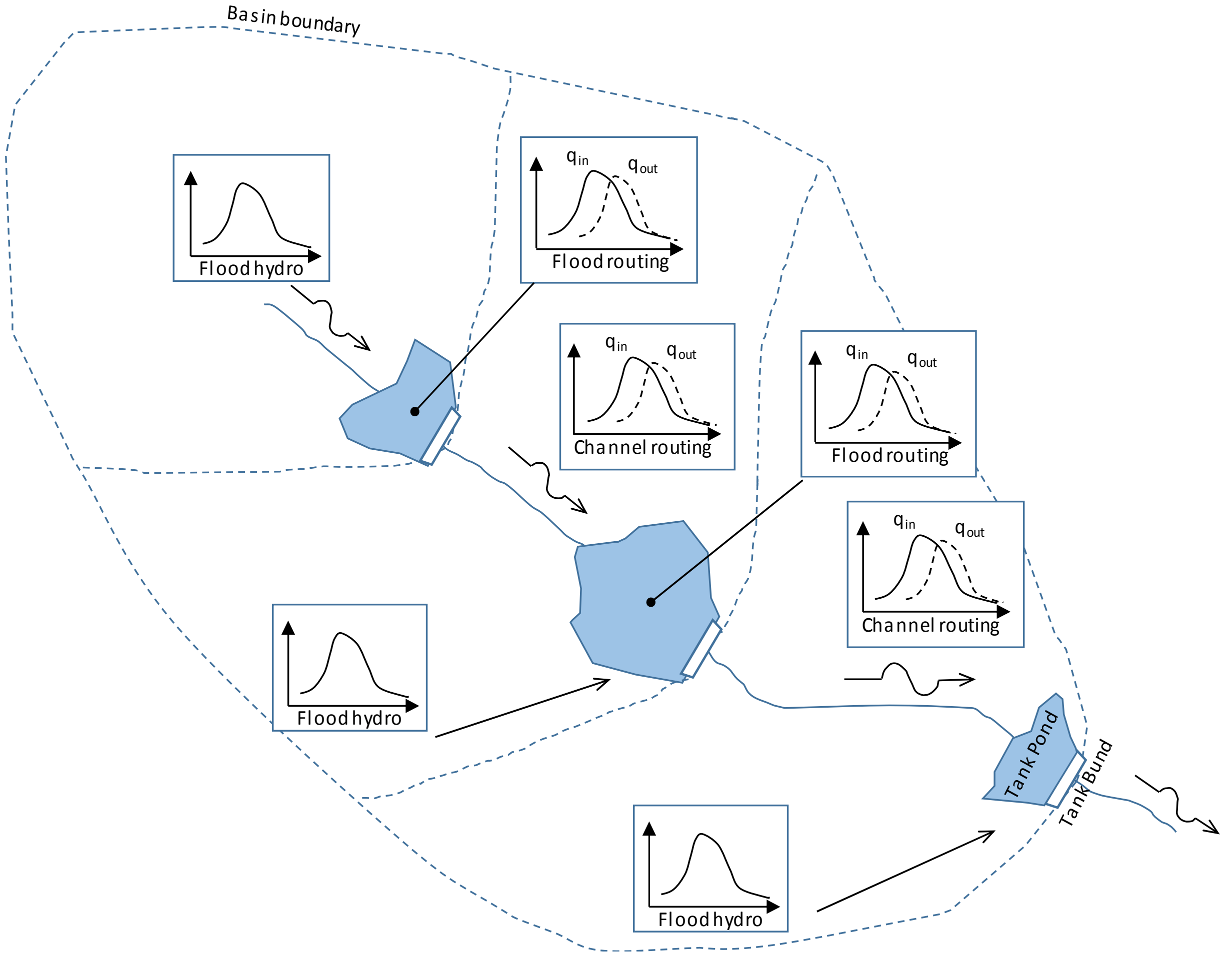
Where, q_d is peak outflow through spillway in cumecs, V_d is stored flood discharge in the reservoir in million m^3, q_{in} is peak inflow, T is base hours of inflow and outflow shown in Figure 6.4.3.

(d) Channel Routing

Channel routing is not mentioned in the guidelines but it has to be considered in the flood analysis in the cascade system. In this analysis, Muskingum method is applied. The equations of Muskingum method are introduced in various guidelines and textbooks such as "Flood Runoff Analysis" of US Army Corps of Engineers, or "Applied Hydrology" by Ven Te Chow, et al.

(e) Flood Discharge for Cascaded System

The flood discharge estimation for the cascaded system is not described in the guideline. The JICA Project Team discussed with the counterpart for the methodology of the cascade flood analysis. It is determined that the cascade flood is studied for each of the tanks considering the upstream storage effect of tank and channel. This concept of the flood analysis for the cascade system is shown in Figure 6.4.4.



Source: JICA Project Team

Figure 6.4.4 Concept of the Flood Analysis for the Cascade System

6.4.2 Estimation of Flood Discharge

The flood discharge of the tanks in the selected six cascades is calculated by the method stipulated in the technical guideline of irrigation works. The lumped flow is estimated by the Snyder's unit hydrograph, and flood routing as well as channel routing calculation is conducted. The return period for the design flood analysis is 25 years.

The results of the design flood discharge for the tanks in the selected six cascades are shown in the table below.

Table 6.4.2 Design Discharge of Each Tank in Selected Six Cascades

Name of Cascade	Name of Tank	Catchment Area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
Allagalla	Kal Kulam	0.99	12.4	11.3
	Thiruwegama	1.81	26.6	25.4
	Wirandagollewa	0.37	27.9	26.7
	Alagalla	1.09	55.5	55.5
	Puliyan Kulam	0.48	28.7	29.1
Ichchankulam	Theankuttiya	0.96	25.7	23.1
	Ihala Kainatama*	1.61	65.9	62.6
	Pahala kinatana	3.04	101.5	101.5
	Karakolawewa	0.83	28.4	24.3
	Ichchankulama*	3.74	148.8	143.1
	Weliwewa	0.43	135.9	133.4
Kiulekada	Puliyankulam	1.09	29.3	24.0
	Halmillawatya*	1.09	45.2	44.1
	Ikirigollawa	0.85	31.0	26.0
	Nawagha	0.28	12.0	10.8
	Gonahathdenawa	2.16	95.5	87.8
	Kuadagama	0.91	41.4	37.3
	Galkadawala	0.19	8.4	7.4
	Kiulekada	4.16	110.5	100.6
	Kiulekada Ihalawewa	0.80	55.5	55.5
	Kiulekada kudawewa	0.23	9.5	8.5
Naveli Kulam	Maruthodai Kulam	0.76	8.5	7.8
	Vala Sinna *	0.85	13.7	13.7
	Panichchan	0.32	18.8	17.9
	Kakkar puliyan kukam	0.61	22.1	22.1
	Omanthai Kukam	1.17	58.0	58.0
	Puthiya puarasan kulam	0.43	5.6	4.6
	Mahilan kulam	1.94	19.2	17.6
	Pakuworiwan kulam*	3.47	55.5	55.5
	Naveli Kulam	2.82	69.0	69.0
Ratmalawewa	Nanumillewa Mahawewa	1.72	53.3	46.6
	Nanumillewa Kudawewa	0.47	31.4	28.9
	Etaweerawewa	0.35	34.4	34.4
	Gurupaswewa*	0.44	18.4	15.3
	Olugaskadawala Mahawewa	3.14	98.9	98.9
	Olugaskadawewa Kudawewa	0.47	99.9	99.9
	Paluketiya	0.32	15.1	19.2
	Weliwewa	0.39	24.1	22.9
	Ihalagama	0.43	31.3	31.3
	Paradehiyakada	1.13	36.9	33.7
	Thirappankadawala*	5.19	154.3	154.3
Siyambalagaswewa	Weddewa	0.48	20.6	17.1
	Timbiriwewa	0.47	22.0	19.7
	Kendewa Mahawewa*	4.23	108.8	108.8
	Diwulgaha wewa	0.39	13.2	11.5
	Poradutuwewa	0.95	34.7	31.0
	Siyambalagaswewa Kudawewa	0.42	13.0	11.4
	Ehetuwewa	0.64	22.5	19.3
	Siyambalagaswewa Mahawewa	3.26	193.2	185.1
	Aluthwewa	0.42	15.3	13.7

Remarks
Ihala Kainathama is including Agalewewa
Ichchankulama is including Kudawewa and Palugaswewa
Halmillawatya is including Kudawewa and Piliyankulam kudawewa
Vala sinna is including Mathavuvaiththa and Umaiyar puliyan
Pakusorinchan is including Alan and Sinnmara irampai
Gurupaswewa is including Pupulagala and Kudagurupaswewa
Thirappankadawala is including Nidikumbawewa
Kendawa Mahawewa is including Kendawa kudawewa

Source: JICA Project Team

It is noted that the estimated design discharge by the Snyder's method gives relatively large peak flood discharge. For example, the capacity of existing spillway in the cascades in NCP has been determined by using empirical equation, i.e., Dicken's formula.

Dicken's formula was originally formulated in the northern part of India and somehow the equation is adopted in the spillway design in Sri Lanka. The equation of the Dicken's formula is as follows:

$Q = CM^{0.75}$

Where, Q is discharge in cusecs, C is coefficient of soil, whilst M is catchment area in square miles. Dicken's formula does not involve rainfall intensity and there is no notion of return period.

If the result of the flood discharge given by Snyder's unit hydrograph method is compared with that of Dicken's formula, the former is around twice of the latter's result. The JICA Project Team also compares the result of Snyder's method with rational formula, which is used to estimate the drainage of small catchment, and the Snyder's method is generally larger than that of rational formula. The use of irrigation guideline of Sri Lanka is requested by the Sri Lankan side. It is concluded that the flood discharge estimated by the Snyder's method gives much safer side discharge than other methods.

6.4.3 Assessment of Present Capacity and Condition of Spillway

(1) Capacity of Existing Spillway

Capacity of most existing spillway is not enough based on the comparison of length of existing and design as shown in Table 6.4.3. Capacity of spillway should be increased to reduce flood damage.

Table 6.4.3 Summary of Evaluation of Spillway Capacity

Cascade	Tank No. in Total	Spillway No. in Total	Evaluation[1)]	
			Out	OK
Alagalla	5	5	4	1
Ichchankulama	10	10	6	4
Kiulekada	12	16	12	4
Naveli kulam	15	15	14	1
Rathmalawewa	15	5	13	2
Siyambalagaswewa	10	11	8	3
Total	67	72	57	15

1): Evaluation:
Out: Existing length < Design length
OK: Existing length > Design length
Source: JICA Project Team

Results of capacity evaluation for each cascade are shown in Table 6.4.3 to Table 6.4.9. All cascades have spillways wherein the capacity is not enough.

Table 6.4.4 Evaluation of Spillway Capacity in Alagalla Cascade

No.	Tank	Existing		Required Dimension						Evaluation (L<B: Out) (L>B: OK)	Remarks
		Spill Type	Length (L) (m)	Spill Type	Design Flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)		
1	Kal kulama	Channel	14	Channel	11.3	2.80	16	0.6	11.6	Out	(1)
2	Thiruwegama	Drop wall	5	Drop wall	25.4	3.33	30	0.6	25.9	Out	(1)
3	Wirandagollewa	Channel	20	Channel	26.7	2.80	37	0.6	26.9	Out	(1)
4	Puliyankulam	Drop wall	19	Drop wall	29.1	3.33	34	0.6	29.4	Out	(1)
5	Alagalla	Drop wall	46	Drop wall	55.5	3.33	35	0.9	55.6	Ok	(1)

Remarks: (1) Q': Calculated design flood based on the criteria (1/25 year return period)
Source: JICA Project Team

Table 6.4.5 Evaluation of Spillway Capacity in Ichchankulama Cascade

No.	Tank	Existing		Required Dimension						Evaluation (L<B: Out) (L>B: OK)	Remarks
		Spill Type	Length (L) (m)	Spill Type	Design Flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)		
1	Agale wewa	-	-	Channel	9.0	2.80	13	0.6	9.5	Out	(2-1), (3)
2	Theankuttiya	Drop wall	13	Drop wall	23.1	3.33	27	0.6	23.3	Out	(1)
3	Ihala kainathama	Drop wall	42	Drop wall	62.6	3.33	40	0.9	63.5	Ok	(1)
4	Pahla Kinathama	Drop wall	30	Drop wall	101.5	3.33	64	0.9	101.7	Out	(1)
5	Kudawewa	Drop wall	5	Drop wall	3.8	3.33	5	0.6	4.3	Ok	(2-1)

6	Palugas wewa	Channel	16	Channel	12.0	2.80	17	0.6	12.4	Out	(2-2)
7	Ichchankulama	Drop wall	122	Drop wall	143.1	3.33	91	0.9	144.6	OK	(1)
8	Wali wewa	Drop wall	82	Drop wall	133.4	3.33	84	0.9	133.4	Out	(1)
9	Karkolawewa	Channel	35	Channel	24.3	2.80	34	0.6	24.7	OK	(1)
10	Mawathawewa	Drop wall	8	Drop wall	51.9	3.33	60	0.6	51.9	Out	(2-1)

Remarks:
(1) Q': Calculated design flood based on the criteria (1/25 year return period)
(2-1) Q'; Assumed by unit flood (per own catchment area): 47.20 (m3/s/km2)
(2-2) Q'; Assumed by unit flood (per irrigable area) : 1.49 (m3/s/ha)
Source: JICA Project Team

Table 6.4.6 Evaluation of Spillway Capacity in Kiulekada Cascade

No.	Tank	Existing		Required Dimension						Evaluation (L<B: Out) (L>B: OK)	Remarks
		Spill Type	Length (**L**) (m)	Spill Type	Design Flood (Q') (m^3/s)	C	Length (**B**) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)		
1	Puliyankulam	Drop wall	16	Drop wall	24.0	3.33	28	0.6	24.2	Out	(1)
2	Kudawala	Channel	10	Channel	1.3	2.80	2	0.6	1.5	Ok	(2-2)
3	Puliyankulam Kudawewa	Channel	15	Channel	7.9	2.80	11	0.6	8.0	Out	(2-2)
4	Halmillawatya	Channel	33	Channel	44.1	2.80	34	0.9	45.4	Out	(1)
5	Ikirigollawa	Drop wall	17	Drop wall	26.0	3.33	31	0.6	26.8	Out	(1)
6	Nawagha wewa	-	10	Channel	10.8	2.80	15	0.6	10.9	Out	(3)
7	Kudagama	Drop wall	30	Drop wall	37.3	3.33	44	0.6	38.0	Out	(1)
8	Gonahathdenawa	Drop wall	54	Drop wall	87.8	3.33	56	0.9	89.0	Out	(1)
10	Kiulekada	Drop wall	44	Drop wall	100.6	3.33	64	0.9	101.7	Out	(1)
11	Kiulekada Ihal wewa	Drop wall	38	Drop wall	55.5	3.33	35	0.9	55.6	Ok	(1)
12	Kiulekada Kuda wewa	Drop wall	11	Drop wall	8.5	3.33	10	0.6	8.6	Ok	(1)
13	Galkadawala	Drop wall	10	Drop wall	7.4	3.33	9	0.6	7.8	Ok	(1)

Remarks:
(1) Q': Calculated design flood based on the criteria (1/25 year return period)
(2-1) Q'; Assumed by unit flood (per own catchment area): - (m3/s/km2)
(2-2) Q'; Assumed by unit flood (per irrigable area): 1.31 (m3/s/ha)
Source: JICA Project Team

Table 6.4.7 Evaluation of Spillway Capacity in Naveli kulam Cascade

No.	Tank	Existing		Required Dimension						Evaluation (L<B: Out) (L>B: OK)	Remarks
		Spill Type	Length (L) (m)	Spill Type	Design Flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)		
1	Puthiya puarasan kulam	Drop wall	25.0	Drop wall	4.6	3.33	6	0.6	5.2	Out	(1)
2	Mahilan kulam	Channel	3.7	Channel	17.6	2.80	25	0.6	18.2	Out	(1)
3	Alan kulam	-	1.1	Channel	15.5	2.80	22	0.6	16.0	Out	(2-2), (3)
4	Sinnmara irampai kulam	Channel	1.3	Channel	26.8	2.80	37	0.6	26.9	Out	(1)
5	Pakkusorinchan kulam	Channel	2.8	Channel	55.5	2.80	42	0.9	56.1	Out	(1)
6	Naveli kulam	Drop wall	3.0	Drop wall	69.0	3.33	44	0.9	69.9	Out	(1)
7	Mathavuvaiththa kulam	Channel	3.7	Channel	14.1	2.80	20	0.6	14.5	Out	(2-2)
8	Umaiyar puliyan kulama	Channel	1.5	Channel	14.1	2.80	20	0.6	14.5	Out	(2-2)
9	Valar sinna kulam	Channel	19.0	Channel	13.7	2.80	19	0.6	13.8	Ok	(1)
10	Panichchan kulam	Drop wall	2.0	Channel	17.9	2.80	25	0.6	18.2	Out	(1)
11	Omanthai kulam	Drop wall	-	Drop wall	58.0	3.33	37	0.9	58.8	Out	(1)
12	Maruthodai kulam	Channel	2.0	Channel	7.8	2.80	11	0.6	8.0	Out	(1)
13	Kakkar puliyan kulama	Channel	1.6	Channel	22.1	2.80	31	0.6	22.5	Out	(1)
14	Arasan kulam	Channel	1.5	Channel	5.2	2.80	8	0.6	5.8	Out	(2-1)
15	Puthar kulam	Channel	2.1	Channel	10.5	2.80	15	0.6	10.9	Out	(2-1)

Remarks
(1) Q': Calculated design flood based on the criteria (1/25 year return period)
(2-1) Q'; Assumed by unit flood (per own catchment area): 21.52 (m3/s/km2)
(2-2) Q'; Assumed by unit flood (per irrigable area): 1.41 (m3/s/ha)
(3) Spill type; Assumed
Source: JICA Project Team

Table 6.4.8 Evaluation of Spillway Capacity in Rathmalawewa Cascade

No.	Tank	Existing		Design						Evaluation (L<B: Out) (L>B: OK)	Remarks
		Spill Type	Length (L) (m)	Spill Type	Design Flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)		
1	Nanumillewa Mahawewa	Channel	30	Channel	46.6	2.80	65	0.6	47.3	Out	(1)
2	Nanumillewa Kudawewa	Channel	20	Channel	28.9	2.80	40	0.6	29.1	Out	(1)
3	Etaweerawewa	Drop wall	4	Drop wall	34.4	3.33	40	0.6	34.6	Out	(1)
4	Olugaskadawala Mahawewa	Channel	16	Channel	98.9	2.80	75	0.9	100.2	Out	(1)
5	Olugaskadawala Kudawewa	Channel	20	Channel	99.9	2.80	75	0.9	100.2	Out	(1)
6	Dumbuluwewa	Channel	20	Channel	26.1	2.80	36	0.6	26.2	Out	(2-1)
7	Thirappankudawala Mahawewa	Drop wall	60	Drop wall	154.3	3.33	98	0.9	155.7	Out	(1)
8	Pupulagala	Drop wall	13	Drop wall	23.0	3.33	27	0.6	23.3	Out	(2-2)
9	Kudagurupaswewa	Channel	17	Channel	23.0	2.80	32	0.6	23.3	Out	(2-2)
10	Gurupaswewa	Channel	25	Channel	15.3	2.80	21	0.6	15.3	Ok	(1)
11	Paluketiya	Drop wall	12	Drop wall	19.2	3.33	23	0.6	19.9	Out	(1)
12	Weliwewa	Channel	13	Channel	22.9	2.80	32	0.6	23.3	Out	(1)
13	Ihalagama	Channel	10	Channel	31.3	2.80	43	0.6	31.3	Out	(1)
14	Nidikumbawewa	Channel	15	Channel	3.8	2.80	6	0.6	4.4	Ok	(2-1)
15	Paradehiyakada	Drop wall	11	Drop wall	33.7	3.33	39	0.6	33.7	Out	(1)

Remarks
(1) Q': Calculated design flood based on the criteria (1/25 year return period)
(2-1) Q'; Assumed by unit flood (per own catchment area): 42.02 (m3/s/km2)
Source: JICA Project Team

Table 6.4.9 Evaluation of Spillway Capacity in Siyambalagaswewa Cascade

No.	Tank	Existing		Required Dimension						Evaluation (L<B: Out) (L>B: OK)	Remarks
		Spill Type	Length (L) (m)	Spill Type	Design Flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)		
1	Timbiriwewa	Channel	12	Channel	19.7	2.80	28	0.6	20.4	Out	(1)
2	Weddewa	Drop wall	30	Drop wall	17.1	3.33	20	0.6	17.3	Ok	(1)
3	Kendewa Mahawewa	Channel	16	Channel	108.8	2.80	82	0.9	109.5	Out	(1)
4	Kendawa Kudawewa	Channel	40	Channel	10.5	2.80	15	0.6	10.9	Ok	(2-2)
5	Diwulgaha wewa	Channel	16	Channel	11.5	2.80	16	0.6	11.6	Ok	(1)
6	Poradutuwewa	Channel	19	Channel	31.0	2.80	43	0.6	31.3	Out	(1)
7	Siyabalgaswewa kudawewa.	Drop wall	9	Drop wall	11.4	3.33	14	0.6	12.1	Out	(1)
8	Siyabalgaswewa Maha wewa	Drop wall	45	Drop wall	185.1	3.33	117	0.9	185.9	Out	(1)
9	Aluthwewa	Channel	9	Channel	13.7	2.80	19	0.6	13.8	Out	(1)
10	Ehetuwewa	Channel	22	Channel	19.3	2.80	27	0.6	19.6	Out	(1)

Remarks:
(1) Q': Calculated design flood based on the criteria (1/25-year return period)
(2) Q'; Assumed by unit flood (per irrigable area)
(3) Spill type; Assumed
(4) Not in the cascade
C: Coefficient of Discharge (Drop wall type: 3.33, Channel type: 2.88)
Length (B): Spillway length (m)
Depth (H): Overflow depth (m), In case Q>50 m^3/s; H=0.9 m, In case Q<50 m^3/s; H=0.6 m
Calculation (Q): $Q=CBH^{3/2}$
Source: JICA Project Team

(2) Conditions of Existing Spillway

There are spillways of good condition, partly not functioning, and totally not functioning based on the field survey as shown in Figure 6.4.5. The capacity shortage spillways should be rehabilitated even if it is in good condition.

Good Condition	Partly not Functioning	Totally not Functioning
		
Kiulekada in Kiulekada Cascade	**Puliyankulam in Kiulekada Cascade**	**Panichchan kulam in Naveli kulam Cascade**

Source: JICA Project Team

Figure 6.4.5 Conditions of Existing Spillway

(a) Conditions of Downstream

There are complete and incomplete overflow condition due to backwater in the jungle regarding drop wall type spillways as shown in Figure 6.4.6. The backwater reduces the capacity of the spillway. In this case, the jungle should be cleared.

Complete Overflow	Incomplete Overflow
	
Thiruwegama in Alagalla Cascade	**Puliyankulam in Kiulekada Cascade**

Source: JICA Project Team

Figure 6.4.6 Conditions of Downstream of Existing Spillway

6.5 Operation and Maintenance Activities in the Cascade System

6.5.1 Methodology

Detailed survey on operation and maintenance activities on the existing tanks by FOs and analysis on possibility of cascade management was conducted as summarised in Table 6.5.1.

Table 6.5.1 Methodologies of Detailed Survey on O&M Activities by FOs

Issues	Survey Items	Information Collection	Term
Tank level water management	Water use, water distribution system and management, water management at water scarce period	- Open and group discussion through FO meetings - Household survey - Questionnaire and interview survey with government officers in-charge	December 2016 – April 2017
O&M of irrigation facilities by FO	Practice of maintenance activities by FOs, finance of maintenance activities,		
Perspectives on cascade management	Farmers' view, expectation, willingness and concerns on cascade level management		
Government support service on O&M	Structure of government support service on water management and O&M by FOs	- Through interview survey with relevant government officers	April – June 2017

Source: JICA Project Team

6.5.2 Current Situation of Water Management by FOs

Tank level water distribution is fairly well managed in each FO, although there are a few cases of conflict reported to the concerned officers. Several officers in-charge of the model cascade pointed out that the major problem referred to them is water distribution related matter.

During the *Maha* season, water is basically distributed in rotation. Water masters control the gate operation and are appointed in all the FOs under the model cascade except four. Majority of the FOs pay to the water master in kind such as a certain amount of paddy, whilst those in Vavuniya District pay in cash. The following summarises the water management system of the FO in each model cascade.

Table 6.5.2 Operation of Water Management of the FOs under the Model Cascade

Cascade	Water Management				Number of FOs
	Appointment of Water Master (% of yes)	Payment to Water Master (% of yes)	Payment		
			In Cash	In Kind	
Alagalla	33%	33%	100%	0%	3
Ichchankulama	100%	100%	0%	100%	5
Kiulekada	100%	100%	0%	100%	4
Naveli kulam	100%	100%	100%	0%	7
Rathmalawewa	71%	57%	0%	100%	7
Siyambalagaswewa	100%	100%	0%	100%	3

Source: JICA Project Team based on the questionnaire survey and HHS

Each FO has their system of water distribution during water scarce period. Cultivation during the *Yala* season is basically decided according to the water remaining in their tanks. In majority cases, they conduct *Bethma* system in which cultivation is done in the traditional paddy field where each farmer has a portion of land. However, Ichchankulama and Siyambalagaswewa farmers hardly operate *Bethma* whilst more than 90% in Kiulekada, Alagalla, and Naveli kulam cultivate through *Bethma* system. As revealed through further interviews with the concerned officers, the main reason for not conducting *Bethma* is the refusal of the owners of the upper field and power relation amongst farmers. In the area where *Bethma* is not operated, some farmers remarked that only limited people have land under the traditional paddy field as the land is succeeded amongst the families, thus other people cannot cultivate in the area. Therefore, only limited farmers owning fields nearby the tanks can cultivate during water scarce period. Table 6.5.3 summarises the operation of *Bethma* in each model cascade.

A different way of *Yala* cultivation mentioned by a Muslim FO is through tendering of cultivation land, in which those who wish to cultivate pay a certain amount per acre to the mosque.

Table 6.5.3 Proportion of *Bethma* Operation in the Model Cascades

Cascade	Farmers Conducting Bethma		Farmers NOT Conducting Bethma	
	(no.)	(%)	(no.)	(%)
Alagalla	130	97.0%	1	0.7%
Ichchankulama	2	1.0%	193	98.5%
Kiulekada	238	93.7%	10	3.9%
Naveli kulam	155	100.0%	0	0.0%
Rathmalawewa	145	52.7%	128	46.5%
Siyambalagaswewa	2	1.3%	148	98.7%
Total	672	57.7%	480	41.2%

Source: JICA Project Team based on the questionnaire survey and HHS

Some conflicts between the upper tank and lower tank regarding water management were reported in some cascades. For example, cultivators of the reservation area, who reside in the upper tank command area, try to release water from the tank so that more land can be cultivated once water level decreases, whilst people residing in the lower tank try to raise their spillway so that the tank can hold more water. In other areas, raising the spillway in downstream tank caused flood in the land under the upper tank. On the other hand, there are some positive cases of water management wherein the upper tank FO releases water to the downstream tank when they have extra water whilst the downstream faces shortage.

6.5.3 Current Situation of Maintenance of Irrigation Facilities by FO

Ordinal maintenance works of canal and bund are done by FO members as decided in the legally authorised *Kanna* meetings. These works are fairly completed as planned fundamentally because the tasks are allocated to each farmer based on their landholdings as legal obligation. As per indicated in Table 6.5.4, FOs in the model cascades perform canal cleaning and bund clearing well, although bund clearing in Siyambalagaswewa is remarkably low. On the other hand, desilting work is hardly done by farmers, except in Naveli kulam. Most of the FOs rely on external support for desilting. Labour contribution for repairing works differ by cascades. Whilst 80% of the farmers in Siyambalagaswewa answered that they provide labour contribution for repairing work, only 4% participated in Rathmalawewa. Some FOs set completion of maintenance work as a condition for receiving fertiliser subsidy.

Table 6.5.4 Participation in Maintenance Works by Cascade

Cascade	Canal Cleaning		Bund Clearing		Desilting		Labour Contribution for Repairing Work		Other		Valid Answer
	no.	%	no.	%	no.	%	no.	%	no.	%	no.
Alagalla	134	99%	131	97%	0	0%	51	38%	0	0%	135
Ichchankulama	198	100%	178	90%	0	0%	18	9%	0	0%	198
Kiulekada	252	99%	188	74%	0	0%	143	56%	0	0%	255
Naveli kulam	145	94%	127	82%	63	41%	112	72%	4	3%	155
Rathmalawewa	271	99%	265	96%	0	0%	11	4%	1	0%	275
Siyambalagaswewa	149	99%	44	29%	2	1%	120	80%	0	0%	150
Total	1149	98%	933	80%	65	6%	455	39%	5	0%	1168

Source: Farm Household Survey (JICA Project Team 2017)

Minor rehabilitation works and urgent repairs are managed by FOs according to their fund availability and labour contribution. Some FOs collect O&M funds especially in Vavuniya District. Some collect emergency funds for repair instead of using FO's savings as it takes time and requires long procedure to withdraw their savings from the bank account because of the strict regulation of DAD. Basically, earthworks are attended by Sramadhana works of members, although desilting works depend on government funds.

Major rehabilitation works are expected to be supported by the government. Only a few FOs have experience contract works for repair of facilities. Major works contracted out from the government to FOs are mostly sublet to private contractors as FOs do not have enough skills. Experience of contract work differ by FOs. One FO explained that although major rehabilitation works are sub-let to contractors, they still monitor the works of contractors based on the Bill of Quantity (BOQ) of the works with the help of DAD technical officers. On the other hand, another FO reported that they have a bad experience with an outside contractor in the contracted rehabilitation works.

Major constraints of the O&M works raised by farmers are the lack of knowledge on O&M activities and construction management, lack of financial capacity of the FO, limited funds from the government, and political interference in prioritisation of rehabilitation work supported by the government, which overwhelm any rule.

Practice of O&M activities by FOs was also assessed through interviews with the Divisional Officer under ASC (DOs) and Agriculture Research & Development Assistants (ARPAs) in the target ASC. Officers evaluated that general maintenance works are conducted to some extent by FOs. Whilst about 20% assessed that FOs always carry out those maintenance works, almost 80% felt they are done only in a few occasions. However, most of the officers answered that quality levels of canal cleaning and bund clearing as well as minor repairing works are satisfactory. The following table summarises the evaluation by the concerned officers on O&M activities by FOs.

Table 6.5.5 Evaluation by DO/ARPA on O&M Activities by FOs

<table>
<tr><th rowspan="4">General maintenance works conducted by FOs</th><th>Extent of Activity</th><th colspan="2">Always</th><th colspan="2">Only on few occasions</th><th>No</th></tr>
<tr><td>Canal cleaning</td><td colspan="2">21%</td><td colspan="2">79%</td><td>0%</td></tr>
<tr><td>Bund cleaning</td><td colspan="2">21%</td><td colspan="2">79%</td><td>0%</td></tr>
<tr><td>Minor repair of facilities</td><td colspan="2">16%</td><td colspan="2">84%</td><td>0%</td></tr>
<tr><th rowspan="6">Evaluation of quality of maintenance by FOs</th><th>Extent of Activity</th><th>Very good</th><th colspan="2">Satisfactory</th><th>Not satisfactory</th><th>Poor</th></tr>
<tr><td>Canal cleaning and bund cleaning</td><td>0%</td><td colspan="2">95%</td><td>5%</td><td>0%</td></tr>
<tr><td>Reasons for unsatisfactory</td><td colspan="5">Lack of coordination amongst members;
Farmers do not recognise the importance because there is no penalty for disobedience</td></tr>
<tr><td>Minor repair of irrigation facilities</td><td>5%</td><td colspan="2">89%</td><td>5%</td><td>0%</td></tr>
<tr><td>Reasons for unsatisfactory</td><td colspan="5">Farmers lack skills and capacity to do the work;
Lack of fund in FO savings;
Farmers do not recognize the importance;
Farmers depend on government support</td></tr>
</table>

Source: JICA Project Team based on the questionnaire survey

One of the difficulties in maintenance works pointed out by the officer in-charge is that some members are not residing in the village therefore making their physical contribution difficult. Moreover, it was expressed that practice of works that require farmers' initiative and coordination depend on quality and capacity of the FO leaders.

The current system of maintenance of canal cleaning and bund clearing, which is fairly functioning, shall be carried on and applied to cascade management as well. In addition to the existing maintenance works, maintenance of inter-tank facilities will be necessary to distribute water from NCP canal. Maintenance works within the tank also need to be planned in consideration of water distribution from NCPC and maintenance works of cascade system. Moreover, capacity building of FOs in O&M skills and construction management are necessary to ensure sustainability of the facilities.

6.5.4 Government Supporting System for O&M

(1) Financial Support System of Relevant Government Agencies

Even though major rehabilitation works are expected to be done by the government, it is highly dependent on the availability of funds in the government. There are budget allocations for rehabilitation of minor tanks in DAD and Provincial Director of Irrigation (PDI), and medium tanks in PDI and Central Department of Irrigation (DoI). However, the allocation of the budgets for tank rehabilitation in the concerned departments significantly differ by financial years. Some FOs mentioned that their tank has not received any rehabilitation fund from government for more than a decade. For Vavuniya, especially for the conflict affected area, the government has allocated budget for major rehabilitation works of abandoned tanks.

For flood damages, immediate actions such as placing sandbags to minimise the damages are taken by the FOs. Disaster management unit of DS office provides sandbags for emergency repair. Major damages were reported to DO; and DAD provides emergency support.

(2) Technical Support System of Relevant Government Agencies

Government structure of management of minor and medium tanks differ in Anuradhapura and Vavuniya.

In the North Central Province, minor tanks are under the responsibility of PDI whilst the management of FOs are under DAD. Medium irrigations in North Central Province are partially under Central DoI and the rest are under PDI, for which there is no clear demarcation. Three medium tanks in the model cascades in Anuradhapura are under Central DoI. Even though minor tanks belong to the provincial government in Anuradhapura, general management of the tanks is under the responsibility of the FOs under supervision of DAD.

In Northern Province, minor tanks are controlled under DAD, whilst medium irrigation except inter-provincial schemes are under PDI. However, no medium irrigation in Vavuniya is under NCP canal system.

In such situation, support of FOs that manage tanks and water management are largely provided by DAD through its field officers, ARPAs. Allocation of field officers with regard to water management and maintenance of facilities in the model areas are summarised in Table 6.5.6. Technical engineering issues are supported by technical officers of DAD who are attached in the technical unit of the District DAD office.

Table 6.5.6 Number of ARPA Officers in the Target ASC

DS Name	ASC Name	No. of ARPA Division	No. of ARPA Officers	No. of FOs	No. of FO per ARPA Officer
Anuradhapura District					
Kebithigollewa	Kebithigollewa	26	23	75	3.3
Horowpothana	Horowpothana	22	20	70	3.5
Rambewa	Kallanchiya	20	18	52	2.9
Mihinthale	Mihinthale	20	19	60	3.2
Galenbindunuwewa	Galenbindunuwewa	27	26	84	3.2
Total			106	341	3.2
Total of whole Anuradhapura			248	760	3.1
Vavuniya District					
Vavuniya	Kovilkulam	19	4	29	7.3
	Omanthai	10	1	30	30.0
Vavuniya South	Madukanda	12	5	31	6.2
Total			10	90	9.0
Total of whole Vavuniya			18	225	12.5

Source: JICA Project Team

The average number of FOs that one ARPA handle in the target ASC of Anuradhapura District is about three FOs, which is close to the average of the whole Anuradhapura District. On the other hand, ARPAs in the target ASC in Vavuniya handle average of nine FOs per officer. Vavuniya District face scarcity of ARPA as the average number of FOs that one ARPA covers in the whole Vavuniya District is more than 12. There is a significant disparity in the allocation of ARPA officers in different ASC.

For the maintenance works funded by PDI are consulted to PDI engineers and technical officers. Although PDI are responsible for maintenance of minor tanks in North Central Province, officers allocated are only a limited number of technical officers in field who mainly supervise maintenance from technical point of view. Technical officers of PDI are not assigned on area basis but rather on work basis. Therefore, the technical officers are handling the whole province.

6.5.5 Perspective on Cascade Water Management with NCPC Water

Needs in cascade level water management and possibility of establishment of cascade management body were discussed with each FO and were asked in the Household Survey (HHS) to judge different opinions from different position of tanks.

Common opinions on cascade level water management heard during FO meetings are as follows:

- Once water is provided from outside, it is fine to share with other tanks as long as a certain amount of water is assured in the upper tank;
- Water should be shared proportionately according to the command areas of each tank;
- Water should be allocated in turn by season (e.g., half of the tanks in a certain season and the remaining in the coming season);
- To select one tank under each FO to allocate water and all FO members to cultivate under the selected tank by operating *Bethma*;
- They need to arrange a system and rules to manage (e.g., if the upper most tank refuse to share water, the gate from NCP canal shall be closed);
- The amount of water to be released shall be adjusted depending on their needs (especially for small tanks that frequently face shortage of water);
- If the water is not enough to fill all the tanks, farmers cultivate different crops that require less water with allocated water; and
- There is a need for separate water management with support of government authorities.

- A cascade level management committee should be organised for proper water management.
- A water master should be assigned to control gate within the cascade.

Table 6.5.7 shows the results of HHS regarding the question on preferable water management system to distribute water fairly to each tank under the cascade if the uppermost tanks of the cascade receive water from the NCP canal. Multiple answers were allowed from the options indicated in the questionnaires.

From the total of six model cascades, the majority of the farmers agreed to decide on water allocation through the cascade committee. Those who answered government intervention, individual negotiation, and fixed proportional allocation are 21%, 19%, and 26%, respectively. However, significant differences between cascades were observed. More than 90% of farmers under Kiulekada and Naveli kulam preferred water allocation to be decided through the cascade committee, whilst only 19% of Ichchankulama opted for the cascade committee. In Alagalla and Ichchankulama cascades, where the propositions of the farmers who chose the cascade committee are relatively low, the majority selected individual negotiation to adjust water. Rathmalawewa Cascade showed higher preference on government intervention compared with other cascades. Preference on fixed proportional allocation are higher in Ichchankulama, Rathmalawewa, and Siyambalagaswewa.

Table 6.5.7 Comparison of Preferable Water Distribution System by Cascade

Cascade	Valid Answer	Government		Individual Tank		Cascade Committee		Fixed Ratio		Other
	No.	No.	%	No.	%	No.	%	No.	%	No.
Alagalla	135	9	7%	70	52%	54	40%	21	16%	0
Ichchankulama	198	23	12%	103	52%	38	19%	84	42%	0
Kiulekada	254	5	2%	17	7%	235	93%	7	3%	0
Naveli kulam	151	54	36%	3	2%	143	95%	0	0%	0
Rathmalawewa	275	128	47%	22	8%	137	50%	120	44%	1
Siyambalagaswewa	150	24	16%	1	1%	97	65%	69	46%	0
Total	1163	243	21%	216	19%	704	61%	301	26%	1

**Options: Government - Government should decide water allocation to each tank*
Individual tank – Farmers in the downstream tank should discuss with farmers in the upper tank to release water individually
Cascade committee – To form a committee with representatives from all tanks in the cascade to discuss water distribution
Fixed ratio – Fixed ratio of water based on the planned extent of area for cultivation in the command area under each tank
Source: Farm Household Survey (JICA Project Team 2017)

Analysing from the results of the HHS and observation in the FO meetings, the following pessimistic features were observed in Ichchankulama, Rathmalawewa, Naveli kulam, and Alagalla cascades. Ichchankulama Cascade indicated higher ratio in individual negotiation, fixed ration, and lower preference in cascade committee, which implies weak unity amongst FOs under the cascade and may result in difficulties in cascade level management. This may have some relation with the complication of the cascade that involves two different ethnic groups and involvement of different ASCs, as well as the experiences of conflict between upper and lower tanks regarding adjustment of spillway to control the water level. During FO meetings there were negative impressions in water distribution in Ichchankulama such as having doubt on upper tank FOs to release water, anticipating problems when they receive NCPC water, and proposing to release spilled water only. Higher preference on government intervention and fixed proportional allocation in Rathmalawewa Cascade may be associated with existence of different communities within the cascade. In Rathmalawewa Cascade, some discord between the different ethnic groups and conflicts between different castes were heard during the cascade level meeting and FO meetings. These indicate that issues of minority communities as well as different caste groups should be carefully attended in the formation and operation of cascade level management. Higher preference on government intervention could be also reflecting the situation of complicated consensus building in the cascade that involve many FOs. Both Rathmalawewa and Naveli kulam that show higher ration in government intervention have many FOs under their cascades. During FO meetings in Naveli kulam, some farmers raised concern on different interest between upper tank FOs and lower tank FOs and possibility of disturbance in water distribution, which might have resulted in higher preference in government intervention. Lower preference of cascade committee in Alagalla is caused by the situation of sharing water between different communities. Negative opinions were raised during FO meetings in Alagalla Cascade such as doubt on Tamil community to share water with Sinhalese community, anticipated problem in sharing resources especially in young generations, current unsolved conflict between upper and downstream tanks, and preference on water releasing to other tanks in the neighbouring cascade under the control of the same FO. In Alagalla Cascade, government intervention cannot be an alternative way as FOs have negative experience in the political intervention in conflict resolution between tanks.

On the other hand, positive perspectives can be drawn in other cascades. Higher preference on both cascade committee and fixed proportional allocation in Siyambalagaswewa Cascade signifies that people prefer to have discussion and coordination through cascade committee whilst water shall be allocated basically on a fixed ratio. Kiulekada Cascade also showed positive signs of cascade management through cascade committee judging from very high preference in cascade committee and very few choices on government intervention. This may be because Kiulekada Cascade has enough confidence in managing by themselves or has trouble in involving the government. The positive tendencies towards cascade management bodies in Siyambalagaswewa and Kiulekada cascades, as well as Naveli kulam where 95% chose cascade committee for water distribution, can be due to homogeneous composition of the communities under the cascade.

Through tank-wise observation, preference in fixed ratio tends to be higher in the minority Muslim community. Government intervention was also preferred in the Muslim communities in Rathmalawewa. These may imply that the minority group fear domination by the majority community in water distribution at the cascade. On the other hand, government intervention was not preferred by the Muslim community in Ichchankulama. In Siyambalagaswewa Cascade, it was observed that smaller FOs tend to prefer water allocation by fixed ratio. This might be because the flexible water allocation can be interfered by power balance between FOs.

Analysing the preference of water distribution system by location of tanks within cascades, as shown in Table 6.5.8, FOs with tanks at the downstream part of the cascades tend to have more farmers preferring individual negotiation and fixed ratio than those in the mid and upper tanks. Preference in cascade committee's decision in lower tanks is less than others. This implies that there is a concern by the downstream FOs that decision at cascade management might be dominated by upper tank's interest.

Table 6.5.8 Comparison of Preferable Water Distribution System by Tank Location

Tank Location	Government		Individual Tank		Cascade Committee		Fixed Ratio		Other		Valid Answer
	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Low	45	*15%*	79	*26%*	167	*55%*	90	*29%*	1	*0%*	306
Mid	90	*25%*	50	*14%*	230	*64%*	84	*23%*	0	*0%*	360
Upper	107	*22%*	88	*18%*	301	*61%*	126	*25%*	0	*0%*	497
(Blank)	2		0		5		0		0		0
Total	244	*21%*	217	*19%*	703	*60%*	300	*26%*	1	*0%*	1163

Source: Farm Household Survey (JICA Project Team 2017)

Possibility of water distribution amongst tanks under the cascade was analysed through preference on water distribution structure as well. Table 6.5.9 indicates the results of HHS on preferable water distribution structure. Quite a large extent of farmers in Ichchankulama and Siyambalagaswewa preferred water to be delivered directly from NCPC by constructing canal from NCP canal to each tank. This result, together with the higher preference of fixed ratio of water distribution amongst cascade, may imply that there is not enough trust between tanks and farmers, feeling the difficulties in managing water distribution amongst FOs. In comparison with the other cascade, Ichchankulama as well as Siyambalagaswewa showed more extreme feature. In those cascades, the majority preferred direct canals whilst those who agreed to construct link canals is low. This situation of preference of water distribution structure, together with the result of preference in water management and lower practice of *Bethma* in water distribution, should be carefully deliberated as these become obstacles in the establishment of the cascade level management system and special strategies to overcome the problem need to be proposed.

Table 6.5.9 Comparison of Preferable Water Distribution Structure by Cascade

Cascade	Valid Answer	Existing System		Direct Canals		Link Canals		Other	
	no.	no.	%	no.	%	no.	%	no.	%
Alagalla	135	1	1%	5	4%	128	95%	1	1%
Ichchankulama	198	51	26%	107	54%	76	38%	0	0%
Kiulekada	255	2	1%	41	16%	218	85%	0	0%
Naveli kulam	155	2	1%	4	3%	149	96%	0	0%
Rathmalawewa	275	8	3%	107	39%	168	61%	0	0%
Siyambalagaswewa	150	30	20%	125	83%	35	23%	0	0%
Total	1168	94	8%	389	33%	774	66%	1	0%

**Option: Existing system –let water flow naturally through their existing system (drainage and through paddy fields)*
Direct canal from NCPC - to construct canal to each tank to deliver water directly from NCP canal
Link canal - to construct link canals and gate to release water from the uppermost tank to the downstream tank
Source: Farm Household Survey (JICA Project Team 2017)

Further concerns and opinions that were raised during the FO meetings regarding water distribution within cascade are stated below.

- There is a need to introduce a separate system to send water from tank to tank.
- To send water to the downstream tanks, pipeline is good as it does not disturb their field, water wastage is minimum, and it requires less maintenance activities in normal situation.
- Canal is better as this can be cleaned seasonally, but maintenance of pipes (e.g., in case of blockage) is difficult.
- The gate level of the pipeline should be at spill level to assure a certain amount of water in the upper tank.
- Spilled water can go to downstream tanks using existing spillways.

6.6 Establishment of Simulation Model for Water Distribution

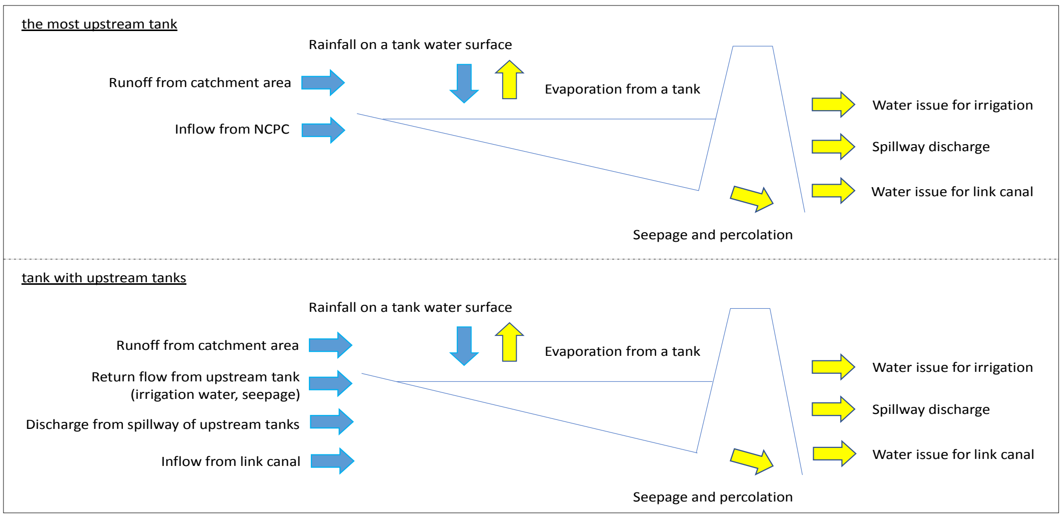
6.6.1 General

The establishment of the simulation model of water distribution within a cascade system has been subcontracted to the Japan International Research Center for Agricultural Sciences (JIRCAS) since August 2016. To decide the necessary parameters for the simulation model, Kiulekada and Alagalla cascade systems were selected for necessary field data collection.

6.6.2 Basic Concept for Water Balance Model

(1) Existing Model

Jayatilaka et al., (2003)、Jayatilaka et al., (2001) developed the cascade model (called as “CASCADE”) considering four tanks in the Thirappane Tank Cascade System. The schematic figure of the water balance in a tank cascade system is provided in Figure 6.6.1.



Source: JIRCAS

Figure 6.6.1 Schematic Figure of the Water Balance in a Cascade System

The water balance equation is shown in equation (1) with the components explained in Table 6.6.1, where ⊿Q is an increase in tank storage.

$$\mathrm{ROF} + \mathrm{RAINTK} + \mathrm{RETFLW} + \mathrm{SPLIN} + \mathrm{TLNIN}$$
$$= \mathrm{EVLOSS} + \mathrm{WTQ} + \mathrm{SPLOUT} + \mathrm{SPLOSS} + \mathrm{LNOUT} + \Delta Q \qquad (1)$$

Table 6.6.1 Components of Water Balance of a Tank Cascade System

	Components	Index
Inflow to a tank	Runoff from catchment area	ROF
	Rainfall on a tank water surface	RAINTK
	Return flow from upstream tanks	RETFLW
	Discharge from spillway of upstream tanks	SPLIN
	Inflow from NCPC or link canal	TLNIN
Outflow from a tank	Evaporation from a tank	EVLOSS
	Water issue for irrigation	WTQ
	Spillway discharge	SPLOUT
	Seepage and percolation	SPLOSS
	Water issue to link canal	LNOUT

Source: JIRCAS

Components other than WTQ “water issue for irrigation” are calculated from equations (2) – (8).

$$\mathrm{ROF} = rcf \times (\mathrm{RAIN} \div 1000) \times \mathrm{CAREA} \div \mathrm{API} \qquad (2)$$

rcf : runoff coefficient

RAIN : daily precipitation (mm)

CAREA : catchment area (m^2)

API : antecedent precipitation index

When n is the number of successive non-precipitation days before precipitation starts:

n=0, then API = 1

$1 \leq n \leq 11$, then $\mathrm{API} = 1 + 1/2 + 1/3 + \cdots + 1/(n+1)$

$n \geq 12$, then $\mathrm{API} = 1 + 1/2 + 1/3 + \cdots + 1/(11+1)$

To calculate a delay in runoff generation that follows an extended dry spell, after “50 days or more of non-precipitation and tanks are dry,” ROF was set to 0 until cumulative precipitation reached a certain level. This cumulative precipitation was named *delay*.

$$\mathrm{RAINTK} = \mathrm{TKAREA} \times \mathrm{RAIN} / 1000 \quad (3)$$

TKAREA : tank submerged area (m^2)

$$\mathrm{RETFLW} = \sum_{k=m}^{n} fret \times \left(\mathrm{WTQ}_k + \mathrm{SPLOSS}_k\right) \qquad (4)$$

fret: return flow coefficient related to water issue and tank seepage

k: number of upstream tanks

m: tank number of the first upstream tank

n: tank number of the last upstream tank

Return flow is generated only in the wet cropping period when water management is extensive.

SPLIN＝ $\sum_{k=m}^{n} fretspil \times \text{SPLOUT}_k$ (5)

fretspill: return flow coefficient related to spillway discharge

k: number of upstream tanks

m: tank number of the first upstream tank

n: tank number of the last upstream tank

EVLOSS＝TKAREA×EVAPO×*fevap* (6)

fevap: coefficient for pan evaporation

EVAPO: pan evaporation

SPLOUT=86400×1.7×WCRL× (TKH-SPLV)$^{1.5}$ (7)

WCRL: spillway overflow width

SPLV: full capacity water level

TKH: tank water level

When water volume over the full capacity is smaller than the water volume in (7), water volume over the full capacity is considered overflow from the spillway.

SPLOSS＝[a ln (h) + b]×TKVOL／100 (8)

a, b: coefficients for individual tanks determined based on water balance during the non-precipitation time

TKVOL: tank water volume

The Japan International Research Centre for Agricultural Sciences (JIRCAS) has improved CASCADE into CASCADE II, and developed a simulation programme that can simulate possible irrigation area under certain rainfall and evaporation condition together with an "irrigation area to water issue for rice cultivation model" developed by Kitamura (1984). CASCADE II was calibrated and validated with two sets of data including rainfall, evaporation, quantity of irrigation water supply, and tank water height. Both calibration and validation results showed a good match with the observed data; the average differences between them is less than one tenth of tank storage capacities. Moreover, CASCADE II uses a common formula for calculating both the amount seepage and percolation, unlike the CASCADE model which uses formulae that are individually defined by using observation results. The present study shows that CASCADE II is easier to apply to other tank cascade systems compared with the original CASCADE model. The "irrigation area to water issue for rice cultivation model" by Kitamura (1984) and Shinogi (2004) utilised the relation between rice cropping calendar and irrigation (Table 6.6.2), pan coefficient for paddy fields (Table 6.6.4), coefficient to convert rainfall to efficient rainfall and irrigation efficiency (Table 6.6.5).

Table 6.6.2 Relation Between Rice Cropping Calendar and Irrigation

	Maha	Yala
Land preparation	1st October to 31st October (without irrigation)	16th April to 30th April （with irrigation）
Growing stage	1st November to 29th January （with irrigation）	1st May to 29th July （with irrigation）
Ripening stage	30th January to 13th February (without irrigation)	30th July to 13th August (without irrigation)

Source: Shinogi（2004） Kitamura（1984）

In Table 6.6.3, daily water requirement for land preparation in the *Yala* season is provided as 8.33 mm, and daily water requirement during growing stage is provided as equations (9) and (10). Components in the equations are explained in Table 6.6.3.

WIS＝PCA×WR/(IEF×1000)　　Formulation (9)
WR＝EP×Cf1－RAIN×Cf2　　Formulation (10)

Table 6.6.3　Components to Calculate Daily Irrigation Requirement

WIS	Daily water requirement (m^3)
PCA	Irrigation area (m^2)
WR	Daily net irrigation water requirement (mm)
IEF	Irrigation efficiency
EP	Pan evaporation (mm)
RAIN	Daily rainfall (mm)
Cf1	Pan coefficient for paddy fields
Cf2	Coefficient to convert rainfall to efficient rainfall

Source: Shinogi (2004), Kitamura (1984)

Cf1, Cf2 and IEF are provided in Table 6.6.4 and Table 6.6.5.

Table 6.6.4　Pan Coefficient for Paddy Fields

Growing Period Day Number	Pan Coefficient for Maha	Pan Coefficient for Yala
1-21	0.8	0.9
22-31	0.9	0.9
32-41	1.1	1.0
42-50	1.2	1.2
51-90	1.4	1.2

Source: Shinogi (2004), Kitamura (1984)

Table 6.6.5　Coefficient to Convert Rainfall to Efficient Rainfall and Irrigation Efficiency

	Maha	Yala
Cf2 Coefficient to convert rainfall to efficient rainfall	0.65	0.80
IEF Irrigation efficiency	0.60	0.60

Source: Shinogi (2004), Kitamura (1984)

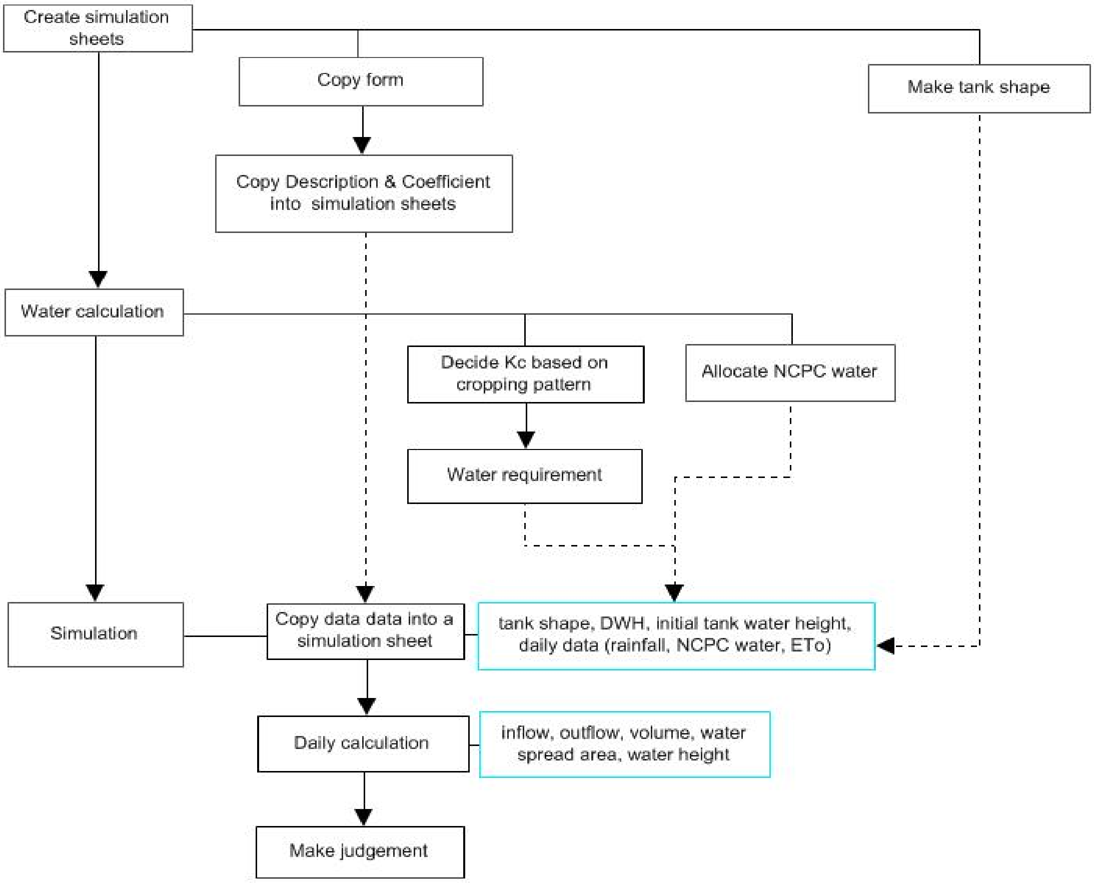
(2)　Development of Simulation Model

The simulation model based on CASCADE II is developed which can verify the water availability of tanks in a cascade system under target condition of cropping pattern, rainfall, evaporation and water allocation from NCPC. The summary of the simulation programme is shown in Table 6.6.6, and the flowchart is shown in Figure 6.6.2.

Table 6.6.6　Summary of the Simulation Programme on Irrigation Planning with NCPC

Necessary software	Microsoft Excel 2016
Input	Daily rainfall and evaporation (25% probability of non-exceedance) Water allocation from NCP (average amount) Description of tanks (catchment area, water spread area, and length of spillway) Irrigation area of tanks Cropping calendar and crop coefficient for planned cropping pattern
Output	Judgement on water availability of tanks

Source: JIRCAS



Note : ＊solid arrow shows programme action flow, dotted arrow shows application of data or format, solid line means detailed contents, blue lined square means data

Source: JIRCAS

Figure 6.6.2 Flowchart of the Simulation Programme on Irrigation Planning with NCPC

6.6.3 Observed Field Data

(1) Observation System of Tank Water Level, Rainfall, and Evapotranspiration

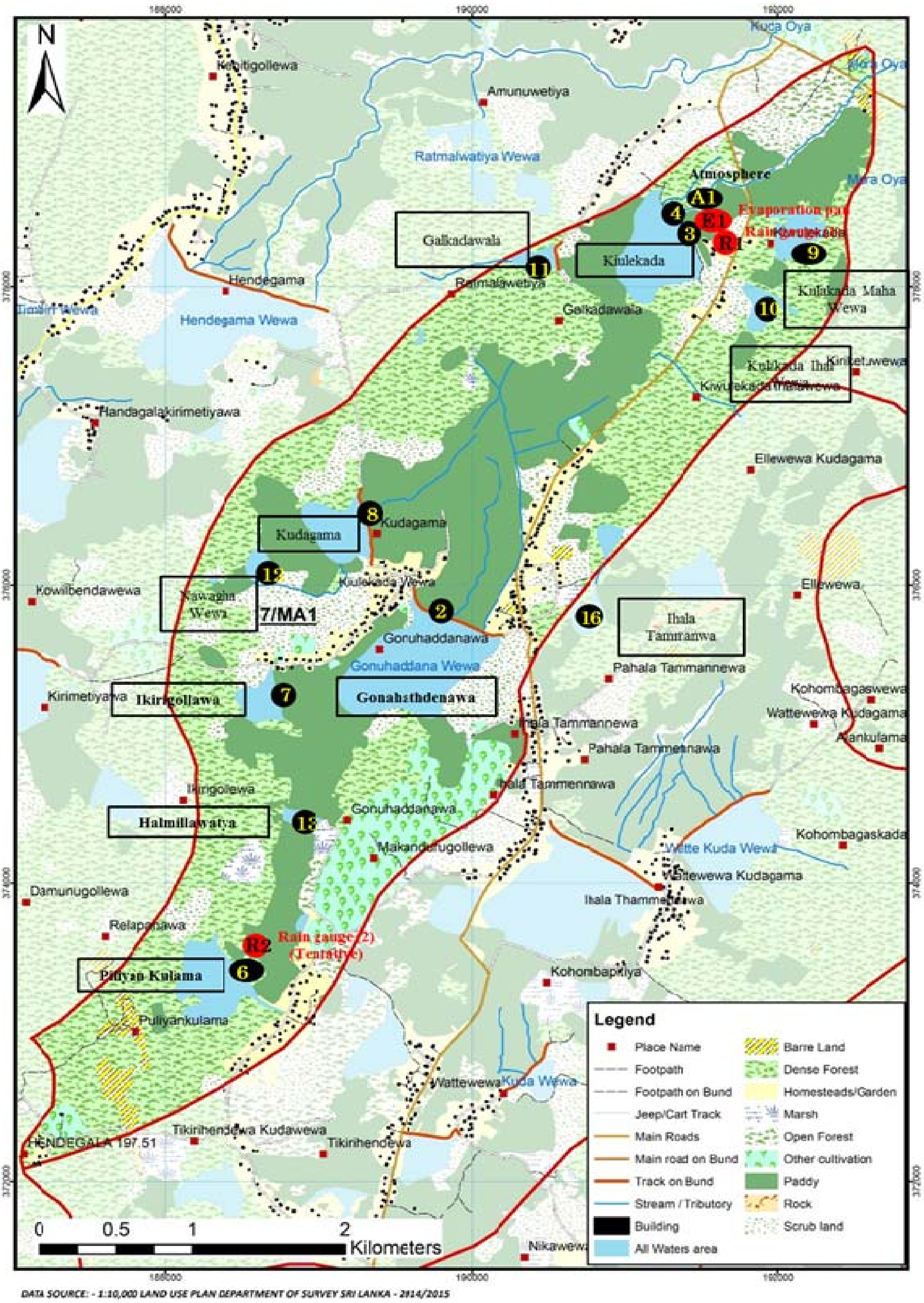
Since the parameters of CASCADE II are determined only for tanks in Thirappane Cascade System, water balance observation was commenced in September 2016 for 12 months in Kiulekada and Alagalla cascade systems. Parameters was modified with the result of those observations.

The measuring equipment such as water level logger, precipitation gauge, and evapotranspiration pan were installed in the two cascade systems in order to find out the relation of precipitation amount and water level of reservoirs, and water flow between tanks in the cascade. Installation points for measuring equipment for Kiulekada and Alagalla are shown in Figure 6.6.4 and Figure 6.6.5, respectively.

		
Water level gauge measuring shuttle (right)	Precipitation gauge (Rain gauge)	Evapotranspiration pan

Source: JICA Project Team

Figure 6.6.3 Instrument of Observation System



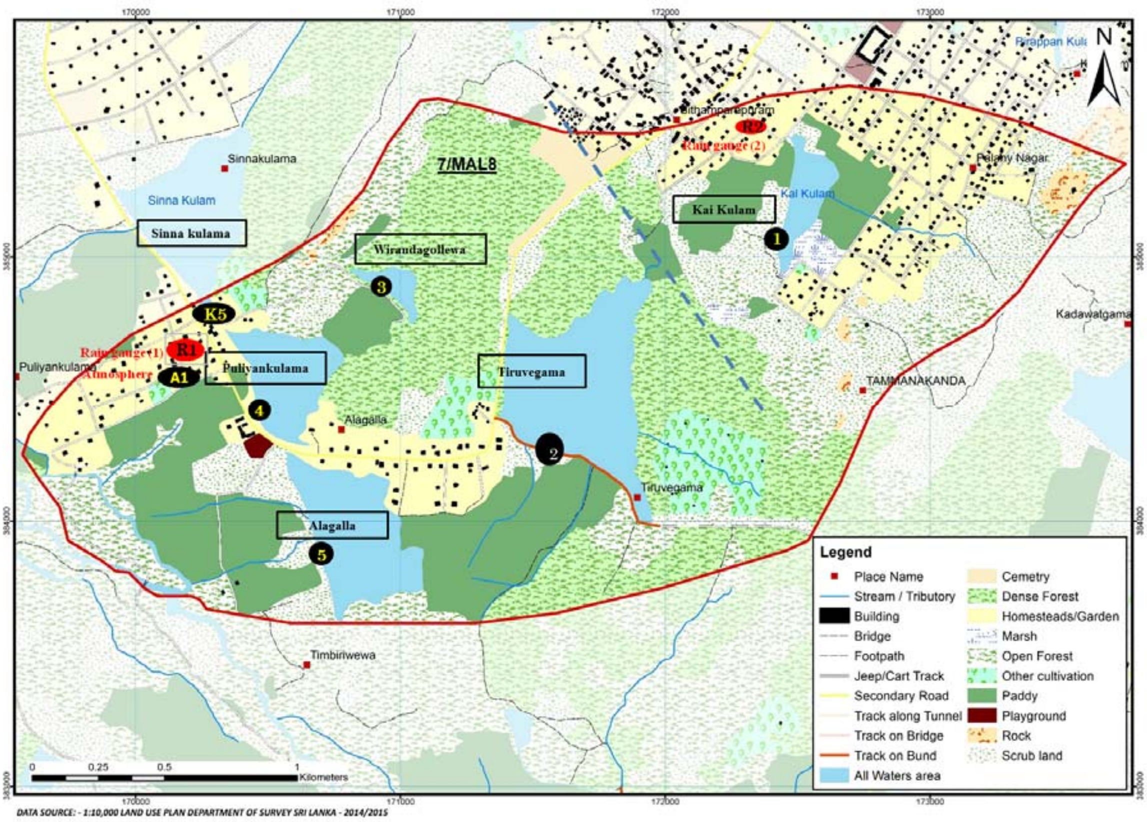
Water Level Logger（ⓘ in the map. Placed in 11 tanks.）
- All loggers are placed at the bottom of low level sluice of each tank using plastic pipe .
- Sampling distance is 1 hour, measuring range is two types (4 m and 9 m).
- Measured data are corrected by the atmospheric pressure (A1 data).

Rain Gauge (Ⓡi in the map.)
- Two gauges are placed at upstream (Puliyankulam) and downstream (Kiulekada) of the cascade.
- Sampling distance is 1 hour, mechanism of the gauge is a type of counting filled cup.

E-Pan (Ⓔ in the map.)
- Manual measurement at a fixed time every day.

Source: JICA Project Team

Figure 6.6.4 Observation System in Kiulekada Cascade



Water Level Logger （① in the map. Placed in 11 tanks.）
・All loggers are placed at the bottom of low level sluice of each tank using plastic pipe .
・Sampling distance is 1 hour, measuring range is two types (4 m and 9 m).
・Measured data are corrected by the atmospheric pressure (A1 data).

Rain Gauge (Ri in the map.)
・Two gauges are placed at upstream (Puliyankulam) and downstream (Kiulekada) of the cascade.
・Sampling distance is 1 hour, mechanism of the gauge is a type of counting filled cup.

E-Pan (Ⓔ in the map.)
・Manual measurement at a fixed time every day.

Source: JICA Project Team

Figure 6.6.5 Observation System in Alagalla Cascade

(2) Observation Results

Although the sets of equipment were installed in September 2016, some data were not collected properly due to the following reasons:

- The *Maha* season in 2016/17 has less rainfall compared with the normal year. Majority of the tanks except Gonahathdenawa and Kiulekada wewa in Kiulekada and Thiruwegama in Alagalla did not have an effective storage during the season.
- Some equipment has been lost during the observation or some has defects at the beginning. This caused the lacked of data in some period.

The continuous data for water balance model parameters was obtained only for five tanks in each system with period 6 to 9 months.

Table 6.6.7 Observation Result in Alagalla Cascade System

No.	Name of Tank	Period of data collection	Data collected up to September	Data collection upstream tank	Availability for calibration
1	Kai Kulam	2016/9/29-2017/5/30	⊿	-	○
2	Tiruvegama	2016/9/29-2017/9/11	○	⊿	○
3	Wirandagollewa	2016/9/29-2017/9/11	○	-	○
4	Puliyankulama	2016/9/29-2017/9/18	○	○	○
5	Alagalla	2016/9/29-2017/9/11	○	○	○

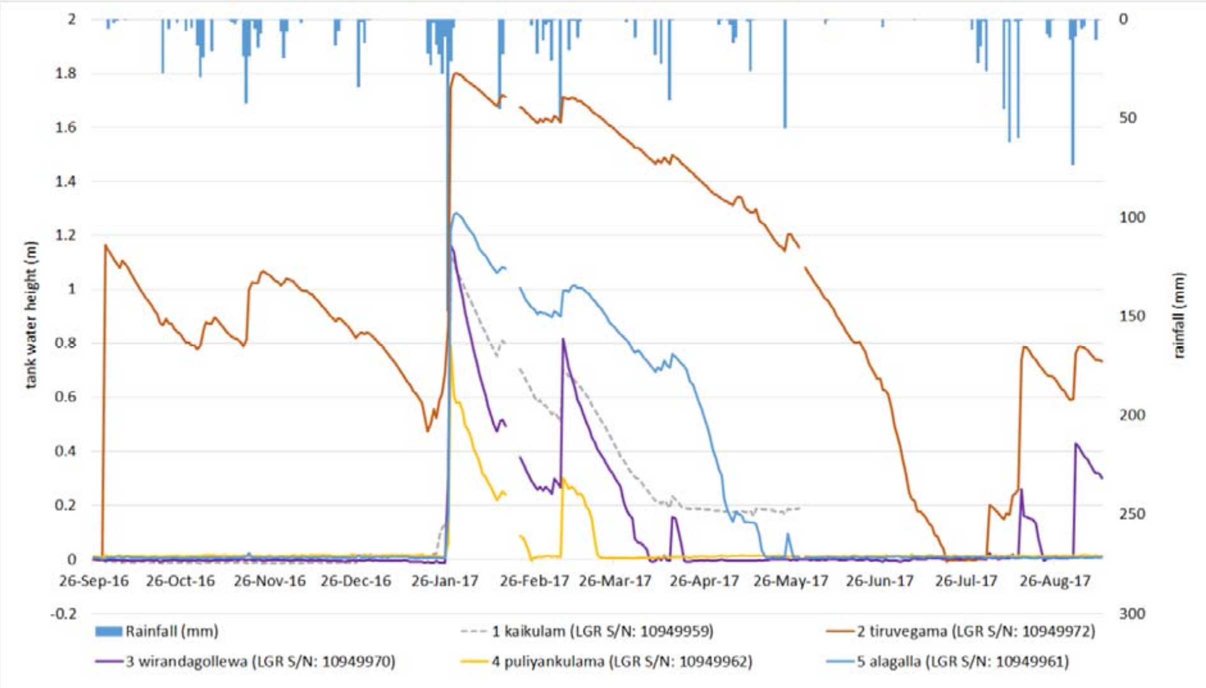
Remarks : ○:available, ⊿:partly available, -:not available
Source: JIRCAS

Table 6.6.8 Observation Result in Kiulekada Cascade System

No.	Tank Name	Period of data collection	Data collected up to September	Data collection upstream tank	Availability for calibration
1	Puliyan Kulama	2016/9/2-2017/2/17	-	-	-
2	Halmillawatya Wewa	2016/9/26-2017/5/31	△	-	-
3	Ikirigollewa	2016/9/2-2016/9/2	△	-	-
4	Gonahathdenawa	2016/9/26-2017/5/31	○	△	○
5	Nawagha Wewa	2016/9/26-2017/5/31	○	-	○
6	Kudagama	2016/9/26-2017/9/4	○	○	○
7	Galkadawala	2016/9/26-2017/9/4	○	-	○
8	Kiulekada	2016/9/26-2017/9/6	○	○	○
9	Kiulekada Ihalawewa	2016/9/26-2017/2/17	-	-	-
10	Kiulekada Kudawewa	2016/9/26-2017/9/4	○	-	-
11	Ihala Tammanawa	2016/9/26-2017/6/1	-	-	-

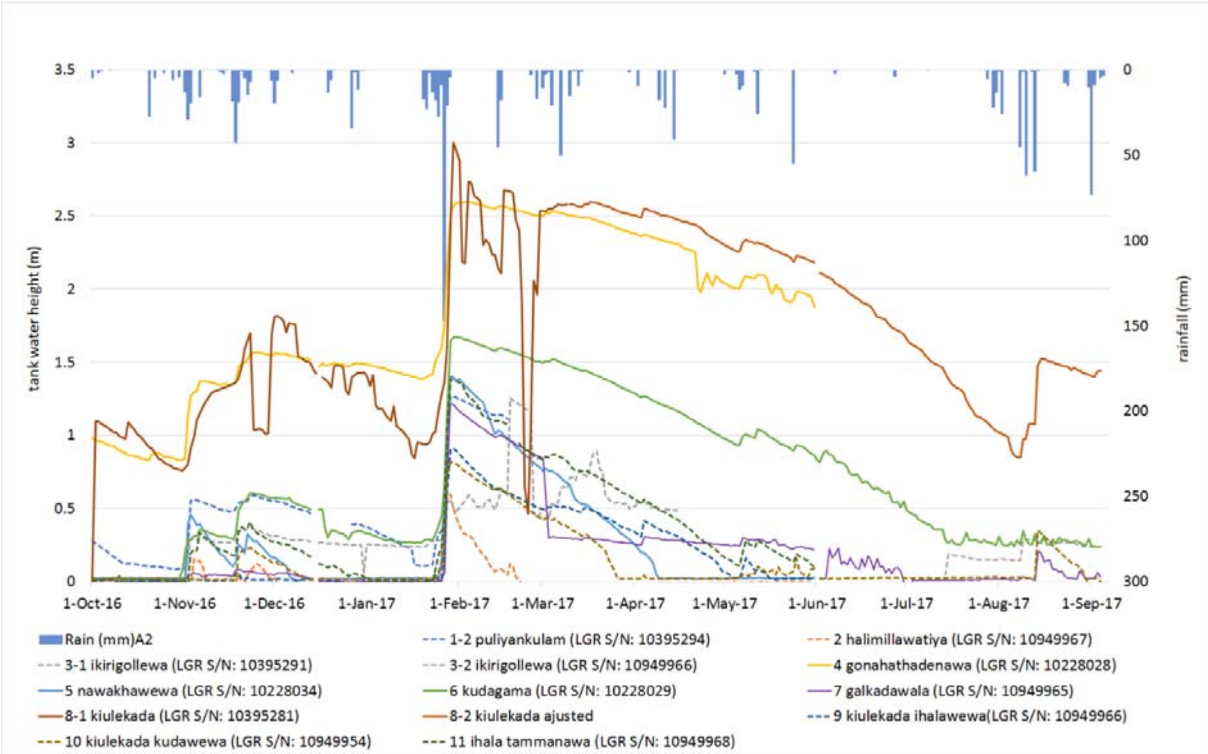
Remarks : ○:available, △:partly available, -:not available
Source: JIRCAS

The relationship between rainfall and tank water level is shown below.



Source: JIRCAS

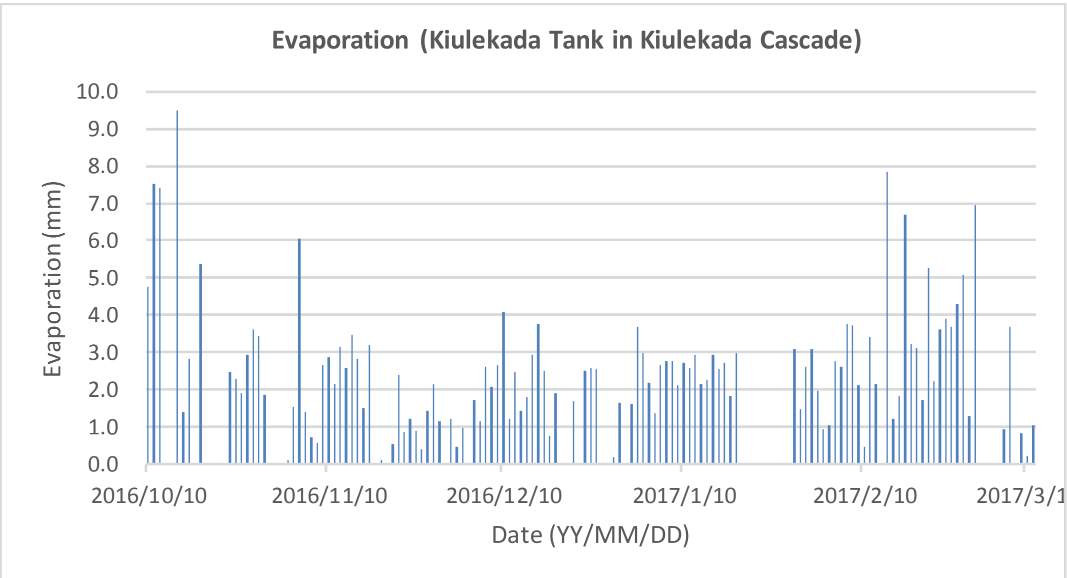
Figure 6.6.6 Relationship between Rainfall and Tank Water Level (Alagalla Cascade System)



Source: JIRCAS

Figure 6.6.7 Relationship between Rainfall and Tank Water Level (Kiulekada Cascade System)

An evapotranspiration pan was placed at the house yard of an inhabitant in Kiulekada. The data have been measured by the inhabitant for one year. Observation result is shown in Figure 6.6.8.



Remarks : The data is not available when data shows zero
Source: JICA Project Team

Figure 6.6.8 Evapotranspiration Data at Kiulekada Tank

Based on those observed results, necessary parameters for establishment of simulation model are decided for water balance study in six model cascade systems. The result of water balance study is shown in Annex 4.

6.7 Soil Investigation

6.7.1 General

The soil investigations covering the tank irrigated areas in the six model cascades were conducted to identify the drainage characteristics of the soils for the formulation of land use plans based on soil suitability for crop diversification and to apply measures of soil amelioration when needed.

The specific objectives of the survey are: (i) to investigate and classify the soils occurring in the irrigation command areas of the six model cascades; (ii) map out the drainage classes at 1:10,000 scale; and (iii) describe the soils, topography, slope, current land use, occurrence of salinity, aquifers, and impervious layers. The conduct of the soil investigation was outsourced to a reputable team of soil scientists under a contract agreement.

Observations were made on borehole samples on a 250 m x 250 m grid along the gridlines established on the ground using global positioning system (GPS) and compass. The observation density is that of medium intensity soil survey as defined by the Land Use Division of the Irrigation Department. The bore observations were made to a depth of 1.2 m and soil physical characteristics such as colour, texture, and organic matter content at five depth levels were determined in the field. Depending on the complexity of the drainage characteristics of the land and assistance in delineating the boundary between poorly drained and well drained lands, intensity of bore observations was increased at some locations.

The drainage class boundaries were determined in the field, and with the information in bore observations, the boundaries were refined with the extrapolation procedure. The bore observations and boundaries were verified independently for further refining of the boundaries.

The observations and boundaries were transferred to 1:10000 scale maps published by the Survey Department and drainage class draft maps were compiled. Subsequently, after refining the boundaries in the verification process, final maps were prepared. The drainage class boundaries were transferred to the corresponding 1:10000 digital images using Arc.

6.7.2 Present Land Use

(1) Area under the Irrigation Command

The major land use in area under the irrigation command is wetland rice. In the Yala season, some areas, although small in extent, have been used for maize and legumes cultivation. Some isolated fields have not been used for any kind of cultivation for a very long time and could be considered abandoned.

(2) Areas above the Irrigation Command

Three major land use types in areas above the irrigation command have been observed.

- Homesteads and adjourning lands with perennial (coconut, mango, papaya, lime, banana) and annual crops (maize, chilli, ginger, etc.) with less inputs for family consumption;
- Lands with perennial crops such as papaya and banana, and annual crops such as maize, chilies, and eggplant with more inputs for commercial scale production; and
- Lands used for upland rice cultivation adjourning to command area of the tank.

(3) Landform

The physiographic position of the surveyed area is mostly plain, lower slopes, and mid slopes. In some cascades, depressions and concave slopes could be observed.

The topography of the area is flat, almost flat or gently undulating generally having slopes of 0–4% whilst majority of the land slopes are 0–2%. In areas lying above the command areas, the slopes rarely exceeded 6%.

6.7.3 Drainage Characteristics

Both the external and internal drainage characteristics of the soils were considered in determining and demarcating the drainage classes in the surveyed area. The distribution of the drainage members in the irrigated area depends on the characteristics of the land in the particular cascade. The drainage classes are those identified and defined by FAO (1977). The following four drainage classes were identified and mapped.

(1) Class 1 - Poorly Drained

Water is removed from the soil so slowly that it remains wet for long periods of time after rains or irrigation. Slow removal of water may be due to flat topography, disturbance to the runoff (external drainage), occurrence of slowly permeable layers (internal drainage), existence of high water table during most part of the year or by seepage from a nearby water body. Often the condition is caused by a combination of these factors.

(2) Class 2 – Imperfectly Drained

Water is removed from the soil slowly and it remains wet for significant periods of time after rains or irrigation. Generally, the external drainage is fairly fast. Occurrence of slowly permeable layers, high water table and seepage may contribute to slow internal drainage.

The external drainage characteristics of the land in some cascades have influenced the formation of large tracts of imperfectly drained soils. Generally, the condition is caused by slow external drainage that is a result of the physiographic position of the irrigated area. Except for rare instances, most of the cascades do not have impervious layers and internal drainage of the soils is good.

(3) Class 3 – Moderately Well-Drained

Water is removed from the soil somewhat slowly and it remains wet for short but significant periods of time after rains or irrigation. External drainage is fast but internal drainage is somewhat slow because of slow permeable layers in the soil. The water table may be fairly high in rainy periods.

(4) Class 3 – Well Drained

Water is removed readily but not rapidly. External and internal drainage is relatively fast. Soils retain water at optimum level for short periods of time after irrigation or rains.

6.7.4 Major Soil Groups

Three major soil groups, namely; the low humic gley (LHG), alluvia, and the reddish brown earth (RBE) soils, are associated with the drainage classes found in the survey area. The main characteristics of these soil groups are given below.

Table 6.7.1 Main Features of the Soil Groups in the Survey Area

Characteristics	Low Humic Gley	Recent Alluvia	Reddish Brown Earth
Slope	0– 1%	0– 1%	1– 4%
Occurrence	Plains and depressions	Plains and depressions in association with LHGs	Lower, mid, and upper slopes
Texture	Sandy clay loam, sandy clay to clay	Loamy sand to clay. Variable in top and sub soil	Top soil: sandy loam or sandy clay loam Sub soil: Sandy loam to sandy clay
Colour	Greyish brown to dark grey	Greyish yellow to dark grey	Reddish brown
Structure	Structure less and massive	Weak	Moderate to strong
Permeability	Slow	Moderate	Good
Organic matter	Low	Moderate	Fair in top soil
Inherited nutrients	Moderate	Medium	Good
Drainage	Poor	Poor	Well, moderately well and imperfectly drained
Consistence	Wet: Sticky and plastic Moist: Firm Dry: Very hard	Wet: Slightly sticky and plastic Moist: Firm or friable Dry: Marginally hard	Wet: Slightly sticky and plastic Moist: Very friable Dry: Soft
Aeration	Poor	Good	Good
Cropping	Suitable for wetland paddy in both the Yala and *Maha* seasons but not for upland farming	Suitable for upland farming in the Yala season and wetland paddy in both seasons	Suitable for upland farming of annual crops with adequate drainage and perennial crops.

Source: JICA Soil Survey

Laboratory testing on random samples selected from each cascade shows no impediments to farming in the survey area in terms of soil salinity, acidity, and presence of hard pans and impervious layers.

6.7.5 Mapping

The survey area was mapped into three mapping units, namely; well-drained/moderately well-drained (WM), imperfectly drained (I), and poorly drained (P). The final maps prepared for each of the six cascades are attached as Annex 3. Major portion of the lands in the survey area comprises the poorly drained lands (63%) followed by imperfectly drained lands (32%) and minor land area (4%) in moderately well drained/well drained category.

Table 6.7.2 Distribution of Soil Drainage Classes

Cascade	Land Form	Soil Drainage Class					
		Poorly Drained (P)		Imperfectly Drained (I)		Mod. Well Drained /Well Drained (WM)	
		Extent	Percent	Extent	Percent	Extent	Percent
Alagalla	0 – 4%	56	47%	61	51%	3	2%
Ichchankulama	0 – 3%	218	64%	92	27%	31	9%
Kiulekada	0 – 6%	186	55%	134	40%	16	5%
Naveli kulam	0 – 1%	182	74%	63	26%	1	1%
Rathmalawewa	0 – 4%	273	62%	156	35%	11	3%
Siyambalagaswewa	0 – 3%	165	74%	44	20%	13	6%
Total		1080	63%	550	32%	75	4%

Source: JICA Soil Survey

6.7.6 Proposed Land Use

Land use recommendations, based on the soil drainage classes identified in the survey area, including the crops and crop categories are summarised in the table below.

Table 6.7.3 Summary of Crop Recommendations

Drainage	Soil	Position	Period of Wetness	Land Use Recommendation	
				Yala Season	Maha Season
W	RBE	Mid and upper slopes	None	Perennial Crops: Coconut, papaya, banana, dragon fruit, others recommended for DL1 Annual Crops: Upland high-quality rice, maize, sesame, other crops recommended for DL1	Perennial Crops: Coconut, papaya, banana, dragon fruit, others recommended for DL1 Annual Crops: Upland high-quality rice, maize, sesame, other crops recommended for DL1
I	RBE	Lower slopes	Inundation in *Maha* and possible inundation for short periods in *Yala*	Perennial Crops: Coconut, banana Annual Crops: High quality rice, maize, other high-value crops for DL1 that can withstand occasional wet feet	Perennial Crops: Coconut, banana Annual Crops: Wetland rice
P	LHG/ AL	Bottomlands and depressions	Inundation in *Maha* and possible inundation in *Yala*	Perennial Crops: None Annual Crops: Wetland rice	Perennial Crops: None Annual Crops: Wetland rice

Source: JICA Soil Survey

6.8 Farm Household Economy and Farming System

6.8.1 Methodology

Household economy and farming systems in the six model cascades were analysed based on the data and information collected through a farm household questionnaire survey and a series of mini focus group discussions. The main objectives of the surveys are to grasp the present household socioeconomic situation, agriculture and livestock production, marketing and farmers' expectations after receiving water from the North Central Province canal (NCPC) diversion.

The survey sample comprised 1,168 respondents selected at random covering 68% of the total households who were members of the FOs in the six model cascades. Interviews with individual household heads were conducted by seven locally recruited enumerators trained through classroom and on-the-job (OJT) sessions. Furthermore, six mini focus group discussions were held with the participation of the respective AIs, ARPAs, and 5–7 selected experienced farmers from each cascade.

Table 6.8.1 Distribution of Households in the Questionnaire Survey

No	Cascade	No of Villages	No. of HH in Survey	No	Cascade	No of Villages	No. of HH in Survey
1	Alagalla	6	135	4	Naveli kulam	16	155
2	Ichchankulama	5	198	5	Kiulekada	8	255
3	Rathmalawewa	5	275	6	Siyambalagaswewa	5	150

Source: Farm Household Survey, JICA Team

A structured questionnaire was used and the questions were framed in multiple choice and dichotomous form to minimise the duration of interviews with each respondent and to assist the relatively inexperienced enumerators deployed. The data collected were analysed at individual tanks in the cascades. In the focus group discussions, paddy crop budgets were developed and selected social issues were examined.

The household survey commenced in January 2017 and concluded by March 2017. The group discussion sessions were conducted in May and June 2017.

6.8.2 General Information

Focus group discussions revealed that the present farming population comprised the descendants of original settlers in the cascade areas centuries back. These farmers settled down in areas close to the tanks to establish their homesteads in clusters which later developed as villages. The areas they cultivated below, the ancient tanks are known as '*Puranawela*'. The land areas were later extended as '*Medawela*' and/or '*Pahalawel*a' in stages to accommodate farmlands of the dependents of original settlers. These additional newly *asweddumized* lands are cultivated mainly in the *Maha* season with rain water supplemented with irrigation water from the tanks whilst in the *Yala* season, they are usually left fallow. Over the generations, land fragmentation has taken place resulting in wide variations in the holding size amongst the farm households. The fragmented farmlands in the tank command area, called '*pangu*', are cultivated by the new generation of farmers but have no legal claim as their parents continue to retain the freehold land ownership.

(1) Household Members

The number of members per household in the six cascades varied between 1 and 9 with an average of 3.7. About 76% of the heads of household are in the age group of 36 and 65 years of which 81% is headed by males.

(2) Ethnicity and Religion

Alagalla, Ichchankulama, Rathmalawewa cascades have Sinhala-Tamil and Sinhala–Muslim mixed populations. Kiulekada and Siyambalagaswewa comprised Sinhala only whilst Naveli kulam only Tamil households. All the Sinhala and Muslim respondents are Buddhists and Islamic, respectively, whilst most of the Tamils are Hindus with a small percentage of Christians.

Table 6.8.2 Percent Distribution of Households by Religion and Ethnicity

Cascade	Ethnicity			Religion			
	Sinhala	Tamil	Moor	Buddhist	Hindi	Muslim	Christianity
Alagalla	85.19	14.81	0.00	85.19	1.48	0.00	13.33
Ichchankulama	63.64	0.00	35.86	63.64	0.00	35.86	0.00
Kiulekada	100.00	0.00	0.00	100.00	0.00	0.00	0.00
Naveli kulam	0.00	100.00	0.00	0.00	100.00	0.00	0.00
Rathmalawewa	79.27	0.00	20.73	79.27	0.00	20.73	0.00
Siyambalagaswewa	100.00	0.00	0.00	100.00	0.00	0.00	0.00
Total	73.97	14.98	10.96	73.97	13.44	10.96	1.54

Source: Farm Household Survey, JICA Team

(3) Community-based Organisations (CBOs)

There were several CBOs functioning in the survey area**.** Almost all the households held membership in one or more FOs. Death Donation Societies were active in the survey area with nearly 70% membership. Fifty-seven percent of the 116 cattle farmers were members of the Cooperative Milk Producer Societies established under the guidance of MILCO Company. It is usual for household members to hold membership in more than one CBO.

Table 6.8.3 Household Membership in CBOs

CBO	As % of Total HHs	CBO	As % of Total HHs
Farmer Organisation	98.9	Rural Development Society	13.7
Death Donation Society	69.7	Co-op Society	4.5
Divineguma/Samurdhi	14.0	Other	1.8
Women's Group	13.9		

Source: Farm Household Survey, JICA Team

6.8.3 Land Holding

(1) Size of Holding

Most households possessed land under more than one land holding category. Whilst all farmers in the survey owned land under the main tank, only 25%, 2%, 37%, and 66% of the households reported of having land under other tanks, *akkarawela, chena*, and home gardens, respectively. Thirty-five percent of the households do not possess home gardens mainly because their houses are either located in lands owned by their parents or in the village/town centres.

Table 6.8.4 Landholdings under Different Land Categories

Cascade	Average Landholding (ha)					
	Irrigated		Rain-fed (Lift Irrigated)			Total Operational Landholding
	Main Tank	Other Tanks	Akkarawela	Chena	Home Garden	
Alagalla	0.54	0.13	0.06	0.26	0.26	1.25
Ichchankulama	0.75	0.38	0.07	0.81	0.27	2.27
Kiulekada	0.90	0.05	0.01	0.19	0.36	1.51
Naveli kulam	1.25	0.14	0.02	0.11	0.53	2.05
Rathmalawewa	0.85	0.20	0.21	0.67	0.27	2.20
Siyambalagaswewa	0.70	0.22	0.27	0.03	0.08	1.30
Total	0.84	0.18	0.10	0.39	0.30	1.82

Source: Farm Household Survey, JICA Team

(2) Land Ownership and Tenure Systems

A complex land ownership and tenure system operated in the irrigated command area of the cascades. '*Ande*' system, a form of share cropping, once legally binding under the Paddy Lands Act, is superseded by the Agrarian Act, 2000 No. 46. Cultivating irrigable lands under seasonal lease agreements with the owner are emerging in the area. In the survey areas, over 82% of the irrigable lands are owner operated with or without additional *pangu* or leased in lands whilst 13% are *pangu* lands.

Table 6.8.5 Land Ownership in Command Area

Cascade	Percent (%) Households					
	Ande	Own/ Leased in	Own/ Pangu	Own	Pangu	Other
Alagalla	14.29	0.00	6.02	22.56	56.39	0.75
Ichchankulama	0.51	0.51	0.51	95.92	0.51	2.04
Kiulekada	8.63	0.00	0.00	90.20	0.39	0.78
Naveli kulam	0.00	12.99	14.29	40.26	24.68	7.79
Rathmalawewa	0.00	0.37	0.00	98.53	0.74	0.37
Siyambalagaswewa	0.00	1.34	16.11	58.39	22.82	1.34
Total	3.62	2.07	4.75	74.63	13.03	1.90

Source: Farm Household Survey, JICA Team

6.8.4 Crop Production

(1) Paddy

Paddy is cultivated in command areas of tanks in the cascades under irrigation and in highlands as a rain-fed crop in the *Maha* season. During the *Yala* season however, cultivation in the command area is restricted to about 25% of the *Maha* extent due to inadequate irrigation water supply. Rathmalawewa cascade shows the largest extent of rain-fed paddy in the *Maha* season.

The average yield of paddy cultivation was calculated based on the total extent cultivated and total production as reported by the respondents. Although this method of calculation is not statistically precise, it indicated a general image on the average yield of the crop in the area. According to the Department of Census and Statistics, the average yield of paddy in minor irrigation schemes in Anuradhapura District in 2015/16 was 4.66 tons per hectare. Except Alagalla, all other cascades showed lower productivity level compared with the average yield of the district. The cultivated extents, production, and yields of paddy in the six cascades under study are shown in the tables below.

Table 6.8.6 Cultivated Extent, Production and Yield of Paddy under Main Tank

Cascade	Main Tank (Irrigated)					
	Maha			Yala		
	Extent (ha)	Production (t)	Yield (t/ha)	Extent (ha)	Production (t)	Yield (t/ha)
Alagalla	74.6	384.4	5.25	53.2	241.9	4.5
Ichchankulama	149.8	591.8	4	0	0	0
Kiulekada	229.9	960.3	4.25	37.9	172.1	4.5
Naveli kulam	195.4	884.8	4.5	48.3	216.6	4.5
Rathmalawewa	240.8	882.3	3.75	28.2	105.7	3.75
Siyambalagaswewa	104.8	438.8	4.25	86.4	349.1	4
Total	995.32	4142.3	4	254	1085.3	4.25

Source: Farm Household Survey, JICA Team

Table 6.8.7 Cultivated Extent, Production and Yield of Paddy under Other Tanks and Rain-fed Highland

Cascade	Other Tanks (Irrigated)						Highland (Rain-fed)		
	Maha			Yala			Maha		
	Extent (ha)	Production (t)	Yield (t/ha)	Extent (ha)	Production (t)	Yield (t/ha)	Extent (ha)	Production (t)	Yield (t/ha)
Alagalla	17.6	75.6	4.25	12.9	43.3	3.25	2.9	6.7	2.25
Ichchankulama	77.5	294.9	3.75	0	0	0	24.5	79.8	3.25
Kiulekada	12.3	46.4	3.75	7.1	27.6	4	25.1	52.3	2
Naveli kulam	0.6	1.7	2.75	0	0	0	7.9	26.2	3.25
Rathmalawewa	50.9	151.1	3	1.4	5.9	4.25	95.1	192.1	2
Siyambalagaswewa	33.5	138.7	4.25	29.3	129.3	4.5	21.1	67.3	3.25
Total	192.4	708.3	3.75	50.7	206.1	4	176.6	424.4	2.4

Source: Farm Household Survey, JICA Team

(2) Other Field Crops

Little or no effort has been made by farmers to diversify their lands in the command area to non-paddy crops and preferred to continue paddy cultivation under the present situation. The cultivated extent under other crops in the command area is insignificant and accounted to a total of less than 4 ha.

Cultivation of other seasonal crops largely takes place in highland areas such as the *akkarawela, chenas,* and home gardens. These crops include coarse grains (maize and millet), grain legumes (green gram, black gram and cowpea), condiments (chilli and onion), and low country vegetables. Farmers in Alagalla and Naveli kulam (Vavuniya District) prefer cultivation of grain legumes, black gram in particular, because of the high local demand. Cultivation of maize is limited in Alagalla and Naveli kulam largely due to poorly established produce marketing system. In cascades located in Anuradhapura

District, *Maha* rain-fed cultivation of maize is well spread, except in Siyambalagaswewa Cascade due to lack of suitable lands.

Table 6.8.8 Cultivated Extents of Other Crop under Rain-fed Condition (ha)

Cascade	Maha Season: Rain-fed			Yala Season: Rain-fed	
	Coarse grain	Grain Legumes	Vegetables	Sesame (ha)	Production (kg)
Alagalla	7.84	17.68	0.50	17.80	7674
Ichchankulama	148.60	0.00	0.00	2.40	
Kiulekada	70.60	1.40	1.50	0.00	
Naveli kulam	0.10	27.50	1.90	1.00	450
Rathmalawewa	179.60	0.40	0.20	0.00	
Siyambalagaswewa	5.70	3.40	0.20	0.00	
Total	412.44	50.38	4.30	21.20	8124

Source: Farm Household Survey, JICA Team

(3) Fruit Crops

Fruit crops are largely confined to home gardens as mixed crops, and therefore, it was difficult to gather the total extent under each fruit crop. However, mango, banana, papaya, and guava are the major fruit crops in the home gardens.

6.8.5 Farm Input Supply

As predominant crops in the cascades, procuring seeds of paddy and maize are major input requirement of the farmers.

(1) Seed Paddy

The main suppliers of seed paddy are the private sector dealers operating in the respective areas. Although farmers have developed trust on certified seed paddy supplied by the government sources, namely; the Department of Agrarian Development (DAD) and Department of Agriculture (DOA), its use has been limited by the low supply level. It is also noted that farmers use their own seeds produced from certified seeds over several seasons before renewal with certified seeds. However, some farmers particularly those growing traditional paddy, are compelled to use their own seeds on a long-term basis.

Table 6.8.9 Sources of Seed Paddy

Cascade	Percent (%) Farmers							
	Govt. Sources	Own Seeds/ Govt	Own Seeds	Private Dealers	Private Dealers/ Govt	Own Seeds/ P. Dealers	Other Farmers	Other
Alagalla	68.89	17.78	2.22	2.22	1.48	0	5.93	1.48
Ichchankulama	8.67	0	11.73	74.49	2.55	0	1.02	1.53
Kiulekada	7.45	0.39	25.49	58.43	0.78	0.78	5.88	0.20
Naveli kulam	12.42	61.44	19.61	0	0.65	2.61	0.65	2.61
Rathmalawewa	3.64	3.64	1.45	69.82	6.55	12.36	0.73	1.82
Siyambalagaswewa	23.49	23.49	3.36	4.70	24.16	11.41	2.01	6.38
Total	16.60	14.10	11.18	42.73	5.50	4.90	2.67	2.33

Source: Farm Household Survey, JICA Team

(2) Maize and Other Crops

Maize varieties cultivated almost exclusively are imported hybrid varieties supplied by private seed dealers. Only about 4% is met by government sources. As regards to other crops, the land extents cultivated are relatively small and limited demand is catered mostly by private sector seed dealers.

6.8.6 Farm Labour

The survey showed that 65% of the heads of the households worked fulltime in their farms whilst 28% worked on part-time basis. The balance of 7% does not contribute to farm work implying that these heads of the households are engaged in off-farm activities on a full-time basis or are too feeble to engage in farm work. Seventy-two percent of the household members contributed to farm labour whilst 88% households depended on hired labour at times of peak farm labour demand periods.

Table 6.8.10 Contribution to Farm Labour (%)

Cascade	Head of Household			Household Members		Hired Labour	
	Fulltime	Part Time	Not Involved	Fulltime	Part Time	Only	Sometimes
Alagalla	48.89	47.41	3.70	35.71	64.29	5.30	94.70
Ichchankulama	63.13	16.16	20.71	23.27	76.73	16.58	83.42
Kiulekada	68.24	31.76	0	30.40	69.60	9.52	90.48
Naveli kulam	70.97	23.23	5.81	9.72	90.28	20.26	79.74
Rathmalawewa	64.10	27.84	8.06	34.86	65.14	9.52	90.48
Siyambalagaswewa	72.48	24.16	3.36	22.73	77.27	7.59	92.41
Total	65.06	27.90	7.04	27.82	72.18	11.45	88.55

Source: Farm Household Survey, JICA Team

Over 42% households reported the scarcity of farm labour whilst over 32% claimed that the current wage rates for hired labour are too high and tend to increase by each season. Further, 15% of the farmers reported on both, i.e., the scarcity and high wage rates of farm labour. On average, each hired labour unit cost the farmer LKR 1,200–1,400 per day plus meals and refreshments. Less than 10% of the households reported that they have no problems with hired labour.

Table 6.8.11 Problems Related to Hired Labour

Cascade	Percent (%) Households			
	High Wage Rate	Shortage	Shortage/High Rate	None
Alagalla	16.03	57.25	5.34	20.61
Ichchankulama	27.91	66.86	0	5.23
Kiulekada	65.34	27.89	3.59	3.19
Naveli kulam	20.92	45.75	30.72	2.61
Rathmalawewa	7.26	49.57	20.51	22.65
Siyambalagaswewa	51.11	8.15	40.74	0
Total	32.68	42.36	15.46	9.40

Source: Farm Household Survey, JICA Team

Participants in the focus crops sessions expressed that the youth showed a marked preference for off-farm employment and keep agriculture, at best, a part-time activity. Parents too encourage their children to gain higher education and seek off-farm employment to ensure regular income as well as to enhance their social standing and acceptance in the community. Youth engaged in off-farm employment have limited time to devote to farm activities compelling them to follow shortcuts and labour contracting often overlooking or ignoring the basic procedures in crop husbandry. This situation has caused high production costs and low productivity. Attracting the young generation to take up farming as profit earning business enterprises is a major issue confronting the future development of the area.

6.8.7 Production Capital

According to the survey, 73% farm households in the survey area invested their own money for cultivation. Only 4% of the farmers totally depended on commercial banks whilst 17% of the farmers borrowed part of their money from commercial banks. The operation of informal lending is minimal.

Table 6.8.12 Sources of Capital for Crop Production

Cascade	Percent (%) Farmers								
	Com. Banks/ Village Boutique	Com. Banks	Friends	Money lender	Own funds/ Com. Banks	Own funds/ Other	Own funds	Trader	Village Boutique
Alagalla	0	5.97	0	0	17.16	0.75	75.37	0.75	0
Ichchankulama	0.51	7.61	0	0	24.87	2.03	60.91	0	4.06
Kiulekada	0	7.48	1.57	0.39	1.57	0.79	86.22	1.97	0
Naveli kulam	0	1.94	0	0	36.77	12.90	48.39	0	0
Rathmalawewa	0	1.46	0	0	21.53	5.84	69.71	1.46	0
Siyambalagaswewa	0	0	0	0	0	4.70	95.30	0	0
Total Study Area	0.09	4.21	0.34	0.09	16.51	4.30	72.91	0.86	0.69

Source: Farm Household Survey, JICA Team

6.8.8 Crop Irrigation

(1) Adequacy of Irrigation Water

Survey revealed that only 53% of the farmers are contented with the quantity of water they receive for their *Maha* season cultivation. In the *Yala* season, the figure falls as low as 1.8% even with the reduced land extent cultivated. More than 47% and 60% said that the available water is insufficient for their *Maha* and *Yala* cultivations, respectively. More than 38% claimed that they do not receive any water for *Yala* cultivation as the tanks fully or partially dry up and the little water if retained is reserved for domestic consumption. Thus, inadequacy of water for irrigation is a major constraint in crop production.

Table 6.8.13 Adequacy of Irrigation Water

Cascade	Maha Season		Yala Season		
	Sufficient	Insufficient	Sufficient	Insufficient	No water
Alagalla	40.74	59.26	0.74	55.56	43.70
Ichchankulama	98.99	1.01	0	97.91	2.09
Kiulekada	42.35	57.65	0.40	52.78	46.83
Naveli kulam	69.68	30.32	0	74.19	25.81
Rathmalawewa	4	96	0.73	17.52	81.75
Siyambalagaswewa	93.29	6.71	11.41	88.59	0
Total	52.87	47.13	1.82	59.69	38.49

Source: Farm Household Survey, JICA Team

Some farmers commence their cultivations with the onset of NE monsoon rains whilst others wait until the respective tank gets adequately filled. In Ichchankulama, Naveli kulam, and Rathmalawewa cascades, nearly all farmers begin their land preparation work on the onset of rains in the *Maha* season whereas 97% farmers in Siyambalagaswewa and 80% in Kiulekada delay the land preparation until commencement of water issue from the tanks.

(2) Agro-wells

There are 304 functioning agro-wells in total in the survey area of which 195 are located in home gardens whilst others are in the command area of the tanks or in highlands. Largest number (87) of agro-wells are found in Kiulekada Cascade. In home gardens, agro-wells are used to lift-irrigate the perennial crops like coconut, banana, and papaw; and annuals such as vegetables. The land extents cultivated in highlands and command areas with agro-wells were reported only by few respondents and averaged to less than 0.12 ha.

6.8.9 Livestock Production

(1) General

Cattle rearing and poultry keeping are the main livestock activities in the survey area. Although the number of households engaged in production is very limited, the potential for increasing the farm income by crop-livestock integration is very high. Farmers participating in the focus group meetings expressed that during the past three seasons, when crop production had been severely affected by the drought conditions, the only source of farm income was from livestock production. The past focus group discussions revealed that until recent times, rearing of livestock remained an integral part of the farming system. However, the large cattle and buffalo population in the survey area dwindled rapidly over the past four decades with the advent of mechanised land preparation and threshing as well as other factors relating to herd management such as drastic reduction in the land area for free grazing.

(2) Dairy Farming

In the survey area, only a few are engaged in animal husbandry with only 116 households representing 9.93% in cattle rearing in six cascades. However, a majority is found in Naveli kulam (49 households– 25% of the cascade households) and Ichchankulama (34 households– 17% of the cascade households) cascades. Alagalla, Siyambalagaswewa, and Kiulekada had more than 5% but less than 10% households in cattle rearing.

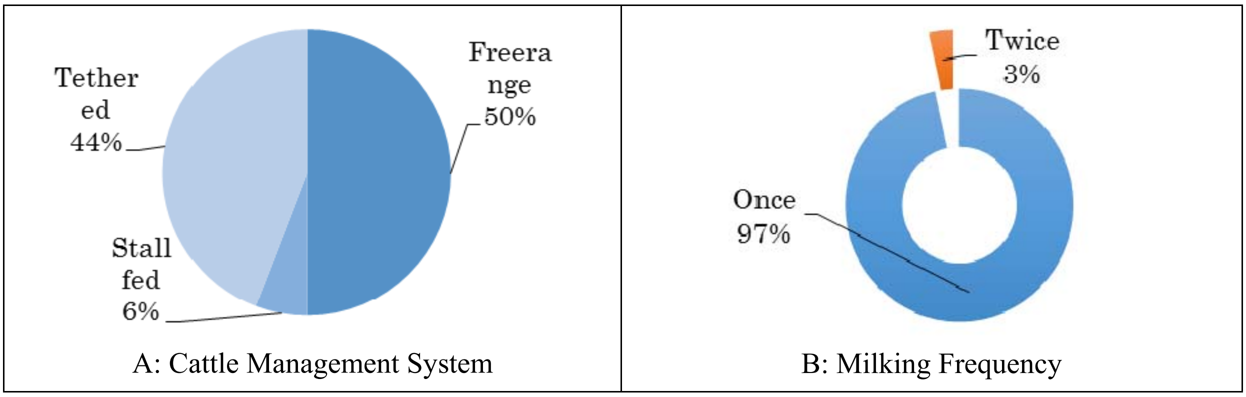
The average herd size amongst the dairy farmers is about 9.2 animals. A large proportion of the cattle are indigenous types, only 29.2% are crossbreds. This accommodates both the milk and meat sectors. Cattle herd consists of 32.5% productive cows, 16.5% dry cows, 15.3% heifers, 8.5% bulls, and 27.2% calves. The composition of 45% productive cows and 8% dry cows is considered as the standard to achieve any smallholder herd.

Table 6.8.14 Dairy Farmers and Cattle Breeds

Cascade	Households		Number of Animals			
	Number	In Cascade	Local	Crossbred	Not Specified	Crossbred %
Alagalla	11	8.2%	19	24	16	40.7%
Ichchankulama	34	17.2%	33	116	72	52.5%
Kiulekada	19	7.5%	87	56	0	39.2%
Naveli kulam	39	25.2%	303	90	137	16.9%
Rathmalawewa	4	1.5%	13	26	2	63.4%
Siyambalagaswewa	9	6.0%	73	0	0	00.0%
All Cascades	116	9.9%	528	312	227	29.2%

Source: JICA Project Team

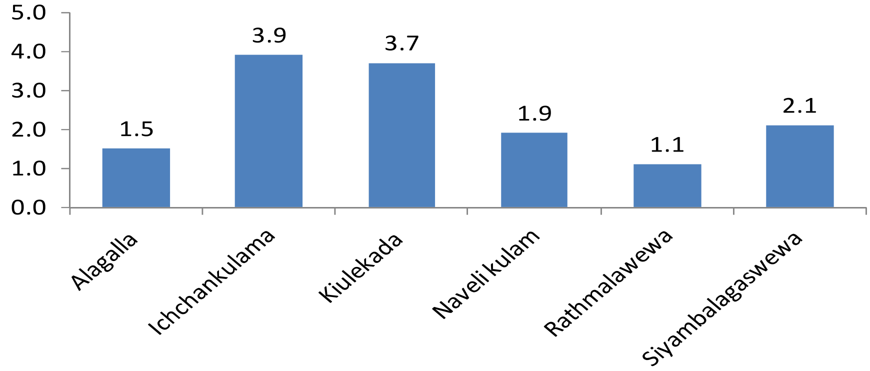
Cattle in the cascade systems convert available plants and grasses into milk, meat, and other products. Hence, the cost of production of these products is minimal. The cattle management practices carried by 94% farmers in the survey area are free range and tethered systems. Furthermore, farmers tend to milk only once a day knowing the quality and intake quantity of herbage.



Note: Left (A) shows the source of animal feed. Right (B) shows that once means milking only in the morning and twice means milking in the morning and evening.
Source: JICA Project Team

Figure 6.8.1 Source of Animal Feed and Milking Frequency

The daily milk production reported in the surveyed area is 845 litres and is sold mainly to MILCO Company. Under the guidance of the company, Cooperative Milk Producer Societies have been established where 57 of the cattle farmers hold membership. The average production per cow per day is 2.435 litres. Rathmalawewa has the lowest milk production of 1.063 litres per day. It is encouraging to observe that more women are gainfully engaged in the dairy sector.



Source: JICA Project Team

Figure 6.8.2 Average Milk Production (litre/cow/day)

(3) Poultry Farming

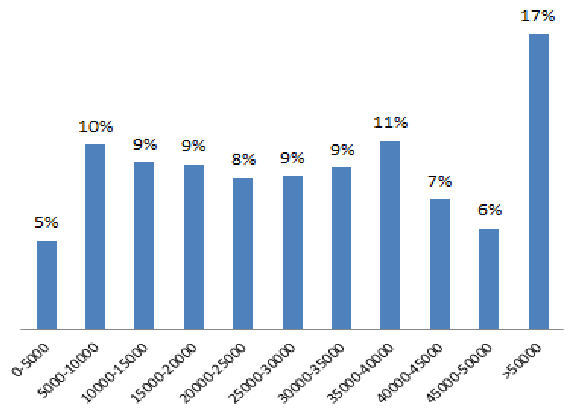
Only 59 households representing 5.1% of the survey sample were engaged in poultry farming, majority of 49 households were in Naveli kulam Cascade. There were 387 hens laying 228 eggs a day, or 58.9% production.

Even though milk production strongly supports consolidating farm income, it has little impact on food security. On the other hand, family poultry keeping has a solid influence on household food security but very little impact on farm income. This may be the reason why only a few households are engaged in poultry keeping. These numbers could increase by making the family poultry sector supports both food security and strengthen the farm income. It must be noted that this activity will be totally handled by woman members in the household to address gender inequality in the rural sector.

6.8.10 Household Income

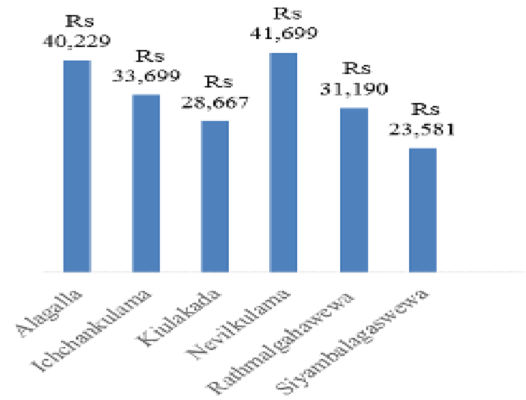
(1) Monthly Household Income

There is a high degree variation in the distribution of monthly household income amongst the households in the survey sample. Such disparities could be attributed to the operational land holding size, contribution of household members to farm labour, from off-farm employment, amongst others.



Source: Farm Household Survey, JICA Team

Figure 6.8.3 Monthly Income Level by Percentage Households



Source: Farm Household Survey, JICA Team

Figure 6.8.4 Monthly Income Level of Households by Cascade

The last Household Income and Expenditure Survey (2012/2013) conducted by the Department of Census and Statistics (DC&S) showed an average monthly income of LKR 35,460 and LKR 41,478 for the rural sectors of Anuradhapura and Vavuniya districts, respectively. The average monthly income of LKR 32,527 recorded in the household survey is thus below those indicated by DC&S for year 2013.

(2) Sources of Household Income

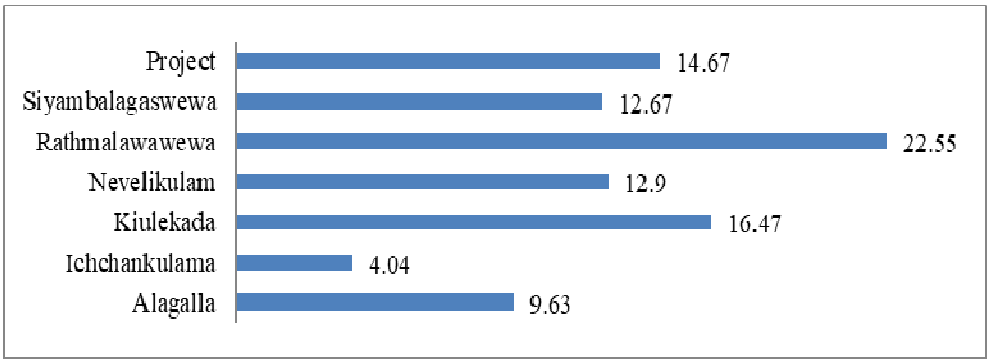
The survey data revealed that primary household income is derived from crop production which accounted for nearly 50%, whilst off-farm employment of household members in government and private sectors contributed 34%. Income from engaging in miscellaneous skilled and unskilled non-farm labour activities accounted for 12%.

Table 6.8.15 Sources of Household Income (Percentage)

Cascade	Off-farm Employment	Crop Production	Livestock	Farm Labour	Skilled Labour	Unskilled Labour	Family Business	Other
Alagalla	57.8	25.9	0	0	0	16.3	0	0
Ichchankulama	25.7	71.2	0	0	0.5	1.5	1.0	0
Kiulekada	46.7	46.0	1.2	0	0.8	3.9	1.2	0
Naveli kulam	14.2	45.2	5.2	0.6	11.6	12.3	3.1	7.7
Rathmalawewa	36.3	41.5	0	0.4	6.9	4.4	5.8	4.7
Siyambalagaswewa	20.0	65.3	0.7	0	4.7	9.3	0	0
Total	33.3	49.2	1.2	0.2	4.1	8.0	1.9	2.1

Source: Farm Household Survey, JICA Team

Under the Divineguma/Samurdhi programme implemented by the government, nearly 15% of the households in the survey area are recipients of the benefits. Rathmalawewa Cascade has the highest number of recipients representing 22.55%. Families having an income of less than LKR 15,000 per month are eligible, depending on the number of family members, receiving LKR 1,250 (less than 3), 2,150 (3), and 3,050 (more than 3) per month net after the statutory deductions.



Source: Farm Household Survey, JICA Team

Figure 6.8.5 Percent Divineguma/Samurdhi Beneficiaries

(3) Income from Crop Production

Crop production in the cascades in the survey is limited to the two crop seasons, i.e., *Maha* and *Yala*. The average household income is estimated at LKR 123,514 in the *Maha* season and that of *Yala* season at LKR 24,804 based on the survey data. However, wide variations in the seasonal and total annual income amongst the six cascades were observed. Households in Ichchankulama Cascade showed the highest income level amongst the cascades surveyed.

Table 6.8.16 Income from Crop Production

Cascade	Average Income (LKR)			
	Maha Season	Yala Season	Annual	Monthly
Alagalla	74,456	40,441	114,897	9,575
Ichchankulama	212,456	8,441	221,810	18,484
Kiulekada	91,210	18,729	109,039	9,162
Naveli kulam	147,897	37,019	184,917	15,410
Rathmalawewa	113,506	5,118	116,969	9,747
Siyambalagaswewa	98,332	6617	164,459	13,705
Survey Area	123,514	24,804	148,084	12,340

Source: Farm Household Survey, JICA Team

(4) Paddy Crop Budget Paddy

Cascade-wise crop budgets of paddy were prepared through focus group discussions. Most of the operations in paddy cultivation are mechanised for which the services are available from private providers in respective areas. On average, the total cost of production of paddy remained around LKR 125,000 per hectare excluding the cost of household labour. A flat rate of LKR 35 is applied in the computation of the net returns.

Table 6.8.17 Generalised Cascade-wise Crop Budgets

Operation		Alagalla	Ichchan kulama	Siyambala gaswewa	Kiulekada	Rathmal awewa	Naveli kulam
Bund making	Man-days x wage	6,000	6,000	4,800	4,800	7,000	4,000
Ploughing	4w Tractor	9,000			8,000	8,500	8,000
	2w Tractor		7,000	8,000			
Levelling and sowing	Seed paddy x price	4,800	5,100	5,100	5,100	6,125	5,550
	Man-days x wage	4,500	2,400	3,600	3,600	1,000	2,400
Fertilizer application	Basal kg x price	1,250		1,500	1,750	1,000	1,000
	TD-1 x price	1,500	500	1,000	2,500	2,500	1,250
	TD-2 x price	3,500	1,750	1,250	3,500	3,500	1,250
	TD-3 x price		2,000				1,850
Weed control-1	Chemical cost	2,500	2,800	4,000	3,400	4,000	5,300
	Spraying cost		500	1,200	1,200	1,500	1,200
Pest and disease control	Chemical cost		500	1000	1000		900
	Spraying cost						1,200
Harvesting	Reaper				4,000		
	Combine harvester	10,000	10,000	9,000		8,500	10,000
Collecting	Man-days x wage				4,800		
Threshing	4w thresher				6,000		
Drying	Man-days x wage	3,000	2,400	6,000		5,000	4,800
Transport		1,000	1,000	1,200	2,000	1,500	2,000
Total cost		47,050	41,950	47,650	51,650	50,125	50,700
Yield	Kg/ha	6,000	5,500	4,750	5,000	5,000	5,250
Producer Price	LKR/kg	35	35	35	35	35	35
Gross Return	LKR/ha	210,000	192,500	166,250	175,000	175,000	183,750
Net Return	LKR/ha	92,375	87,625	47,125	45,875	49,688	57,000

Source: Focus Group Discussions, JICA Team (2017)

6.8.11 Future Expectation for Crop Diversification

(1) Farmers Willingness

The response of the farmers on willingness to diversify paddy lands varied widely within tanks and between cascades. About 14% and 65% of the farmers were willing to consider crop diversification, partially or totally in the *Maha* and *Yala* seasons, respectively. Although wide variations in the responses were observed, the general trend showed that the farmers' outlook towards diversification is a positive one in the backdrop of highly traditional paddy centric cropping system operating in the area.

Table 6.8.18 Farmers Willingness to Diversify Paddy Lands

Tank	Percent (%) Households					
	Maha			Yala		
	Yes	No	Undecided	Yes	No	Undecided
Alagalla	2.2	97.8	0	100.00	0	0
Ichchankulama	3.5	96.4	0	74.11	25.89	0
Kiulekada	0.8	94.1	5.10	83.53	7.06	9.41
Naveli kulam	17.4	76.1	6.45	36.77	56.77	6.45

Rathmalawewa	15.6	84.4	0	46.91	53.09	0
Siyambalagaswewa	52.00	48.0	0	52.67	47.33	0
Total Study Area	13.7	84.3	1.97	65.01	32.08	2.92

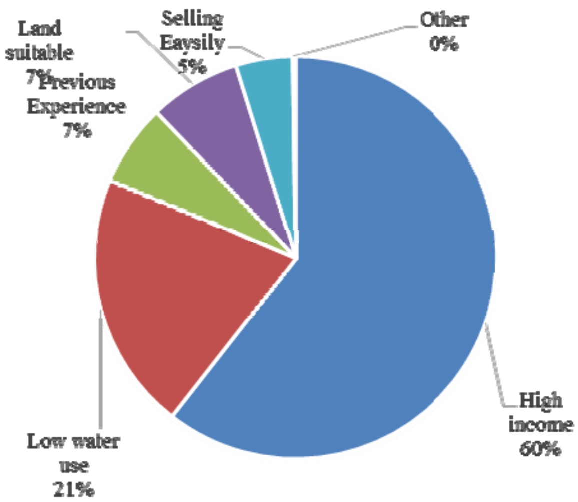
Source: Farm Household Survey, JICA Team

(2) Reasons for Diversification

Majority of the farmers willing to diversify were convinced of the high income that non-paddy crops would generate. They were also confident of increased water use efficiency that diversification would bring about. Availability of suitable land, previous experience in growing other crops, and availability of ready market for the produce are other positive factors identified.

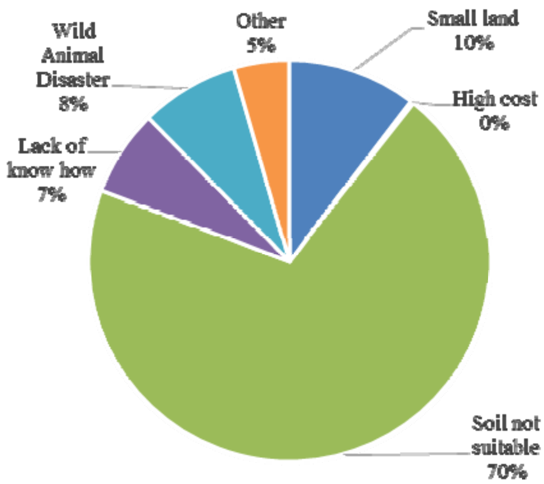
(3) Reluctance to Diversification

Large majority of the respondents in the survey who were reluctant to diversify are of the view that the soils in their farms are not suitable to raise crops other than paddy. Around 10% expressed that their land holding sizes are too small in extent and could only provide rice for household consumption and use as seed paddy for the next crop season. Lack of adequate knowledge on growing of non-paddy crops and crop damage by wild animals also discourage farmers to diversify.



Source: Farm Household Survey, JICA Team

Figure 6.8.6 Reasons for Willingness to Diversify

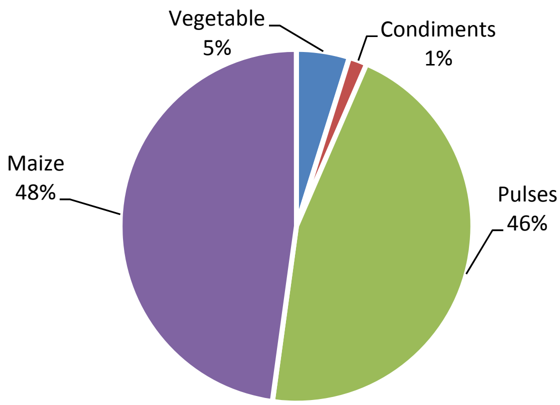


Source: Farm Household Survev. JICA Team

Figure 6.8.7 Reasons for Reluctance to Diversify

(4) Preferred Crops for Diversification

Farmers preferred maize and pulses, which they are quite familiar with, as irrigated crops in the *Yala* season after receiving water from NCPC. This may partly be attributed to lack of knowhow and experience in growing as well clear awareness on the range of potential crops available for consideration. The situation reflected the need for intensive agricultural information and technology transfer system to disseminate in order to create awareness and promote new crops for inclusion in the cropping system.



Source: Farm Household Survey, JICA Team

Figure 6.8.8 Crop Preference for Future Diversification

6.9 Agriculture Marketing and Post Harvest

6.9.1 Methodology

The detailed survey of marketing consists of four approaches, namely; (1) the farm household survey in the six targeted cascades, (2) the survey of contract farming, (3) the market potential of traditional rice varieties, in Colombo, and finally, (4) the market potential of high-valued vegetables and fruits, targeted at the tourist industry in Anuradhapura area. Table 6.9.1 summarises the methods, targets, and objectives of each survey.

Table 6.9.1 Summary of Detailed Surveys in Marketing and Post Harvest

		Methods	Targets	Objectives
(1)	Farm household survey	Household survey with a structured and semi-structured interview	1,168 households in the six targeted cascades	Clarify the current status of major cash crops and ways to sell them
(2)	Survey of contract farming	Focus group discussion	12 farmers in Ichchankulama Cascade	Clarify the ways and constraints of contract farming
(3)	Market potential of traditional rice varieties in Colombo	Structured and semi-structured interview	236 traders, wholesalers, retailers of traditional rice varieties in Colombo area	Identify the current and future market potential of traditional rice varieties
(4)	Market potential of high-valued vegetables in Anuradhapura area	Structured and semi-structured interview	171 middle-high end hotels and restaurants in Anuradhapura area	Identify the current and future market potential of high-valued vegetables and fruits in the tourist industry

Source: JICA Project Team

6.9.2 Findings through Farm Household Survey

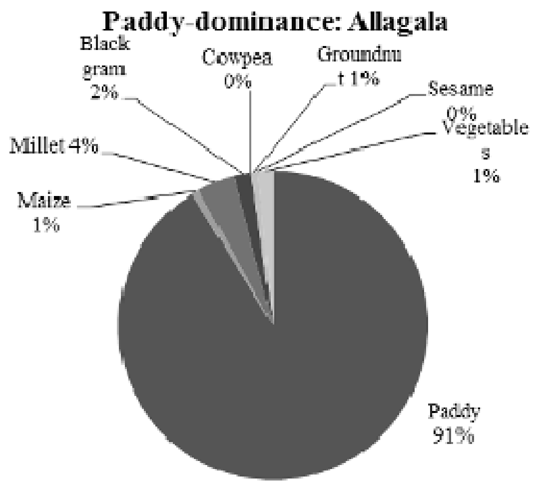
(1) Major Crops for Sale

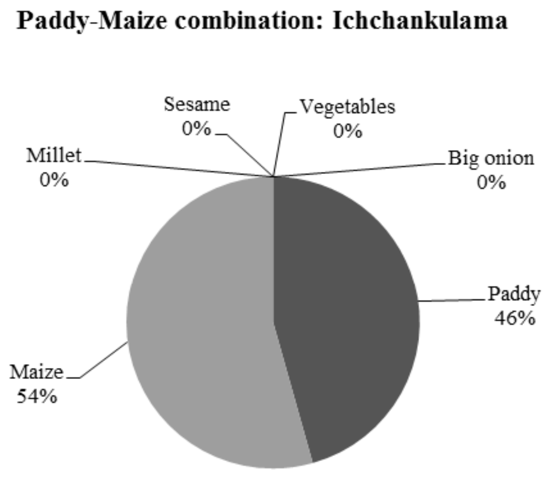
Table 6.9.2 shows the major crops for sale in the six targeted cascades. The cascades are classified into two types of crop structure in the *Maha* season, namely, (1) paddy-dominance and (2) paddy-maize combination. Alagalla, Kiulekada, Naveli kulam and Siyambalagaswewa cascades are categorised as (1) paddy-dominance, whilst Ichchankulama and Rathmalawewa are categorised as (2) paddy-maize combination.

Table 6.9.2 Cash Crops in the Six Cascades (kg)

		Alagalla	Ichchankulama	Kiulekada	Naveli kulam	Rathmalawewa	Siyambalagaswewa
Paddy	Maha	225,230	573,920	556,250	677,420	667,900	333,175
	Yala	140,390	0	107,740	144,760	39,450	230,060
Maize	Maha	1,862	683,675	59,000	0	628,625	7,050
	Yala	0	0	0	0	4,500	0
Millet	Maha	9,710	0	15,750	0	1,380	1,800
	Yala	0	750	0	0	0	0
Green gram	Maha	0	0	0	322	25	1,500
	Yala	0	0	0	0	0	0
Black gram	Maha	4,580	0	130	18,330	0	1,325
	Yala	0	0	0	0	0	0
Soya	Maha	0	0	0	0	0	0
	Yala	0	0	0	0	600	0
Cowpea	Maha	45	0	175	2,193	60	0
	Yala	0	0	0	0	0	0
Ground nut	Maha	1,530	0	100	3,120	0	0
	Yala	115	0	0	1,770	0	0
Sesame	Maha	200	0	225	350	0	25
	Yala	4,500	1,030	0	610	0	0
Red Onion	Maha	0	0	0	0	0	0
	Yala	0	0	0	700	0	0
Big onion	Maha	0	0	0	0	0	0
	Yala	0	10,200	0	0	0	0
Vegetables	Maha	3,825	0	100	8,820	150	15
	Yala	3,305	3,500	0	7,700	150	0

Source: JICA Project Team





Source: Farm Household Survey, JICA Project Team 2017

Figure 6.9.1 Paddy Dominance and Paddy-Maize Combination in the Maha Season

In the *Yala* season, on the other hand, most of the targeted cascades rely on paddy as an income source except for Ichchankulama, where big onions, vegetables, and sesame are sold.

Fruits are also income source especially for Ichchankulama and Siyambalagaswewa cascades, although the scale of income is limited, compared with paddy and maize. Mango is the most popular one, followed by banana and papaya (Table 6.9.3).

Table 6.9.3 Quantity of Fruits Sold in the Six Cascades (kg)

Cascade	Mango	Papaya	Banana	Guava	Lime	Pomegranate	Cashew	Total
Alagalla	7,500	400	3,275	-	250	30	-	11,455
Ichchankulama	88,700	-	2,530	-	-	-	-	91,230
Kiulekada	13,200	-	-	-	-	-	250	13,450
Naveli kulam	6,650	1,400	6,825	3,500	-	-	-	18,375
Rathmalawewa	4,000	-	650	-	-	-	-	4,650
Siyambalagaswewa	77,000	-	500	-	1,500	-	-	79,000

Source: Farm Household Survey, JICA Project Team 2017

(2) Market Channels

Most farmers in the targeted cascades sell their produces to conventional channels. Paddy is mainly sold directly or via collectors, to Paddy Marketing Board (PMB) and millers. Other crops are transacted mainly to the Dedicated Economic Centre (DEC, public wholesale markets) or *Pola* (weekly rural markets), directly or via collectors/traders. Organised marketing has not been well practiced. Notably, however, a number of farmers practice contract farming of maize in the Ichchankulama Cascade (see below Table 6.9.5 Survey of Contract Farming).

Table 6.9.4 Major Buyers of Cash Crops in the Targeted Cascade

Cash Crops	Major Buyers	Remarks
Paddy	PMB, Millers	
Maize and other cereals	DEC, Pola, Agribusiness companies	Contract farming is observed in Ichchankulama
Others	DEC, Pola	

Source: Farm Household Survey, JICA Project Team 2017

6.9.3 Survey of Contract Farming

The JICA Project Team conducted a focus group discussion, inviting 12 farmers who practice a contract farming in Ichchankulama Cascade on 4th September 2017, in order to clarify the *status quo* of the contract farming and explore its potential.

(1) Basic Information of Contract Farming

Table 6.9.5 summarises the major practices of contract farming in the project area. All listed agri-business companies target maize and soya for contract farming.

Table 6.9.5 Major Contract Farming in the Project Area

Company	Contract Summary	Service Package	Quality Standard
Maliban Dairy and Agri Products (Pvt) Ltd	・Minimum price is agreed, prior to each cropping season	・Seeds, agro-chemicals, bags, transport, and technical support are provided by the company ・Social welfare such as religious activities and medical equipment are also supplied	・Moisture level ・Free from discoloured and damaged grains ・Physical matters must be below 2%
CIC Agri Businesses Ltd	・Price is determined mainly by moisture level	・Seeds, agro-chemicals are supplied through a bank loan with the company's coordination (not from the company) ・Technical assistance is provided by the company's extension officers ・Social welfare such as scholarship programme, farmer events /functions are supported	・Moisture level
S.D.K. United Agri Ventures (Pvt) Ltd	・Price is determined mainly by the quality of produces such as moisture level	・Services, including a technical assistance are provided by the Department of Agriculture, not by the company's field officer ・There is no social programme for farmers ・Farmer agents are provided extra benefits such as commission	・Moisture level ・Portion of physical matters

Plenty Food (Pvt) Ltd	・ Minimum price is agreed prior to a contract. ・ Price can be negotiable if the open market price is higher than the agreed price	・ Seeds and agro-chemicals are provided on credit by the company ・ Technical assistance is provided by the company's extension officers ・ Members of "Farm Club", a society organised by the company are eligible to gain social benefits such as books for school children. ・ Extra assistance if crop is totally damaged	・ Aflatoxin free ・ Moisture level ・ Physical matters must be less than 2%

Source: JICA Project Team

All the 12 farmers in Ichchankulama Cascade have a forward sale contract of maize with Plenty Food (Pvt) Ltd., which is a subsidiary of Ceylon Biscuits Limited, one of the largest food processing companies in Sri Lanka. The contract is a crop season basis and the Plenty Food guarantees a minimum price, prior to each cropping season. For instance, in the *Maha* season of 2017, the contracted price was LKR 52.0 per kg against LKR 47-48 of the market price.

The company also provides a package of service, including supplying inputs (quality seeds and agrochemicals), technical assistance by a field officer, and even social welfare services as shown in Table 6.9.5.

(2) Potential and Challenges to Expand Contract Farming

Currently, participated farmers cultivate maize only in the *Maha* season on the highland farm. All of them expressed their satisfaction with the contract and willingness to expand it in the *Yala* season if the following challenges are overcome:

i) Accessibility to qualified seeds;
ii) Agricultural loan system for agricultural inputs;
iii) Introduction of crop insurances such as a climate index insurance;
iv) Shortage of labour through the promotion of agricultural mechanization; and
v) Legal support of the contract.

Farmers are able to purchase only limited volume of seeds from the Plenty Food, without other procurement source. They require to improve the accessibility of qualified seeds in order to expand the cropping area of other field crops (OFC). They also insist on agricultural loan through bank or agribusiness company, in particular for agricultural inputs such as fertilizers and pesticide.

Crop insurances such as index insurance, encourage to expand contract farming of OFC. The Plenty Food itself has an emergence support, whilst most do not include such services.

A group of farmers also explained that mechanisation of OFC farming needs to be supported. At this moment, the mechanisation service, from land preparation, transplanting, harvesting and post harvesting is limited to paddy farming, although OFC farming also requires high labour intensity.

Finally, the group requested the government to act as a regulator of the contract. Currently, most of the contracts do not provide any safeguards to farmers, according to them. Some of the farmers in the group had bad experience wherein a company did not purchase their contracted volume of maize in the past even though the produce met the required quality. This vulnerable situation keeps farmers from expanding a contract farming.

6.9.4 Potential in Traditional Rice Varieties

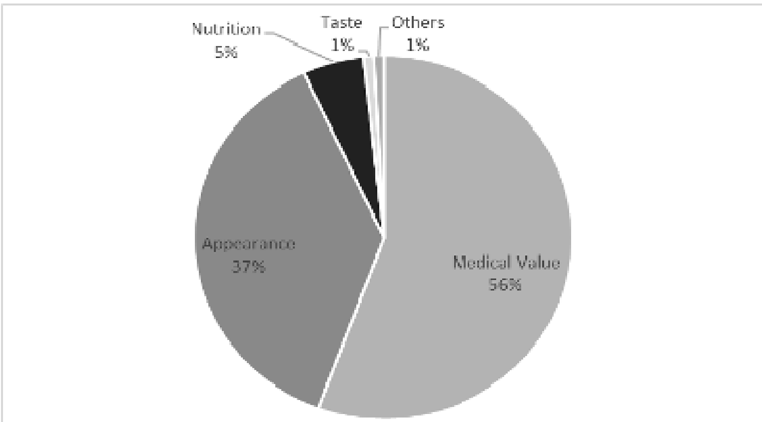
(1) High Demand Amongst the Health Concerned, Middle Class Consumers

The demand in traditional rice varieties such as *Suwandel* and *Pachchaperumal* has drastically increased amongst health conscious consumers in the urban areas. Table 6.9.6 shows the sales and price of the top ten popular rice varieties, whilst Figure 6.9.2 describes the reasons to purchase traditional rice varieties. The main consumers of the traditional varieties, mostly middle-income class, attribute their reason of choosing these varieties to medical value.

Table 6.9.6 Top Ten Sales in Variety of Traditional Rice

		Average Price at Retailers (LKR/kg)	
Name of Rice	**Monthly Sales (kg)**	**Purchasing**	**Selling**
Suwandel	178,252	178.56	209.44
Kuruluthuda	64,987	162.54	185.18
Pachchaperumal	44,742	170.14	199.00
Heenati	41,230	181.38	211.33
Madathawalu	22,519	158.06	180.59
Kahawanu	9,307	149.40	166.31
Ma vee	4,935	195.71	223.57
Rathdel	3,490	145.14	181.43
Dik Vee	3,000	213.00	250.00
Kirinaram	3,000	120.00	150.00

Source: JICA Project Team



Source: JICA Project Team

Figure 6.9.2 Reasons to Purchase Traditional Rice Varieties

Industrial Technological Institute verifies that traditional varieties contain higher protein, iron, and anti-oxidant, compared with the major modern varieties (Table 6.9.7). The composition of the traditional rice varieties benefits diabetic patients and people with obesity since they are able to gain essential nutrients with smaller intake.

Table 6.9.7 Comparison of Modern and Traditional Rice Varieties in Nutrition

	Type	**Protein (%)**	**Fat (%)**	**Carbohydrate (%)**	**Iron mg/100 g**	**Anti-oxidant (%)**
Modern Rice Varieties	Bg 352	7.5	4.3	72.7	1.9	0.7
	Bg 358	6.6	2.9	73.6	1.8	0.4
	At 307	8.6	2.7	72.7	2.1	0.4
	At 354	8.4	2.4	71.9	2.0	0.8
Traditional Rice Varieties	Pacchaperumal	13.3	2.8	70	3.0	3.3
	Kalu Balave	12.5	2.7	71	3.2	3.1
	Rath Suwandel	12.9	2.6	72	2.4	2.8
	Kalu Heenati	11.4	2.7	71	2.7	2.7

Source: Industrial Technological Institute

(2) Excessive Demand and Potential Value

Notably, approximately 46% of the downstream players (wholesalers and retailers) mentioned that the demand in traditional rice varieties has been expanding and lack of supply loses their business opportunity. The excessive demand can be seen from the supply-demand balance. Table 6.9.8 computes the balance of supply and demand in the top five traditional rice varieties and their potential value. Currently, the supply of the top five varieties only covers 25.6% of the demand (352 tons out of 1,375 tons of demand). Those wholesalers/retailers are also willing to pay LKR 148-152 /kg, 2-3 times higher price than modern rice varieties.

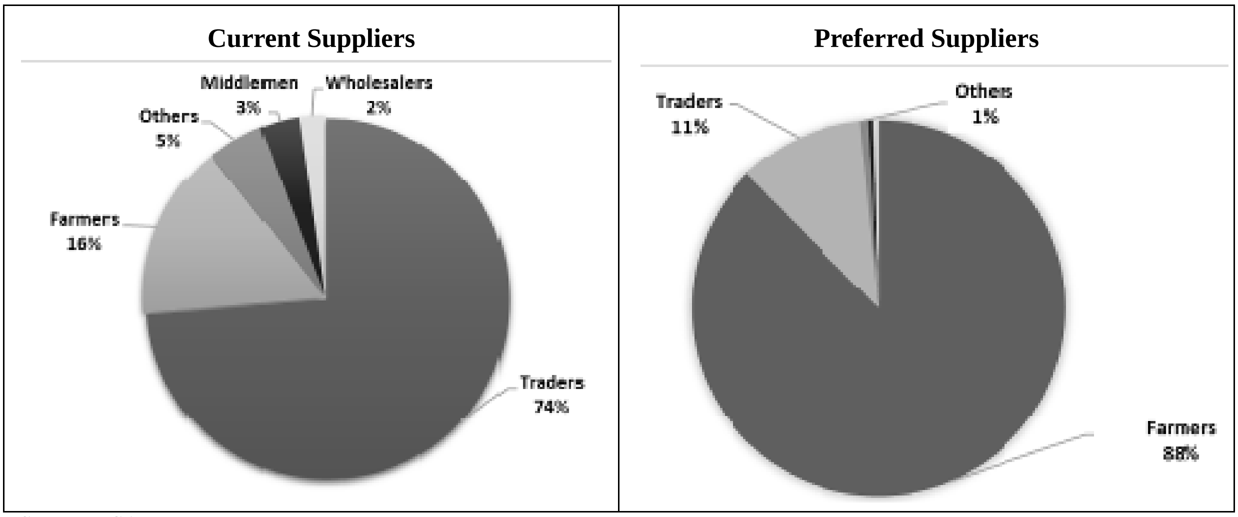
Table 6.9.8 Potential of Traditional Rice Varieties in Colombo Market

Name of Variety	Monthly (`000 kg) Supply	Demand	Balance	Annual Balance (`000 kg)	Preferred Purchasing Price per kg	Potential Annual Value (`000 LKR)
Suwandel	178	677	498	5,980	148.40	**887,436**
Kuruluthuda	65	303	238	2,862	146.72	**419,896**
Pachchaperumal	45	245	200	2,398	151.45	**363,165**
Heenati	41	103	62	744	151.74	**112,914**
Madathawalu	23	47	25	299	152.12	**45,410**
Total	352	1,375	1,024	12,282	150.09	**1,843,423**

Source: JICA Project Team

(3) Preference in Direct Transaction from Farmers

Approximately 90% of the downstream players prefer to transact traditional rice varieties directly from producers whilst 74% of them currently purchase from traders (Figure 6.9.3). They gave the reasons that the supply of the popular traditional rice is unstable, and traders require over-prices. (For instance, the current average purchased price of *Suwandel* is LKR 178.56 /kg against 148.49 for the average preferred price).



Source: JICA Project Team

Figure 6.9.3 Current and Preferred Suppliers of Traditional Rice Varieties

6.9.5 Market Potential in High-valued Vegetables and Fruits in Anuradhapura Area

The project area is surrounded by or closed to the "Cultural triangle of Sri Lanka", Anuradhapura-Kandy-Polonnaruwa, which invites over 700,000 tourists annually. In the triangle, the hotel industry is well developed, from middle class to high-end resorts. Assuming that those hotels have a demand in high-valued vegetables and fruits, the JICA Project Team surveyed 171 hotels, which are above the middle class (their minimum room charge is more than LKR 5,000/night), in the Anuradhapura area.

(1) High Demanded Crops and their Potential in Value Addition

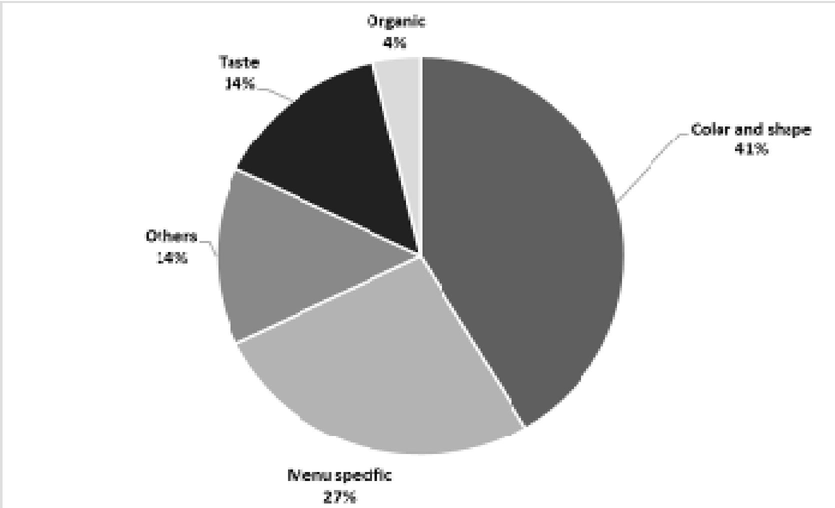
Table 6.9.9 lists up the top ten popular crops amongst the targeted hotels and their affordable value on market price that they are willing to pay for the value added. Cabbage is the most demanded crop, followed by watermelon, cantaloupe melon, and cauliflower. In terms of the affordable value on market price, cantaloupe melon (69.53%), broccoli (53.13%), and bell pepper (51.58%) indicate higher percentage.

The indicators of their value addition are shown in Figure 6.9.4. Colour and shape are the top priority. The second concern is "menu specific" which includes particular local vegetables in traditional curry, suitable vegetables for boiled or salad recipes. Taste, as the third concern, includes clear taste such as sweetness, creaminess, and bitterness of the vegetable.

Table 6.9.9 Top Ten Products for Value Addition

	Annual Demand (kg)	Affordable Additional Price (%)
Cabbage	109,164	31.73
Watermelon	94,824	26.92
Cantaloupe melon	72,960	69.53
Cauliflower	43,584	32.50
Bell pepper	40,764	51.58
Sweet corn	31,212	41.17
Baby corn	27,168	41.43
Broccoli	7,308	53.13
Pumpkin	6,336	25.00
Carrot	5,880	25.00

Source: JICA Project Team



Source: JICA Project Team

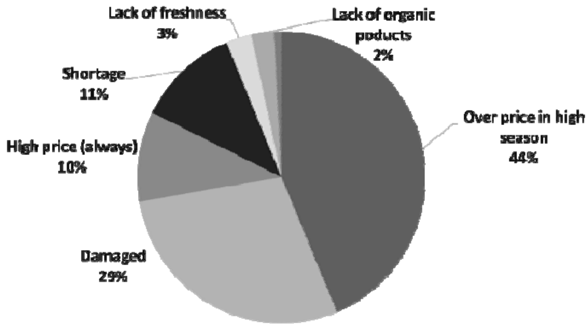
Figure 6.9.4 Key Elements for Value Addition

(2) Potential in Direct Transaction: Hotel – Farmers Partnership

Figure 6.9.5 shows the constraints of procuring vegetables and Figure 6.9.6 compares the current suppliers and preferred supplier for the targeted hotels. Most of the hotels do not have regular or contract suppliers who are able to provide on demand with the expected qualities and price and above 80% of them purchase vegetables at an open market or wholesale market such as the DECs.

Several managers of the hotels complained that a higher price does not guarantee the quality of vegetables. Indeed, 44% of them observed over pricing of common vegetables in the off season (June-July and December-January), and 29% indicated damage is a constraint to hinder their business. Under the circumstances, if the price and quality are well assured, a notable number of hotels, about 65%, are willing to purchase vegetables directly from the farmers (Figure 6.9.6.)

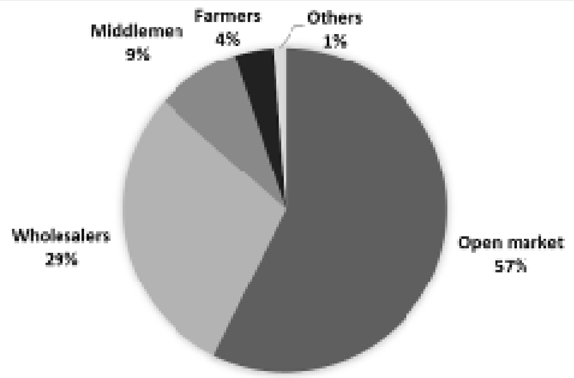
The findings confirmed that a partnership between farmers' group and hotels will be a realistic solution to profit hotels who require a stable supply of qualified products, as well as farmers who are willing to start vegetable and fruits cultivation, with secured market channels.



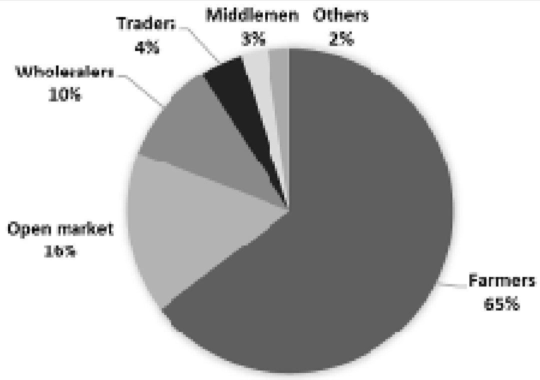
Source: JICA Project Team

Figure 6.9.5 Constraints in Procuring Vegetables and Fruits

Current Suppliers



Preferred Suppliers



Source: JICA Project Team

Figure 6.9.6 Current and Preferred Suppliers for Hotels

6.9.6 Key Findings

From the results of the four surveys, the key findings will be summarised as follows:

i) The six targeted cascades mainly cultivate cash crops in the *Maha* season and can be classified as either paddy-dominance, or paddy-maize combination as its cash crop structure in the season. A smaller volume of other crops such as vegetables and fruits are sold.

ii) All targeted cascades sell their produce to the conventional market channels, namely, paddy to PMB or millers, other crops to DEC or *pola*. Organised selling is not well practiced. Only some farmers in Ichchankulama Cascade practice contract farming.

iii) Some farmers in Ichchankulama practice contract farming of maize and they are satisfied with the higher and stable sales. Contract farming of OFCs will be expanded even in the *Yala* season if farmers gain proper support such as introduction of crop insurances, promotion of mechanisation service, and legal support of contracts.

iv) The demand in traditional rice varieties has been expanding amongst health conscious consumers in the urban areas and excess demand is observed in Colombo Market.

v) Most wholesalers/retailers of traditional rice varieties prefer to transact directly with farmers to secure the supply. They are willing to pay 2-5 times higher price as that of modern rice varieties.

vi) Cabbage, watermelon, cantaloupe melon, cauliflower, and bell pepper are amongst the top five vegetables that hotels are willing to pay at higher price (30-70% premium)

Most of the hotels (65%) preferred to transact directly with farmers in order to secure their procurement of vegetables/fruits. The partnership between farmer's groups and hotels indicates a high potential to provide profit to both parties.

6.10 Farmers' Organisation (FO)

6.10.1 Methodology

Detail survey of the existing FOs and current extension services were conducted as follows.

Table 6.10.1 Methodologies of Detail Survey on FOs and Extension Service

Topic	Items	Survey items	Information Collection	Term
FO	Organisational functions	Organisational structure, membership	- Open and group discussion through FO meetings - Questionnaire interview survey to government officers in-charge	December 2016 – April 2017
	Operation of the FO	Constitution, meetings, rules and regulation on the management		
	Financial status	Financial records, bank account, bank balance, financial management		
	Common activities	Activities as a FO, management of the activities		

Source: JICA Project Team

6.10.2 Social Situation of the Model Cascades

Kiulekada and Siyambalagaswewa are totally Sinhalese community whilst Naveli kulam is pure Tamil community. Alagalla covers both Sinhalese and Tamil area, and Ichchankulama and Rathmalawewa have minority groups of Sri Lankan Moor. The following table shows the ethnic distribution in each model cascade.

Table 6.10.2 Ethnicity of Beneficiary Households of the Model Cascades

Cascade	Sinhala		Tamil		Sri Lankan Moor		Total	
	(no.)	(%)	(no.)	(%)	(no.)	(%)	(no.)	(%)
Alagalla	115	85.2%	20	14.8%		0.00%	135	100.0%
Ichchankulama	126	64.0%		0.0%	71	36.04%	197	100.0%
Kiulekada	255	100.0%		0.0%		0.00%	255	100.0%
Naveli kulam		0.0%	155	100.0%		0.00%	155	100.0%
Rathmalawewa	218	79.3%		0.0%	57	20.73%	275	100.0%
Siyambalagaswewa	150	100.0%		0.0%		0.00%	150	100.0%
Total	**864**	**74.0%**	**175**	**15.0%**	**128**	**10.97%**	**1167**	**100.0%**

Source: JICA Project Team based on the result of HHS conducted in March 2017

Basically, Sinhalese speak Sinhalese language, whilst Tamil and Sri Lankan Moor people speak Tamil language. Although some Tamil people and many of Sri Lankan Moor people can understand Sinhalese language, many are having difficulty in expressing complicated issues in Sinhalese language.

Religion is closely related with ethnicity in Sri Lanka, although there are some Christian communities in some area. Religion of the model cascades is as shown in the table below.

Table 6.10.3 Religion of the Beneficiary Households per Cascade

Cascade	Buddhist		Christian		Hindi		Muslim		Total valid responses	
	(no.)	(no.)	(%)	(%)	(no.)	(%)	(no.)	(%)	(no.)	(%)
Alagalla	115	85.2%	18	13.3%	2	1.5%		0.0%	135	100%
Ichchankulama	126	64.0%		0.0%		0.0%	71	36.0%	197	100%
Kiulekada	255	100%		0.0%		0.0%		0.0%	255	100%
Naveli kulam		0.0%		0.0%	155	100%		0.0%	155	100%
Rathmalawewa	218	79.3%		0.0%		0.0%	57	20.7%	275	100%
Siyambalagaswewa	150	100%		0.0%		0.0%		0.0%	150	100%
Total	864	74.0%	18	1.5%	157	13.5%	128	11.0%	1167	100%

Source: JICA Project Team based on the result of HHS conducted in March 2017

Amongst the three FOs in Alagalla, two are totally Sinhalese FOs and the other one is totally Tamil, majority of which are Christians. Tamil FO manages the upmost tank of the Alagalla. One FO in Ichchankulama is totally Muslim community, which covers the upper tanks of the cascade. Three FOs out of the seven in Rathmalawewa Cascade are Muslim dominant FOs, out of which two are totally Muslim and one is mixed with Sinhalese. Tanks managed by these Muslim dominant FOs in Rathmalawewa are located in the middle of the cascade.

6.10.3 General Features of FOs under the Model Cascades

The summary of the basic feature of each FO under the model cascades is shown in the following table. The number of FOs covering each cascade varies from three to seven. Whilst many FOs also manage tanks in other cascades, boundary of cascade, and FOs match in Siyambalagaswewa Cascade. Disparity between cascade boundary and FO boundary may create difficulties in management within FO that needs to participate in management of more than one cascade.

There is an inequality in the number of tanks managed by each FO and the number of members. The number of tanks one FO manages ranges from 1 to 12. A large FO has more than 200 members whilst the smallest has only 15. The difference in size of FOs may influence the power relation between FOs at the cascade level.

Table 6.10.4 Basic of the FOs under the Model Cascades

Cascade	ASC	Name of FO	GN Division	Members			Total No. of the Tank under the FO	Tanks under the Cascade
				Male	Female	Total		
Alagalla	Madukanda	Alagalla	Alagalla	95	35	130	6	Alagalla Wirandagollewa Puliyankulam
		Thiruwegama (Ekamuthu)	Alagalla	35	7	42	1	Thiruwegama
	Kovil kulam	Periya koomarasan kulam	Ashi kulam	84	74	158	5	Kal kulam
Naveli kulam	Omanthai	Arasan kulam	Omanthai	25	5	30	1	Arasan kulam
		Mahilan kulam	Mahilan kulam	60	6	66	6	Puthiya puarasan kulam Mahilan kulam Alan kulam Sinnmara irampai kulam
		Irampai kulam	Mahilan kulam	31	4	35	3	Pakkusorinchan kulam
		Periyavilanthi kulam	Omanthai	122	8	130	6	Puthar kulam
		Konthakaran kulam	Maruda madu	130	6	136	7	Naveli kulam
		Vala sinna kulam	Maruthan kulam	70	3	73	7	Mathavuvaiththa kulam Umaiyar puliyan kulam Vala sinna kulam Panichchan kulam Maruthodai kulam Kakkayar puliyan kulam
		Omanthai	Omanthai			50	2	Omanthai kulam
Ichchankulama	Galenbindunuwewa	Karkolawewa	Upuldeniya	47	30	77	3	Karkolawewa
		Ihala Kainathama	Upuldeniya	48	20	68	5	Ihala Kainathama Theankuttiya Agale wewa
		Pahala Kainathama	Upuldeniya	53	30	83	4	Pahala Kainathama Kudawewa Palugas wewa
		Ambagahawewa	Himbutugollewa	43	13	56	2	Ichchankulama
	Mihintale	Madeena	Katukeliyawa	15	75	90	3	Weliwewa
Kiulekada	Kebithigollewa	Perakum	Wattewewa	24	14	38	3	Puliyankulam Kudawala Puliyankulam Kudawewa Halmillawatya
		Ekamuthu	Gonahathdenawa	22	4	26	1	Ikirigollewa

		Gonahathdenawa	Gonahathdenawa	132	18	150	12	Nawagha wewa Gonahathdenawa Kudagama Pahala Tammanawa Ihala Tammanawa*
		Govi udana	Gonahathdenawa	15	40	55	4	Galkadawala Kiulekada Kiulekada Ihala wewa Kiulekada Kudawewa
Rathmalawewa	Horowpothana	Weliwewa	Mukkarawewa	26	32	58	5	Weliwewa Paluketiya
		Gurupaswewa	Mukkarawewa	21	8	29	2	Gurupaswewa
		Maheer	Mukkarawewa	48	20	48	3	Kudagurupaswewa
		Dutugamunu	Nanumillewa	98	34	132	5	Nanumillewa Mahawewa Nanumillewa Kudawewa Etaweerawewa Pupulagala
		Olugaskada	Nanumillewa	46	22	68	3	Olugaskadawala Mahawewa Olugaskadawala Kudawewa Dumbuluwewa
		Isuru	Thirappankadawala	122	90	212	5	Thirappankadawala Mahawewa Paradehiyakada
		Minimuthu	Medawachchiya Handiya	32	11	43	3	Ihalagama Nidikumbawewa
Siyambalagaswewa	Kallanchiya	Perakum	Kendewa	41	14	55	3	Siyambalagaswewa Mahawewa Siyambalagaswewa Kudawewa Aluthwewa
		Shakti-Kendewa	Kendewa	78	49	127	6	Kendewa Mahawewa Kendewa Kudawewa Poradutuwewa Diwulgaha wewa Timbiriwewa Weddewa
		Dilenatharu	Kapiriggama	11	4	15	1	Ehetuwewa

Source: JICA Project Team based on the questionnaire survey

(1) Evaluation of Organisational Functions of FOs

(a) FO Meetings

Basic functions of the FOs are precisely regulated by DAD. All the FOs under the model cascades follow the constitution prepared by DAD as defined in the Agrarian Development Act.

Meetings of FOs are regularly organised. *Kanna* meetings have been organised every season practically called by Divisional Officer (DO) under Agrarian Service Centre (ASC), as the *Kanna* meetings require legal authorisation. Frequency of *Kanna* meetings differs depending on availability of water in their tank in the Yala season, even though they are supposed to be organised seasonally. Some FOs conduct pre-*Kanna* meeting and post-*Kanna* meeting in one season, which are before onset of rain and once rain starts, respectively. Larger FOs tend to have lower participation as it is difficult to coordinate with all the members. Some FOs not conducting committee meeting seem to face difficulties in the normal operation of their organisation. Other meetings conducted in each FO are ad-hoc meetings for occasions such as fertilizer distribution, flood damage, drought relief activities, development activities, and collection of data.

Table 6.10.5 Practice of Meetings of FOs under Model Cascade

Name of FO	Kanna Meeting			Committee Meeting			Other Meetings
	Base	Times/ year	Particip ation	Base	Times /year	Participat ion	
Alagalla	Seasonal (100%)	2	14-47%	Seasonal (66%)/ Needs (33%)	2-4	50-60%	Irregular meeting when required
Ichchankulama	Needs (80%) / Seasonal (20%)	1 - 6	39-100%	Needs (80%) Quarterly (20%)	2-8	45-90%	General meeting once a year, monthly meeting according to needs, small meeting after religious occasions, Ad-hoc meetings, agriculture meeting organised by AI
Kiulekada	Yearly (50%) Seasonal (50%)	1 - 2	35-85%	Yearly (50%) Needs (50%)	1	27-75%	General meeting once a year, emergency meetings, meetings for emerging issues
Naveli Kulam	Seasonal (100%)	2	20-50%	Quarterly	0-4	25-50%	Meeting after DO meeting to share with members, Need-based meetings General meeting
Rathmalawewa	Seasonal (86%) / Needs (14%)	1-2	14-100%	Needs (86%) / Not conducting (14%)	0-4	65~90%	General meetings, need-based meeting, small meetings with concerned office bearers, emergency meetings organised by DO
Siyambalagaswewa	Seasonal (100%)	2-4	33-73%	Needs (100%)	1-2	60-90%	Special meeting as per need

Source: JICA Project Team based on the questionnaire survey and FO meeting

From the viewpoint of DO and Agriculture Research & Development Assistant (ARPA), most of the officers in-charge of the model cascades do not have any difficulty in organising meetings with FOs, apart from those in Kallanchiya ASC. The reasons for the difficulties mentioned in Kallanchiya are poor participation of FO members and lack of involvement of community leaders. Majority of the officers in-charge of the six model cascades evaluated that FOs are organising meetings by themselves only in a few occasions whilst about 30% answered FOs always organise without the help of the officers. The following table indicates the result of questionnaire interview with DOs and ARPAs in the target ASC regarding organisation of meetings by FOs.

Table 6.10.6 Summary of Evaluation of FOs by DO and ARPA on FO Meetings

Issues		Responses
Those having difficulties in organising meeting with FOs		11%
Reasons of difficulties		Poor participation of members. Leaders are not fully involved
Do you think FOs organise meeting by themselves when necessary without the help of ARPA	Always	32%
	Only few occasion	63%
	No	5%
	Reason for no	Leaders have no capacity
Total respondents (DO/ARPA)		19

Source: JICA Project Team based on the questionnaire survey

(b) Problem Solving Capacity of FOs

According to the group discussion with each FO, the critical problems they faced are conflicts during water distribution. Problems are solved mostly within FOs either through the FO meetings or by discussing with the concerned members. In case of problems related to water distribution, water master is involved to reconcile the issue. Problems that are beyond their control are referred to ARPA or DO.

Analysing from the interview survey with DOs and ARPAs in the target ASCs, frequencies of the officers to intervene in conflict resolution range from once or twice a year to almost every week. Major problems referred to the officers are issues in water distribution, problems in maintenance works by members, and problems in cultivation. Almost 80% of the officers in the target ASC are involved in problems of water distribution. Major rehabilitation, conflict amongst members, conflict with other FOs or tanks, and financial management are problems observed in some areas.

Table 6.10.7 Summary of Involvement of DOs and ARPAs in Problem Resolution

Consultation Issues		Answer (%)
Frequency of consultation in the conflict solving of FO	Almost every week	5%
	Almost every month	26%
	Once in 2-3 month	42%
	1-2 in a year	26%
Problems FO consult the officers (multi answer)	Problem in water distribution	79%
	Problem in maintenance works by members	58%
	Problem in major rehabilitation	16%
	Conflict amongst members	37%
	Conflict between tanks	11%
	Conflict with other FOs	11%
	Problem in financial management	21%
	Problem in cultivation	68%
	Other	21%
Respondent (DO/ARPA)		19

Source: JICA Project Team based on the questionnaire survey

(c) Financial Capacities of FOs

All the FOs collect membership fees ranging between LKR 60 and LKR 240 per year, whilst very few face problems in collection and suspend for the moment. As the rate of membership fee is decided in each FO, it might reflect their income level in the area. Financial records are maintained in most of the FOs except three, and the records are checked by DO as defined in the Agrarian Development Act. Major incomes of FOs are membership fee, profit from contract works and lease of tank for inland fishery. Some FOs in Vavuniya collect O&M fund as the DAD Vavuniya introduced it. FOs leasing their tanks for inland fishery have substantial revenue from the leasing of the tanks. The major expenses are minor repairing works done by FO, meeting expenses, administrative and running cost, and expenses during Sramadhana work. Use of FOs' savings is controlled by DO as they need to take official procedure set by DAD. For an FO to withdraw its fund, the FO should first call a committee meeting to get consent from the committee for the use of fund, the minutes of which is submitted to DO office for approval. If the expense concerns engineering works, a technical officer of DAD assesses appropriateness of the proposed expense. Therefore, possibility of misuse of funds seems to be low.

Table 6.10.8 Financial Status of the FOs under Model Cascades

Cascade	Membership Fee	Bank Balance		Financial Record	Major Income Source	Major Expenditure
		Per FO	Per Member			
Alagalla	LKR 100 - 120/year	LKR 287,226 –411,262	LKR 2,051 – 9,792 /member	Yes (100%)	Funds from the government, contract works, membership fee, O&M funds collected from members, donation	Small-scale O&M works, Administrative expenses
Ichchankulama	LKR 100 - 120/year	LKR 67,000 – 325,000	LKR 722 – 3,915 /member	Yes (100%)	Membership fee, profit of contract work (5%), lease of tank for fishery	Small repairing works, refreshments for Sramadhana
Kiulekada	LKR 120/year (one not collecting)	LKR 23,000 – 230,000	LKR 605 – 4,182 /member	Yes (75%) No (25%)	Membership fee, profit of contract work (5%)	Small-scale repairing works
Naveli kulam	LKR 120/year (one not collecting)	LKR 25,000 –500,000	LKR 342 – 3,846 /member	Yes (86%) No (14%)	Membership fee, lease if tank maintenance fund, fine on the violation of rules, profit of contract work (5%)	Meeting expenses, small scale tank maintenance cost, administrative expenses

Rathmalawewa	LKR 120 – 240 /year	LKR 40,000 – 182,000	LKR 150 – 1,974 /member	Yes (86%) No (14%)	Membership fee, profit of contract work (5%), lease of tank	Small repairing work, refreshment during Sramadhana, contribution for functions at ASC, administration cost,
Siyambalagaswewa	LKR 60 -120 /year	LKR 34,000 – 281,000	LKR 1,023 – 5,109 /member	Yes (100%)	Membership fee, profit of contract work (5%), lease of tank for fishery	Minor rehabilitation works

Source: JICA Project Team based on the questionnaire survey

According to the interview survey with DOs and ARPAs, financial records as well as other relevant records are inspected by DO. Even though most of the officers evaluated the records maintained by FOs are good or fair, 95% of them feel the need for improvement in financial records keeping. The following summarises the practice of records inspection and evaluation of record kept by FOs based on the interview survey with DOs and ARPAs in the target ASCs.

Table 6.10.9 Evaluation by DO/ARPA on Record Keeping by FOs

Conduct Record Inspection (yes)	Type of Records Inspected				Quality of their Record Keeping					Improvement Required			
	Meeting Minutes	Financial Record	Member Register	Other	Very Good	Good	Fair	Poor	Very Bad	Meeting Minutes	Financial Record	Member Register	Other
95%	79%	89%	74%	5%	0%	74%	21%	0%	0%	37%	95%	21%	11%

Source: JICA Project Team based on the questionnaire survey

(2) Need of Strengthening FOs' Functions

The FOs in the model cascades are functioning to a certain extent. *Kanna* meetings are conducted periodically mainly due to the initiative of DOs, whilst frequencies of committee meetings depend on the emerging issues. Problems are mostly solved by themselves, and problems that cannot be solved within FOs are referred to DOs for reasonable solution. However, once cascade management system is established, diversified cultivation plan will be prepared with water from NCPC, more disputes are expected due to different interests between farmers within FOs. Therefore, further rules on the expected dispute shall be prepared to avoid complicated situations and conflicts. Moreover, many FOs will belong to more than one cascade, management of FO itself will become more complicated influenced by cascade management.

Even though the financial capacity of the FOs differs in different FOs, majority of the FOs have a fair amount of savings. Even though some FOs actually carried out repairing works of irrigation facilities with their own savings, others face lack of maintenance budget and wait for government support. Once a cascade level management body is established, FOs should consider expenses for cascade management as each FO needs to contribute for payment of cascade water controller and maintenance of inter-tank facilities. Although financial records are fully checked by DOs, there is a room for improvement in the quality of records. Further financial capacity building shall be included in the programme to each FO, which will result in better cascade level management as well.

Through the interview survey with relevant officers, DOs and ARPAs in-charge of the model cascades expressed that the FOs need improvement in financial capacity, financial management, operation and maintenance (O&M) skills, and flood management as shown in Table 6.10.10. These issues shall be taken into consideration in planning the capacity development programme for individual FO.

Table 6.10.10 Evaluation of Capacity of FO by DO/ARPA in the Model Cascades

Respondent (DO/ARPA)	Average number of FO the ARPA covers	Areas that FOs Lack in Capacity						
		Financial Capacity	Financial Management	Organising Meeting	O&M Skills	Conflict Solving	Flood Management	Other
19	5.17	68%	53%	16%	53%	26%	37%	5%

Source: JICA Project Team based on the interview survey to DO and ARPA

6.11 Administration and Extension System of the Model Cascades

6.11.1 Administration of the Model Cascades

Whilst majority of the model cascades cover only one ASC division, Ichchankulama and Alagalla cascades are located over two ASC divisions. The number of *Grama Niladhari* (GN) divisions covered by the cascade varies from 2 to 5. Total gross beneficiary households of the model cascades numbered to 2,390. The following table summarises the administrative location and number of target beneficiaries of the model cascades.

Table 6.11.1 Administrative Location and Target Population of the Model Cascades

Cascade	DS Division	ASC	GN Division	Number of Tanks	No. of HHs Benefitted	Target No. of HH*1	Estimated Target Population*2
Alagalla	Vavuniya South / Vavuniya	Madukanda Kovilkulam	Alagalla Ashi kulam	5	144	116	493
Ichchankulama	Galenbindunuwewa Mihinthale	Galenbindunuwewa Mihinthale	Upuldeniya Himbutugollewa Katukeliyawa	9	573	300	1,151
Kiulekada	Kebithigollewa	Kebithigollewa	Wattewewa Gonahathdenawa	13	488	378	1279
Naveli kulam	Vavuniya	Omanthai	Mahilan kulam Maruda madu Maruthan kulam Omanthai	16	256	201	726
Rathmalawewa	Horowpothana	Horowpothana	Nanumillewa Mukkarawewa Thimbiriaththawala Medawachchiya handiya Thirappankadawala	15	538	390	1499
Siyambalagaswewa	Rambewa	Kallanchiya	Kendewa Kapiriggama	10	391	214	685
Total				68	2,390	1,599	5,833

**1 The number of target HH is determined as the farmers who are using tanks as their main tank. There are a few farmers who have land under different tanks are categorised in their main tank.*
**2 Calculated from the number of household and average number of family members*
Source: JICA Project Team based on the FO interview and HHS result

6.11.2 Extension System of Relevant Government Agency

(1) Agriculture Extension Service

(a) Extension Channels

Nearly all householders (93%) interviewed in the survey identified the Agriculture Research & Development Assistants (ARPA) (DAD), Agricultural Instructor (AI) (DOA), or their combination as the primary providers of extension services. However, farmers showed a wide variation in their responses amongst the three sources within each cascade. The contribution made by the media, private sector companies, and others are marginal in all cascades.

Table 6.11.2 Extension Service Providers

Cascade	Percent Households						
	AI/DOA	ARPA/DOA	AI/ARPA	Companies	Traders	Mass Media	Other
Alagalla	33.3	27.4	34.1	2.9	0.0	1.5	0.7
Ichchankulama	27.5	9.2	59.2	1.0	0.0	3.1	0.0
Kiulekada	0.78	60.4	29.0	2.7	0.0	0.4	6.7
Naveli kulam	53.5	1.3	41.9	0.6	0.0	1.9	0.6
Rathmalawewa	6.2	54.9	34.9	1.4	1.1	0.0	1.4
Siyambalagaswewa	47.3	17.7	18.0	8.7	0.0	7.3	1.3
Survey Area	23.3	33.4	36.4	2.1	0.3	2.0	2.1

Source: Household survey, JICA Team

Farmers' dependency on the AIs and ARPAs for extension services is very high. However, the Provincial Director of Agriculture (PDOA) of Anuradhapura and District Office of Vavuniya reported that there is a severe shortage of field AIs working at range level. In the North Central Province, only 68 out of the 140 AI carder provision and in Vavuniya District, only 15 out of 34 AI carder provision are available for deployment in field level extension work. This has made AI ranges very large and the AI: Farmer ratio is estimated to be more than 1: 3,000.

ARPAs are allocated at GN division level with 1–3 ARPAs serving the area. ARPA carder in most of the GN divisions, excluding the Vavuniya South DS division, remained vacant. Field level discussions revealed that the role of ARPA is to coordinate with the AIs when technical advice is needed by the farmers as ARPAs often lack the required technical information.

(b) Training Needs of the Farmers

Crop production and plant protection are the major subject areas that 65% of the farmers desired to learn more whilst 20% of the farmers remained undecided. Some note that they are too old to learn new technologies for them to apply in the field successfully, and that their past experience is adequate to meet the present needs. Difficulty to reach the extension workers is also highlighted. Lower priority was placed on subject areas of livestock and marketing by the majority of farmers interviewed in the household survey.

Table 6.11.3 Training Needs of the Farmers

Cascade	Percent Households						
	Crop Production	C.P. and Livestock	C.P and Marketing	C.P. and Protection	Livestock	Marketing	None
Alagalla	25	1	13	45	5	2	7
Ichchankulama	32	5	0	25	8	2	30
Kiulekada	66	4	1	27	2	0	0
Naveli kulam	14	14	22	37	7	6	0
Rathmalawewa	30	0	0	13	3	0	54
Siyambalagaswewa	43	2	3	38	2	1	12
Total Survey Area	37	4	5	28	4	2	20

Source: Household survey, JICA Team

(c) Conclusion

Proposed increase in the productivity of paddy and diversification to non-paddy crops in tank command areas under the cascades demand a concerted effort from the extension workers. Agricultural extension encompasses technology transfer, advisory work, human resource development, and facilitation for empowerment needs. The competency of extension workers should be fine-tuned through appropriate training by improving their performance and contribution to the proposed transformation of cropping systems.

Extension outreach is constrained with the large land area covered under each AI range and the high number of farm households expected to serve.

Crop diversification is essentially a process that takes time for its full establishment. From the farmers' side, the usual stages must be followed through awareness, interest, decision, trial before adoption of an innovation that can be used in a sustainable manner.

(2) Government Support System on FOs

All the FOs are registered under DAD; and DAD officers are in-charge of supporting and supervising FOs' activities, whilst some support on maintenance and rehabilitation of irrigation facilities are provided by the Provincial Director of Irrigation (PDI). Government officers appointed for field support of FOs are ARPAs. Current appointment of ARPAs in the target area is described in Section 6.5.2 (3). One of the critical issues in this area is the lack of ARPA in Vavuniya to support the operation of FOs, especially because most of the FOs have been recently reactivated after closure during the conflict. Therefore, currently, there are only a few ARPAs assigned in Vavuniya District. Since most of the ARPAs appointed before in Vavuniya were Sinhalese and could not communicate with Tamil farmers, DAD Vavuniya is on the process of recruiting suitable ARPAs for the field activities. Presently, boundary lining of ARPA divisions for ARPAs to be assigned was approved by the cabinet and 98 ARPA divisions will be formed.

Capacity building programmes of concerned officers shall also be proposed as some officers faced difficulties in managing FOs. Major difficulties in managing FOs stated by the ASC officers in-charge in the target ASCs were communication with FOs, lack of ARPAs, and transportation to meet FOs, as shown in Table 6.11.4. As the officers in different ASCs faced difficulties in different issues, some learning opportunities shall be provided amongst ASC officers. Since the officers are expected to face more emerging problems in management of cascade, coordination and experience, sharing system between the officers from different ASC shall be created.

Table 6.11.4 Difficulties in Managing FOs by DAD Officers

Difficulties in Managing FOs	Total
Communication with FOs is difficult	26%
They do not follow the instruction	5%
Difficult to instruct as FO leaders are senior than me	11%
Poor understanding of farmers	5%
Too many FOs to handle (lack of ARPA)	21%
Transportation to meet FOs	58%
Other	0%

Source: JICA Project Team based on interview survey with DO and ARPA

Chapter 7 Field Verification Programme

7.1 General

Chapter 7 describes the activities and findings of the field verification programme carried out in order to verify and/or refine the part of the basic concept of the cascade development plan. The field verification programme includes four types of activities, namely: (1) infrastructure rehabilitation and development for effective usage of irrigation water, (2) assessment and mitigation of flood risk by farmers' organisation (FO), (3) promotion of agriculture diversification, and (4) establishment of cascade management organisation.

The outline of those programmes is described in Table 7.1.1.

Table 7.1.1 Summary of Field Verification Programme

Name of Verification Programme	Objectives	Contents	Target Sites	
			Cascade	Beneficiaries
Infrastructure rehabilitation and development for effective usage of irrigation water	Verify the feasibility of proposed plan through demonstration of the link canal and other rehabilitation activities	(1) Construction of link canal (2) Increase the capacity of spillway (3) Enhance tank bund (4) Rehabilitation of irrigation canal	Kiulekada Naveli kulam	Puliyankulam Halmillawatya Vala sinna kulam Panichchan kulam
		(5) Install water level monitoring facilities (Installation of observing system)	Kiulekada	Puliyankulam
		(6) Construction of canal with STEIN	Kiulekada Naveli kulam	Puliyankulam Kiulekada Ihalawewa Naveli kulam
Assessment and mitigation of flood risk by farmers' organisation	Verify the feasibility of the FO level flood risk mitigation plan through field activities	(1) Empower FO to identify the risk of collapse and breach of tank bund (2) Rehabilitate or enhance the tank bund by FO	Kiulekada Naveli kulam	Halmillawatya Naveli kulam
Promotion of agriculture diversification	Verify the feasibility of the agriculture diversification plan through demonstration of high-value vegetable, high-value variety of paddy cultivation, and silage making for animal feed	(1) Cultivate and demonstrate high-value vegetable in CIC farms and collect the necessary data and share the knowledge with farmers and government frontline officers for necessary feedback	Alagalla Ichchankulama Kiulekada Naveli kulam Rathmalawewa Siyambalagaswewa	105 farmers
		(2) Cultivate and demonstrate traditional and new variety of paddy and collect the necessary data and share the knowledge with farmers and government frontline officers for necessary feedback	-do-	30 farmers (trained) 3 farmers (demonstrated)
		(3) Provision of equipment for silage making and demonstrate intensive livestock farming in the selected farm for the necessary data collection and sharing the knowledge with farmers and government frontline officers for feedback	Alagalla, Ichchankulama Rathmalawewa Siyambalagaswe wa	18 farmers
Establishment of cascade management organisation	Verify the feasibility and acceptability of the proposed cascade management organisational plan and water management plan in the cascade system	(1) Share and discuss the proposed regulation of the cascade management organisation for necessary feedback (2) Share and discuss the proposed water management plan for necessary feedback	-do-	29 FOs

Source: JICA Project Team

7.2 Infrastructure Rehabilitation and Development for Effective Usage of Irrigation Water

7.2.1 Outline and Objectives

In order to verify the feasibility of the proposed plan, some components such as link canal construction with tank and canal system rehabilitation, installation of water level monitoring facilities, and application of the STEIN for canal rehabilitation were demonstrated and tested in the selected cascade systems. The activities are mainly implemented during the *Yala* season of 2017 with cooperation of relevant organisations in Sri Lanka and Japan such as the National Agriculture and Food Research Organisation in Japan (NARO), SPEC Co., Ltd., and OSASI Technos Co., Ltd.

7.2.2 Selection of Site for Field Demonstration and Verification

Two target cascade systems of Kiulekada in Anuradhapura and Naveli kulam in Vavuniya were selected for verification of infrastructure rehabilitation and development for effective usage of irrigation water considering the rationality, replicability, and availability of data. In the selected two cascade systems, two adjacent tanks of Puliyankulam and Halmillawatya, out of the 13 tanks in Kiulekada, Vala sinna kulam and Panichchan kulam; out of 16 tanks in Naveli kulam were selected for verification programme.

The selection was made considering the following points:

- Not to be isolated or abandoned
- Not to be separated by road in the command area
- Have good access
- Have average farmer household and command area
- Have enough water resources in upstream tank to utilise the link canal for sending the water to downstream canal even before receiving the water from North Central Province Canal Project (NCPC)

The site selection was carried out in close coordination with the provincial council and District Department of Agrarian Development (DAD) and approved in the Joint Coordination Committee (JCC).

The summary of the selected four tanks are summarised in Table 7.2.1 below.

Table 7.2.1 Summary of the Selected Four Tanks

Name of Scheme	Puliyankulam	Halmillawatya	Vala sinna kulam	Panichchan kulam
Name of Cascade	Kiulekada	Kiulekada	Naveli kulam	Naveli kulam
GN Division	Wattewewa	Wattewewa	Maruthan kulam	Maruthan kulam
ASC Division	Kebithigollewa	Kebithigollewa	Omanthai	Omanthai
Name of FO	Perakum	Perakum	Vala sinna kulam	Vala sinna kulam
No. of Farmers	59	33	14	12
Command Area (ha)	38	16	17	12
Headworks				
Tank Capacity (1,000 m^3)	248.3	3.2	94	9.1
Height of Tank (m)	1.7	3.0	2.8	2.0
Length of Tank (m)	730	332	500	375
Spillway (Nos.)	2	2	1	1
Canal System				
Length by Name	LB (725 m)	LB (356 m)	LB (550 m)	LB (222 m)
	Centre (525 m)	RB (375 m)	RB (275 m)	RB (275 m)
	RB (450 m)			

Source: JICA Project Team

7.2.3 Rehabilitation Plan and Design of Irrigation Facilities

(1) Survey and Investigation

The topographic survey was carried out in four targeted tank irrigation schemes before planning. The topographic data on tank profile and cross section, related structures, tank bed, and canal route were collected using the Global Navigation Satellite System. On the other hand, the walkthrough survey to identify the farmers' rehabilitation needs and government officers' opinion was carried out with relevant farmers and officers in February 2017.

(2) Basic Concept for Rehabilitation/Construction Works

As a pilot model area to be applied to the whole Project area in the future, the basic concept of design for the rehabilitation or construction of the irrigation facilities was set up as described hereinafter.

- The rehabilitation of the tank is to be conducted. To avoid adverse environmental and social effects, special attention should be made so that an elevation of the tank bund top and crest of the spillway will be maintained.
- Length of a spillway is to be reviewed and extended, if needed, based on estimated probable flood discharge.
- As for the rehabilitation works of the canals, taking into consideration the easiness of future maintenance works by farmers, earth lined canals are to be adopted. Furthermore, aiming at efficient water use from the NPC canal, farm turnouts are provided.
- Link canals will be constructed to convey water from upstream tank to downstream tank in the cascade system.

(a) Rehabilitation of Tanks

According to "the Technical Guidelines for Irrigation Works by Eng. A. J. P. Ponrajah", planning and design for rehabilitation work of the tanks, consisting of tank bund forming, repair or reconstruction of sluices, improvement of spillway and provision of bathing steps, were carried out taking into consideration matters indicated in Table 7.2.2.

Table 7.2.2 Rehabilitation Planning and Design of the Tanks

Item	Description of Planning and Design
Tank Bund	・ Designed bund top elevation was determined based on the currently highest one obtained from the levelling works. ・ The bund top width is to be maintained between 2.4 to 3.0 m with gravel to reduce wear and tear and for easy access for proper maintenance of the tank bund and also for smooth transport. ・ Bund slope is 1 on 2 for the stability of the tank bund. ・ In Puliyankulam Tank, clay wall was introduced for certain critical section of the bund for arresting of seepage or piping through. ・ Turfing to fill earth was provided to protect the bund slope.
Sluice	・ Repairs and modification to sluice gates were proposed with easy operation and access for the gates on the basis of the current condition of the structures.
Spillway	・ To escape surplus water without damaging the bund, capacities of the spillways to release flood water were enhanced with modifications and extension of the spill length based on the flood analysis conducted under the Project (see details in Section 6.4). ・ Generally, determining length of spillway, a 2-feet afflux is set with 2 feet free board. ・ There might be several cases to apply a 3-feet afflux in the structures, taking into consideration the results of field investigation on previous flood damages in their areas.
Related Structures	・ As per the farmers' request, a Bathing Step is to be provided in Puliyankulam and Vala sinna kulam tanks to improve their livelihood condition, preventing damages to the tank bund slope

Source: JICA Project Team

The salient features of the tanks are indicated in Table 7.2.3.

Table 7.2.3 Salient Features of Tank Rehabilitation Works

Cascade		Kiulekada	Kiulekada	Naveli kulam	Naveli kulam
Name of Scheme		Puliyankulam	Halmillawatya	Vala sinna kulam	Panichchan kulam
Tank Bund					
Length	(m)	730.00	332.00	500.00	375.00
Bund Top Level	(m)	118.70	110.30	94.20	90.70
Bund Top Width	(m)	3.00	3.00	2.40	2.40
Slope U/S and D/S		1: 2.0	1: 2.0	1: 2.0	1 : 2.0
Sluice					
Type of Sluice		Tower and Wall	Tower	Tower and Wall	Tower
Nos. of Sluices to be Reconstructed	Nos.	1	0	0	0
Nos. of Sluices to be Rehabilitated	Nos.	2	2	2	2
Spillway					
Type of Spillway		Drop wall	Natural	Natural	Natural
Crest Top Elevation	(m)	117.50	109.06	93.06	89.71
Existing length (m)		16	33	19	2
Design flood Discharge (1)	(m^3/s)	29.4	51.9	9.8	16.1
Length (1)	(m)	16	39	14	22
Repair/ Reconstruction		Repair	Reconstruction	-	Reconstruction
Design flood Discharge (2)	(m^3/s)	24.0	44.1	13.7	17.9
Length (2)	(m)	16	34	19	25

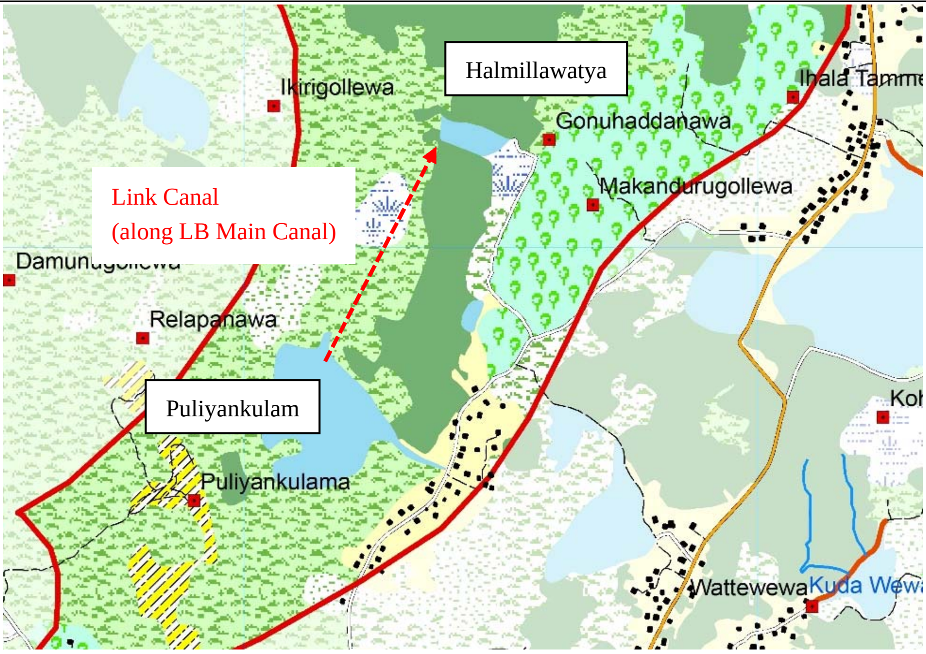
Remarks:
Design flood discharge (1) was calculated based on map (1: 50:000). Length (1) was designed by using "design flood discharge (1)". Repair/ Reconstruction works was implemented based on Length (1). Spillway length (16m, repair) of Puliyankulam in Kiuelkada Cascade is decided by engineering judge considering site conditions.
Design flood discharge (2) was calculated based on map (1: 10,000). Length (2) was designed by using "design flood discharge (2)".
Source: JICA Project Team

(b) Construction of Link Canals

The allocated water is to be distributed to each tank proportionally according to the command area of the tank through tertiary and link canals. The construction of the link canal to send the maximum monthly water flow as per the feasibility study report was adopted to determine the dimension of the link canals for each cascade.

1) Alignment of Link Canal in Kiulekada Cascade

The link canal to connect Puliyankulam and Halmillawatya tanks was planned to convey the augmented irrigation water to the downstream tank. The alignment of the link canal was decided to be along with the existing irrigation canal considering less land acquisition, low construction cost, and easy operation and maintenance (O&M). Out of three irrigation canals in Puliyankulam, namely; Centre Canal, Left Bank Canal, and Right Bank Canal, only Left Bank Canal could reach to the downstream of Halmillawatya Tank without any disturbance to the existing paddy field. It is therefore that the alignment of Left Bank Canal was selected as the link canal trace in close discussion amongst the farmers, FO members, Provincial Director of Irrigation (PDI), and DAD officers.



Source: JICA Project Team

Figure 7.2.1 Schematic Layout Map of Link Canal in Kiulekada Cascade

2) Alignment of Link Canal in Naveli kulam Cascade

The link canal to connect Vala sinna kulam and Panichchan kulam tanks for conveying the augmented irrigation water to the downstream tank was planned. The alignment of the link canal was decided to be along with the existing irrigation canal considering less land acquisition, low construction cost, and easy O&M. Out of the two irrigation canals in Vala sinna kulam, namely; Left Bank and Right Bank canals, Left Bank Canal has short and less intersection points. After the discussion amongst the farmers and DAD officers, the Project decided that the Left Bank Canal shall serve as an alignment of link canal.

Source: JICA Project Team

Figure 7.2.2 Schematic Layout of Link Canal in Naveli kulam Cascade System

3) Design Discharge of the Link Canals

Based on the pre-FS, the estimated maximum water distribution volume from NCP canal to Kiulekada Cascade was 0.229 m^3/s whilst that to Naveli kulam Cascade was set at 0.207 m^3/s. The maximum water distribution from NCP canal to each tank in the cascades was proportionally determined according to its commanding area based on the pre-FS. Meanwhile, it is to be noted that, as a purpose of the verification study, the estimated design discharge was set for feeding the downstream tanks only. Thus, the design discharge of the link canal from Puliyankulam to Halmillawatya is 9.25 litre/sec whilst that from Vala sinna kulam to Panichchan kulam is set at 9.14 litre/sec as indicated.

4) Type of Link Canals

As for selecting the type of link canal, the JICA Project Team proposed to introduce a pipeline system, highlighting such advantages such as less water conveyance loss than an open channel and no reservation area required for the construction of the facilities. Meanwhile, some officers of the counterpart personnel expressed their concern of technical feasibility for the pipeline system, mentioning difficulties for construction of the pipeline systems under gentle slope along the canal route. On the other hand, application of the open canal to the link canal may cause illicit water tapping by farmers and subsequent decline of conveyed water to downstream tank.

As described above, since there were several different views amongst the officers for the selection of the canal type, it was agreed that, for the verification study, both types of canals would be considered to construct in order to determine what type of canal would be adopted for future project implementation in view of technical, economical, and environmental/social aspects.

In the link canal, 1,085 m-long open channel system was applied for the link canal in Kiulekada Cascade. The canal is a rectangular concrete-lined type with 300 mm bottom width and 300 mm height.

On the other hand, a 400 m-long pipeline made of polyvinyl chloride (PVC) pipe with a 160 mm diameter was introduced in the link canal in Naveli kulam Cascade.

5) Intake and Offtake Arrangement of Link Canal

a) Intake Arrangement

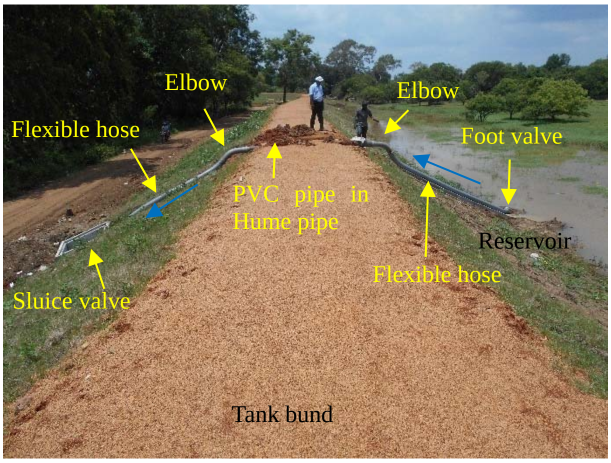
The intake structure is siphon system. This system has several merits: 1) lower construction cost (does not need to excavate tank bund), 2) operate irrigation water by farmer (easy operation), and 3) only use gravity (low operation cost). The siphon consists of a foot valve (d=160 mm), flexible hose (d=160 mm), PVC pipe (d=160 mm, t=5.7 mm), two elbows (45 degree, d=160 mm), a sluice valve (d=160 mm), a water pouring tee (PVC pipe (d=90 mm, t=5.7 mm), a sluice valve (d=90 mm)), and a Hume pipe as shown in Source: JICA Project Team

Figure 7.2.3.

b) Offtake Arrangement

The offtake structure consists of a sluice valve (d=160 mm), protective structure (concrete: width=1.0 m, length=1.0 m, depth=1.51 m, t=0.10 m), a discharge chamber (concrete: width=1.0 m, length=1.5 m, depth=1.51 m, t=0.10 m), and a triangular measuring weir as shown in Source: JICA Project Team

Figure 7.2.3.



Intake (Siphon) Under Construction

Offtake (Discharge Chamber) Under Construction

Source: JICA Project Team

Figure 7.2.3 Intake and Offtake Arrangement

6) Summary of Construction Plan of Link Canal

The salient features of the link canal are shown in Table 7.2.4.

Table 7.2.4 Salient Features of Link Canal

Cascade	Kiulekada	Naveli kulam
Location	Puliyankulam to Halmillawatya	Vala sinna kulam to Panichchan kulam
Canal Type	Open canal with concrete lining	Pipeline with PVC
Design Discharge (m^3/s)	0.00925	0.00914
Length (m)	1,085	370
Dimension	Width=0.30 m, depth=0.30 m	Diameter 160 mm
Gradient	0.0050 (1/200)	0.0031 (1/330)
Velocity (m/s)	0.40	0.45

Source: JICA Project Team

(c) Rehabilitation of Irrigation Canal System

The rehabilitation plan and design of the irrigation canals were carried out as indicated in Table 7.2.5.

Table 7.2.5 Rehabilitation Plan and Design of Irrigation Canals

Item	Description of Planning/Design
Irrigation Requirement	・ The unit irrigation requirement is calculated based on the "Technical Notes for the Guideline of the Technical Officers of the Department of Agrarian Services on Minor Irrigation Works". ・ The unit water requirement of 2.00 litres/sec/ha is estimated to determine capacities of irrigation facilities. ・ Taking into consideration field level application, 20% of irrigation is added to the above. ・ Thus, unit irrigation requirement for the design of the canal was determined at 2.40 litres/sec/ha. ・ Based on the unit water requirement and commanding area indicated in the Irrigation Diagram, design discharge of the irrigation canals was decided.
Scope of Rehabilitation Works	・ In general, irrigation canals were rehabilitated with trapezoidal earth canals with such related structures as farm turnouts and drops whilst concrete lining canals were introduced partially taking into consideration site condition. ・ Those facilities enable farmers to conduct proper and efficient water distribution at their field level.
Alignment of Irrigation Canals	・ Basically, whilst the alignment of the irrigation canals followed the current route of the existing irrigation canals, the alignment of the canals was reviewed and deviated with series of discussion with the farmers.
Related Structures	・ Field Turnouts (FTO) was provided to divert water from a canal to each farm plot accompanied with timber gating arrangement for better water management. ・ Due to steep topographic condition in the commanding area, drop structures were provided to protect canals against erosion, keeping required longitudinal gradient and subsequent velocity.

Source: JICA Project Team

Based on the design discharge of the canals, the dimension of the irrigation canals was determined as shown in Table 7.2.6.

Table 7.2.6 Applied Dimension for Rehabilitated Irrigation Canals

Type	Commanding area A	Design Discharge Q	Canal Slope S	Trapezcidal-Earth Canal with Side slop 1:1.5					
				Bed Width	FSD	FB	FSD+FB	Velocity	CVR
	(ha)	(m3/sec)		(m)	(m)	(m)	(m)	(m/s)	
Type 1	Up to 12	0.0279	0.0004	0.30	0.22	0.23	0.45	0.20	0.97
Type 2	From 12 to 20	0.0471	0.0004	0.45	0.25	0.20	0.45	0.23	1.01
Type 3	From 20 to 24.5	0.0580	0.0004	0.60	0.25	0.20	0.45	0.24	1.06

Source: JICA Project Team

The salient features of the irrigation canal are indicated in Table 7.2.7.

Table 7.2.7 Salient Features of the Irrigation Canal Rehabilitation

Cascade	Name of Scheme	Name of Canal	Length of Canal (m)	Type of Canal	FTOs (Nos.)	Drops (Nos.)
Kiulekada	Puliyankulam	LB Canal	1,085	Types 1, 2, 3	26	9
		Centre Canal	433	Type 1	10	4
		RB Canal	448	Type 1	4	2
		Sub Total	1,966		40	15
	Halmillawatya	LB Canal	347	Type 1	8	2
		RB Canal	367	Type 1	6	3
		Sub Total	714		14	5
Naveli kulam	Vala sinna kulam	LB Canal	536	Type 1	11	5
		RB Canal	267	Type 1	2	0
		Sub Total	803		13	5
	Panichchan kulam	LB Canal	196	Type 1	4	1
		RB Canal	738	Type 1	6	2
		Sub Total	934		10	3
Total			4,417		77	28

Source: JICA Project Team

(3) Cost Estimate and Preparation of Bid Documents

As per the design described in the preceding section, construction cost of the facilities was estimated on the basis of work quantities and unit rate for each work item, consisting of earth works, concrete works, metal works, and so on. The unit rate in the current year was quoted from the approved rate in Anuradhapura District, Irrigation Department, and DAD-Vavuniya.

The rehabilitation works under the Project were procured through biddings. The JICA Project Team prepared bid documents, which the sample bid documents published by Institute of Construction Training and Development (ICTAD) were referred to. The number of the bids was five, taking into consideration the scope of works and construction period.

7.2.4 Procurement of Rehabilitation Works

As per the recommendation of PID/DAD, five contractors, having ICTAD grade 7 or above, were shortlisted and invited to each bidding. After the distribution of the bidding documents, the JICA Project Team held a pre-bid meeting, in which clarification to the tender document was made and the visit to the construction site was organised. A Technical Evaluation Committee (TEC) and a Procurement Committee were organised, whose members consist of officers of the PID/DAD as well as members of the JICA Project Team.

After the opening of the bids accompanied with checking responsiveness to each bid, financial evaluations were conducted by the TEC. The lowest evaluated bidder was recommended by the TEC and approved by the Procurement Committee. The evaluated bidder was called for the pre-contract negotiation meeting, and after the meeting, contract award was made, issuing a letter of acceptance. Finally, contract agreements were signed between the JICA Project Team and the contractors. Details of each contract package are shown in Table 7.2.8.

Table 7.2.8 Results of Procurement for Rehabilitation Works

Package No.	No. 1	No. 2	No. 3	No. 4	No. 5
Description of Works	Rehabilitation of Tank in Puliyankulam	Rehabilitation of Tank in Halmillawatya	Rehabilitation of Tanks in Vala sinna kulam and Panichchan kulam	Rehabilitation of Canals in Puliyankulam and Halmillawatya	Rehabilitation of Canals in Vala sinna kulam and Panichchan kulam
Date of Distribution of Bid Documents	31/03/2017	31/03/2017	31/03/2017	17/05/2017	17/05/2017
Date of Bid Close and Opening	21/04/2017	21/04/2017	21/04/2017	31/05/2017	31/05/2017
Date of TEC Meeting	28/04/2017	28/04/2017	28/04/2017	06/06/2017	06/06/2017

Package No.	No. 1	No. 2	No. 3	No. 4	No. 5
Name of Awarded Contractor	Lisal Construction	Abeywardena Construction	Babithan Construction	Dissanayake Construction	Sevvel Construction
Date of Signing of Contract Agreement	04/05/2017	12/05/2017	04/05/2017	07/06/2017	12/06/2017
Contract Period					
From	07/05/2017	12/05/2017	09/05/2017	15/06/2017	19/06/2017
To	03/09/2017	11/09/2017	04/09/2017	12/10/2017	16/10/2017
Contract Amount (with Taxes) (LKR)	6,964,841.22	4,200,120.34	4,687,506.71	16,093,356.25	6,692,573.32

Source: JICA Project Team

7.2.5 Setting Up on Construction Supervision

In order to maintain the quality, budget, and time schedule, construction work has been supervised by the JICA Project Team in collaboration with the counterpart agencies. Daily performance by the contractors were monitored by field staff of the JICA Project Team, who instructed the contractors to improve the quality of the works, keeping the records in log books, or issuing official letters to the contractors.

Quality control tests such as soil compaction tests for filling materials and concrete compression tests, were carried out at the laboratories of the counterpart agencies, namely, PID, NCP, and DAD-Vavuniya. Based on the test results, the contractors were instructed to rectify the condition if the test result failed to meet the requirement indicated in the Technical Specification.

The contractors were required to submit a safety management plan in accordance with the requirement specified in the Technical Specification. A “safety control management guidance, including environmental protection” has also been prepared and distributed to the contractors. Daily monitoring of the safety control management was conducted by using a checklist, focusing on the following aspects:

7.2.6 Findings and Remarks to Finalisation of Development Plan

(1) Importance with Farmers’ Participation in the Process of Planning

The rehabilitation plan was prepared based on the workshop. However, there were many design modifications in the construction stage. The design modification includes shifting of canal alignment avoiding high-value trees and rock foundation of canals. There were not many design modifications by farmer regarding tank bund, spillways, sluice, and link canals. Meanwhile, there were many modifications made by farmer regarding location and alignment of irrigation canals and farm turnout because the canals may influence their farming directly. Based on the walkthrough survey implemented by farmers, the JICA Project Team, PID officers, and DAD officers proposed to identify control points of design (horizontal and vertical alignment, etc.) before surveying and design.

(2) Increase of Storage Capacity of the Tanks

Farmers in Halmillawatya Irrigation Scheme requested to increase storage capacity of the tank, raising the tank bund or spillway. Meanwhile, the Government of Sri Lanka (GOSL) is required to assess an impact for increase of storage capacity, investigating extents of impounding farm lands in upstream scheme, and incremental commanding areas in views of engineering and social aspects. Since such a lengthy procedure was required to approve the request, the Project did not accept the farmers’ request. It was tentatively concluded that neither bund nor spillway rising would be included in the final project plan.

(3) Improvement of the Facility of Tanks

Designing sluice structure on tanks, special attention would have been paid to the size of wing walls taking into consideration the completed cross section of the tank bunds. In Puliyankulam Scheme, during the investigation stage, one bathing step was planned, but there was a request by farmers in the scheme, requesting to construct an additional bathing step because of their culture that men and women take a bath in different locations. In view of gender and social consideration, the Project agreed to construct the additional bathing step on the tank. It is suggested for future planning, therefore, that provision of two bathing steps may be considered, based on farmers' view on provision of the facility. This aspect will be incorporated in the cost estimate for the whole Project area.

(4) Selection of the Type of the Link Canals

Whilst it was understood amongst the counterparts that the link canal would contribute to appropriate distribution of the augmented irrigation water within tanks in a cascade, there were several discussions on what type of canal was to be introduced; that was either open channel or pipeline system. For a comparative study, it was agreed that both types of canals would be constructed under the verification study. In the cascade in Vavuniya District, pipeline system was introduced whilst in Anuradhapura District, open channel type canal was constructed. Both types of channels were evaluated by the officers and farmers in terms of easiness of construction and system operation. The results of the evaluation is described below and incorporated in the final plan and action plan.

(5) Selection of Type of the Irrigation Canals

At first, the Project intended to upgrade irrigation canals with a concrete-lined rectangular type, aiming at improving conveyance efficiency of canal compared with an earthen one. Through series of discussion with the counterpart personnel, it was understood that earthen canal might have a technical and economic advantages for future maintenance by the farmers themselves. Thus, it was concluded that earthen canal would be adopted basically whilst concrete-lined canal would be provided partially considering site condition. In particular, lined canals would be considered at the location, where canals might be damaged by flood water flown from spillway.

(6) Construction Cost

Based on the final construction cost under the pilot schemes, level of investment cost such as cost per ha and unit cost for tank rehabilitation (LKR/m), will be obtained, and that information will be utilised for cost estimation for the whole Project area.

(7) Procurement of the Contractor

The procurement method was appropriate, following the Institute of Construction Training and Development (ICTAD) Guideline. On the other hand, it is suggested that contractors having experience in water supply distribution line would be shortlisted to construct the pipelined link canals, as most of the contractors registered as irrigation work seem to have little experience for the work category.

(8) Environmental/Social Considerations

During the construction works, it was found that a particular contractor cut trees without approval of the government agent (GA) office. Thus, it is essential to conduct an awareness session before commencement of the work, stressing importance to follow the regulation. During the field inspection in Vala sinna kulam, Vavuniya, it was observed that the rehabilitated tank and canals have been damaged by cattle owned by FO members. Thus, it is recommended to hold a meeting with the FO members to raise awareness to avoid such situation for proper management of the irrigation facilities.

7.2.7 Validity and Applicability of the Improved Infrastructure

Completed structures for cascade management especially the link canals to connect tanks were evaluated to assess suitability and applicability to the total development plan of the NCPC. Whilst it was understood amongst the counterparts that the link canals would contribute to appropriate distribution of the augmented irrigation water between tanks in a cascade, there were several discussions on what type of canal was to be introduced. Two types of canals, that are open channel and pipeline system, were constructed under the verification study for a comparative study.

Validity of the link canals was evaluated from the perspective of efficiency and adaptability of link canals and difference between the two types of link canal. Firstly, it was analysed whether construction of link canal is a suitable and effective way to convey water within cascade. Secondary, efficiency and applicability of two different types of link canal were compared and evaluated. Since concerns were raised regarding technical feasibility for the pipeline system, and social problem such as illicit water tapping, for the open canal system, efficiency and suitability of the two types were evaluated from view point of technical, economical, and environmental/social aspects.

Even though it is difficult to evaluate actual effectiveness before receiving NCPC water, the structure was tested and used to send water to the downstream tank. The following evaluation was elicited from the trial use and discussion with farmers and relevant officers.

(1) Validity of Link Canal for Cascade Water Distribution

Estimated reduction of water loss by sending through the link canal is about 15% and 45% higher respectively compared with the earth canal and natural flow over the fields. Trial use of the link canals in the pilot sites proved that efficient water flow with minimum water loss and time. It was also proved that local contractors are technically capable to construct the required structure for link canal with proper consultation and supervision. Therefore, construction of link canal to distribute water is technically suitable for efficient use of NCPC water.

Acceptability for link canal by farmers was also one of the concerns raised during prior discussions with counterpart officers. Through the construction of link canals as well as a series of awareness raising meetings with farmers, the concept of link canals to send additional water from NCPC to the downstream tanks was generally accepted. Impression of both farmers and field officers towards the constructed link canals, be it pipeline or open canal, is mostly positive with expectation for the improved water efficiency and water availability. Farmers expressed that they prioritize construction of link canal to receive NCPC water more than improvement of tank level irrigation structure. This means farmers accepted and recognised importance of link canal for efficient use of NCPC water.

Although farmers in the pilot sites appreciated the efficiency of link canal to send water to the other tank, it should be noted that this appreciation can be mainly due to the situation that beneficiaries of those pilot tanks connected with the link canal are the same FO members, as such cases were selected to judge technical feasibility of the link canal without NCPC water. Therefore, careful attention should be paid for the link canal that connects tanks managed by two different FO or communities. Moreover, there are some concerns raised by farmers especially for link canals that connects tanks managed by different FOs. Since a link canal should pass land of upper tank beneficiaries to send water to downstream, the upper tank land owner may be reluctant to sacrifice their land for the benefit of other FO. This situation can be reconciled in case of pipeline system, in the land above which farmers can still cultivate. Another concern is route and design of the link canal that may disturb natural drainage flow such as rain water from jungle area. As some field have been relying on such drainage water from other area, the link canal should be designed not to disturb those natural flow as much as possible.

Since it was proved that the link canals are accepted by farmers and technically feasible improving efficiency of water distribution compared to the natural flow or earth canals, link canals are appropriate for cascade water distribution as long as the above mentioned issues of concern are taken into consideration.

(2) Effectiveness and Suitability of Pipeline and Open Canal

Although suitability and selection of the link canal designs highly depend on topographic conditions, the followings were evaluated for each type of the link canal. In addition, further applicability to other cascade systems was assessed through comparison between the pilot sites of pipeline in Naveli kulam and open canal in Kiulekada.

Regarding technical concern on the pipeline link canal system, the one installed in Naveli kulam cascade succeeded and it was verified that the pipeline can function even under gentle slope along the canal route with siphonage as long as a certain head difference between intake and outlet is assured. Through the trial use of the pipeline, it was proved that the pipeline can send water to the downstream tank within a few minutes, which enables efficient water distribution from the uppermost tank to the whole cascade. It was also appraised by farmers and officers that pipeline system has higher water efficiency with minimum water wastage.

Farmers also appreciate pipeline as it can minimize disturbance and water tapping compared to open canal. As per mentioned above, pipeline can also reduce risk of refusal of landowners to consent on laying link canal under their land even if the link canal is connected to a tank of different FOs. However, it should be noted that even though pipeline require less problem in land acquisition, there is possibility to cause claim on the land ownership and right over the underground pipeline, the details is mentioned in Chapter 9.

Regarding operation and maintenance of pipeline, farmers are not familiar with pipeline operation and maintenance. Some farmers prefer open canal to pipeline that they cannot solve if blockage occurs in the underground pipe. It was requested to organise intensive training to responsible farmers on technical operation and how to maintain the pipeline. Government officers assess that farmers can manage its operation and maintenance works as long as they are properly trained and for the repairing works beyond their capacity can be done by the concerned government agencies as per done for existing minor irrigation systems. On the other hand, some farmers take pipeline as common facilities beyond their control and to be maintained fully by the government in the same way as medium or major irrigation scheme. Therefore, it is important to enlighten farmers for them to take ownership and to train them with necessary skills on maintenance of pipeline.

Open canal in Kiulekada cascade was also tested and water reached the downstream tank efficiently enough. Farmers mentioned that the downstream tank can receive water immediately while in the previous situation they had to wait till the upper tank farmer cultivate and remaining water drain. The major concern with open canal is illicit water tapping raised by many farmers and officers, which can be minimised through strengthening cascade level water management. Judging from discussion with farmers, it will be possible to manage such prohibited use by establishing formal management body with legal authorisation.

Land acquisition or voluntary provision of land for link canal is also an issue for open canal. As those who sacrifice their land do not benefit from the link canal as the link canal is to send water to downstream. Considerable discussion and clear documentation of prior consent for the land provision shall be required.

Regarding operation and maintenance, open canal is more familiar to farmers and they are more confident to maintain by themselves. However, some farmers doubt actual practice of maintenance of a link canal as beneficiaries of the link canal are downstream tank but not the ones who provide their land for the link canal. It would be more feasible for the CMO to manage link canals with fair contribution from all the member FOs. Necessary organisational establishment for cascade operation and maintenance is discussed and proposed in the following chapter.

Advantages and disadvantages of the pipeline and open canal are summarised in the below table.

Table 7.2.9 Comparison between Pipeline and Open Canal

Issues	Pipeline	Open Canal
Cost	High. (However, when Q is less than 15 L/s, cost of pipeline is lower than open canal)	Low
Water efficiency	High (95%)	Low (90%)
Technical difficulties	High: (Need special attention for joint and siphon part construction)	Low: (Need special attention when canal is crossing other structure)
Acceptance by farmers	Well accepted and many prefer pipeline to open canal due to water efficiency and less risk for illicit water tapping	Generally accepted though some fear water tapping and issue of land acquisition
Other benefit	Field above the pipeline can be cultivated	
Operation	Requires training of farmers as they are not familiar	Farmers can manage with minimum training
Maintenance	Less maintenance is required though it is difficult for farmers to attend in case of problems. Farmers may rely on the government for maintenance	Maintenance is relatively easy and farmers are technically able to maintain though responsibility of maintenance among the cascade should be clarified.
Potential risks and difficulties		Refusal of land provision for link canal

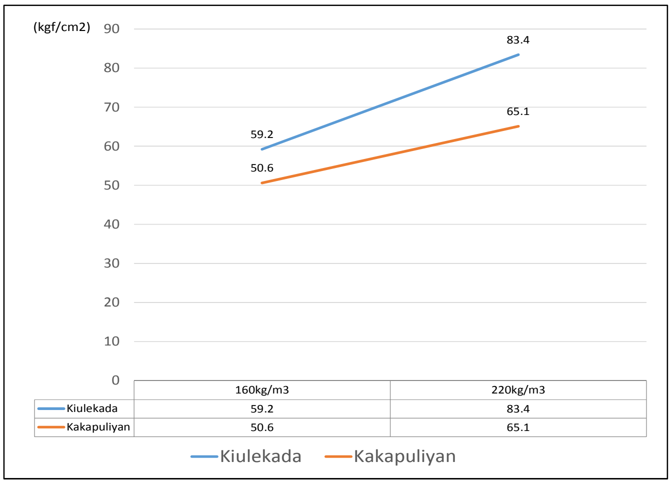
Source: JICA Project Team

In consideration of the above observations and findings through the pilot verification programme, selection of either type of canal should be judged according to the situation of each cascade.

7.2.8 Demonstration and Verification of STEIN Utilisation for Canal Construction

(1) General

The STEIN is soil hardening agent developed in Japan. The STEIN is composed of 95% cement and 5% of the element includes 20-30% of calcium sulfate, 15-25% of aluminium hydroxide, 10-30% of bentonite, acid-leached, 20-30% of magnesium oxide, and 6-10% of lignosulfonic acid[1]. The STEIN has been used for road and waterway construction since 1975 in nearly 1,500 places in Japan and other countries such as Taiwan, East Timor, Indonesia and Malaysia. Considering the economic advantage and easy construction in the previous achievements, it is decided to demonstrate the works in the selected pilot cascade system to verify the feasibility of the usage of it for canal construction works.



Source: JICA Project Team

Figure 7.2.4 Result of Strengthen Test of STEIN for 28 days

(2) Preparation of Field Works

Since the main producer of STEIN, SPEC Company Limited, does not have a distributor in Sri Lanka, SPEC exported 600 kg of STEIN elements from Japan to Sri Lanka before starting the work in the field. With the cooperation of the Tokyo Cement Group in Sri Lanka, 14 tons of STEIN were produced with element of locally available Portland cement.

On the other hand, the suitability of the available soil in the field was checked in the laboratory. With support from the Regional Director of Irrigation Office in Anuradhapura, compaction test with number of samples are carried out to decide the mixture ratio of STEIN and soil to achieve the expected strengthening in the field. The result said that the 200 kg of STEIN for 1 m^3 of soil is suitable.

(3) Field Demonstration and Verification

With the discussion with FOs in Kiulekada and Naveli kulam and government officers, the three locations for field demonstration, namely, Kiulekada, Ihalawewa, and Puliyankulam in Kiulekada and Kakkayar puliyan kulam in Naveli kulam were selected. A total of 175 m canal was constructed with STEIN which includes 64 m in Kiulekada Ihalawewa, 35 m in Puliyankulam, and 76 m in Kakkayar puliyan kulam. The outline of the field demonstration and general procedure of the canal construction with STEIN are shown in Table 7.2.10 and Figure 7.2.5, respectively.

Table 7.2.10 Outline of Field Demonstration and Verification

Cascade	Kiulekada	Naveli kulam	Kiulekada
Tank	Kiulekada Ihalawewa	Kakkayar puliyan kulam	Puliyankulam
Canal Name	Left bank canal	Left bank canal	Right bank canal
Length	64 m	76 m	35 m
Dimension	Trapezoid (B:0.5 m, H:0.35 m), Rectangle (B:0.5 m, H:0.35 m)	Rectangle (B:0.5 m, H:0.35 m)	Trapezoid (B:0.30 m, H:0.45 m)

Source: JICA Project Team

[1] *Publication of SPEC Company Ltd.*

1. Mixing

Mixing with sand, soil, water, and STEIN using a mixer

Mixing by labour (in case of small quantity)

2. Transportation

Transportation by monocycle

3. Compaction and Shaping

Trapezoid section: compaction by labour

Rectangle section: compaction using form

Rectangle section: compaction using form

3. Compaction and Shaping

Bed compaction by machine

4. Removing Form

Removing form

5. Curing

Curing by water

Source: JICA Project Team

Figure 7.2.5 Procedure of Canal Construction by STEIN for Field Test

(4) Results of the Field Programme

After completion of all field works, the strengthening test with Schmidt hammer in the field was carried out to evaluate the quality of work. In addition, the actual record of works, including labour productivity and material and machinery use, were summarised for the evaluation of economic productivity of the usage of STEIN for canal construction works.

Table 7.2.11 shows the results of strengthening test of STEIN works in the field.

Table 7.2.11 Results of Field Strengthening Test

Location	Total Length Constructed	Major Canal Type	Completion After	Strengthening (kgf/cm^2)			
				Right Wall	Left Wall	Base	Average
Kiulekada Ihalawewa	64 m	Rectangle	67 days	85	79	76	80
Kakkayar puliyan kulam	76 m	Rectangle	58 days	69	76	106	84
Puliyankulam	35 m	Trapezoid	7 days	121	119	104	115
Average				92	91	95	93

Source: JICA Project Team

According to the actual record of material importation and production and labour and machinery usage, the construction cost per m^3 was figured out. Since the best achievement of the placement of STEIN is at 2.8 m^3 per day during the field demonstration, 2.8 m^3 per day is used for the economic evaluation. As shown in Table 7.2.12, the construction cost per m^3 for STEIN was LKR 19,507 composed of LKR 10,686 of material cost, LKR 4,464 of labour cost, and LKR 4,357 of machinery cost whilst placement of the concrete is LKR 32,260 according to the approved rate for irrigation drainage works 2016. Considering the life cycle year of STEIN and concrete for 20 and 30 years, respectively, the life cycle cost for STEIN is LKR 975 per m^3 per year, which is less than concrete of LKR 1,075 by LKR 100.

Table 7.2.12 Average Construction Cost of STEIN (LKR per m^3)

Material	Construction Cost	Material				Labour	Machinery
		Total	STEIN Element	Transport and Tax	Cement Mixing in Factory		
STEIN	19,507	10,686	2,190	3,296	5,200	4,464	4,357
Concrete (Class A)	32,260	13,960	-	-	-	16,000	2,300

Source: JICA Project Team

(5) Findings and Remarks

After field demonstration, verification programme, and wrap up meeting with relevant government officers, the following findings and remarks are observed:

- The quality of trapezoid section in Puliyankulam achieved higher strengthening than the one in rectangle shape in Kiulekada, Ihalawewa, and Kakkayar puliyan kulam. It can be considered the following reasons:
  - Rectangle canal section requires the form work for placement of STEIN. It is the cause of decline of quality of shape and strengthening whilst deforming.
  - The vertical compaction on the left and right wall in the rectangle section with wooden pole has some difficulties in maintaining the quality, whilst the compaction of both in trapezoid section with wooden plate maintains better quality of work.
- Skilled development of labour is one of the factors to maintain high-quality works.
- Considering the variation of quality of works, clear quality control measures by soil type should be established.
- Although the life cycle cost of STEIN is slightly lower than the one of concrete, considering the increment of market price of sand and coarse aggregate, STEIN construction may have more economical benefit in the near future.
- The laboratory contamination test for STEIN carried out by Industrial Technology Institute (ITI) under supervision of the Ministry of Mahaweli Development and Environment showed the inclusion of cadmium and arsenic. Since STEIN elements do not include those according to the “Safety Data Sheet” issued in Japan, it may be from other material of cement. In order to proof the safety of STEIN for further expansion of material in other places in the country, additional tests are needed.
- The strengthening could be achieved with soil deposit on the tank bed. It would contribute to the desilting of the tank as well as prevention of the sand and rock mining in the environmentally sensitive area.
- The establishment of distributor or agent of STEIN element in the country is needed for sustainable production of STEIN in the country.

7.2.9 Establishment of Supporting System for Water Management

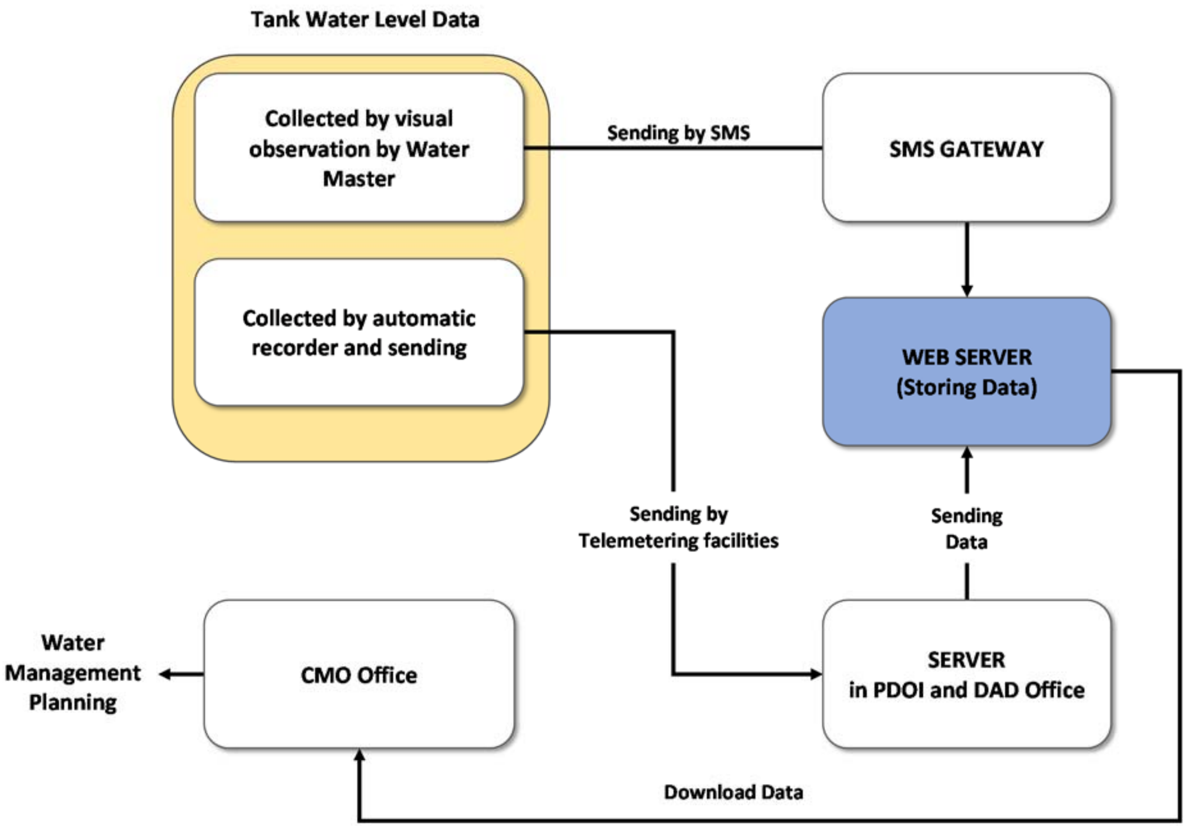
(1) Development of Tank Water Level Information Management System

Based on the cascade system development concept written in Chapter 5, the water management supporting system is developed under the verification programme. The system is designed from acquisition of tank water level data to storing those in server in PDI Anuradapura. The system can be fit to two water level acquisition methods namely acquire by visual observation and sending those through Short Messaging System (SMS) and acquire by automatic recorder and sending through telemetering facilities.

At first, the system requires to build the tank inventory data such as name and location. After registration of the mobile phone of expected water master in respective cascade system, the observed data of tank water level in the field are sent by SMS with registered mobile phone. The data will be stored in web server though SMS gateway. The webserver and SMS gateway system services of MOBITEL company Ltd. were used for establishment of this system.

On the other hand, the data sent by telemetering facilities is also stored in respective webserver. The both data can be used for water management planning by member of CMO.

The schematic drawing of established Tank Water Level Information Management System is shown below.



Source : JICA Project Team

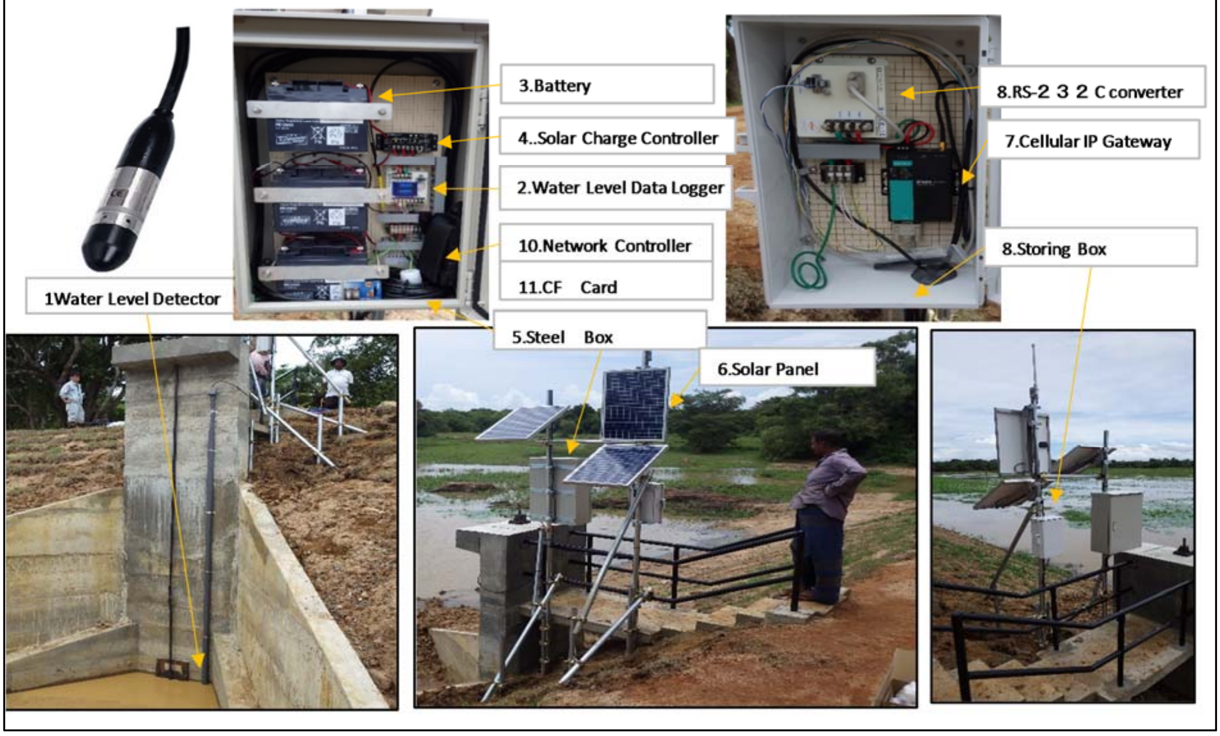
Figure 7.2.6 schematic drawing of established Tank Water Level Information Management System

(2) Installation of Automatic Water Level Recorder with Telemetering Equipment

After the radio wave survey in the Kiulekada cascade system, the automatic water level recorder and telemetering facilities were installed on the left bank inlet sluice of Puliyankulam, which is the upper most tank of the Kiulekada cascade system, as demonstration activities. The installation of the facilities in the field and setting the receiving server in PDI Office in Anuradhapura were carried out by the National Agriculture and Food Research Organisation (NARO) in Japan. The main equipment of water level logger and telemetering facility were the products of OSASI Technos Company Ltd. Japan as shown in Figure 7.2.7.

By inviting the number of technical staff of the provincial council, awareness and demonstration of data acquisition through telemetering equipment were carried out in PDI Office in Anuradhapura.

No.	description	type	quantity
1	Water Pressure Type Water Level Detector	DS-1 10m range cable20m	1
2	Water Level Data Logger	NetLG-001NE	1
3	Battery	12V40Ah	3
4	Solar Charge Controller	20A/12V	1
5	Steel Box	250mm×500mm×700mm	1
6	Solar Panel	50W pipe mounting bracket	3
7	Cellular IP Gateway	Oncell G3111-HSPA MOXA	1
8	RS-232C converter	NetGW-1E	1
9	Storing Box	Plastic Box−16T	1
10	Network Controller	NetCT-1E	1
11	CF Card	256MB	1
12	Automatic observation software	OSNET OBSERVER	1



Source: NARO

Figure 7.2.7 List of Installed Equipment at LB Sluice in Puliyankulam

7.3 Assessment and Mitigation of Flood Risk by Farmers' Organisation

7.3.1 General

Some tanks suffer serious damages due to flooding during the *Maha* season. When the major system or medium system tanks are damaged, repairs are started immediately as these tanks are the priority of the government.

However, if the minor system tanks are damaged (this includes most of the tanks in the cascade), their turn for repair takes a long time to come around. Some tanks are still unrepaired when the next *Maha* season comes around, aggravating flood damage.

If the farmers' organisations are able to identify the risk and attend to the minor repairs of the tanks, O&M of the tanks will be greatly improved. In particular, early discovery and early repair of piping holes, which are directly linked to bund collapse, are also means of preventing tank collapse which leads to large-scale damage.

This verification study verifies that risk assessment can be performed by the farmers' organisations provided that there is an appropriate checklist for functional problems and deterioration of bunds and sluices.

7.3.2 Activities and Operation Plan

(1) Selection of Target Tanks for Field Verification

One tank in each of the two cascades was selected and disaster prevention inspection of the tanks was carried out by the farmers' organisation in-charge of the tank concerned.

The two cascades selected were Kiulekada and Naveli kulam. They were included in the six cascades in the detailed study and they are the cascades where tank repairs and work using the STEIN soil hardening agent were verified. Thus, as these cascades were used for verification focused on tank disaster prevention measures, it was considered effective to use these cascades to verify disaster prevention inspection of tanks by farmers. In addition, by concentrating various initiatives for tank disaster prevention in these two cascades, disaster prevention measures applicable to other cascades can be shown as a package.

One tank from each cascade was selected for disaster prevention inspection. For the selection, a preliminary survey was carried out to check if any of the tanks in the cascade were covered by the following items:

- The grass was cut to the extent that deformation of the bund was apparent.
- The tank plays an important role in the cascade.
- There were cracks, depressions, or other deformation in the bund.
- There were traces of piping.
- The spillway also needed improving.

The selected tanks were Halmillawatya (Kiulekada Cascade) and Naveli kulam (Naveli kulam Cascade). The specifications and current state of the two tanks are shown in Table 7.3.1.

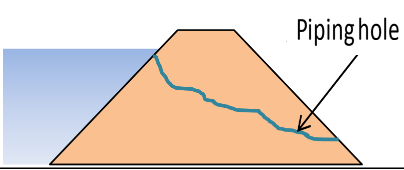
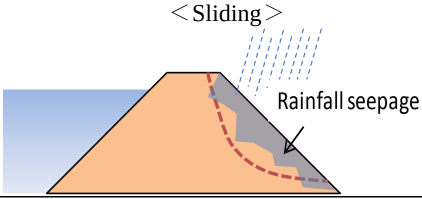
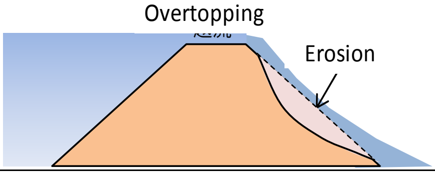
Table 7.3.1 Selected Tanks for Disaster Prevention Inspection

Tank name	Halmillawatya	Naveli kulam
Bund height	1.65 m	3.0 m
Bund length	354.0 m	926 m
Storage volume	11,088 m^3	320,880 m^3
Position in cascade	This is the second most upstream tank. It currently serves as intermediate storage for irrigation water from the most upstream tank. When water passes along the NCP channel, this and the most upstream tank receive the distributed water.	This is the most downstream tank in the cascade. It is large in size and should it collapse, the impact in the lower reaches will be huge.
Current state	Tank repairs were verified here and at Puliyankulam farthest upstream.	It has a number of structurally weak points.

Source: JICA Project Team

(2) Checklist for Facility Inspection

The causes of tank collapse in times of torrential rain are classified as shown in Figure 7.3.1. As the worst damage to the tanks is collapse and washout, the most important item when inspecting these facilities is to find any indication of the three collapse patterns.

Failure Pattern	**Mechanism of Failure**
＜Seepage＞ 	When the tank's structural capacity deteriorates and its water-shielding capacity decreases, it may collapse if the water level in the reservoir rises. This happens because the rise in the water level increases the water pressure within the tank body, compromising its strength. Also, if a piping hole is formed through the tank from upstream to downstream, it may cause the tank to collapse.
＜Sliding＞ 	When the water in the reservoir and rainwater seep into the tank body, the water content of the tank increases, reducing the strength of the tank slope. Slipping is likely to occur on such surface causing its collapse.
＜Over Topping＞ 	When heavy rainfall causes rapid rise in water level of the reservoir and the water begins flowing over the tank, this causes erosion of the tank slope on the downstream side which may lead to tank failure. The reservoir may fail when the water level rises, because the rise in the water level increases the water pressure within the dam and the high-water pressure reduces the structural strength.

Source: Reference from "Tank Management Manual, M.A.F.F, Japan, 2015", translated by the JICA Project Team.

Figure 7.3.1 Mechanism of Tank Failure caused by Heavy Rainfall

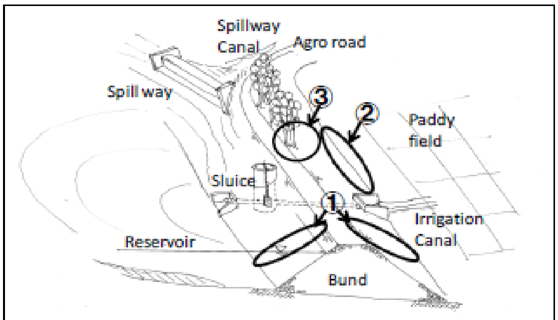
The checklist used by the farmers is a simple sheet on which the facilities to be inspected are divided into (1) bund, (2) spillway, and (3) sluice, the inspection points are indicated by illustrations and the farmers just check the items at each inspection point (Figure 7.3.2).

[Cascade Tank Safety Check Sheet]

Day/Month/Year	
Name of F.O.	
Name of Cascade	
Name of tank	
Name of check person	

[Check Point]

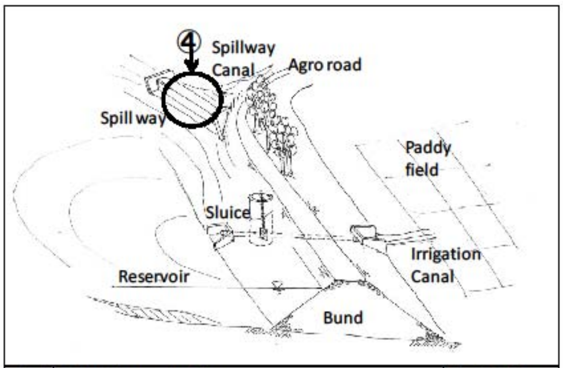
(1) Bund



Check point No.	Deformation or Troubles (View Point of Check)	Check[✔] to the View point Yes	No
①	・Hole, crack and swelling appears in band slope. ・Reservoir side slope is eroded by the water. ・There are small hole digged by animals, there are disturbed area by elephants.		
②	・Leakage water or piping hole appears at downstream toe of bund.		
③	・There are holes of stump pulling.		

MEMO

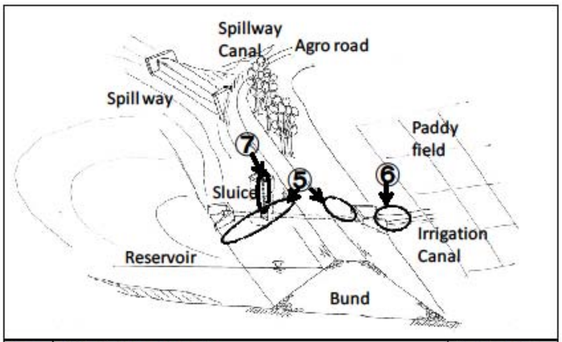
(2) Spillway



Check point No.	Deformation or Troubles (View Point of Check)	Check[✔] to the View point	
		Yes	No
④	・Partially broken (cutout, crack, erosion, et.al)		
④	・Dry vegetation gather in front of the spillway ・Many plants grow in the spillway canal.		
④	・Soil bags put on the spillway crest.		

MEMO

(3) Sluice



Check point No.	Deformation or Troubles (View Point of Check)	Check[✔] to the View point	
		Yes	No
⑤	・Holes appears on the slope or near structures.		
⑥	・Muddy water flow out from the exit pipe in case of close condition of the gate. ・Seepage water appear outside of the concrete structure.		
⑦	・There are some trouble in the gate and gate operation.		

MEMO

Source: JICA Project Team

Figure 7.3.2 Check Sheet for Inspection of Farmers

In the case of bund, they check for deformation, cracks, and leaks.

In the case of spillway, they check that it has not been sandbagged (if it has, the water level will rise in times of flooding and overflow the bund, increasing the risk of collapse), and for damage of the facilities and leaks.

In the case of sluice, they check for depressions, leaks, and other deformations around the structures in the bund.

With these checks, it is possible to check for the three collapse patterns. In addition, two check sheets were prepared, one in Sinhalese and one in Tamil, and these are used in Halmillawatya and Naveli kulam, respectively.

(3) Seminar for Farmers' Organisations

Ahead of the field inspection by the farmers' organisations, a seminar was held to explain the purpose and inspection points.

A flip-chart type presentation consisting of diagrams and photos was created to aid the farmers in understanding the seminar. The storyline is outlined below.

- Just like human beings, there is a need for regular check-ups to stay healthy, tanks also need regular safety inspections. The farmers are the tank doctors.
- The three main causes of tank collapse are piping, slippage, and overflow.
- Grasping the signs of the three causes and taking emergency measures, etc.
- Regular inspections and grass-cutting on the bund are important.

Various comments were made in the question and answer (Q&A) session after the explanation, such as, "I'd never heard about anything like this before, so it was very significant" and "Public agencies never tell you about emergency measures".

Afterwards, the check sheets were handed out to all participants and they were told what to look for at the site.

Halmillawatya

Naveli kulam

Source: JICA Project team

Figure 7.3.3 Seminar for Farmers' Organisations

(4) Risk Assessment (Facility Inspection) and Analysis

After the seminar, the participants moved to the site to start the inspection. They had been encouraged beforehand to see themselves as tank doctors and to mention anything, no matter how small, that came to their notice. In addition, the tanks where the inspections took place had been inspected beforehand by the JICA Project Team and red ribbons had been attached near deformations that they wanted the farmers to see.

The participants discussed as they walked around the tank bund and filled in their individual checklists. Scenes from this time are shown in below.

Halmillawatya

A farmer confirming a hole in the upstream surface. Study of risk of piping.

Naveli kulam

An officer from ASC teaches how to check in the check sheet of farmers.

Soil bags put on the spillway crest.
Discuss about the risks.

Small pool appears in the downstream toe.
This section has the risk of leakage.

Source: JICA Project team

Figure 7.3.4 Field Inspection Training

The following findings were obtained as a result of the tank inspection by the farmers:

- The farmers act proactively as they listened intently at the seminar, and during the field verification they asked questions, such as how the cracks in the bund surface were caused.
- The farmers are the ones carrying out day-to-day management, but up to now they have been given no guidance on how to go about controlling the tanks and irrigation channels. In addition, the farmers have high awareness both as FO and as individuals, and provided they are given accurate guidance, they can manage the facilities and channels on their own initiative.
- Therefore, if DAD, ID, or other authorities hold this kind of seminar on a regular basis (this particular seminar was on tank safety inspections), the farmers' organisations and individual farmers can be expected to gain a sound understanding of the tanks, channels, and other irrigation facilities and a heightened awareness of inspections.

(5) Support for Repairs by Farmers' Organisations

The method of emergency repair is usually making a guard for upstream side piping hole and fill in the downstream hole using soil bags. Because of the possibility of failure again at the same portion, the construction of toe drain is recommended on the repair of the downstream piping hole.

Toe drain exercises have filtering effect to soil particle flowing in the piping holes. As a result, the piping holes are plugged gradually. In this way, it is better to make a choice of repair method that can strengthen the tank bund and facilities.

Early detection of piping holes becomes possible by the farmer's inspection. If the tank deformations and leakages identified in the inspection, farmers can repair the indication of piping by using sandbags.

In most cases, bund deformation can be dealt with by earthworks using mainly sandbags. However, it is likely that earthworks used to repair concrete structures such as spillways will be washed away at the first flood. In this case, there are items that the farmers can repair by themselves using STEIN soil hardening agent which has been verified by a separate study in this Project.

Source: JICA Project team

Figure 7.3.5 shows examples of scouring repairs downstream of the spillway. After being shaped like a sandbag, STEIN hardens and demonstrates the strength of concrete. It is not deformed by scouring or loads by being walked on by wild animals (elephants). These repairs were carried out by the farmers with guidance of the JICA Project Team.

◇Placement of STEIN bags

・Place the STEIN bags.
・Compact stiffly using hammer or plate.
・Watering (Curing)
.

◇Finishing

・Form the bags.
・Compact again full structure.
・Watering at full.

◇About two months after

・Burst the bag surface
・STEIN hardened like as cement

Source: JICA Project team

Figure 7.3.5 Restoration Work using STEIN Bag (Spillway of Kiulekada Ihalawewa)

7.3.3 Outcome and Feedback to Finalisation of Development Plan

(1) Outcome

The following conclusions were obtained from the verification study:

- The farmers' organisations and individual farmers at the two locations lack information on tank operation and management and risk assessment and are eager to obtain such information.
- The farmers, who see themselves as tank doctors, proactively asked questions and pointed things out during the field inspection. From this result, it was found that it is important to give the farmers some degree of sense of ownership.
- However, despite the lively discussion in the face of certain events, no countermeasures were put together. In the present situation, experts are needed to guide the farmers' problem

awareness toward technical solutions.

- It can be seen from this that the farmers have the capacity and motivation to carry out risk assessment of the tanks, and with appropriate education and guidance, they can adequately serve as tank doctors and primary judges in risk assessment.

(2) Feedback

It was found that farmers play a significantly important role in tank disaster prevention. To maximise the abilities of the farmers in actual risk assessment and disaster prevention measures, coordinated initiatives with administrative agencies and farmers' organisations are necessary.

The following initiatives are proposed as examples of coordinated efforts:

- As Sri Lanka is a country of tanks, ID or DAD establishes one day a year as 'Tank Day'.
- On this day, PID and DAD hold training courses on minor tank systems.
- Participation in the training courses by multiple members of the FOs under their jurisdiction is obligatory. In addition, FO farmers cut the grass on the tank bunds on this day.
- After the grass has been cut, the tanks are inspected using the check sheet and the results are summarised by the FO on one sheet per tank and submitted to PID or DAD.
- PID or DAD provides guidance on measures within the farmers' capabilities. Events that need to be handled by the administration are prioritised using the check sheet as reference.

7.4 Promotion of Agriculture Diversification

7.4.1 General

Two main approaches were considered in the promotion of crop diversification in the study area. In the first approach, the horizontal diversification, crop intensification by addition of new high-value crops to the existing cropping system is attempted as means to improve overall production and productivity of the farm economy, e.g., cultivation of high-value OFCs and vegetables in the irrigated lands. The second approach, called vertical diversification, farmers and others add value to products through processing, regional branding, packaging, etc., to enhance the product value, e.g., protected agriculture, growing traditional and new paddy varieties, value chains, etc.

Farmers expressed positive response to diversification of their paddy fields, but named maize and pulses as the preferred crops. Since the income from these crops are only marginally higher than that of paddy, it is necessary to introduce high-value crops for inclusion in their cropping patterns. The aim was to activate the stages of adoption process to confirmation through awareness.

In addition, the integration crop and livestock and livestock farming development is also the main theme of the verification programme. This verification study focused on livestock feed resources in particular since the land that can be used as grazing will be restricted after receiving the water from NCPC. Develop feed resources instead for grazing is an urgent issue. Moreover, development of feed resource will equalise seasonal variability of feed resources that can be accessed in the rainy season and dry season. The stable availability of feed resources is the foundation of livestock development in these areas.

7.4.2 Field Demonstration and Training of Farmers on High-Value Vegetable Cultivation

The objective of the programmes was to promote crop diversification in the paddy centric cropping system to combinations, rotations, and/or replacement with high-value seasonal crops for enhancement of farm income.

In this regard, it is necessary to demonstrate to farmers the technical feasibility and economic viability of growing selected high-value crops for adoption under their own farming conditions. For this purpose, two field demonstration and training programmes on high-value vegetable cultivation were organised in collaboration with CIC Seed (Pvt.) Ltd. under a contract agreement.

As a follow-up to the programme, it was planned to establish demonstration plots of selected high-value crops in the irrigated fields of selected farmers in the *Yala* 2017 season.

(1) Field Demonstrations

The demonstration plots were established at the Seed Farms of CIC in Pelwehera (Dambulla) and Malwanegama (Talawa) to coincide with the two cultivation seasons, *Maha* 2016/07 and *Yala* 2017, respectively, under the supervision of the JICA Project Team.

(a) Crop Selection

Crop selection was based largely on existing demand of the hoteliers in and around Anuradhapura and the prevailing market prices as well as the regional crop adaptability. Accordingly, five crops were selected for demonstration at each site. Bell pepper, tried out in Pelwehera Farm, was replaced with beetroot at Talawa demonstration. Furthermore, two new crops, broccoli and Chinese cabbage, were introduced purely on an experimental level in small plots to observe their performance under open field conditions. The crops were established on raised beds, each crop occupying an area of 40 m^2. A uniform plant spacing of 30 cm x 30 cm was used to facilitate drip irrigation system.

Table 7.4.1 Crops Selected for Demonstration

Location: Pelwehera Seed Farm (Maha 2016/17)				Location: Talawa Seed Farm (Yala 2017)			
No	**Crop**	**Variety**	**Plot Size**	**No**	**Crop**	**Variety**	**Plot Size**
1	Cabbage	Super Coronet	20 m^2 x 2	1	Cabbage	Super Coronet	20 m^2 x 2
2	Cauliflower	Contra	20 m^2 x 2	2	Cauliflower	Contra	20 m^2 x 2
3	Sweet corn	Sugar 75	20 m^2 x 2	3	Sweet corn	Sugar 75	20 m^2 x 2
4	Cantaloupe	Sweet D 25	20 m^2 x 2	4	Cantaloupe	Sweet D 25	20 m^2 x 2
5	Bell pepper		20 m^2 x 2	5	Beetroot	Red Ace	20 m^2 x 2
				6	Broccoli	Tirate F-1	20 m^2 x 1
				7	Chinese cabbage	Hero	20 m^2 x 1

Source: CIC/JICA Study Team

(b) Crop Calendar

The crop calendar and the plot level yield data in respect to the *Maha* and *Yala* field demonstrations in Pelwehera and Talawa, respectively, are summarised in Table 7.4.2.

Table 7.4.2 Crop Calendar for Demonstration

Crop	Pelwehera Seed Farm (Maha 2016/17)					Talawa Seed Farm (Yala 2017)				
	Days in Nursery	**Date Planted**	**Harvest Date (1st)**	**No. of Picks**	**Yield kg**	**Days in Nursery**	**Date Planted**	**Harvest Date (1st)**	**No. of Picks**	**Yield kg/40 m^2**
Cabbage	25	19 Jan	07 Apr	2	158	20	10 Jun	02 Sep	3	135
Cauliflower	22	12 Feb	10 Apr	6	100	22	22 Jun	26 Aug	2	85
Sweet corn	Seeded	19 Jan	04 Apr	1	189 (cobs)	Seeded	20 Jun	26 Aug	1	195 (cobs)
Cantaloupe	Seeded	10 Jan	24 Mar	3	43	Seeded	29 Jun	Abandoned		
Bell pepper	Abandoned					Not included				
Beetroot	Not included					26	26 Jun	26 Aug	1	35
Broccoli	Not included									
C. cabbage	Not included									

Source: CIC/JICA Study Team

(c) Crop Performance

Crop-wise brief notes on crop agronomy covering nursery management, field establishment, fertiliser application, and pest and disease management have been prepared. Overall crop performance in the demonstration plots is summarised in Table 7.4.3.

Table 7.4.3 Crop Performance in Demonstration

Crop	Field Performance
Bell pepper	Poor with plants exhibiting stunted growth, early flowering, and few missed sharpened pods. Not included in demonstration in Talawa
Cantaloupe	Pelwehera: Satisfactory up to late maturity stage, succumbed to fungal infection at the harvesting stage. Talawa: Succumbed to fungal infection at the seedling stage
Cabbage, cauliflower, beetroot and sweet corn	Performed exceptionally well
Chinese cabbage	Showed lush growth with dark green open leaves Typical closed compact plant form and coloration was poor.
Broccoli	Early growth was satisfactory, but showed poor head formation.

Source: CIC/JICA Project Team

Because of the small plot size and plant spacing applied to suit drip irrigation, it would not be realistic to extrapolate the recorded yields on a unit of cultivation area for comparisons. The recorded yields per 40 m^2 plot are shown in Table 7.4.2

(d) Training Component

Field observation and training on the crops demonstrated at the two sites were organised as a series of field days where the Agricultural Instructors (AIs)/Agricultural Research and Production Assistants (ARPAs) with farmers representing the respective model cascades participated. Accordingly, four field days were held, three at Pelwehera Farm and one at Talawa Farm.

Table 7.4.4 Summary of Field Day Training Programme

Activity	Pelwehera Seed Farm			Talawa Seed Farm
Field Day	1	2	3	1
Date	6 March	10 March	4 April	22 August
Crop Growth Stage	Early Growth	Early Growth	Late Mature	Late Mature
Participants (No.) AIs	5	1	5	0
ARPAs	0	0	0	7
Farmers	19	9	21	38
Total	24	10	26	45
Medium of Instruction	Sinhalese	Tamil	Bilingual	Bilingual

Source: CIC/JICA Study Team

In the field days, the participants were encouraged to clarify issues relating to the crops demonstrated through direct interaction. This was followed by training sessions where the trainers explained nursery management, field establishment, fertiliser application, and pest and disease management operations practiced for each crop ensued by an interactive discussion sessions.

(e) Opinions of Participants

The observations made by participants at the conclusion of the field days are summarised below.

- Highly impressed and encouraged by the performance of crops demonstrated.
- Gained new knowledge on growing of new crops and wished to try them out in their paddy fields.
- Soils suitable for growing of these crops are available within irrigated lands in the cascade.
- Preferred growing of cabbage, cauliflower, sweet corn, melons, and traditional low country vegetables in the irrigated paddy lands.
- Learned correct technologies, particularly the use of agro-chemicals and thereby improve the current field practices.
- Needed further knowledge including pest and disease management.
- Train other farmers in the cascade through programmes of this nature.
- Cultivation of these crops in the *Yala* season will ensure good market prices.
- Marketing particularly highly perishable vegetables will be a problem.

- Needed reliable sources to supply seeds and planting materials (seedlings).
- Needed demonstrations under actual farm conditions such as with surface irrigation.

(2) Outcome and Feedback

Comparatively poor performance of bell pepper, cantaloupe, broccoli, and Chinese cabbage may be due to low adaptability to harsh weather conditions that prevailed during the season under open field conditions. Being a high-value crop much in demand in the region enjoying premium prices, further testing with new cultivars, different planting times, and disease management practices would be a worthwhile endeavour.

Other crops, namely, cabbage, cauliflower, beetroot, and sweet corn performed exceptionally well. The demonstrations gave the expected visual impact to the participants on the technical feasibility of growing and yield potential of the crops. This is supported by previous experience of CIC with contact farmers, and views of farmers in major irrigation schemes in Anuradhapura District. In this context, it is proposed that the crops can be considered for inclusion in basic cropping plans.

The second phase of the programme which is to establish demonstration plots at field level with selected farmers in the *Yala* 2017 had to be cancelled because of non-availability of water for cultivation due to failed *Maha* rains.

7.4.3 Promotion of High-value New Paddy Varieties and Traditional Paddy Varieties

Paddy will continue to be the dominant crop in the project area even with the anticipated qualitative changes to cropping pattern after delivery of water through the North Central Province Canal Project (NCPCP). The situation is largely influenced by factors such as climate regime, soil characteristics, farmer preference, amongst others.

The general objective of this programme is to promote cultivation of traditional paddy varieties and selected new releases of the Rice Research and Development Institute (RR&DI) for vertical diversification of the paddy in the centric cropping system. Being products that fetch relatively high market prices, it is anticipated that the introduction of these paddy varieties to the cascade would lead to increased farm incomes as well as promote regional specialisation for market penetration.

(1) Training Programme

With the consensus of the officials of the Interprovincial and Provincial Department of Agriculture (DOA), the training programme was discussed and finalised with the director and training staff of/RR&DI, Bathalagoda. The programme summary is given below.

Programme : Training on Cultivation of High-value New and Traditional Paddy Varieties

Specific Objectives : The trainees will be able to:

- Acquire the knowledge and skills based on innovative practices and adapt them for paddy cultivation;
- Identify high-value new and traditional paddy varieties for production; and
- Assist extension workers to conduct demonstrations to promote adaption by farmers in the community.

Organised by:	JICA Project Team for Formulating Cascade System Development Plan under North Central Province Canal
Conducted by:	Rice Research and Development Institute, Department of Agriculture
Venue:	Training Centre, Rice Research and Development Institute, Bathalagoda
Participants:	24 farmers and six agricultural instructors from six selected cascades in the Project area.
Duration:	3 days residential training

Table 7.4.5 Programme Summary

Date	Activity/Subjects
24 Jan (1/2 day)	Arrival of participants at the training centre, Registration, Inauguration, Water Management, Pest and Disease Management
25 Jan (Full day)	Fertiliser Application, Paddy Varieties, and Seed Production with special reference to Traditional Varieties and New Releases At 311 and At 373, Present Situation of Paddy Cultivation, Importance of Proper Land Preparation, and Cultivation of Traditional Paddy
26 Jan (1/2 day)	Weed Management, Weed Control in Traditional Paddy with special reference to IPM, Concluding Discussion and Departure

Notes:(a) All presentations are focused on paddy varieties specifically targeted under the programme.
(b) Training sessions included field visits for direct observation.
(c) Trainers encouraged free discussion to clarify technical issues during individual session.
Source: RR&DI/JICA Team

The responses of the participants in the training programmes collected through end-evaluation and discussion are summarised below.

- Expressed satisfaction in terms of coverage of subject matter presented and found it comprehensive and easy to understand.
- Acknowledged use of low cost locally manufactured seed trays for crop establishment could save water over a period of two weeks as against broadcasting method practiced now and also reduce use of herbicides.
- Realised benefits of disc ploughing as against rotovater used now for the first ploughing operation for weed control and minimising the need for herbicides.
- Use of disc or moldboard plough, although effective, is expensive.
- Learned about the three growth stages: vegetative, reproductive, and maturity and the need to time the operation of weed and P&D control, fertiliser application, etc., according to age and class of paddy variety.
- Found information on identification and control for pests and disease management highly appropriate and useful.
- Appreciated the information on traditional paddy varieties, confident of the market demand and higher prices, but stated non-availability of good seed paddy as it is highly mixed over their use for decades.
- Expressed great interest on new paddy varieties released by RR&DI, namely, At 311 and At 373 for their special grain qualities.

(2) Field Level Establishment of Demonstration Plots

It was planned to establish 12 plots, six traditional and six new paddy varieties in the cascade area in the *Yala* 2017 for demonstration amongst other farmers and for seed multiplication to be used in the next season. For this purpose, lands of nominated farmers by the AIs were examined for establishment of traditional paddy plots and shortlisted to six.

However, the programme had to be curtailed due to failure of *Maha* rains, which necessitated the irrigation officials to stop water issues, except in few scattered larger tanks to cultivate restricted areas in the Puranawela area. As a result, only three farmers were able to establish the demonstration plots.

Certified seeds of four varieties (Pokkali, Pachchaperumal, Suwandel, and Kalu Heeneti) were secured from RR&DI and distributed amongst farmers. Plan to distribute the new releases, i.e., At 311 and At 373 was, however, terminated as the farmlands selected did not receive water during the season.

Although the weather conditions continued to deteriorate through the season, two farmers were able to raised the crop under difficult conditions. The third farmer was compelled to abandon his plot since there was no water issue from the tank and the agro-well used to supplement water supply went dry. In general, performance of the varieties cultivated was poor. Plants grew tall and tended to lodge easily when compared with the rest of the paddy in the field. However, the farmers were determined to continue with the cultivation of traditional paddy varieties in the forthcoming season.

Table 7.4.6 Summary of Field Programme

Item	Demonstration-1	Demonstration-2	Demonstration -3
Cascade	Alagalla	Alagalla	Kiulekada
Location (Tank)	Alagalla	Sinnakulam	Gonahathdenawa Mahawewa
Name of the Farmer	Gamini Rajapaksa	C.Premasingha	Dharmasiri Bandara
Paddy Variety	Suwandel + Pachchaperumal	Kalu Heenati	Kalu Heenati
Quantity Issued (kg)	10 + 5	10	10
Extent	0.1 hectare (Suwandel)	0.1 hectare	0.1 hectare
Crop Establishment	10 May	25 April	04 May
Method	Transplanted	Direct seeded	Direct seeded
Status	Abandoned	Harvested	Harvested
Date of Harvesting	-	12 Aug	17 Aug
Crop Duration	-	107 days	103 days
Yield (kg/ha)	0	1,800 kg/ha	1,300 kg/ha
Observations	Overgrown seedlings used. Improper machine transplanting making weed control by machine not possible. Insufficiency of water due to drying up of agro-well	Crop loss due to severe lodging. Only standing panicles have been harvested.	Crop loss due to severe lodging. Only standing panicles have been harvested. 
Farmers Observations	0.4 he land area, a quarter of which was under traditional rice, was abandoned due to lack of water. Planning to continue with traditional paddy in the next season	Plant height makes the variety more susceptible to lodging compared with the other improved varieties cultivated. Manually harvested. Planning to continue with traditional paddy in the next season.	Plants in the entire tract were subjected to lodging, traditional paddy. Comparative yield is less since only part of the crop could be harvested with combined harvest. Planning to continue with traditional paddy in the next season.

Source: JICA Project Team

(3) Outcome and Feedback

Farmers who participated in the training programme shared the view that they learned new techniques that they can apply in their paddy lands to improve farming practices.

Farmers were confident that they could earn a higher bet income from growing traditional paddy although the productivity was less. They are aware that the traditional paddy has high demand and fetch higher market prices.

One reason for not cultivating traditional paddy varieties is the non-availability of good quality seeds. The seed paddy circulating in the area is highly mixed through commercial cultivation over many years. Certified seeds of high purity are demanded by the interested farmers for cultivation.

Although the interest on new paddy varieties, namely, At 311 (*Niroga red*) and At 373 (*Suwanda sanb*a) led by the grain attributes was high, the planned programme was abandoned due to non-availability of irrigable land.

It was unfortunate that the field demonstration programme by farmers could not be implemented in full and satisfactorily. However, farmers' willingness to continue with the programme is still strong.

7.4.4 Livestock-related Programme

(1) General

The arrival of NCP canal water is met with new challenge of transformation from traditional free grazing management system to integrated dairy farming system. This transition includes issues to be addressed as soon as possible for the development of stable livestock farming in the cascade area, even before waiting for NCP canal water.

Due to the rise in domestic milk demand as an import substitute, the number of farmers entering livestock especially dairy farming is increasing at the project site. Livestock makes it possible to secure stable income compared with agricultural crop cultivation where production is heavily influenced by the weather. But animal feeds mainly depend on grazing and its productivity seasonal variation is large. In particular, the difference in land use between rainy season and dry season affects the quantity and quality of feed accessible to livestock. In order to obtain stable income from livestock farming, it is necessary to improve the sources of animal feed.

In the cascade area, grazing land mainly use farmlands during non-crop cultivate periods, hence, access to feeds during the dry season and rainy season varies greatly. Therefore, milk production varies greatly in season. In order to promote a stable livestock industry, it is necessary to supply animal feed stably throughout the year. This is a fundamental change from the traditional animal husbandry. In order to achieve sustainable livestock development, it is important not only for the improvement of livestock feed but also many technical improvements as shown below.

- Improve recurring seasonal inadequate of quantity and quality of feed.
- Development unused feed resource including crop residue.
- Introduction of crossbreds enabling high milk production.
- Reduction of mortality in calves through improvement of facilities.
- Construction of hygienic and efficient milk collecting system.
- Promote of mechanisation to compensate for labour.
- Evaluation of impact of livestock on the peripheral environment.

Amongst the technical issues to promote livestock farming in the cascade area, this verification study focused on livestock feed resources in particular. The reason is that, as mentioned above, when NCP canal water arrives, the land that can be used as grazing will be restricted, hence, to develop feed resources instead for grazing is urgent issue. In addition, development of feed resource will equalise seasonal variability of feed resources that can be accessed in the rainy season and dry season. The stable availability of feed resources is the foundation of livestock development in these areas.

Securing livestock feeds stably supports the stable milk production. Therefore, in this verification study, the JICA Project Team conducted activities following five items focusing on improving feed resources as a priority issue amongst them.

Table 7.4.7 Summary of Activities in Verification Study

Subject	Verification Study	Outcomes for Action Plan
1) Forage cultivation	Yield survey	Crop residue availability
2) Feeding for animal	Silage making and feeding	Effect on production traits
3) Keep animal in shed	(Concrete floor)	Improve shed design
4) Farm management	Composition of animal type	Profit by herd size
5) Dairy products	Fresh cheese making training	Market test (hotel or school)

Source: JICA Project Team

(2) Activities and Operation Plan

(a) Forage Cultivation

In order to identify feed resources to replace grazing, the JICA Project Team investigated the type and availability of feed crops at the project site. The information was collected from the University of Peradenia and the Department of Animal Production and Health (DAPH).

Yield survey was conducted on maize with high possibility of utilising as material of silage in the farm field. Maize within the five spots of 2 m × 2 m frame was cut and weighed.

Growth of Maize

Measuring Weight

Source: JICA Project Team

Figure 7.4.1 Maize Yield Survey

(b) Feeding for Animal

The objective of this activity is to acquire technical knowledge to transform from grazing to feeding. In order to achieve this objective, the JICA Project Team conducted a training and practical instruction with equipment support to the Anuradhapura and Vavuniya farmers.

1) Training of Silage Making

Theoretical and practical training with brainstorming sessions for farmers were programmed. The objectives of this training are to provide necessary knowledge and technical skills in line with silage preparation using green forages and crop residue in order to increase shelf life of these materials and to manage dairy cattle without feed shortage during the cropping season when free grazing is not possible. A two-day programme was conducted in Polonnaruwa where the National Livestock Development Board (NLDB) water buffalo farm is situated and lot of experience in silage utilisation is provided. Contents of the first day training were on the theory of general milk production, silage making, and cattle management with discussion between trainer and trainees. The second day training included farmer field demonstration and hands-on activity in the preparation of silage by participants. The lecturer of theoretical lecture is a professor from DAPH in Kandy.

Lecture of animal feeding by Dr. Premeral

Cutting grass with grass chopper

Source: JICA Project Team

Figure 7.4.2 Training of Silage Making

2) Support Equipment

Since the work of silage making is labour intensive, the introduction of small equipment is effective. In order to promote silage making, small grass chopper and plastic tank were distributed to the model farmers.

Grass chopper

Plastic tanks for silage

Source: JICA Project Team

Figure 7.4.3 Equipment for Silage Production

3) Monitoring of Feed Preservation and Milk Production

The following factors were monitored at the model farm to verify the effect of forage preparation to livestock production in the rainy season: silage production, milk production, fat percentage, lactation periods, body condition, and breeding.

(a) Keep Animal in Shed

Because of the high mortality in traditional livestock farming system in Sri Lanka, it is necessary to provide a clean environment for disease control.

Preparation of animal shed is important for effective livestock farming by forage feeding. Especially at the project site, since the necessity of forage feeding in the rainy season is high, animal shed to avoid rain is required. Improvement point was summarised by surveying existing animal shed.

(b) Farm Management

Several farmer focus group meetings were held in the six cascades. All these farmers are from farmer organisations and they are not directly involved in dairy farming. However the discussion focused on crop-livestock integration, their experiences regarding livestock keeping, the difficulties or anxieties in including livestock in their farming system, current usage of crop residue, and youth participation in agriculture.

(c) Dairy Products

In order to increase milk production, it is most effective to make milking time twice than once a day. However, the cold chain is not adequately arranged, the fresh milk that was collected in the evening may be discarded due to quality degradation. Hence, processing the milk to yogurt and cheese will extend its shelf life and provide additional income. In addition, increased milk production by milking twice is expected to contribute not only to achieve additional income but also to improve human nutrition through self-consumption. The programme summarises dairy product development technology that can be tackled at the farmer's level through training of fresh cheese.

(3) Outcome and Feedback to Finalisation of Development Plan

(a) Forage Cultivation

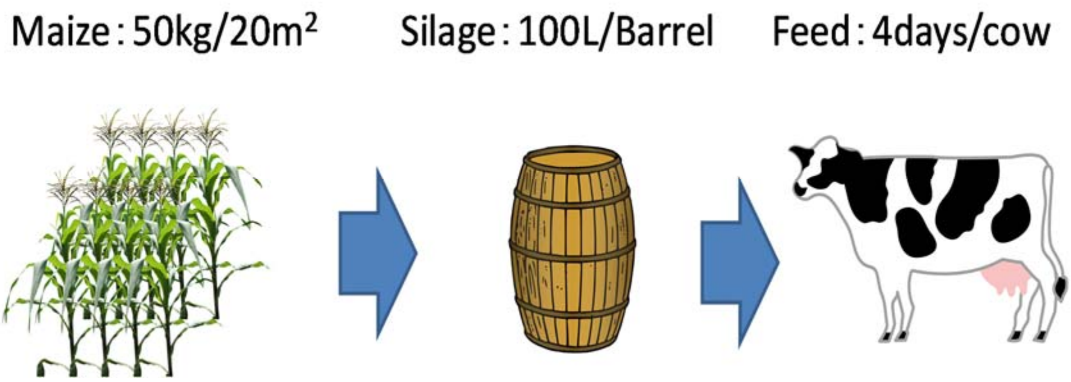
The yield of maize per square meter was 2.81 kg in fresh matter. This can be converted to 28 t/ha, which is about same of comparing with the Food and Agriculture Organisation (FAO) data (30–35 t/ha, *http://www.fao.org/faostat/en/#data/QC*). This result of maize yield is acceptable for silage utilisation in the project area.

Table 7.4.8 Yield of Maize

Plant Weight (kg/m2 ± S.D.)			Number of Stalk and Crop in m^2	
Whole (W)	Crop (C)	W-C	Stalk	Crop
5.09±0.92	2.28±0.41	2.81±0.53	10±1.33	10±1.41

Note: Fresh weight
Source: JICA Project Team

According to the field trials, 50 kg of fresh weight maize can make silage of 100 L barrel. Assuming that a cow can eat 15 kg per day, one barrel of silage can be used for four days per cow.



Source: JICA Project Team

Figure 7.4.4 Relationship Amongst Yield of Maize, Silage Preparation, and Feeding Periods

(b) Feeding for Animal

1) Training of Silage Making

The trainings were conducted on 27-28 February 2017 for the 12 participants of Anuradhapura farmers and 2 –3 March 2017 for the eight participants of Vavuniya farmers. Participants received a systematic and comprehensive training on animal feed. Participants stated their eagerness to learn with several questions especially on the practical training by the advanced farmer.

2) Support Equipment for Silage Making

Five fodder choppers, plastic tanks, and plastic bags for storage of silage were distributed to the selected five farmers. Each chopper is shared with other farmers for use.

In the silage making conducted in Anuradhapura, 50.5 kg of maize in fresh weight was stored in a 100-litre plastic tank. Calculating from maize yield a calculation that requires 18 m^2 of maize cultivation area is needed.

3) Result of the Verification Survey by Model Farmers

a) Silage

All model farmers prepared silage using project supported equipment in Anuradhapura but only two farmers in Vavuniya are prepared. This is because of the drought weather in 2017 and limited quantities of silage were prepared based on availability of maize stalk.

Table 7.4.9 Result of Silage Making by Model Farmers

	Area	Farmer	Address	Q'ty of Silage (Kg)
Anuradhapura	Galenbindunuwewa	L.G. Janaka Malinda Bandara	Upuldeniya	1,000
		G.S.S.P. Gunadasa	Koonwewa	1,000
		C.P. Upul Chandrasekara	Chandrasekara	1,000
		S.L. Sarath Kumara	Upuldeniya	1,000
		P Herath Banda	Wellahangawa	5,000
		S.M. Kumarasekara	Wellahangawa	1,000
		W.M. Jayaratne	Upuladeniya	1,000
		H.L Anura de Silva	Wellahangawa	1,000

	Kahatagasdigiliya	W.N. Weerakone	Kapirithgama	1,000
		N.H.K. Jayawardena	Kadawa	700
		B.M. Anura Basnayake	Kapirithgama	400
		S.R. Jayasinghe	Walahawidda wewa	700
		T. Wijesooriya	Walahawidda wewa	700
Vavuniya	Omanthai	Pirar Nakularaja	Maraiyadiththakulam, Omanthai	-
		Nadesu Saththiyananthan	Unit 01 Semamadu	-
		P.Navaneethan	Unit 01 Semamadu	-
		Thiyagarasa Piratheepan	Unit 01 Semamadu	400
		Kanthasamy Ruksan	Vinayagapuram Semamadu	-
		S. Markkandu	Vinayagapuram Semamadu	-
		S. Santhirakumar	Unit 01 Semamadu	-
		S. Pirasanth	Unit 01 Semamadu	-
Total				15,900

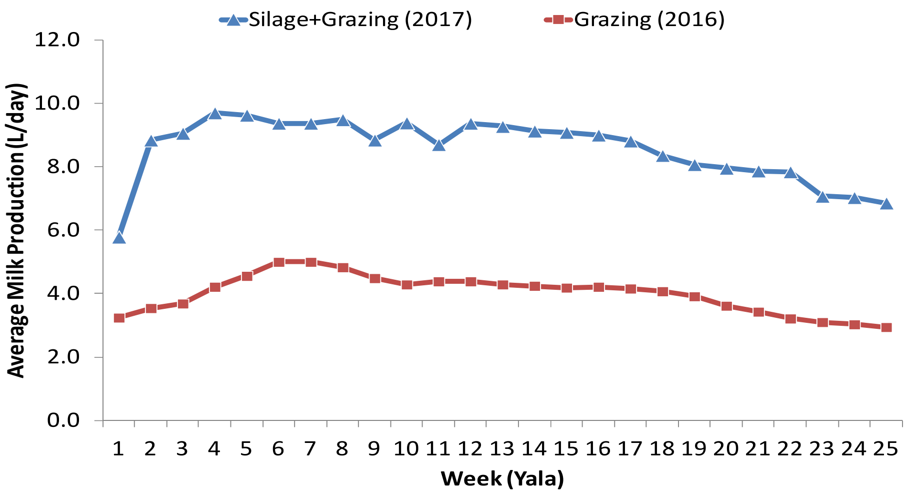
Source: JICA Project Team

b) Milk Production

Sri Lanka has been experiencing a drought from the beginning of 2016 and it was recorded that the cultivated land during Yala 2016 was only less than 20% and Maha 2016/17 was only 35%. Due to the farmers were able to allow their cattle to graze in uncultivated croplands, cattle production was not affected by drought condition.

Following figure shows the comparison of milk production under the condition between silage given and only grazing. The red line is during 2016 Yala with only grazing. Low soil moisture prevents a good growth of grass. Therefore, cattle could only eat around 50% of the dry matter requirement. Hence, milk productions become low. The blue line is during Yala 2017 with silage and grazing. Intermittent rain and slow maturing of grasses (before flowering) provided sufficient grass to consume around 50% of the dry matter requirement. Milk production was fortified with providing daily of 5kg of maize silage. Feeding silage increased the dry matter intake to about 75 to 80%.

The difference of average daily milk production between two conditions was 4.0 litre. This increase of milk production is not only silage feeding but also quality of grazing grass. The important point is that the farmers intend to grow 100% of the arable land in Yala after NCP water comes. The maize silage may be required up to 25 to 30 kg per day. This is a vital area that has to be considered.



Source: JICA Project Team

Figure 7.4.5 Comparison of milk production under the condition between silage given and only grazing

c) Fat Percentage

It is observed that the milk fat percentage drops during the hot period from June, July, and August. However, during the past three months, it was stable. This resulted in increased milk unit price.

d) Lactation Length

The improvement observed in lactation length from 150 days to 250 days is significant. A 100-day increase in milking period means 800 litres more and extra income during lactation.

e) Body Condition

The body condition score (from 1(poor) to 5(best)) at the beginning of calving is 2 or closer to 3, but will drop to 1 by the end of four months. This means ending of body reserves and it results in milk cessation by the fifth month or 150 days. However, with silage supplementing free grazing, the body condition score is expected to remain at 3 until the subsequent calving. Trainee farmers observed and questioned about this condition at the model farm in Polonnaruwa.

f) Breeding

Dairy cattle without silage feeding stay open (non-pregnant) for five to six months. However, it is observed that this period is reduced to two months. This will allow the cow to provide a calf annually as standards expect.

(c) Stall Feeding

The most important factors for the animal shed are the roof and floor, avoiding rainfall from falling off the shelter. Puddles during the rainy season increase the risk of diseases arising from hooves. This is particularly a major factor that increases the mortality of calves, so it must be improved urgently.

Traditional method is to pile soil to prevent puddle, but this should be replaced to concrete flooring. Ten square meters of floor can keep seven to eight calves. Fifty bags of 25 kg of cement are required for the concrete floor.

Traditional animal shed (Anuradhapura)

Modernised animal shed (Vavuniya)

Note: Modernise animal shed was funded by World Food Programme (WFP)
Source: JICA Project Team

Figure 7.4.6 Traditional and Modernised Animal Shed

(d) Value Addition

Traditional dairy products in Sri Lanka are curds. Unlike curds, fresh cheese manufacturing needs fermenting bacteria (starters), but they can also be made from dairy milk with low fat content, and its procedure is almost the same as curds, fresh cheese is one of the most potential dairy products.

7.5 Establishment of Cascade Management Organisation

7.5.1 General

A comprehensive and inclusive O&M structure to manage the whole cascade system is required for efficient use of the irrigation system with water from the NCP canal. Establishment of an umbrella organisation at the cascade system level to manage cascade level irrigation-related matters is one of the priority issues in the development of cascade systems.

Even though there have been several attempts to establish cascade level organisation in the past, they have not shown sustainable consequence. The possible reason of the unexpected results would be mainly because that the objective of the cascade level organisation focused on preservation of ecological system, on which residing farmers did not have strong interest and motivation. The verification activities in the project shall emphasis on the objective and roles as critical factors of the sustainable organisations that should meet the farmers felt needs and motives.

Introduction of social system requires different sort of verification from the introduction of technology. Adaptability of the system highly depends on the situation of existing social system and people's readiness. In order to establish self-sustainable bodies for cascade management, the possibility of establishing cascade level organisation shall be assessed by identifying or generating crucial aspects for sustainable organisation such as common explicit goal, trust, collaboration, motives, and communication.

7.5.2 Methodologies and Activities

(1) Verification Activities

Since the completion of NCP canal and actual water distribution is in about seven years' time, potential of formulating such organisations was verified instead of actual formation at this moment. The abovementioned aspects for sustainable organisation and possibility of establishing cascade level organisation were evaluated through the following activities:

Table 7.5.1 Activities for Verification of Cascade Management

Category	Activities	Time
Establishment of CMO	Farmer meeting at each FO under the model cascade	December 2016 - March 2017
	Household survey to draw individual opinion and feelings toward cascade management	February - April 2017
	Preparation of draft proposal on establishment and operation of cascade level organisation	May - June 2017
	Cascade level discussion for possible manner of cascade level organisation	August 2017
	Consultation with relevant government officers	August - September 2017
	Analysis of the view and opinions of the stakeholders	September 2017
Water Management Model	Development of water management model	August 2017
	Demonstration and trial on crop planning and water distribution model with NCP water	September 2017

Source: JICA Project Team

(a) FO Level Meetings

Taking the opportunities of farmers meetings for the detailed survey, questions and discussion were made on the possibility of cascade level management. Since the views on the cascade management shall differ by different communities and by the location of the tanks they manage, meetings were organised at the FO level. Possibility of cooperation amongst the cascade was assessed by analysing the current relationships with surrounding FOs, as well as collaboration within FOs in water management. Discussions were made in general gatherings of all the FOs under the six model cascades.

(b) Household Survey (HHS)

The household survey was utilised not only for the detailed survey but for the analysis of the possibility of establishment of the cascade level organisation as well. In order to draw opinions of the people who do not speak up in a gathering, questions for the individual views on cascade level management were included in the HHS questionnaire.

(c) Preparation of Draft Proposal on Establishment and Operation of CMO

Based on the information and analysis through the above survey, a draft proposal on the form of Cascade Management Organization (CMO) was prepared, the possibility of establishment of cascade level management bodies was verified through discussion with target farmers and relevant officers.

(d) Cascade Level Meetings

Details of the proposed cascade level organisation and management were discussed and simulated in cascade level meetings with representatives of all FOs under the model cascades. Issues that can be agreed by the majority were identified and differences of opinions between FOs were clarified through the discussion. Significant attention was paid on the relation between the FOs through observation of their discussion, including co-existence of different communities, involvement of minority groups, and opinions of small FOs.

(e) Consultation with Relevant Government Offices

It is crucial to make an organisation legally authorised in this country where FOs are functioning to a decent extent largely due to legal authorisation under the Agrarian Development Act and support of DAD. Clarification of the structure and roles of government shall also highly influence the effectiveness of the cascade level organisations. Possibility to integrate the cascade management system in the current structure of the government was consulted with relevant government offices such as DAD, Provincial Irrigation Department, and Central Irrigation Department as the cascade involve medium irrigation schemes.

(f) Demonstration of Crop Planning and Water Distribution Model with NCP Water

Water distribution model within the cascade with practice of crop planning with available water from NCP canal was prepared by the Project based on the information from the detailed survey and proposed cascade management. The models were prepared in a computer system and demonstrated to the representatives of the FOs under the model cascade for their feedback. Since the model was developed as an excel system, verification was to assess the acceptability and operational capacity of the FOs' representatives who has mathematical and computer knowledge.

7.5.3 Verification on Possibility of Establishment of Cascade Management Organisation (CMO)

(1) Proposed CMO

Judging from the decent operation of FOs under DAD's support and supervision, it was assessed that several aspects of FO functions can be applied to the cascade management. Even though the structure of the CMO shall be a federation of FOs with representatives of each FO instead of an organisation that has fixed membership, CMOs can adopt their basic function and operation from the FOs' experiences. The following are the essential aspects of the CMOs' structure, function, and operation.

Table 7.5.2 Design of CMO

Items	Proposed System
Organisational Structure	· Members of FOs are all FOs managing the tanks under the concerned cascade · A committee consists of representatives of each FO and tank under the cascade · Relevant government officers are involved as supporting members
Legal Authorisation	· CMO to be registered under DAD and governed by the Agrarian Development Act
Area of Authority of CMO	· CMO to be responsible only for cascade-related issues and issues of each tank remain under each FO
Government Agencies In-charge	· DAD: Supervision and authorisation of CMO · Central Irrigation Department: Authorisation of FOs of medium irrigation to participate in CMO · PDI: operation of tertiary canal and technical maintenance of cascade level facilities
Water Management	· CMO shall decide water distribution to each tank and each FO should prepare crop plan and allocate water complying the decision of the CMO · A cascade level water master (water controller) is appointed for water distribution and gate control · The water master is selected by CMO and officially and legally appointed by Agrarian Development Council at each ASC · Contribution is collected from each FO and deposited to ADC account, from which water master shall be paid.

O&M	· CMO is responsible for inter-tank facilities whilst each FO shall manage facilities of each tank · Minor maintenance works are under the responsibility of CMO and major rehabilitation is done with support of the government · Contribution from member FO managed by CMO shall be utilised for minor maintenance under supervision of DO

Source: JICA Project Team

Legal authorisation of the CMO is crucial for its sustainable operation. DAD has included a clause of cascade level FO federation for cascade level management in the amendment of the Agrarian Development Act, which is under process of endorsement by the Legal Department. This is a remarkably strong advantage in realisation of CMO establishment in the future.

One of the critical issues of CMOs' function is water management. Appointment of one cascade level water controller was generally agreed. Payments to the additionally appointed water masters, whose workload is considerably high, were also reasonably accepted. Since most of the FOs nominate their own water masters with payment either by cash or in kind, they do not have any difficulty in applying the same system to the cascade water master. Since the collection and deposit of the contribution from each FO to the CMO are slightly complicated, it was proposed to deposit the cash collected from each FO to the account of the Agrarian Development Council (ADC), which is an Agrarian Service Centre (ASC) level federation of FOs with their legal body defined in the Agrarian Development Act. Since ADCs have the right to legally appoint (employ) workers, cascade water masters shall be officially appointed and paid by the ADCs, whilst selection of the water masters shall be decided by CMOs.

(2) Results of the Study and Verification on Possibility of Establishment of CMO

(a) Evaluation of Potential of Establishing CMO through Study with FOs

1) Observation and Analysis of Each Model Cascade

Needs on the cascade level management body are widely recognised due to the requirement of cascade level water distribution. Unity amongst people under a cascade is judged fair, largely attributable to their current relation developed through ASC level meetings and communal activities amongst the FOs under the same ASC. However, different perspectives were drawn in different cascades.

There is high potential in establishing CMO in Naveli kulam and Kiulekada cascades, since 95% and 93% of the farmers under these cascades, respectively, preferred to decide water distribution through a cascade level management body. Since people in the area are relatively homogeneous, coordination of people and FOs seems to be relatively straightforward.

In Naveli kulam, even though FOs in this area are recently reactivated or newly formed after resettlement, people in the area know each other and FOs currently keep good relations. Monthly meetings at ASC for all FOs maintain good relationship amongst FOs. It was observed that FOs release water to downstream tank when they have enough water and the downstream FOs request for release. However, there are several opinions that indicated people's fear or concern on unfair distribution of water. Some of the upper tank farmers preferred to share only spilling water and downstream farmers feared that upper tank people would not share water. These opinion gaps should be equitably attended and be taken into consideration in the formation of CMO.

Even in Kiulekada, although large majority agreed to manage through cascade committee, some power relations amongst FOs were observed especially between larger FOs and small inactive FOs. Small FOs mentioned that control by *the Grama Niladhari* (GN) and ARPA to manage relations amongst FOs is essential. Moreover, existence of politically powerful landowners in a certain tank can cause political intervention in water management of the cascade. This aspect shall be carefully observed in the operation of cascade management and some strategies shall be discussed with relevant stakeholders.

Establishment of CMO in Siyambalagaswewa seems to be ideal from the viewpoint of composition of the cascade, where all FO boundaries are within the cascade boundary. It means each FO takes part in only one cascade and all FO members belong to the same cascade. This situation is rare and all other model cascades have FOs with tanks in other cascades. A fair percentage of farmers chose the option of establishing cascade committee for water management at the cascade level. Many positive opinions on establishment of CMO were also heard during FO meetings. However, results of preferences in water distribution systems and structures may imply needs of special attention as per analysis mentioned in the previous chapter. Preference on the fixed ratio of water distribution was high and the majority answered water to be delivered to individual tanks directly from the NCP canal, which may be because most of the tanks are upmost tanks, thus, there is a fear of not receiving water unless they are connected directly from the NCP. Moreover, very few farmers share water within their tanks during water scarce period. These indicate some difficulties in creating unity and collaboration of cascades. Higher preference on water distribution to individual tanks implies possible conflict of different interests amongst FOs. Even though it seems that there is high possibility to establish CMO, the above concerns should be taken into consideration.

In Alagalla Cascade, even though the need of cascade level organisation was generally accepted, some difficulties were observed mainly owing to the involvement of two different ethnic groups in different ASCs and Divisional Secretariat (DS) divisions speaking different languages. Some people raised concern that even though these different ethnic communities had a good relationship before, new generation wherein newly settled people may not be able to continue the good relations. Even though people on the ground in this area presently do not have any negative feelings towards each other, people seem to have concern on ethnic differences. Some people of downstream community doubt that the community of the upper tank releases water. Moreover, even though people generally agreed to establish a common organisation at the cascade level with mixed communities, they expressed tension when it comes to the distribution of water. The most critical issue was to which community the selected water controller belongs. A special attention should be paid in the establishment of cascade level management body as it might create conflict easily with small issues amongst FOs.

Establishment of CMO in Ichchankulama needs to be prepared with particular consideration as per analysis of the detailed survey mentioned in Chapter 6. Preference on cascade level committee to take charge of water distribution is significantly low in Ichchankulama Cascade in comparison with other cascades. The majority proposed that water be delivered to individual tank directly from the NCP canal. Besides, very few farmers share water within tanks during water scarce period. These indicate some difficulties in creating unity and collaboration of cascades. Lower preference on cascade level committee and higher preference on water distribution to individual tanks imply possible conflict of different interests amongst FOs. The minimum practice of water sharing within tank during water scarce period may also create a similar situation at the cascade level, as per indicated in the opinion of filling only specific tanks during water scarce period. Moreover, ethnic balances of two different groups should be carefully dealt as some suspects were raised during the survey that problem might come once the cascade receives water, even though both communities are currently collaborating well.

In the case of Rathmalawewa Cascade, despite the fact that two different ethnic groups speaking different languages are involved, there is a potential of establishing a CMO. Although the preference on cascade level committee to take charge of water distribution is relatively low in comparison with other cascades, half of the farmers proposed to form a cascade management organisation. As a precondition of forming a cascade level management body, people from different FOs under the cascade know each other, largely because they have periodical meetings at the DO and DS office level, through which they maintain their relationship. People also meet in general social and religious activities. It was stated that even Muslim FOs contribute in the Buddhist’s occasions although they do not physically participate. People also mentioned that these two communities in the area have no any problem even during the war period. However, it is still favoured to come up with preventive measures in case of conflicts in cascade level management as small disputes were heard in the cascade level meeting. One of the possible solutions is considerable involvement of government authority to control cascade management, as many FO members suggested involving a certain authority to intervene in cascade level water management.

2) Comprehensive Analysis on the Model Cascades

Some common features can be drawn from the abovementioned analysis of each cascade. The following table summarises the observed risk factors and relation with farmers’ perspective towards cascade management.

Table 7.5.3 Risk Factors and Perspectives Towards Cascade Management

Cascade			Alagalla	Ichchankulama	Kiulekada	Navelikulam	Rathmalawewa	Siyambalagaswewa
Risk factors	Cascade located over more than one ASC		○	○	×	×	×	×
	% of minority population		15%	36%	0%	0%	21%	0%
	Number of FOs		3	5	4	7	7	3
	No. of FOs covering more than one cascade		2	5	2	6	6	0
	Bethma practice		97%	1%	94%	100%	53%	1%
	Current problem/dispute between FOs		○ b/w upper and lower FOs	○ b/w upper and lower FOs	△ upper and lower tank	△ upper and lower tank	○ Sinhalese and Muslim, Caste	
	Existence of inactive FO					○	○	△
Preference in cascade management	Preferred water distribution system	CMO	40%	19%	93%	95%	50%	65%
		Individual tank	52%	52%	7%	2%	8%	1%
		Government	7%	12%	2%	36%	47%	16%
		Fixed ratio	16%	42%	3%	0%	44%	46%
	Preferred distribution structure	Existing system	1%	26%	1%	1%	3%	20%
		Direct canals	4%	54%	16%	3%	39%	83%
		Link canal	95%	38%	85%	96%	61%	23%

** Risk factors in effective water distribution*

High risk
Medium
low risk

Source: JICA Project Team

The following are the findings through analysis of the risk factors:

Firstly, cascades with mixed communities, including different caste groups, tend to show low preference on CMO and high preference on individual tank negotiation or fixed proportional allocation. This would be because their concern on possible disagreement amongst CMO members from different communities and difficulties in making consensus. Even though discussions on the establishment of CMO in the FO meetings and cascade level meetings were generally positive and the necessity of the cascade level management body is fairly recognised, some negative opinions and attitudes were observed towards different communities. Even though some expected conflicts are not necessary due to differences in ethnicity, religion, or caste, there is a possibility of aggravating the situation if the case happens between different communities.

Apart from the involvement of different communities, one of the constraints generally observed is the cascade with a relatively large number of FOs. Higher rate in government intervention in Naveli kulam and Rathmalawewa cascades can be due to a large number of FOs under the cascades, which makes it difficult to reach a consensus. A larger number of FOs increase the risk of conflicts, as more parties are involved the more issues will be raised due to differences in their interests. Moreover, disparity in the size of FOs may cause power relations between FOs and some dominant groups. A fair decision-making system with fair representation from each FO should be proposed in the establishment of CMO.

Another constraint observed in the cascade that covers two ASC divisions, such as Alagalla and Ichchankulama, is problem in coordination. Current relationship between FOs is one of the crucial factors to establish an effective management at the cascade level. Whilst FOs under the same ASC know each other, FOs in the neighbouring ASCs hardly communicated with each other. Although the FO in the neighbouring ASC agreed to work with other FOs in the cascade, coordination seems to be difficult, as some CMO functions and procedures are associated with the existing ASC structures.

A further concern in the cascade level management is the FO that manages several tanks. Some FOs with several tanks in different cascades mentioned that since the tank in the concerned cascade is connected to the other tank in the neighbouring cascade through its spillway, they prefer to send water to the other tank under the same FO. Although the case might be emphasised in the area involving different ethnic groups and in the cascade crossing over two ASCs, this situation is not a special case but frequently observed in other cascades with the existing cascade boundaries. Management of an FO that belongs to more than one cascade might require special arrangement for smooth management especially in the case where the area cultivated by the same farmers are divided by the cascade boundaries.

Lastly, the cascades with lower Bethma practice showed higher preference in fixed ratio and direct canal. This may be because they are accustomed to the situation that upper land owners take water without sharing with others, and they may feel that the fixed allocation through direct canal is the only way they can receive water regardless of power relation and location of their field.

The abovementioned factors are identified as risk factors in establishing effective management bodies at the cascade level. Therefore, those risk factors should be analysed in each cascade under NCP canal before formation, as well as during operation of the CMO, to take necessary action for the cascades that have higher risk of confronting difficulties.

(b) Evaluation of Potential of Cascade Management through Study with Relevant Officers

Possibility to establish CMOs was assessed with the opinions from relevant officers as well. Although all officers expressed positive opinions towards the formation of cascade level organisation, some concerns were raised through interview survey. Table 7.5.4 indicates expected difficulties stated by DOs and ARPAs in the concerned ASCs regarding cascade level management. The majority of the officers raised maintenance of inter-tank facilities as a possible problem. Almost half stated decision making amongst different FOs under the cascade might be difficult. About one-third of the officers answered the management of FOs that belongs to several cascades might be difficult and financial contribution for CMO from each FO shall be a problem.

Table 7.5.4 Expected Issues in Formation of CMO by DAD Officers

Expected Issues	% of Responses
Communication between FOs will be a problem	16%
Distance to meet periodically	26%
ARPA's boundary and cascade boundary is different and difficult to manage	11%
Decision making amongst FOs is difficult	47%
Will expect more conflicts between FOs and tanks	21%
Difficult to manage FOs that belong to several cascades	37%
Financial contribution from FOs might be a problem	37%
Maintenance of inter-tank facilities might be a problem as it is not clear who shall take responsibility	58%
Others	0%

Source: JICA Project Team based on the interview survey to DO and ARPA

Further opinions and suggestions raised from DO/ARPA in-charge of the model cascades regarding establishment of CMO are as follows:

- CMO should be registered under DAD (although some proposed to register CMO under DS office),CMO should be supervised by DO,
- CMO members should be office bearers of all FOs and representative of each tank,
- Grassroots level government officers should be included in CMO,
- A suitable constitution for CMO should be prepared,
- Financial strengthening of CMO is required,
- CMO should be trained for smooth function, and
- CMO’s account shall be newly created or use the ADC committees’ account that is under the supervision of DO.

These concerns and opinions are to be taken into consideration in planning and legislation making of CMO as DAD officers are the ones to supervise and intervene CMO operations. It is also recommendable to organise training programmes for the concerned officers to deal with those difficulties.

(3) Recommendation and Feedback to Finalisation of Development Plan

In consideration of the results of the demonstration survey, it is concluded that it is feasible and preferable to establish cascade management organisations as proposed in the above. However, as mentioned in the previous session, several difficulties and concerns were observed. The following discusses the proposed cascade level management system and possible constraints with their countermeasures. Furthermore, necessary considerations and recommendations drawn from the analysis of the verification are stated.

(a) Observed Constraints in CMO Management and Proposed Countermeasures

1) Management of Cascades Crossing-over ASC Divisions

Cascades crossing-over more than one ASC division may face difficulties in management due to the following reasons: Firstly, it was observed that unity of people from different ASCs might be weak as relation between people from different ASC divisions is much less than those from the same ASC. Secondly, the proposed cascade management is integrated in the existing system of ASC such as the Agrarian Development Committee at ASC level. Although these cases are limited in particular cascades, there seems to be several in the total 128 cascades. Therefore, the Project proposes possible options of water management for those cases and countermeasures on the disadvantages in each option.

Table 7.5.5 Options of Countermeasures against the Observed Difficulties

Options of Water Management	Advantages	Disadvantages	Necessary Action to Overcome the Disadvantages
CMO to be formed by current cascade boundary involving FOs from different ASCs and manage as a whole	・ The irrigation system is the most optimised and less costly ・ It is in line with the government policy of social integration	・ Possibility of triggering conflicts ・ Weak unity between different communities or under different ASCs ・ Difficulties in management amongst different communities or under different ASCs ・ (e.g., where the contribution shall be deposited)	・ Fair regulation shall be set to avoid conflict ・ Train officers in-charge on conflict resolution and fair treatment ・ System of collaboration between two ASCs should be established especially in deposit of contribution
Separate water distribution through separate tertiary canal to the upmost tank of each area	・ Strong unity under the same ASC ・ Management is easier being controlled within the ASC	・ Possibility of higher cost to link to the neighbouring cascade ・ Technical difficulty in linking to the neighbouring cascade in some cases ・ Ethical view in making exception on cascade boundary	・ More budget allocation ・ Re-demarcation of cascade boundary
Controlled by the government	・ Management is easier and more stable	・ Lower farmers' participation and ownership ・ Need to employ extra staffs ・ To be applied only to the cascade of exceptional case or to all the cascades ・ Role of CMO shall be obscure	・ Department in-charge should be decided. ・ Appointment and employment of extra staff ・ Separate system and regulation should be applied for these exceptional cases

Source: JICA Project Team

It is recommended to manage with the first option of establishing CMO with FOs from different ASCs, judging from the disadvantages of other options, even though the management shall be easier in other options. Since there are probable constraints in the proposed option of establishing CMO crossing over the ASC divisions, it is strongly proposed to make appropriate intervention with the mentioned countermeasures to reconcile the constraints.

2) Management by Mixed Community

Possibility of internal conflict cannot be denied in the cascade with mixed community, especially in water distribution and appointment of a cascade level water master. Management amongst Sinhalese communities and Muslim community of Sri Lankan Moor shall not face much problem as their current relations are fair and people are socially coexisting. Their expected conflict seems to be originated by water availability regardless the ethnic differences. On the other hand, careful intervention will be necessary in the cascades co-managed by the Sinhalese and Tamil communities as some disputes were observed during the meetings. Even though there are similar options as the cascade crossing over two ASC divisions, situation in decision making is more complicated. Separate water flow through different tertiary canals for different ethnic groups seems to reduce risk of conflict and make the management easier. On the other hand, it may remind them of separation of ethnicities and bring negative impacts on ethnic coexistence. According to the DAD field officers who are expected to be involved in any problem solution of FOs, they are confident to manage conflict between different communities, which is better than underlining separation of the communities even before any occurrence of conflict. Therefore, it shall be recommended to encourage them to manage the cascade system by the mixed community with fair distribution of water. In order to avoid occurrence of conflict, a fundamental step to be taken is behavioural change of farmers through collaboration in the CMOs' activities as well as awareness programmes and social interaction, which shall be initiated far prior to the formation of the CMOs. More systematic conflict management training shall also be organised to enhance capacity of conflict resolution of the organisation. In addition, the officers in-charge shall take important roles in handling the communities. Meticulous trainings on conflict management and inclusion of minority and socially underprivileged people should be organised for the field officers who are expected to be consulted by the communities in case of any conflict amongst cascades. It is also crucial to create a system to assure fair relation between different groups and legal provision to comply the system. Moreover, different languages that different communities use shall be equally applied in the documentation, information delivery, and discussion, in which Sinhalese language is, in most of current cases, dominant as many Tamil and Muslim people understand Sinhalese.

(b) Further Needs to be Considered in the Development Plan

1) Need in Legal Framework

Most of the FOs under the model cascades have fair O&M implementation and collection of fees mainly due to the legal regulation defined in the Agrarian Development Act. Even though they have not executed any legal action, farmers follow the decision of *Kanna* meeting as compulsory responsibility. This means strong legal authorisation of regulation can work and it will be necessary for effective function of CMOs. Legal frameworks are to be developed with general regulations and ordinance of CMO. Since DAD is taking the process of legalising cascade level organisation to be formed and be assigned with authority, further specification of the organisation with their roles and functions, as well as rights and restrictions to be imposed are proposed. The specification shall be prepared with some rooms for adjustment according to the field situation to adapt complicated situation observed in some special cases. In the cases of cascades where different communities speak different languages or different social groups work together, the legal frameworks should assure fair rights and power to all the communities regardless of ethnicity, religion, and caste. Moreover, positive discriminative strategy might be necessary if there is a risk for the minority groups to be overwhelmed. Appointment of officers to be involved in the CMO who can stand as the voice of the minority groups can be also adopted.

2) Need in Administrative Structure

Expected administrative structure for NCP and cascade management is mentioned in Chapter 5.7.2. Judging from the operation of each FO, effective functions of FOs are highly attributed to regulation and supervision of DAD officers. Regarding establishment of CMO, it seems preferable to involve relevant government authorities to monitor and intervene the issues expected to happen in cascade level management.

Administrative structure is one of the important factors for the sustainable development of cascade level management as administrative boundaries are significantly influencing social relations of the communities. People from the FOs under the same ASC generally know each other, largely because they have periodical meetings at ASC and DS office level, in which they maintain their relationship. This is a positive precondition of forming cascade level management body. Siyambalagaswewa Cascade is ideal in terms of boundaries of cascade, FOs, and administrative area. Therefore, existing administrative structure can be applied in management of the cascade as well as the cascade level management body. On the other hand, some cascades are located crossing over more than one ASC division as mentioned above. Coordination between FOs under different ASCs seems to be more complicated. People largely say that FOs under a different area hardly know each other. The minority FOs from other ASC division proposed to have support of relevant government officers for cascade management in consideration of the situation that the cascade covers two different ASCs and DS divisions. Proposing the CMO to be established following the cascade boundaries even covering two ASCs, a particular arrangement of coordination is necessary at a higher level of authorities as involvement of areas of two different authorities and officers may cause confusion. Rules on procedures and communication system are defined in the proposed ‘operational rules’ as legal administrative rules as per attached as attachment of the action plan project sheet.

Another concern regarding administrative structure is coordination between minor tanks and medium tank within the cascades. Three out of the six model cascades have medium tanks within their cascades. The medium tanks are administratively controlled by separate FOs under the supervision of Irrigation Departments, whilst minor tanks are managed by FOs under DAD. Judging from the situation observed in the model cascades with medium tanks, many of the FO members for the medium tanks are overlapping with FO members of the neighbouring FOs of the minor tanks. Even though collaboration with FOs under medium rank at farmers’ level seems to have no problem, coordination between authorities for management of whole cascade shall be critical. Coordination between different government agencies or offices shall be handled through supportive members of CMO representing each office, as well as coordination meetings at ASC, DS, and district level.

3) Needs of Permeation of Cascade Management Concepts

Even in the cascade where very few people preferred cascade committee to manage water, discussion in the FO meetings and cascade level meeting was positive and enthusiastic towards establishment of cascade management organisation. The positive discussions during the FO meetings conducted to enhance awareness on the necessity of cascade level water management imply high possibility of forming cascade level management body. Through the explanation about expected situation with the NCP canals and discussion on necessity of cascade level management, all the FOs agreed to establish cascade level management bodies as a whole. The participants of the meeting even proposed that CMO can decide by introducing rules in case of disagreement between the upper and lower tanks such as refusal of releasing water.

Judging from the abovementioned situation, intensive awareness programme on necessity of cascade level organisation is inevitable to create foundation for CMO. Activities to enhance collaboration between FOs should be started prior to the establishment of CMO for the farmers to be ready for the operation of the organisation by the time NCP water is delivered.

4) Needs of Fair Management for Different Groups

In addition to the different communities due to ethnicity and religion, fairness should be ascertained in the following situation. Proposed ‘Operational rules of CMO’ define some rules to assure fairness and avoid disadvantages for a particular group of people.

a) Caste groups

Even though caste systems are not a perilous issue in water distribution in current situation, it is still existing in some areas. Since people from different caste are co-existing and participating in the common social activities, the risk of conflicts between different caste groups will not be critical. It is rather important to provide equal opportunities for the underprivileged group to raise their opinions and for them not to face difficulties.

b) Gender

Participation of women in decision making of water management is limited judging from the allocation of positions of office bearers. In Muslim communities, in particular, women hardly participate in the meetings. This situation seems to be applied even to the cascade level management. Even though it is highly driven from cultural and traditional practice, it will deprive women of access to information and services. Culturally acceptable arrangement to involve women in decision making shall be provided.

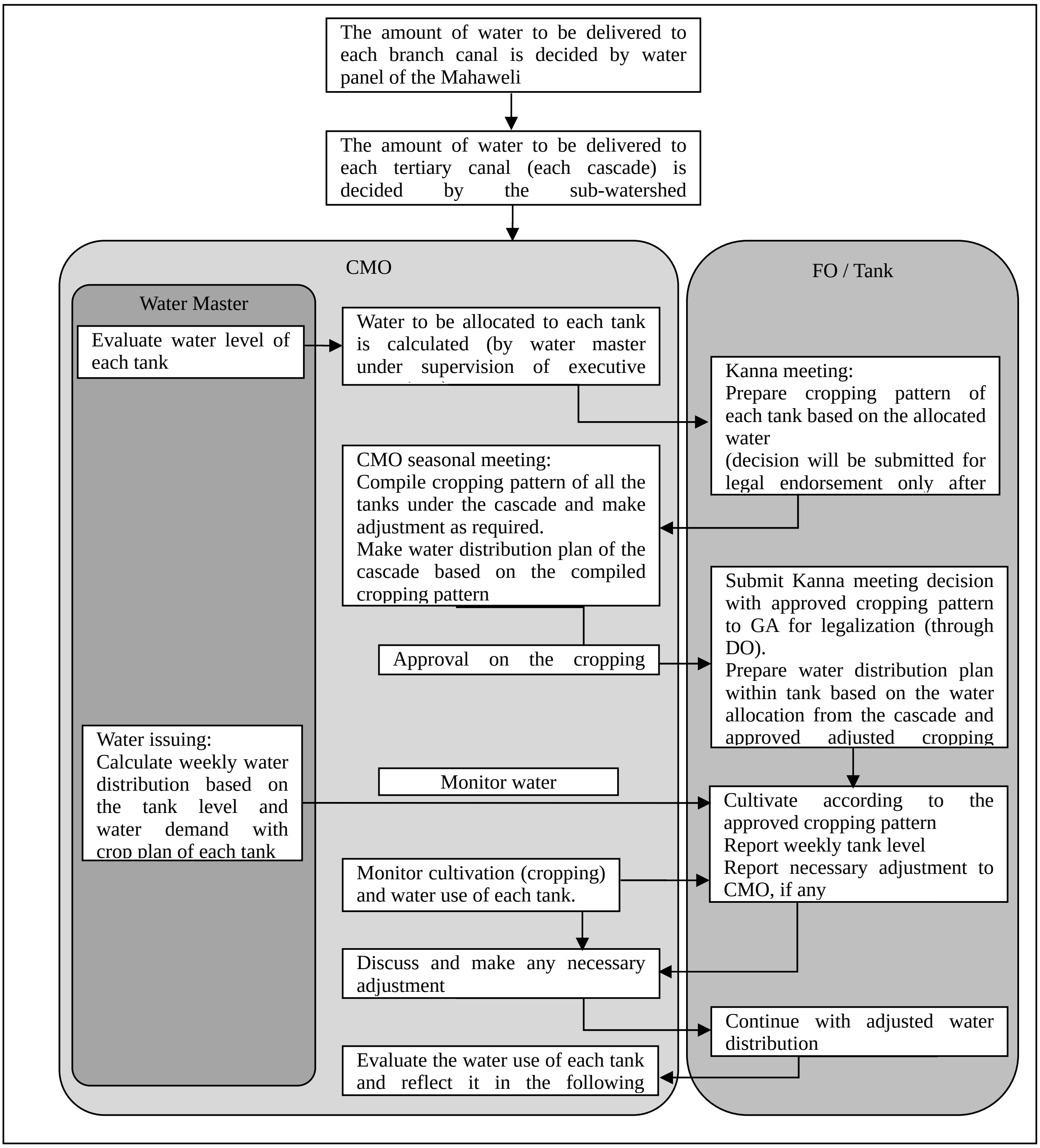
c) FOs' Power Relations

Power relations between FOs under cascades differ in different cascades. Equal representation to the cascade management body will give equal opportunity to all FOs and tanks regardless of their size, capacities, and power. Whilst this system provides equal power to small and weak FOs and tanks in decision making, it may create unfairness in larger and stronger FOs as they may feel larger FO should have proportional representation.

7.5.4 Verification of Water Distribution Model

(1) Proposed Cascade Water Distribution Model

The overall feature of the procedures of water distribution is indicated in Figure 7.5.1.

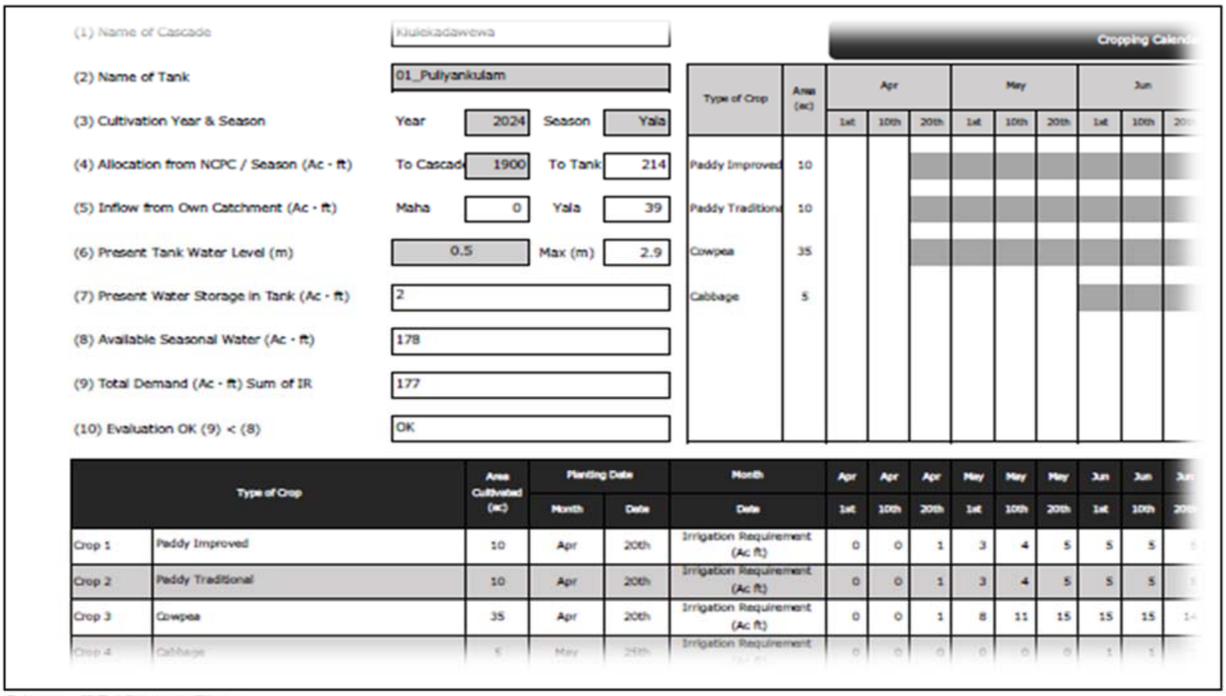


Source: JICA Project Team

Figure 7.5.1 Proposed Process of Water Management

The available water amount to the cascade for a season is decided by the Irrigation Department that manages the branch canals of NCP, based on which the amount of water to be allocated to each tank within the cascade is principally calculated on proportional basis according to the command area of each tank. Each FO under the cascade prepares a crop plan based on the allocated water amount to the tank using the developed crop planning model. The crop plan prepared by each FO is examined and compiled by the CMO to balance the water requirement and supply. For the water distribution, the water master will measure the water level every ten days and calculate water discharge of each link canal with the developed model for link canal operation based on the water requirement of each tank calculated from the crop plan.

The developed model for crop planning and water distribution within cascade is indicated in Figure 7.5.2.

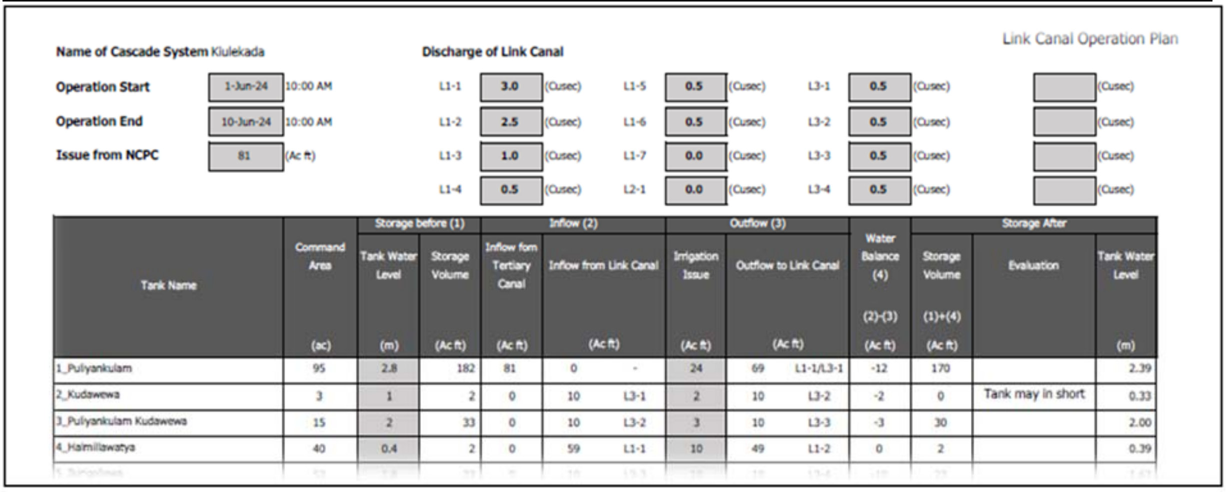


Source: JICA Project Team

Figure 7.5.2 Crop Planning Model

The required amount of water for the planned crops is calculated with the variables of varieties of crops, cultivation extents, and planting time, which the FO members can decide in consideration of their preference and other factors. Through the calculation by the system, the FOs can judge the sufficiency of water for the planned cultivation in comparison with the allocated water, thus, they can select their cultivation with maximum use of water.

Water distribution is calculated every ten days with the tank water level and water requirement of each tank in the particular operation period. The system indicates shortage and excess of water in each tank calculated from the variables of water level and requirement during the specified operation period. The water master shall adjust water discharge of each link canal to avoid shortage and overflow of the tanks. Figure 7.5.3 shows the developed model of water distribution.


Link Canal Operation Plan

Name of Cascade System Kiulekada

Operation Start 1-Jun-24 10:00 AM

Operation End 10-Jun-24 10:00 AM

Issue from NCPC 81 (Ac ft)

Discharge of Link Canal

L1-1	**3.0** (Cusec)	L1-5	**0.5** (Cusec)	L3-1	**0.5** (Cusec)		(Cusec)
L1-2	**2.5** (Cusec)	L1-6	**0.5** (Cusec)	L3-2	**0.5** (Cusec)		(Cusec)
L1-3	**1.0** (Cusec)	L1-7	**0.0** (Cusec)	L3-3	**0.5** (Cusec)		(Cusec)
L1-4	**0.5** (Cusec)	L2-1	**0.0** (Cusec)	L3-4	**0.5** (Cusec)		(Cusec)

Tank Name	Command Area	Storage before (1)		Inflow (2)			Outflow (3)			Water Balance (4)	Storage After		
		Tank Water Level	Storage Volume	Inflow fom Tertiary Canal	Inflow from Link Canal	(link)	Irrigation Issue	Outflow to Link Canal	(link)	(2)-(3)	Storage Volume (1)+(4)	Evaluation	Tank Water Level
	(ac)	(m)	(Ac ft)	(Ac ft)	(Ac ft)		(Ac ft)	(Ac ft)		(Ac ft)	(Ac ft)		(m)
1_Puliyankulam	95	2.8	182	81	0	-	24	69	L1-1/L3-1	-12	170		2.39
2_Kudawewa	3	1	2	0	10	L3-1	2	10	L3-2	-2	0	Tank may in short	0.33
3_Puliyankulam Kudawewa	15	2	33	0	10	L3-2	3	10	L3-3	-3	30		2.00
4_Halmillawatya	40	0.4	2	0	59	L1-1	10	49	L1-2	0	2		0.39

Source: JICA Project Team

Figure 7.5.3 Water Distribution Model (Link Canal Operation Plan)

(2) Results and Feedback to Finalisation of Development Plan

Concepts of the model and indications in the system were generally understood through demonstration session to the FO representatives. Reaction of the farmers participated in the demonstration sessions was positive expecting the systematic models to facilitate more efficient water use. It was proved that some young representatives of the FOs have skills in operating the systems in Excel. Even though those who can handle Excel system are limited at this stage, it is expected that larger population of the young generations will acquire computer knowledge by the time of NCPC operation, judging from the rapid development and penetration of IT skills in the rural areas in these years. However, establishment of infrastructure such as computers are required, which are not commonly available at present in the target area. Moreover, even though the system was fairly understood by the farmer representatives, actual operation may cause some complications in decision making especially in crop planning. Specific trainings with practical follow-up programmes are required to adopt the system in the actual situation. The system itself shall be handed over either to PDI or to DAD, officers of which will receive training of trainers (ToT) on the operation skills as well as maintenance of the system.