スリランカ国
マハヴェリ開発環境省

スリランカ国
北中部乾燥地域における
連珠型ため池灌漑開発計画プロジェクト

ファイナルレポート

別添資料

平成 30 年 5 月
(2018 年)

独立行政法人
国際協力機構（JICA）

日本工営株式会社
NTC インターナショナル株式会社

農村
JR
18-009

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ANNEX-1

THE REPORT ON RESULT OF DETAILED SURVEY IN SIX CASCADE SYSTEMS

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

THE PROJECT
FOR
FORMULATING CASCADE SYSTEM DEVELOPMENT PLAN
UNDER NORTH CENTRAL PROVINCE CANAL
IN
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE REPORT ON RESULT OF DETAILED SURVEY IN ALAGALLA CASCADE SYSTEM

June 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

NTC INTERNATIONAL CO., LTD.

THE PROJECT
FOR
FORMULATING CASCADE SYSTEM
DEVELOPMENT PLAN UNDER NORTH CENTRAL PROVINCE CANAL
IN
DEMOCRATIC SOCIALIST REPUBLICOF SRI LANKA

The Report on Result of Detailed Survey in Alagalla Cascade System

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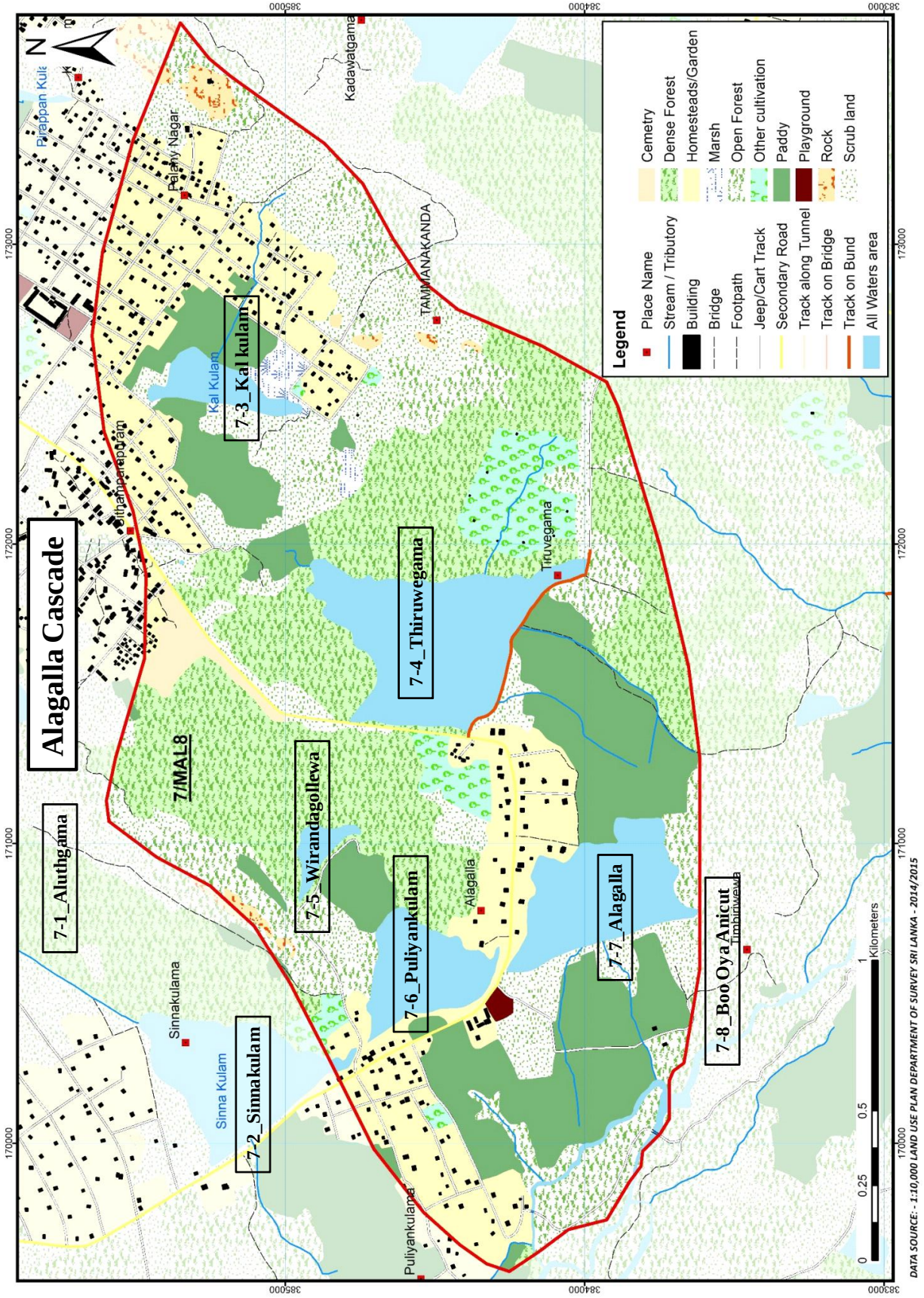
Attachments

Abbreviations

ACAD	Assistant Commissioner Agrarian Development
AI_1	Agricultural Instructor
AI_2	Artificial Insemination
ARPA	Agriculture Research & Development Assistants
ASC	Agrarian Service Centre
CBO	Community Based Organization
CIC	(Company Name previously called 'Chemical Industry of Colombo')
CMFO	Cascade Management Farmer Organization
CN	Centre
CoP	Cost of Production
DAD	Department of Agrarian Development
DAPH	Department of Animal Production and Health
DEC	Dedicated Economic Centre
DO	Divisional Officer under ASC
DOA	Department of Agriculture
DOI	Department of Irrigation
DS	Divisional Secretariat / Divisional Secretary
FO	Farmer Organization
GN	Grama Niladhari
GND	Grama Niladhari Division
GOSL	Government of Sri Lanka
HH	House Hold
HHS	Household Survey
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
LB	Left Bank
LHG	Low Humid Grey
MASL	Mahaweli Authority of Sri Lanka
MCM	Million Cubic Meter
MMDE	Ministry of Mahaweli Development and Environment
MOI	Ministry of irrigation
MT	Metric ton
MW	Mega Watt
NCP	North Central Province
NCPC	North Central Province canal
NCPCP	North Central Province Canal Project
NGO	Non-Government Organization
NLDB	National Livestock Development Board
NP	Northern Province
O&M	Operation and Management
OFC	Other Field Crops
PDAPH	Provincial Department of Animal Production and Health
PDI	Provincial Director of Irrigation
PMB	Paddy Marketing Board
RB	Right Bank
RBE	Reddish Brown Earth
RDS	Rural Development Society
RR&DI	Rice Research and Development Institute
RVS	Range Veterinary Surgeon
TO	Technical Officer
WRDS	Women Rural Development Society



Source: JICA Project Team (Source of Map: 1:10,000 Land Use Plan Department of Survey Sri Lanka – 2014/2015)

Location Map of Alagalla Cascade

Chapter 1 Introduction

1.1 General

The Report on the Result of Detailed Survey in Alagalla Cascade System was prepared under JICA funded project named "The Project for Formulating Cascade System Development Plan under North Central Province Canal in Democratic Socialist Republic of Sri Lanka" with nodal counterpart agency of Ministry of Mahaweli Development and Environment. The detailed survey was carried out in the selected six cascade systems namely Ichchankulama, Siyambalagaswewa, Rathmalawewa, Kiulekada, Alagalla and Naveli kulam located in Anuradhapura and Vavuniya District to be benefited by North Central Province Canal Project in order to identify the actual ground situation and development needs for formulation of total cascade system development plan covering 128 cascade systems. The report describes methodology for detailed survey in the Chapter 1, present condition with several aspects namely administration and socio economic, soil and land use, meteorology and water resources, agriculture and agro-economy, livestock, infrastructure and farmers' organization in Chapter 2 and needs for development in Chapter 3.

1.2 Methodology

The detailed survey was composed of four surveys namely (1) inventory survey for present infrastructure such as tank, canal system and rural roads, (2) farm household survey, (3) group discussion on farmers' organization and (4) interview survey on government frontline officers. The objectives, methodology, timing and main implementers for those surveys are described in the following table.

Table 1.2.1 Outline of Detailed Survey

Name of Survey	Objectives	Major Activities or Major Information Collected	Target	Timing	Main Implementer
Inventory survey for present infrastructure	Collect data for rehabilitation planning and cost estimation	(1) Topographic survey for tank bund and canal route (2) Inventory survey for tank and canal related structures (Sluice & spillway, farm turnouts) (3) Inventory survey for rural road	69 tanks irrigation schemes Ichchankulama : 9 tanks Siyambalagaswewa : 10 tanks Rathmalawewa : 15 tanks Kiulekada : 14 tanks Alagalla : 5 tanks Naveli kulam : 16 tanks	January to May 2017	JICA Project Team, DAD Anuradhapura and Vavuniya and PDI in North Central and Northern Province
Farm household survey	Identify the present farm household socio economic condition, livelihood, agriculture & livestock activities and development need etc. through questionnaire survey	(1) General (2) Income and expenditure (3) Landholding (4) Agriculture production and management (5) Livestock production and management (6) Marketing (7) Irrigation and water management	1168 farm household in the selected six cascade systems Ichchankulama : 198 nos. Siyambalagaswewa : 150 nos. Rathmalawewa : 275 nos. Kiulekada : 255 nos. Alagalla : 135 nos. Naveli kulam : 155 nos.	January to March 2017	JICA Project Team and DAD Anuradhapura and Vavuniya
Group discussion on	Collect information on	(1) Member (2) Regulation	29 farmers' organizations Ichchankulama : 5 nos.	December 2016 to	JICA Project Team and DAD

farmers' organization	present farmers' organization activities and functions and idea for future cascade management	(3) Activities (4) Financial status (5) Water management (6) Present constraint and development need	Siyambalagaswewa : 3 nos. Rathmalawewa : 7 nos. Kiulekada : 4 nos. Alagalla : 3 nos. Naveli kulam : 7 nos.	May 2017	Anuradhapura and Vavuniya
Interview survey on government frontline officers	Collect information on present farmers' organization activities and possibility for future cascade management	(1) Present functions of FO and challenges faced (2) Possibility for formation of cascade FO and points to be addressed when forming the cascade level FO	19 officers attached to Agrarian Service Centre (ASC) such as DO and ARPA	May 2017	JICA Project Team

Source: JICA Project Team

The contents described in the following chapters are based on above surveys.

Chapter 2 Present Condition of Alagalla Cascade System

2.1 Administration and Socio Economic Condition

2.1.1 Administration in Alagalla Cascade

Alagalla cascade is located in Vavuniya District. A major part of the cascade belongs to Vavuniya Divisional Secretariat (DS) division while it is partially located in Vavuniya South DS division. The part in Vavuniya DS division is under Kovilkulam Agrarian Service Centres (ASC) and that in Vavuniya South DS division is under Madukanda ASC. Vavuniya DS division is Tamil dominated area while Vavuniya South DS division is Sinhalese dominated area. The following table indicates administrative location of the tanks under Alagalla cascade and target beneficiaries of each tank.

Table 2.1.1 Administrative Location and Target Population of the Target Tanks

DS Division	ASC	GN Division	GN Code	Tank	No. of HHs Benefitted	Target no. of HH*1	Estimated Target Population*2
Vavuniya South	Madukanda	Alagalla	C212B	Alagalla	55	35	165
				Aluthgama*3	15	9	51
				Boo Oya*3	35	32	130
				Puliyankulam	10	14	24
				Sinnakulam*3	56	55	202
				Wirandagollewa	12	3	40
				Thiruwegama	41	41	160
Vavuniya	Kovilkulam	Ashi kulam	244	Kal kulam	26	23	104
				Total	250	212	876

**1The number of target HH is determined as the farmer families who are using the tank as their main tank. There are a few farmers who have land under different tanks are categorised in their main tank.*
**2Calculated from the number of household ands average number of family members*
**3Those tanks are outside the cascade boundary even though there have water flow to or from Alagalla cascades*
Source: JICA Project Team based on the FO interview and HHS result

Agrarian services to the farm households are provided by the Agricultural Research and Production Assistants (ARPA) under the purview Divisional Officer (DO) of Agrarian Service Centre Madukanda, reporting to the Department of Agrarian Development, Vavuniya. Agricultural extension services are provided by the Agricultural Instructor (AI) of Irattaperiyakulam Range of Provincial Department of Agriculture, Vavuniya. Four ARPAs are managing 29 FOs in Madukanda ASC and five ARPAs are assigned for 31 Farmers Organisations (FOs) in Madukanda as shown in the table below. This means one ARPA handles about six to seven FOs in the area, which is fair in consideration of other area in Vavuniya where one ARPA is handling from 30 to 40 FOs, even though the average number of FOs under one ARPA in Anuradhapura is three to four. The ARPAs who are handling tanks under Alagalla cascades are one in Madukanda ASC and one in Kovilkulam ASC.

Table 2.1.2 Number of ARPA Officers incharge in Vavuniya District

DS Name	ASC Name	No. of ARPA Division	No. of ARPA Officers	No. of FOs	No. of FO per ARPA Officer
Vavuniya	Kovilkulam	19	4	29	7.25
	Pampaimadu	13	1	40	40.00
	Omanthai	10	1	30	30.00
Vavuniya South	Madukanda	12	5	31	6.20
	Illuk kulam	8	4	15	3.75
Vavuniya North	Nedunkerni	11	0	19	n/a
	Kanagarayan Kulam	9	1	19	19.00
Vengalacheddikulam	Vengalacheddikulam	-	2	42	21.00

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

2.1.2 Socio Economic Situation of Alagalla Cascade

As per mentioned in the previous section, Alagalla cascade is located over two DS divisions, where there are two different dominant ethnic groups. Beneficiaries of the tanks in Vavuniya DS division are totally Tamil and those in Vavuniya South DS division are Sinhalese. The following table shows the ethnic distribution in each tank under Alagalla cascade.

Table 2.1.3 Ethnicity of the Beneficiary Households per Tank

Tank	Sinhala		Tamil		Total Valid Responses	
	(no.)	(%)	(no.)	(%)	(no.)	(%)
Alagalla	23	100.0%		0.0%	23	100.0%
Aluthgama	9	100.0%		0.0%	9	100.0%
Boo Oya	19	100.0%		0.0%	19	100.0%
Puliyankulam	7	100.0%		0.0%	7	100.0%
Sinnakulam	38	100.0%		0.0%	38	100.0%
Wirandagollewa	3	100.0%		0.0%	3	100.0%
Thiruwegama	16	100.0%		0.0%	16	100.0%
Kal kulam		0.0%	20	100.0%	20	100.0%
Total	115	85.2%	20	14.8%	135	100.0%

Source: JICA Project Team based on the result of HHS conducted in March 2017

Even though religion is closely related with ethnicity in Sri Lanka, there are a few other religious groups. While most of the Tamil population is Hindi, the majority of the Tamil beneficiaries in the target area is Christian. The area where Kal kulam is located is a Christian dominant community in the Tamil area. Details of allocation of religion in the area is shown in the table below.

Table 2.1.4 Religion of the Beneficiary Households pre Tank

	Buddhist		Christian		Hindi		Total	
Tank	(no.)	(%)	(no.)	(%)	(no.)	(%)	(no.)	(%)
Alagalla	23	100.0%		0.0%		0.0%	23	100.0%
Aluthgama	9	100.0%		0.0%		0.0%	9	100.0%
Boo Oya	19	100.0%		0.0%		0.0%	19	100.0%
Puliyankulam	7	100.0%		0.0%		0.0%	7	100.0%
Sinnakulam	38	100.0%		0.0%		0.0%	38	100.0%
Wirandagollewa	3	100.0%		0.0%		0.0%	3	100.0%
Thiruwegama	16	100.0%		0.0%		0.0%	16	100.0%
Kal kulam		0.0%	18	90.0%	2	10.0%	20	100.0%
Total	115	85.2%	18	13.3%	2	1.5%	135	100.0%

Source: JICA Project Team based on the result of HHS conducted in March 2017

The average size of families in the Alagalla area is 3.5 members per family. Puliyankulam has remarkably low figure of the average of 2.4 members while Thiruwegama and Kal kulam have relatively large families.

Table 2.1.5 Number of Household by Number of Family Members per Tank

Tank	No. of family member in household							Valid answer	Average family member
	1	2	3	4	5	6	7		
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(no.)	
Alagalla	8.7%	34.8%	8.7%	43.5%	4.3%	0.0%	0.0%	23	3.0
Aluthgama	0.0%	33.3%	22.2%	22.2%	11.1%	11.1%	0.0%	9	3.4
Boo Oya	10.5%	10.5%	15.8%	42.1%	10.5%	5.3%	5.3%	19	3.7

Puliyankulam	14.3%	42.9%	28.6%	14.3%	0.0%	0.0%	0.0%	7	2.4
Sinnakulam	8.3%	16.7%	19.4%	25.0%	22.2%	8.3%	0.0%	36	3.6
Wirandagollewa	0.0%	0.0%	66.7%	33.3%	0.0%	0.0%	0.0%	3	3.3
Thiruwegama	7.7%	7.7%	0.0%	53.8%	30.8%	0.0%	0.0%	13	3.9
Kal kulam	0.0%	20.0%	10.0%	35.0%	25.0%	10.0%	0.0%	20	4.0
Total	6.9%	20.8%	15.4%	34.6%	16.2%	5.4%	0.8%	130	3.5

Source: JICA Project Team based on the result of HHS conducted in March 2017

Analysis on household income sources were carried out through a questionnaire survey with options of the following; 1 = Government service, 2 = Private sector, 3 = Crop production, 4 = Livestock, 5 = Agriculture labour, 6 = Skilled labour, 7 = Unskilled labour, 8= Family business, 9 = nil, and 10 = Others. The following table shows the ratios of the primary income sources in each tank.

Table 2.1.6 Primary Income Source of the Beneficiary Households per Tank

Tank under the Cascade	1.Govt Service	2.Private Sector	3.Crop Production	7.Unskilled Labor	Total Valid Answer
Alagalla	43.5%	0.0%	52.2%	4.3%	23
Aluthgama	44.4%	0.0%	33.3%	22.2%	9
Boo Oya	63.2%	5.3%	10.5%	21.1%	19
Puliyankulam	57.1%	14.3%	14.3%	14.3%	20
Sinnakulam	68.4%	2.6%	26.3%	2.6%	7
Wirandagollewa	0.0%	0.0%	33.3%	66.7%	38
Thiruwegama	62.5%	0.0%	25.0%	12.5%	16
Kal kulam	20.0%	25.0%	10.0%	45.0%	3
Total	51.9%	5.9%	25.9%	16.3%	135

Source: JICA Project Team based on the result of HHS conducted in March 2017

In Alagalla cascade, most of the households rely on government service, private sector, crop production or unskilled labour for their income source. More than a half of the beneficial households in the area have government jobs as their primary occupation. Beneficiaries who operate agricultural crop production as their primary income source is 25.9% of the total beneficiaries, which is the lowest in the six model cascades, as the total average of the model cascades is 49.3% as shown in the table below. There is also a significant disparity by tank within the cascade. Nearly a half of the beneficiaries mentioned crop production as their primary occupation in Alagalla while only 10% in Kal kulam and Boo Oya. Significantly more than 60% of the households has government services in Boo Oya, Sinnakulam, and Thiruwegama, whereas nil in Wirandagollewa and only 20% in Kal kulam. The majority of households in Wirandagollewa are engaged in unskilled labour for their income. Even though the option of livestock rearing was provided, no household operates livestock rearing as their major income source in Alagalla.

Table 2.1.7 Primary Income Source by Cascade of Six Model Sites

Cascade	1.Govt Service	2.Private Sector	3. Crop Production	4. Livestock	5.Agriculture Labour	6.Skilled Labour	7.Unskilled Labor	8.Family Business	10. Others	Total
Alagalla	51.9%	5.9%	25.9%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%	100%
Naveli kulam	11.0%	3.2%	45.2%	5.2%	0.6%	11.6%	12.3%	3.2%	7.7%	100%
Ichchankulama	22.2%	3.5%	71.2%	0.0%	0.0%	0.5%	1.5%	0.0%	1.0%	100%
Kiulekada	44.7%	2.0%	46.3%	1.2%	0.0%	0.8%	3.9%	1.2%	0.0%	100%
Rathmalawewa	34.5%	1.8%	41.5%	0.0%	0.4%	6.9%	4.4%	5.8%	4.7%	100%
Siyambalagaswewa	17.3%	2.7%	65.3%	0.7%	0.0%	4.7%	9.3%	0.0%	0.0%	100%
Total	31.3%	2.9%	49.3%	1.0%	0.2%	4.0%	6.8%	2.1%	2.3%	100%

Source: JICA Project Team based on the result of HHS conducted in March 2017

Secondary income sources have more varieties in Alagalla cascade. In addition to the occupational categories selected as the primary income sources, there are some households engaged in skilled labour and family business as their secondary occupations. About 71% of the families in Alagalla run agricultural crop production as their secondary income source. Details of the secondary income sources per tank are shown in the following table. Livestock rearing is not even the secondary income source in the area.

Table 2.1.8 Secondary Income Source of the Beneficiary Households

Tank name	1.Govt Service	2.Private Sector	3.Crop Production	6.Skilled Labour	7.Unskilled Labour	8.Family Business	9.nil	Blank	Total Valid Answer
Alagalla	0.0%	0.0%	47.8%	0.0%	21.7%	0.0%	0.0%	30.4%	23
Aluthgama	0.0%	0.0%	66.7%	0.0%	22.2%	0.0%	0.0%	11.1%	9
Boo Oya	0.0%	0.0%	84.2%	0.0%	5.3%	0.0%	5.3%	5.3%	19
Puliyankulam	0.0%	0.0%	85.7%	0.0%	0.0%	14.3%	0.0%	0.0%	20
Sinnakulam	2.6%	2.6%	65.8%	0.0%	0.0%	0.0%	0.0%	28.9%	7
Wirandagollewa	0.0%	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%	33.3%	38
Thiruwegama	18.8%	0.0%	75.0%	0.0%	0.0%	0.0%	0.0%	6.3%	16
Kal kulam	0.0%	0.0%	90.0%	10.0%	0.0%	0.0%	0.0%	0.0%	3
Total	3.0%	0.7%	71.1%	1.5%	5.9%	0.7%	0.7%	16.3%	135

Source: JICA Project Team based on the result of HHS conducted in March 2017

Alagalla, instead, has the largest ratio in crop production as the secondary income source among the model cascades. The largest percentage of people in Alagalla operates agriculture as their secondary income sources in comparison with the other cascades as shown in the table below. Together with the figure in the primary income source, 97% of the households in total in Alagalla are engaged in crop production as either the primary or secondary income source.

Table 2.1.9 Secondary Income Source by Cascade of Six Model Sites

Cascade	1.Govt Service	2.Private Sector	3.Crop Production	4. Livestock	5.Agriculture labour	6.Skilled labour	7.Unskilled Labor	8.Family business	9. nil	10. Other	Blank
Alagalla	3.0%	0.7%	71.1%	0.0%	0.0%	1.5%	5.9%	0.7%	0.7%	0.0%	16.3%
Naveli kulam	3.9%	3.2%	47.7%	12.9%	0.0%	1.9%	10.3%	6.5%	0.0%	11.6%	1.9%
Ichchankulama	0.0%	1.5%	26.3%	11.6%	0.0%	0.0%	4.5%	1.0%	0.0%	4.5%	50.5%
Kiulekada	0.0%	0.8%	51.8%	4.3%	0.0%	1.2%	17.3%	2.4%	0.0%	9.4%	12.9%
Rathmalawewa	0.7%	0.4%	54.5%	0.7%	3.3%	7.3%	2.2%	5.5%	1.5%	10.5%	13.5%
Siyambalagaswewa	2.7%	1.3%	31.3%	3.3%	0.0%	0.0%	8.7%	0.0%	0.0%	26.7%	26.0%
Total	1.4%	1.2%	47.2%	5.2%	0.8%	2.4%	8.2%	2.9%	0.4%	10.3%	20.0%

Source: JICA Project Team based on the result of HHS conducted in March 2017

The following table shows the monthly household income of Alagalla area. As a whole cascade, the average of monthly income is Rs.40,229. Only 3% of the households have income of less than Rs.5,000 per month, while 20.7% earns more than Rs.50,000. An inequality is observed in the average income between tanks. Puliyankulam has the highest average of Rs.50,314, while the lowest is Rs.23,144 of Wirandagollewa where there is no household engaged in government service nor private sector according to the above data of the income sources.

Table 2.1.10 Monthly Household Income of the Beneficiary Households

Tank	Income Level (LKR)											Average Income (Rs.)
	0-4999	5000-9999	10000-14999	15000-19999	20000-24999	25000-29999	30000-34999	35000-39999	40000-44999	45000-50000	>50000	
Alagalla	8.7%	8.7%	13.0%	0.0%	13.0%	8.7%	8.7%	13.0%	8.7%	4.3%	13.0%	29,413
Aluthgama	0.0%	11.1%	11.1%	0.0%	22.2%	0.0%	11.1%	11.1%	0.0%	11.1%	22.2%	77,388
Boo Oya	5.3%	0.0%	0.0%	5.3%	5.3%	5.3%	31.6%	31.6%	5.3%	5.3%	5.3%	34,268

Puliyankulam	0.0%	0.0%	0.0%	14.3%	0.0%	0.0%	0.0%	14.3%	14.3%	14.3%	42.9%	50,314
Sinnakulam	2.6%	7.9%	5.3%	5.3%	0.0%	2.6%	7.9%	7.9%	10.5%	15.8%	34.2%	46,648
Wirandagollewa	0.0%	33.3%	0.0%	0.0%	0.0%	33.3%	0.0%	33.3%	0.0%	0.0%	0.0%	23,144
Thiruwegama	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	18.8%	18.8%	12.5%	12.5%	25.0%	41,390
Kal kulam	0.0%	5.0%	10.0%	20.0%	15.0%	20.0%	5.0%	10.0%	5.0%	0.0%	10.0%	27,516
Total	3.0%	5.9%	7.4%	5.9%	6.7%	6.7%	11.9%	14.8%	8.1%	8.9%	20.7%	40,229

Source: JICA Project Team based on the result of HHS conducted in March 2017

Alagalla cascade, in comparison with the other model cascades, has the second highest monthly income that is slightly lower than Naveli kulam. The average income of Rs.40,229 is much higher than the average of the model cascades. Details of the monthly income of all the model cascades are shown in the table below.

Table 2.1.11 Monthly Household Income of the Beneficiary Households by Cascade

Cascade	Income Level (LKR)											Average Iincome (Rs)
	0- 4999	5000-9999	10000-14999	15000-19999	20000-24999	25000-29999	30000-34999	35000-39999	40000-44999	45000-50000	> 50000	
Alagalla	3.0%	5.9%	7.4%	5.9%	6.7%	6.7%	11.9%	14.8%	8.1%	8.9%	20.7%	40,229
Naveli kulam	0.0%	1.9%	2.6%	6.5%	11.0%	10.3%	11.0%	13.5%	9.0%	8.4%	25.8%	41,699
Ichchankulama	1.5%	14.1%	15.2%	10.6%	8.1%	7.6%	5.6%	7.6%	3.5%	4.5%	21.7%	33,699
Kiulekada	8.6%	8.6%	7.8%	9.0%	8.2%	7.5%	9.8%	13.7%	11.0%	7.1%	8.6%	28,667
Rathmalawewa	6.2%	13.8%	7.3%	11.3%	5.5%	10.2%	8.7%	8.4%	7.6%	4.4%	16.7%	31,190
Siyambalagaswewa	8.0%	14.7%	16.7%	10.0%	14.0%	8.7%	8.7%	6.0%	2.7%	1.3%	9.3%	23,581
Total	5.0%	10.4%	9.3%	9.2%	8.5%	8.6%	9.1%	10.5%	7.3%	5.7%	16.5%	32,527

Source: JICA Project Team based on the result of HHS conducted in March 2017

Economic situation can be also estimated by the number of beneficiaries of Divineguma, which is provided to the low-income households. The following shows the number and ratio of Divineguma beneficiaries. This also indicates Wirandagollewa and Kal kulam have more lower-income families. In Alagalla, even though the average income range is relatively high, there are a certain number of low-income households, which means there is a large inequality of economic status in the area.

Table 2.1.12 Divineguma/ Samurdhi Beneficiaries

Tank	Divineguma/Samurdhi Beneficiaries (HH)	Total HH	% of Divineguma/Samurdhi Beneficiaries
Alagalla	5	23	21.7%
Aluthgama	1	9	11.1%
Boo Oya		19	0.0%
Kal kulam	4	20	20.0%
Puliyankulam		7	0.0%
Sinnakulam	2	38	5.2%
Thiruwegama		16	0.0%
Wirandagollewa	1	3	33.3%
Total	**13**	**135**	9.6%

Source: JICA Project Team based on the result of HHS conducted in March 2017

Beneficiaries of the cascade are basically members of Farmers Organisations (FOs) managing each tank. Farmers are generally taking part of several different Community Based Organisations (CBOs) in the area. The following shows membership of CBOs operated in the area. Most of the households have membership in the Death Donation Society, except Kal kulam as Death Donation Society is typical cultural relations in the Sinhalese community. While a certain number of households belong to Rural Development Societies (RDSs) and women groups, cooperatives are not major organisations for the target beneficiaries to take part in.

Table 2.1.13 CBO Membership

(No. of households)

Tank	FO	RDS	Coop	Divineguma/ Samurdhi	Women Group	Death Donation Soc	Other	Valid No.
Alagalla	22	9	3	5	6	21		23
Aluthgama	9	1	1	1	1	9		9
Boo Oya	19	4			5	18		19
Kal kulam	19	4		4	7			20
Puliyankulam	7	3	1		3	5	1	7
Sinnakulam	37	14	7	2	11	37		38
Thiruwegama	16	14	1		4	16		16
Wirandagollewa	3	1		1		1		3
Total	**132**	**50**	**13**	**13**	**37**	**107**	**1**	**135**

Source: JICA Project Team based on the result of HHS conducted in March 2017

2.2 Soil and Land Use

2.2.1 Soil Type of the Area

Alagalla cascade is located in the "DL 1" Agro-Ecological Region of Sri Lanka. The area terrain is undulating and the dominant soil group in the area is Reddish Brown Earth (RBE) and it has associated with Low Humic Gley (LHG) soils. The RBE occupies the crest and upper and mid slopes of the landscape. The LHG occupies the lower part of the slope and upper part of the valley bottom while a thin strip of alluvial soil appears along the natural drainage path. The ratio of RBE and LHG varies from place to place depending on the series of soil. In general, RBE, LHG and alluvial is about 60%, 30% and 10% of land surface, respectively.

RBE has been divided into two drainage classes, namely; Well-drained RBE and Imperfectly-drained RBE. Well-drained RBE appears in the upper and middle aspects of the undulating landscape, while Imperfectly-drained RBE appears in middle aspects of the undulating landscape.

Well-drained RBE has good drainage properties and it is used traditionally for cultivating other field crops under shifting nature with rainwater. This soil has a good potential for cultivation of other field crops and vegetables with supplementary irrigation. Soil reaction, depth, texture, and drainage are quite satisfactory for growing wide range of crops such as cereals, pulses, oil crops, and vegetables.

Imperfectly-drained RBE are used as support for several land uses such as homesteads, upland annuals, and shrub jungles. Although, potential for cultivating other field crops is very much higher, most of the cultivation fields with Imperfectly-drained RBE have already been developed for paddy cultivation in the Maha season and mostly abandoned in the Yala season due to shortage of water. Some areas, which are not developed for paddy cultivation, cultivate other field crops and vegetables with improved drainage practices in the Maha season. Farmers in the area are in view that Imperfectly-drained RBE area can be used to grow other field crops in the Yala season successfully with irrigation facilities.

LHG soils are predominantly used for wetland paddy cultivation. The LHG soil is mainly made of poorly drained soil which lies in the lowest position of the catena and it is influenced always by the seepage flow of the upper portion. This situation has led to keep the water table shallow most of the time creating favourable situation for paddy cultivation. In general, frequency of irrigation in this soil is lower due to the additional downward seepage of catena and poor drainage outflow from the soil. The soil is not suitable at all for other field crops under normal circumstance.

2.2.2 Land Holdings and Land Use

Farming lands of individual households in the cascade are categorized based on the location of the land. The irrigable lands in the command area are holdings cultivated under the main tank and under other tanks in the cascade. Akkarawela or lands located in the uplands adjoining the irrigated command areas of the tanks and the home gardens are used for crop production under rain-fed conditions and/or lift irrigation off agro-wells. In addition, some farmers possess Chena lands, which are usually the encroached lands, located in the highlands bordering the forests for seasonal cropping. The percentages of the farm holdings under each category in acres are shown in the tables below.

(1) Main Tank

The average land area held by individual households under the respective main tanks is 1.3 acres. The analysis shows that over 63% of the farmers cultivate farm lands of less than 1.5 acres in extent.

Table 2.2.1 Land Holdings under Main Tanks (Acres)

Tank	Percent Households						
	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Alagalla	4.35	21.74	21.74	26.09	8.70	8.70	8.70
Aluthgama	0	0	55.56	0	22.22	11.11	11.11
Boo Oya	0	47.37	36.84	0	5.2	10.53	0
Kal kulam	0	0	60.00	20.00	15.00	0	5.00
Puliyankulam	0	28.57	57.14	14.29	0	0	0
Sinnakulam	7.89	28.95	34.21	10.53	13.16	5.26	0
Thiruwegama	18.75	0	18.75	25.00	12.5	6.25	18.75
Wirandagollewa	0	0	100.00	0	0	0	0
Cascade	5.19	20.00	38.52	14.07	11.11	5.93	5.19

Source: Farm Household Survey, CSDPP (JICA 2017)

(2) Other Tanks in the Cascade

Besides the command area of the main tank, 18% of the farmers cultivated irrigated lands under other tanks within the cascade. The land area per farmer averaged to 1.71 acres. Percentage distribution of these households by extents in acres is shown in the table below.

Table 2.2.2 Land Holdings under Other Tanks in the Cascade (Acres)

Tank	Percent Households						
	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Alagalla	11.11	22.22	22.22	0	33.33	0	11.11
Aluthgama	0	0	0	0	0	0	0
Boo Oya	0	0	0	0	0	0	0
Kal kulam	0	0	0	0	0	0	0
Puliyankulam	0	50.00	50.00	0	0	0	0
Sinnakulam	0	0	30.77	15.38	23.08	15.38	15.38
Thiruwegama	0	0	0	100.00	0	0	0
Wirandagollewa	0	0	0	0	0	0	0
Cascade	4.00	12.00	28.00	12.00	24.00	8.00	12.00

Source: Farm Household Survey, JICA Project Team 2017

(3) Akkarawela

About 8% of the households possessed Akkarawela lands for farming and the extents varied between 1 and 3 acres at an average of 1.82 acres. The low extent of farmlands in the Akkarawela reflects non-availability of this land category for farming due to particular land terrain in the area and/or State regulations. Cropping in Akkarawela lands are either irrigated off agro-wells and/or rain-fed during the Maha season or lift irrigated during the Yala season.

Table 2.2.3 Distribution of Akkarawela Lands by Extent (Acres)

Tank	Percent Households			
	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0
Alagalla	0	50	50	0
Aluthgama	0	50	0	50

Boo Oya	0	0	0	0
Kal kulam	0	0	0	0
Puliyankulam	0	0	100	0
Sinnakulam	66.67	0	33.33	0
Thiruwegama	33.33	0	33.33	33.33
Wirandagollewa	0	0	0	0
Cascade	27.27	18.18	36.36	18.18

Source: Farm Household Survey, JICA Project Team 2017

(4) Home Gardens

Extent of individual home gardens varied between less than 0.5 and 3 acres with an average of 0.84 acres per household. Mixed cropping system with perennial crops such as coconut and fruit trees, semi-perennials such as banana and papaya and annuals such as Other Field Crops (OFCs) and vegetables, principally for household consumption, are observed in the home gardens. As with Akkarawela lands, crop production in home gardens is under lift irrigation and/or rain-fed condition. No home gardens are reported for Kal kulam. The distribution of land area among householders in the cascade is shown in the table below.

Table 2.2.4 Distribution of Home Gardens by Land Extent (Acres)

Tank	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0
Alagalla	15	40	35	10	0	0
Aluthgama	0	12.5	62.5	12.5	12.5	0
Boo Oya	5.56	38.89	55.56	0	0	0
Kal kulam	30	60	0	10	0	0
Puliyankulam	20	60	20	0	0	0
Sinnakulam	10.34	48.28	27.59	3.45	6.90	3.45
Thiruwegama	0	30.77	38.46	15.38	7.69	7.69
Wirandagollewa	0	50	50	0	0	0
Cascade	10.48	41.90	35.24	6.67	3.81	1.90

Source: Farm Household Survey, JICA Project Team 2017

(a) Chena Lands

Twenty -six percent of the farmers in the sample possessed Chena lands at an average of 2.5 acres each. There were no Chena reported in the Kal kulam area while the highest number was reported for Sinnakulam area.

Table 2.2.5 Distribution of Chena Lands by Land Extent (Acres)

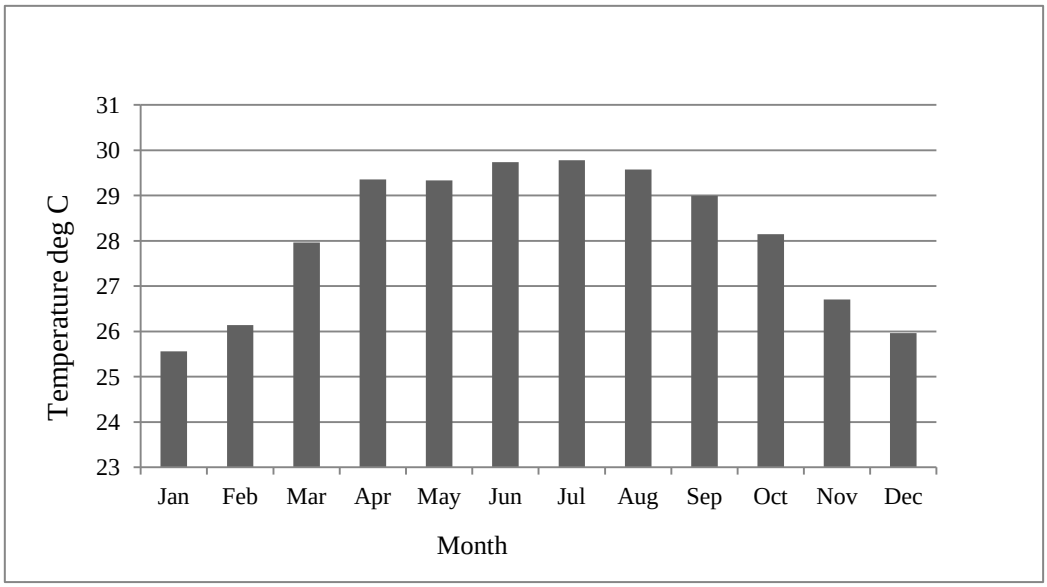
Tank	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Alagalla	12.5	0	0	37.5	25	25
Aluthgama	0	50	0	50	0	0
Boo Oya	0	0	0	75	0	25
Kal kulam	0	0	0	0	0	0
Puliyankulam	0	66.67	0	0	33.33	0
Sinnakulam	18.18	27.27	9.09	18.18	18.18	9.09
Thiruwegama	0	25	0	37.5	12.5	25
Wirandagollewa	0	0	0	0	0	0
Cascade	8.33	22.22	2.78	33.33	16.67	16.67

Source: Farm Household Survey, JICA Project Team 2017

2.3 Meteorology and Water Resources

2.3.1 Temperature and Humidity

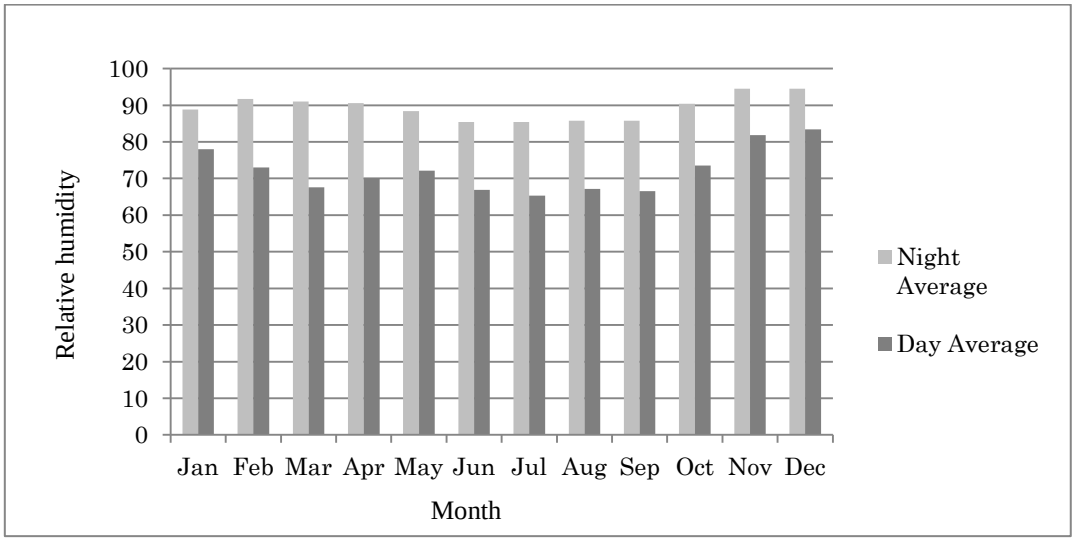
The metrological station, which can represent Alagalla cascade, is located in Vavuniya about 4 km away from Alagalla. The data is available only from 2009 and the data for the period of 2009-2016 indicate that monthly average temperature varies from about 25 to 30 degrees Celsius over the year. Highest temperatures have recorded during the period of April to September. Similar to the most part of dry zone, temperature in the area decreases from September to January, which is the period of the rainy season in dry zone of Sri Lanka. Annual average of temperature in the period concerned (2009-2016) is about 28°C in the area.



Source: Statistical Abstract/Department of Census and Statistics, Sri Lanka

Figure 2.3.1 Monthly Average (2009-2016) Temperature

As indicated in the graph below, the relative humidity in the area varies from about 65% during day time to about 94% at night time. Like in other part of the dry zone, relative humidity is comparatively low in both day and night during the south-west monsoon period, May to September, Yala season. During the period of inter-monsoon following the South-west monsoon, relative humidity starts increasing and reaches to its maximum in November and December. The annual average relative humidity in the area is about 89% and 71% during the night and day respectively.

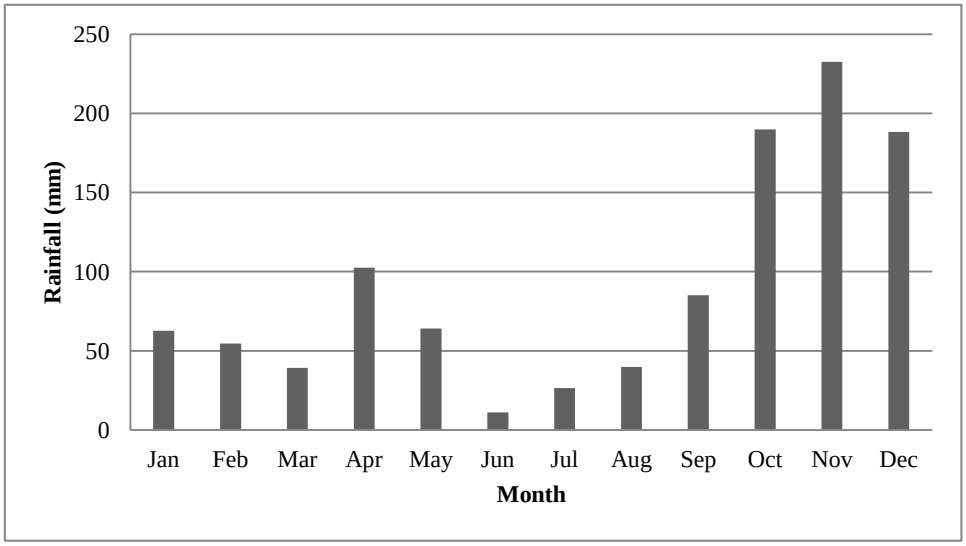


Source: Statistical Abstract/Department of Census and Statistics, Sri Lanka

Figure 2.3.2 Monthly Average(2009-2016) Relative Humidity

2.3.2 Rainfall

The closest rainfall gauging station of Alagalla cascade is Pavatkulam. The monthly rainfall data is obtained from the Meteorological Department of Sri Lanka. According to the data, the annual rainfall of Pavatkulam ranges from 674.9 mm to 1622.0 mm, the average of which is 1083.15 mm. The monthly rainfall is the lowest in July and the highest in November.



Source: Department of Meteorology, Sri Lanka

Figure 2.3.3 Average (1977-2016) Monthly Rainfall (Pavatkulam)

2.4 Agriculture and Agro-economy

2.4.1 Farm Land Holdings and Ownership

(1) Farm Holding

The average total land holding size of households in Alagalla cascade varies between 1.5 and 4.7 at an average of 3.13 acres. This comprises of extents held under different land area categories of irrigable (main tank, other tanks), Akkarawela, Chena and home garden.

Table 2.4.1 Average Land Holding of Households by Category

Tank	Average Landholding (Acres)					
	Main Tank	Other Tank	Akkarawela	Chena	Home Garden	Total Landholding
Alagalla	1.53	0.58	0.15	0.95	0.65	3.85
Aluthgama	1.83	0	0.5	0.33	1.00	3.67
Boo Oya	1.08	0	0	0.53	0.72	2.33
Kal kulam	1.50	0	0	0	0.27	1.77
Puliyankulam	1.00	0.21	0.29	0.71	0.39	2.61
Sinnakulam	1.11	0.70	0.11	0.68	0.66	3.24
Thiruwegama	1.83	0.09	0.38	1.45	0.97	4.72
Wirandagollewa	1.00	0	0	0	0.50	1.50
Cascade	1.36	0.32	0.15	0.66	0.65	3.13

Source: Farm Household Survey, JICA Project Team 2017

(2) Land Ownership and Tenure

A number of land ownership and tenure systems operate in the cascade. The main categories are identified as ‘own’, ‘pangu’ and ‘ande’ lands. Owned lands are legal holdings while pangu refers to fragmented portions inherited by the children of the original owners. Extent is decided by mutual agreement without physical partitioning. Ande system is a form of share cropping, where the land owner opts to get other farmers to cultivate the land for a share of the crop as payment. In Kal kulam, nearly all

beneficiaries (95%) are 'ande' farmers while in all other tank areas, the majority are 'pangu' farmers (56.4%). Kal kulam and Wirandagollewa recorded the lowest of owned land category with 5% and 0%, respectively. Cultivation of leased and mortgaged lands was not recorded. Multiple answers were allowed since many farmers resorted to cultivate lands through different ownership and tenure patterns. The percent distribution of households by type of land ownership in the command areas is shown in the table below.

Table 2.4.2 Distribution of Land Ownership and Tenure Systems

Tank	Percent Households				
	Ande	Own/Ande	Own/ Pangu	Own	Pangu
Alagalla	0.00	0.00	8.70	4.35	86.96
Aluthgama	0.00	11.11	0.00	11.11	77.78
Boo Oya	0.00	0.00	11.11	27.78	61.11
Kal kulam	95.00	0.00	0.00	5.00	0.00
Puliyankulam	0.00	0.00	0.00	16.67	83.33
Sinnakulam	0.00	0.00	10.53	42.11	47.37
Thiruwegama	0.00	0.00	0.00	31.25	68.75
Wirandagollewa	0.00	0.00	0.00	0.00	100.00
Cascade	14.29	0.75	6.02	22.56	56.39

Source: Farm Household Survey, JICA Project Team 2017

2.4.2 Crop Production

(1) Cropped Extents, Production and Yields

The cascade is predominantly a paddy growing area. Other crops are grown in small extents and they are also mostly confined to rain-fed highlands during the Maha season.

(a) Paddy

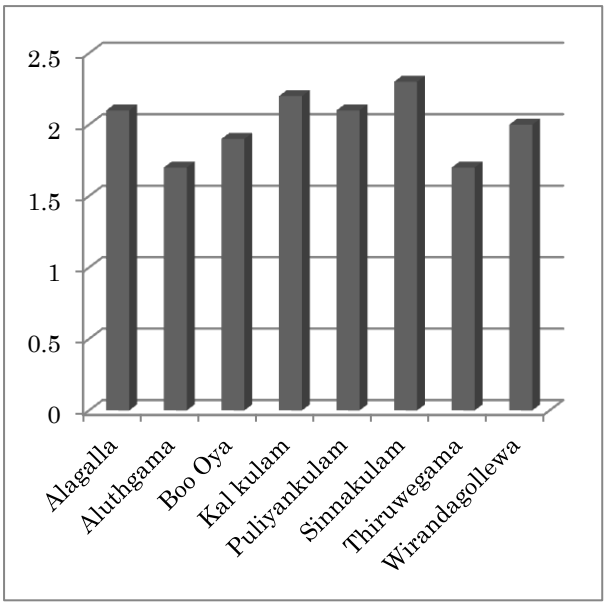
The land area cultivated in the Yala season is 70% of the area in the Maha season, which is high when compared with most of the other cascades. Except for Aluthgama, Kal kulam and Puliyankulam tanks, nearly the entire land area cultivated during the Maha season is cultivated during the Yala season as well. Land extent under paddy in other land categories such as Akkarawela is minor except in Aluthgama and Kal kulam where 13.5 and 23.2 acres, respectively, are cultivated.

Average yields of 2.1 MT/acre (5.35 MT/Ha) and 1.8mt/acre (4.50 MT/Ha) are reported for the Maha and Yala seasons respectively. The productivity levels are quite satisfactory under the existing conditions.

Table 2.4.3 Paddy Extents, Production and Yield by Season

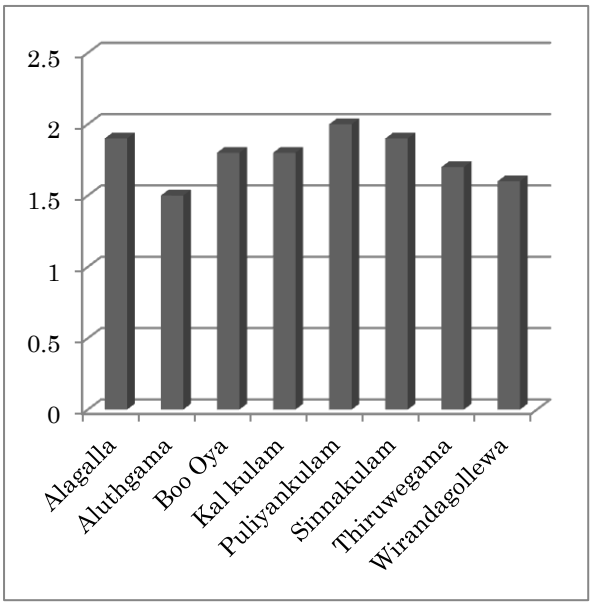
Tank	Maha Season			Yala Season		
	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)
Alagalla	35.5	76.4	2.1	29.0	52.7	1.9
Aluthgama	16.5	28.4	1.7	1.0	15.0	1.5
Boo Oya	20.5	39.0	1.9	17.5	31.26	1.8
Kal kulam	30.0	65.3	2.2	9.75	17.78	1.8
Puliyankulam	7.0	15.3	2.1	4.5	9.00	2.0
Sinnakulam	44.7	103.3	2.3	42.5	81.33	1.9
Thiruwegama	29.2	50.5	1.7	25.7	43.26	1.7
Wirandagollewa	3.0	6.1	2.0	3.0	5.02	1.6
Cascade	186.5	384.4	2.1	133.0	241.9	1.8

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.1 Average Paddy Yield (Maha)



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.2 Average Paddy Yield (Yala)

(b) Other Crops Cultivation

Coarse grains and grain legumes are the major crop groups grown in the Maha season in highlands. In the Yala season gingerly is cultivated in high lands as a rain-fed crop.

Table 2.4.4 Cultivated extents of Other Crops under Rain-fed Conditions

Tank	Maha Season: Rain-fed (Acres)			Yala Season: Rain-fed	
	Coarse grain	Grain legumes	Vegetables	Sesame (Acres)	Production (Kg)
Alagalla	7.5	8.25	-	12	2,609
Aluthgama	2.0	1.5	-	2.0	180
Boo Oya	1.25	6.0	-	3.5	770
Kal kulam	-	-	1.0	-	-
Puliyankulam	1.5	1.5	0.25	-	-
Sinnakulam	2.1	16.5	-	10.75	1345
Thiruwegama	5.25	9.75	-	15.5	2340
Wirandagollewa	-	0.75	-	0.75	430
Cascade	19.6	44.25	1.25	44.5	7,674

Source: Farm Household Survey, JICA Project Team 2017

(c) Fruit Cultivation

Banana, mango, lime and papaya are grown in homesteads and very small marketable surplus is available in the area. These crops are largely confined to the home gardens as mixed crops.

(2) Input Supply

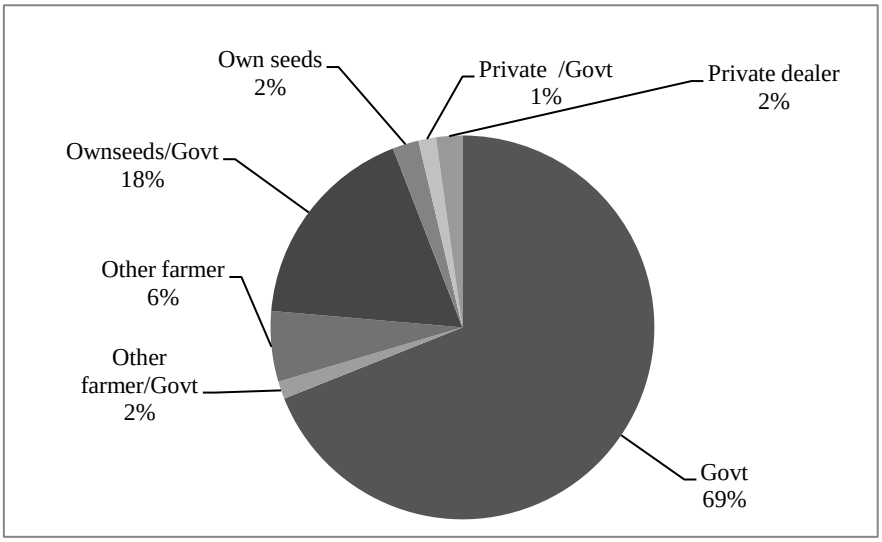
(a) Seeds and Planting Material

Majority of the farmers depend on the Government seed supply sources, namely the Provincial Department of Agriculture and the Department of Agrarian Services for their seed paddy. Farmers have developed trust on the assured purity and germinability of certified seeds supplied by above sources through use over time. It is also noted that farmers use own seeds produced from the certified seeds for several seasons before renewal with certified seeds. The percent distribution of seed paddy by source is shown in the table below.

Table 2.4.5 Sources of Seed Paddy Supply (%)

Tank	Govt	Other Farmer/Govt	Other Farmer	Own Seeds/Govt	Own Seeds	Private /Govt	Private Dealer
Alagalla	73.9		4.34	13			8.7
Aluthgama	77.8		11.1			11.1	
Boo-Oya	73.6	5.26	21.05				
Kal kulam				100			
Puliyankulam	100						
Sinnakulam	81.5	5.26	5.26	2.6	5.26	1.1	
Thiruwegama	87.5				6.25		6.25
Wirandagollewa	100						
Cascade	68.8	1.48	5.92	17.7	2.2	1.48	2.2

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.3 Sources of Seed Paddy Supply

The extent under maize in Alagalla cascade is very small, but those who grow the crop have switched over to hybrid varieties. Since seeds of these varieties are imported, farmers totally rely on private seed companies. Nineteen percent of the farmers in the cascade cultivated grain legumes such as black gram, green gram, and cowpea for which the seed material originated from government institutions and farmers own seed supplies. Few relied on other seed producing farmers and private seed dealers.

Cultivation of fruits and vegetables are confined to home gardens and is mainly for local consumption. Under the prevailing conditions, a need for seeds and planting materials of fruits and vegetables among farmers is not observed.

(b) Farm Labour

Direct labour contribution to farm activities by the heads of the household is split equally between full-time and part-time at 47%, while 3% of the households were not engaged in farm work. Five percent of the households totally depend on hired labour and the majority used hired labour for some of the labour intensive farm operations. A significant labour contribution is made by members of the household on full-time or part-time basis. High level of part-time engagement by heads of households in farm activities reflects their involvement in non-farm activities to augment farm incomes.

Table 2.4.6 Percent Contribution to Farm Work by Labour Category

Tank	Head of Household			Members of Household		Hired Labour	
	Full time	Part time	Not Involved	Full time	Part time	Only Hired Labour	Sometimes
Alagalla	60.87	30.43	8.70	23.81	76.19	4.55	95.45
Aluthgama	33.33	55.56	11.11	77.78	22.22	0	100
Boo Oya	47.37	52.63	0	30.00	70.00	5.26	94.74
Kal kulam	80.00	20	0	44.44	55.56	15	85
Puliyankulam	71.41	28.57	0	33.33	66.67	0	100
Sinnakulam	28.95	68.42	2.63	36.36	63.64	5.26	94.74
Thiruwegama	37.50	56.25	6.25	22.22	77.78	0	100
Wirandagollewa	66.67	33.33	0	0	100	0	100
Cascade	48.89	47.41	3.7	34.11	65.89	5.3	94.7

Source: Farm Household Survey, JICA Project Team 2017

Major problems related to hired labour situation were highlighted during the field survey, the most prominent being their shortage. Scarcity of hired labour in the vicinity during peak operational times is reported by 57% of the farmers. On the other hand, over 20% of the households claimed that the labour rates are high and tended to increase by the season. On average, each hired labour costs the farmer Rs.1,200-1,300 per day plus meals and refreshments. Twenty percent of the farmers found that they had no problems with regard to engagement of hired labour.

Table 2.4.7 Problems Related to Hired Labour

Tank	Percent Households			
	High Rate	None	Shortage/High Rate	Shortage
Alagalla	9.09	9.09	0	81.82
Aluthgama	0	12.5	12.5	75
Boo Oya	27.78	16.67	0	55.56
Kal kulam	0	90	5	5
Puliyankulam	28.57	0	28.57	42.86
Sinnakulam	21.05	7.89	0	71.05
Thiruwegama	26.67	0	13.33	60
Wirandagollewa	0	0	33.33	33.33
Cascade	16.03	20.61	5.34	57.25

Source: Farm Household Survey, JICA Project Team 2017

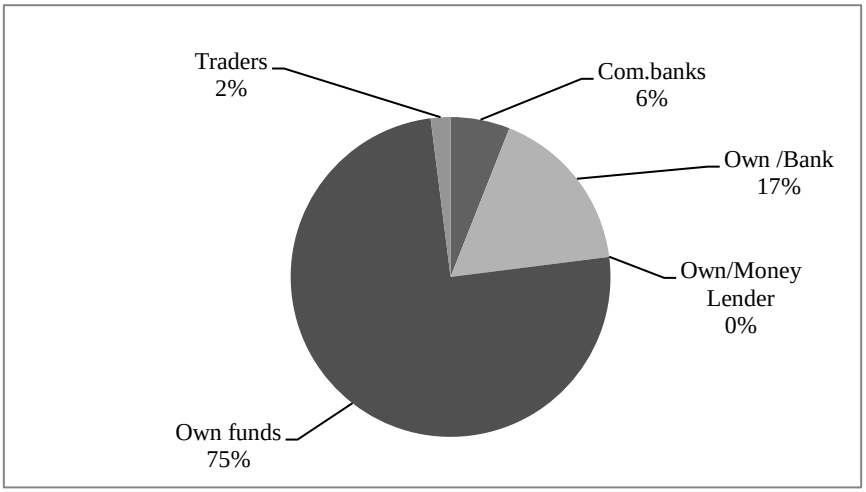
(c) Production Capital

Majority of the households in the cascade use their own savings only or combined with bank loans from commercial banks as production capital with minimal dependence on commercial banks alone or traders. Only 6% of total households obtain cultivation loans from commercial banks and a very small (2%) from informal sources. One reason for this situation is that the majority of households are having sufficient income from other sources to invest in the cultivation. On the other hand, some farmers may not be able to raise cultivation loans from formal lending sources due to default of previous loans.

Table 2.4.8 Sources of Capital for Cultivation

Tank	Percent Households			
	Commercial Banks	Own /Banks	Own Funds	Traders
Alagalla	18		82	
Aluthgama	22		78	
Boo Oya			100	
Kal kulam		100		
Puliyankulam			100	
Sinnakulam	2.5	5	90	2.5
Thiruwegama	6		93.75	
Wirandagollewa		33	66	
Cascade	6	17	75	2

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.4 Sources for Cultivation Capital

(d) Irrigation water

With regard to adequacy of irrigation water, only one farmer in the survey sample of 135 was satisfied with the quantity he receives during the Yala cultivation season. Fifty-six percent of the farmers stated that the quantity is inadequate while 43% stressed that they did not receive any water during the season.

During the Maha cultivation season, nearly 40% of the farmers are satisfied with the quantity of irrigation water they received while the balance 60% said that it was insufficient.

Table 2.4.9 Percent of Householders by Adequacy of Irrigation Water

Tank	Maha		Yala		
	Sufficient	Insufficient	Sufficient	Insufficient	No water
Alagalla	34.78	65.22	4.35	30.43	65.22
Aluthgama	22.22	77.78	0	11.11	88.89
Boo Oya	89.47	10.53	0	94.74	5.26
Kal kulam	0	100	0	100	0
Puliyankulam	0	100	0	0	100
Sinnakulam	44.74	55.26	0.00	44.74	55.26
Thiruwegama	68.75	31.25	0	68.75	31.25
Wirandagollewa	0	100	0	33.33	66.67
Cascade	40.74	59.26	0.74	55.56	43.70

Source: Farm Household Survey, JICA Project Team 2017

Seventy-one percent of the farmers commence land preparation with the onset of seasonal rains while the balance preferred to delay until the tanks are adequately filled up with water for commencement of the operation. The late operators sited uncertainty of receiving adequate rainfall to support the crop.

Table 2.4.10 Commencement of Land Preparation by Percent Farmers

Tank	After Tank Fills Up	With Onset of Rains	Uncertainty
Alagalla	26.09%	73.91%	15.38%
Aluthgama	44.44%	55.56%	10.26%
Boo Oya	31.58%	68.42%	15.38%
Kal kulam	0.00%	100.00%	0.00%
Puliyankulam	14.29%	85.71%	2.56%
Sinnakulam	34.21%	65.79%	33.33%
Thiruwegama	56.25%	43.75%	23.08%
Wirandagollewa	0.00%	100.00%	0.00%
Cascade	28.89%	71.11%	100.00%

Source: Farm Household Survey, JICA Project Team 2017

(e) Agro-wells

On average, 41% of the households in the cascade area have agro-wells with over 60% owning agro-wells in Alagalla and Aluthgama tank areas. The majority of agro-wells are located in the home gardens while some are sited within the command area and in the highlands, usually the Akkarawela lands.

Table 2.4.11 Distribution of Agro-wells by Location

Tank	Agro-wells (%)	Location (%)		
		Command area	Highland	Home Garden
Alagalla	60.87	14.29	0	85.71
Aluthgama	66.67	16.67	0	83.33
Boo Oya	21.05	0	0	100
Kal kulam	45.00	0	88.89	11.11
Puliyankulam	28.57	0	0	100
Sinnakulam	34.21	23.08	0	76.92
Thiruwegama	43.75	0	0	100
Wirandagollewa	33.33	100	0	0
Cascade	41.48	12.5	14.29	73.21

Source: Farm Household Survey, JICA Project Team 2017

2.4.3 Technology Transfer

Nearly all householders (94%) interviewed in the survey found the ARPA and AI (DOA) as the primary providers of extension services. The contribution made by the media, private sector companies and others were marginal. Households in Kal kulam tank failed to identify any extension provider. The percentage distribution of the respondents among providers of the service is shown in the table below.

Table 2.4.12 Agricultural Extension Providers

Tank	Percent Households					
	AI/DOA	ARPA/DAD	AI/ARPA	DOA/Company	Company	Mass Media
Alagalla	27.3	31.8	36.4	0	4.5	0
Aluthgama	75.0	0	0	12.5	12.5	0
Boo Oya	27.8	44.4	27.8	0	0	0
Kal kulam	0	0	0	0	0	0
Puliyankulam	42.8	28.5	100.0	0	0	0
Sinnakulam	51.3	18.9	14.3	0	14.3	0

Thiruwegama	25.0	62.5	27.0	0	0	2.7
Wirandagollewa	66.6	33.3	12.5	0	0	0
Cascade	33.8	27.1	34.6	1.5	1.5	0.7

Source: Farm Household Survey, JICA Project Team 2017

The specific areas that the farmers wished to learn more on agricultural innovations were identified as plant protection, crop production and marketing which together ranked high at 82%. The percentages of positive responses in respect main subject areas as expressed by the farmers are shown in the table below.

Table 2.4.13 Training Needs Identified by Farmers

Tank	Percent Households								
	Crop Production	Crop Prodn. & Marketing	Crop Prodn. & Livestock	Plant Prodn. & Livestock	Plant Prodn. & Market	Plant Prodn.	Market	Livestock	None
Alagalla	27	0	27	5	0	23	5	9	0
Aluthgama	44	0	0	0	0	56	0	0	0
Boo Oya	37	0	5	5	0	32	5	5	11
Kal kulam	5	80	5	0	5	0	0	5	0
Puliyankulam	14	0	14	0	0	71	0	0	0
Sinnakulam	21	5	8	0	0	50	0	3	13
Thiruwegama	31	0	19	0	0	31	0	6	13
Wirandagollewa	0	0	33	0	0	33	0	33	0
Cascade	25	13	11	1	1	34	1	4	7

Source: Farm Household Survey, JICA Project Team 2017

2.4.4 Crop Diversification

(1) Farmer Response to Crop Diversification

Nearly all farmers interviewed in Alagalla cascade expressed their reluctance to diversify paddy fields during the Maha season while they were willing to do so during the Yala season. Farmers were of the view that the poor drainage conditions make soils unsuitable for growing of other crops. Only 2% of the sample farmers representing Alagalla and Thiruwegama are willing to diversify part of paddy lands to maize and pulse cultivation in the Maha season.

In the Yala season, the farmers expressed their willingness to diversify paddy lands fully or partially. The major crops preferred by the farmers were the pulses (53.5%), maize (39.0%) and vegetables (7.5%).

Table 2.4.14 Farmer Response to Crop Diversification

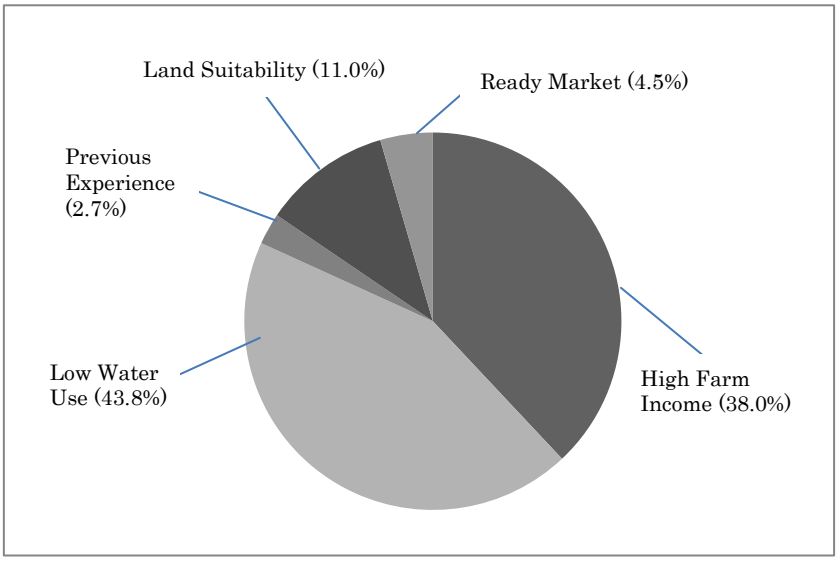
Tank	Maha		Yala	
	Yes	No	Yes	No
Alagalla	4.35	95.65	100	0
Aluthgama	0	100	100	0
Boo Oya	0	100	100	0
Kal kulam	0	100	100	0
Puliyankulam	0	100	100	0
Sinnakulam	0	100	100	0
Thiruwegama	12.5	87.5	100	0
Wirandagollewa	0	100	100	0
Cascade	2.22	97.78	100	0

Source: Farm Household Survey, JICA Project Team 2017

(2) Reasons For and Against Crop Diversification

The main seasons in support of crop diversification during the Yala season were identified as higher farm income and less water use. In addition, few reported of previous experience in growing other crops in the past and high marketability in Yala season as positive factors. About 30% find that the land suitability is better in the Maha season.

As reasons for unwillingness to diversify in the Maha season, nearly all the respondents think that the soils are not suitable to cultivate other crops during the season.



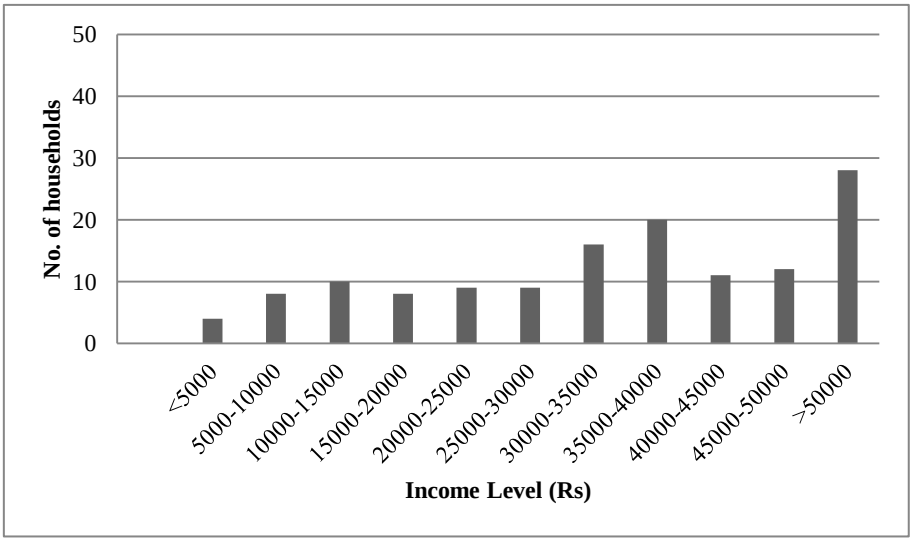
Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.5 Reasons for Diversification

2.4.5 Household Income

(1) Total Income

The total monthly income of households varied between Rs. 5,000 and over Rs. 50,000. Sixty-four percent of the households showed monthly income in excess of Rs. 30,000. The high number of off-farm employment by members in the household, particularly in the government service (52%) and the low number of Samurdhi beneficiaries (10%) supports the household income situation.



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.6 Household Monthly Income Distribution

(2) Farm Income

Income of majority of the households is derived from agricultural activities as revealed in the results of farm household survey. Crop production constituted the primary and secondary income source of 26% and 71% of the households, respectively. Monthly income realized from crop production varied between Rs.5,500 and Rs.16,000 with an average of Rs.9,500.

Table 2.4.15 Farm Income from Crop Production (Rs)

Tank	Maha Season	Yala Season	Average per Annum	Average per Month
Alagalla	73,061	46,840	119,901	9,992
Aluthgama	62,257	4,389	66,646	5,554
Boo Oya	38,207	29,326	67,533	5,628
Kal kulam	80,570	21,800	102,370	8,531
Puliyankulam	155,557	40,679	196,236	16,353
Sinnakulam	77,949	55,055	133,003	11,084
Thiruwegama	83,718	53,513	137,231	11,436
Wirandagollewa	27,700	38,833	66,533	5,544
Cascade	74,456	40,441	114,897	9,575

Source: Farm Household Survey, JICA Project Team 2017

2.4.6 Marketing

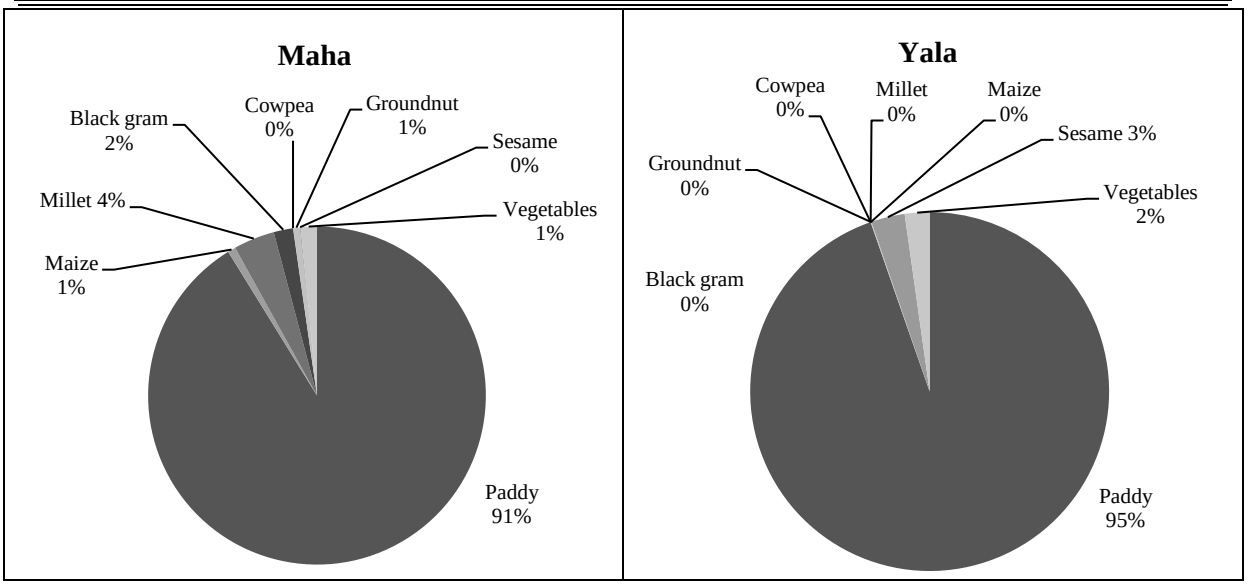
(1) Major Cash Crops: Paddy-centred

The cascade is a paddy growing area and diversification of cash crops are not well practiced. Table 2.4.16 and Figure 2.4.7 show the quantity of crops sold in the cascades in the Maha and Yala seasons. In Alagalla, paddy is the main cash crop in Maha, as the other targeted cascades, followed by millet, black gram and vegetables. In Yala, farmers also rely on paddy while some sells pulses and vegetables.

Table 2.4.16 Cash crops in Alagalla cascade

Crop	Unit	Maha season	Yala season
Paddy	Volume (kg)	225,230	140,390
	Number	70	68
Maize	Volume (kg)	1,862	0
	Number	7	0
Millet	Volume (kg)	9,710	0
	Number	11	0
Black gram	Volume (kg)	4,580	0
	Number	16	0
Cowpea	Volume (kg)	45	0
	Number	2	0
Groundnut	Volume (kg)	1,530	115
	Number	6	2
Sesame	Volume (kg)	200	4,500
	Number	1	15
Vegetables	Volume (kg)	3,825	3,305
	Number	3	3

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.7 Crop Diversification in Alagalla Cascade

Fruits such as mango and banana are other income sources for a few farmers. Six farmers earn cash from mangoes, and nine from banana. For all cash crops, farmers sell them individually. Either contract farming or collective selling is not observed.

Table 2.4.17 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	-	1,455
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) Paddy-Limited Market Channels

Although paddy is a single major cash crop in the cascade, farmers rely on the limited market channels.

Both in Maha and Yala, collectors is the major buyer. PMB is the second major buyer and offer a better price in Maha. Only one farmer has a contract farming of paddy. In Yala, the number of selling to PMB is overtaken by millers.

Table 2.4.18 Paddy Sales in the Maha Season

Buyer	Volume sold (kg)	Average volume (kg)	Price (Rs/kg)
Collector	146,580	3,409	33.37
PMB	39,800	1,990	37.30
Miller	29,200	5,840	36.60
Contract	6,500	6,500	34.00
N/A	3,150	3,150	30.00
Total	**225,230**	**3,218**	**34.69**

Source: Farm Household Survey, JICA Project Team 2017

Table 2.4.19 Paddy Sales in the Yala Season

Buyer	Volume sold	Average volume (kg)	Price (Rs/kg)
Collector	112,390	2,614	35.42
Miller	18,950	2,707	36.43
PMB	9,050	503	31.56
Total	**140,390**	**2,065**	**34.50**

Source: Farm Household Survey, JICA Project Team 2017

(3) Others

Millet, black gram, vegetables and fruits are sold with the limited volume. For instance, 11 farmers sell millet, mainly to collectors. Notably, 16 farmers sells black gram although farmer did not identify any type of buyers. Three farmers sell vegetables both in Maha and Yala season.

Table 2.4.20 Sales of Millet in the Maha Season

Buyer	Volume sold (kg)	Number of farmers	Price (Rs/kg)
Miller	6,500	2	82.50
Collector	3,110	8	82.13
N/A	100	1	54.00
Total	**9,710**	**11**	**79.64**

Source: Farm Household Survey, JICA Project Team 2017

2.5 Livestock

2.5.1 General Situation of Livestock Activities in the Area

Whilst, it was a hidden fact that the livestock species play very important economic function for rural households, this was not understood till the drought destroyed all crops in Maha 2016/2017. The importance of livestock sub-sector was felt when the drought destroyed all crops in Maha 2016/2017.

The dairy farmers from Alagalla cascade mentioned that during the drought period when they had no income from crops, their regular source of income every two weeks from September 2016 to April 2017 was by selling milk. The most immediate consequence of the drought is a fall in crop production. However, the output of natural pastures tends to be less vulnerable than crops. The cattle rearing in this area is predominantly a free grazing system in natural pastures or in the uncultivated land during the Yala season. The milk output varies during these two cultivation seasons; in the wetter Maha season the milk production is lower than in the drier Yala season. The milk production is lower in the Maha season due to the restriction of cattle to marginal areas to prevent damage to paddy and field crops.

The following table shows the characteristics of the cattle farming system in this area.

Table 2.5.1 Characteristics of the Cattle Farming System in Alagalla Cascade

Issues on farming system	Situation
1. Cattle keeping is a family tradition	Yes
2. Genetic value of cattle	Low, non-descriptive genetics
3. Feed resource	Free grazing and controlled grazing
4. Knowledge on technology	Minimum
5. Reproductive management	None
6. Health management	None
7. Access and ability to financing	Yes
8. Labour	Family

Source: Farm Household Survey, JICA Project Team 2017

2.5.2 Livestock Farming Population and Income

It is observed that the system of livestock management in the Alagalla cascade is through minimal resources of the holding. This maintains a low production cost of milk and it is lowering the risk factor of rearing cattle. Furthermore most farmers with off-farm activities have limited time to care for all the

farming activities. Therefore, they choose to give preference on paddy and crop cultivation and perform livestock activities with minimal attention. However, such traditional livestock systems supported this group of farmers for risk aversion. They actually realised the risk aversion, by offsetting the crop cultivation losses during the drought, in recently concluded Maha 2016/2017 cropping season.

As shown in Table 2.5.2, around 11.1% of the households rear livestock or poultry. The majority of those livestock farmers are in Alagalla and Aluthgama. Cattle were kept both for supplementary revenue and for milk for family consumption, whereas, poultry was mainly for egg consumption and sale of chicken for meat.

Even though a certain number of households have livestock, their earning from livestock is marginal. The average income from livestock of the household earning from livestock is as low as Rs.5,000. Even though farmers may have realized the value of livestock, they have failed to foresee any improvements to increase income through livestock production.

Table 2.5.2 Livestock Farmers and Average Monthly Income from Livestock per Tank

Tanks	Total Surveyed	Cattle Farmers		Poultry Farmers		Average Monthly Income from Livestock
	(no. HH)	(no. HH)	%	(no. HH)	%	(Rs.)
Alagalla	23	6	26.1%	1	4.3%	2,400
Aluthgama	9	2	22.2%	2	22.2%	7,800
Boo Oya	19	1	5.3%		0.0%	
Kal kulam	20		0.0%		0.0%	
Puliyankulam	7		0.0%		0.0%	
Sinnakulam	38	1	2.6%	1	2.6%	
Thiruwegama	16		0.0%		0.0%	
Wirandagollewa	3	1	33.3%		0.0%	4,800
Cascade	135	11	8.1%	4	3.0%	5000

Source: Farm Household Survey, JICA Project Team 2017

2.5.3 Livestock Population and Breed

The following table indicates the livestock population in Alagalla cascade. There are in total 59 cattle and 61 poultry birds kept by 11 and 4 farmers respectively. It means average number of cattle and poultry kept in each household is relatively large, as the average cattle number per household is more than 10 and that of poultry is more than 15 per household. The possible reason for relatively large cattle herds and chicken flocks is because there was sufficient space for them to graze and scavenge around.

Table 2.5.3 Livestock Population

Tank	Cattle						Poultry	
	Dairy Cows	Dry cows	Heifers	Bulls	Calves	Cattle Total	Layers	Pullets
Alagalla	4	7	14	4	6	35	1	2
Aluthgama	2		4	2	1	9	4	7
Boo Oya		1	4		5	10		
Kal kulam						0		
Puliyankulam						0		
Sinnakulam		1				1		47
Thiruwegama						0		
Wirandagollewa	2		2			4		
Total	8	9	24	6	12	59	5	56

Source: Farm Household Survey, JICA Project Team 2017

In Alagalla cascade, about 45% of the cattle are crossbred while the majority is local breeds or low production types. These local cattle are bred through natural mating using locally available bull of

similar productivity characteristics. All the poultry birds are local breeds in this cascades. Nevertheless with the increased demand for milk and with extension activities farmers initiated crossbreeding in view of increasing their farm and family income.

Table 2.5.4 Livestock Population by Breed (no. of livestock)

Tank	Cattle		Poultry	
	Cross	Local	Farm	Local
Alagalla	16	13	0	3
Aluthgama	4	5	0	7
Boo Oya	0	10		
Kal kulam				
Puliyan kulam				
Sinnakulam	0	1	0	47
Thiruwegama				
Wirandagollewa	4	0		
Total	24	29	0	57

Source: Farm Household Survey, JICA Project Team 2017

2.5.4 Livestock Production

In Alagalla cascade, there are eight dairy cows, out of which six are producing 12 litres of milk a day. Even though nearly half of the cattle are crossbreds, the average milk productivity in this cascade is as low as 1.5 litre/day/cow, which is even lower than the average of 1.72 litre in Anuradhapura District ('Livestock Statistical Bulletin 2014', Department of Animal Production and Health). For the poultry, the number of egg production is insignificant as only 5 out of 61 are layers.

Table 2.5.5 Livestock Production

Tank	Cattle			Poultry		
	Total Daily Milk Production (litres/day)	No. of Dairy cows	Average Milk Productivity (litres/day/cow)	Total Egg Production (eggs/day)	No. of Layers	Average Egg Production (egg/day/layer)
Alagalla	8	4	2.0	1	1	1.0
Aluthgama	0	2		0	4	
Boo Oya	0	0		0	0	
Kal kulam	0	0		0	0	
Puliyan kulam	0	0		0	0	
Sinnakulam	0	0		0	0	
Thiruwegama	0	0		0	0	
Wirandagollewa	4	2	2.0	0	0	
Total	12	8	1.5	1	5	0.2

Source: Farm Household Survey, JICA Project Team 2017

The cost of production (CoP) of a litre of milk is as low as Rs 5 to 10. Hence, the daily CoP for total milk in this cascade according to the above table is from Rs.60 to Rs.120. On the other hand, income from 12 litres of milk with selling price of Rs.67 per litre makes Rs.804 per day. This means the total monthly milk profit is Rs 24,000. The turnover is 570%.

Milking once a day is the most popular form. There are many reasons for adopting this procedure according to Alagalla cascade farmers as shown in the following table.

Table 2.5.6 Milking Once versus Twice

Reason	Once	Twice
Milk Production	Less milk production	25% more milk production
Difficulty	Easily fit into daily farmers chores	Create problems - requires cleaning and washing twice
Time	Sufficient time available	No extra time as more time is set aside for cropping activities

Milk collecting	Milk collecting transport from the village milk collecting point to chilling centre is available only in the morning	No transport for milk collecting and no cool storage facilities at the village milk collecting centre
Inputs for milk production	Fits the current grazing management system for feed management	Increased milk production require extra feed and the cost of production of milk increases
Replacement calf nutrition	Is better and the calf grows faster	Calf is allowed limited milk consumption during the first three months can affect lifetime growth and productivity

Source: Farm Household Survey, JICA Project Team 2017

2.5.5 Livestock Management System

Cattle in the area are maintained in the crop-livestock integrated farming system. The productivity of cattle highly depends on the management of the livestock that include availability of feed by grazing, tethering and stall-feeding. In most cases, feeding livestock does not cost these farmers anything. Livestock are mostly fed by grazing and scavenging in common or wasteland except during the Maha season when they are fed with collected crop residue of low quality. Availability of feed is largely determined by the extent of crop cultivation. Availability of water plays the main role in farmers' decision to plant or not to plant. Hence, drought condition often increase productivity of livestock as there is ample space for the cattle to graze.

The table below shows the distribution of current livestock management system by tank in Alagalla cascade. About 30% manage cattle in tethered. These households can be considered as a new cattle farming unit, though there is none kept in stall fed.

Table 2.5.7 Livestock Management Structure (no. of HH)

Tank	Cattle			Poultry	
	Free range	Stall fed	Tethered	Free range	Deep litter
Alagalla	5	0	2		
Aluthgama	2	0	1	1	
Boo Oya	1	0	0		
Kal kulam	-	-	-		
Puliyan kulam	-	-	-		
Sinnakulam	1	0	0		1
Thiruwegama	-	-	-		
Wirandagollewa	0	0	1		
Cascade	9	0	4	1	1

Source: Farm Household Survey, JICA Project Team 2017

The following table shows that livestock keeping is principally a male activity, especially for free range grazing. This situation signifies the fact that women cannot easily handle free grazing and tethering system of management.

On the other hand, poultry is taken care more by women than by men. Therefore, poultry activities are important supplementary income source for women headed households.

Table 2.5.8 Gender in Livestock Management (no. of HH)

Tanks	Cattle		Poultry	
	By Female	By Male	By Female	By Male
Alagalla	2	3	1	
Aluthgama	1	1	2	
Boo Oya		1		
Kal kulam				
Puliyan kulam				
Sinnakulam		1		1
Thiruwegama				
Wirandagollewa		1		
Cascade	3	7	3	1

Source: Farm Household Survey, JICA Project Team 2017

2.5.6 Crop residue and Livestock feed

These livestock farmers of the Alagalla cascade with local and low productive cattle see no reason to purchase concentrated feed, which is of high price. However, as shown in the table below, it seems they prefer purchasing grass during the Maha season due to their crop production workload. The question is where they can get cut and bundled grass. There is no such enterprise in this area to cut, bundle and sell grass.

Table 2.5.9 Response to Purchase of Livestock Feed

Tank	Concentrate feed		Grass	
	Agreed to Purchase	Not willing to purchase	Agreed to Purchase	Not willing to purchase
Alagalla	50%	50%	66.7%	33.3%
Aluthgama	0%	100%	50%	50%
Boo Oya	0%	100%	0%	100%
Puliyankulam				
Sinnakulam	100%	0%	100%	0%
Wirandagollewa	0%	100%	100%	0%
Thiruwegama				
Kal kulam				
Total	36.4%	63.6%	63.6%	36.4%

Source: Farm Household Survey, JICA Project Team 2017

Free grazing is the common management practice followed by farmers in this cascade to sustain the cattle population. In a normal season in Alagalla cascade, 100% of land is cultivated during the Maha season and only 70% is cultivated in the Yala season. This allows 172 acres grazing area for cattle during the Yala season. The stocking-density of this area is 172 livestock units. This can maintain 100 milking cows providing 500L of milk per day. However, this grazing area will not be available after the introduction of NCPC water by 2024, as farmers shall cultivate crops in this kind of field.

Even though these farmers are currently cultivating 6.25 acres of maize, its crop residue or stalk is hardly used in this area. Use of crop residue has to be promoted, as it can bring an extra income to maize cultivators as well as benefit for livestock farmers. The area can produce 112 metric tons of maize. The opportunity cost of selling 85 metric tons (75%) of the maize stalk for livestock feed and other (25%) as fertilizer can be considered as a good option for maize growers. The maize cultivators could make an additional income of Rs.85,000 to maize growers in this area.

2.6 Irrigation, Drainage and Other Rural Infrastructure

2.6.1 Irrigation, Drainage and Farm Road

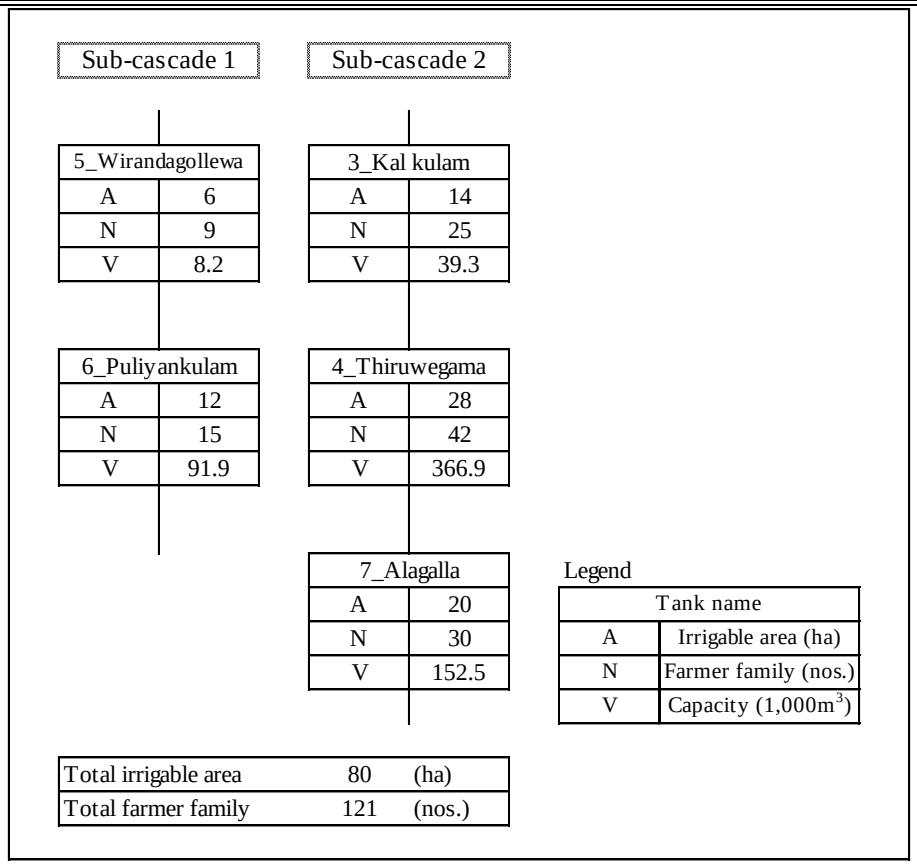
(1) Diagram for Irrigation Drainage

In the Alagalla cascade, there are five existing irrigation schemes, with an extent of 80 ha.

The cascade consists of two sub-catchments, namely, Sub-cascades. Each Sub-cascade has several irrigation schemes. Those tanks are inter-linked by natural stream. Water spilled from upstream tank during Maha season and returned flow from its command area flow into tank located downstream.

Thiruwegama irrigation scheme has the largest command area of 28ha.

Irrigation diagram of the cascade is shown in Figure 2.6.1.

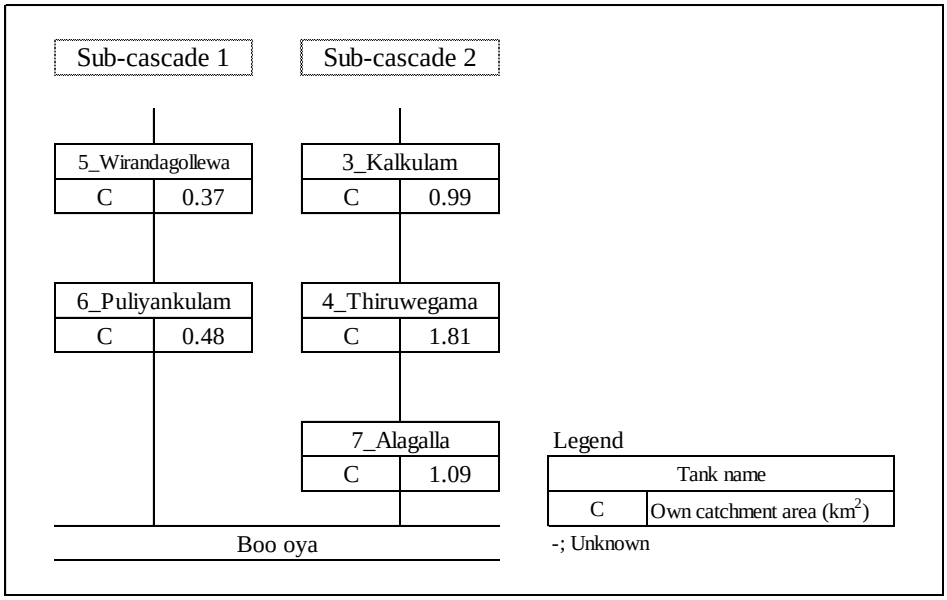


Source: JICA Project Team

Figure 2.6.1 Irrigation Drainage Diagram of Alagalla Cascade

(2) Diagram for Spillway Drainage

The Alagalla cascade is located in the Malwath Oya basin. As indicated in Figure 2.6.1, the drainage water in the cascade flows into Boo Oya.



Source: JICA Project Team

Figure 2.6.2 Spillway Drainage Diagram of Alagalla Cascade

(3) Existing irrigation facilities

Irrigation facilities in the Cascade, such as composing tanks, irrigation canals, and rural roads are maintained by FOs under the technical guidance of the Department of Agrarian Development (DAD), Vavuniya.

A tank under Alagalla irrigation scheme has the longest tank bund with a length of 685m.

A spillway is equipped to protect tank bund against flood. While the number of the structure is basically one per each tank, there are several tanks with two or more spillways so that the flood water can be flown safely to downstream.

Each irrigation scheme has two or three irrigation canals to feed water in the fields.

Existing irrigation facilities in the irrigation scheme under the Alagalla Cascade are outlined in Table 2.6.1.

Table 2.6.1 List of Facilities of Alagalla Cascade

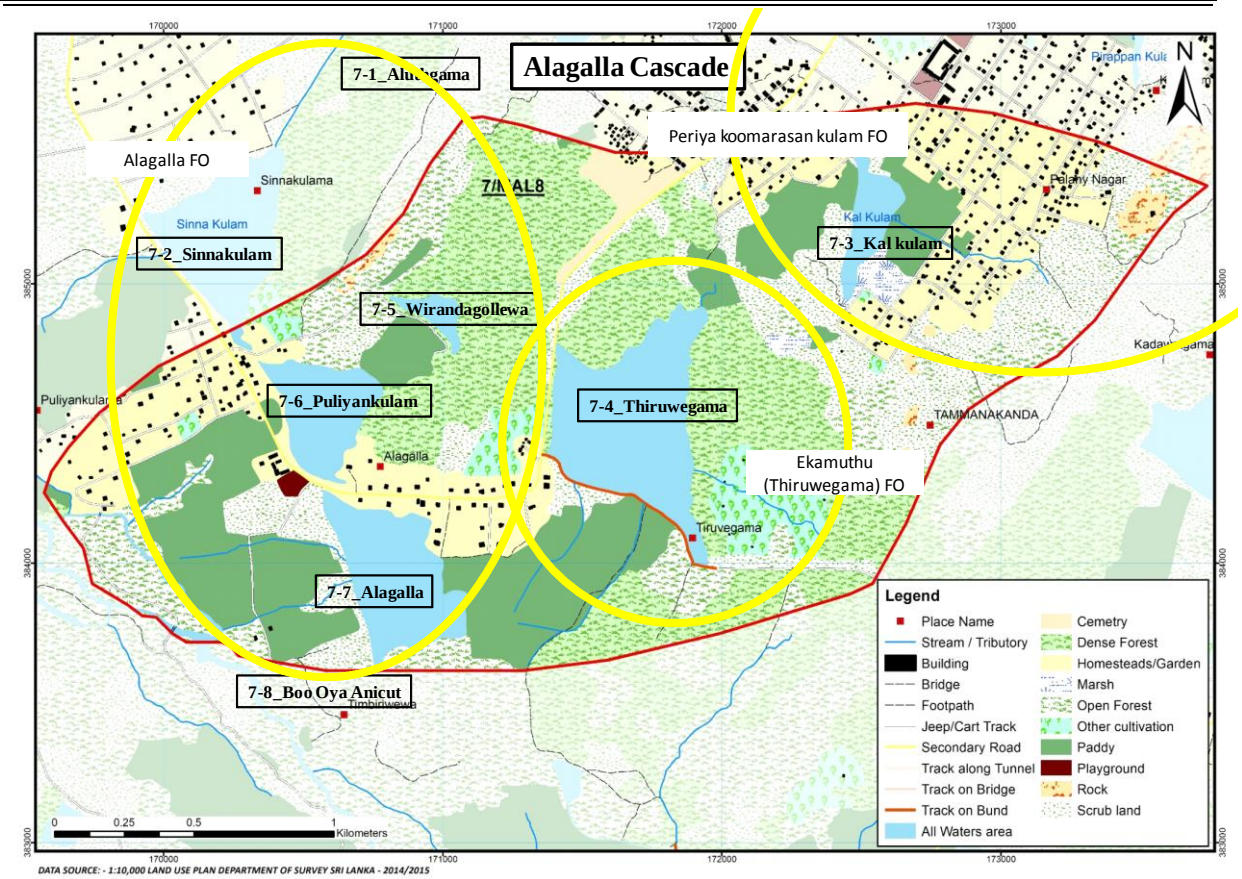
Tank No.	Name of Tank	Tank bund		Spillway			Sluice			Canal			Farm road
		L (m)	H (m)	Location	Type	L (m)	Location	Type	Number	Location	Type	L (m)	L (m)
1	Kalkulam	490	-	RB	Channel	14	LB	Tower	1	LB	Earth	515	200
							RB	Tower	1	RB	Earth	205	
2	Thiruwegama	591	21.0	RB	Drop	5	LB	No	1	LB	Earth	158	500
							CN1	Wall	1	CN	Earth	155	
							CN2	Wall	1	RB	Earth	260	
							RB	Wall	1				
3	Wirandagollewa	470	2.0	LB	Channel	20	LB	Tower	1	LB	Earth	185	550
							RB	Tower	1	RB	Earth	227	
4	Puliyankulam	625	2.0	LB	Drop	19	LB	Tower	1	LB	Earth	240	650
							RB	Tower	1	RB	Earth	790	
5	Alagalla	685	2.1	LB	Drop	46	LB	Tower	1	LB	Earth	210	1,500
							RB	Tower	1	RB	Earth	1,515	
Total		2,861				104			12			4,460	3,400

Remarks: Location; LB (Left bank), CN (Centre), RB (Right bank), W (Width), - (Unknown)
Source: JICA Project Team

2.7 Farmers' Organization and O&M Activities for Irrigation Facilities

2.7.1 General Features of FOs under Alagalla Cascade

Alagalla cascade covers two ASC divisions in different DS divisions, one of which is Tamil dominant area and the other is Sinhalese dominant area. Three FOs are managing the total of five tanks within the cascade boundary, three of which are managed by one FO. Two FOs belong to Madukanda ASC (Sinhalese dominant area) and the other one to Kovilkulam (Tamil dominant area). Only one tank out of five belongs to Tamil dominant community. Even though Periya koomarasan kulam FO (Tamil dominant community) manages five tanks in total under its FO boundary, only one of their tanks belongs to Alagalla cascade, which raised an opinion that they prefer to send water to other tanks managed by their FO instead of the tanks under Alagalla. The following figure indicates the FO boundary in Alagalla tank.



Source: JICA Project Team (Source of Map: 1:10,000 Land Use Plan Department of Survey Sri Lanka – 2014/2015)

Figure 2.7.1 FO Boundary in Alagalla Cascade

2.7.2 Organisational functions of FOs

(1) Basic feature of FOs

Summary of the basic feature of each FO under the cascade is as follows.

Table 2.7.1 Basics of the FOs under Alagalla Cascade

Name of FO	GN Division	ASC Division	Members			Total No. of the Tank under the FO	Tanks under the Cascade
			Male	Female	Total		
Alagalla	Alagalla	Madukanda	95	35	130	6	Alagalla wewa Wirandagollewa Puliyankulam
Thiruwegama (Ekamuthu)	Alagalla	Madukanda	35	7	42	1	Thiruwegama
Periya koomarasan kulam	Ashi kulam	Kovilkulam	84	74	158	5	Kal kulam

Source: JICA Project Team based on the questionnaire survey

Basic functions of the FOs are precisely organised by DAD. All the FOs under Alagalla cascade follow the constitution prepared by DAD. Although the Agrarian Development Act states that "regulation may be made in respect of the manner of election of office bearers and their terms of office, removal or resignation of committee members, filling up of vacancies, the enrolling of members", no FO in the area has prepared their own rules in a written form. Most of the important decision are made during Kanna meeting and annual general meetings, where decisions are authorised by the DO.

(2) FO meetings

Meetings of the FOs are regularly organised. Especially Kanna meetings have been organised every season practically called by the DO as it has legal authorisation. Frequency of Kanna meeting and committee meetings and participation of members to the meetings are summarised in the following table. Other meetings are organised based on emerging needs such as rehabilitation of facilities, maintenance works, fertiliser distribution, boundary problems, Sramadhana (communal works), and loan application for members. Ad-hoc activities to be done as a FO are discussed and decided in Kanna meetings.

Table 2.7.2 Practice of Meetings of the FOs under Alagalla Cascade

Name of FO	Kanna meetings			Committee meeting			Other meetings
	Base	Times /year	Participation	Base	Times /year	Participation	
Alagalla	Seasonal	2	14%	Seasonal	2	50%	Ad-hoc meeting 3-4 times /year
Thiruwegama (Ekamuthu)	Seasonal	2	38%	Need basis	4	60%	Irregular meeting when required
Periya koomarasan kulam	Seasonal	2	47%	Seasonal	2	50%	Ad-hoc committee meeting normally 5-6 times/year

Source: JICA Project Team based on the questionnaire survey and FO meeting

From the view point of the DO and ARPA, most of the officers in-charge of the model cascades do not have any difficulty in organising meetings with the FOs, apart from those in Kallanchiya ASC. The reasons for the difficulties in organising a meeting with the FO as mentioned in Kallanchiya are the poor participation of the FO members and the lack of involvement of the community leaders. The majority of the officers in-charge of the six model cascades evaluated that the FOs are organising meetings by themselves only on a few occasions while about 30% answered FOs always organise meetings without the help of officers. The following table indicates the result of the questionnaire interview to the DO and ARPA in the target ASC regarding organisation of meetings by FOs.

Table 2.7.3 Evaluation of the FOs by the DO and ARPA on Conducting Meetings

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Those having difficulties in organising meeting with FOs		0%	0%	0%	0%	0%	67%	0%	11%
Reasons of difficulties		Poor participation of members Leaders are not fully involved							
Do you think FOs organise meeting by themselves when necessary without help of ARPA	always	50%	50%	0%	40%	50%	0%	33%	32%
	only few occasion	50%	50%	100%	60%	50%	67%	67%	63%
	no	0%	0%	0%	0%	0%	33%	0%	5%
	Reason for no.	Leaders have no capacity							

Source: JICA Project Team based on the questionnaire survey

(3) Problem Solving Capacity of FOs

According to the group discussion organised with each of the FO, problem solving procedure is not clearly established. All the FOs solve their problem internally through discussions and mutual understanding based on their social relations as most of the members are related. Even though FOs are entitled in the Agrarian Development Act to pose penalty for disobedience to their rules, they have never execute the penalty so far. While members discuss and solve most of the problem, some problems that they cannot solve are referred to the ARPA or DO.

Analysing from the interview survey to DOs and ARPAs in the target cascades, frequencies of ARPAs and DOs to intervene conflict resolution ranging from once to twice a year to almost every month. 42% of DO/ARPA answered they are involved in the conflict solving once in 2-3 months. Major problems the officers attend are issues in water distribution and problems in maintenance works.

Almost 80% of the DO/ARPA intervene problems of water distribution. There are also some conflicts between members consulted to DO/ARPA.

Table 2.7.4 Involvement of DO and ARPA in Conflict Resolution

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Frequency of consultation in the conflict solving of FO	Almost every week	50%	0%	0%	0%	0%	0%	0%	5%
	Almost every month	0%	100%	50%	20%	0%	33%	0%	26%
	Once in 2-3 month	50%	0%	50%	80%	50%	0%	33%	42%
	1-2 in a year	0%	0%	0%	0%	50%	67%	67%	26%
Problems FO consult the officers (multi answer)	Problem in water distribution	50%	100%	50%	60%	100%	100%	100%	79%
	Problem in maintenance works by members	50%	100%	100%	60%	0%	67%	33%	58%
	Problem in major rehabilitation	0%	50%	50%	0%	0%	0%	33%	16%
	Conflict among members	100%	0%	0%	60%	0%	0%	67%	37%
	Conflict between tanks	50%	50%	0%	0%	0%	0%	0%	11%
	Conflict with other FOs	50%	50%	0%	0%	0%	0%	0%	11%
	Problem in financial management	50%	0%	50%	20%	0%	0%	33%	21%
	Problem in cultivation	100%	50%	50%	60%	100%	67%	67%	68%
	Other	50%	0%	0%	20%	0%	33%	33%	21%

Source: JICA Project Team based on the questionnaire survey

(4) Financial Capacities of FOs

All the FOs collect membership fees ranging from Rs.100 to Rs.120 per year and collection is fairly good as members will not receive fertiliser subsistence if they do not pay membership fee. In addition, due to the policy introduced by the DAD Vavuniya, they collect O&M fund from members. All FOs are maintaining financial records even though the quality varies and some seem to be below standard. Financial records together with monthly report are to be submitted to the DO office for their inspection. Major income of the FOs includes membership fee, O&M fund, donation, profit from contract works, and fund allocated by government. Use of FOs' saving is strictly controlled by the DO as they need to take official procedure set by DAD. For an FO to withdraw their fund, the FO should first call a committee meeting to get a consent from the committee for the use of the funds, the minutes of which are submitted to the DO office for approval. If the expense is concerning engineering works, a DAD technical officer assesses its appropriateness for the proposed expense. Therefore, the possibility of a misuse in funds seems to be low.

Table 2.7.5 Financial Status of the FOs under Alagalla Cascade

Name of FO	Membership Fee	Bank Balance (as of Jan 2017)	Financial Record	Major Income Source	Major Expenditure
Alagalla	Rs.120/year	Rs.287,226	Yes	Fund from Government (through proposal), membership fee, O&M fund collected from members, donation	O&M works
Thiruwegama (Ekamuthu)	Rs.100/year	Rs.411,262	Yes	Membership fee, profit of contract work (5%)	Small scale O&M expenses
Periya koomarasan kulam	Rs.100/year	Rs.323,999	Yes	Contract works, O&M fund collected from members (Rs.100/acre/season), membership fee	Administrative expenditure, Small scale O&M works

Source: JICA Project Team based on the questionnaire survey

According to the interview survey conducted to the DOs and ARPAs, financial records, as well as other relevant records are inspected by the DO/ARPAs. Even though most of the DO/ARPA evaluated the records maintained by FOs were good or fair, 95% of the officers feel some improvement is required in the financial records keeping. The following summarises the practice of records inspection and evaluation of the record kept by FO based on the interview survey to DO and ARPAs in the target cascades.

Table 2.7.6 Evaluation by DO/ARPA on Record Keeping by FOs

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Record inspections		100%	100%	100%	100%	100%	67%	100%	95%
Type of records inspected	Meeting minutes	100%	100%	100%	100%	50%	33%	67%	79%
	Financial record	100%	100%	50%	100%	100%	67%	100%	89%
	Membership register	50%	100%	100%	80%	50%	33%	100%	74%
	Other	0%	0%	50%	0%	0%	0%	0%	5%
Quality of their record keeping	Very good	0%	0%	0%	0%	0%	0%	0%	0%
	good	50%	100%	0%	100%	100%	67%	67%	74%
	fair	50%	0%	100%	0%	0%	0%	33%	21%
	poor	0%	0%	0%	0%	0%	0%	0%	0%
	very bad	0%	0%	0%	0%	0%	0%	0%	0%
Improvement required	Meeting minutes	50%	50%	50%	40%	50%	0%	33%	37%
	Financial record	100%	50%	100%	100%	100%	100%	100%	95%
	Membership register	50%	50%	50%	0%	0%	0%	33%	21%
	Other	0%	50%	0%	0%	0%	33%	0%	11%

Source: JICA Project Team based on the questionnaire survey

2.7.3 Water Management and O&M Activities of FOs

In most of the tanks under Alagalla cascade, tank water normally spills out in every Maha season. Water management during water scares period is distributing water in rotation by controlling gates. One FO prepares timetable for water distribution. A water master (gate controller) is appointed in one FO who is paid in cash, while other two FOs do not have any particular appointed water controller. During Yala season, one FO cultivates one-third of the total cultivation land in normal season and the other cultivate in a limited portion of land only for seed paddy preparation. All the three FOs practice Bethma during water scarce period for their limited cultivation. More than 99% of the farmers in HHS answered they practice Bethma, which implies that cultivation land is allocated to all the farmers during water scarce period.

General O&M works such as canal cleaning and clearing tank band are done by FO members, in which works are allocated to each member according to the landholding. One FO mentioned that fertiliser shall not be issued to a member unless the allocated work is completed. Basically minor rehabilitation works are done by FO with their fund and major repairs are done by government through application for funds. Constraints in maintenance raised from FOs are prioritisation of rehabilitation with government funds and political influences overwhelming any rules. A conflict between tanks regarding water management was observed when flood damage on the paddy occurred after the downstream tank raised its spillway, which has not been solved due to political influence.

The following table indicates practice of water management and O&M activities in each FO.

Table 2.7.7 O&M of the FOs under Alagalla Cascade

Name Of FO	Water Management				O&M	Participation In O&M Work			
	Appointed Water Master	Payment To Water Master	Payment	Bethma Practice	Contract Work Received	Canal Cleaning	Bund Clearing	Desilting	Labour Contribution
Alagalla	No	No		99%	No	99%	98%	0%	27%
Thiruwegama (Ekamuthu)	No	No		100%	No	100%	95%	0%	95%

Periya koomarasan kulam	Yes	Yes	Cash	100%	Yes (Agri dept).	100%	95%	0%	33%

Source: JICA Project Team based on the questionnaire survey and HHS

Practice of O&M activities by the FOs was also assessed through an interview with the DO and ARPA. Officers evaluate that general maintenance works are conducted to some extent by the FOs. While about 20% assessed that the 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 done by the concerned officers on O&M activities by the FOs.

Table 2.7.8 Evaluation by DO/ARPA on O&M Activities by FOs

ASC			Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
General maintenance works conducted by FOs	Canal cleaning	always	0%	50%	0%	20%	50%	0%	33%	21%
		only a few occasion	100%	50%	100%	80%	50%	100%	67%	79%
		no	0%	0%	0%	0%	0%	0%	0%	0%
	Bund cleaning	always	0%	50%	0%	20%	50%	0%	33%	21%
		only a few occasion	100%	50%	100%	80%	50%	100%	67%	79%
		no	0%	0%	0%	0%	0%	0%	0%	0%
	Minor repair of facilities	always	0%	0%	0%	20%	50%	0%	33%	16%
		only a few occasion	100%	100%	100%	80%	50%	100%	67%	84%
		no	0%	0%	0%	0%	0%	0%	0%	0%
Evaluation of quality of maintenance by FOs	Canal cleaning & bund cleaning	very good	0%	0%	0%	0%	0%	0%	0%	0%
		Satisfactory	50%	100%	100%	100%	100%	100%	100%	95%
		not satisfactory	50%	0%	0%	0%	0%	0%	0%	5%
		poor	0%	0%	0%	0%	0%	0%	0%	0%
	Reason for not satisfactory	Lack of coordination among members Farmers do not recognize importance Because there is no penalty for disobedience								
	Minor repair of irrigation facilities	very good	0%	0%	0%	0%	50%	0%	0%	5%
		Satisfactory	50%	100%	100%	100%	50%	100%	100%	89%
		not satisfactory	50%	0%	0%	0%	0%	0%	0%	5%
		poor	0%	0%	0%	0%	0%	0%	0%	0%
	Reason for not satisfactory	Farmers lack skills and capacity to do Lack of fund in FO savings Farmers do not recognize importance Farmers depend on government support								

Source: JICA Project Team based on the questionnaire survey

Activities FOs operate other than irrigation management are Sramadhana, loan application for members by certifying members for loan, and linking members with paddy market and buyers. Even though the Agrarian Development Act encourages FO to form small groups to carry out agriculture activities, no FO has much collective activities on agriculture related works.

Chapter 3 Needs for Development in Alagalla Cascade

3.1 Agriculture Production and Marketing

3.1.1 Agriculture Production

The project envisages improvement of the livelihood of cascade communities in the target area by promoting agricultural activities. The overall development direction falls within the purview of National Food Production Program: 2016-2017, which 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.

(1) Paddy Production

Sri Lanka has reached self-sufficiency level in the production of rice with its existing land area and productivity levels under normal rainfall distribution. However, unpredictable weather patterns, attributed to climate change associated with global warming, have resulted into wide fluctuations in the national production level of paddy during the recent years causing severe shortages and slight excesses in the supply. Thus, there is an urgent need to stabilise and increase the production level to meet the present national requirements as well as the future "natural increase" in the demand. Being the major crop in the project area, paddy has traditionally played a pivotal role shaping the socio-economic backdrop of the farming communities living the villages therein.

In Alagalla cascade, all irrigated areas under the tanks are cultivated with paddy in the Maha season while in the Yala season only 70% of the irrigable area is cultivated due to shortage of water. Almost all the households wish to cultivate only paddy during the Maha season, but are willing to diversify the paddy lands fully or partially during the Yala season. Under the circumstances, it would appear that paddy would continue to be the dominant crop in the project area even with the anticipated qualitative changes in the cropping pattern after delivery of water through the NCPC.

The needs for enhancing the farm income generated from paddy cultivation is reviewed under three perspectives.

(a) Paddy Productivity

Average paddy yield in the cascade command area remains comparatively high with 5.35MT/ha and 4.50MT/ha in the Maha and Yala seasons, respectively. The yield level appears to be high and is on par with the average yield reported for paddy under minor tanks in the Vavuniya district (Department of Census and Statistics 2015 - 2016 Maha). However, productivity is lower than that reported for the major irrigation schemes, e.g. Mahaweli System H at 6.26 MT/ha (Department. of Census and Statistics 2014 - 2015 Maha). Inadequacy in the supply of irrigation water was cited by 41% and nearly 100% of the farmers for Maha and Yala cultivation, respectively. An assured supply of water after the project completion would encourage the farmers to adopt recommended production technologies with confidence leading to higher productivity levels. The following recommendations are made by the Department of Agriculture to bridge the present yield gap:

i) Select appropriate cultivar.
ii) Use quality seeds.
iii) Undertake collective and timely cultivation.
iv) Improve and sustain soil fertility.
v) Practice effective crop management including weed, pest & disease and nutrient management.
vi) Add value to the produce.

(b) New Improved Paddy Varieties

Rice Research and Development Institute (RR&DI) of the Department of Agriculture releases new improved paddy varieties having yield potential and possessing special quality attributes on a regular basis. Two such varieties were identified during the study period, namely, At 311 (yield potential

7.7MT/ha, low glycaemic index and known as Niroga Red) and At 373 (yield potential 6.7 MT/ha, distinctive aroma and known as Suwanda Samba).

Such paddy varieties with high yield potential and special attributes that fetch high market prices need to be first identified, introduced and actively promoted among farmers in the project area for enhancing their farm incomes.

(c) Traditional Paddy Varieties

Traditional paddy essentially targets a niche market that appears to be undersupplied. It is stated that a monthly market deficit of about 1,000 MT of traditional rice exist in Colombo and suburbs alone. (Market Survey of the JICA Project Team 2017). This indicates an immediate need to bridge the current gap of 75% in the supply level for Colombo markets and to cater to the expected natural growth in demand. In fact, few of the farmers have already established themselves as producers of traditional paddy with own marketing linkages. Recommended varieties are Suwandel, Kuruluthuda, Pachchaperumal, Kalu Heeneti and Madthuwalu which are in demand among the consumers and fetch higher market prices. Although the potential yield of traditional paddy is low, which is less than 4MT/ha compared with that of new improved varieties, which are greater than 6 MT/ha), it is amply compensated by the lower input use and higher produce prices.

However, it is necessary to provide the farmers with high quality seed paddy, particularly of high varietal purity status, as the material used by the farmers at present is highly mixed. This would enable the farmers to establish some degree of regional specialization for selected traditional paddy varieties.

(2) Crop Diversification

The concept of crop diversification in the irrigable fields, as applied to minor irrigation systems, is to overcome the problems of water shortage and low farm profitability of paddy cultivation. It implies a shift from regional dominance of one crop to a regional production of number of crops to meet the increasing demand for OFCs, vegetables, fruits and fodder/grasses. Through the process, it is anticipated that the water use efficiency, cropping intensities as well as farm incomes are increased. The main factors relating to the establishment of a sustainable basis for crop diversification are highly interrelated and are discussed below. Produce marketing, perhaps the most important factor in the drive towards crop diversification, is addressed in Section 3.1.2.

(a) Willingness of Farmers

Farmers' willingness to diversify the paddy lands into other crops during the Yala season in Alagalla cascade was evident from the findings of the Farm Household survey. Nearly all farmers expressed their readiness to diversify their irrigated farm holding during the Yala season fully or partially. The main reasons attributed by farmers as to why they favoured crop diversification are i) high water use efficiency, ii) high farm income, iii) suitability of land, (iv) existence of ready market and (v) available previous experience in that order.

(b) Irrigation Management

Majority of the farmers in the survey area were not content with the quantity of water they received for cultivation of paddy, particularly in the Yala season. In fact, 44% of the farmers did not receive any water during the Yala season. After diversion of water from NCPC, it is presumed that the problems relating to water shortage faced by the paddy farmers would be adequately resolved. However, this does not imply that an unlimited quantity would be available for cultivation of the entire irrigable area with paddy in both seasons. For successful cultivation of other crops strict control and regulation for management of the water delivery system is essential and the framers need to adopt stringent practices and extend their cooperation as a group to optimize water and thereby increase the cropping intensities. Households in Alagalla cascade show high degree of cohesiveness with regard to sharing of water during periods of drought by resorting to 'Bethma' system of land use. Based on the quantity of water available in the tank, it involves selection of proportionate land extent in the command area and allocating portions to farmers by consensus for cultivation for the particular season. The cooperation among the farmers could be built-up to the best advantage in irrigation management.

(c) Soils

It was generally presumed that the irrigable land under cascade systems comprise of mainly of poorly drained LHGs with patches of imperfectly drained and well drained RBEs. Poorly drained soils are not suitable for growing of most of the OFCs and vegetables unless appropriate provisions are made to improve soil drainage conditions. In the Yala season, nearly 30% of the irrigable land area in the Alagalla cascade is left fallow due to shortage of water. These lands could be used for establishment of crops other than paddy during the Yala season thereby increasing the cropping intensity and farm income. However, it is prudent to appraise the soil drainage characteristics in order to establish its suitability and before planning for crop diversification in these fields.

(d) Crops

The potential seasonal crops for a diversification program include OFCs and vegetables. These are further be grouped as low risk and high-risk crops. Coarse grains (maize, kurakkan, and sorghum), grain legumes (green gram, black gram, and cowpea) and most traditional vegetables are low risk crops while condiments and exotic vegetables come under high-risk crops.

The selection of specific crops as an alternative to paddy depend on a number of factors such as its profitability, adoptability to the agro-ecological conditions, production costs, availability of inputs, technical competency and market conditions among others. In the Alagalla cascade, pulses (grain legumes), maize (coarse grain) and traditional vegetables are the main crops and crop groups identified by the households for diversifying paddy lands. It is apparent that the farmers' preference for the crops is influenced by the familiarity with their cultivation in the past, low perishability of the product and market stability. Cultivation of these crops having less water requirement would increase the cropping intensity and thereby increase the farm income. However, the net income realized from cultivation of these crops is in the same range as that of paddy and the effect on the farm income would be marginal.

On the other hand, net returns from cultivation of condiments and up-country vegetables are several times higher than the other possible crops. Taking other determining factors into consideration, promotion of high value crops is highlighted as means of any significant increases in the farm income. Labour requirement, total cost of production and net returns for selected crops are shown in the Table 3.1.1.

Table 3.1.1 Comparison of Labor Use, Total Cost and Net Returns of Selected Crops

Crop	Labour Man (days)	Total Cost (Rs/ha)	Net return (Rs/ha)	Crop	Labour Man (days)	Total Cost(Rs/ha	Net return (Rs/ha)
Paddy	52.5	116,762.5	101,737.5	Bitter Gourd	317.5	604,820.0	775,180.0
Maize	92.5	151,467.5	141,032.5	Big Onion	447.5	678,092.5	1,121,907.5
Green Gram	130	171,195.0	68,805.0	Chilli	275	367,487.5	507,512.5
Black Gram	86.25	105,260.0	114,740.0	Cabbage	342.5	524,845.0	675,155.0
Cowpea	115	158,677.5	75,622.5	Capsicum	410	489,192.5	1,295,807.5
Soya Bean	130	178,000.0	122,000.0	Tomato	357.5	475,587.5	784,412.5
Okra	215	301,395.0	86,105.0	Pole Bean	300	389,530.0	735,470.0
Beet Root	305	531,970.00	143,030.00	Carrot	310	489,950.0	1,084,848.0

Source: Crop Enterprise Budgets (DoA 2015) - Modified

(e) Labour

One obstacle for diversifying into other crops would be the shortage of farm labour. In Alagalla cascade, 57% of the paddy farmers are facing scarcity of hired labour while 20% complained about labour scarcity and high rates charged by them.

All condiments and vegetables in general require high labour input for their cultivation as shown in Table 3.1.1. Option such as mechanization and staggered cultivation needs concerted assessment for promotion.

(f) Capital Requirements

Working capital requirements for cultivation of high value crops are high and involve capital investment as well. Over 64% households in the Alagalla cascade showed a monthly income in excess of Rs. 30,000 and about 75% used their own financial resources for agricultural investments. Dependence on commercial banks was low at 6%. Households need to be encouraged to seek agricultural credit from formal lending institutions such as commercial banks to meet the additional cash flow requirements when undertaking cultivation of high investment crops. Government intervention to simplify the farmer obligations and thereby enhance accessibility to agricultural credit from formal lending agencies needs careful consideration.

(g) Extension and Training

Crop diversification is looked as a process that evolves to a sustainable system through stages over a period of time. As with any innovation, it passes through the adoption stages of awareness, persuasion, decision and implementation before the field adoption takes place on a sustainable basis. In this situation, the extensionists are called upon to play a key role to introduce, promote and thereby accelerate the adoption process. 94% of the farmers in Alagalla cascade recognize AI and ARPA as the grass-root level providers of extension services and 62% expressed keenness to learn more on crop production and crop protection.

It was apparent at the training program on cultivation of high value traditional and new paddy varieties, organized by the project and conducted by the RR&DI, Bathalagoda, that the subject matter presented and discussed was a new learning experience to most of the participants. The trainees expressed their desire to apply some of the practices and techniques learned during the next crop season. The program was, however, symbolic as only few farmers from each cascade could attend the session. Demonstrations and training of this nature need to be conducted at training centres as well as in farmers' fields to reach more farmers and accelerate the adoption process.

Farmers' interest on the cultivating selected exotic vegetables was boosted through field demonstration and training on high value vegetables conducted at the CIC Seed Farm, Pelwehera. As with the paddy training, only few farmers representing each cascade participated in the program. Field demonstrations of this nature are essential as an extension method to promote crop diversification. In addition to establishment of demonstration plots and training sessions, the extensionists need to ensure availability of production inputs such as seed and planting materials, fertilizers and agro-chemicals etc. in adequate quantities at correct time order to realize the objectives of crop diversification and its sustainability.

To improve the competency of the extenstionists to take up the challenge confidently, their knowledge, skills as well as the attitude need constant upgrading through refresher training and exposure to current and new production technologies.

3.1.2 Marketing

(1) Towards Profitable Agriculture

The Project proposes qualitative changes to the current agricultural system in the target cascades to enable profitable agriculture. Profitable agriculture requires appropriate marketing strategy wherein production, processing and distribution are strategically designed to meet market needs in order to reap the full benefits of the market economy. Assuming that the NCPCP significantly increase the quantity and quality of crop production in the target cascades through improvements in irrigation infrastructure and water supply, this section will highlight areas that will enable the cascades to achieve profitable agriculture in a financially and environmentally sustainable manner.

(2) Introduction of New and Traditional Paddy Varieties

According to the marketing study conducted by the Project from December to March 2017, there is a high-demand niche market for new and traditional rice varieties in urban areas, including Colombo. The study indicated that traditional paddy varieties such as *Suwandel, Pachchaperumal*, and *Madathawalu* are purchased at one and half to two times higher than the price of ordinal varieties. The study also reveals that 88% of targeted retailers in this niche market prefer to purchase the traditional variety of rice directly from farmers. Currently, majority of farmers plant only the ordinal variety, which is purchased

solely by the government. Introducing new and traditional paddy to target cascade is a low-risk strategy that will increase market access and opportunities for direct selling (from farmer directly to buyer, reducing the transaction cost by shortening the supply chain).

However, it is important to consider that most farmers sell only paddy. Noting that buyers from this niche market, particularly from Colombo, purchase mostly rice (and not paddy), post-harvest support is central to facilitate market access. Given that the process of milling paddy and transporting rice significantly affects rice quality, together with the introduction of the new and traditional paddy varieties, post-harvest support is crucial in creating linkage to new markets.

In Alagalla cascade, paddy is the dominant cash crop. Introducing new and traditional paddy varieties is a potential option for profitable agriculture since farmers in the said cascade are already accustomed to the planting methods. In order to ensure profitability in the traditional paddy varieties, however, the key is to create linkages with buyers from Colombo.

A farmer in Kanthale, Trincomalee District, for instance, accounts that he sells the traditional paddy called Kalu heenati, to Keels supermarket in Colombo. His paddy price is 102.4 Rs/kg against the 30-40 Rs/kg price of ordinal paddy. He mills his own paddy and sends them to buyers by train.

In Alagalla cascade where collectors and PMB are the only two major buyers, farmers are not familiar with rice transactions. As such, they require a step-by-step training and support on how to establish and strengthen linkages with new buyers and how to produce quality traditional paddy/rice buyers require. Establishing an alliance with millers and logistics providers is essential in ensuring the success of this marketing approach.

(3) Introduction/Expansion of OFCs with Contract Farming

OFCs such as coarse grains (maize, sorghum) and grain legumes (green gram, black gram, cowpea), is another potential source of profitable agriculture in the cascade. A notable number of farmers have indicated their keen interest in starting pulses (53.5%) and maize (39.0%), particularly in the Yala season, mainly due to familiarity and experience in planting the crops.

To ensure profits from OFCs, farmers can engage in contract farming. While there is no experience in contract farming of OFCs in the cascade, a number of farmers in Anuradhapura district have successfully secured their markets through contract farming. These farmers enjoy a sense of security as they practice contract farming to secure their minimum selling price for their OFCs, particularly soya, maize, onion, to name a few. Most agri-business enterprises also offer support packages with contractors. For instance, Maliban Dairy and Agri Products Ltd. in Dambulla provide training and farming inputs such as seeds, agrochemicals, and bags with a forward minimum price to purchase. Based on the marketing study conducted by this Project, contract farming is a feasible market strategy not only because there are already successful farmers but also it reduces risks for farmers, since the price is determined by the contracting parties before the cropping season, huge fall in market price will not affect the farmers' profits.

The marketing study notes, however, that there are cases of contract violations that typically stems from low quality of crops and when there is a higher bidder for the crops. A classic example is when the contracting company refuses to purchase the product because it does not meet the required quality. Farmers, however, contend that their products are of "quality" and demand that the contract must be honoured. In other cases, farmers violate contracts by selling to other buyers who offer a higher price than what was previously contracted. Given these typical cases, the agreement process should be thoroughly understood by both parties and carefully monitored in order to avoid contract violations. Knowledge on market price and trends, for example, will help farmers in contract negotiations as well as appreciating the importance of trust in strengthening and maintaining market linkages.

(4) Introduction of High-value Vegetables/Fruits

Vegetable and fruits are another potential source of profit for farmers. Vegetable farming offers good profitability for farmers as cash flow is faster, which the farmers can earn within three to four months. Moreover, if the crops are strategically and timely managed to meet market preference, profits are easily attainable. Unfortunately, only 7.5 % farmers in the cascade show interest in these crops, arguably due to lack of knowledge and experience in vegetable farming. Although there is currently a small number of

farmers who earn through vegetables and fruits, they individually sell them directly to, as opposed to collective selling.

The Project's marketing team interviewed a total of 171 middle and high class hotels in the Anuradhapura and Sigiriya areas and identified high valued crops that hotels and restaurants in the area are willing to purchase at premium prices. These include cantaloupe melon (69.53%), bell pepper (51.58%), and baby corn (41.43%). Most hotels currently purchase vegetables and fruits at open markets and wholesale markets but more than 65% of those hotels prefer to purchase directly from farmers to lessen damage in crops due to improper handling and ensure freshness.

Considering that the Anuradhapura and Sigiriya areas, surrounded by ancient heritages, was visited by over 50 million foreign tourists in 2015 alone (Sri Lanka Tourism Development Authority; "Annual Statistical Report 2015"), it captures a huge market that farmers can directly access, provided they meet market preference.

In order to optimize market benefits, support in farming, post-harvest and marketing will significantly enable farmers to access this market. Formulating cooperation schemes with hotels show promise as hotels are open to establish partnerships with farmers.

3.2 Livestock

Needs on livestock sector development in Alagalla can be summarised and categorised as follows;

i) Enhancement of livestock production system in the area,
ii) Improvement of productivity of livestock,
iii) Overcoming constraints in livestock farm management,
iv) Needs on institutional frameworks and supporting system, and
v) Potential on poultry sector development.

The following section discuss these needs indentified in Alagalla for further development

3.2.1 Issues in Livestock Production System in Alagalla Cascade

In Alagalla cascade, the household that operate agriculture as the primary income source is 25.9%, the rest 74.1% remain outside the farm during the daytime. 11% of the Alagalla cascade farmers have cattle or poultry, although none of them operating livestock as their primary occupation. While the total average monthly income in this cascade is as high as Rs.40,229, those from crop and livestock activities are as low as Rs.9,575 and Rs.5,000 respectively. This means livestock activities in the area is very marginal level, and there is a plenty of room to improve income of full-time farmers with supplementary revenue from livestock activities.

Table 3.2.1 Monthly Average Income of a Crop & Livestock Farm

Tanks	Average Monthly Income (Rs.)			Proportion of Livestock Farmers	Operational Economical Land Holdings (Acres)
	Crop Only	Livestock Only	Total Average Income		
Alagalla	9,575	5,000	40,229	8.1%	2.17
Ichchankulama	18,408	20,332	33,699	17.2%	4.07
Kiulekada	9,162	18,100	28,667	7.5%	2.74
Naveli kulam	15,410	13,438	41,872	31.6%	3.46
Rathmalawewa	9,747	32,500	31,190	1.5%	4.32
Siyambalagaswewa	13,705	11,075	23,581	6.0%	2.50
Project Total	12,514	15,337	32,527	10.8%	3.33

Source: Farm Household Survey (JICA Project Team 2017)

The operational economical land holdings area is 2.17 acres in Alagalla cascade. One of the option for these farmers to increase crop income with NCPC water is to cultivate more area under maize. Maize farmer can sell both the cobs and corn stalk. The maize stalk will give an additional income of Rs.18,000 per acre to the Rs.50,000 by selling maize cobs. Arrival of NCPC water will prevent free grazing, as land will be mostly cultivated even in the Yala season. Hence, silage from maize stalks can transform the management system of free grazing to stall-feeding for the sustenance of the economically powerful milk production sector in the cascade system after the arrival of NCPC water.

Increasing the number of farmers with livestock sub-sector will benefit the whole cascade community. There are a number of farmers solely depending on their crop production for their income. These farmers can enhance their farm income and stabilize their income even during drought time by including livestock sub-sector in their agriculture practice. More facilitation activities at farmer level to encourage them to initiate livestock activities and transfer of technology through farmer owned model units would be useful.

3.2.2 Needs in Increasing Livestock Productivity

Farmers' priority is to increase income from milk sales to generate extra revenue to the farm economy, whereas, at the national level priority is import substitution. However, if farmers' priority is addressed beforehand, the national objective will be automatically achieved. Therefore, it has sense to address farmers' priority of farming as rural livelihood is now under threat.

In the whole Alagalla cascade area, there are only 8 dairy cows producing 12 litres of milk per day. The average milk productivity of 1.5 litre/day/cow is lower than both the average of whole Anuradhapura District, and the average of the model cascades.

Table 3.2.2 Average Milk Production (Litres / cow / day)

Tank	Average Daily Milk Production (Litres/day)	No. of Dairy Cows	Milk Productivity (litre/day/cow)
Alagalla	12	8	1.5
Ichchankulama	269	69	3.9
Kiulekada	121	33	3.7
Naveli kulam	378	198	1.9
Rathmalawewa	17	16	1.1
Siyambalagaswewa	48	23	2.1
Total	845	347	2.4

Source: Farm Household Survey (JICA Project Team 2017)

Main areas of thrust in Alagalla cascade are milk for income generation and egg production mainly for nutritional purposes. Expected income margin in milk production is between 500% and 800%. Judging from the current productivity of cattle in Alagalla, potentials of increasing productivities is high. Social, genetic, and nutritional aspects of the causes of low productivity observed in the household survey of the Alagalla cascade are described below.

(1) Social Aspects Regarding Milk Productivity

First of all, most of the farmers are indifferent to livestock keeping. Traditionally Sinhala peasants unless they were cattle herders for generation will not be attracted to cattle keeping, Tamil peasants keep local varieties of cattle and chicken for home consumption and Muslim herders for ruminant meat for generations.

Traditional cattle rearing is time consuming as the owner need to attend cattle, while the crop cultivations can be attended collectively and by hired labours. For the full-time crop farmers, it is found difficult to attend livestock during the crop cultivation period, as they have to focus on cultivation activities. Moreover, there has been no tradition in the area to set aside land and irrigation for growing feed for cattle. In addition, the majority in Alagalla cascade, farming is not their only income generating activity. Therefore, less time and resources are spent on farming as well as livestock activities. This problem shall be solved through community mobilization and facilitation activity to increase milk productivity with farming style that suit the situation.

(2) Biological (Genetic) Issues in Milk Productivity

A major problem in biological aspect of low productivity is high proportion of local or indigenous cattle. Traditionally these indigenous cattle were raised for meat purposes. However, the drive for increased milk production together with high milk prices have given these farmers an opportunity to increase their income by extracting milk from the local breeds. The potential for milk output of these local types is very low (maximum 2 litres milk). Most farmers resort to scrap bulls to breed their cattle as milk production is initiated after a calving. A good quality bull will, on one hand, produce an offspring

that will respond to higher plane of nutrition (heterosis - Hybrid vigour) and produce more milk (maximum 10 litres milk). On the other hand, local cattle genotypes can survive and produce even under harsh conditions as they have higher adaptive qualities. This first cross (F1) is suitable to the condition in Alagalla cascade area.

In order to achieve higher productivity by improving genetics, there has to be a two-pronged effort, (1) natural breeding program and (2) artificial breeding program. Main stakeholders PDAPH and Milco company should be activated and mobilized for this endeavour. Interaction between extension staff and the farmer will be useful to improve these programmes. A proper facility for such regular meetings can improve livestock management, thus increasing production.

(3) Biological (Nutritional) Issues in Milk Productivity

Another problem in biological aspect is nutrition of cattle. Variability of the supply of quality feed is problem for livestock farmers. The main reason why farmer's resort to free grazing is that it is the easiest and the most convenient method. Alagalla cascade farmers cultivate Maize in both Yala and Maha. This crop residue or stalk is hardly used in this area. An acre of maize stalk can be sold for between Rs.15,000 and Rs.18,000 to dairy farmers, as dairy farmers can convert maize stalk into silage that will increase its shelf life and nutritive value, and will allow farmers to continue stall-feeding. Maize silage can be used when cattle have to be restricted to marginal areas during the crop cultivation period. This system and stall-feeding based on maize silage has to be promoted in the Alagalla area, as it will bring an extra income to maize cultivators and will benefit dairy farmers as well.

Sunn Hemp (*Crotalaria juncea*), an annual tropical legume crop that can be used as a green manure, as covering of crops, and also as livestock feed, can be grown in fields at the end of the Maha season. This will increase the stocking density of the available land in the Yala season. Upgrade stock replacement through feeding regime will increase the productivity of the herd. This will control movement of cattle and increase market value for crop residue biomass, which is otherwise wasted.

3.2.3 Needs in Livestock Farm Management System

(1) Crop-Livestock Farming System

An issue identified in ineffectual livestock activities is poor understanding of the impact of crop-livestock production system. Household survey data on Alagalla cascade clearly shows that most farmers are unaware of economic effects of integrating livestock into their crop farms.

As shown in the below table, land efficiency in Alagalla especially for that of livestock mixed with crop cultivation is remarkably low in comparison with other cascade. As the effectiveness of crop-livestock integration is proved by other cascades, there is high potential for livestock activities in Alagalla to increase land efficiency.

Table 3.2.3 Monthly Land Efficiency per Acre

Cascades	Monthly land efficiency (Rs)	
	Crop only	Crop + Livestock
Alagalla	4544.32	6767.50
Ichchankulama	4705.43	2,6702.94
Kiulekada	3356.45	1,6334.76
Naveli kulam	4482.61	2,0203.68
Rathmalawewa	2262.09	1,0923.24
Siyambalagaswewa	5481.97	1,4086.51
Project	3754.58	1,8844.87

Source: Farm Household Survey (JICA Project Team 2017)

The existing institutional framework with no collaboration between organizations is at fault for not transmitting this information to farmers. Some government organization like Milco Company, the main purchaser of milk in this area, can support farmers in integrating livestock activities. Training program with a familiarizing excursion to other dairy farms (model farms) in the same area will have an effect on changing the mind-set of the Alagalla cascade farmers. Exchange of views may give a boost to the fledgling dairy sector. A model farm has to be developed prior to these visits.

(2) Livestock Farm Management

The need to improve current practices in management was identified. Upgrading of the genetics of the existing herds of Alagalla cascade for milk producing ability is necessary as mentioned above and the upgraded cattle require better management and good practices to maximize their potential. Therefore, activities to improve livestock farm management shall be included in the project planning.

It is also important to initiate livestock activities prior to the availability of NCPC water, otherwise most of farmers focus on crop cultivation with NCPC water and the livestock sector will have a negative effect with full cultivation in both Yala and Maha.

3.2.4 Needs in Institutional Framework and Supporting System

Expansion of extension staff to increase interactions with farmers is important for the above mentioned expected development of livestock sector, as it requires change of mind set of farmers and close technical supports. In the proposed project, PDAPH and Milco company officials are expected to actively participate in addition to their current heavy workload and capacity. These officers will find it easier to handle these activities with extra resources such as, staff, funding, vehicles and training.

Development of the milk collecting centres for extension activities of those who provide services to the farmers (PDAPH) and milk purchasing organizations will also encourage interaction between farmers and extension staff.

3.2.5 Needs in Family Poultry Sector

Expansion of poultry is beneficial for women as well as the whole family. Women generally handle family poultry sector within the home garden and this is one area for women to supplement the household income. Scavenging chickens are primarily kept for eggs, and then by-products such as spent chicken, adult males or replacement chicks bring additional income to women. Even though only four households rear chicken, 20% of the households are women headed families.

However, the average home garden land holding size of 0.65 acres is insufficient to keep both vegetables and scavenging chicken. Therefore, in order to expand poultry activity in the home garden, a new system has to be promoted to keep these poultry birds within confined areas. A system of raising maize seedlings of a week old grown on water can be introduced.

3.3 Irrigation System and Rural Road

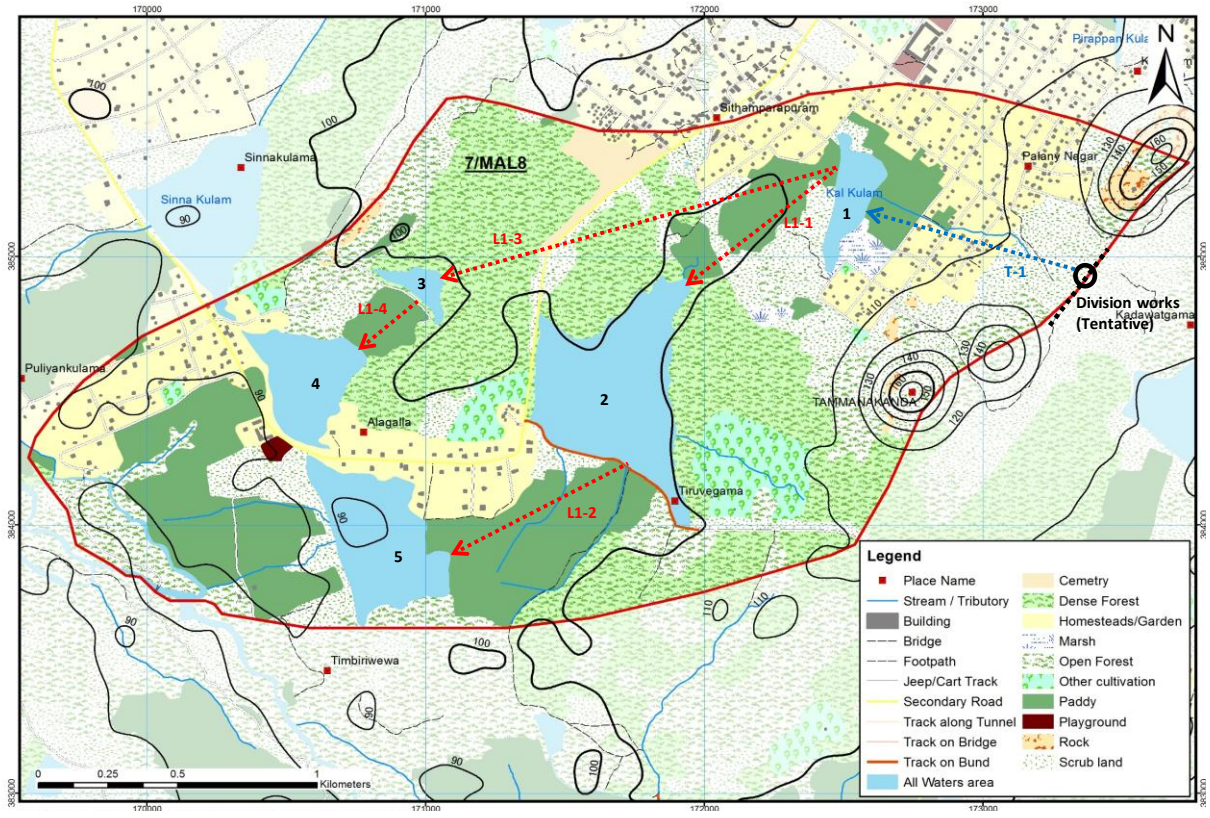
3.3.1 Water Distribution Plan

The water distribution plan was prepared for each tank in the cascade system. The maximum monthly water flow as per the Feasibility Study Report was applied to determine water allocation for each cascade. The allocated water is to be distributed to each tank proportionally according to command area of the particular tank by Tertiary and Link Canals.

Although the location of off-takes on the main or branch canals is not finalized yet, it is tentatively placed at the most elevated area in the cascade. Tertiary canals are proposed be constructed to convey water from the off-take to the most upstream tanks of the Sub-cascade.

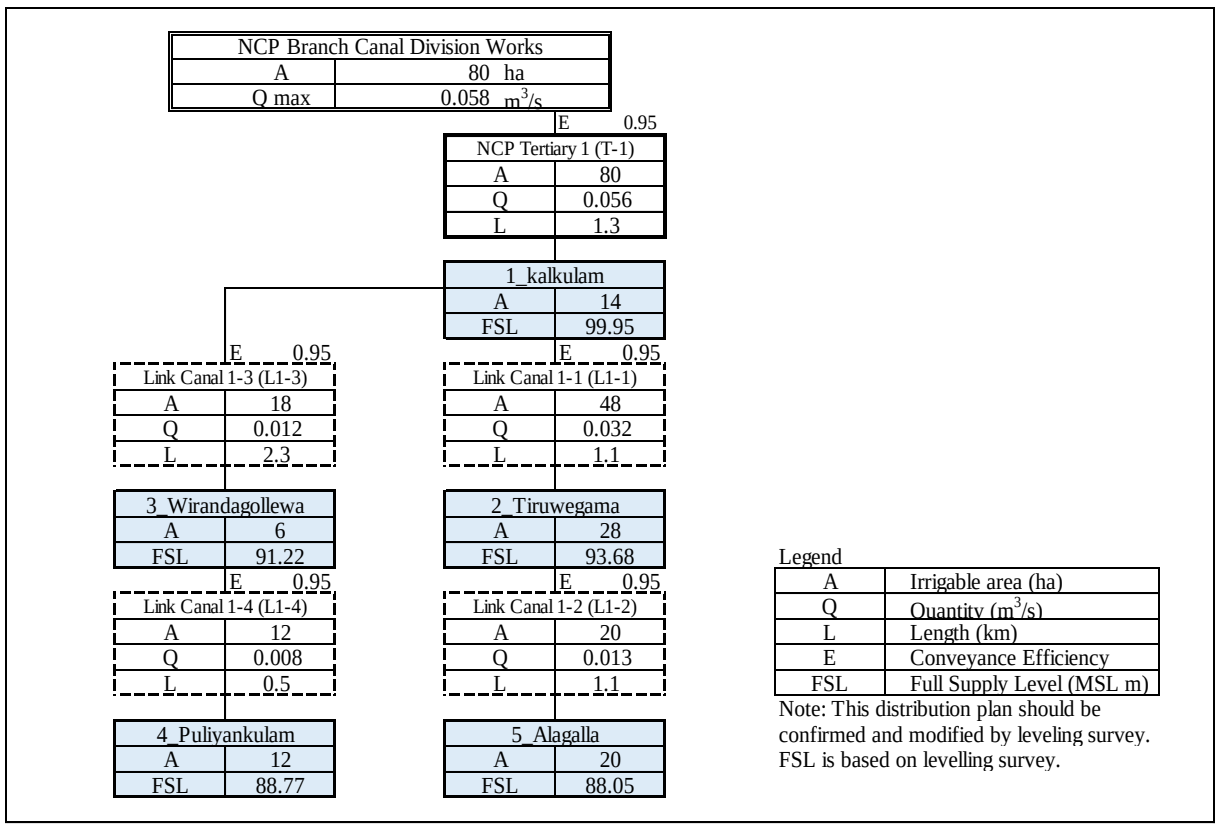
Link canals will be constructed to convey water from upstream tanks to downstream tanks in the Cascade system.

Layout of the tertiary and link canals is indicated in Figure 3.3.1 while water distribution diagram in the Cascade is shown in Figure 3.3.2



Source: JICA Project Team (Map data: -1:10,000 Land Use Plan Department of Survey Sri Lanka - 2014/2015

Figure 3.3.1 Distribution Plan in Alagalla Cascade



Source: JICA Project Team

Figure 3.3.2 Distribution Diagram in Alagalla Cascade

In the cascade, only one tertiary canal is planned to feed water to the sub-cascade so that the augmented water can reach all the tanks in the cascade. Furthermore, four link canals are proposed to distribute water in the Yala season, design discharge of which ranges from 0.004 m^3/sec to 0.017 m^3/sec.

3.3.2 Rehabilitation Plan

To achieve proper water distribution and consequent sustainable irrigation scheme management and market-oriented farming, the construction or the rehabilitation plan for infrastructure is prepared based on the field investigation, which consists of rehabilitation of tanks and irrigation canals and construction of tertiary canals and link canals.

Rehabilitation work of the tanks covers tank bund forming, repair/reconstruction of sluices, improvement of spill way and provision of washing steps. Capacity of the spillways to release flood water is expanded 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 fields to the main road.

As for the tertiary canals, taking into consideration the topography in the area, pipeline system is adopted. The tertiary canals are to connect off-takes on the main or branch canals of the NCPC and the most upstream tanks in the cascade. Likewise, the link canals with pipeline system are introduced to convey irrigation water from upstream tanks to downstream tanks, aiming at utilizing the augmented irrigation water efficiently.

Major construction or rehabilitation work for the four irrigation schemes under the cascade is presented in Table 3.3.1.

Table 3.3.1 Major Rehabilitation Plan of Alagalla Cascade (1/2)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
1	Kalkulam	Headworks	Tank bund			Reshaping	490 m	H= - m
			RB spillway		Channel	Reconstruction	16 m	
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	520 m	
			LB canal (new)		Earth	New construction	200 m	
			RB canal		Earth	Reconstruction	210 m	
		Link canal	(L1-1)		Pipeline	New construction	1.1 km	Tentative
			(L1-3)		Pipeline	New construction	2.3 km	Tentative
		Tertiary canal	(L1-1)		Pipeline	New construction	1.3 km	Tentative
		Farm road			Gravel	Pavement	200 m	
2	Thiruwegama	Headworks	Tank bund			Reshaping	600 m	H=2.1 m
			RB spillway		Drop	Reconstruction	30 m	
			LB sluice	Gate	Wall	New construction	1 nos.	
				Structure		New construction	1 nos.	
			CN sluice 1	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			CN sluice 2	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	160 m	
			CN 2 canal		Earth	Reconstruction	160 m	
			RB canal		Earth	Reconstruction	260 m	
		Link canal	(L1-2)		Pipeline	New construction	1.1 km	Tentative
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	m	
3	Wirandagollewa	Headworks	Tank bund			Reshaping	470 m	H=2.0 m
			LB spillway		Channel	New construction	37 m	
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	190 m	
			RB canal		Earth	Reconstruction	230 m	
		Link canal	(L1-4)		Pipeline	New construction	0.5 km	Tentative
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	550 m	
4	Puliyankulam	Headworks	Tank bund			Reshaping	630 m	H=2.0 m
			LB spillway		Drop	Reconstruction	34 m	
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	240 m	
			RB canal		Earth	Reconstruction	790 m	
		Link canal			Pipeline	New construction	km	
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Gravel pavement	m	

Source: JICA Project Team

Table 3.3.2 Major Rehabilitation Plan of Alagalla Cascade (2/2)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
5	Alagalla	Headworks	Tank bund			Reshaping	690 m	H=2.1 m
			LB spillway		Drop	Reconstruction	35 m	
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	210 m	
			RB canal		Earth	Reconstruction	1,540 m	
		Link canal			Pipeline	New construction	km	
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Gravel pavement	m	

Source: JICA Project Team

3.4 Farmers Organization and Cascade System Management

3.4.1 Need of Strengthening FO Functions

All three FOs in Alagalla cascade are functioning fairly to manage each tank. Meetings, especially Kanna meetings, are periodically organised, which are in most of the cases set by DO. FOs are conducting meeting whenever necessary to discuss issues such as fertilizer issuing, required repairing works, communal works, and problems among members. Additional meetings shall be required once cascade management is established, as discussion at the cascade level should reflect the needs of each FO and feed back of the cascade level discussion should be shared with FO members. FO meeting should be organised by coordinating with cascade level meetings.

Even though FOs in Alagalla cascade do not have clear procedures for problem solving, they have been solving problem through discussion among members and consultation with officers. However, once cascade management system is established, and cultivation plan is prepared with NCP water in Yala, more disputes are expected due to different interests between farmers within FOs. Therefore, further rules on expected disputes shall be prepared to avoid complicated situation and conflicts.

Even though financial capacities of FOs differ in different FOs, all the FOs collect fees from members and have more than Rs.250,000 of saving. Once they receive NCP water, FOs should consider expenses for cascade management. For example, each FO is expected to contribute for maintenance of inter-tank facilities. Although FOs in Alagalla cascade currently have good financial capacity, maintenance of inter-tank facilities may entail increase of membership fee to increase periodical revenue instead of relying on irregular fund.

Needs on capacity development of FOs were assessed through interview to the concerned officers as well. The result of the interview to the concerned officers are summarised in the below table. DO and ARPA in charge of the Alagalla cascade expressed that the FOs need improvement of capacity in financial management, organising meetings, O&M skills, conflict solving, and flood management, as shown in the below table. Those issues shall be taken into consideration in planning of capacity development programme for individual FOs.

Table 3.4.1 Evaluation of Capacity of FO by DO/ARPA in the Model Cascades

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Average number of FO the ARPA covers		2	3	34	2.75	4	2	2	5.17
In which area do you feel FOs are lacking capacity	Financial capacity	0%	50%	50%	80%	50%	100%	100%	68%
	Financial management	0%	0%	50%	100%	0%	67%	67%	53%
	Organising meeting	50%	0%	0%	40%	0%	0%	0%	16%
	O & M skills	50%	50%	50%	20%	50%	67%	100%	53%
	Conflict solving	50%	0%	50%	0%	0%	33%	67%	26%
	Flood management	0%	50%	0%	0%	100%	33%	100%	37%
	Other	0%	0%	0%	0%	0%	33%	0%	5%

Source: JICA Project Team based on the interview survey to DO and ARPA

Tank level water distribution is fairly well managed in each FO, as there is no issue raised from members regarding water distribution. Each FO has their system of water distribution during water scarce period. However, the applied water distribution system in some of the FOs may not be efficient in maximising water use, as they do not have any alternative plan when their original plan is failed. With introduction of NCPC water, more systematic water distribution system with crop planning within tank needs to be established with calculation of water from NCP and adjustment of water among tanks within cascade. Rules on crop planning for Yala season at each tank also needs to be prepared in consideration of NCPC water and water distribution within Cascade.

General maintenance works of canal and bund are done by FO members as decided in Kanna meetings. These works are fairly completed as planned, largely because they are decided in the legally authorised Kanna meetings. As per indicated in the following table, FOs in Alagalla cascade perform canal cleaning and bund clearing well in comparison with other target cascades. However, desilting works are nil and labour contribution for repairing works is relatively low among the six model cascades.

Table 3.4.2 Participation in O&M Works by Cascade

Tank	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: JICA Project Team based on the HHS

High performance on normal maintenance shall be adopted in the cascade management especially for maintenance of inter-tank facilities. However, maintenance works within tank need to be reviewed in consideration of water distribution from NCPC and maintenance works of cascade system as well. Only one FO has received contract work for repairing works. This means either fund is not available or FOs do not have enough capacity to execute contract works. Improvement of skills on both contract management and rehabilitation techniques is required.

3.4.2 Need for Cascade System Management

(1) Water Distribution within Cascade

Needs in cascade level water management and possibility of establishment of cascade management body were discussed with each FO and were asked in HHS to judge different opinions from different

position of tanks. Table 3.4.3 shows results of HHS regarding the question on preferable water management system to distributed water equally to each tank under the cascade if the upper most tank of the cascade receives water from the major irrigation scheme. Multiple answers were allowed from the options indicated in questionnaires.

Table 3.4.3 Preferable Water Distribution System in Alagalla per FO

FO	Government		Individual Tank		Cascade Committee		Fixed Ratio		Other		Valid Answer
	no.	%	no.	%	no.	%	no.	%	no.	%	no.
Alagalla	9	10%	60	65%	24	26%	15	16%	0	0%	93
Periya koomarasan kulam	0	0%		0%	20	100%		0%	0	0%	20
Thiruwegama	0	0%	9	43%	10	48%	6	29%	0	0%	21
(Blank)	0	0%	1	100%	0	0%	0	0%	0	0%	1
Total	9	7%	70	52%	54	40%	21	16%	0	0%	135

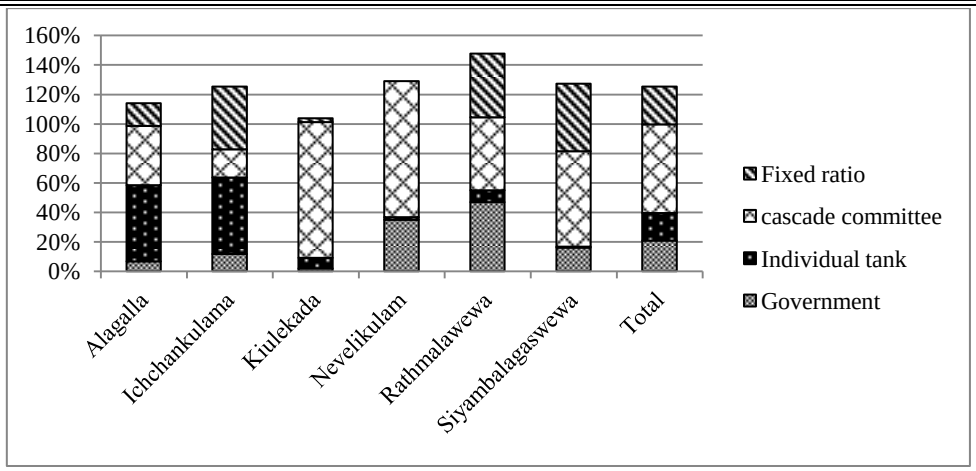
**Options: Government- Government should decide water allocation to each tank*
Individual tank – Farmers in downstream tank should discuss with the farmers in upper most tank for release of water individually
Cascade committee – To form a committee with representatives from all tanks in the cascade to 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: JICA project team based on the HHS

The majority of the Alagalla FO and more than 40% of Thiruwegama FO prefer individual negotiation between tanks for water distribution, while whole Periya koomarasan kulam FO, whose tank is located at uppermost part of the cascade, answered cascade committee should be formed. 10% of Alagalla FO members, whose tanks are located at downstream part, prefer government to control water distribution. No one of Thiruwegama prefer government to decide, which might be because their conflict with downstream tank regarding raising spillway of downstream tank has not be solved even though they have been consulting relevant officials. Fixed rate of water against cultivation land is preferred by 16% of Alagalla and 29% of Thiruwegama.

Table 3.4.4 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 downstream tank should discuss with farmers in upper most tank for release of 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: JICA project team based on the HHS



Source: JICA project team based on the HHS

Figure 3.4.1 Comparison of Preferable Water Distribution System by Cascade

In comparison with other model cascades, Alagalla cascade, together with Ichchankulama, has more preference on individual negotiation. While the majorities prefer deciding in cascade committee in other cascades, these two cascades, followed by Rathmalawewa, have relatively smaller number of choice on cascade committee. This may have some relation with the fact that these three cascades have different ethnic groups within the cascades. This should be further examined to judge whether it is feasible to establish cascade level organization in consideration of mixture of ethnic groups.

Analyzing the preference by location of tanks within cascade, as shown in the following table, FOs with tanks at downstream part of the cascades tend to have more preference in individual negotiation and fixed ratio than those in mid and upper tanks. Preference in cascade committee's decision in downstream tanks is lower than others. This may indicate that people fear decision at cascade management might be dominated by the upper tanks. Further investigation is required to establish fair decision making in the cascade management system. The below table show summary of the preference of water distribution options by tank location of all the model cascades.

Table 3.4.5 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: JICA project team based on the HHS

Regarding the water distribution structure to be constructed, all the farmers except a few in Alagalla FO agree on construction of link canal between upper tanks and downstream tanks, as indicated in the following table.

Table 3.4.6 Preferable Water Distribution Structure within Cascade

FO name	Existing System	Direct Canal from NCPC	Link Canal between Tanks	Other
Alagalla	1	5	87	
Periya koomarasan kulam			20	
Thiruwegama			20	1
Total	1	5	127	1

**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 uppermost tank to downstream tank
Source: JICA project team based on the HHS

Further concerns and opinions were raised during FO meetings in Alagalla cascade regarding water distribution within cascade as stated below.

- (Although it might be difficult to share water in current situation,) if water is provided from outside, it is fine to share with other tanks.
- 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 etc.).
- Some farmers doubt that Tamil community share water with Sinhalese community (possibility of sharing may be 75% but 25% of fear still remain).
- Some young generation may have problem in sharing resources, thus better to have awareness programme is necessary especially for the young generation.
- If more water is released to downstream tank, more field of upper tank will come under water. Unless this problem is solved, they are not willing to release water to downstream tank.
- Regarding water sharing, as long as a certain level of water is assured for their own tank, they do not have problem to share water.
- Sending water to downstream tank is not a problem but prefer to be connected with other tanks that their FO manage though they are under different cascade.
- For the management, water master should be assigned to control gate (possibly one to be employed by government), applying a similar system as that of Mahaweli systems.

(2) Possibility of Establishment of Cascade Management Farmers Organisation (CMFO)

Even though two different ethnic groups in different ASC and DS division speaking different language are involved in Alagalla Cascade, there is potential of establishing CMFO.

Basically, there is no special communication among FOs at the organisational level, even between FOs of the same ethnic group. Although there is no official coordination at FO's organisational level, people know each other. However, some people raised concern that even though they had very good relationship before, new generation with newly settled people may not be able to continue the good relations. Even though people on the ground in this area do not have any conflict regarding ethnicity, people seems to have concern on ethnic difference, as some people doubt the Tamil community of upper tank releases water. A special attention should be paid in establishment of cascade level management body as it might create conflict easily with small issues between FOs. One of the possible solution is considerable involvement of government authority to control cascade management. Some FO members strongly suggested to involve a certain authority to intervene/control cascade level water management and assign water master to control gates who should be instructed by the authority (e.g. DOI).

Another concern in cascade level management is the FO that manages several tanks, of which only one is located in Alagalla cascade. The FO with several tanks in different cascade mentioned that since the concerned tank in Alagalla cascade has two spillways and one of them goes to a tank in another cascade under the same FO, they prefer to send water to another tank under them. Although this case might be emphasised because of involvement of different ethnic group in Alagalla, this situation is not a special case but frequently observed in other cascades with the existing cascade boundaries. Management of a FO that belongs to more than one cascade might require special arrangement for their smooth management especially in the case where the area cultivated by the same farmers are divided by the cascade boundaries.

Opinions raised during FO meetings regarding cascade level management body are as follows.

- Government intervention is necessary for cascade management.
- Whether upper tank release water or not is an issue of government. Within the limitation made by the authority, all FOs under the cascade discuss with help of the authority.
- For the management of water, some authority is definitely necessary to control gates and distribution. The authority can be community member who passed some training following instruction from government authority.
- Cascade level management body should be formed.
- To manage cascade, each FO sends representatives for cascade level discussion.
- Water sharing can be decided by the cascade level committee and each FO monitors.

- Persons to control gate should be appointed.
- Maintenance of inter-tank facilities can be done by the FO that use the facility or to be attended by CMFO.
- Small fund contribution can be done from each FO for functions of CMFO.
- financial contribution from each FO to CMFO can be done based on the cultivated area.

Possibility of establishment of CMFO shall be assessed with opinion from relevant officers as well. The following table indicate the expected difficulties stated by DOs and ARPAs in the concerned ASCs. A majority of the officers raised maintenance of inter-tank facilities as a possible problem. Almost a half stated decision making among different FO under the cascade might be difficult. About one-third of officers answered management of FOs that belongs to several cascades might be difficult and financial contribution for CMFO from each FO shall be problem.

Table 3.4.7 Expected Issues in Formation of CMFO by DAD Officers

	Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Communication between FOs will be problem	0%	0%	0%	20%	0%	33%	33%	16%
Distance to meet periodically	0%	0%	0%	0%	100%	33%	67%	26%
ARPA's boundary and cascade boundary is different and difficult to manage	0%	50%	0%	20%	0%	0%	0%	11%
Decision making among FOs is difficult	50%	50%	100%	20%	50%	67%	33%	47%
Will expect more conflict between FOs and tanks	50%	50%	0%	0%	50%	33%	0%	21%
Difficult to manage FOs that belongs to several cascade	50%	50%	0%	20%	50%	33%	67%	37%
Financial contribution from FOs might be problem	100%	50%	0%	20%	50%	33%	33%	37%
Maintenance of inter - tank facilities might be problem as it is not clear who shall take responsibility	100%	100%	0%	0%	50%	100%	100%	58%
Other	0%	0%	0%	0%	0%	0%	0%	0%

Source: JICA project team based on interview survey to DO and ARPA

Further opinions and suggestions raised from DO/ARPA in charge of Alagalla cascade regarding establishment of CMFO are as follows.

- CMFO should be registered under control of DAD,
- Relevant government officers should be also include in CMFO (DO, AI, ARPA & Irrigation officers and TO from DAD),
- Executive members should be ACAD / Irrigation Engineer,
- CMFO members should be representatives of each tank (instead of representatives of FO),
- CMFO members selection should be based on tank and land extend wise, and
- Financial strengthening of CMFO is important.

3.4.3 Need in Administration Structure and Legal Frameworks

This cascade as well as Ichchankulama cascade covers two ASC divisions in two DS divisions. A particular arrangement of coordination is necessary at higher level of the authority as involvement of two different areas of authorities and officers may cause some confusion. Clear procedures and communication system should be established between the concerned offices.

All the FOs under Alagalla cascade have fair O&M implementation and collection of fees mainly due to the legally defined regulation and penalty system posed by the Act. Even though they have not executed any penalty, farmers follow the decision of Kanna meeting as compulsory responsibility. Even the O&M funds are collected in two out of three FOs that was introduced by DAD Vavuniya. This means strong legal authorisation of regulation can work in the area and it will be necessary for effective function of CMFO. Legal frameworks are to be proposed as general condition of CMFO with some adjustment according to the field situation to accustom the special cases like Alagalla cascade where different ethnic communities work together involving different government offices.

ASC officers raised some difficulties in managing FO such as communication with FOs, instruction to FO leader as they are senior to the officer, too many FOs to look after, and transportation to meet FOs.

These problems shall be taken into consideration in proposing administrative structure of cascade management.

Table 3.4.8 Difficulties in Managing FO by DAD Officers

	Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Communication with FOs is difficult	50%	50%	50%	20%	0%	33%	0%	26%
They do not follow instruction	0%	0%	0%	0%	0%	33%	0%	5%
Difficult to instruct as FO leaders are senior	50%	0%	0%	20%	0%	0%	0%	11%
Poor understanding of farmers	0%	0%	50%	0%	0%	0%	0%	5%
Too many FOs to handle (lack of ARPA)	0%	100%	50%	20%	0%	0%	0%	21%
Transportation to meet FOs	50%	50%	100%	60%	100%	0%	67%	58%
Other	0%	0%	0%	0%	0%	0%	0%	0%

Source: JICA project team based on interview survey to DO and ARPA

Regarding establishment of CMFO, it seems preferable to include relevant government authorities to monitor and solve any issues expected to happen in cascade level management. Water master to be appointed to control gates between tanks can be either employed by the CMFO or government, which shall be further scrutinizes in the planning process.

ATTACHMENT 1

PRESENT CONDITION OF ALAGALLA CASCADE

Alagalla Cascade **2 Thiruwegama**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=591 m H=2.1 m	2007	Shrubs jungle, Uneven bund top, Erosion of slope. Water leakage
Right bank spillway	Drop wall	L=5 m	2007	Length in not enough.
Left bank sluice	No structure	N=1 nos.	2011	Gate: No gate, Structure: No structure
Center sluice 1	Wall	N=1 nos.	2011	Gate: leakage, Structure: minor deterioration
Center sluice 2	Wall	N=1 nos.	2011	Gate: leakage, Structure: minor deterioration
Right bank sluice	Wall	N=1 nos.	2011	Gate: leakage, Structure: minor deterioration
Left bank canal	Earth	L=158 m	Unknown	Natural canal
Center canal 2	Earth	L=155 m	Unknown	Natural canal
Right bank canal	Earth	L=260 m	Unknown	Natural canal
Farm road		L=500 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Right bank spillway

Left bank sluice

Center Sluice 1

Left bank canal

Center canal 1

Alagalla Cascade **1 kalkulam**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=490 m H= - m	-	Shrubs jungle
Right bank spillway	Channel	L=14 m	-	Damage
Left bank sluice	Tower	N=1 nos.	-	Gate: damage, Structure: damage
Right bank sluice	Tower	N=1 nos.	-	Gate: damage, Structure: damage
Left bank canal	Earth	L=515 m	Not rehabilitated	Natural
Right bank canal	Earth	L=205 m	-	Natural
Farm road		L=200 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Roght bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Alagalla Cascade **4 Puliyamkulam**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=625 m H=2.0 m	1984	Heavy jungle,Erosion of slope, Uneven bund top
Left bank spillway	Drop wall	L=19 m	1984	No baffle wall
Left bank sluice	Tower	N=1 nos.	1984	Gate: minor deterioration, Structure: minor deterioration
Right bank sluice	Tower	N=1 nos.	1984	Gate: comletely damage, Structure: comletely damage
Left bank canal	Earth	L=240 m	1972	Damage, No function structures
Right bank canal	Earth	L=790 m	1972	Damage, No function structures
Farm road		L=650 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph


Tank bund


Left bank spillway


Left bank sluice


Right bank sluice


Left bank canal


Right bank canal

Alagalla Cascade **3 Wirandagollewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=470 m H=2.0 m	1984	Heavy jungle, Erosion of bund slope, Uneven bund top
Left bank spillway	No structure	L=20 m	1984	No structure
Left bank sluice	Tower	N=1 nos.	1984	Gate: water leakage, Structure: deterioration
Right bank sluice	Tower	N=1 nos.	1984	Gate: minor deterioration, Structure: minor deterioration
Left bank canal	Earth	L=185 m	1984	Damage, No function sturctures
Right bank canal	Earth	L=227 m	1984	Damage, No function sturctures
Farm road		L=550 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph


Tank bund


Left bank sluice


Right bank sluice


Left bank canal


Right bank canal

Alagalla Cascade **5 Alagalla**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=685 m H=2.1 m	1983	Heavy jungle, Erosion of slope, Uneven bund top
Left bank spillway	Drop wall	L=46 m	1983	Minor deterioration
Left bank sluice	Tower	N=1 nos.	1994	Gate: damage and water leakage, Structure:damage
Right bank sluice	Tower	N=1 nos.	1994	Gate: damage, Structure:damage
Left bank canal	Earth	L=210 m	1972	Damage, No function structures
Right bank canal	Earth	L=1,535 m	1983	Damage, No function structures
Farm road		L=1,500 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Left bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

ATTACHMENT 2

TANK CAPACITY OF ALLAGALLA CASCADE

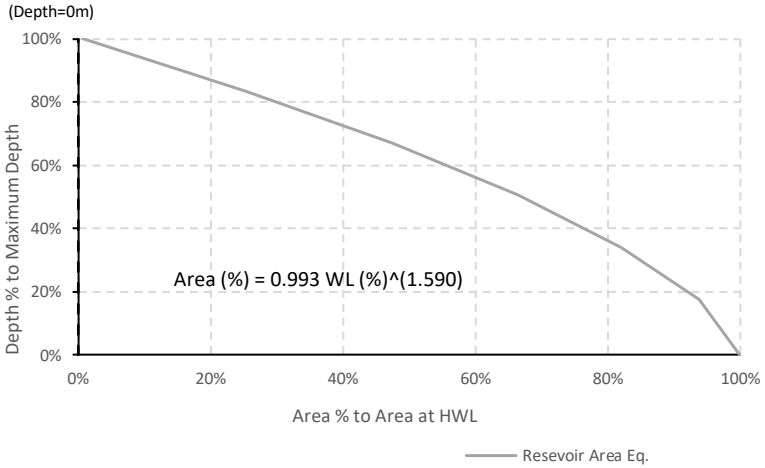
Summary of Tank Capacity

Cascade	Tank		Volume (1,000 m^3)	Renarks
Alagalla	2	Sinna kulam	163.6	Not in the cascade
	3	Kai kulam	39.3	
	4	Tiruwegama	366.9	
	5	Wiradagollawa	8.2	
	6	Puliyankulam	91.9	
	7	Alagalla	152.5	

Remarks:
1); assumed by using average volume per irrigable area
4.6 (1,000 m^3/ha)

Tank Capacity Calculation

H-A Curve



Alagalla Cascade

Cascade: Alagalla
Tank (No.): Sinna kulam (7-2)
Water depth (H): 2.37 (m)
Resevoir area (A): 18 (ha)
Reservoir volume (V): 163.554 (1,000m^3)

H (m)	A (ha)	V (1,000m^3)
0.00	0.0	0.000
0.24	0.5	0.544
0.47	1.4	2.183
0.71	2.6	6.945
0.95	4.2	15.002
1.19	5.9	26.972
1.42	7.9	43.409
1.66	10.1	64.824
1.90	12.5	91.691
2.13	15.1	124.459
2.37	17.9	163.554

Cascade: Alagalla
Tank (No.): Kai kulam (7-3)
Water depth (H): 2.05 (m)
Resevoir area (A): 5 (ha)
Reservoir volume (V): 39.297 (1,000m^3)

H (m)	A (ha)	V (1,000m^3)
0.00	0.0	0.000
0.21	0.1	0.131
0.41	0.4	0.525
0.61	0.7	1.669
0.82	1.2	3.605
1.03	1.6	6.481
1.23	2.2	10.430
1.44	2.8	15.575
1.64	3.5	22.031
1.85	4.2	29.904
2.05	5.0	39.297

Cascade: Alagalla
Tank (No.): Tiruwegama (7-4)
Water depth (H): 3.30 (m)
Resevoir area (A): 29 (ha)
Reservoir volume (V): 366.903 (1,000m^3)

H (m)	A (ha)	V (1,000m^3)
0.00	0.0	0.000
0.33	0.7	1.221
0.66	2.2	4.898
0.99	4.2	15.581
1.32	6.7	33.655
1.65	9.6	60.507
1.98	12.8	97.381
2.31	16.3	145.421
2.64	20.2	205.692
2.97	24.4	279.202
3.30	28.8	366.903

Cascade: Alagalla
Tank (No.): Wiradagollawa (7-5)
Water depth (H): 1.07 (m)
Resevoir area (A): 2 (ha)
Reservoir volume (V): 8.205 (1,000m^3)

H (m)	A (ha)	V (1,000m^3)
0.00	0.0	0.000
0.11	0.1	0.027
0.21	0.2	0.110
0.32	0.3	0.348
0.43	0.5	0.753
0.53	0.7	1.353
0.64	0.9	2.178
0.75	1.1	3.252
0.86	1.4	4.600
0.96	1.7	6.243
1.07	2.0	8.205

Cascade: Alagalla
Tank (No.): Puliyankulam (7-6)
Water depth (H): 2.18 (m)
Resevoir area (A): 11 (ha)
Reservoir volume (V): 91.937 (1,000m^3)

H (m)	A (ha)	V (1,000m^3)
0.00	0.0	0.000
0.22	0.3	0.306
0.44	0.8	1.227
0.65	1.6	3.904
0.87	2.5	8.433
1.09	3.6	15.162
1.31	4.8	24.401
1.53	6.2	36.439
1.74	7.7	51.541
1.96	9.2	69.961
2.18	10.9	91.937

Cascade: Alagalla
Tank (No.): Alagalla (7-7)
Water depth (H): 2.34 (m)
Resevoir area (A): 17 (ha)
Reservoir volume (V): 152.512 (1,000m^3)

H (m)	A (ha)	V (1,000m^3)
0.00	0.0	0.000
0.23	0.4	0.508
0.47	1.3	2.036
0.70	2.5	6.476
0.94	3.9	13.990
1.17	5.6	25.151
1.40	7.5	40.479
1.64	9.6	60.448
1.87	11.8	85.501
2.11	14.3	116.057
2.34	16.9	152.512

ATTACHMENT 3

FLOOD DISCHARGE ESTIMATIONF FOR SPILLWAY DESIGN IN ALAGALLA CASCADE

(1) Methodology

By the request of the counterpart, the study for flood discharge estimation follows the Sri Lankan technical standard named "Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah. The guidelines stipulate the methodology of hydrological analysis, design of spillway, bund, and sluice.

(2) Climate Zone

According to the guideline, the country of Sri Lanka is divided to 6 hydrological zones as shown in

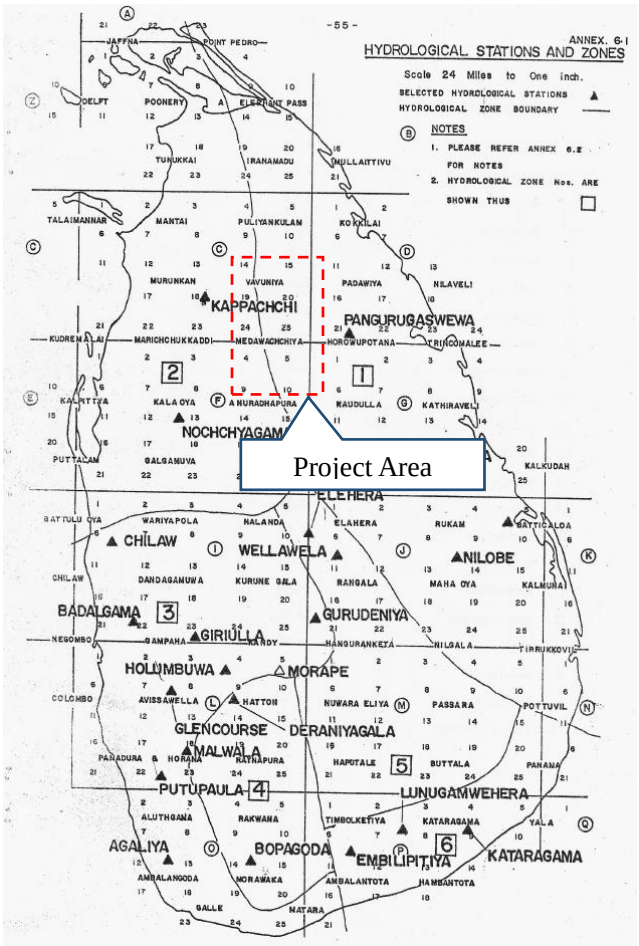


Figure 2.3.2.1. The project area is fallen to Zone 1 and Zone 2.

Source: "Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

Figure 2.3.2.1 Hydrological Zone in the Irrigation Guidelines

(3) 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 2.3.2.1

Table 2.3.2.1 Probable Rainfall Depth for 24-hour Storm Presented in Irrigation Guideline

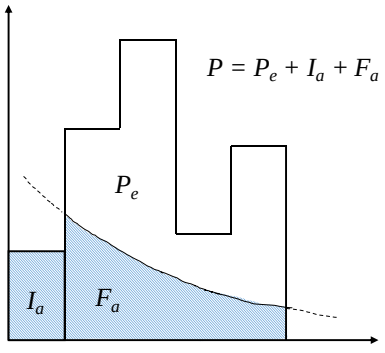
Unit: inches

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	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
25 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

Ref: Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

(4) 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 our study, the rainfall loss is calculated by the SCS(Soil Conservation Services) method.



Source: "Applied Hydrology" Ven Te Chow, et al

Figure 2.3.2.2 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 above equation is the rainfall excess. "*P*" is total rainfall, "*Ia*" is initial loss, "*Fa*" is infiltration loss, and "*S*" is the potential maximum retention. By using 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.

(5) Flood Hydrograph

1) Method to Derivation of Flood Hydrograph

In the guideline, Snyder unit hydrograph is introduced. The coefficients of the Snyder's hydrograph is 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.

2) 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.

$$t_p = C_t (L \cdot L_C)^{0.3}$$

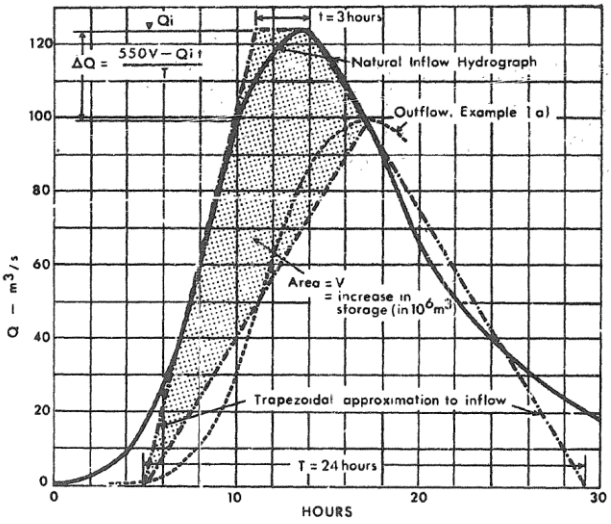
Where, L is length of the longest river course of catchment in miles, and L_c is length from the point of interest to the point on the river course closest to the centroid of the catchment in miles.

C_t and C_p are given to the closest hydrological stations.

For Kiulekada cascade, the closest hydrological station is Kappachchi, C_t and C_p are 4.42 and 0.87, respectively.

3) Flood Routing

The inflow of the flood flow will be released from the spillway but a part of the inflow will be storage 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 isosceles triangle. The fore slope and rear slope of the trapezoid are drawn to fit the tangent of the hydrograph.



Source: M.J.H. West "Flood Control in Reservoirs and Storage Pounds-A Discussion," Journal of Hydrology, 23 (1974)67-71

Figure 2.3.2.3 Flood Routing by J.H.West Method

According to the guideline, the peak outflow is estimated by the following equation.

$$q_d = \frac{555.5V_d - q_{in}}{T}$$

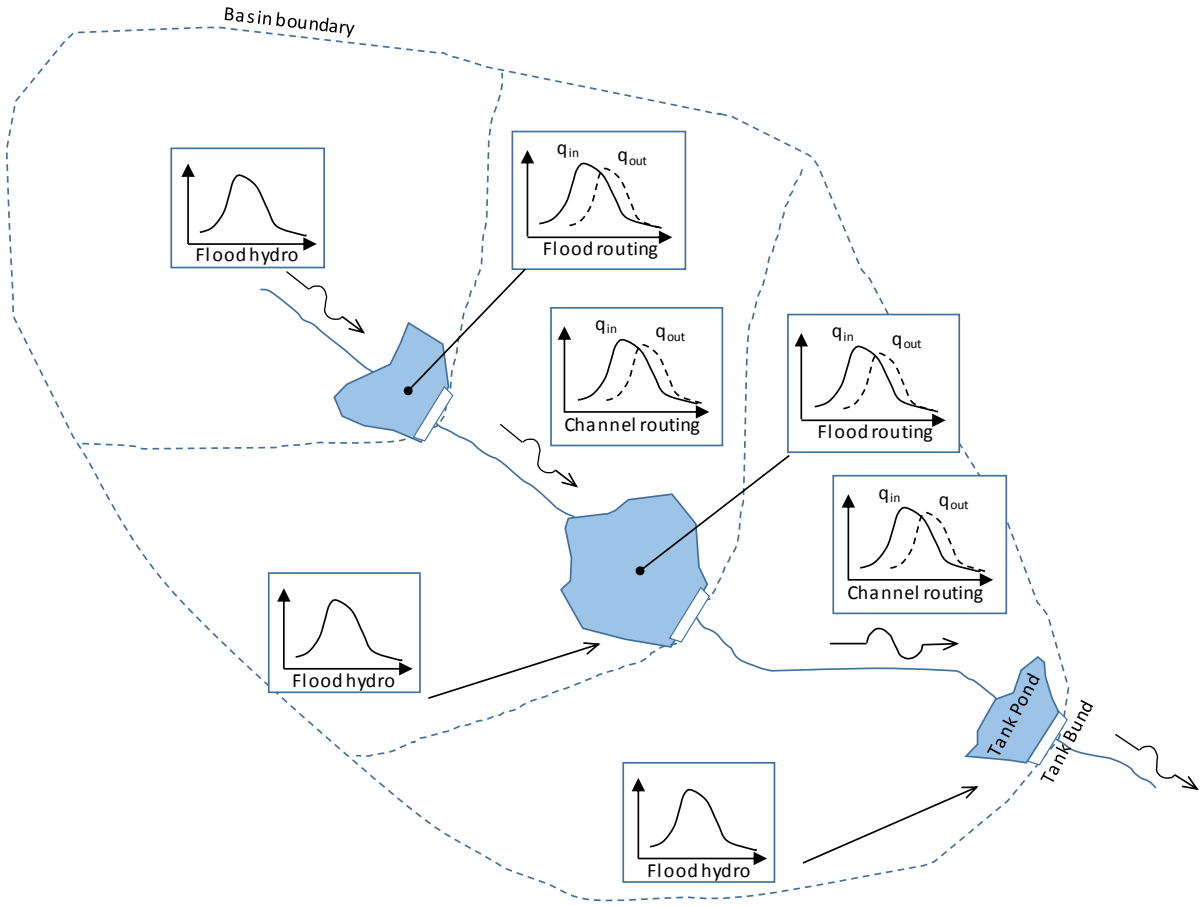
Where, q_d is peak outflow through spillway in cumecs, V_d is stored flood discharge in the reservoir in million m^3, q_{in} is peak inflow, T is base hours of inflow and outflow shown in the Figure 2.3.2.3.

4) 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 is introduced in various guideline and text books such as "Flood Runoff Analysis" of US Army Corps of Engineers, or "Applied Hydrology" by Ven Te Chow, et al.

5) 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 2.3.2.4.



Source: JICA Project Team

Figure 2.3.2.4 Concept of the Flood Analysis for the Cascade System

6) Flood Peak Discharge for Spillway of the Tanks in Alagalla Cascade

The flood peak discharge is estimated by the method in the aforesaid sections. Result of the peak discharge of the tank is summarized in Table 2.3.2.2.

The calculation spreadsheet for the calculation of peak discharge for the Alagalla cascade is shown in Annex 1.

Table 2.3.2.2 Summary of Flood Flow Analysis for Alagalla Cascade

Name of Tank	Catchment Area	Peak Inflow	Peak Outflow
	(km^2)	(m^3/s)	(m^3/s)
Kal Kulam (6)	0.78	9.7	8.8
Tiruvegama (4)	1.81	24.6	23.6
Tiruvegama (4)	1.81	24.6	23.6
Wirandagollewa (3)	0.17	24.1	24.1
Puliyan Kulam (1)	0.71	28.0	28.4

Source: JICA Project Team

ATTACHMENT 4

SPILLWAY LENGTH OF TANKS IN ALAGALLA CASCADE

Alagalla Cascade

No.	Tank	Existing		Design							
		Spill type	Length (m)	Spill type	Design flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)	Evaluation Q>Q'	Remarks
1	Kal kulama	Channel	14.0	Channel	11.3	2.80	16	0.6	11.6	OK	(1)
2	Thiruwegama	Drop wall	5.0	Drop wall	25.4	3.33	30	0.6	25.9	OK	(1)
3	Wirandagollewa	Channel	20.0	Channel	26.7	2.80	37	0.6	26.9	OK	(1)
4	Puliyankulam	Drop wall	19.0	Drop wall	29.1	3.33	34	0.6	29.4	OK	(1)
5	Alagalla	Drop wall	46.0	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)

(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: 2.80)

Length (B): Spillway length (m)

Depth (H): Overflow depth (m), In case Q>50 m3/s; H=0.9m, In case Q<50 m3/s; H=0.6m

Calculation (Q): $Q=CBH^{3/2}$ (m^3/s)

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

THE PROJECT
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UNDER NORTH CENTRAL PROVINCE CANAL
IN
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE REPORT ON RESULT OF DETAILED SURVEY IN ICHCHANKULAMA CASCADE SYSTEM

June 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

NTC INTERNATIONAL CO., LTD.

THE PROJECT

FOR

FORMULATING CASCADE SYSTEM

DEVELOPMENT PLAN UNDER NORTH CENTRAL PROVINCE CANAL

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The Report on Result of Detailed Survey in Ichchankulama Cascade System

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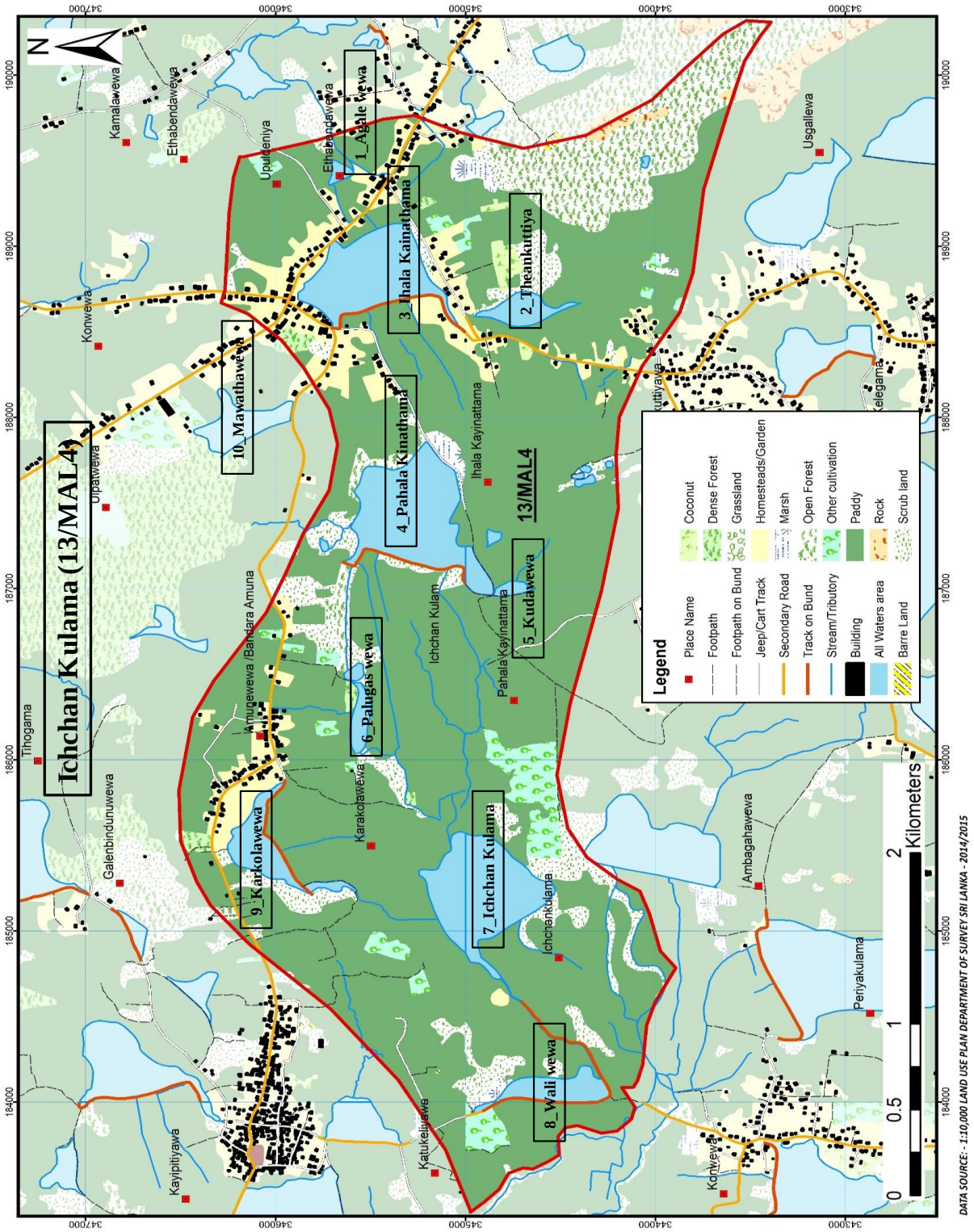
Attachments

Abbreviations

ACAD	Assistant Commissioner Agrarian Development
AI_1	Agricultural Instructor
AI_2	Artificial Insemination
ARPA	Agriculture Research & Development Assistants
ASC	Agrarian Service Centre
CBO	Community Based Organization
CIC	(Company Name previously called 'Chemical Industry of Colombo')
CMFO	Cascade Management Farmer Organization
CN	Centre
CoP	Cost of Production
DAD	Department of Agrarian Development
DAPH	Department of Animal Production and Health
DEC	Dedicated Economic Centre
DO	Divisional Officer under ASC
DOA	Department of Agriculture
DOI	Department of Irrigation
DS	Divisional Secretariat / Divisional Secretary
FO	Farmer Organization
GN	Grama Niladhari
GND	Grama Niladhari Division
GOSL	Government of Sri Lanka
HH	House Hold
HHS	Household Survey
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
LB	Left Bank
LHG	Low Humid Grey
MASL	Mahaweli Authority of Sri Lanka
MCM	Million Cubic Meter
MMDE	Ministry of Mahaweli Development and Environment
MOI	Ministry of irrigation
MT	Metric ton
MW	Mega Watt
NCP	North Central Province
NCPC	North Central Province canal
NCPCP	North Central Province Canal Project
NGO	Non-Government Organization
NLDB	National Livestock Development Board
NP	Northern Province
O&M	Operation and Management
OFC	Other Field Crops
PDAPH	Provincial Department of Animal Production and Health
PDI	Provincial Director of Irrigation
PMB	Paddy Marketing Board
RB	Right Bank
RBE	Reddish Brown Earth
RDS	Rural Development Society
RR&DI	Rice Research and Development Institute
RVS	Range Veterinary Surgeon
TO	Technical Officer
WRDS	Women Rural Development Society



Source: JICA Project Team (Source of Map: 1:10,000 Land Use Plan Department of Survey Sri Lanka – 2014/2015)

Location Map of Ichchankulama Cascade

Chapter 1 Introduction

1.1 General

The Report on the Result of Detailed Survey in Ichchankulama Cascade System was prepared under JICA funded project named "The Project for Formulating Cascade System Development Plan under North Central Province Canal in Democratic Socialist Republic of Sri Lanka" with nodal counterpart agency of Ministry of Mahaweli Development and Environment. The detailed survey was carried out in the selected six cascade systems namely Ichchankulama, Siyambalagaswewa, Rathmalawewa, Kiulekada, Alagalla and Naveli kulam located in Anuradhapura and Vavuniya District to be benefited by North Central Province Canal Project in order to identify the actual ground situation and development needs for formulation of total cascade system development plan covering 128 cascade systems. The report describes methodology for detailed survey in the Chapter 1, present condition with several aspects namely administration and socio economic, soil and land use, meteorology and water resources, agriculture and agro-economy, livestock, infrastructure and farmers' organization in Chapter 2 and needs for development in Chapter 3.

1.2 Methodology

The detailed survey was composed of four surveys namely (1) inventory survey for present infrastructure such as tank, canal system and rural roads, (2) farm household survey, (3) group discussion on farmers' organization and (4) interview survey on government frontline officers. The objectives, methodology, timing and main implementers for those surveys are described in the following table.

Table 1.2.1 Outline of Detailed Survey

Name of Survey	Objectives	Major Activities or Major Information Collected	Target	Timing	Main Implementer
Inventory survey for present infrastructure	Collect data for rehabilitation planning and cost estimation	(1) Topographic survey for tank bund and canal route (2) Inventory survey for tank and canal related structures (Sluice & spillway, farm turnouts) (3) Inventory survey for rural road	69 tanks irrigation schemes Ichchankulama : 9 tanks Siyambalagaswewa : 10 tanks Rathmalawewa : 15 tanks Kiulekada : 14 tanks Alagalla : 5 tanks Naveli kulam : 16 tanks	January to May 2017	JICA Project Team, DAD Anuradhapura and Vavuniya and PDI in North Central and Northern Province
Farm household survey	Identify the present farm household socio economic condition, livelihood, agriculture & livestock activities and development need etc. through questionnaire survey	(1) General (2) Income and expenditure (3) Landholding (4) Agriculture production and management (5) Livestock production and management (6) Marketing (7) Irrigation and water management	1168 farm household in the selected six cascade systems Ichchankulama : 198 nos. Siyambalagaswewa : 150 nos. Rathmalawewa : 275 nos. Kiulekada : 255 nos. Alagalla : 135 nos. Naveli kulam : 155 nos.	January to March 2017	JICA Project Team and DAD Anuradhapura and Vavuniya
Group discussion on	Collect information on	(1) Member (2) Regulation	29 farmers' organizations Ichchankulama : 5 nos.	December 2016 to	JICA Project Team and DAD

farmers' organization	present farmers' organization activities and functions and idea for future cascade management	(3) Activities (4) Financial status (5) Water management (6) Present constraint and development need	Siyambalagaswewa : 3 nos. Rathmalawewa : 7 nos. Kiulekada : 4 nos. Alagalla : 3 nos. Naveli kulam : 7 nos.	May 2017	Anuradhapura and Vavuniya
Interview survey on government frontline officers	Collect information on present farmers' organization activities and possibility for future cascade management	(1) Present functions of FO and challenges faced (2) Possibility for formation of cascade FO and points to be addressed when forming the cascade level FO	19 officers attached to Agrarian Service Centre (ASC) such as DO and ARPA	May 2017	JICA Project Team

Source: JICA Project Team

The contents described in the following chapters are based on above surveys.

Chapter 2 Present Condition of Ichchankulama Cascade System

2.1 Administration and Socioeconomic Condition

2.1.1 Administration in Ichchankulama Cascade

Ichchankulama cascade is located at the border between Galenbindunuwewa DS division and Mihinthale DS division in Anuradhapura District. Most of the cascade belongs to Galenbindunuwewa Agrarian Service Centres (ASC) in Galenbindunuwewa DS division, while a small part belongs to Mihinthale ASC in Mihinthale DS division. The cascade covers three GN divisions, one of which is in Mihinthale. Total gross beneficiary households amount to 573. There are nine tanks within the cascade, out of which, one is under Mihinthale ASC. The following table summarizes administrative location of the tanks under Ichchankulama cascade and the number of target beneficiaries of each tank in the survey.

Table 2.1.1 Administrational Location and Target Population of the Target Tanks

DS Division	ASC	GN Division	GN Code	Tank	No. of HHs Benefitted	Target No. of HH*[1]	Estimated Target Population*[2]
Galenbindunuwewa	Galenbindunuwewa	Upuldeniya	155	Agale wewa	4	3	6
				Theankuttiya	55	28	95
				Ihala Kainathama	110	61	244
				Pahala Kainathama	141	61	220
				Kudawewa	11	11	33
				Palugas wewa	7	6	19
				Karkolawewa	125	91	382
				Mawathawewa*[3]	17	n.a	n.a
		Himbutugollewa	157	Ichchankulama	95	39	152
Mihinthale	Mihinthale	Katukeliyawa	574	Weliwewa	45	n.a	n.a
				Total	573	300	1,151

**[1] The number of target HH is determined as the number of farmers who are using tank as their main tank. There are a few farmers who have land under different tanks but are categorised in their main tank.*
**[2] Calculated from the number of household and average number of family members*
**[3] Although the Mawathawewa is not in the cascade boundary, it is taken in this cascade in terms of the water flow*
Source: JICA Project Team based on the FO interview and HHS result

Agrarian services in the area are provided by the Agriculture Research and Production Assistants (ARPA) under the purview of the Divisional Officer (DO) of ASC, reporting to the Department of Agrarian Development, Anuradhapura. Agricultural extension services are provided by the Agricultural Instructor (AI) of Galenbindunuwewa and Mihinthale areas reporting to the Provincial Department of Agriculture, Anuradhapura. About 26 ARPA officers are appointed to support 84 farmers organisations (FOs) in Galenbindunuwewa ASC, while 19 ARPA for 60 FOs in Mihinthale. Each ARPA manages three to four FOs, which is reasonable practically and in comparison with other ASCs. The following shows details of agricultural service system of the target cascades.

Table 2.1.2 Number of ARPA Officers in-charge in Anuradhapura District

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
Horowpothana	Horowpothana	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

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

2.1.2 Socioeconomic Situation of Ichchankulama Cascade

There are two ethnic groups residing under the Ichchankulama cascade area. Even though the majority is Sinhalese, Sri Lankan Moor shares a significant part. Sri Lankan Moor communities are resigning in Karkolawewa tank, which is used totally by Sri Lankan Moor people. The following tables show the ethnic distribution of the major tanks under the Ichchankulama cascade.

Table 2.1.3 Ethnicity of Beneficiary Households per Tank

Tank	Sinhala		Sri Lankan Moor		Total Valid Responses	
	(no.)	(%)	(no.)	(%)	(no.)	(%)
Agale wewa	3	100.0%		0.00%	3	100.0%
Ichchankulama	35	100.0%		0.00%	35	100.0%
Ihala Kainathama	12	100.0%		0.00%	12	100.0%
Karkolawewa		0.0%	71	100.00%	71	100.0%
Kudawewa	7	100.0%		0.00%	7	100.0%
Pahala Kainathama	46	100.0%		0.00%	46	100.0%
Palugas wewa	5	100.0%		0.00%	5	100.0%
Theankuttiya	18	100.0%		0.00%	18	100.0%
Weliwewa	-	n.a	-	n.a	-	n.a
Total	126	64.0%	71	36.04%	197	100.0%

Source: Farm Household Survey, JICA Project Team 2017

Religion is closely related with ethnicity in Sri Lanka. Distribution of religion in the area is totally matching the ethnicity as shown in the table below. Karkolawewa is totally managed by a Muslim community.

Table 2.1.4 Religion of the Beneficiary Households per Tank

Tank	Buddhist		Muslim		Total	
	(no.)	(%)	(no.)	(%)	(no.)	(%)
Agale wewa	3	100.0%		0.00%	3	100.0%
Ichchankulama	35	100.0%		0.00%	35	100.0%
Ihala Kainathama	12	100.0%		0.00%	12	100.0%
Karkolawewa		0.0%	71	100.00%	71	100.0%
Kudawewa	7	100.0%		0.00%	7	100.0%
Pahala Kainathama	46	100.0%		0.00%	46	100.0%
Palugas wewa	5	100.0%		0.00%	5	100.0%
Theankuttiya	18	100.0%		0.00%	18	100.0%
Mawathawewa	-	n.a	-	n.a	-	n.a
Weliwewa	-	n.a	-	n.a	-	n.a
Total	126	64.0%	71	36.04%	197	100.0%

Source: Farm Household Survey, JICA Project Team 2017

The average size of families in the Ichchankulama area is 3.9 members per family, ranging from 2.3 to 4.2 by tank. Two tanks, namely; Karkolawewa and Ihala Kainathama, have averages of more than four family members. Details of the family members per tank are shown in the following table.

Table 2.1.5 Number of Household by Number of Family Members per Tank

Tank	No. of Family Member in the Household									Total Valid Answer	Average Family Member
	1	2	3	4	5	6	7	8	9		
	(%)	%	(%)	(%)	(%)	(%)	(%)	(%)	(%)		
Agale wewa	33.3%	33.3%	0.0%	33.3%	0.0%	0.0%	0.0%	0.00%	0.00%	3	2.3
Ichchankulama	0.0%	14.3%	22.9%	28.6%	22.9%	11.4%	0.0%	0.00%	0.00%	35	3.9
Ihala Kainathama	16.7%	0.0%	16.7%	41.7%	0.0%	16.7%	0.0%	8.33%	0.00%	12	4.0
Karkolawewa	0.0%	12.5%	23.6%	19.4%	23.6%	18.1%	0.0%	1.39%	1.39%	72	4.2
Kudawewa	0.0%	28.6%	28.6%	28.6%	14.3%	0.0%	0.0%	0.00%	0.00%	7	3.3
Pahala Kainathama	2.2%	23.9%	19.6%	30.4%	19.6%	0.0%	2.2%	2.17%	0.00%	46	3.6
Palugas wewa	20.0%	20.0%	0.0%	40.0%	20.0%	0.0%	0.0%	0.00%	0.00%	5	3.2
Theankuttiya	11.1%	33.3%	5.6%	16.7%	22.2%	11.1%	0.0%	0.00%	0.00%	18	3.4
Mawathawewa	-	-	-	-	-	-	-	-	-	n.a	n.a
Weliwewa	-	-	-	-	-	-	-	-	-	n.a	n.a
Total	3.5%	17.7%	19.7%	25.8%	20.2%	10.6%	0.5%	1.52%	0.51%	198	3.9

Source: Farm Household Survey, JICA Project Team 2017

An analysis on household income sources was carried out through a questionnaire survey with options of the following; 1 = Government service, 2 = Private sector, 3 = Crop production, 4 = Livestock, 5 = Agriculture labour, 6 = Skilled labour, 7 = Unskilled labour, 8= Family business, 9 = nil, and 10 = Others. The following table shows the ratios of the primary income sources in each tank.

Table 2.1.6 Primary Income Source of the Beneficiary Households per Tank

Tank under the Cascade	1.Govt Service	2.Private Sector	3.Crop Production	6.Skilled Labour	7.Unskilled Labour	10. Others	Total Valid Answer
Agale wewa	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	3
Ichchankulama	25.7%	2.9%	71.4%	0.0%	0.0%	0.0%	35
Ihala Kainathama	58.3%	0.0%	41.7%	0.0%	0.0%	0.0%	12
Karkolawewa	5.6%	8.3%	80.6%	0.0%	4.2%	1.4%	72
Kudawewa	42.9%	0.0%	57.1%	0.0%	0.0%	0.0%	7
Pahala Kainathama	34.8%	0.0%	63.0%	0.0%	0.0%	2.2%	46
Palugas wewa	20.0%	0.0%	80.0%	0.0%	0.0%	0.0%	5
Theankuttiya	22.2%	0.0%	72.2%	5.6%	0.0%	0.0%	18
Mawathawewa	-	-	-	-	-	-	n.a
Weliwewa	-	-	-	-	-	-	n.a
Total	22.2%	3.5%	71.2%	0.5%	1.5%	1.0%	198

Source: Farm Household Survey, JICA Project Team 2017

In Ichchankulama cascade, major occupation is farming, in which more than 70% of the households are engaged as their primary income source. Ichchankulama cascade, in comparison with other model cascades as shown in the below table, has the highest proportion of the households engaging in agriculture as their primary income source. However, there are some disparities between tanks as the percentages ranged from 41.7% to 80.6%. The households that earned from government jobs amounted to 22.2%, which is much lower than the average of the model cascades. Apart from the tanks with small numbers of samples, Karkolawewa showed slightly different allocation of income sources. Karkolawewa, the Muslim dominant community, has more variety in their occupation, while nearly all in other tanks are engaged either in agriculture or government jobs. Even though the option of livestock was provided, no household operates livestock rearing as their major income source in Ichchankulama.

Table 2.1.7 Primary Income Source by Cascade of Six Model Sites

Cascade	1.Govt Service	2.Private Sector	3. Crop Production	4.Livestock	5.Agri. Labour	6.Skilled Labour	7.Unskilled Labour	8.Family Business	10. Others	Total
Alagalla	51.9%	5.9%	25.9%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%	100%
Naveli kulam	11.0%	3.2%	45.2%	5.2%	0.6%	11.6%	12.3%	3.2%	7.7%	100%
Ichchankulama	22.2%	3.5%	71.2%	0.0%	0.0%	0.5%	1.5%	0.0%	1.0%	100%
Kiulekada	44.7%	2.0%	46.3%	1.2%	0.0%	0.8%	3.9%	1.2%	0.0%	100%
Rathmalawewa	34.5%	1.8%	41.5%	0.0%	0.4%	6.9%	4.4%	5.8%	4.7%	100%
Siyambalagaswewa	17.3%	2.7%	65.3%	0.7%	0.0%	4.7%	9.3%	0.0%	0.0%	100%
Total	31.3%	2.9%	49.3%	1.0%	0.2%	4.0%	6.8%	2.1%	2.3%	100%

Source: Farm Household Survey, JICA Project Team 2017

Even though there is a remarkable number of blank answers for the secondary income source, 26.3% of households in the area answered agricultural crop production as their secondary income source. Together with the figure of primary occupation shown in the previous table, in total 97.5% of the households in Ichchankulama operate agriculture as either their primary or secondary income sources. There are a relatively larger number of households engaging in livestock rearing as their secondary income source in Ichchankulama. Details of the secondary income sources per tank are shown in the following table.

Table 2.1.8 Secondary Income Source of the Beneficiary Households

Tank Name	2.Private Sector	3.Crop Production	4.Livestock	7.Unskilled Labour	8.Family Business	10. Other	Blank	Total Valid Answer
Agale wewa	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%	3
Ichchankulama	2.9%	25.7%	22.9%	0.0%	0.0%	2.9%	45.7%	35
Ihala Kainathama	0.0%	58.3%	16.7%	0.0%	0.0%	0.0%	25.0%	12
Karkolawewa	0.0%	19.4%	5.6%	11.1%	0.0%	0.0%	63.9%	72
Kudawewa	14.3%	28.6%	0.0%	14.3%	0.0%	0.0%	42.9%	7
Pahala Kainathama	2.2%	32.6%	13.0%	0.0%	0.0%	10.9%	41.3%	46
Palugas wewa	0.0%	0.0%	40.0%	0.0%	20.0%	0.0%	40.0%	5
Theankuttiya	0.0%	27.8%	5.6%	0.0%	5.6%	11.1%	50.0%	18
Mawathawewa	-	-	-	-	-	-	-	n.a
Weliwewa	-	-	-	-	-	-	-	n.a
Total	1.5%	26.3%	11.6%	4.5%	1.0%	4.5%	50.5%	198

Source: Farm Household Survey, JICA Project Team 2017

In comparison with the other model cascades as shown in the table below, Ichchankulama has a relatively lower proportion of crop production for the secondary income source as most of the people are engaged in agriculture as their primary occupation. Livestock activities in Ichchankulama is the second highest among the model cascades, following Naveli kulam.

Table 2.1.9 Secondary Income Source by Cascade of Six Model Sites

Cascade	1.Govt Service	2.Private Sector	3.Crop Production	4. Livestock	5.Agriculture Labour	6.Skilled Labour	7.Unskilled Labor	8.Family Business	9. Nil	10. Other	Blank
Alagalla	3.0%	0.7%	71.1%	0.0%	0.0%	1.5%	5.9%	0.7%	0.7%	0.0%	16.3%
Naveli kulam	3.9%	3.2%	47.7%	12.9%	0.0%	1.9%	10.3%	6.5%	0.0%	11.6%	1.9%
Ichchankulama	0.0%	1.5%	26.3%	11.6%	0.0%	0.0%	4.5%	1.0%	0.0%	4.5%	50.5%
Kiulekada	0.0%	0.8%	51.8%	4.3%	0.0%	1.2%	17.3%	2.4%	0.0%	9.4%	12.9%
Rathmalawewa	0.7%	0.4%	54.5%	0.7%	3.3%	7.3%	2.2%	5.5%	1.5%	10.5%	13.5%
Siyambalagaswewa	2.7%	1.3%	31.3%	3.3%	0.0%	0.0%	8.7%	0.0%	0.0%	26.7%	26.0%
Total	1.4%	1.2%	47.2%	5.2%	0.8%	2.4%	8.2%	2.9%	0.4%	10.3%	20.0%

Source: Farm Household Survey, JICA Project Team 2017

The following table shows the monthly household income of the target area. The average monthly income of the whole cascade in Ichchankulama is Rs.33,699. Only 1.5% of the households have income of less than Rs.5,000 per month, while 21.7% of the households earned more than Rs.50,000.

A remarkable inequality is observed in the average range of income between tanks. While Ihala Kainathama, where nearly 60% of households earned from government service, has more than Rs.50,000 of average income, that of Agale wewa is only Rs.14,387.

Table 2.1.10 Monthly Household Income of the Beneficiary Households

Tank	Income Level (LKR)											Average Income (Rs.)
	0-4999	5000-9999	10000-14999	15000-19999	20000-24999	25000-29999	30000-34999	35000-39999	40000-44999	45000-50000	>50000	
Agale wewa	0.0%	33.3%	33.3%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14,387
Ichchankulama	0.0%	17.1%	5.7%	2.9%	11.4%	5.7%	8.6%	20.0%	5.7%	5.7%	17.1%	33,242
Ihala Kainathama	0.0%	16.7%	8.3%	8.3%	0.0%	0.0%	8.3%	8.3%	0.0%	0.0%	50.0%	52,847
Karkolawewa	1.4%	23.6%	27.8%	16.7%	4.2%	6.9%	5.6%	1.4%	2.8%	1.4%	8.3%	20,928
Kudawewa	0.0%	0.0%	14.3%	28.6%	14.3%	0.0%	0.0%	0.0%	14.3%	0.0%	28.6%	38,040
Pahala Kainathama	0.0%	2.2%	2.2%	6.5%	10.9%	15.2%	4.3%	8.7%	4.3%	8.7%	37.0%	47,194
Palugas wewa	0.0%	20.0%	0.0%	0.0%	20.0%	0.0%	20.0%	20.0%	0.0%	0.0%	20.0%	42,120
Theankuttiya	11.1%	0.0%	22.2%	11.1%	5.6%	5.6%	0.0%	5.6%	0.0%	11.1%	27.8%	37,610
Mawathawewa	-	-	-	-	-	-	-	-	-	-	-	n.a
Weliwewa	-	-	-	-	-	-	-	-	-	-	-	n.a
Total	1.5%	14.1%	15.2%	10.6%	8.1%	7.6%	5.6%	7.6%	3.5%	4.5%	21.7%	**33,699**

Source: Farm Household Survey, JICA Project Team 2017

The average monthly income of Ichchankulama cascade is slightly higher than the total average of the six model cascades. Details of the monthly income of all the model cascades are shown in the table below.

Table 2.1.11 Monthly Household Income of the Beneficiary Households by Cascade

Cascade	Income Level (LKR)											Average Income (Rs)
	0- 4999	5000-9999	10000-14999	15000-19999	20000-24999	25000-29999	30000-34999	35000-39999	40000-44999	45000-50000	> 50000	
Alagalla	3.0%	5.9%	7.4%	5.9%	6.7%	6.7%	11.9%	14.8%	8.1%	8.9%	20.7%	40,229
Naveli kulam	0.0%	1.9%	2.6%	6.5%	11.0%	10.3%	11.0%	13.5%	9.0%	8.4%	25.8%	41,699
Ichchankulama	1.5%	14.1%	15.2%	10.6%	8.1%	7.6%	5.6%	7.6%	3.5%	4.5%	21.7%	33,699
Kiulekada	8.6%	8.6%	7.8%	9.0%	8.2%	7.5%	9.8%	13.7%	11.0%	7.1%	8.6%	28,667
Rathmalawewa	6.2%	13.8%	7.3%	11.3%	5.5%	10.2%	8.7%	8.4%	7.6%	4.4%	16.7%	31,190
Siyambalagaswewa	8.0%	14.7%	16.7%	10.0%	14.0%	8.7%	8.7%	6.0%	2.7%	1.3%	9.3%	23,581
Total	5.0%	10.4%	9.3%	9.2%	8.5%	8.6%	9.1%	10.5%	7.3%	5.7%	16.5%	32,527

Source: Farm Household Survey, JICA Project Team 2017

Economic situation can be also estimated by the number of beneficiaries of Divineguma, which is provided to the low-income households. The following shows the number and ratio of Divineguma beneficiaries. Only 4% of the total households in Ichchankulama received Divineguma benefits, which is lower in comparison with other model cascades.

Table 2.1.12 Divineguma Beneficiaries

Tank	Divineguma Beneficiaries (HH)	Total HHs	% of Divineguma Beneficiaries
Agale wewa		3	0.0%
Ichchankulama	6	35	17.1%
Ihala Kainathama		12	0.00%
Karkolawewa		72	0.00%
Kudawewa		7	0.00%
Pahala Kainathama	1	46	2.2%
Palugas wewa	1	5	20.0%
Theankuttiya		18	0.0%
Mawathawewa	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a
Total	8	198	4.0%

Source: Farm Household Survey, JICA Project Team 2017

Beneficiaries of the cascade are basically members of FOs that manage the tanks under the cascade. Farmers are generally taking part of several different CBOs in the area apart from the FOs. The following shows membership of CBOs operating in the area. Most of the households have membership in the Death Donation Society, except Karkolawewa where all the beneficiaries are Muslim, as Death Donation Society is typical cultural relations in the Sinhalese community. RDS seems to be relatively active in Ichchankulama tank area.

Table 2.1.13 CBO Membership (No. of households)

Tank	FO	RDS	Coop	Divineguma /Samurdhi	Women Group	Death Donation Society	Other	Valid No.
Agale wewa	3					2		3
Ichchankulama	35	10		6	3	35	1	35
Ihala Kainathama	12					9	1	12
Karkolawewa	70							72
Kudawewa	7		1		1	6	2	7
Pahala Kainathama	45	3		1	1	34	2	46
Palugas wewa	5			1		2		5
Theankuttiya	16	1				14	2	18
Mawathawewa	-	-	-	-	-	-	-	n.a
Weliwewa	-	-	-	-	-	-	-	n.a
Total	193	14	1	8	5	102	8	198

Source: Farm Household Survey, JICA Project Team 2017

2.2 Soil and Land Use

2.2.1 Soil Type in the Area

Ichchankulama cascade is located in the "DL 1" Agro-Ecological Region of Sri Lanka. The area terrain is undulating and the dominant soil group in the area is Reddish Brown Earth (RBE) and it has associated with Low Humic Gley (LHG) soils. The RBE occupies the crest and upper and mid slopes of the landscape. The LHG occupies the lower part of the slope and upper part of the valley bottom while a thin strip of alluvial soil appears along the natural drainage path. The ratio of RBE and LHG varies from place to place depending on the series of soil. In general, RBE, LHG and alluvial is about 60%, 30% and 10% of land surface, respectively.

RBE has been divided into two drainage classes, namely; Well-drained RBE and Imperfectly-drained RBE. Well-drained RBE appears in the upper and middle aspects of the undulating landscape, while Imperfectly-drained RBE appears in middle aspects of the undulating landscape.

Well-drained RBE has good drainage properties and it is used traditionally for cultivating other field crops under shifting nature with rainwater. This soil has a good potential for cultivation of other field crops and vegetables with supplementary irrigation. Soil reaction, depth, texture, and drainage are quite satisfactory for growing wide range of crops such as cereals, pulses, oil crops, and vegetables.

Imperfectly-drained RBE are used as support for several land uses such as homesteads, upland annuals, and shrub jungles. Although, potential for cultivating other field crops is very much higher, most of the cultivation fields with Imperfectly-drained RBE have already been developed for paddy cultivation in the Maha season and mostly abandoned in the Yala season due to shortage of water. Some areas, which are not developed for paddy cultivation, cultivate other field crops and vegetables with improved drainage practices in the Maha season. Farmers in the area are in view that Imperfectly-drained RBE area can be used to grow other field crops in the Yala season successfully with irrigation facilities.

LHG soils are predominantly used for wetland paddy cultivation. The LHG soil is mainly made of poorly drained soil which lies in the lowest position of the catena and it is influenced always by the seepage flow of the upper portion. This situation has led to keep the water table shallow most of the time creating favourable situation for paddy cultivation. In general, frequency of irrigation in this soil is lower due to the additional downward seepage of catena and poor drainage outflow from the soil. The soil is not suitable at all for other field crops under normal circumstance.

2.2.2 Land Holdings and Land Use

Farming lands of the households are usually spread as land parcels situated at different locations. In addition to the irrigable land area under the main tank, some farmers own irrigable land areas under other tanks within the cascade. Akkarawela are lands located in the uplands adjoining the irrigated command area and are cropped under rain-fed conditions or lift irrigation off agro-wells. Some farmers possessed Chena lands which are often encroached lands located in the highlands bordering the forest areas and used for growing seasonal and semi-permanent crops. Home gardens, where the farmhouses are situated, are mixed cropped with coconut, fruit crops, OFCs and vegetables, mainly for domestic consumption. The following discuss these different land use and land holdings under the cascade.

(1) Main Tank

The size of landholdings under their main tanks in Ichchankulama cascade is not uniform and varies widely between less than 0.5 and more than 3 acres at an average of 1.87 acres. *Palugas wewa* households have the largest landholdings with an average of 2.6 acres and the smallest in *Ihala Kainathama* tank with an average of 1.29 acres per household.

Table 2.2.1 Land Holdings under Main Tanks (Acres)

Tank	Percent Households						
	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Agale wewa	0	0	33.33	0	0	66.67	0
Ichchankulama	0	8.57	25.71	20.00	8.57	17.14	20.00
Ihala Kainathama	8.33	25.00	25.00	16.67	8.33	16.67	0
Karkolawewa	0.00	36.11	19.44	15.28	8.34	11.11	9.73
Kudawewa	0	0	42.86	28.57	28.57	0	0
Pahala Kainathama	0	13.04	15.22	10.87	21.74	21.74	17.39
Palugas wewa	0	0	0	0	60.00	20.00	20.00
Theankuttiya	0	16.67	22.22	22.22	0	27.78	11.11
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	0.51	20.71	20.71	15.66	12.63	17.17	12.63

Source: Farm Household Survey, JICA Project Team 2017

(2) Other Tanks in the Cascade

About 52% farmers in the cascade have cultivation land in command areas of other tanks as well, 38% of which are from Pahala Kainathama main tank. Similar to the land holdings in main tanks Palugas wewa households have the largest average holding size.

Table 2.2.2 Land Holdings under Other Tanks in the Cascade (Acres)

Tank	Percent Households						
	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Agale wewa	0	50.00	50.00	0	0	0	0
Ichchankulama	0	20.00	26.67	13.33	13.33	20.00	6.67
Ihala Kainathama	0	36.36	18.18	9.09	18.18	9.09	9.09
Karkolawewa	27.78	18.06	18.06	0.00	0.00	9.03	27.08
Kudawewa	0	28.57	28.57	14.29	14.29	0	14.29
Pahala Kainathama	10.00	15.00	15.00	12.50	27.50	12.50	7.50
Palugas wewa	0	0	20.00	20.00	20.00	20.00	20.00
Theankuttiya	6.67	33.33	13.33	13.33	6.67	13.33	13.33
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	5.77	22.12	19.23	11.54	17.31	12.50	11.54

Source: Farm Household Survey, JICA Project Team 2017

(3) Akkarawela

As per the Farm Household Survey in 2017, only 13% of the households have reported that they have lands in Akkarawela adjourning the tank command area. The average land holding is 1.3 acres and are mainly cultivated under rain-fed conditions during the Maha season.

Table 2.2.3 Distribution of Akkarawela Lands by Extent (Acres)

Tank	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Agale wewa	0	0	0	0	0	0	0
Ichchankulama	16.67	50	0	0	0	0	16.67
Ihala Kainathama	0	33.33	0	0	0	33.33	0
Karkolawewa	0	0	0	0	0	0	0
Kudawewa	0	0	0	0	0	0	0
Pahala Kainathama	10	20	10	10	0	10	10
Palugas wewa	0	50	0	0	0	0	0
Theankuttiya	0	50	0	0	50	0	0
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	8	32	4	4	4	8	8

Source: Farm Household Survey, JICA Project Team 2017

(4) Home Gardens

Home gardens in the cascade are not developed for commercial agriculture and generally cultivated with perennial crops such as coconut, mangoes, and banana under rain-fed conditions. The land holding size under home gardens varies in the range of 0.5-3 acres at an average of 0.91 acres. However, the majority or 81% of home gardens of farm households are less than 1.5 acres and the majority have 0.5-1.5 acres.

Table 2.2.4 Distribution of Home Gardens by Land Extent (Acres)

Tank	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Agale wewa	0	33.33	66.67	0	0	0	0
Ichchankulama	6.67	50	40	3.33	0	0	0
Ihala Kainathama	12.5	12.5	25	25	25	0	0
Karkolawewa	25.45	38.99	24.28	4.51	6.77	0.00	0.00
Kudawewa	0	33.33	66.67	0	0	0	0
Pahala Kainathama	9.30	30.23	32.56	18.60	6.98	2.33	0
Palugas wewa	0	20	40	20	20	0	0
Theankuttiya	8.33	33.33	33.33	8.33	8.33	0	8.33
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	11.64	35.62	34.25	10.27	6.85	0.68	0.68

Source: Farm Household Survey, JICA Project Team 2017

(5) Chena Lands

Chena lands in the past fit into a system of shifting cultivation, but have now established as permanent holdings used for cultivation of annual crops under rain-fed conditions. Seventy-five percent of the households in the cascade have this type of land. The land holding sizes compared with other land types are bigger and average to 2.66 acres, which may be due to annexing crown lands at their discretion.

Table 2.2.5 Distribution of Chena Lands by Land Extent (Acres)

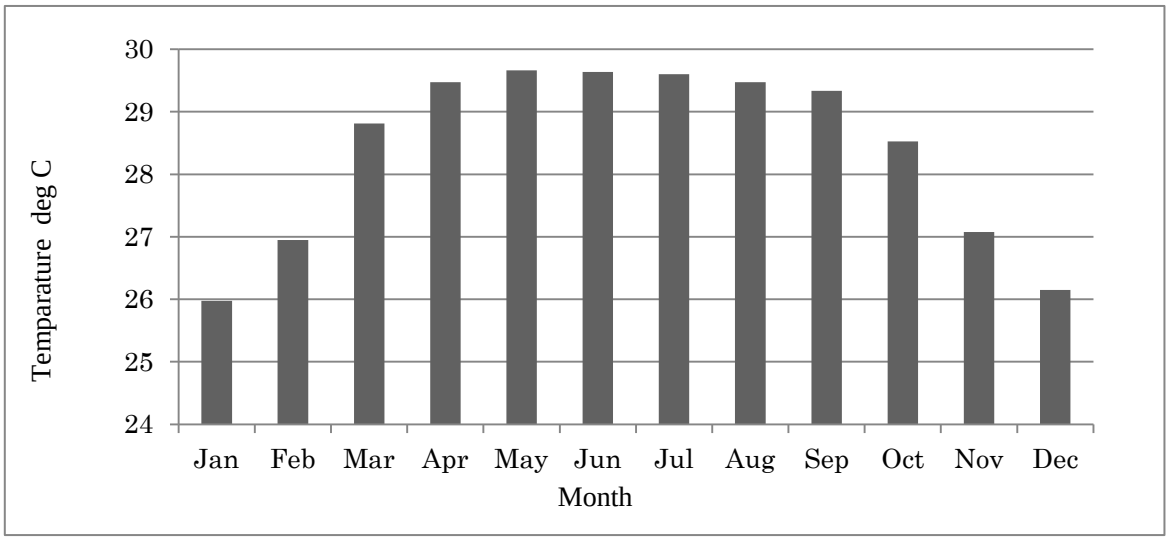
Tank	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Agale wewa	0	0	0	100	0	0
Ichchankulama	0	9.68	12.90	22.58	16.13	38.71
Ihala Kainathama	0	10	20	0	50	20
Karkolawewa	1.63	28.10	8.41	30.12	18.44	13.31
Kudawewa	0	14.29	14.29	28.57	28.57	14.29
Pahala Kainathama	0	10.81	8.11	21.62	32.43	27.03
Palugas wewa	0	0	0	0	20	80
Theankuttiya	0	36.36	9.09	27.27	9.09	18.18
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	0.66	17.22	9.93	23.84	23.18	25.17

Source: Farm Household Survey, JICA Project Team 2017

2.3 Meteorology and Water Resources

2.3.1 Temperature and Humidity

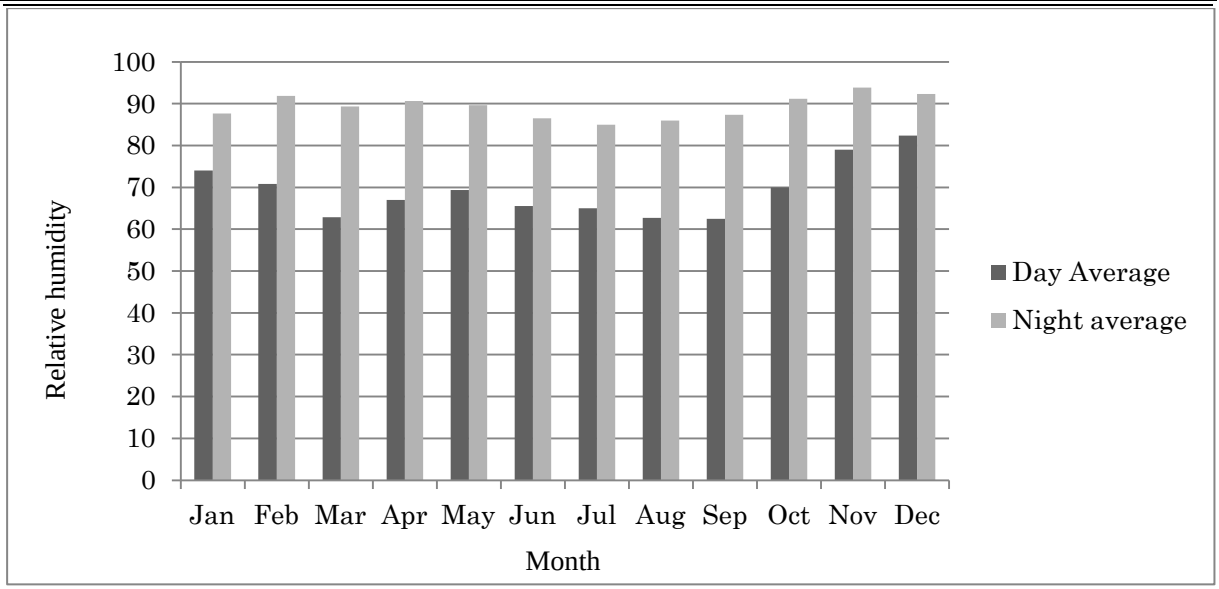
Temperature variations in the area can be observed in line with the two cultivation seasons named Yala and Maha. The highest temperature takes place in April to September and this period overlaps with Yala cultivation season which is generally dry due to poor rains in the dry zone. Monthly average temperature in the area decreases from September to January, in line with the rainy season Maha. The lowest monthly average temperature (25 °C) appears in the month of January. Annual average temperature in the area is about 28 °C.



Source: Statistical Abstract/Dept. of Census and Statistics, Sri Lanka

Figure 2.3.1 Monthly Average (2008-2016) Temperature-Ichchankulama

Annual average relative humidity in the area is about 69% and 89% in day time and night time, respectively. The monthly average relative humidity in the area varies from about 65% to 82% during the day and about 87% to 93% at night for the entire year. Like in many other parts of dry zone, lower relative humidity values are experienced in March, April, June, July, August and September during day time and in January, June, July, August and September during night time. Higher relative humidity values are experienced in January, February, October, November and December during day time and February, March, April, May, October, November, and December during night time.

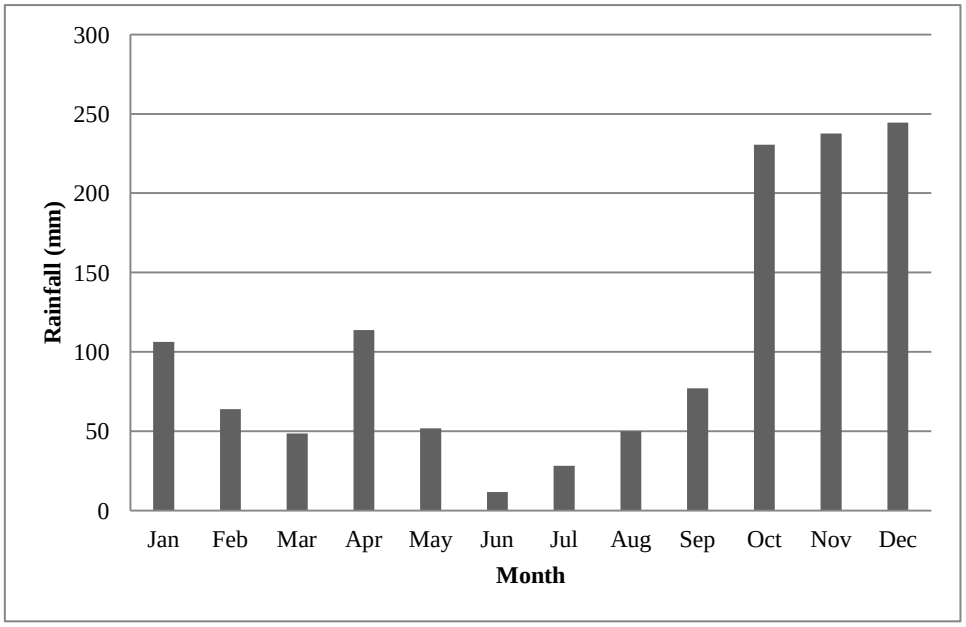


Source: Statistical Abstract/Dept. of Census and Statistics, Sri Lanka

Figure 2.3.2 Monthly Average (2010-2016) Relative Humidity-Ichchankulama

2.3.2 Rainfall

The closest rainfall gauging station of Ichchankulama cascade is Kahatagasdigiliya. The monthly rainfall data is obtained from the Meteorological Department of Sri Lanka. According to the data, the annual rainfall of Kahatagasdigiliya ranges from 975.0 mm to 1889.5 mm, the average of which is 1303.02 mm. The monthly rainfall is at the lowest in July and at the highest in November.



Source: Department of Meteorology, Sri Lanka

Figure 2.3.3 Average (1977-2016) Monthly Rainfall (Kahatagasdigiliya)

2.4 Agriculture and Agro-economy

2.4.1 Farm Land Holdings and Ownership

(1) Farm Holding

The total holding comprises the irrigable lands under the main tank and other tanks in the cascade, Akkarawela lands, Chena lands, and home gardens. The average farm land holding size of the

households in Ichchankulama cascade is relatively larger than that in other cascades. It ranges between 3.6 acres and 12.5 acres by tank at a total average of 5.7 acres.

Table 2.4.1 Average Land Holding of Households by Category

Tank	Average Landholding (Acres)					
	Main Tank	Other Tank	Akkarawela	Chena	Home Garden	Total
Agale wewa	2.17	0.5	0	0.67	0.83	4.17
Ichchankulama	2.29	0.71	0.22	2.76	0.64	6.61
Ihala Kainathama	1.29	1.42	0.42	2.42	0.81	6.35
Karkolawewa	1.51	0.26	0.01	1.47	0.40	3.64
Kudawewa	1.50	1.64	0.14	2.36	0.71	6.36
Pahala Kainathama	2.23	1.51	0.30	2.27	0.94	7.26
Palugas wewa	2.60	3.05	0.35	4.80	1.25	12.05
Theankuttiya	1.83	1.54	0.14	1.33	0.88	5.72
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	1.87	0.94	0.17	2.03	0.67	5.68

Source: Farm Household Survey, JICA Project Team 2017

(2) Land Ownership and Tenure

There are several land ownership and tenure systems operating in the study area. These include 'own lands' where the ownership is documented, 'pangu' where portions of land owned by the parent are shared by the offspring, 'ande', a share cropping system where land is cultivated by a tenant under Paddy Lands Act, and 'leased in/out' where land is seasonally cultivated by a lessee. Almost 96% of the farm households have their 'own' lands while the types of land tenure systems are not much in operation in the cascade**.**

Table 2.4.2 Distribution of Land Ownership and Tenure Systems

Tank	Percent Households							
	Ande	Leased in	Other	Own/ Leased in	Own/Other	Own/Pangu	Own	Pangu
Agale wewa	0	0	0	0	0	0	100.0	0
Ichchankulama	0	2.8	0	0	2.8	2.8	91.4	0
Ihala Kainathama	0	0	0	0	0	0	100.0	0
Karkolawewa	0	0	1.4	0	0	0	97.2	1.4
Kudawewa	0	0	0	0	0	0	100.0	0
Pahala Kainathama	2.1	0	2.1	0	0	0	95.6	0
Palugas wewa	0	0	0	20.0	0	0	80.0	0
Theankuttiya	0	0	0	0	0	0	100.0	0
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	0.51	0.5	1.0	0.5	0.5	0.5	95.9	0.5

Source: Farm Household Survey, JICA Project Team 2017

2.4.2 Crop Production

(1) Cropped Extents, Production and Yields

Crop production in the command area of the cascade is totally dependent on the rainfall and available water collected in the tanks from the catchment runoff. For this reason, crop production in command areas as well as other production locations, is usually confined to the Maha season. A minor land extent is cultivated under lift irrigation of agro-wells.

(a) Paddy

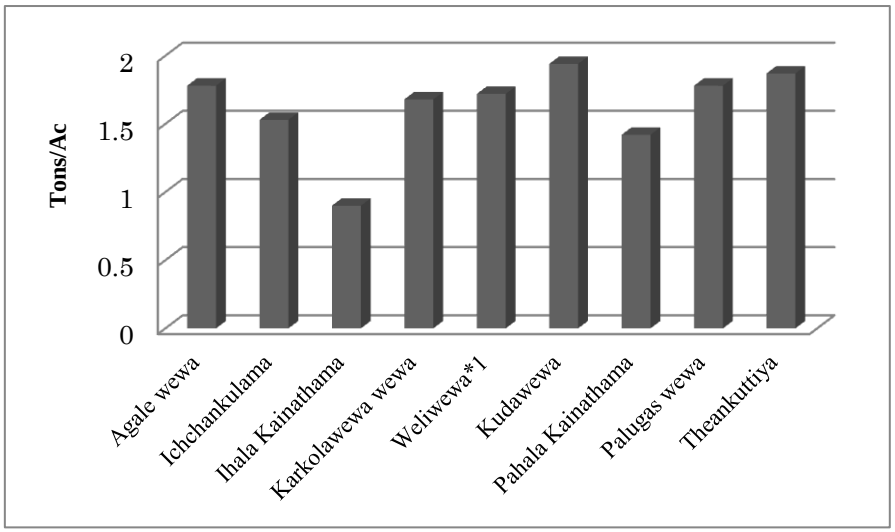
Paddy is the only crop grown in the command area of the tanks as well as in land owned by the households in the cascade. Bg 300, Bg 310, Bg 359, and Pokuru samba are the main paddy varieties grown in the area. The total area of paddy cultivation reported by 198 farm households in their main tank command area is 375 acres, of which 107 acres are located under Pahala Kainathama tank. In addition, a total of 193 acres of paddy is reported as an irrigated crop under other tanks. As with the number of households, Pahala Kainathama has the largest land extent of 71 acres under irrigated paddy lands in other areas. Further, another 61 acres of paddy is reported in rain-fed highland areas making the total paddy extent 629 acres in the Maha season.

The average yield of paddy cultivation is 1.58 per acre in the command areas of the cascade whereas that of Anuradhapura District is 1.87 (Department of Census and Statistics, 2015/16 Maha). Kudawewa and Theankuttiya farmers have equalled the district yields level.

Table 2.4.3 Paddy Extents, Production and Yield by Season

Tank	Maha Season		
	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)
Agale wewa	6.5	11.6	1.78
Ichchankulama	80	122.76	1.53
Ihala Kainathama	15.5	13.9	0.90
Karkolawewa	66.99	114.77	1.71
Kudawewa	10.5	20.4	1.94
Pahala Kainathama	107.25	152.5	1.42
Palugas wewa	13	23.1	1.78
Theankuttiya	33	61.7	1.87
Mawathawewa	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a
Cascade	374.5	591.77	1.58

Source: Farm Household Survey, JICA Project Team 2017



**1 Weliwewa attached to Karkolawewa*
Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.1 Average Paddy Yield (Maha)

(b) Other Crops Cultivation

Ichchankulama cascade is located in a major maize growing area of the district. Accordingly, the cascade was reported to be 370 acres of rain-fed and 26 acres of irrigated maize crop in the Maha season.

The varieties used for maize cultivation are mostly imported hybrid varieties, which give higher productivity compared with locally produced open pollinated varieties.

Table 2.4.4 Cultivated Extents of Maize

Tank	Irrigated Other Tanks-Maha			Rain-fed Highland-Maha		
	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)
Agale wewa	0	0	0	2	4.5	2.25
Ichchankulama	3	5	1.67	91.5	153	1.67
Ihala Kainathama	1.5	0	0	20	22.5	1.13
Karkolawewa	3.97	6.50	1.18	53.67	89.64	1.65
Kudawewa	1	2	2.00	12	29.5	2.46
Pahala Kainathama	6.5	16	2.46	106	153.75	1.45
Palugas wewa	0	0	0	19	40.5	2.13
Theankuttiya	6	7.75	1.29	23	31.5	1.37
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	23.5	39.75	1.69	369.5	592.05	1.60

Source: Farm Household Survey, JICA Project Team 2017

There is a wide variation in yield per acre of maize crop among the households under different tanks in the cascade. The average yields of irrigated and rain-fed crops in the cascade are 1.68 and 1.60 metric tons per acre, respectively. Kudawewa farmers recorded the highest yield which is 2.46 tons per acre under rain-fed conditions. Apart from maize cultivation, cultivation of other crops is insignificant in the cascade area.

(c) Fruit Cultivation

No commercial scale fruit cultivation is recorded in the area while few fruit trees are grown in homesteads. Mango and banana are the main fruit crops grown in homesteads.

(2) Input Supply

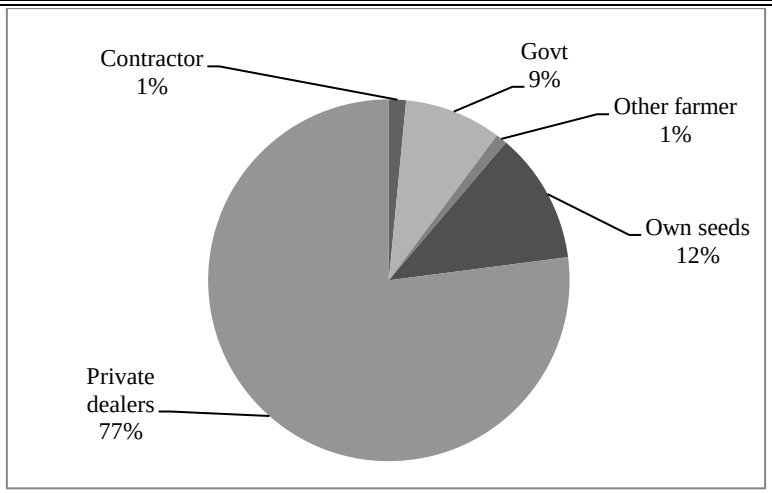
(a) Seeds and Planting Material

Paddy cultivation being the main crop grown in the cascade, the seed paddy assumes prominence over other crops. It is interesting to note that about 77% of households fulfilled their seed paddy requirements through private dealers and only 9% are depending on government sources.

Table 2.4.5 Sources of Seed Paddy Supply (% HH)

Tank	Contractor	Govt	Other Farmers	Own Seeds	Private Dealers
Agale wewa	0	0	0	33.33	66.67
Ichchankulama	0	2.94	0	17.65	79.41
Ihala Kainathama	8.33	25	0	8.33	58.33
Karkolawewa	1.39	9.72	2.78	1.39	84.72
Kudawewa	0	0	0	0	100
Pahala Kainathama	0	10.87	0	26.09	63.04
Palugas wewa	0	0	0	25	75
Theankuttiya	5.56	5.56	0	5.56	83.33
Mawathawewa	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a
Cascade	1.53	8.67	1.02	11.73	77.04

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.2 Sources of Seed Paddy Supply

At present, almost all farmers in the cascade are used to hybrid maize cultivation and obtained the seeds from the private dealers. Only 6% of the farmers depend on government sources while 93% depend on imported seeds through private sector.

(b) Farm Labour

Sixty-three percent of heads of the household contributed to farm labour requirement on full time basis while 20% are not engaged in farm work and the remaining 16% worked only on part-time basis. About 23% of the household members worked in the farms on full time and 76% on part-time basis. About 16% of the households totally depended on hired labour while 83% engaged hired labour at times of intensive farm operations.

Table 2.4.6 Percent Contribution to Farm Work by Different Labour Categories

Tank	Head of household			Household members		Hired Labour	
	Full time	Part time	Not involved	Full time	Part time	Only	Sometimes
Agale wewa	66.67	0	33.33	0.00	100.00	33.33	66.67
Ichchankulama	77.14	17.14	5.71	27.27	72.73	9.09	90.91
Ihala Kainathama	50	25	25	25.00	75.00	33.33	66.67
Karkolawewa	73.61	11.11	15.28	17.16	82.84	12.66	87.34
Kudawewa	28.57	42.86	28.57	40.00	60.00	28.57	71.43
Pahala Kainathama	54.35	17.39	28.26	24.32	75.68	13.33	86.67
Palugas wewa	60	0	40	50.00	50.00	40.00	60.00
Theankuttiya	38.89	22.22	38.89	37.50	62.50	29.41	70.59
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	63.13	16.16	20.71	23.27	76.73	16.58	83.42

Source: Farm Household Survey, JICA Project Team 2017

Major problems related to hired labour situation were assessed during the survey. The pressing issues faced by the farmers are the scarcity of farm labour and prevailing wage rates, which is high and increasing virtually every season.

Table 2.4.7 Problems Related to Hired Labour (Percent Households)

Tank	High Rate	Shortage	None
Agale wewa	33.33	66.67	0
Ichchankulama	29.63	48.15	22.22
Ihala Kainathama	40	60	0
Karkolawewa	29.79	68.75	1.46
Kudawewa	40	60	0
Pahala Kainathama	25.64	71.79	2.56
Palugas wewa	40	40	20
Theankuttiya	6.25	93.75	0
Mawathawewa	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a
Cascade	27.91	66.86	5.23

Source: Farm Household Survey, JICA Project Team 2017

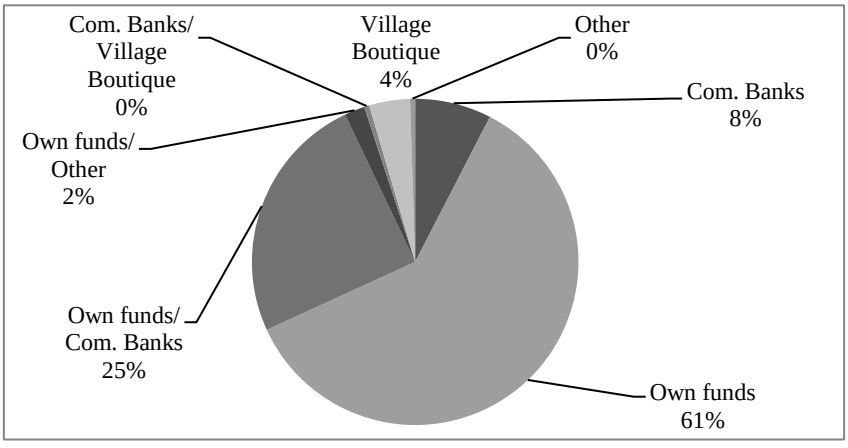
(c) Production Capital

Although the heads and members of the household contributed significantly to reduce the labour costs, there are other costs that the farmers have to bear in order to secure the needed inputs for crop production. Capital requirement to procure these inputs accounted for 55% of the total cost of production of paddy (Crop Enterprise Budget, DOA 2015). However, 61% of the households managed their own funds to invest in cultivation while another 27% of households used their own funds supplemented by other sources such as commercial banks.

Table 2.4.8 Sources of Capital for Cultivation (% HH)

Tank	Com. Banks	Own Funds	Own Funds/ Com. Banks	Own Funds/ Other	Com. Banks/ Village Boutique	Village Boutique	Other
Agale wewa	0	66.67	33.33	0	0	0	0
Ichchankulama	0	57.14	42.86	0	0	0	0
Ihala Kainathama	8.33	75.00	16.67	0	0	0	0
Karkolawewa	15.28	44.45	23.61	4.17	1.39	11.11	0
Kudawewa	14.29	85.71	0	0	0	0	0
Pahala Kainathama	4.35	65.22	26.09	2.17	0	0	2.17
Palugas wewa	0	80.00	20.00	0	0	0	0
Theankuttiya	0	94.44	5.56	0	0	0	0
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	7.58	60.61	24.75	2.02	0.51	4.04	0.51

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.3 Sources for Cultivation Capital

(d) Irrigation Water

Ichchankulama cascade totally depends on monsoon and inter-monsoon rains in the catchment and there is no inflow of water from other sources. Therefore, the water collected in the tanks in the Maha season is sufficient only for cultivation of total command area of tanks in that season, and the rainfall in the Yala season is inadequate to complete a crop cycle. Accordingly, 99% of the households in the cascade get sufficient water in the Maha season while 100% households are not contented with the supply in the Yala season. About 1% of households who do not get sufficient water in the Maha season may have location specific irrigation problems.

Table 2.4.9 Percent of Households by Adequacy of Irrigation Water (% HH)

Tank	Maha		Yala	
	Sufficient	Insufficient	Insufficient	No water
Agale wewa	100	0	100	0
Ichchankulama	100	0	100	0
Ihala Kainathama	100	0	90.91	9.09
Karkolawewa	98.61	1.39	100.00	0
Kudawewa	85.71	14.29	66.67	33.33
Pahala Kainathama	100	0	100	0
Palugas wewa	100	0	80	20
Theankuttiya	100	0	100	0
Mawathawewa	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a
Cascade	98.99	1.01	97.91	2.09

Source: Farm Household Survey, JICA Project Team 2017

The table below shows that the farmers in the cascade do not wait until the tanks are filled up before they commence their cultivation in the Maha season, but instead they start land preparation with the onset of rains. However, the commencement of water issuing from the tank is decided by the 'Kanna meeting' attended by all farmers and relevant field level government officers.

Table 2.4.10 Commencement of Land Preparation (%HH)

Tank	After Tank Fills Up	With Onset of Rain
Agale wewa	0	100
Ichchankulama	0	100
Ihala Kainathama	0	100
Karkolawewa	1.39	98.61
Kudawewa	0	100
Pahala Kainathama	2.17	97.83
Palugas wewa	0	100
Theankuttiya	0	100
Mawathawewa	n.a	n.a
Weliwewa	n.a	n.a
Cascade	1.01	98.99

Source: Farm Household Survey, JICA Project Team 2017

(e) Agro-wells

There are 43 agro-wells in the cascade which represents 21% of the households. The agro-wells are mostly located in the home gardens and are used to maintain the perennial crops, but are not used for efficient agricultural production.

Table 2.4.11 Distribution of Agro-wells by Location (%)

Tank	Owned Agro-wells	Location		
		Command Area	Highland	Home Garden
Agale wewa	0	0	0	0
Ichchankulama	45.71	0	50	50
Ihala Kainathama	33.33	25	75	0
Karkolawewa	11.11	14.44	23.70	61.85
Kudawewa	0			
Pahala Kainathama	26.09	16.67	8.33	75
Palugas wewa	0	0	0	0
Theankuttiya	16.67	0	0	100
Mawathawewa	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a
Cascade	21.72	9.76	31.71	58.54

Source: Farm Household Survey, JICA Project Team 2017

2.4.3 Technology Transfer

Unlike in other cascades, agricultural extension activities in Ichchankulama cascade come under the purview of the Interprovincial Department of Agriculture through AI of Upuldeniya Range. About 96% of farmers in the cascade received agricultural technology information either from the AI or ARPA or both sources.

Table 2.4.12 Sources of Agricultural Extension Services

Tank	Percent Households						
	ARPA	AI/ ARPA	AI/ Company	AI	Mass Media / ARPA	Mass Media / Other	Mass Media
Agale wewa	33.33	0	33.33	33.33	0	0	0
Ichchankulama	6.06	63.64	0	18.18	6.06	0	6.06
Ihala Kainathama	8.33	58.33	0	33.33	0	0	0
Karkolawewa	4.17	58.33	0	36.11	0	0	1.39
Kudawewa	14.29	85.71	0	0	0	0	0
Pahala Kainathama	13.04	60.87	0	23.91	0	2.17	0
Palugas wewa	0	80	0	20	0	0	0
Theankuttiya	22.22	44.44	5.56	27.78	0	0	0
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	9.18	59.18	1.02	27.55	1.02	0.51	1.53

Source: Farm Household Survey, JICA Project Team 2017

Crop production and plant protection are the major subject areas that 52% of the farmers desired to learn more while nearly 30% of the farmers remained undecided. Some note that they are too old to learn about new technologies for them to apply in the field successfully, and that their experience is adequate to meet the present needs.

Table 2.4.13 Training Needs Identified by Farmers

Tank	Percent Households							
	Crop Product Livestock	Crop Production/ Plant Protection	Crop production	Livestock/ Plant Protection	Livestock	Marketing	None	Plant Protection
Agale wewa	0	0	33.33	0	0	33.33	33.33	0
Ichchankulama	18.75	0	28.13	6.25	3.13	0	28.13	15.63
Ihala Kainathama	0	27.27	27.27	0	18.18	0	9.09	18.18
Karkolawewa	0	0	26.39	0	5.55	1.39	29.17	37.50
Kudawewa	0	28.57	42.86	0	14.29	0	14.29	0
Pahala Kainathama	2.17	4.35	36.96	0	10.87	0	34.78	10.87
Palugas wewa	20	0	60	0	0	0	20	0
Theankuttiya	5.56	0	38.89	0	0	5.56	44.44	5.56
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	4.64	3.61	31.96	1.03	6.70	1.55	29.90	20.62

Source: Farm Household Survey, JICA Project Team 2017

2.4.4 Crop Diversification

(1) Farmer Response to Crop Diversification

Nearly all farmers in Ichchankulama cascade do not wish to diversify their irrigable paddy land in the Maha season. Farmers claimed that the soils are not suitable for diversification in the season. However, 74% responded positively for diversification in the Yala season. Grain legumes and maize ranked high with 53% and 41%, respectively in their crop preference.

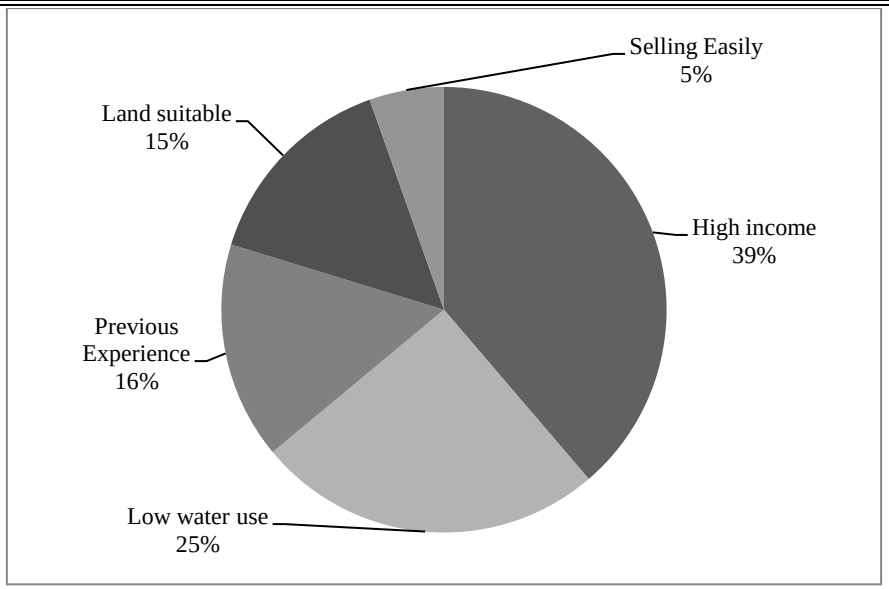
Table 2.4.14 Farmers' Response to Crop Diversification (%HH)

Tank	Maha		Yala	
	Yes	No	Yes	No
Agale wewa	0	100	66.67	33.33
Ichchankulama	8.57	91.43	77.14	22.86
Ihala Kainathama	0	100	83.33	16.67
Karkolawewa	1.42	98.58	95.78	4.22
Kudawewa	14.29	85.71	57.14	42.86
Pahala Kainathama	2.17	97.83	52.17	47.83
Palugas wewa	0	100	60	40
Theankuttiya	5.56	94.44	44.44	55.56
Mawathawewa	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a
Cascade	3.55	96.45	74.11	25.89

Source: Farm Household Survey, JICA Project Team 2017

(2) Reasons For and Against Crop Diversification

At present, farmers do not cultivate during the Yala season due to the inadequacy/non-availability of water in the tanks in the cascade. There is no record that they have tried out other crops in the Yala season with available water. Farmers indicated high income, water saving, previous experience, land suitability, and marketability, in that order, are the main advantages of crop diversification.



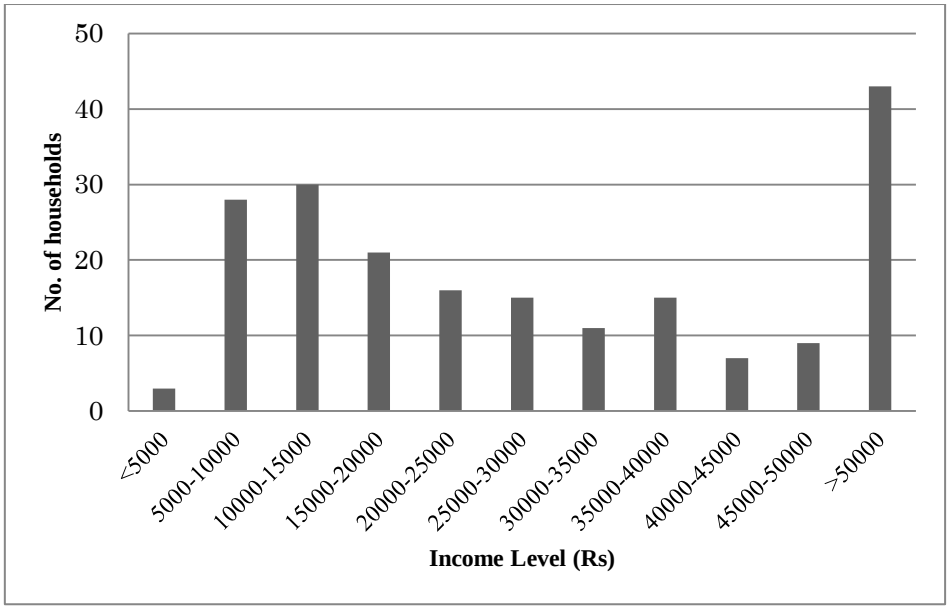
Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.4 Reasons for Diversification

2.4.5 Household Income

(1) Total Income

The total monthly income of households varies between less than Rs.5,000 and over Rs.50,000 with an average of about Rs.33,000 as explained in the section above. Over 20% of the households earned monthly income in excess of Rs.50,000.



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.5 Household Monthly Income Distribution

(2) Farm Income

The livelihood of the households in Ichchankulama is highly dependent on crop farming. Thus about 71% of household get their primary income from crop production which is mainly from Maha cultivation.

The average monthly income from crop production of the households in Ichchankulama cascade is Rs 18,408. Palugas wewa tank has only five farmers and they get the highest income among the households in the cascade. The bigger land holding size and investments may be the reasons for it.

Table 2.4.15 Farm Income from Crop Production (Rs)

Tank	Average Income-Maha	Average Income-Yala	Average Annual Income	Average Monthly Income
Agale wewa	169,313	0	169,313	14,109
Ichchankulama	198,886	0	198,886	16,574
Ihala Kainathama	178,022	0	178,022	14,835
Karkolawewa	144,468	2,361	146,829	12,236
Kudawewa	288,731	2,750	291,481	24,290
Pahala Kainathama	310,524	12,141	322,665	26,889
Palugas wewa	410,844	0	410,844	34,237
Theankuttiya	205,551	0	205,551	17,129
Mawathawewa	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a
Cascade	212,456	8,441	220,896	18,408

Source: Farm Household Survey, JICA Project Team 2017

2.4.6 Marketing

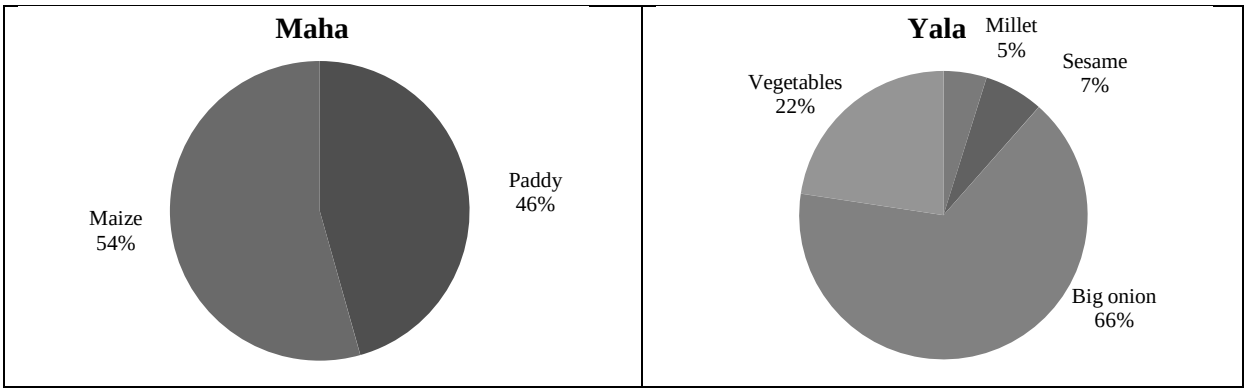
(1) Major Cash Crops: Paddy and Maize in Maha

Ichchankulama cascade concentrates on two crops, namely; maize and paddy for cash crops, in the Maha season. In Yala, on the other hand, paddy is not transacted. A limited number of farmers sell big onion and vegetables in the season.

Table 2.4.16 Cash Crops in Ichchankulama Cascade

Crop		Maha Season	Yala Season
Paddy	Volume (kg)	573,920	0
	Number	185	0
Maize	Volume (kg)	683,675	0
	Number	154	0
Millet	Volume (kg)	0	750
	Number	0	1
Sesame	Volume (kg)	0	1,030
	Number	0	3
Big onion	Volume (kg)	0	10,200
	Number	0	3
Vegetables	Volume (kg)	0	3,500
	Number	0	2

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.6 Cash Crops in Ichchankulama Cascade

(2) Paddy

Paddy in the cascade is mainly sold to collectors. PMB offers a better price, but with the limited volume. Two farmers practice contract farming, although buyers of the contract farming do not offer a better price than PMB.

Table 2.4.17 Paddy Sales in Maha Season

Buyer	Volume sold (kg)	Average volume (kg)	Price (Rs/kg)
Collector	634,200	3155.22	35.90
PMB	88,600	2605.88	40.79
Miller	37,200	5314.29	36.86
N/A	24,650	2465.00	39.00
Contract	14,500	4833.33	35.67
Total	**799,150**	**3133.92**	**36.71**

Source: Farm Household Survey, JICA Project Team 2017

(3) Others

Maize is the other major cash crop during the Maha season. About 154 farmers out of 300, earned by selling maize. The selling volume is more than that of paddy. While the survey does not identify the practice of contract farming of maize, the cascade may have a market channel for maize.

Table 2.4.18 Maize Sales in the Maha Season

Buyer	Volume sold (kg)	Number of farmers	Price (Rs/kg)
Collector	2,000	1	42.00
N/A	681,675	153	38.35
Total	**683,675**	**154**	**38.38**

Source: Farm Household Survey, JICA Project Team 2017

Another notable cash crop is mango, as shown in the table below. Ichchankulama has the largest mango sales among the six model cascades.

Table 2.4.19 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

Approximately, 54 tons of mangoes are transacted by collectors and traders. Only one farmer sells his/her mango collectively to a trader while the others sell individually.

Table 2.4.20 Mango Sales in the Cascade

Buyer	Selling Method	Volume Sold	Price(Kg/unit)
Collector	Individual	1,600	10.00
Trader	Collective	10,000	7.00
	Individual	42,800	5.00
Total		54,400	6.00

Source: Farm Household Survey, JICA Project Team 2017

2.5 Livestock

2.5.1 General Situation of Livestock Activities in the Area

This area had been a free grazing area for cattle until irrigated water from the tanks in the cascade system allowed people to grow crops. With bigger drive to increase crop food production during the past four to five decades, more and more lands were used for crop cultivation. In the Maha season almost the whole area is utilized for crop cultivation, while the cultivation during Yala is done only in the limited land with available water. Due to the expanded crop cultivation, cattle herders came to graze their cattle in the government-owned grazing land and forestland. However, government prohibited this grazing land around four decades ago. As a result, herders were unable to maintain a large population of cattle due to the lack of grazing areas. Large herds transformed gradually into smaller herds and livestock activities totally disappeared in some areas.

Presently, farmers keeping cattle in the area under Ichchankulama cascade, are mostly from the families that have been traditionally doing cattle rearing. Those who have no historical family background in keeping cattle hesitate to start rearing cattle. This is a major problem faced by the extension staff when introducing dairy farming to rural community.

The following table shows the characteristics of the cattle farming system in this area.

Table 2.5.1 Characteristics of the Cattle Farming System in Ichchankulama Cascade

Issues on farming system	Situation
1. Cattle keeping is a family tradition	Yes
2. Genetic value of cattle	Crossbred cattle
3. Feed resource	Free grazing, tethering and stall feeding
4. Knowledge on technology	Sufficient for this level of management
5. Reproductive management	Yes
6. Health management	Yes
7. Access and ability to financing	Yes
8. Labour	Family

Source: Farm Household Survey, JICA Project Team 2017

This area has a large amount of herbage of good quality. This saved the livestock-crop mixed farming community with extra income during drought period as livestock is more resistant with drought situation than crops. In fact, Ichchankulama farmers continue providing milk even during drought, which provides as their only regular income during the drought period. It is proven that in Ichchankulama cascade, livestock thrived better during drought than the normal periods as they had more field for grazing area during the absence of crop cultivation. However, most of the other farmers in this area are unaware of the economic contribution of milk production.

2.5.2 Livestock Farming Population and Income

Table 2.5.2 shows the number of cattle farms. Cattle are reared in all tanks except in Agale wewa and Kudawewa, where the target populations are very small. Only 17.2% of the households have livestock. Basically, all livestock farmers who have livestock have cattle, while poultry are kept only in two households in Ichchankulama and Theankuttiya tank areas.

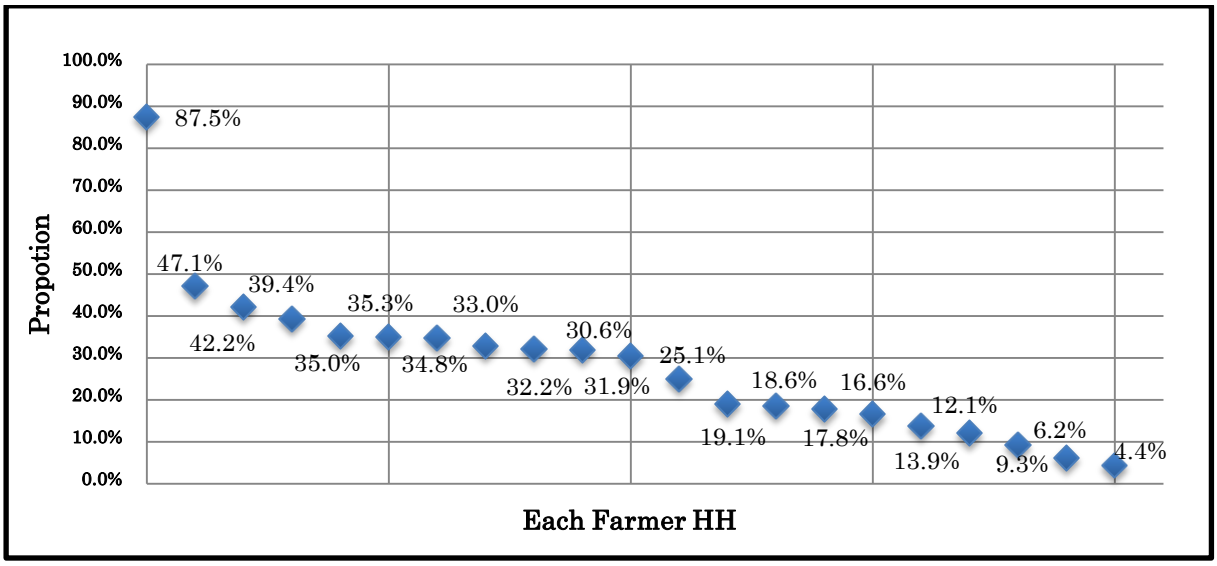
Average monthly income from livestock activities of livestock farmers who have income from livestock is Rs.20,332, ranges from Rs.8,250 to Rs.52,500 at individual household level. This means a significant portion of household income comes from livestock activities for those farmers in consideration of the general average monthly income of Rs.33,699 under Ichchankulama cascade.

Table 2.5.2 Livestock Farmers and Average Monthly Income from Livestock per Tank

Tanks	Total Surveyed	Cattle Farmers		Poultry Farmers		Average Monthly Income from Livestock
	(no. HH)	(no. HH)	%	(no. HH)	%	(Rs.)
Agale wewa	3		0.00%		0.00%	-
Ichchankulama	35	10	28.57%	1	2.86%	13,200
Ihala Kainathama	12	2	16.67%		0.00%	14,400
Karkolawewa	72	9	12.50%		0.00%	20,511
Kudawewa	7		0.00%		0.00%	-
Pahala Kainathama	46	9	19.57%		0.00%	25,225
Palugas wewa	5	2	40.00%		0.00%	10,500
Theankuttiya	18	2	11.11%	1	5.56%	8,400
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	198	34	17.17%	2	1.01%	20,332

Source: Farm Household Survey, JICA Project Team 2017

In Ichchankulama, the livestock sector has moved beyond the subsistence level of production. Proportion of income from livestock is relatively high in those who operate livestock rearing as their income source. The following Figure 2.5.1 indicates the proportion of income from livestock activities in the total income of each livestock farmer. One farmer received 87.5% of his household income from the sale of milk. Around 57% of the livestock farmers received over 25% of the income from milk production.



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.5.1 Proportion of Annual Income from Livestock of Each Household

2.5.3 Livestock Population and Breed

The following table indicates the livestock population in Ichchankulama cascade area

Table 2.5.3 Livestock Population

Tank	Cattle						Poultry	
	Dairy Cows	Dry cows	Heifers	Bulls	Calves	Cattle Total	Layers	Pullets
Agale wewa	0	0	0	0	0	0	0	0
Ichchankulama	21	7	8	2	18	56	2	0
Ihala Kainathama	2	0	1	0	2	5	0	0
Karkolawewa	13	6	12	4	16	51	0	0

Kudawewa		0	0	0	0	0	0	0
Pahala Kainathama	23	9	3	11	20	66	0	0
Palugas wewa	8	7	7	5	8	35	0	0
Theankuttiya	2	1	1	2	2	8	2	0
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Total	**69**	**30**	**32**	**24**	**66**	**221**	**4**	**0**

Source: Farm Household Survey, JICA Project Team 2017

A large proportion of the cattle are crossbreds as shown in the table below. However, due to the inadequate management of farmers, they are unable to get the maximum potential. Both natural mating and artificial breeding are used to get the subsequent generation.

Table 2.5.4 Proportion of Livestock Breed

Breed	Cattle			Poultry	
	Both	Cross	Local	Farm	Local
Agale wewa					
Ichchankulama	30.4%	39.1%	30.4%	0.0%	100.0%
Ihala Kainathama	20.0%	80.0%	0.0%		
Karkolawewa	7.51%	75.95%	16.54%		
Kudawewa					
Pahala Kainathama	17.5%	82.5%	0.0%		
Palugas wewa	100.0%	0.0%	0.0%		
Theankuttiya	0.0%	0.0%	100.0%	0.0%	100.0%
Mawathawewa	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a
Cascade total	32.7%	52.3%	15.1%	0.0%	100.0%

Source: Farm Household Survey, JICA Project Team 2017

2.5.4 Livestock Production

Livestock production is summarised in the table below. Total average milk production in the cascade is 269 L per day. The average milk productivity in the cascade is 3.9 L/day/cow, which is much higher than the average of 1.72 L in Anuradhapura District ('Livestock Statistical Bulletin 2014', Department of Animal Production and Health). Ihala Kainathama farmers have the highest average milk production of 5.5 L/day/cow, followed by 4.9 L/day/cow in Weliwewa.

Table 2.5.5 Livestock Production

Tank	Cattle			Poultry	
	Total Daily Milk Production (liters/day)	No. of Dairy Cows	Average Milk Productivity (liters/day/cow)	Total Egg Production eggs/day	Average Egg Production (eggs/day/HH)
Agale wewa	0	0			
Ichchankulama	78	21	3.7		
Ihala Kainathama	11	2	5.5		
Karkolawewa	63	13	4.8		
Kudawewa	0	0			
Pahala Kainathama	95	23	4.1		
Palugas wewa	15	8	1.9		
Theankuttiya	7	2	3.5	2	2
Mawathawewa	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a
Cascade Total	269	69	3.9	2	

Source: Farm Household Survey, JICA Project Team 2017

Milking once a day is the most popular form. Most of the livestock farmers in all the model cascades are milking only once and is done in the morning. There are many reasons for adopting this procedure according to Ichchankulama cascade farmers as shown in the following table.

Table 2.5.6 Milking Once versus Twice

Reason	Once	Twice
Milk Production	Less milk production	25% more milk production
Difficulty	Easily fit into daily farmers chores	Create problems - requires cleaning and washing twice
Time	Sufficient time available	No extra time as more time is set aside for cropping activities
Milk collecting	Milk collecting transport from the village milk collecting point to chilling centre is available only in the morning.	No transport for milk collecting and no cool storage facilities at the village milk-collecting centre.
Inputs for milk production	Fits the current grazing management system for feed management	Increased milk production require extra feed and the cost of production of milk increases
Replacement calf nutrition	Is better and the calf grows faster	Calf is allowed limited milk consumption during the first three months can affect lifetime growth and productivity

Source: Farm Household Survey, JICA Project Team 2017

2.5.5 Livestock Management System

Cattle in the area are maintained in the crop-livestock integrated farming system. The productivity of cattle highly depends on the management of the livestock that include availability of feed by grazing, tethering, and stall-feeding. Availability of feed is largely determined by the extent of crop cultivation. Availability of water plays the main role in farmers' decision to plant or not to plant. Hence, drought condition often increases productivity of livestock as there is ample space for the cattle to graze. In addition to grass in the field, they had crop residue due to failure of crop cultivation in the drought situation.

Most of the cattle farmers have both local and crossbred cattle. This implies that they were initially rearing local cattle and are gradually in the process of increasing the crossbred levels in their farms. This transition towards fully crossbred high producing cattle requires a concerted effort of farmers. A set of dairy farmers have realized the value of livestock and are very much interested in improving their livestock management. The household survey showed the enthusiasm of the livestock farmers as 70.6% have indicated the need for training in new technology. Some farmers have already started stall-feeding, and 70% of the farmers resorted to tether cattle instead of free grazing. The table below shows the distribution of the current livestock management system by the tank in Ichchankulama cascade. All three types, free grazing, tethering and stall-feeding, are practised in this cascade to sustain the cattle population.

Table 2.5.7 Livestock Management Structure (No. of HH)

Tank	Cattle			Poultry	
	Free range	Stall fed	Tethered	Free Range	Deep Litter
Agale wewa					
Ichchankulama	4	1	4		
Ihala Kainathama			1		
Karkolawewa	2		6		
Kudawewa					
Pahala Kainathama		1	7		
Palugas wewa	1		1		
Theankuttiya			2	1	
Mawathawewa	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a
Cascade total	7	2	21	1	0

Source: Farm Household Survey, JICA Project Team 2017

The following table shows the gender in livestock management. It indicates that a sizable population of women have entered this system as they are able to tether the cattle closer to their homes.

Table 2.5.8 Gender in Livestock Management

Tanks	Cattle		Poultry	
	By Female	By Male	By Female	By Male
Agale wewa				
Ichchankulama	56%	44%		
Ihala Kainathama	50%	50%		
Karkolawewa	10%	90%		
Kudawewa				
Pahala Kainathama	13%	88%		
Palugas wewa	0%	100%		
Theankuttiya	50%	50%	100%	0%
Mawathawewa	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a
Cascade total	28%	72%	100%	0%

Source: Farm Household Survey, JICA Project Team 2017

The household survey also revealed that most farming households with livestock tend to have agriculture as their primary income source. The correlation (r) between these two factors is +0.34 and for Ichchankulama it is +0.05. Households that uses agriculture as their part-time work received 80.8% of the income of full-time agriculture farmer as shown in the following table. Hence, this means the productivity of their farms is lesser than that of the full-time farmers.

Table 2.5.9 Difference in Agricultural Income between Fulltime and Part-time Farming

Type	Average income (Rs.)	Ratio (full time=100)
Full time	249,696	100%
Part time	201,686	80.8%

Source: Farm Household Survey, JICA Project Team 2017

2.5.6 Crop Residue and Livestock Feed

In Ichchankulama cascade, those rearing livestock as shown earlier receives a substantial income. In most cases, feeding these livestock does not cost these farmers anything. Their diet is mostly made up of the livestock crop residue and cut-and-fed grass; except during the Maha season when they resort to feed with collected crop residue.

The following table indicates willingness of purchasing livestock feed. More farmers would like to purchase livestock feed, although the difference in the proportion of willing and not willing is not significant. The main reason of purchasing livestock feed heard from the famers is because it will reduce their burden thus increasing the farm income further.

Table 2.5.10 Response to Purchase of Livestock Feed

Tanks	No	Yes
Agale wewa		
Ichchankulama	4	3
Ihala Kainathama	1	1
Karkolawewa	4	3
Kudawewa		
Pahala Kainathama	3	5
Palugas wewa	1	1
Theankuttiya		2
Mawathawewa	n.a	n.a
Weliwewa	n.a	n.a
Cascade	13	15

Source: Farm Household Survey, JICA Project Team 2017

The above table shows the possibility of transforming from predominantly grazing management system to stall-feeding or tethering. High willingness of livestock feed signifies that women can handle the cattle with purchased feed, although currently, male is dominant in free grazing system.

This will allow women from the low-income rural families to enter the cash economy. In this way, livestock production provides increased stability in income for the family without disrupting other food producing activities.

In a normal season in Ichchankulama cascade, maize is cultivated in 26.5 acres of land in irrigated highlands in Maha. Feeding livestock with crop residue can profit maize cultivating farmers as well. The following table shows the estimated benefit of crop residue both for livestock farmers with maize cultivation.

Table 2.5.11 Estimated Probable Production and Income from Maize Crop Residue

Tank	Irrigated Highland Maha - Maize		Income for Maize Crop Farmers (Rs)	Stocking Density (Livestock Units)/Year	No. Milking Cows (60%)	No. Cows in Milk	Milk / day (8 L/cow)	Monthly Income from Milk (Rs)
	Area (Acres)	Crop Residue (Kg)						
Agale wewa		-	-	0.00	0.0	0.0	0.0	-
Ichchankulama	3	54,000	54,000	7.40	4.4	3.7	29.6	59,474
Ihala Kainathama	1.5	27,000	27,000	3.70	2.2	1.8	14.8	29,737
Karkolawewa	5.5	99,000	99,000	13.56	8.1	6.8	54.2	109,036
Kudawewa	1	18,000	18,000	2.47	1.5	1.2	9.9	19,825
Pahala Kainathama	6.5	117,000	117,000	16.03	9.6	8.0	64.1	128,860
Palugas wewa	3	54,000	54,000	7.40	4.4	3.7	29.6	59,474
Theankuttiya	6	108,000	108,000	14.79	8.9	7.4	59.2	118,948
Mawathawewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Weliwewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	26.5	477,000	477,000	65.34	39.2	32.7	261.4	525,353

Source: Farm Household Survey, JICA Project Team 2017

The stocking-density of this area is 65 livestock units. Furthermore, now, these farmers cultivate 26.5 acres of maize and a small quantity of crop residue or stalk is used in this area. This will allow the area to maintain around another 40 milking cows giving 320 L of milk that will bring Rs.22,000 per day. It will bring maize cultivators an additional income of Rs.18,000 per acre.

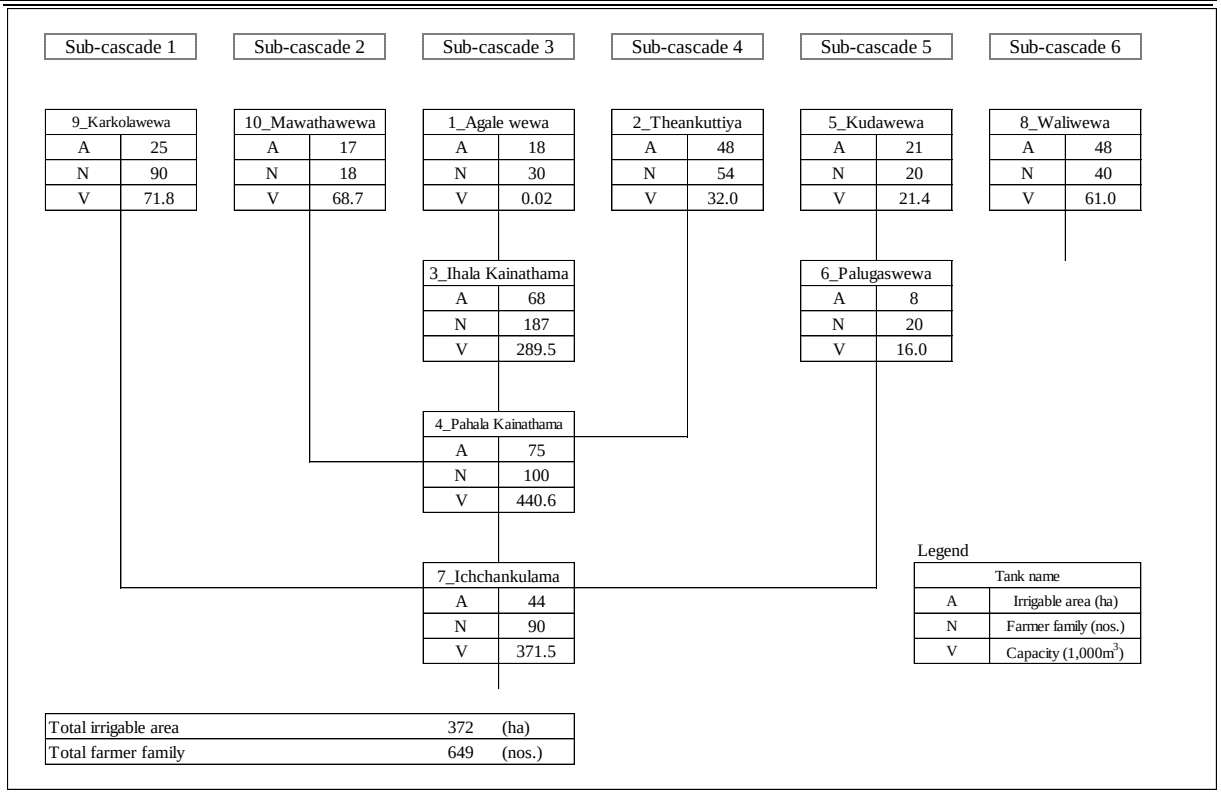
2.6 Irrigation, Drainage, and Other Rural Infrastructure

2.6.1 Irrigation, Drainage and Farm Road

(1) Diagram for Irrigation Drainage

In the Ichchankulama cascade, there are nine existing irrigation schemes, with an extent of 355 ha of cultivation area. Pahala Kainathama tank, has the largest commanding area of 75 ha.

The cascade consists of five sub-catchments, namely, sub-cascades. Each sub-cascade has several irrigation schemes. Those tanks are interlinked by natural stream. Water spilled from upstream tank during the Maha season and those returned flow from its commanding area flow into the tanks located at the downstream. Irrigation diagram of the cascade is shown in Figure 2.6.1.

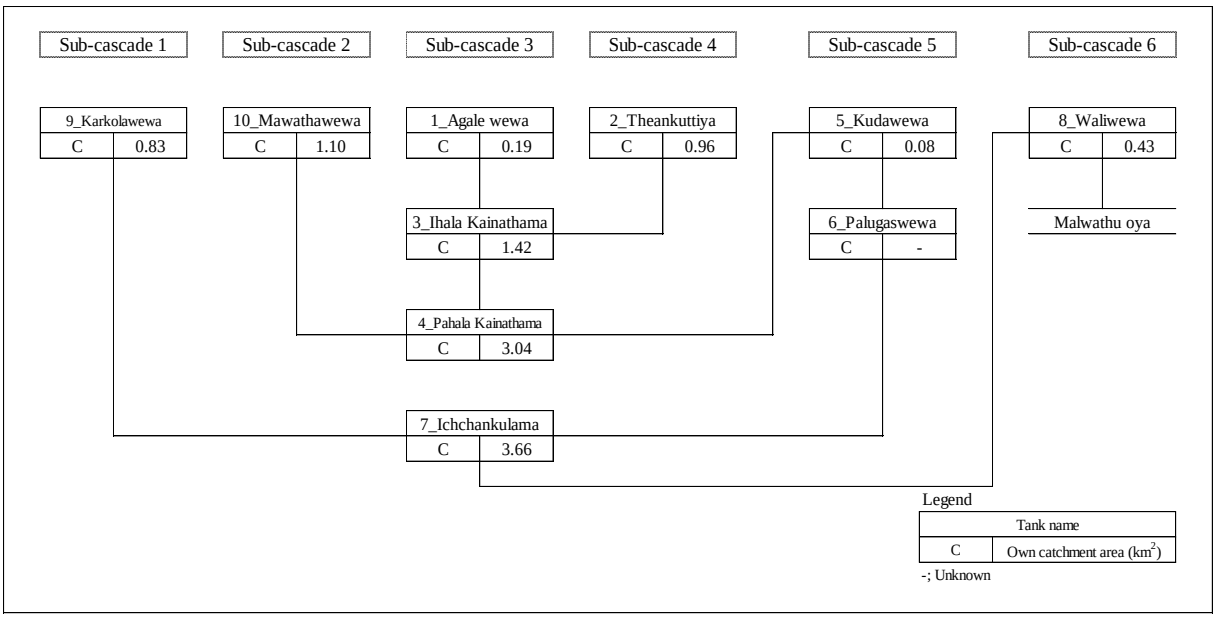


Source: JICA Project Team

Figure 2.6.1 Irrigation Drainage Diagram of Ichchankulama Cascade

(2) Diagram for Spillway Drainage

The Ichchankulama cascade is located in the Malwath Oya basin. As indicated in Figure 2.6.1, most of the drainage water in the cascade flows into Ichchankulama tank.



Source: JICA Project Team

Figure 2.6.2 Spillway Drainage Diagram of Ichchankulama Cascade

(3) Existing Irrigation Facilities

Irrigation facilities in the cascade, such as tanks, irrigation canals, and rural road are maintained by the FOs under the technical guidance of the Provincial Department of Irrigation, NCP.

A tank under Weliwewa tank has the longest tank bund with a length of 1,050 m.

A spillway is equipped to protect tank bund against flood. While the number of spillway structure is basically one in each tank, there are several tanks with two or more spillways so that the flood water can be flown safely to downstream.

Each irrigation scheme has two or three irrigation canals to deliver water to the fields.

Existing irrigation facilities in the irrigation scheme under the Ichchankulama cascade are outlined in Table 2.6.1.

Table 2.6.1 List of Facilities of Ichchankulama Cascade

Tank No.	Name of Tank	Tank bund		Spillway			Sluice			Canal			Farm road
		L (m)	H (m)	Location	Type	L (m)	Location	Type	Number	Location	Type	L (m)	L (m)
1	Agale wewa	290	0.8										
2	Theankuttiya	650	1.6	RB	Drop	13	LB	Wall	1	LB	Earth	1,188	250
							RB	Wall	1	RB	Earth	360	
3	Ihala Kainathama	1,040	2.0	RB	Drop	42	LB	Wall	1	LB	Earth	408	450
							CN	Tower	1	CN	Earth	1,691	
							RB	Tower	1	RB	Earth	800	
4	Pahala Kainathama	970	2.0	RB	Drop	30	LB	Wall	1	LB	Earth	418	2,437
							CN	Tower	1	CN	Earth	1,818	
							RB 1	Wall	1	RB 1	Earth	382	
							RB 2	Tower	1	RB 2	Earth	770	
5	Kudawewa	591	2.1	RB	Drop	5	LB	Wall	1	LB	Earth	158	
							CN	Wall	1	CN	Earth	155	
							RB	Wall	1	RB	Earth	260	
6	Palugas wewa	540	2.0	RB	Channel	16	LB	Wall	1	LB	Earth	200	
							RB	Wall	1	RB	Earth	165	
7	Ichchankulama	855	-	LB	Drop	112	LB	Wall	1	LB	Earth	234	
				RB	Drop	10	CN	Wall	1	CN	Earth	1,084	
							RB 1	Wall	1	RB 1	Earth	863	
							RB 2	Wall	1	RB 2	Earth	954	
8	Weliwewa	1,050	1.6	RB	Drop	82	LB	Wall	1	LB	Earth	700	2,500
							CN	Wall	1	CN	Earth	295	
							RB	Wall	1	RB	Earth	410	
9	Karkolawewa	850	3.0	RB	Channel	35	LB	Tower	1	LB	Earth	500	1,000
							CN1	Tower	1	CN1	Earth	185	
							CN2	Tower	1	CN2	Earth	700	
							RB	Tower	1	RB	Earth	490	
10	Mawathawewa	480	3.0	LB	Drop	8	LB	Wall	1	LB	Earth	580	
							RB	Wall	1	RB	Earth	380	
Total		7,316				353			27			16,148	6,637

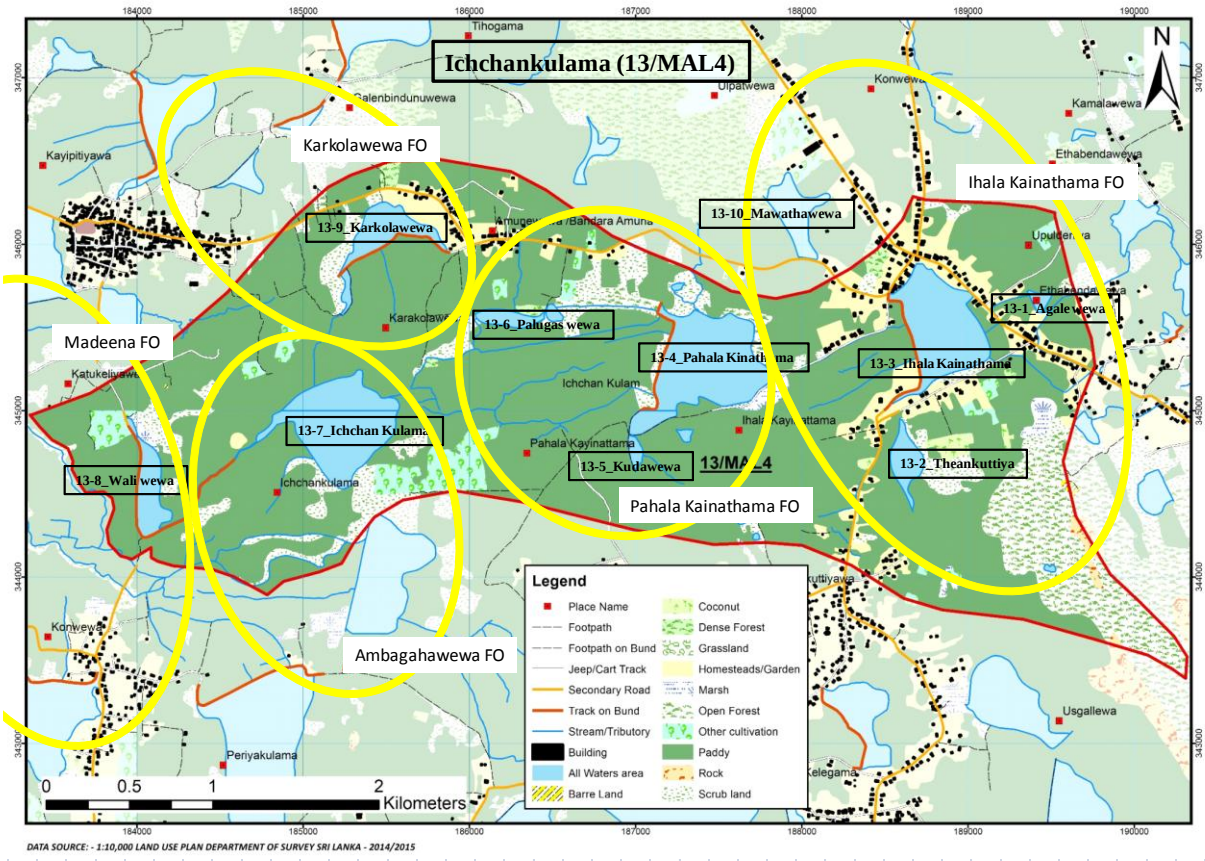
Remarks: Location; LB (Left bank), CN (Centre), RB (Right bank), W (Width), - (Unknown)
Source: JICA Project Team

2.7 Farmers' Organization and O&M Activities for the Irrigation Facilities

2.7.1 General Features of FOs under Ichchankulama Cascade

Tanks under Ichchankulama cascade are managed by five different FOs. Four FOs are registered under Galenbindunuwewa ASC and one is under the Mihinthale ASC. All the FOs manage some tanks outside the cascade, in addition to the tanks under Ichchankulama cascade. The following map shows FOs' boundaries of Ichchankulama cascade.

Out of the five FOs, Karkolawewa FO is a totally Muslim community, most of which speak Tamil language. Even though Ihala Kainathama FO and Pahala Kainathama FO are different FOs, members are almost overlapping. There are about 10% of tenant farmers in the command area of each FO except Ambagahawewa.



Source: JICA Project Team (Source of Map: 1:10,000 Land Use Plan Department of Survey Sri Lanka – 2014/2015)

Figure 2.7.1 FO Boundary in Ichchankulama Cascade

2.7.2 Organisational Functions of FOs

(1) Basic Feature of FOs

Summary of the basic feature of each FO under the cascade is shown in the following table. All the FOs under Ichchankulama cascade have relatively larger number of members. Even though Madeena FO in Mihinthale ASC manages three tanks, only one tank is in Ichchankulama cascade while others are under another cascade in Mihinthale ASC area. The FO of Muslim community has slightly different feature from those of Sinhalese community due to their cultural customs. For example, only men participate in the meeting even though a good number of women have memberships in the FO.

Table 2.7.1 Basics of the FOs under Ichchankulama Cascade

Name of FO	GN Division	ASC Division	Members			Total No. of the Tanks under the FO	Tanks under the cascade
			Male	Female	Total		
Karkolawewa	Upuldeniya	Galenbindunuwewa	47	30	77	3	Karkolawewa
Ihala Kainathama	Upuldeniya	Galenbindunuwewa	48	20	68	5	Ihala Kainathama Theankuttiya Agale wewa Mawathawewa
Pahala Kainathama	Upuldeniya	Galenbindunuwewa	53	30	83	4	Pahala Kainathama Kudawewa Palugas wewa
Ambagahawewa	Himbutugollewa	Galenbindunuwewa	43	13	56	2	Ichchankulama
Madeena	Katukeliyawa	Mihinthale	15	75	90	3	Weliwewa

Source: JICA Project Team based on the questionnaire survey

Basic functions of the FOs are precisely organised by DAD. All the FOs under Ichchankulama cascade follow the Constitution prepared by DAD as defined in the Agrarian Development Act. However, it was heard that not many members are aware of the contents of the Constitution and some have never seen it. Even though the rules of the FOs are defined in detail, they might not have been fully understood by the members.

(2) FO Meetings

Meetings of FOs are regularly organised. Especially Kanna meetings which is organised every season as strictly called by the DOs, as it has legal authorisation. Frequencies of Kanna meetings differ depending on the availability of water in their tanks. Some FOs conduct pre-Kanna meetings and post-Kanna meetings in one season, which are before onset of rain and once rain starts, respectively. Even though Ihala Kainathama FO and Pahala Kainathama FO are separately registered, they are normally conducting meetings together as most of the members are the same beneficiaries.

Apart from the Kanna meetings, FOs organise meetings to discuss special emerging issues, and to plan for development project when they receive fund. Agriculture officers also use FOs to meet for training on agricultural skills development.

Table 2.7.2 Practice of Meetings of the FOs under Ichchankulama Cascade

Name of FO	Kanna Meetings			Committee Meeting			Other Meetings
	Base	Times/ year	Partici pation	Base	Times/ year	Partici pation	
Karkolawewa	Needs	1	100 %	Every 3-6 months	2	90%	Ad-hoc meetings, agriculture meeting organized by AI
Ihala Kainathama	Needs	6	n.a	Needs	8	90%	General meeting once a year, special meeting when they receive fund
Pahala Kainathama	Needs	6	n.a	Needs	5	90%	General meeting once a year, special meeting when they receive fund
Ambagahawewa	Seasonal	2	64%	Needs	2	45%	General meeting once a year, monthly meeting according to needs, small meeting after religious occasions
Madeena	Seasonal	2	39%	Needs	5	50%	Committee meeting, General meeting Special meeting for the special occasions, General meeting in every year

Source: JICA project team based on the questionnaire survey and FO meeting

From the view point of the DO and ARPA, most of the officers in-charge of the model cascades do not have any difficulty in organising meetings with the FOs, apart from those in Kallanchiya ASC. The reasons for the difficulties in organising a meeting with the FO as mentioned in Kallanchiya are the poor participation of the FO members and the lack of involvement of the community leaders. The majority of the officers in-charge of the six model cascades evaluated that the FOs are organising meetings by themselves only on a few occasions while about 30% answered FOs always organise meetings without the help of officers. The following table indicates the result of the questionnaire interview to DO and ARPA in the target ASC regarding organisation of meetings by FOs.

Table 2.7.3 Evaluation of the FOs by the DO and ARPA on Conducting Meetings

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Those having difficulties in organising meeting with FOs		0%	0%	0%	0%	0%	67%	0%	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	50%	50%	0%	40%	50%	0%	33%	32%
	Only few occasion	50%	50%	100%	60%	50%	67%	67%	63%
	No	0%	0%	0%	0%	0%	33%	0%	5%
	Reason for no.	Leaders have no capacity							

Source: JICA Project Team based on the questionnaire survey

(3) Problem Solving Capacity of FOs

According to the group discussion with each of the FOs, major problems are conflicts during water distribution, non-compliance of the members in allocated maintenance works, and disputes during fertilizer issuing. Problems are solved mostly by the FO either in the FO meeting or by discussing with the concerned members. Even though there is a system of charging fines on those who violate rules, they have never executed the fine. Problems that are beyond their control is referred to the ARPA and the DO. Some issues between the FOs are also reported to the concerned officers.

Analysing from the interview survey to the DO and ARPA in the target cascades, frequencies of the ARPA and DO to intervene conflict resolution in Galenbindunuwewa range from once or twice a year to once in 2-3 months. Major problems that DO/ARPA are asked to attend are issues regarding water distribution, conflict among members, and problem in cultivation in Galenbindunuwewa. In addition, it was pointed out that the FOs sometimes consult officers with the problem in fertilizer issuing. Almost 80% of the DO/ARPA in the whole model cascades interfere in the problem with water distribution.

Table 2.7.4 Involvement of DO and ARPA in Conflict Resolution

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Frequency of consultation in the conflict solving of FO	Almost every week	50%	0%	0%	0%	0%	0%	0%	5%
	Almost every month	0%	100%	50%	20%	0%	33%	0%	26%
	Once in 2-3 month	50%	0%	50%	80%	50%	0%	33%	42%
	1-2 in a year	0%	0%	0%	0%	50%	67%	67%	26%
Problems FO consult the officers (multi answer)	Problem in water distribution	50%	100%	50%	60%	100%	100%	100%	79%
	Problem in maintenance works by members	50%	100%	100%	60%	0%	67%	33%	58%
	Problem in major rehabilitation	0%	50%	50%	0%	0%	0%	33%	16%
	Conflict among members	100%	0%	0%	60%	0%	0%	67%	37%
	Conflict between tanks	50%	50%	0%	0%	0%	0%	0%	11%
	Conflict with other FOs	50%	50%	0%	0%	0%	0%	0%	11%
	Problem in financial management	50%	0%	50%	20%	0%	0%	33%	21%
	Problem in cultivation	100%	50%	50%	60%	100%	67%	67%	68%
	Other	50%	0%	0%	20%	0%	33%	33%	21%

Source: JICA Project Team based on the questionnaire survey

(4) Financial Capacities of FOs

All the FOs in Ichchankulama cascade collect membership fees ranging between Rs.100 and Rs.150 per year. They also maintain a financial record together with the member registration and meeting minutes, even though the quality varies as one FO revealed that they did not have proper records during the repair of facilities. Major income of the FOs are from the membership fees, profit from contract works and from the lease of tank for inland fishery. Four out of five FOs lease their tank for inland fishery and the revenue from the leasing of tank is substantial as their income. Major expenses are minor repairing works, meeting expenses, administrative and running cost, and expenses during Sramadhana. Use of the FO saving is controlled by the DO as they need to take the official procedure set by the DAD. For an FO to withdraw their fund, the FO should first call a committee meeting to get a consent from the committee for the use of the funds, the minutes of which are submitted to the DO office for approval. If the expense is concerning engineering works, a DAD technical officer assesses its appropriateness for the proposed expense. Therefore, the possibility of a misuse in funds seems to be low.

Table 2.7.5 Financial Status of the FOs under the Ichchankulama Cascade

Name of FO	Membership Fee	Bank Balance (as of Jan 2017)	Financial Record	Major Income Source	Major Expenditure
Karkolawewa	Rs.120/year	Rs.116,000	Yes	Membership fee, profit of contract work (5%), lease of tank for fishery (Rs.24,000 in 2016)	Small repairing works, refreshments for Sramadhana.
Ihala Kainathama	Rs.120/year	Rs.147,000	Yes	Membership fee, profit of contract work (5%)	Minor construction works (e.g., repair of agricultural road, culvert, canal and sluice)
Pahala Kainathama	Rs.120/year	Rs.325,000	Yes	Membership fee, profit of contract work (5%), lease of tank for fishery (Rs.110,000 in 2016)	Minor repairing works
Ambagahawewa	Rs.100/year	Rs.67,000	Yes	Membership fee, profit of contract work (5%), lease of tank for fishery (Rs.45,000 in 2016)	Minor repairing works
Madeena	Rs.120/year	Rs.65,000	Yes	Membership fees, Contract commission of 5 % of the contract amount	Administrative expenses, meeting expenses, small scale repairing expenses

Source: JICA project team based on the questionnaire survey

According to the interview survey conducted to the DOs and ARPAs, financial records, as well as other relevant records are inspected by the DO/ARPAs. Even though most of the DO/ARPA evaluated that the records maintained by FOs were good or fair, 95% of the officers feel some improvement is still required in the financial records keeping. The following summarises the practice of records inspection and evaluation of the record kept by FO based on the interview survey to DO and ARPAs in the target cascades.

Table 2.7.6 Evaluation by DO/ARPA on Record Keeping by FOs

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Record Inspections		100%	100%	100%	100%	100%	67%	100%	95%
Type of records inspected	Meeting minutes	100%	100%	100%	100%	50%	33%	67%	79%
	Financial record	100%	100%	50%	100%	100%	67%	100%	89%
	Membership register	50%	100%	100%	80%	50%	33%	100%	74%
	Other	0%	0%	50%	0%	0%	0%	0%	5%
Quality of their record keeping	Very good	0%	0%	0%	0%	0%	0%	0%	0%
	Good	50%	100%	0%	100%	100%	67%	67%	74%
	Fair	50%	0%	100%	0%	0%	0%	33%	21%
	Poor	0%	0%	0%	0%	0%	0%	0%	0%
	Very bad	0%	0%	0%	0%	0%	0%	0%	0%
Improvement required	Meeting minutes	50%	50%	50%	40%	50%	0%	33%	37%
	Financial record	100%	50%	100%	100%	100%	100%	100%	95%
	Membership register	50%	50%	50%	0%	0%	0%	33%	21%
	Other	0%	50%	0%	0%	0%	33%	0%	11%

Source: JICA Project Team based on the questionnaire survey

2.7.3 Water Management and O&M Activities of FOs

(1) Water Management

In Ichchankulama cascade area, water spills out from the tanks in every Maha season in the normal year. Four tanks under the two FOs, Ihala Kainathama and Pahala Kainathama FO, normally have water in Yala for cultivation. The average extent of cultivation in those tank in Yala season range from 10% to 50%. A Water Master is appointed in all the FOs to control the gate operation, and they are paid in kind such as a certain amount of paddy.

Table 2.7.7 O&M of the FOs under Ichchankulama Cascade

Name of FO	Water Management				O&M	Participation in O&M Work			
	Appointed Water Master	Payment to Water Master	Payment	Bethma Practice	Contract Work Received	Canal Cleaning	Bund Clearing	Desilting	Labour Contribution
Karkolawewa	Yes	Yes	In kind	0%	No	100%	94%	0%	4%
Ihala Kainathama	Yes	Yes	In kind	6%	No	100%	84%	0%	9%
Pahala Kainathama	Yes	Yes	In kind	0%	Yes	100%	84%	0%	2%
Ambagahawewa	Yes	Yes	In kind	0%	No	100%	97%	0%	29%
Madeena	Yes	No	-	n.a	Yes	n.a	n.a	n.a	n.a

Source: JICA Project Team based on the questionnaire survey and HHS

During the Maha season, water is distributed either by simply opening the gate when the rain stops and the field get dried, or by allocating to each field in turn. Cultivation during the Yala season is decided according to the water remaining in their tanks. In most of the cases, they conduct Bethma system in which cultivation is done in the traditional paddy field where each farmer has a portion of land. However, some revealed that actually only a limited people have land under the traditional paddy field as the land is succeeded in the families, and other people cannot cultivate in the area. Karkolawewa FO explained that they have stopped sharing the land because of a bad experience, in which the whole area was damaged as some people did not take care of the allocated land properly. Currently, fields nearby the tanks are cultivated by limited owners during water scarce period. Even the HHS result indicated that not many people cultivate in the shared land, as only a few in Ihala Kainathama answered that they practice Bethma and nil in other tanks. This situation is outstandingly different from the other model cascades as shown in the table below. Ichchankulama and Siyambalagaswewa farmers hardly operate Bethma while more than 90% in Kiulekada, Alagalla and Naveli kulam cultivate through Bethma during water scarce period. Through a further interview with the concerned officers, the main reasons for not conducting Bethma are the refusal of the owners in the upper field and the power relation among farmers.

Table 2.7.8 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

(2) Maintenance of Irrigation Facilities

Ordinal maintenance works are done by the FOs by allocating works to the members based on their landholdings. According to the results of the HHS, canal cleaning and bund clearing were attended well, while labour contribution for repairing works was comparatively low in this cascade. One FO explained that they check the canals and does not release water unless it is clean. Minor rehabilitation works and urgent repairs are managed by the FO with their fund and labour contribution. Basically, earthworks are attended by the members through the *Sramadhana* works (communal work), although no major desilting works have been done. One FO mentioned that even though they are given a small fund for the rehabilitation, they still managed because of their labour contribution and they just save the fund for further maintenance works. Major repair works are reported to the DO and is done using the government fund. Two FOs experienced flood damages. Damages on earthworks were attended by the FO with their labour contribution.

Four FOs replied that people cultivate in the reservation area of the tank. It was mentioned in Ichchankulama cascade that cultivation in the reservation area sometimes causes conflict between the upper tank and the lower tank. Cultivators of the reservation area, who reside in the upper tank command area, try to release water from the lower tank so that more land can be cultivated once water level decreases, while people residing in the lower tank try to raise their spillway so that the tank can hold more water.

Practice of O&M activities by the FOs was assessed through an interview with the DO and ARPA. Officers evaluated that general maintenance works such as canal cleaning and bund clearing are conducted by the FOs to some extent. While about 20% assessed that the FOs always carry out those maintenance works, almost 80% felt that they attain only in a few occasions. However, most of the officers answered that quality levels of canal cleaning and bund clearing as well as minor repair works are satisfactory. The following table summarises the evaluation done by the concerned officers on O&M activities by the FOs.

Table 2.7.9 Evaluation by the DO/ARPA on the O&M Activities by the FOs

ASC			Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
General maintenance works conducted by FOs	Canal cleaning	Always	0%	50%	0%	20%	50%	0%	33%	21%
		Only a few occasions	100%	50%	100%	80%	50%	100%	67%	79%
		No	0%	0%	0%	0%	0%	0%	0%	0%
	Bund cleaning	Always	0%	50%	0%	20%	50%	0%	33%	21%
		Only a few occasions	100%	50%	100%	80%	50%	100%	67%	79%
		No	0%	0%	0%	0%	0%	0%	0%	0%
	Minor repair of facilities	Always	0%	0%	0%	20%	50%	0%	33%	16%
		Only a few occasions	100%	100%	100%	80%	50%	100%	67%	84%
		No	0%	0%	0%	0%	0%	0%	0%	0%
Evaluation of quality of maintenance by FOs	Canal cleaning and bund cleaning	Very good	0%	0%	0%	0%	0%	0%	0%	0%
		Satisfactory	50%	100%	100%	100%	100%	100%	100%	95%
		Not satisfactory	50%	0%	0%	0%	0%	0%	0%	5%
		Poor	0%	0%	0%	0%	0%	0%	0%	0%
	Reason for not satisfactory	Lack of coordination among members Farmers do not recognize importance Because there is no penalty for disobedience								
	Minor repair of irrigation facilities	Very good	0%	0%	0%	0%	50%	0%	0%	5%
		Satisfactory	50%	100%	100%	100%	50%	100%	100%	89%
		Not satisfactory	50%	0%	0%	0%	0%	0%	0%	5%
		Poor	0%	0%	0%	0%	0%	0%	0%	0%
	Reasons why not satisfactory	Farmers lack skills and capacity to do Lack of fund in FO savings Farmers do not recognize the importance Farmers depend on government support								

Source: JICA Project Team based on the questionnaire survey

Other activities of the FOs other than the irrigation management are Sramadhana, which is the maintenance of farm roads and culverts, religious activities, and certification of members to sell paddy to the marketing board. One FO has a warehouse and a separate committee is elected for the warehouse management. Individual farmers store their paddy in the warehouse and receive receipt voucher, with which they can get a loan from the banks. The management committee also calls buyers of the paddy for the farmers to sell through negotiation.

Chapter 3 Needs for Development in Ichchankulama Cascade

3.1 Agriculture Production and Marketing

3.1.1 Agriculture Production

The project envisages improvement of the livelihood of cascade communities in the target area by promoting agricultural activities. The overall development direction falls within the purview of the National Food Production Program: 2016-2017, which 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. The following part discusses identified needs in agriculture production and marketing development in Ichchankulama cascade area.

(1) Paddy

Sri Lanka has reached self-sufficiency level in the production of rice with its existing land area and productivity levels under normal rainfall distribution. However, unpredictable weather patterns, attributed to climate change associated with global warming, have resulted into wide fluctuations in the national production level of paddy during the recent years causing severe shortages and slight excesses in the supply. Thus, there is an urgent need to stabilise and increase the production level to meet the present national requirements as well as the future "natural increase" in the demand. Being the major crop in the project area, paddy has traditionally played a pivotal role shaping the socioeconomic backdrop of the farming communities living in the villages.

In Ichchankulama cascade, all irrigable areas under the tanks are cultivated with paddy in the Maha season while hardly any cultivation is reported in the Yala season due to shortage of water. Almost all the households wish to cultivate only paddy during the Maha season, but are willing to diversify the irrigable lands fully or partially during the Yala season. Under the circumstances, it appears that paddy would continue to be the dominant crop in the cascade area even with the anticipated qualitative changes in the cropping pattern after delivery of water through the NCPC. The needs for enhancing the farm income generated from paddy cultivation is reviewed under three perspectives.

(a) Paddy Productivity

Average paddy yield in the cascade command area in the Maha season is 3.9 MT/ha. The yield level is much lower than that reported for the major irrigation schemes, e.g., Mahaweli System H at 6.26 MT/ha (Department of Census and Statistics 2014–2015 Maha). While almost all the farmers are content with Maha water supply, inadequacy in the supply of irrigation water for Yala cultivation is cited by nearly 100% of the farmers. An assured supply of water after the project completion would encourage the farmers to adopt recommended production technologies with confidence leading to higher productivity levels. The following recommendations are made by the Department of Agriculture (DoA) to bridge the present yield gap:

i) Select appropriate cultivar.
ii) Use quality seeds.
iii) Undertake collective and timely cultivation.
iv) Improve and sustain soil fertility.
v) Practice effective crop management including weed, pest, disease, and nutrient management.
vi) Add value to the produce.

(b) New Improved Paddy Varieties

The Rice Research and Development Institute (RR&DI) of the Department of Agriculture releases new improved paddy varieties having yield potential and possessing special quality attributes on a regular basis. Two such varieties were identified during the study period, namely, At 311 (yield potential 7.7 MT/ha, low glycaemic index and known as Niroga Red) and At 373 (yield potential 6.7 MT/ha, distinctive aroma and known as Suwanda Samba).

The location of the specific paddy varieties with high yield potential and special attributes that fetch high market prices need to be first identified, introduced, and actively promoted among farmers in the project area for enhancing their farm incomes.

(c) Traditional Paddy Varieties

Traditional paddy essentially targets a niche market that appears to be undersupplied. It is stated that a monthly market deficit of about 1,000 MT of traditional rice exist in Colombo and the suburbs alone. (Market Survey of the JICA Project Team 2017). This indicates an immediate need to bridge the current gap of 75% in the supply level for Colombo markets and to cater to the expected natural growth in demand. In fact, few of the farmers have already established themselves as producers of traditional paddy with own marketing linkages. The recommended varieties are Suwandel, Kuruluthuda, Pachchaperumal, KaluHeeneti, and Madthuwaluas which are in demand among the consumers and fetch higher market prices. Although the potential yield of traditional paddy is low, which is less than 4 MT/ha, compared with that of new improved varieties, which are greater than 6 MT/ha, it is amply compensated by the lower input use and higher produce prices.

However, it is necessary to provide farmers with high quality seed paddy, particularly of high varietal purity status, as the material used by the farmers at present is highly mixed. This would enable the farmers to establish some degree of regional specialisation for selected traditional paddy varieties.

(2) Crop Diversification

The concept of crop diversification in the irrigable fields, as applied to minor irrigation systems, is to overcome the problems of water shortage and low farm profitability of paddy cultivation. It implies a shift from regional dominance of one crop to a regional production of number of crops to meet the increasing demand for OFCs, vegetables, and other crops. Through the process, one anticipates that the water use efficiency, cropping intensity as well as farm income is increased. The main factors relating to the establishment of a sustainable basis for crop diversification are highly interrelated as discussed below.

(a) Willingness of Farmers

Nearly 75% of the farmers expressed their readiness to diversify their irrigated farm holding during the Yala season fully or partially. The main reasons attributed by the farmers as to why they favoured crop diversification are: i) high farm income, ii) high water use efficiency, iii) previous experience, iv) suitability of land, and (v) existence of ready market in that order.

(b) Irrigation Management

Majority of the farmers in the survey area were not contented with the quantity of water they received for cultivation of paddy, particularly in the Yala season. There is hardly any cultivation in the command areas in the Yala season. After diversion of water from NCPC, it is presumed that the problems relating to water shortage faced by the paddy farmers would be adequately resolved. However, this does not imply that an unlimited quantity would be available for cultivation of the entire irrigable area with paddy in both seasons. For successful cultivation of other crops, strict control and regulation for management of the water delivery system is essential and the farmers need to adopt stringent practices and extend their cooperation as a group to optimise water use and thereby increase the cropping intensities. The cohesiveness observed among farmers in some cascades to share water by adopting Bethma System is not evident in Ichchankulama cascade. Cooperation among farmers needs strengthening.

(c) Soils

It was generally presumed that the irrigable land under cascade systems comprised mainly of poorly drained LHGs associated with tracts of imperfectly-drained and well-drained RBEs. Poorly drained soils were not suitable for growing most of the OFCs and vegetables unless appropriate provisions are made to improve soil drainage conditions, particularly in the Maha season. This view was shared by 90% of the farmers in the cascade. In the Yala season, the entire irrigable land area in Ichchankulama cascade is left fallow due to shortage of water and these lands could be used for establishment of crops other than paddy and thereby increasing the cropping intensity and farm income. However, it is

prudent to appraise the drainage and other characteristics of the soil in order to establish its suitability before planning for crop diversification in these fields.

(d) Crops

The potential seasonal crops for a diversification program include OFCs and vegetables. These crops can be grouped as low-risk and high-risk crops. In general, coarse grains (maize, kurakkan, and sorghum), grain legumes (green gram, black gram, and cowpea), and most traditional vegetables are considered low-risk crops while condiments (chilli, onion) and exotic vegetables as high-risk crops.

The selection of specific crops as an alternative to paddy depends on a number of factors such as its profitability, adoptability to the agro-ecological conditions, production costs, availability of inputs, technical competency, market conditions, among others. In Ichchankulama cascade, pulses (grain legumes) and maize (coarse grain) were the main crops and crop groups identified by the households for diversifying paddy lands. It is apparent that the farmers' preference for the crops was influenced by the familiarity with their cultivation, low perishability of the produce, and market stability. Cultivation of these crops having less water requirement would increase the cropping intensity and thereby increase the farm income. However, the net income realised from cultivation of these crops is in the same range as that of the paddy and the effect on the farm income would be marginal.

On the other hand, net returns from cultivation of condiments and exotic vegetables are several times higher than the other possible crops. Taking other determining factors into consideration, promotion of high value crops needs careful consideration as means of increasing the farm income significantly. Labour requirement, total cost of production, and net return for selected crops, which were modified from Crop Enterprise Budgets (Department of Agriculture 2015), are presented for comparative purposes.

Table 3.1.1 Comparison of Labor Use, Total Cost, and Net Return of Selected Crops

Crop	Labour Man (days)	Total Cost(Rs./ha)	Net Return (Rs./ha)	Crop	Labour Man (days)	Total Cost(Rs./ha)	Net Return (Rs./ha)
Paddy	52.5	116,762.5	101,737.5	Bitter Gourd	317.5	604,820.0	775,180.0
Maize	92.5	151,467.5	141,032.5	Big Onion	447.5	678,092.5	1,121,907.5
Green Gram	130	171,195.0	68,805.0	Chilli	275	367,487.5	507,512.5
Black Gram	86.25	105,260.0	114,740.0	Cabbage	342.5	524,845.0	675,155.0
Cowpea	115	158,677.5	75,622.5	Capsicum	410	489,192.5	1,295,807.5
Soya Bean	130	178,000.0	122,000.0	Tomato	357.5	475,587.5	784,412.5
Okra	215	301,395.0	86,105.0	Pole Bean	300	389,530.0	735,470.0
Beet Root	305	531,970.00	143,030.00	Carrot	310	489,950.0	1,084,848.0

Source: Crop Enterprise Budgets (DoA 2015) - Modified

(e) Labour

One obstacle for diversifying into other crops would be the shortage of farm labour. In Ichchankulama cascade, 66% of the paddy farmers are facing scarcity of hired labour while 28% complained about the combined labour scarcity and high rates charged by them in the present context. The situation could be worse under an extensive diversification drive, particularly with high value crops such as condiments and vegetables in general, which require high labour input for their cultivation as shown in Table 3.1.1.

Option such as farm mechanisation and staggered cultivation approaches needs concerted assessment for promotion.

(f) Capital Requirements

Working capital requirements for cultivation of high value crops are high and may involve capital investment as well. Over 64% of households in Ichchankulama cascade show their monthly income exceeding Rs.31,000 and about 60% used their own financial resources for agricultural investments. Dependence on commercial banks is low at 7%. Households need to be encouraged to seek agricultural credit from formal lending institutions such as commercial banks to meet the additional cash flow

requirements when undertaking cultivation of high investment crops. Government intervention to simplify the farmer obligations and thereby enhance accessibility to agricultural credit from formal lending agencies needs careful consideration.

(g) Extension and Training

Crop diversification is looked as a process that evolves a sustainable system through stages over a period of time. As with any innovation, it passes through the adoption stages of awareness, persuasion, decision, and implementation before the field adoption can take place on a sustainable basis. In this situation, the extensionists are required to play a key role to introduce, promote, and thereby accelerate the adoption process. AIs and ARPAs are recognised by 96% of the farmers in Ichchankulama cascade as the grass-root level providers of extension services and 56% expressed keenness to learn more on crop production and protection.

It was apparent at the training program on cultivation of high value traditional and new paddy varieties, organised by the project and conducted by the Rice Research and Development Institute, Bathalagoda, that the subject matter presented and discussed was a new learning experience to most of the participants. Further, farmers' interest on cultivating selected exotic vegetables was boosted through field demonstration and training on high value vegetables conducted at the CIC Seed Farm, Pelwehera. Trainees who participated in these sessions expressed their desire to apply some of the practices and techniques learned during the next cropping season. The program was, however, symbolic as only few farmers from each cascade could attend the session. Organising and conducting demonstration and training sessions of this nature covering wider representations of interested farmers are necessary to accelerate the adoption process.

In addition to the establishment of demonstration plots and training sessions, the extensionists need to ascertain availability of production inputs such as seed and planting materials, fertilisers, agro-chemicals, etc., in adequate quantities at the right time in order to realise the objectives of crop diversification and ensure its sustainability.

In order to improve the competency of the extensionists to take up the challenge confidently, their knowledge and skills as well as their attitude need constant upgrading through refresher training and exposure to current and new production technologies.

3.1.2 Marketing

(1) Towards Profitable Agriculture

The project proposes qualitative changes to the current agricultural system in the target cascades to enable profitable agriculture. Profitable agriculture requires appropriate marketing strategy wherein production, processing, and distribution are strategically designed to meet market needs in order to reap the full benefits of the market economy. Assuming that NCPCP significantly increase the quantity and quality of crop production in target cascades through improvements in irrigation infrastructure and water supply, this section will highlight areas that will enable the cascades to achieve profitable agriculture in a financially and environmentally sustainable manner.

(2) Introduction of New and Traditional Paddy Varieties

According to the marketing study conducted by the Project from December to March 2017, there is a high-demand niche market for new and traditional rice varieties in urban areas, including Colombo. The study indicated that traditional paddy varieties such as Suwandel, Pachchaperumal, and Madathawalu are purchased at one and a half to two times higher than the price of ordinal varieties. The study also reveals that 88% of targeted retailers in this niche market prefer to purchase the traditional variety of rice directly from farmers. Currently, majority of farmers plant only the ordinal variety, which was purchased solely by the government. Introducing new and traditional paddy to target cascade are a low-risk strategy that will increase market access and opportunities for direct selling (from farmer directly to buyer, reducing the transaction cost by shortening the supply chain).

However, it is important to consider that most farmers sell only paddy via collectors. Noting that buyers from this niche market, particularly from Colombo, purchase mostly rice (and not paddy), post-harvest support is central to facilitate market access. Given that the process of milling paddy and transporting

rice significantly affects rice quality, together with the introduction of the new and traditional paddy varieties, post-harvest support is crucial in creating linkage to new markets.

In the case of Ichchankulama cascade, crop production is only active in the Maha season since most of farm lands are dependent on rainfall and tank water. Paddy and maize are the two dominant cash crops in the Maha season, however, both crops are hardly cultivated during the Yala season.

Currently, farmers in the cascade cultivate modern varieties including Bg 300, Bg 310, and Bg 359. Introducing new and traditional paddy varieties is a potential option for profitable agriculture since farmers in the said cascade are already accustomed to the planting methods of paddy. In order to ensure profitability in the traditional paddy varieties, the key is to create linkages with buyers from Colombo.

In the cascade, where collectors are the major buyers followed by the PMB, farmers are not familiar with rice transactions. As such, they require a step-by-step training and support on how to establish and strengthen linkages with new buyers and how to produce quality traditional paddy or rice that buyers require. Establishing an alliance with millers and logistics providers is essential in ensuring the success of this marketing approach.

(3) Expansion of OFCs with Contract Farming

OFCs such as coarse grains (maize and sorghum) and grain legumes (green gram, black gram, and cowpea), are another potential source of profitable agriculture in the cascade. A notable number of farmers have indicated their keen interest in starting grain legumes and maize in the Yala season, mainly due to familiarity and experience in planting the crops in the Maha season.

In Ichchankulama cascade, where maize is the second major cash crops to paddy, farmers are willing to expand their crop portfolio provided that the NTPCP supply sufficient water during Yala season.

To ensure profits from OFCs, farmers can engage in contract farming. Currently, 154 farmers earn cash through maize in the Maha season, but the practice of contract farming is not identified. However, a number of farmers in Anuradhapura district have successfully secured their markets through contract farming. These farmers enjoy a sense of security as they practice contract farming to secure their minimum selling price for their OFCs, particularly soya, maize, onion, to name a few. Most agri-business enterprises also offer support packages with contractors. Typically, those companies provide training and farming inputs such as seeds, agrochemicals, and bags with a forward minimum price to purchase. Based on the marketing study conducted by this Project, contract farming is a feasible market strategy not only because there are already successful farmers but also because it reduces risks for farmers, as the price was determined by the contracting parties before the cropping season, and huge fall in market price will not affect the farmers' profits.

The marketing study notes, however, that there are cases of contract violations that typically stems from low quality of crops and when there is a higher bidder for the crops. A classic example is when contracting company refuses to purchase the product because it does not meet the required quality. Farmers, however, contend that their products are of quality and demand that the contract must be honoured. In other cases, the farmers violate contracts by selling to other buyers who offer a higher price than what was previously contracted. Given these typical cases, the agreement process should be thoroughly understood by both parties and carefully monitored in order to avoid contract violations. Knowledge on market price and trends, for example, will help farmers in contract negotiations as well as appreciating the importance of trust in strengthening and maintaining market linkages.

(4) Introduction of High-value Vegetables/Fruits

Vegetable and fruits are another potential source of profit for farmers. Vegetable farming offers good profitability for farmers as cash flow is faster, which the farmers can earn within three to four months. Moreover, if the crops are strategically and timely managed to meet market preference, profits are easily attainable. Unfortunately, very few farmers in the cascade show interest in these crops, arguably due to lack of knowledge and experience in vegetable farming.

In the case of fruits, a notable number of farmers earn through mango, mainly selling to traders. A few farmers sell it collectively at higher price. It is assumed that fruit farmers are able to secure their profit if more strategic marketing is practiced.

The project's marketing team interviewed a total of 171 middle and high class hotels in the Anuradhapura and Sigiriya areas and identified high valued crops that hotels and restaurants in the area are willing to purchase at premium prices. These include cantaloupe melon (69.53%), bell pepper (51.58%), and baby corn (41.43%). Most hotels currently purchase vegetables and fruits at open markets and wholesale markets but more than 65% of those hotels prefer to purchase directly from farmers to lessen damage in crops due to improper handling and ensure freshness.

Considering that the Anuradhapura and Sigiriya areas, surrounded by ancient heritages, which was visited by over 50 million foreign tourists in 2015 alone (Sri Lanka Tourism Development Authority; "Annual Statistical Report 2015"), it captures a huge market that farmers can directly access, provided they meet the market preference.

In order to optimise market benefits, support in farming, post-harvest, and marketing will significantly enable farmers to access this market. Formulating cooperation schemes with hotels shows promise as hotels are open to establish partnerships with farmers.

3.2 Livestock

Needs on livestock sector development in Ichchankulama can be summarised and categorised as follows:

i) Enhancement of livestock production system in the area,
ii) Improvement of productivity of livestock,
iii) Overcoming constraints in livestock farm management,
iv) Needs on institutional frameworks and supporting system, and
v) Potential on poultry sector development.

The following sections discuss these needs identified in Ichchankulama for further development.

3.2.1 Issues in Livestock Production System in Ichchankulama Cascade

Ichchankulama cascade has a very high number of farmers rearing cattle. However, the average monthly income from livestock in the cascade is Rs.20,332, which is lower than the average. The income margin in milk production fluctuates between 500% and 800%. Table3.2.1 shows the contribution of livestock activities in Ichchankulama cascade compared with other cascades.

Table 3.2.1 Monthly Average Income of Crop and Livestock Farm

Tanks	Average Monthly Income (Rs.)			Proportion of Livestock Farmers	Operational Economical Land Holdings (Acres)
	Crop Only	Livestock Only	TotalAverage Income		
Alagalla	9,575	5,000	40,229	8.1%	2.17
Ichchankulama	18,408	20,332	33,699	17.2%	4.07
Kiulekada	9,162	18,100	28,667	7.5%	2.74
Navelikulam	15,410	13,438	41,872	31.6%	3.46
Rathmalawewa	9,747	32,500	31,190	1.5%	4.32
Siyambalagaswewa	13,705	11,075	23,581	6.0%	2.50
Project Total	12,514	15,337	32,527	10.8%	3.33

Source: Farm Household Survey (JICA Project Team 2017)

Increasing the number of farmers with livestock sub-sector will benefit the crop production sector. There is a group of farmers solely depending on their crop production income. These farmers can enhance their farm income and benefit a lot by including livestock sub-sector. More facilitation activities at the farmer level and transfer of technology through farmer owned model units would be useful.

The operational economical land holdings area is the highest in Ichchankulama cascade. Expansion of maize cultivation in the area is an option that can bring benefit for the cascade community. The maize farmers can sell both the cobs and corn stalk. An additional income of Rs.18,000 per acre can be expected from maize cultivation. Corn stalks can be converted into a nutritious cattle feed that can allow transformation of the management system of free-grazing to stall-feeding for the sustenance of the economically powerful milk production sector in the cascade system after the arrival of NCPC water.

3.2.2 Needs in Increasing Livestock Productivity

Farmers' priority is to increase milk income to generate extra revenue to the farm economy. Whereas, the priority at the national level is import substitution. However, if farmers' priority is addressed beforehand, the national priority will automatically be achieved. Therefore, it has sense to address farmers' priority of farming as rural livelihood is now under threat.

Milk productivity in Ichchankulama is the highest among the model cascades as shown in Table 3.2.2, which is much higher than the average of the North Central Province as described in Chapter 2.

Table 3.2.2 Average Milk Production

Tank	Average Daily Milk Production (litre/day)	No. of Dairy (cows)	Milk Productivity (litre/day/cow)
Alagalla	12	8	1.5
Ichchankulama	269	69	3.9
Kiulekada	121	33	3.7
Naveli kulam	378	198	1.9
Rathmalawewa	17	16	1.1
Siyambalagaswewa	48	23	2.1
Total	845	347	2.4

Source: Farm Household Survey (JICA Project Team 2017)

However, potential productivities are still high, as average productivities of other areas such as Central Province and highland area achieved 6-10 litres/day/cow (Department of Animal Production and Health, 2008). As discussed in the previous chapter, milk productivity still has room for improvement. The social, genetic, and nutritional aspects of causes of low productivity observed in the household survey of Kiulekada cascade are described below.

(1) Social Aspects Regarding Milk Productivity

It is generally observed that farmers are indifferent to livestock keeping. The Sinhala peasants are not attracted to cattle rearing unless they descend from traditional cattle headers over the generation. Tamil peasants keep local breeds of cattle for milk, mainly for home consumption, while Muslims herders keep local breeds for ruminant meat. During the peak crop production periods, farmers find it difficult to attend to livestock as they are focused on cultivation activities. Furthermore, crop-livestock integration, where a part of the farmland designated for growing of cattle feed, has never been a traditional practice in the area. Income generated from engaging in farming activities remains the principle if not the only source of revenue of a large proportion of households in Ichchankulama cascade. Incidentally, farmers in the cascade have registered the highest income level derived from agriculture when compared with the other cascades. However, the general reluctance of farmers to dispose male calves when they are added to the heard has become problematic in cattle rearing. This is mostly because of religious thing, because male calves will be used as meat when they are sold even though it is better to dispose male calves to improve productivity. Additionally, there is a general disinclination of the youth to take up dairying as a profit-making enterprise due to the cumbersome manual operations.

(2) Biological (Genetic) Issues in Milk Productivity

One of the major problems in the biological aspect of low productivity observed in Ichchankulama area is poor monitoring of breeding activities. Firstly, replacement of subsequent generations is very slow due to the following reasons: i) long generation interval due to poor nutrition, ii) long calving interval, and iii) no gender selection at early conception that reduces female siblings by 50%. Secondly, milk production was highly determined by calving intervals. Milk production of cow is initiated after calving. Calving results from the completion of pregnancy after ten months. Pregnancy can be achieved only by breeding at the right time, otherwise conception is deferred by another 28 days. This results in longer calving intervals, thus, total milk production is reduced.

Artificial insemination (AI) with high quality studs will allow to generate better quality cattle with high productivity. The breeding method is mostly AI carried out by Provincial Department of Animal

Production and Health (PDAPH) staff. Even though farmers do not generally have a view that they should have high quality studs for natural mating, many of them responded well after the training program. However, even if the quality AI is provided, it is still found difficult for new comers to the dairy sector to get good quality heifers. A crossbred pregnant heifer will cost Rs.120,000. This constraint needs to be reconciled to improve genetic issue of low productivity.

Improvement of productivity and production through genetic change will require at least two-generation intervals. A one-generation interval from birth of a heifer calf to its first calving is four to four and a half years. Therefore, the improvement of breeding should be initiated as soon as possible.

(3) Biological (Nutritional) Issues in Milk Productivity

Another problem in biological aspect is nutrition of cattle. Variability of supply of quality feed is a problem for cattle farmers. A new born calf grows at a steady and determined pace to achieve the first calving at the age of 24 months. This activity is supported by the amount of milk received before being weaned to adult feed such as grass. Then the quality and quantity of grass matters if the calf is not provided with concentrated feed, vitamins, and minerals. Feeding poor quality herbage through free grazing and tethering will not result in the target calving period. This situation will increase the generation interval of these cattle from two years to four and half years. This prolonged generation interval has happened to cattle in Ichchankulama.

Farmers are not prepared to address the fact that there will be a shortage of good quality crop-residue between seasons, hence, they resort to free grazing. As feeding with crop residue or stalk, especially between seasons, can increase productivity, it should be utilised in this area. It is beneficial to increase production of maize in their highland and sometimes in paddy lands to increase the availability of silage during shortage of feed. Proper nutritional management will help them to reduce the generation interval to two years and calving intervals to 12 months.

Sunn Hemp (*Crotalaria juncea*), an annual tropical legume crop that can be used as a green manure, as covering of crops, and also as livestock feed, can be grown in fields at the end of Maha season. This will increase the stocking density of the available land in Yala season. Upgrade stock replacement through feeding regime will increase the productivity of the herd. This will control the movement of the cattle and increase market value for crop residue biomass, which is otherwise wasted. However, the usage of natural grasses requires to be improved by planned harvesting.

3.2.3 Needs in Livestock Farm Management System

(1) Crop-Livestock Farming System

An issue identified in ineffectual livestock activities is poor understanding of the impact of crop-livestock production system. The farmers having both crop and livestock in Ichchankulama cascade have proved that crop-livestock integration will bring more uniform income distribution as the livestock and crop activities separately contribute to income generation. Furthermore, it was observed that crop-livestock integration increases crop and livestock productivity, while costs of production in both are reduced. Integration of crop and livestock is risk averting as farmers ended up having more capital after the 2016 or 2017 Maha drought

Household survey data on Ichchankulama cascade clearly shows that most farmers are unaware of the economic effects of integrating livestock into their crop farms. The existing institutional framework with no collaboration between organisations is at fault for not transmitting this information to farmers, especially to the 48.2% without any income from livestock. The 2016 or 2017 Maha was a good opportunity to show the value of livestock during such situations. Some government organisations like Milco Company, which is the main purchaser of milk in this area, can support farmers for such collaboration.

Training program with familiarising excursion to other dairy farms (model farms) in the same area will have an effect on changing the mind-set of the Ichchankulama cascade farmers. Exchange of views may give a boost to the fledgling dairy sector. A model farm has to be developed prior to these visits and should be a farmer owned crop-livestock integrated farms.

(2) Livestock Farm Management

The need to improve current practices in management was identified. Upgrading of the genetics of the existing herds in the cascade for milk producing ability is necessary as mentioned above and the upgraded cattle require better management and good practices for maximum potential. Improvements of management by introducing cattle sheds are essential, which shall be included in the project planning. It is important to initiate transformation of management from the current free grazing system activity to stall-feeding prior to the availability of NCPC water, otherwise, the livestock sector will have a negative effect with full cultivation in both Yala and Maha seasons.

3.2.4 Needs in Institutional Framework and Supporting System

The expansion of extension staff to increase interactions with farmers is important for the abovementioned expected development of livestock sector, as it requires change of mindset of farmers and close technical supports. In the proposed project, PDAPH and Milco officials would be actively engaged to participate in addition to their current heavy workload and capacity. These officers will find it easier to handle these activities with extra resources such as staff, funding, vehicles, and training.

Development of the milk collecting centres for extension activities of those who provide services to the farmers (PDAPH) and milk purchasing organisations will also encourage interaction between farmers and extension staff.

3.2.5 Needs in Family Poultry Sector

Only a few households in this cascade maintain local birds for nutritional purposes, even though poultry is an area that can benefit women not only for family nutrition but also as an income source. This sector is very important for rural women to have an income source as this area has a very high unemployment rate (38%, Department of Census and Statistics). Furthermore, low nutritional levels of children can be reduced through consumption of eggs. Scavenging chicken is primarily kept for eggs, and then by-products such as spent chicken, adult males, or replacement chicks bring additional income to women. In consideration of the area situation and benefit of poultry activities, development of poultry can contribute to improvement of socioeconomic development of the cascade area.

The family poultry sector activities have to be promoted at the household level. Artificial incubation and brooding systems have to be developed. In addition, a new system has to be promoted to keep these poultry birds within confined areas as the average home garden land holding a size of 0.67 acres is too small to keep both vegetables and scavenging chicken. A system of raising maize seedlings of a week old grown on water can be introduced.

3.3 Irrigation System and Rural Road

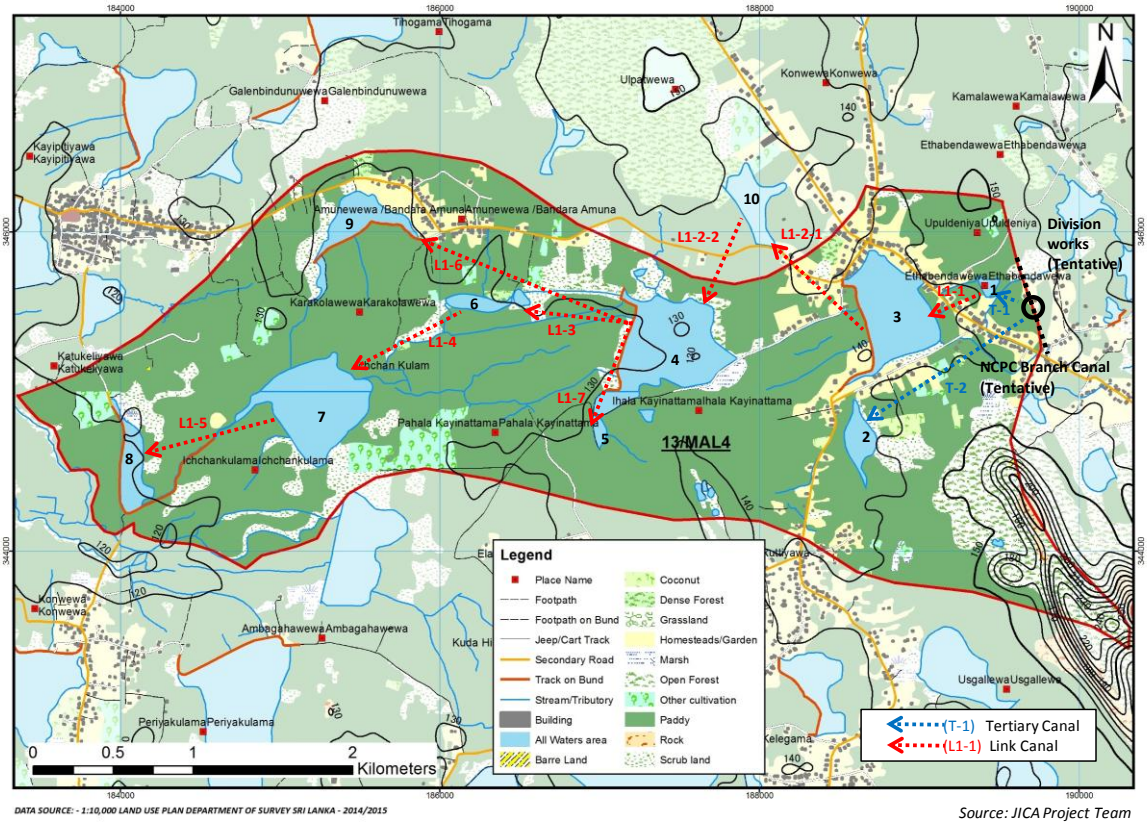
3.3.1 Water Distribution Plan

The water distribution plan was prepared for each tank in the cascade system. The maximum monthly water flow as per the feasibility study report was applied to determine water allocation for each cascade. The allocated water is to be distributed to each tank proportionally according to the command area of the particular tank through a tertiary and link canals.

Although location of off-takes on the main or branch canals is not finalised yet, it is tentatively put at the most elevated area under the cascade. Tertiary canals are proposed to be constructed to convey water from the off-take to the most upstream tanks of the sub-cascade.

Link canals will be constructed to convey water from upstream tanks to downstream tanks in the cascade system.

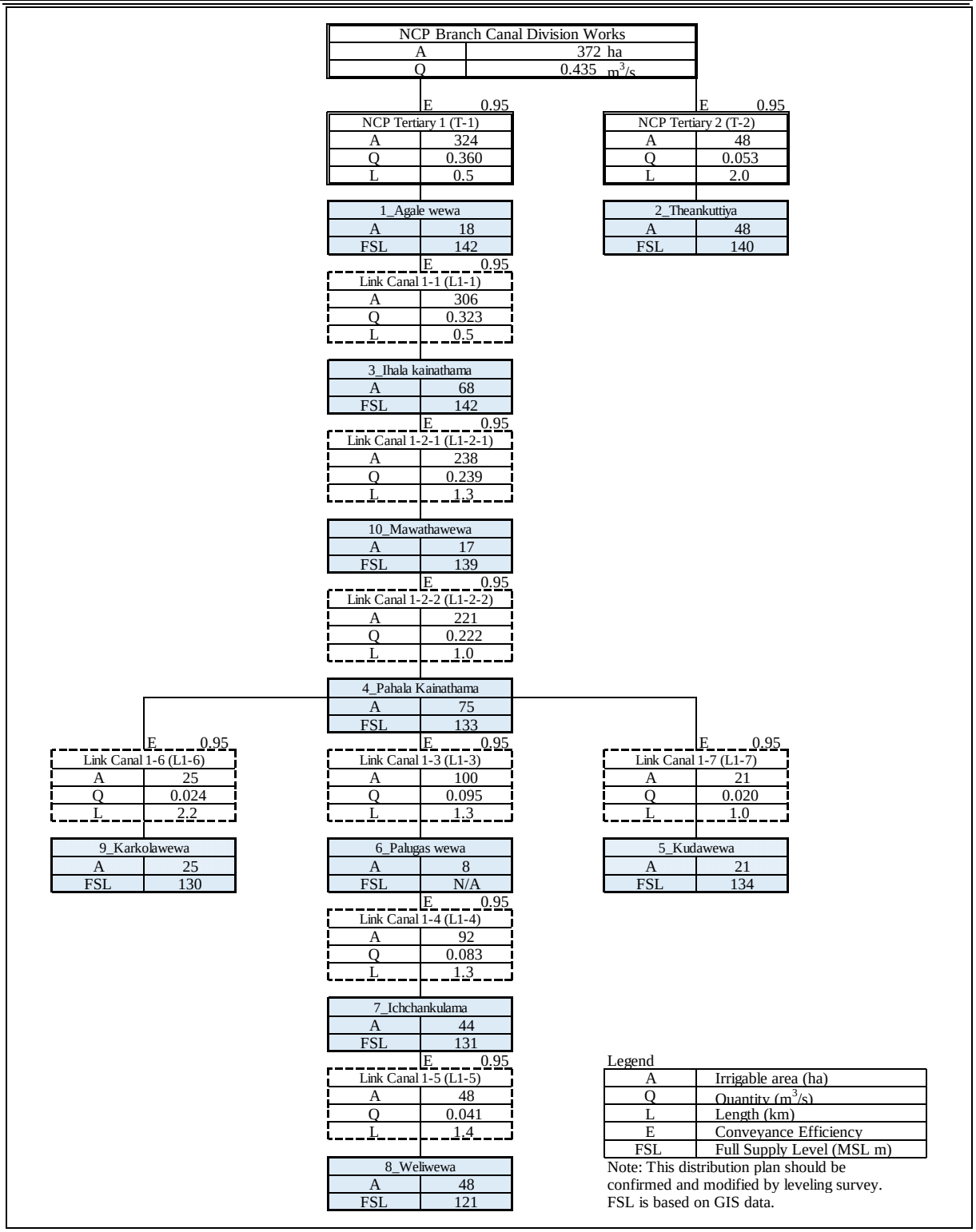
Layout of the tertiary and link canals is indicated in Figure 3.3.1 while water distribution diagram in the cascade is shown in Figure 3.3.2



Source: JICA Project Team (Map data: 1: 10,000 Land Use Plan Development of Survey Sri Lanka 2014/2015

Source: JICA Project Team (Map data: -1:10,000 Land Use Plan Department of Survey Sri Lanka - 2014/2015

Figure 3.3.1 Distribution Plan in Ichchankulama Cascade



Source: JICA Project Team

Figure 3.3.2 Distribution Diagram in Ichchankulama Cascade

In the cascade, two tertiary canals are planned to feed water to the sub-cascade so that the augmented water can reach all the tanks in the cascade. Furthermore, seven link canals are proposed to distribute the water in the Yala season, design discharge of which ranges from 0.010 m^3/sec to 0.153 m^3/sec.

3.3.2 Rehabilitation Plan

To achieve proper water distribution and consequent sustainable irrigation scheme management and market-oriented farming, the construction or the rehabilitation plan for infrastructure is prepared based

on the field investigation, which consists of rehabilitation of tanks, irrigation canals, and construction of the tertiary and link canals.

Rehabilitation work of the tanks covers tank bund forming, repair or reconstruction of sluices, improvement of spill way and provision of washing steps. Capacities of the spillways to release flood water are expanded 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 fields to the main road.

As for the tertiary canals, taking into consideration the topography in the area, pipeline system is adopted. The canals are to connect off-takes on the main or the 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.

Major construction or rehabilitation work for the nine irrigation schemes under the cascade is presented in Table 3.3.1.

Table 3.3.1 Major Rehabilitation Plan of Ichchankulama Cascade (1/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
1	Agale wewa	Headworks	Tank bund			Reshaping	290 m	H=0.8 m
			Spillway		Channel	New construction	13 m	
			Sluice	Gate	Wall	New construction	1 nos.	
				Structure		New construction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	Canal		Earth		m	
		Link canal	(L1-1)		Pipeline	New construction	0.5 km	Tentative
		Tertiary canal	(T-1)		Pipeline	New construction	0.5 m	Tentative
		Farm road			Gravel	Pavement	m	
2	Theankuttiya	Headworks	Tank bund			Reshaping	650 m	H=1.6 m
			RB spillway		Drop	Repair	27 m	
			LB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	1,190 m	
			RB canal		Earth	Reconstruction	360 m	
		Link canal				New construction	km	
		Tertiary canal	(T-2)		Pipeline	New construction	2.0 km	Tentative
		Farm road			Gravel	Pavement	250 m	
3	Ihala Kainathama	Headworks	Tank bund			Reshaping	1,040 m	H=2.0 m
			RB spillway		Drop	Reconstruction	40 m	
			LB sluice	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			CN sluice	Gate	Tower	Repair	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Tower	Repair	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	410 m	
			CN canal		Earth	Reconstruction	1,700 m	
			RB canal		Earth	Reconstruction	800 m	
		Link canal	(L1-2-1)		Pipeline	New construction	1.3 km	Tentative
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	450 m	

Source: JICA Project Team

Table 3.3.2 Major Rehabilitation Plan of Ichchankulama Cascade (2/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
4	Pahala Kainathama	Headworks	Tank bund			Reshaping	970 m	H=2.0 m
			RB spillway		Drop	Reconstruction	64 m	
			LB sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			CN sluice	Gate	Tower	Repair	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice 1	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice 2	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	420 m	
			CN canal		Earth	Reconstruction	1,820 m	
			RB canal 1		Earth	Reconstruction	390 m	
			RB canal 2		Earth	Reconstruction	770 m	
		Link canal	(L1-3)		Pipeline	New construction	1.3 km	Tentative
		Link canal	(L1-6)		Pipeline	New construction	2.2 km	Tentative
		Link canal	(L1-7)		Pipeline	New construction	1.0 km	Tentative
		Tertiary canal	(T-2)		Pipeline	New construction	km	
		Farm road			Gravel	Pavement	2,440 m	
5	Kudawewa	Headworks	Tank bund			Reshaping	600 m	H=2.1 m
			RB spillway		Drop	Reconstruction	5 m	
			LB sluice	Gate	Wall	New construction	1 nos.	
				Structure		New construction	1 nos.	
			CN sluice 1	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			CN sluice 2	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	160 m	
			CN canal 2		Earth	Reconstruction	160 m	
			RB canal		Earth	Reconstruction	260 m	
		Link canal				New construction	km	
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	m	

Source: JICA Project Team

Table 3.3.3 Major Rehabilitation Plan of Ichchankulama Cascade (3/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
6	Palugas wewa	Headworks	Tank bund			Reshaping	540 m	H=2.0 m
			RB spillway		Channel	Reconstruction	17 m	
			LB sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			RB sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	200 m	
			RB canal		Earth	Reconstruction	170 m	
		Link canal	(L1-4)		Pipeline	New construction	1.3 km	Tentative
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	m	
7	Ichchankulama	Headworks	Tank bund			Reshaping	890 m	H= - m
			LB spillway		Drop	Repair	91 m	
			RB spillway		Drop	Repair		
			LB sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			CN sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			RB sluice 1	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			RB sluice 2	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	240 m	
			CN canal		Earth	Reconstruction	1,100 m	
			RB canal 1		Earth	Reconstruction	870 m	
			RB canal 2		Earth	Reconstruction	960 m	
		Link canal	(L1-5)		Pipeline	New construction	1.4 km	Tentative
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	m	

Source: JICA Project Team

Table 3.3.4 Major Rehabilitation Plan of Ichchankulama Cascade (4/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
8	Waliwewa	Headworks	Tank bund			Reshaping	1,050 m	H=1.6 m
			RB spillway		Drop	Repair	84 m	
			LB sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			CN sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			RB sluice	Gate	Wall	No repair	1 nos.	
				Structure		No repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	700 m	
			CN canal		Earth	Reconstruction	300 m	
			RB canal		Earth	Reconstruction	410 m	
		Link canal				New construction	km	
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	2,500 m	
9	Karkolawewa	Headworks	Tank bund			Reshaping	850 m	H=3.0 m
			RB spillway		Channel	Reconstruction	34 m	
			LB sluice	Gate	Tower	No repair	1 nos.	
				Structure		No repair	1 nos.	
			CN sluice 1	Gate	Tower	No repair	1 nos.	
				Structure		No repair	1 nos.	
			CN sluice 2	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			RB sluice	Gate	Tower	No repair	1 nos.	
				Structure		No repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	500 m	
			CN canal 1		Earth	Reconstruction	190 m	
			CN canal 2		Earth	Reconstruction	700 m	
			RB canal		Earth	Reconstruction	490 m	
		Link canal				New construction	km	
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	1,000 m	
10	Mawthawewa	Headworks	Tank bund			Reshaping	480 m	H=3.0 m
			LB spillway		Drop wall	Reconstruction	60 m	
			LB sluice	Gate	Tower	Repair	1 nos.	
				Structure		No repair	1 nos.	
			RB sluice	Gate	Tower	Repair	1 nos.	
				Structure		No repair	1 nos.	
			Bathing step		Concrete	Reconstruction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	580 m	
			RB canal		Earth	Reconstruction	380 m	
		Link canal	(L1-2-2)		Pipeline	New construction	1.0 km	Tentative
		Tertiary canal			Pipeline	New construction	km	
		Farm road			Gravel	Pavement	m	

Source: JICA Project Team

3.4 Farmers Organisation and Cascade System Management

3.4.1 Need of Strengthening Farmers Organisation (FO) Functions

The Farmers Organisations (FOs) in Ichchankulama cascade are functioning to a certain extent. All FOs under Ichchankulama cascade are large enough to sustain their function financially and with selected leaders. There is no difference in the level of effectiveness in their organisational functions between FOs of the Buddhist community and FOs of Muslim community. On the other hand, large organisations may face difficulties in coordination and participation of members. However, all FOs in Ichchankulama fairly conduct meetings, which may be largely initiated by the concerned officers. Meetings, especially Kanna meetings, are periodically organised, which are in most of the cases set by DO. All FOs are conducting committee meetings and other meetings were organised whenever necessary to discuss issues such as fertiliser issuing, communal works, and development activities. Most of the problems the FOs face were solved by themselves. Intervention of officers in conflict resolution is relatively low in Ichchankulama cascade. However, once cascade management system is established, and cultivation plan is made with limited water in the Yala season, 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.

Even though the financial capacity of the FOs differs in different FOs, the amount of FOs' savings is relatively large, a fair portion of which is earned from leasing out the tanks. Some FOs actually carried out repairing works of irrigation facilities with their own savings. Once a cascade level management body is established, FOs should consider expenses for cascade management as each FO needs to contribute for maintenance of inter-tank facilities. Contribution from each FO shall be allocated by cultivation areas of each tank under the FO. Even though this may entail increase in expenses, it seems possible for each FO to bear with their current capacity. Financial records are fully checked by DO and ARPAs, as shown in the previous chapter, but there is a room for improvement in the quality of the records. Further financial capacity building shall be included in the programme to each FO, which will improve cascade level management however, this will be more complicated than that of individual FOs.

DO and ARPA in-charge of the Ichchankulama cascade expressed that the FOs need improvement in financial capacity, financial management, O&M skills, conflict solving, and flood management as shown in Table 3.4.1. Those issues shall be taken into consideration in planning the capacity development programme for individual FO.

Table 3.4.1 Evaluation of Capacity of FO by DO/ARPA in the Model Cascades

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Average number of FO the ARPA covers		2	3	34	2.75	4	2	2	5.17
In which area do you feel FOs are lacking capacity?	Financial capacity	0%	50%	50%	80%	50%	100%	100%	68%
	Financial management	0%	0%	50%	100%	0%	67%	67%	53%
	Organising meeting	50%	0%	0%	40%	0%	0%	0%	16%
	O&M skills	50%	50%	50%	20%	50%	67%	100%	53%
	Conflict solving	50%	0%	50%	0%	0%	33%	67%	26%
	Flood management	0%	50%	0%	0%	100%	33%	100%	37%
	Other	0%	0%	0%	0%	0%	33%	0%	5%

Source: JICA Project Team based on the interview survey to DO and ARPA

Water distribution within each FO is managed to some extent, although there are a few cases of conflict reported to the concerned officers. According to the officers in-charge of Ichchankulama, the major problem referred to them is water distribution related matter. Each FO has their system of water distribution during water scarce period. However, some FOs explained that their water sharing system is not functioning especially during water scarce period and only limited people cultivate with limited water. This situation may affect water distribution among tanks within the cascade. If people are used to the situation that only upper cultivation land owners can benefit, upper tank may not release water to the downstream tank among cascade during water scarce time. The rules on water distribution and

crop planning at each tank needs to be reviewed in consideration of NCPC water and water distribution within the cascade.

General maintenance works of canal and bund are done by FO members as decided in Kanna meeting. These works are fairly completed as planned fundamentally because the tasks are allocated to each farmer in the legally authorised Kanna meeting. As per indicated in Table 3.4.2, FOs in Ichchankulama cascade perform canal cleaning and bund clearing well, while desilting work is nil. Labour contribution for repairing works is the second lowest following Rathmalawewa. 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.

Table 3.4.2 Participation in O&M Works by Cascade

Tank	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)

In addition to the existing maintenance works, maintenance of inter-tank facilities will be necessary to distribute water from NCP. Maintenance works within the tank also need to be planned in consideration of water distribution from NCPC and maintenance works of cascade system. Only one FO has experience contract works for repairing of facilities, while some FOs have managed small repairing works with their own funds. Those experiences of contract works and minor rehabilitation works shall be studied to judge whether they can be applied to cascade level contract works.

3.4.2 Need for Cascade System Management

(1) Water Distribution within Cascade

Needs in cascade level water management and possibility of establishment of cascade management body were discussed with each FO and were asked in HHS to judge different opinions from different position of tanks. Table 3.4.3 shows results of HHS regarding the question on preferable water management system to distribute water equally to each tank under the cascade if the uppermost tanks of the cascade receive water from the major irrigation scheme. Multiple answers were allowed from the options indicated in the questionnaires.

Table 3.4.3 Preferable Water Distribution System in Ichchankulama per FO

FO	Government		Individual Tank		Cascade Committee		Fixed Ratio		Other		Valid Answer
	no.	%	no.	%	no.	%	no.	%	no.	%	no.
Ambagahawewa	0	0%	16	46%	5	14%	14	40%	0	0%	35
Ihala Kainathama	5	16%	14	44%	7	22%	13	41%	0	0%	32
Karkolawewa	6	8%	38	54%	13	18%	38	54%	0	0%	71
Pahala Kainathama	12	21%	34	59%	13	22%	18	31%	0	0%	58
Madeena	n/a		n/a		n/a		n/a		n/a		n/a
Total	23	12%	102	52%	38	19%	84	42%	0	0%	197

**Options: Government- Government should decide water allocation to each tank*
Individual tank – Farmers in downstream tank should discuss with the farmers in upper most tank for release of 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)

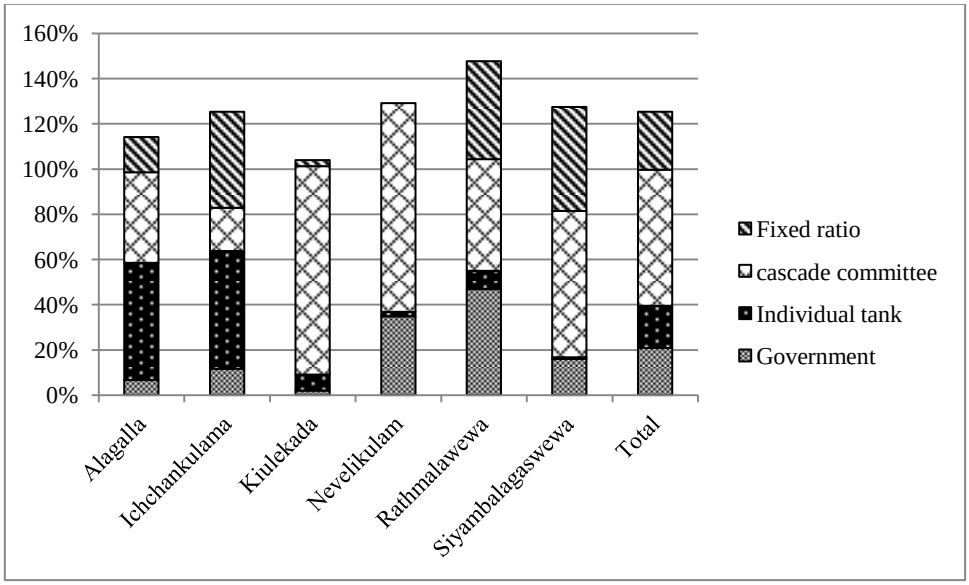
The majority of the farmers in Ichchankulama cascade chose distribution of water through negotiation between tanks. The second major answer was a fixed ratio. Unlike other cascades, only 19% of the farmers selected decision by cascade committee. Those who chose government intervention is as low as 12%. Preference in fixed rate is especially higher in Karkolawewa. Government intervention is not preferred in Ambagahawewa and Karkolawewa's FO.

Higher ratios in individual negotiation and fixed ratio and lower preference in cascade committee imply weak unity among FOs under the cascade, which may result in difficulties in cascade level management. Even in comparison with other model cascades, Ichchankulama cascade shows the lowest preference in cascade committee and highest in negotiation between individual tanks. This may have some relation with the complication of the cascade that involves two different ethnic groups and involvement of different ASC and DS divisions. Even though there is a possibility of poor understanding on the cascade committee as a reason for non selection, it should be further investigated to analyse possible constraints in cascade management. Moreover, a conflict between the upper and lower tank regarding the spillway to control water level was observed, which was mentioned in the previous chapter. Current relation between FOs regarding water use may also affect cascade level water management. These situations should be carefully taken into consideration in preparation of rules on cascade level water distribution.

Table 3.4.4 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 most tank for release of 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)



Source: Farm Household Survey (JICA Project Team 2017)

Figure 3.4.1 Comparison of Preferable Water Distribution System by Cascade

Analysing the preference of water distribution system by location of tanks within cascades, as shown in Table 3.4.5, FOs with tanks at downstream part of the cascades tend to have more farmers preferring individual negotiation and fixed ratio than those in mid and upper tanks. Preference in cascade committee's decision in lower tanks is less than others. This implies that there is a fear by the downstream FOs that decision at cascade management might be dominated by upper tank's interest. Further investigation is required to establish fair decision making in the cascade management system. Table 3.4.5 also shows the summary of the preference of water distribution options by tank location of all the model cascades.

Table 3.4.5 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 among tanks under the cascade was analysed through preference on water distribution structure. Quite a large extent of farmers in Ichchankulama prefer 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 among cascade, may imply that there is not enough trusts between tanks and farmers, feeling difficulties in managing water distribution among FOs.

Table 3.4.6 Preferable Water Distribution Structure within Cascade

FO Name	Existing System	Direct Canal from NCPC	Link Canal between Tanks	Other
Ambagahawewa	9	21	6	0
Ihala Kainathama	9	12	16	0
Karkolawewa	14	47	28	0
Pahala Kainathama	19	27	24	0
Madeena	n.a	n.a	n.a	n.a
Total	51	107	74	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)

In comparison with other cascade, Ichchankulama as well as Siyambalagaswewa shows more extreme feature. In those cascades, the majority preferred direct canals while those who agree 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 establishment of cascade level management system and special strategies to overcome the problem need to be proposed.

Table 3.4.7 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 were raised during FO meetings under Ichchankulama cascade regarding water distribution within cascade as stated below.

Water distribution system:

- Distribute equally and cultivate OFC, if water is not enough.
- Distribute equally according to land extent and upper tank FO must release water.
- Divide equally to each tank and execute the traditional Bethma under each tank with the limited water.
- If one FO has more than one tank, select one tank to be filled under each FO.
- Feed only one tank in the cascade and all the farmers cultivate under one tank.
- Having doubt that upper tank FOs release water.
- Problems may occur when they receive NCPC water.
- Only spilled water can go to the next tank.

Water distribution structure:

- Separate canals are required to send water, otherwise, they need to wait to receive water and season will pass.
- New link canals are necessary either with concrete canal or pipeline.
- Pipeline is suitable for link canal as water efficiency is good.
- Develop link canals between tanks by constructing new canals, using drainage canal or introducing pipeline.

(2) Possibility of Establishment of Cascade Management Farmers Organisation (CMFO)

Establishment of CMFO in Ichchankulama needs to be prepared with special attention as per analysis mentioned above. Preference on cascade level committee to take charge of water distribution is significantly low in Ichchankulama cascade in comparison with other cascades. Majority answered that water be delivered to individual tank directly from the NCP canal and very few farmers share water within tanks during water scarce period. These indicate some difficulties in creating unity and collaboration of cascade. Lower preference on cascade level committee and higher preference on water distribution to individual tanks imply possible conflict of different interests between FOs. Minimum practice of water sharing within tank during water scarce period may also create the same situation at cascade level, as some people suggested to fill only specific tanks during water scarce period.

Moreover, ethnic balances of two different groups and location of the cascade that covers two DS divisions may make its management more difficult. Current relationship between FOs is one of the crucial factors to establish effective management at cascade level. While FOs under Galenbindunuwewa ASC know each other, Welusumana FO under Mihinthale ASC does not have much communication with other FOs under the cascade. Even though Welusumana FO agreed to work with other FOs in the cascade, coordination seems to be difficult. Other concern is that although in general people know each other and there has been no conflict among the FOs, some opinions that imply disputes among FOs were raised. The Muslim community, for example, suspects that problem may come once the cascade receive water. Another conflict observed was disputes between the upper and lower tanks regarding raising spillways.

On the other hand, discussion during the FO meeting conducted to enhance awareness on necessity of cascade level water management implies 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. The participants proposed that CMFO can decide by introducing rules in case of disagreement between the upper and lower tanks such as refusal of releasing water.

Opinions raised during FO meetings regarding cascade level management body are as follows:

- CMFO can decide how and how much water to be distributed.
- If upper tank FO refuse to release water, CMFO can decide by introducing rules (e.g., once the tank receives a certain amount of water, they must release water).
- Nominate one government officer to manage water distribution.
- The downstream FOs proposed to involvement of government and nomination of a government officer to manage water from NCP canal.

Judging from the abovementioned situation, intensive awareness programme on necessity of cascade level organisation is inevitable to create foundation for CMFO in this area. Activities to enhance collaboration between FOs should be started prior to the establishment of CMFO.

Possibility of establishment of CMFO shall be assessed with opinion from relevant officers as well. Table 3.4.8 indicates expected difficulties stated by DOs and ARPAs in the concerned ASCs. The majority of the officers raised maintenance of inter-tank facilities as a possible problem. Almost a half stated decision making among different FOs under the cascade might be difficult. About one-third of the officers answered the management of FOs that belongs to a several cascades might be difficult and financial contribution for CMFO from each FO shall be a problem.

Table 3.4.8 Expected Issues in Formation of CMFO by DAD Officers

	Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Communication between FOs will be a problem	0%	0%	0%	20%	0%	33%	33%	16%
Distance to meet periodically	0%	0%	0%	0%	100%	33%	67%	26%
ARPA's boundary and cascade boundary is different and difficult to manage	0%	50%	0%	20%	0%	0%	0%	11%
Decision making among FOs is difficult	50%	50%	100%	20%	50%	67%	33%	47%
Will expect more conflict between FOs and tanks	50%	50%	0%	0%	50%	33%	0%	21%
Difficult to manage FOs that belong to several cascade	50%	50%	0%	20%	50%	33%	67%	37%
Financial contribution from FOs might be problem	100%	50%	0%	20%	50%	33%	33%	37%
Maintenance of inter - tank facilities might be problem as it is not clear who shall take responsibility	100%	100%	0%	0%	50%	100%	100%	58%
Other	0%	0%	0%	0%	0%	0%	0%	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 Ichchankulama cascade regarding establishment of CMFO are as follows:

- CMFO should be registered under DAD,
- CMFO members should be office bearers of all FOs,
- Grassroots level government officers should be included in CMFO,
- A suitable constitution for CMFO should be prepared, and
- CMFO should be controlled by DAD.

3.4.3 Need in Administration Structure and Legal Frameworks

Even if it is only one tank that belongs to other DS division, coordination between FOs under different ASC seems to be difficult. Basically, people from the FOs under the same ASC know each other, largely because they have periodical meetings at DO and DS office level, in which they maintain their relationship. This is a positive precondition of forming cascade level management body. On the other hand, people largely say that FOs under a different area hardly know each other. Welusumana FO proposed to have support of relevant government officers for cascade management in consideration of the situation that the cascade covers two different ASC and DS division. A particular arrangement of coordination is necessary at a higher level of authority as involvement of two different areas of authorities and officers may cause confusion. Clear procedures and communication system should be established among the concerned offices.

Judging from the operation of each FO, effective functions of FOs are highly attribute to regulation and supervision of DAD officers. As recommended by relevant officers stated above, legal frameworks for general conditions of CMFO are to be proposed with some rooms for adjustment according to the field situation to accustom complicated situation observed in Ichchankulama cascade.

Capacity building programmes of concerned officers shall also be proposed. Difficulties in managing FOs by the ASC officers in-charge in Galenbindunuwewa were only about transportation to meet FOs as shown in Table 3.4.9. As the officers in other ASC face more difficulties, some learning opportunities shall be provided among 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 3.4.9 Difficulties in Managing FO by DAD Officers

	Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Communication with FOs is difficult	50%	50%	50%	20%	0%	33%	0%	26%
They do not follow instruction	0%	0%	0%	0%	0%	33%	0%	5%
Difficult to instruct as FO leaders are senior to me	50%	0%	0%	20%	0%	0%	0%	11%
Poor understanding of farmers	0%	0%	50%	0%	0%	0%	0%	5%
Too many FOs to handle (lack of ARPA)	0%	100%	50%	20%	0%	0%	0%	21%
Transportation to meet FOs	50%	50%	100%	60%	100%	0%	67%	58%
Other	0%	0%	0%	0%	0%	0%	0%	0%

Source: JICA Project Team based on interview survey to DO and ARPA

Regarding establishment of CMFO, it seems preferable to involve relevant government authorities to monitor and solve any issues expected to happen in cascade level management. The officers and departments to be involved should be further considered through discussion with relevant government offices.

ATTACHMENT 1

PRESENT CONDITION OF ICHCHANKULAMA CASCADE

Ichchankulama Cascade **2 Thenkuttiya**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=650 m H=1.6m	1982	Heavy jungle, Erosion of slope
Right bank spillway	Drop wall	L=13 m	1982	Minor deteriorasion
Left bank sluice	Wall	N=1 nos.	1982	Gate: damage, Structure: minor deterioration
Right bank sluice	Wall	N=1 nos.	1982	Gate: damage, Structure: damage
Left bank canal	Earth	L=1,188 m	1982	Natural canal
Right bank canal	Earth	L=360 m	1982	Natural canal
Farm road		L=250 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Right bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Ichchankulama Cascade **1 Agalewewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=290 m H=0.75 m	1982	Erosion of slope
Spillway				No spillway
Sluice				No sluice
Canal				No canal
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Ichchankulama Cascade **4 Pahala kinathama**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=970 m H=2.0 m	-	Shrubs jungle, Shortage of top wodth, Erosion of slope
Right bank spillway	Drop wall	L=30 m	-	No road
Left bank sluice	Wall	N=1 nos.	-	Gate: good condition, Structure: good condition
Center sluice	Tower	N=1 nos.	-	Gate: minor deterioration, Structure: minor deterioration
Right bank sluice 1	Wall	N=1 nos.	-	Gate: minor deterioration, Structure: minor deterioration
Right bank sluice 2	Tower	N=1 nos.		Gate: damage, Structure: damage
Left bank canal	Earth	L=418 m	-	Natural canal
Center canal	Earth	L=1,818 m	-	Natural canal
Right bank canal 1	Earth	L=382 m	-	Natural canal
Right bank canal 2	Earth	L=770 m		Natural canal
Farm road		L=2,437 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph


Tank bund


Right bank spillway


Left bank sluice


Right bank sluice 1


Left bank canal


Right bank canal

Ichchankulama Cascade **3 Ihala kinathama**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=1,040 m H=2.0 m	-	Shrubs jungle, Shortage of top wodth, Erosion of slope, Water leakage
Right bank spillway	Drop wall	L=42 m	-	Leakage
Left bank sluice	Wall	N=1 nos.	-	Gate: minor deterioration, Structure: minor deterioration
Center sluice	Tower	N=1 nos.	-	Gate: minor deterioration, Structure: minor deterioration
Right bank sluice	Tower	N=1 nos.	-	Gate: minor deterioration, Structure: minor deterioration
Left bank canal	Earth	L=408 m	-	Natural canal
Center sluice	Earth	L=1,691 m	-	Natural canal
Right bank canal	Earth	L=800 m	-	Natural canal
Farm road		L=450 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph


Tank bund


Right bank spillway


Left bank sluice


Right bank sluice


Left bank canal


Right bank canal

Ichchankulama Cascade **6 Palugaswewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=540 m H=2.0 m	2009	Heavy jungle, Erosion of slope
Right bank spillway	Channel	L=16 m	2009	Damage
Left bank sluice	Wall	N=1 nos.	2009	Gate: good condition, Structure: good condition
Right bank sluice	Wall	N=1 nos.	2009	Gate: good condition, Structure: good condition
Left bank canal	Earth	L=200 m	-	Natural canal
Right bank canal	Earth	L=165 m	-	Natural canal
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Ichchankulama Cascade **5 Kudawewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=591 m H=2.1 m	2007	Light jungle, Erosion of slope, Uneven bund top
Right bank spillway	Drop wall	L=5 m	2007	Damage and shortage of capacity
Left bank sluice	-	N=1 nos.	2011	Gate: no structure, Structure: onl pipe
Center sluice 1	Wall	N=1 nos.	2011	Gate: damage, Structure: minor deterioration
Center sluice 2	Wall	N=1 nos.	2011	Gate: damage, Structure: minor deterioration
Right bank sluice	Wall	N=1 nos.	2011	Gate: damage, Structure: minor deterioration
Left bank canal	Earth	L=158 m	-	Natural canal
Center canal 2	Earth	L=155 m	-	Natural canal
Right bank canal	Earth	L=260 m	-	Natural canal
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Right bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Ichchankulama Cascade **7 Ichchankulama**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=855 m H= - m	-	Good condition
Left bank spillway	Drop wall	L=112 m	-	Good condition
Right bank spillway	Drop wall	L=10 m	-	No road
Left bank sluice	Wall	N=1 nos.	-	Gate: good condition, Structure: good condition
Center sluice	Wall	N=1 nos.	-	Gate: good condition, Structure: good condition
Right bank sluice 1	Wall	N=1 nos.	-	Gate: good condition, Structure: good condition
Right bank sluice 2	Wall	N=1 nos.	-	Gate: good condition, Structure: good condition
Left bank canal	Earth	L=234 m	-	Natural canal (part: concrete)
Center sluice	Earth	L=1,084 m	-	Natural canal (part: concrete)
Right bank canal 1	Earth	L=863 m	-	Natural canal
Right bank canal 2	Earth	L=954 m	-	Natural canal
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph


Tank bund


Left bank spillway


Center sluice


Right bank sluice


Left bank canal


Center canal

Ichchankulama Cascade **8 Waliwewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=1,050 m H=1.6m	2012	Erosion of slope, Unecven bund top
Right bank spillway	Drop wall	L=82 m	2017	Good condition
Left bank sluice	Wall	N=1 nos.	2011	Gate: good condition, Structure: good condition
Center sluice	Wall	N=1 nos.	2011	Gate: good condition, Structure: good condition
Right bank sluice	Wall	N=1 nos.	2011	Gate: good condition, Structure: good condition
Left bank canal	Earth	L=700 m	2012	Natural canal
Center canal	Earth	L=295 m	-	Natural canal
Right bank canal	Earth	L=410 m	-	Natural canal
Farm road		L=2,500 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph


Tank bund


Right bank spillway


Left bank sluice


Right bank sluice


Left bank canal


Right bank canal

Ichchankulama Cascade **10 Mawatha wewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=480 m H=3 m	2008	Light jungle, Erosion of slope, Uneven bund top, Water leakage
Left bank spillway	Drop wall	L=8 m	2008	Minor repair
Left bank sluice	Head wall	N=1 nos.	2008	Gate: Minor repair, Structure: Good condition
Right bank sluice	Head wall	N=1 nos.	2008	Gate: Minor repair, Structure: Good condition
Left bank canal	Earth	L=580 m	-	Natural canal
Right bank canal	Earth	L=380 m	-	Natural canal
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Left bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Ichchankulama Cascade **9 Karakolawewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund		L=850 m H=3.0 m	1994	Erosion of slope, Uneven bund top
Right bank spillway	No structure	L=35 m	-	No sturcture
Left bank sluice	Tower	N=1 nos.	2011	Gate: good condition, Structure: good condition
Cener sluice 1	Tower	N=1 nos.	2011	Gate: good condition, Structure: good condition
Cener sluice 2	Tower	N=1 nos.	2011	Gate: damage, Structure: damage
Right bank sluice	Tower	N=1 nos.	2015	Gate: good condition, Structure: good condition
Left bank canal	Earth	L=500 m	2012	Natural canal
Cener canal 1	Earth	L=185 m	-	Natural canal
Cener canal 2	Earth	L=700 m	-	Natural canal
Right bank canal	Earth	L=490 m	-	Natural canal
Farm road		L=1,000 m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Right bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

ATTACHMENT 2

TANK CAPACITY OF ICHCHANKULAMA CASCADE

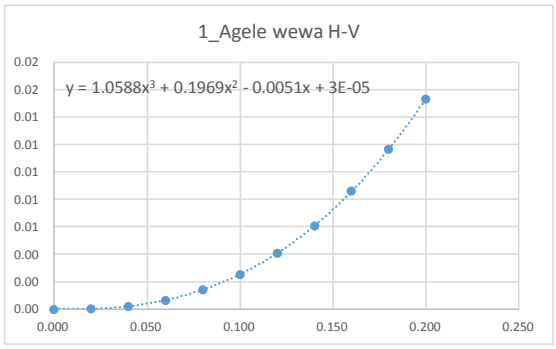
Summary of Tank Capacity

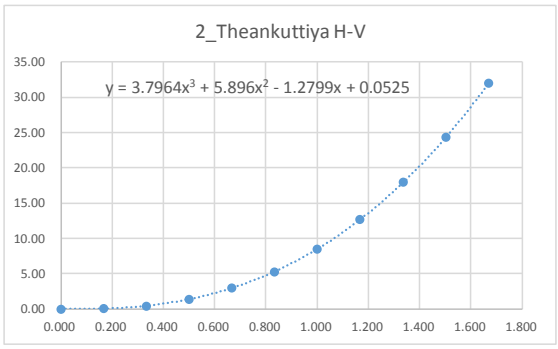
Cascade	Tank		Volume (1,000 m^3)	Renarks
Ichchankulam	1	Agale wewa	0.02	
	2	Theankuttiya	32.0	
	3	Ihala kainathama	289.5	
	4	Pahala kinathama	440.6	
	5	Kudawewa	21.4	
	6	Plagas wewa	16.0	
	7	Ichchankulama	371.5	
	8	Wali wewa	61.0	
	9	Karakolawewa	71.8	
	10	Mawathawewa	68.7	

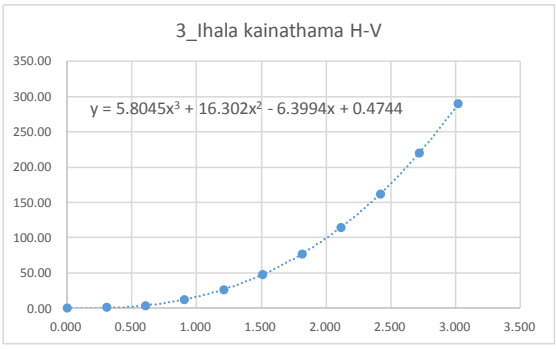
Source: JICA Project Team

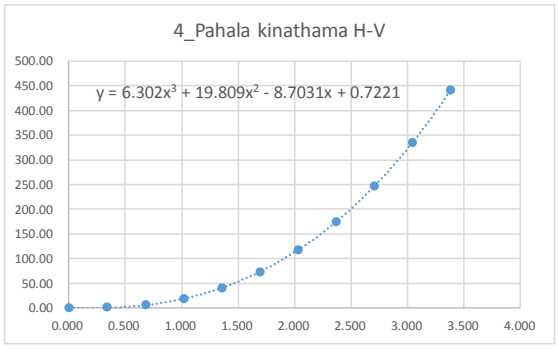
Tank Capacity Calculation

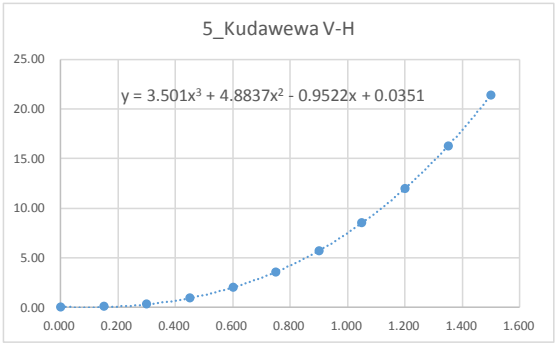
H-V Curve

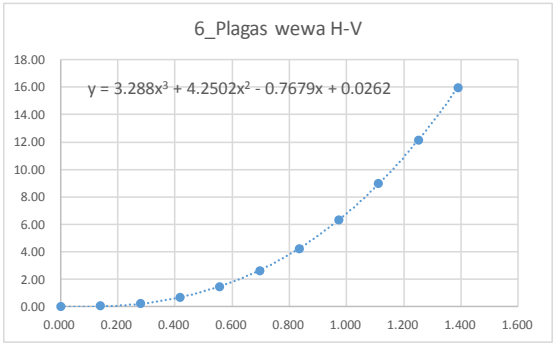


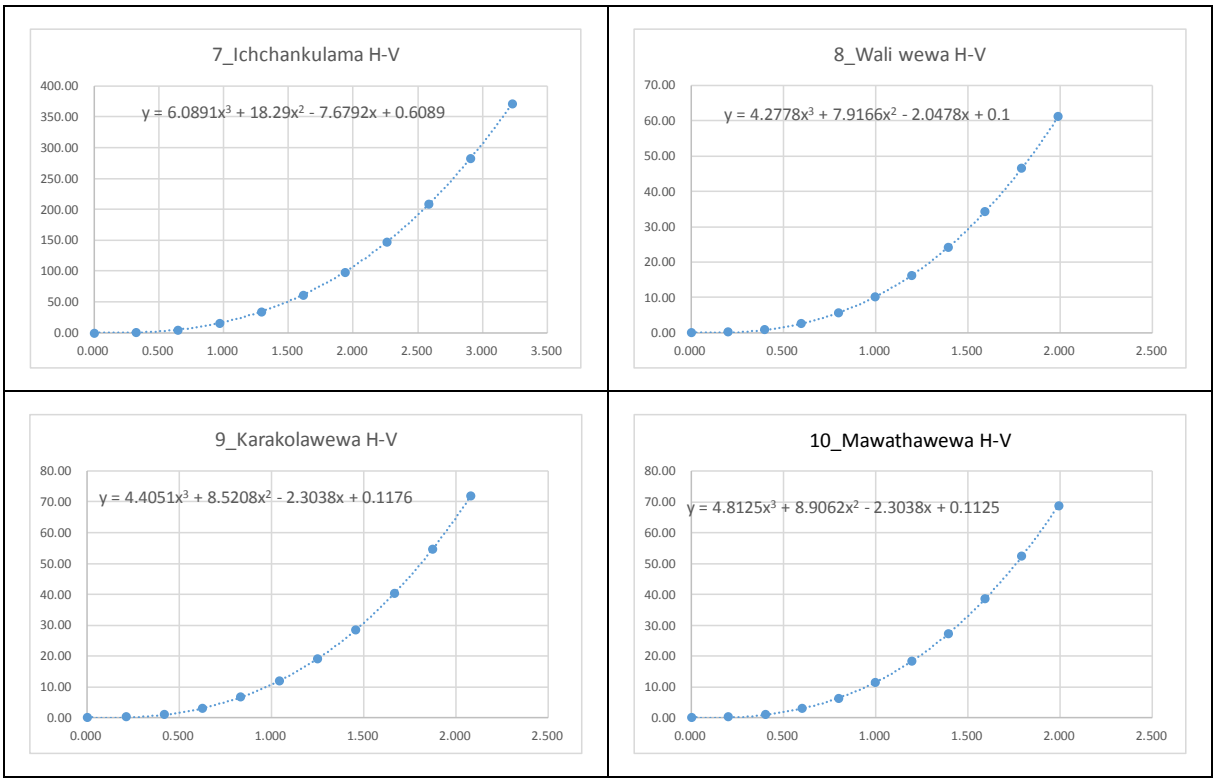












Source: JICA Project Team

ATTACHMENT 3

FLOOD DISCHARGE ESTIMATIONF FOR SPILLWAY DESIGN IN ICHCHANKULAMA CASCADE

(1) Methodology

By the request of the counterpart, the study for flood discharge estimation follows the Sri Lankan technical standard named "Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah. The guidelines stipulate the methodology of hydrological analysis, design of spillway, bund, and sluice.

(2) Climate Zone

According to the guideline, the country of Sri Lanka is divided to 6 hydrological zones as shown in

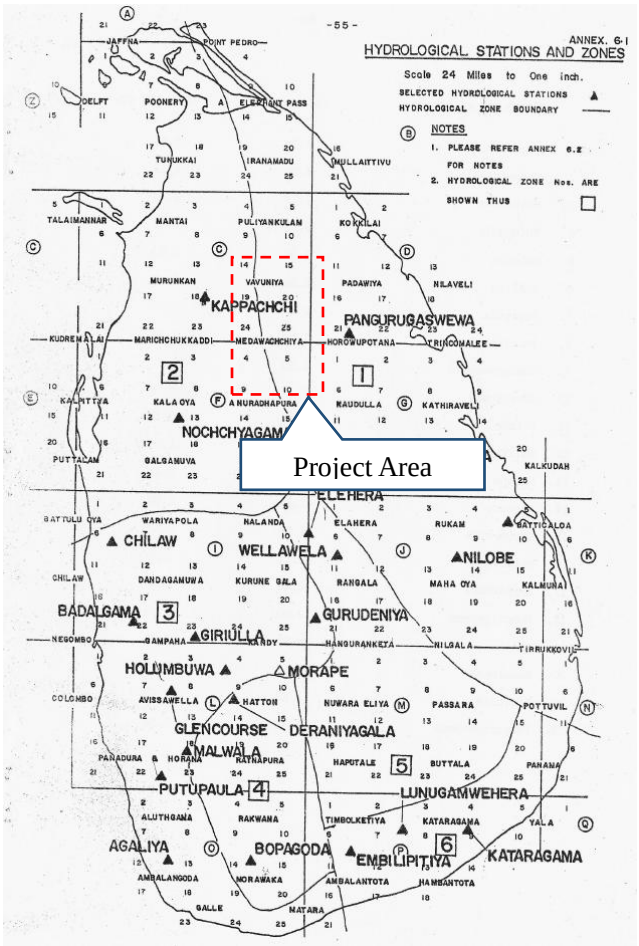


Figure 2.3.2.1. The project area is fallen to Zone 1 and Zone 2.

Source: "Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

Figure 2.3.2.1 Hydrological Zone in the Irrigation Guidelines

(3) 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 2.3.2.1

Table 2.3.2.1 Probable Rainfall Depth for 24-hour Storm Presented in Irrigation Guideline

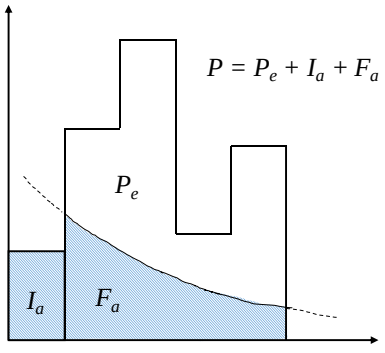
Unit: inches

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	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
25 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

Ref: Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

(4) 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 our study, the rainfall loss is calculated by the SCS(Soil Conservation Services) method.



Source: "Applied Hydrology" Ven Te Chow, et al

Figure 2.3.2.2 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 above equation is the rainfall excess. "*P*" is total rainfall, "*Ia*" is initial loss, "*Fa*" is infiltration loss, and "*S*" is the potential maximum retention. By using 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.

(5) Flood Hydrograph

1) Method to Derivation of Flood Hydrograph

In the guideline, Snyder unit hydrograph is introduced. The coefficients of the Snyder's hydrograph is 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.

2) 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.

$$t_p = C_t (L \cdot L_C)^{0.3}$$

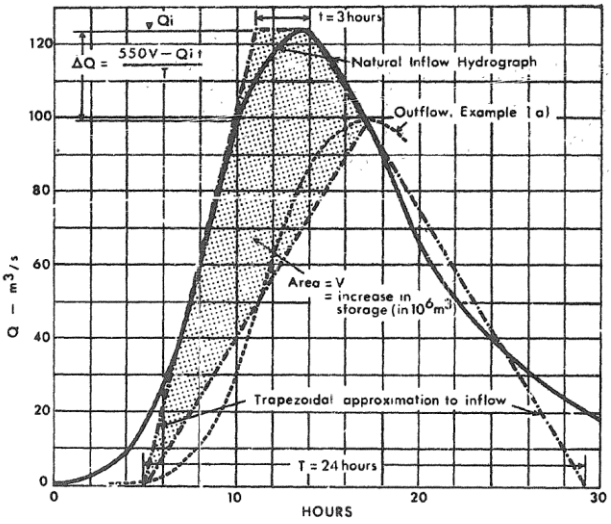
Where, L is length of the longest river course of catchment in miles, and L_c is length from the point of interest to the point on the river course closest to the centroid of the catchment in miles.

C_t and C_p are given to the closest hydrological stations.

For Kiulekada cascade, the closest hydrological station is Pangurugaswewa, C_t and C_p are 1.88 and 0.94, respectively.

3) Flood Routing

The inflow of the flood flow will be released from the spillway but a part of the inflow will be storage 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 isosceles triangle. The fore slope and rear slope of the trapezoid are drawn to fit the tangent of the hydrograph.



Source: M.J.H. West "Flood Control in Reservoirs and Storage Pounds-A Discussion," Journal of Hydrology, 23 (1974)67-71

Figure 2.3.2.3 Flood Routing by J.H.West Method

According to the guideline, the peak outflow is estimated by the following equation.

$$q_d = \frac{555.5V_d - q_{in}}{T}$$

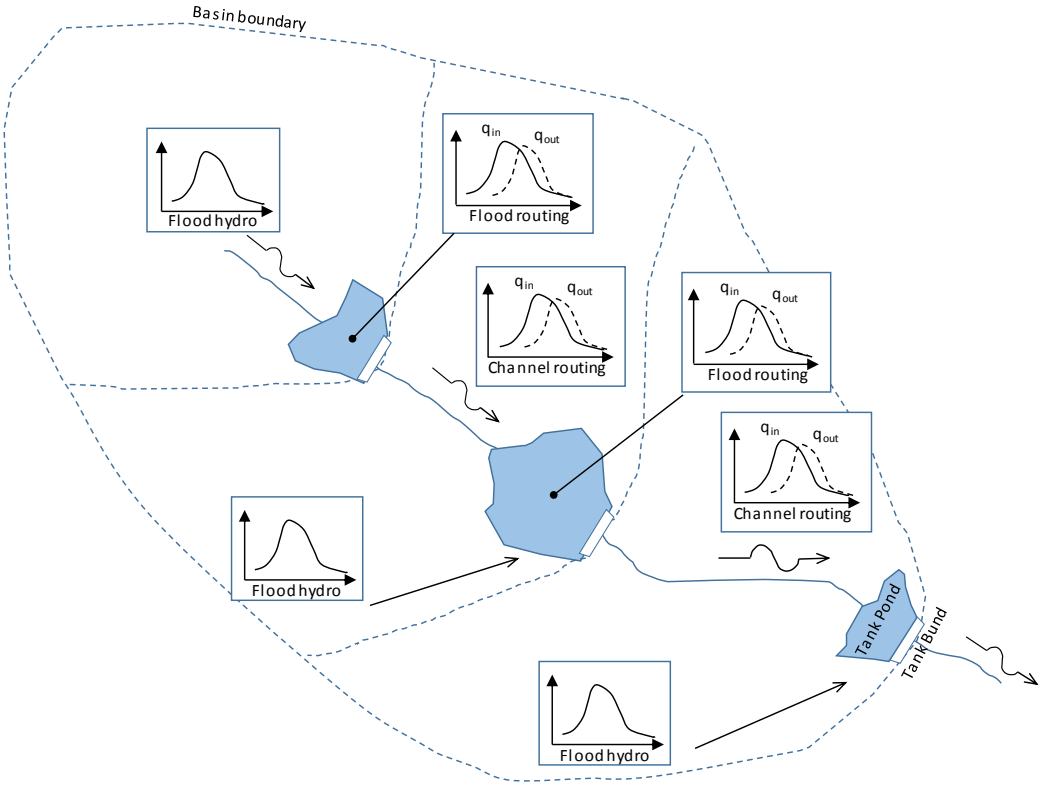
Where, q_d is peak outflow through spillway in cumecs, V_d is stored flood discharge in the reservoir in million m^3, q_{in} is peak inflow, T is base hours of inflow and outflow shown in the Figure 2.3.2.3.

4) 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 is introduced in various guideline and text books such as "Flood Runoff Analysis" of US Army Corps of Engineers, or "Applied Hydrology" by Ven Te Chow, et al.

5) 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 2.3.2.4.



Source: JICA Project Team

Figure 2.3.2.4 Concept of the Flood Analysis for the Cascade System

6) Flood Peak Discharge for Spillway of the Tanks in Ichchankulama Cascade

The flood peak discharge is estimated by the method in the aforesaid sections. Result of the peak discharge of the tank is summarized in Table 2.3.2.2.

The calculation spreadsheet for the calculation of peak discharge for the Ichchankulama cascade is shown in Annex 1.

Table 2.3.2.2 Summary of Flood Flow Analysis for Ichchankulama Cascade

Name of Tank	Catchment Area	Peak Inflow	Peak Outflow
	(km^2)	(m^3/s)	(m^3/s)
Theankuttiya (8)	0.84	22.4	20.2
Ihala Kainathama (7)	1.62	64.1	60.9
Pahala kainathana (6)	4.16	118.2	118.2
Palugas Wewa (5)	0.72	117.7	117.7
Karakolawewa (3)	0.54	18.3	15.7
Ichchan Kulama (2)	3.48	148.5	148.5
Wali Wewa (1)	0.45	141.8	141.8

Source: JICA Project Team

ATTACHMENT 4

SPILLWAY LENGTH OF TANKS IN ICHCHANKULAMA CASCADE

Ichchankulama Cascade

No.	Tank	Existing		Design							
		Spill type	Length (m)	Spill type	Design flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)	Evaluation Q>Q'	Remarks
1	Agale wewa	-	-	Channel	9.0	2.80	13	0.6	9.5	OK	(2-1), (3)
2	Theankuttiya	Drop wall	13.0	Drop wall	23.1	3.33	27	0.6	23.3	OK	(1)
3	Ihala kainathama	Drop wall	42.0	Drop wall	62.6	3.33	40	0.9	63.5	OK	(1)
4	Pahla Kinathama	Drop wall	30.0	Drop wall	101.5	3.33	64	0.9	101.7	OK	(1)
5	Kudawewa	Drop wall	5.0	Drop wall	3.8	3.33	5	0.6	4.3	OK	(2-1)
6	Palugas wewa	Channel	16.0	Channel	12.0	2.80	17	0.6	12.4	OK	(2-2)
7	Ichchankulama	Drop wall	122.0	Drop wall	143.1	3.33	91	0.9	144.6	OK	(1)
8	Wali wewa	Drop wall	82.0	Drop wall	133.4	3.33	84	0.9	133.4	OK	(1)
9	Karkolawewa	Channel	35.0	Channel	24.3	2.80	34	0.6	24.7	OK	(1)
10	Mawathawewa	Drop wall	8.0	Drop wall	51.9	3.33	60	0.6	51.9	OK	(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 (m^3/s/km2)

(2-2) Q'; Assumed by unit flood (per irrigable area) 1.49 (m^3/s/ha)

(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 m3/s; H=0.9m, In case Q<50 m3/s; H=0.6m

Calculation (Q): $Q=CBH^{3/2}$ (m^3/s)

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

THE PROJECT
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DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE REPORT ON RESULT OF DETAILED SURVEY IN KIULEKADA CASCADE SYSTEM

June 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

NTC INTERNATIONAL CO., LTD.

THE PROJECT
FOR
FORMULATING CASCADE SYSTEM
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The Report on Result of Detailed Survey in Kiulekada Cascade System

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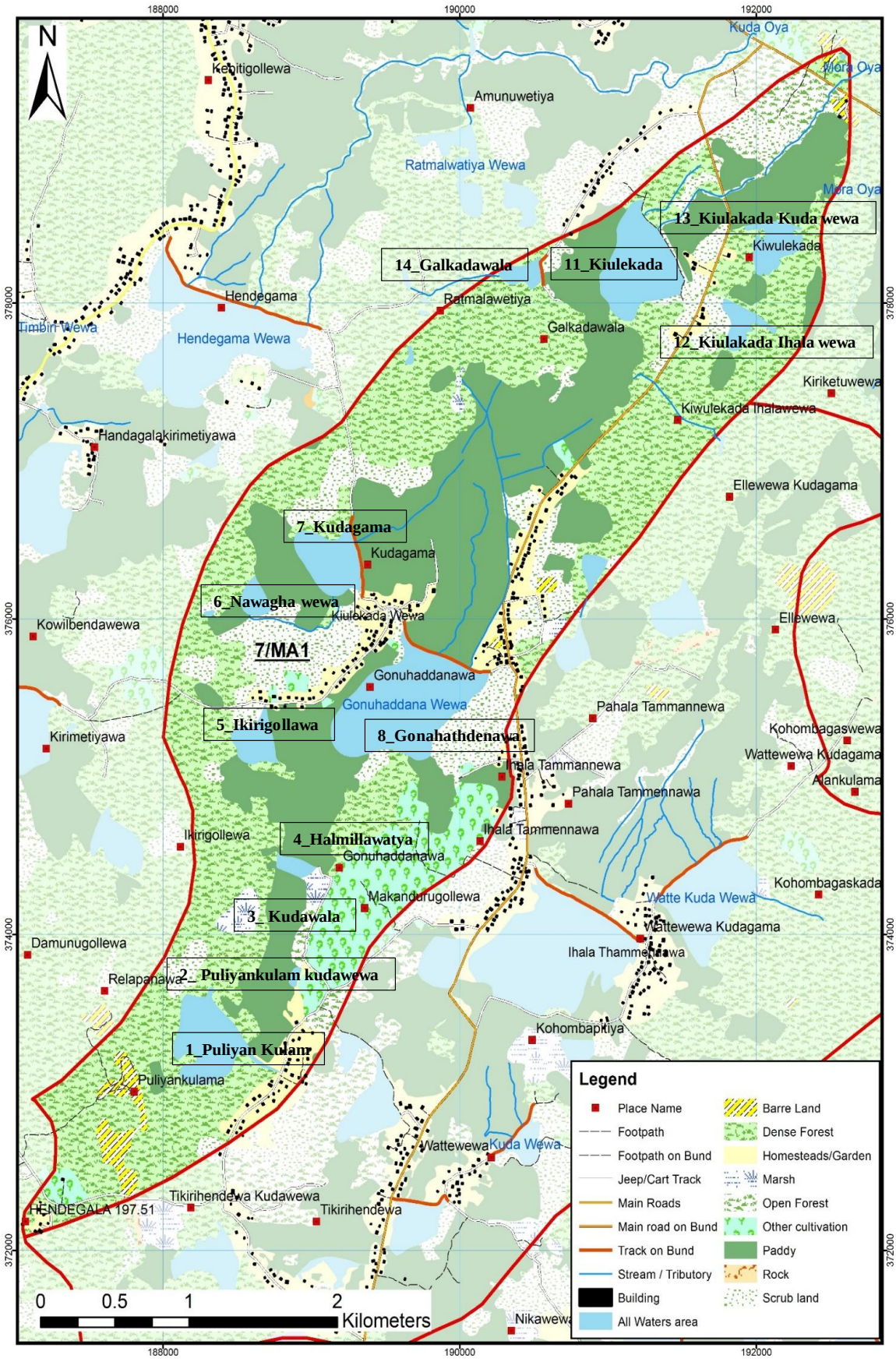
Attachments

Abbreviations

ACAD	Assistant Commissioner Agrarian Development
AI_1	Agricultural Instructor
AI_2	Artificial Insemination
ARPA	Agriculture Research & Development Assistants
ASC	Agrarian Service Centre
CBO	Community Based Organization
CIC	(Company Name previously called 'Chemical Industry of Colombo')
CMFO	Cascade Management Farmer Organization
CN	Centre
CoP	Cost of Production
DAD	Department of Agrarian Development
DAPH	Department of Animal Production and Health
DEC	Dedicated Economic Centre
DO	Divisional Officer under ASC
DOA	Department of Agriculture
DOI	Department of Irrigation
DS	Divisional Secretariat / Divisional Secretary
FO	Farmer Organization
GN	Grama Niladhari
GND	Grama Niladhari Division
GOSL	Government of Sri Lanka
HH	House Hold
HHS	Household Survey
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
LB	Left Bank
LHG	Low Humid Grey
MASL	Mahaweli Authority of Sri Lanka
MCM	Million Cubic Meter
MMDE	Ministry of Mahaweli Development and Environment
MOI	Ministry of irrigation
MT	Metric ton
MW	Mega Watt
NCP	North Central Province
NCPC	North Central Province canal
NCPCP	North Central Province Canal Project
NGO	Non-Government Organization
NLDB	National Livestock Development Board
NP	Northern Province
O&M	Operation and Management
OFC	Other Field Crops
PDAPH	Provincial Department of Animal Production and Health
PDI	Provincial Director of Irrigation
PMB	Paddy Marketing Board
RB	Right Bank
RBE	Reddish Brown Earth
RDS	Rural Development Society
RR&DI	Rice Research and Development Institute
RVS	Range Veterinary Surgeon
TO	Technical Officer
WRDS	Women Rural Development Society



Source: JICA Project Team (Source of Map: 1:10,000 Land Use Plan Department of Survey Sri Lanka – 2014/2015)

Location Map of Kiulekada Cascade

Chapter 1 Introduction

1.1 General

The Report on the Result of Detailed Survey in Kiulekada Cascade System was prepared under JICA funded project named "The Project for Formulating Cascade System Development Plan under North Central Province Canal in Democratic Socialist Republic of Sri Lanka" with nodal counterpart agency of Ministry of Mahaweli Development and Environment. The detailed survey was carried out in the selected six cascade systems namely Ichchankulama, Siyambalagaswewa, Rathmalawewa, Kiulekada, Alagalla and Naveli kulam located in Anuradhapura and Vavuniya District to be benefited by North Central Province Canal Project in order to identify the actual ground situation and development needs for formulation of total cascade system development plan covering 128 cascade systems. The report describes methodology for detailed survey in the Chapter 1, present condition with several aspects namely administration and socio economic, soil and land use, meteorology and water resources, agriculture and agro-economy, livestock, infrastructure and farmers' organization in Chapter 2 and needs for development in Chapter 3.

1.2 Methodology

The detailed survey was composed of four surveys namely (1) inventory survey for present infrastructure such as tank, canal system and rural roads, (2) farm household survey, (3) group discussion on farmers' organization and (4) interview survey on government frontline officers. The objectives, methodology, timing and main implementers for those surveys are described in the following table.

Table 1.2.1 Outline of Detailed Survey

Name of Survey	Objectives	Major Activities or Major Information Collected	Target	Timing	Main Implementer
Inventory survey for present infrastructure	Collect data for rehabilitation planning and cost estimation	(1) Topographic survey for tank bund and canal route (2) Inventory survey for tank and canal related structures (Sluice & spillway, farm turnouts) (3) Inventory survey for rural road	69 tanks irrigation schemes Ichchankulama : 9 tanks Siyambalagaswewa : 10 tanks Rathmalawewa : 15 tanks Kiulekada : 14 tanks Alagalla : 5 tanks Naveli kulam : 16 tanks	January to May 2017	JICA Project Team, DAD Anuradhapura and Vavuniya and PDI in North Central and Northern Province
Farm household survey	Identify the present farm household socio economic condition, livelihood, agriculture & livestock activities and development need etc. through questionnaire survey	(1) General (2) Income and expenditure (3) Landholding (4) Agriculture production and management (5) Livestock production and management (6) Marketing (7) Irrigation and water management	1168 farm household in the selected six cascade systems Ichchankulama : 198 nos. Siyambalagaswewa : 150 nos. Rathmalawewa : 275 nos. Kiulekada : 255 nos. Alagalla : 135 nos. Naveli kulam : 155 nos.	January to March 2017	JICA Project Team and DAD Anuradhapura and Vavuniya
Group discussion on	Collect information on	(1) Member (2) Regulation	29 farmers' organizations Ichchankulama : 5 nos.	December 2016 to	JICA Project Team and DAD

farmers' organization	present farmers' organization activities and functions and idea for future cascade management	(3) Activities (4) Financial status (5) Water management (6) Present constraint and development need	Siyambalagaswewa : 3 nos. Rathmalawewa : 7 nos. Kiulekada : 4 nos. Alagalla : 3 nos. Naveli kulam : 7 nos.	May 2017	Anuradhapura and Vavuniya
Interview survey on government frontline officers	Collect information on present farmers' organization activities and possibility for future cascade management	(1) Present functions of FO and challenges faced (2) Possibility for formation of cascade FO and points to be addressed when forming the cascade level FO	19 officers attached to Agrarian Service Centre (ASC) such as DO and ARPA	May 2017	JICA Project Team

Source: JICA Project Team

The contents described in the following chapters are based on above surveys.

Chapter 2 Present Condition of Kiulekada Cascade System

2.1 Administration and Socio Economic Condition

2.1.1 Administration in Kiulekada Cascade

Kiulekada cascade is located in Kebithigollewa Divisional Secretariat (DS) division in Anuradhapura District. The whole cascade belongs to Kebithigollewa Agrarian Service Centre (ASC). The area is in north east of Anuradhapura between Horowpothana town and Vavuniya town. The cascade covers two Grama Niladhari (GN) divisions. The farm households totalling to approximately 397 are spread among nine villages in the cascade system The following table indicates administrative location of the tanks under Kiulekada Cascade and target beneficiaries of each tank.

The area is affected by elephant damages. Gonahathdenawa tank under the cascade belongs to Medium irrigation scheme, which is under control of Irrigation department with different rules from minor irrigation schemes applied. The area under Kiulekada tank is mostly owned by a former minister of the previous central government. Therefore the beneficial farmers in the tank are basically tenant farmers.

Table 2.1.1 Administrational Location and Target Population of the Target Tanks

DS Division	ASC	GN Division	GN code	Tank	No. of HHs Benefitted	Target no. of HH*[1]	Estimated Target Population*[2]
Kebithigollewa	Kebithigollewa	Wattewewa	20	Puliyankulam	59	42	134
				Puliyankulam Kudawewa	5	5	16
				Kudawewa*[3]	12	7	n.a
				Halmillawatya	33	33	122
		Gonahathdenawa	19	Ikirigollewa	27	23	78
				Nawagha wewa	12	11	44
				Ihala Tammanawa*[4]	30	19	65
				Pahala Tammanawa*[5]	20	17	61
				Kiulekada	38	9	32
				Kiulekada Ihala wewa	25	11	n.a
				Kiulekada Kudawewa	17	11	33
				Galkadawala	45	40	142
				Kudagama	65	64	218
				Gonahathdenawa*[6]	130	105	399
				Total	518	397	1344

**[1]The number of target HH is determined as the farmers who are using tank 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 the target household ands average number of family members*
**[3] Kudawewa is not a tank but a silt trap, therefore it is not included in HHS target*
**[4]Iahala Tammanawa is not included in the cascade in terms of water flow. However, it is included in the original cascade boundary.*
**[5]Pahala Tammanawa is not included in the revised cascade boundary*
**[6]Gonahathdenawa tank is under medium irrigation scheme.*
Source: JICA Project Team based on the FO interview and HHS result

Agrarian services in the area are provided by the Agriculture Research and Production Assistants (ARPA) under the purview of the Divisional Officer (DO) of ASC, Kebithigollewa reporting to the Department of Agrarian Development (DAD), Anuradhapura. Agricultural extension services are provided by the Agricultural Instructor (AI) Kebithigollewa Range reporting to the Provincial Department of Agriculture, Anuradhapura. Kebithigollewa ASC is covering the whole Kebithigollewa DS division. An ARPA is assigned for each 3-4 FOs under Kebithigollewa ASC, which is reasonable both practically and in comparison with other ASCs. The following shows details of administrative system of the target cascades.

Table 2.1.2 Number of ARPA Officers incharge in Anuradhapura District

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
Horowpothana	Horowpothana	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

Source: Farm Household Survey (JICA Project Team 2017)

2.1.2 Socio Economic Situation of Kiulekada Cascade

Being located in the middle of Anuradhapura District, beneficiaries of tanks under Kiulekada are totally Sinhalese as show in the result of the HHS.

Table 2.1.3 Ethnicity of Beneficiary Households per Tank

Tank	Sinhala		Tamil		Total valid responses	
	(HH no.)	(%)	(HH no.)	(%)	(HH no.)	(%)
Galkadawala Kudawewa	5	100.0%	0	0%	5	100.0%
Galkadawala Mahawewa	27	100.0%	0	0%	27	100.0%
Kudagama	55	100.0%	0	0%	55	100.0%
Gonahathdenawa	63	100.0%	0	0%	63	100.0%
Halmillawatya	21	100.0%	0	0%	21	100.0%
Ihala Tammanawa	18	100.0%	0	0%	18	100.0%
Ikirigollewa	19	100.0%	0	0%	19	100.0%
Kiulekada Kudawewa	1	100.0%	0	0%	1	100.0%
Kiulekada	2	100.0%	0	0%	2	100.0%
Nawagha wewa	1	100.0%	0	0%	1	100.0%
Pahala Tammanawa	12	100.0%	0	0%	12	100.0%
Puliyankulam Kudawewa	5	100.0%	0	0%	5	100.0%
Puliyankulam	26	100.0%	0	0%	26	100.0%
Kiulekada Ihala wewa	-	n.a	-	n.a	-	n.a
Total	255	100.0%	0	0%	255	100.0%

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

Religion is totally related with ethnicity in the Kiulekada cascade area, where all beneficiaries are Buddhists as shown in the table below.

Table 2.1.4 Religion of the Beneficiary Households per Tank

Tank	Buddhist		Christian		Hindu		Total	
	(no.)	(%)	(no.)	(%)	(no.)	(%)	(no.)	(%)
Galkadawala Kudawewa	5	100.0%	0	0.0%	0	0.0%	5	100.0%
Galkadawala Mahawewa	27	100.0%	0	0.0%	0	0.0%	27	100.0%
Kudagama	55	100.0%	0	0.0%	0	0.0%	55	100.0%
Gonahathdenawa	63	100.0%	0	0.0%	0	0.0%	63	100.0%
Halmillawatya	21	100.0%	0	0.0%	0	0.0%	21	100.0%
Ihala Tammanawa	18	100.0%	0	0.0%	0	0.0%	18	100.0%
Ikirigollewa	19	100.0%	0	0.0%	0	0.0%	19	100.0%
Kiulekada Kudawewa	1	100.0%	0	0.0%	0	0.0%	1	100.0%
Kiulekada	2	100.0%	0	0.0%	0	0.0%	2	100.0%
Nawagha wewa	1	100.0%	0	0.0%	0	0.0%	1	100.0%
Pahala Tammanawa	12	100.0%	0	0.0%	0	0.0%	12	100.0%
Puliyankulam Kudawewa	5	100.0%	0	0.0%	0	0.0%	5	100.0%
Puliyankulam	26	100.0%	0	0.0%	0	0.0%	26	100.0%
Kiulekada Ihala wewa	-	n.a	-	n.a	-	n.a	-	n.a
Total	255	100.0%	0	0.0%	0	0.0%	255	100.0%

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

The average size of families in Kiulekada area is 3.5 members per family. There is not significant disparity par tank as the average numbers of family members per tank range from 3.2 to 3.8 excluding the tank with only one respondent.

Table 2.1.5 Number of Household by Number of Family Members per Tank

Tank	No. of family member in household								Total valid answer	Average family member
	1	2	3	4	5	6	7	8		
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(no)	
Galkadawala Kudawewa	0.0%	20.0%	20.0%	20.0%	40.0%	0.0%	0.0%	0.00%	5	3.8
Galkadawala Mahawewa	0.0%	25.9%	18.5%	37.0%	14.8%	3.7%	0.0%	0.00%	27	3.5
Kudagama	5.6%	22.2%	20.4%	35.2%	14.8%	1.9%	0.0%	0.00%	54	3.4
Gonahathdenawa	6.5%	12.9%	19.4%	27.4%	22.6%	9.7%	0.0%	1.61%	62	3.8
Halmillawatya	5.0%	10.0%	25.0%	40.0%	10.0%	10.0%	0.0%	0.00%	20	3.7
Ihala Tammanawa	11.1%	11.1%	22.2%	38.9%	16.7%	0.0%	0.0%	0.00%	18	3.4
Ikirigollewa	0.0%	21.1%	36.8%	26.3%	10.5%	5.3%	0.0%	0.00%	19	3.4
Kiulekada Kudawewa	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.00%	1	3.0
Kiulekada	0.0%	50.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.00%	2	3.5
Nawagha wewa	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.00%	1	4.0
Pahala Tammanawa	8.3%	16.7%	0.0%	58.3%	16.7%	0.0%	0.0%	0.00%	12	3.6
Puliyankulam Kudawewa	0.0%	40.0%	20.0%	20.0%	20.0%	0.0%	0.0%	0.00%	5	3.2
Puliyankulam	12.5%	16.7%	20.8%	37.5%	8.3%	0.0%	4.2%	0.00%	24	3.3
Kiulekada Ihala wewa	-	-	-	-	-	-	-	-	n.a	n.a
Total	5.6%	18.0%	20.8%	34.0%	16.4%	4.4%	0.4%	0.40%	250	3.5

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

Analysis on household income sources was carried out through a questionnaire survey with options of the following; 1 = Government service, 2 = Private sector, 3 = Crop production, 4 = Livestock, 5 = Agriculture labour, 6 = Skilled labour, 7 = Unskilled labour, 8= Family business, 9 = nil, and 10 = Others. The following table shows ratio of the primary income sources in each tank.

Table 2.1.6 Primary Income Source of the Beneficiary Households per Tank

Tank	1.Govt Service	2.Private Sector	3.Crop Production	4. Livestock	6.Skilled Labour	7.Unskilled Labour	8.Family Business	Total Valid Answer
Galkadawala Kudawewa	40.0%	0.0%	60.0%	0.0%	0.0%	0.0%	0.0%	5
Galkadawala Mahawewa	44.4%	3.7%	44.4%	0.0%	0.0%	7.4%	0.0%	27
Kudagama	29.1%	0.0%	65.5%	0.0%	1.8%	1.8%	1.8%	54
Gonahathdenawa	49.2%	1.6%	38.1%	3.2%	1.6%	4.8%	1.6%	62
Halmillawatya	57.1%	4.8%	28.6%	0.0%	0.0%	9.5%	0.0%	20
Ihala Tammanawa	61.1%	0.0%	38.9%	0.0%	0.0%	0.0%	0.0%	18
Ikirigollewa	47.4%	0.0%	52.6%	0.0%	0.0%	0.0%	0.0%	19
Kiulekada Kudawewa	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	1
Kiulekada	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2
Nawagha wewa	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	1
Pahala Tammanawa	58.3%	0.0%	41.7%	0.0%	0.0%	0.0%	0.0%	12
Puliyankulam Kudawewa	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	5
Puliyankulam	38.5%	3.8%	42.3%	3.8%	0.0%	7.7%	3.8%	24
Kiulekada Ihala wewa	-	-	-	-	-	-	-	n.a
Total	44.7%	2.0%	46.3%	1.2%	0.8%	3.9%	1.2%	250

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

Less than a half of the households in the whole cascade rely on agriculture production as their primary income source. This figure is slightly below the average of the six model cascades as shown in the following table. Relatively larger portions of the households are engaged in agriculture as their primary income source in Galkadawala Kudawewa, Kudagama, and Ikirigollewa, leaving the tanks with one to two respondents. The ratio of government jobs is the second largest in all six model cascades with 44.7% following Alagalla cascade. Relatively larger ratios of government servants are shown in Halmillawatya, Pahala Tammanawa and Ihala Tammanawa, while Kudagama, where the percentage of the household engaging in crop production is the highest, has smaller ratio of government servants.

Table 2.1.7 Primary Income Source by Cascade of Six Model Sites

Cascade	1.Govt Service	2.Private Sector	3. Crop Production	4.Livestock	5.Agriculture Labour	6.Skilled Labour	7.Unskilled Labour	8.Family Business	10. Other	Total
Alagalla	51.9%	5.9%	25.9%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%	100%
Naveli kulam	11.0%	3.2%	45.2%	5.2%	0.6%	11.6%	12.3%	3.2%	7.7%	100%
Ichchankulama	22.2%	3.5%	71.2%	0.0%	0.0%	0.5%	1.5%	0.0%	1.0%	100%
Kiulekada	44.7%	2.0%	46.3%	1.2%	0.0%	0.8%	3.9%	1.2%	0.0%	100%
Rathmalawewa	34.5%	1.8%	41.5%	0.0%	0.4%	6.9%	4.4%	5.8%	4.7%	100%
Siyambalagaswewa	17.3%	2.7%	65.3%	0.7%	0.0%	4.7%	9.3%	0.0%	0.0%	100%
Total	31.3%	2.9%	49.3%	1.0%	0.2%	4.0%	6.8%	2.1%	2.3%	100%

Source: Farm Household Survey (JICA Project Team 2017)

The major secondary income source in Kiulekada cascade is crop production. Slightly more than half of the target households are engaged in crop production as their secondary income source. Together with the figure of the primary income source, in total about 98% of the households operates agriculture either as their primary or secondary income sources. Although livestock is not a major income source in this area, there are a certain number of people engaged in livestock activities as the total ratio of households that conduct livestock rearing. Galkadawala Mahawewa has a remarkably larger proportion of livestock farmers. Details of the secondary income source per tank is shown in the following table.

Table 2.1.8 Secondary Income Source of the Beneficiary Households

Tank Name	1.Govt Service	2.Private Sector	3.Crop Production	4.Livestock	6.Skilled Labour	7.Unskilled Labour	8.Family Business	10. Other	Blank	Total Valid Answer
Galkadawala Kudawewa	0.0%	0.0%	40.0%	0.0%	0.0%	20.0%	0.0%	40.0%	0.0%	5
Galkadawala Mahawewa	0.0%	0.0%	55.6%	18.5%	0.0%	14.8%	0.0%	3.7%	7.4%	27
Kudagama	0.0%	1.8%	30.9%	7.3%	1.8%	16.4%	3.6%	3.6%	34.5%	54
Gonahathdenawa	0.0%	1.6%	60.3%	1.6%	1.6%	14.3%	6.3%	11.1%	3.2%	62
Halmillawatya	0.0%	0.0%	66.7%	0.0%	0.0%	19.0%	0.0%	9.5%	4.8%	20
Ihala Tammanawa	0.0%	0.0%	61.1%	5.6%	0.0%	22.2%	0.0%	0.0%	11.1%	18
Ikirigollewa	0.0%	0.0%	47.4%	0.0%	0.0%	21.1%	0.0%	10.5%	21.1%	19
Kiulekada Kudawewa	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	0.0%	1
Kiulekada	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2
Nawagha wewa	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	1
Pahala Tammanawa	0.0%	0.0%	58.3%	0.0%	0.0%	16.7%	0.0%	16.7%	8.3%	12
Puliyankulam Kudawewa	0.0%	0.0%	60.0%	0.0%	0.0%	20.0%	0.0%	20.0%	0.0%	5
Puliyankulam	0.0%	0.0%	53.8%	0.0%	3.8%	23.1%	0.0%	15.4%	3.8%	24
Kiulekada Ihala wewa	-	-	-	-	-	-	-	-	-	n.a
Total	0.0%	0.8%	51.8%	4.3%	1.2%	17.3%	2.4%	9.4%	12.9%	100%

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

Kiulekada has higher ratio in unskilled labour as their secondary income sources in comparison with other model cascades, followed by Naveli kulam. In total 21% of Kiulekada beneficiaries are engaged in unskilled labour either as their primary or secondary income sources.

Table 2.1.9 Secondary Income Source by Cascade of Six Model Sites

Cascade	1.Govt Service	2.Private Sector	3.Crop Production	4. Livestock	5.Agriculture Labour	6.Skilled Labour	7.Unskilled Labor	8.Family Business	9. Nil	10. Other	Blank
Alagalla	3.0%	0.7%	71.1%	0.0%	0.0%	1.5%	5.9%	0.7%	0.7%	0.0%	16.3%
Naveli kulam	3.9%	3.2%	47.7%	12.9%	0.0%	1.9%	10.3%	6.5%	0.0%	11.6%	1.9%
Ichchankulama	0.0%	1.5%	26.3%	11.6%	0.0%	0.0%	4.5%	1.0%	0.0%	4.5%	50.5%
Kiulekada	0.0%	0.8%	51.8%	4.3%	0.0%	1.2%	17.3%	2.4%	0.0%	9.4%	12.9%
Rathmalawewa	0.7%	0.4%	54.5%	0.7%	3.3%	7.3%	2.2%	5.5%	1.5%	10.5%	13.5%
Siyambalagaswewa	2.7%	1.3%	31.3%	3.3%	0.0%	0.0%	8.7%	0.0%	0.0%	26.7%	26.0%
Total	1.4%	1.2%	47.2%	5.2%	0.8%	2.4%	8.2%	2.9%	0.4%	10.3%	20.0%

Source: Farm Household Survey (JICA Project Team 2017)

The following table shows monthly household income of the Kiulekada cascade area. As a whole cascade, average monthly income is Rs.28,667. 8.6% of the household have income of less than Rs.5,000 per month, while other 8.6% earn more than Rs.50,000. Inequality is observed in average income between tanks. Pahala Tammanawa, Gonahathdenawa and Halmillawatya have higher average income of more than Rs.35,000 per month, while Kudagama and Nawagha wewa are less than Rs.20,000 and Kiulekada is even less than Rs.10,000. More than 20% of the households in Ikirigollewa and Kudagama have monthly income of less than 5,000, while nearly 20% of households earn more than Rs.50,000 per month in Halmillawatya and Galkadawala Mahawewa.

Table 2.1.10 Monthly Household Income of the Beneficiary Households per Tank

Tank	Income Level (LKR)											Average income (Rs)
	0-4999	5000-9999	10000-14999	15000-19999	20000-24999	25000-29999	30000-34999	35000-39999	40000-44999	45000-50000	> 50000	
Galkadawala Kudawewa	0.0%	20.0%	0.0%	20.0%	20.0%	0.0%	0.0%	20.0%	0.0%	20.0%	0.0%	26,330
Galkadawala Mahawewa	3.7%	3.7%	3.7%	14.8%	11.1%	7.4%	11.1%	11.1%	11.1%	3.7%	18.5%	32,903

Kudagama	20.0%	21.8%	12.7%	12.7%	5.5%	7.3%	9.1%	5.5%	3.6%	0.0%	1.8%	16,592
Gonahathdenawa	0.0%	6.3%	3.2%	6.3%	7.9%	6.3%	14.3%	9.5%	17.5%	15.9%	12.7%	35,561
Halmillawatya	9.5%	0.0%	4.8%	9.5%	9.5%	0.0%	9.5%	28.6%	4.8%	4.8%	19.0%	35,258
Ihala Tammanawa	0.0%	0.0%	22.2%	5.6%	11.1%	0.0%	0.0%	5.6%	38.9%	11.1%	5.6%	33,590
Ikirigollewa	26.3%	10.5%	10.5%	5.3%	0.0%	0.0%	10.5%	26.3%	5.3%	0.0%	5.3%	22,936
Kiulekada Kudawewa	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8,333
Kiulekada	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	50.0%	0.0%	0.0%	0.0%	30,867
Nawagha wewa	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13,167
Pahala Tammanawa	0.0%	0.0%	0.0%	0.0%	16.7%	25.0%	0.0%	25.0%	8.3%	16.7%	8.3%	37,018
Puliyankulam Kudawewa	0.0%	0.0%	0.0%	40.0%	0.0%	0.0%	20.0%	20.0%	20.0%	0.0%	0.0%	28,217
Puliyankulam	11.5%	3.8%	7.7%	3.8%	11.5%	19.2%	11.5%	19.2%	3.8%	3.8%	3.8%	26,456
Kiulekada Ihala wewa	-	-	-	-	-	-	-	-	-	-	-	n.a
Total	8.6%	8.6%	7.8%	9.0%	8.2%	7.5%	9.8%	13.7%	11.0%	7.1%	8.6%	28,667

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

The average monthly income of the whole Kiulekada cascade is lower than total average of all six model cascades, and it is the second lowest among the model cascades. The proportion of the households earning less than Rs.5,000 is the highest in Kiulekada, followed by Siyambalagaswewa. Details of the monthly income of all model cascades are shown in the table below.

Table 2.1.11 Monthly Household Income of the Beneficiary Households by Cascade

Cascade	Income Level (LKR)											Average income (Rs)
	0- 4999	5000-9999	10000-14999	15000-19999	20000-24999	25000-29999	30000-34999	35000-39999	40000-44999	45000-50000	> 50000	
Alagalla	3.0%	5.9%	7.4%	5.9%	6.7%	6.7%	11.9%	14.8%	8.1%	8.9%	20.7%	40,229
Naveli kulam	0.0%	1.9%	2.6%	6.5%	11.0%	10.3%	11.0%	13.5%	9.0%	8.4%	25.8%	41,699
Ichchankulama	1.5%	14.1%	15.2%	10.6%	8.1%	7.6%	5.6%	7.6%	3.5%	4.5%	21.7%	33,699
Kiulekada	8.6%	8.6%	7.8%	9.0%	8.2%	7.5%	9.8%	13.7%	11.0%	7.1%	8.6%	28,667
Rathmalawewa	6.2%	13.8%	7.3%	11.3%	5.5%	10.2%	8.7%	8.4%	7.6%	4.4%	16.7%	31,190
Siyambalagaswewa	8.0%	14.7%	16.7%	10.0%	14.0%	8.7%	8.7%	6.0%	2.7%	1.3%	9.3%	23,581
Total	5.0%	10.4%	9.3%	9.2%	8.5%	8.6%	9.1%	10.5%	7.3%	5.7%	16.5%	32,527

Source: Farm Household Survey (JICA Project Team 2017)

Economic situation can be also estimated by the number of beneficiaries of Divineguma, which is provided to the low-income households. The following shows the number and ratio of Divineguma beneficiaries. Ikirigollewa has higher ratio of Divineguma beneficiaries compared to other tanks apart from the tanks with very small samples.

Table 2.1.12 Divineguma Beneficiaries

Tank	Divineguma Beneficiaries (HH)	Total HH	% of Divineguma Beneficiaries
Galkadawala Kudawewa	1	5	20%
Galkadawala Mahawewa	6	27	22%
Kudagama	7	55	13%
Gonahathdenawa	11	63	17%
Halmillawatya	4	21	19%
Ihala Tammanawa		18	0%
Ikirigollewa	6	19	32%
Kiulekada Kudawewa	1	1	100%
Kiulekada	1	2	50%
Nawagha wewa	1	1	100%
Pahala Tammanawa		12	0%

Puliyankulam Kudawewa		5	0%
Puliyankulam	4	26	15%
Kiulekada Ihala wewa	-	-	n.a
Total	42	255	16%

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

Beneficiaries of the cascade are basically members of the Farmers Organisations (FOs) managing each tank. Farmers are generally taking part of several different Community Based Organisations (CBOs) in the area apart from the FOs. The following shows membership of CBOs operated in the area. Most of the households have membership in Death Donation Societies which is cultural society in Sinhalese community. It seems there are some active cooperatives in Gonahathdenawa.

Table 2.1.13 CBO Membership

(No. of household)

Tank	FO	RDS	Coop	Divineguma/ Samurdhi	Women Group	Death Donation Soc	Other	Valid No.
Galkadawala Kudawewa	5			1		1		5
Galkadawala Mahawewa	27	1	1	6	6	26		27
Kudagama	55	1	7	7	3	55		55
Gonahathdenawa	63	2	14	11	6	59	1	63
Halmillawatya	21		3	4	7	21	2	21
Ihala Tammanawa	18					18		18
Ikirigollewa	19	1	3	6	7	17		19
Kiulekada Kudawewa	1		1	1		1		1
Kiulekada	2		1	1		2		2
Nawagha wewa	1		1	1	1	1		1
Pahala Tammanawa	12		2		1	12		12
Puliyankulam Kudawewa	5				1	5		5
Puliyankulam	26	1	1	4	1	24	3	26
Kiulekada Ihala wewa	-	-	-	-	-	-	-	n.a
Total	255	6	34	42	33	242	6	255

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey (JICA Project Team 2017)

2.2 Soil and Land Use

2.2.1 Soil Type of the Area

Kiulekada cascade is located in the "DL 1" Agro-Ecological Region of Sri Lanka. The area terrain is undulating and the dominant soil group in the area is Reddish Brown Earth (RBE) and it has associated with Low Humic Gley (LHG) soils. The RBE occupies the crest and upper and mid slopes of the landscape. The LHG occupies the lower part of the slope and upper part of the valley bottom while a thin strip of alluvial soil appears along the natural drainage path. The ratio of RBE and LHG varies from place to place depending on the series of soil. In general, RBE, LHG and alluvial is about 60%, 30% and 10% of land surface, respectively.

RBE has been divided into two drainage classes, namely; Well-drained RBE and Imperfectly-drained RBE. Well-drained RBE appears in the upper and middle aspects of the undulating landscape, while Imperfectly-drained RBE appears in middle aspects of the undulating landscape.

Well-drained RBE has good drainage properties and it is used traditionally for cultivating other field crops under shifting nature with rainwater. This soil has a good potential for cultivation of other field crops and vegetables with supplementary irrigation. Soil reaction, depth, texture, and drainage are quite satisfactory for growing wide range of crops such as cereals, pulses, oil crops, and vegetables.

Imperfectly-drained RBE are used as support for several land uses such as homesteads, upland annuals, and shrub jungles. Although, potential for cultivating other field crops is very much higher, most of the cultivation fields with Imperfectly-drained RBE have already been developed for paddy cultivation in the Maha season and mostly abandoned in the Yala season due to shortage of water. Some areas, which are not developed for paddy cultivation, cultivate other field crops and vegetables with improved drainage practices in the Maha season. Farmers in the area are in view that Imperfectly-drained RBE area can be used to grow other field crops in the Yala season successfully with irrigation facilities.

LHG soils are predominantly used for wetland paddy cultivation. The LHG soil is mainly made of poorly drained soil which lies in the lowest position of the catena and it is influenced always by the seepage flow of the upper portion. This situation has led to keep the water table shallow most of the time creating favourable situation for paddy cultivation. In general, frequency of irrigation in this soil is lower due to the additional downward seepage of catena and poor drainage outflow from the soil. The soil is not suitable at all for other field crops under normal circumstance.

2.2.2 Land Holdings and Land Use

Land holdings of individual households in the cascade belong to several categories based on the location of the holdings. The irrigable lands in the command are holdings cultivated under the main tank and other tanks in the cascade. Akkarawela or lands located in the uplands adjoining the irrigated command areas of the tanks and the home gardens is used for crop production under rain-fed conditions and/or lift irrigation of agro-wells. In addition, some farmers possess Chena lands, which are usually the encroached lands located in the highlands bordering the forests, for seasonal cropping. The percentages of the farm holdings under each category in acres are shown in the tables below.

(1) Main Tank

The average land area held by individual households under the respective main tanks is 2.3 acres. The percentage of households cultivating extents of more than two acres and less than two acres are almost equally divided with 50% each.

Table 2.2.1 Land Holdings under Main Tanks (Acres)

Tank	Percent Households						
	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Galkadawala Kudawewa	0	0	0	0	40	20	40
Galkadawala Mahawewa	3.70	11.11	22.22	14.81	22.22	18.52	7.41
Kudagama	7.55	26.42	24.53	7.55	13.21	11.32	9.43
Gonahathdenawa	0	1.59	17.46	12.70	22.22	19.05	26.98
Halmillawatya	4.76	19.05	14.29	19.05	4.76	9.52	28.57
Ihala Tammanawa	0	0	0	0	38.89	16.67	44.44
Ikirigollewa	0	22.22	33.33	5.56	22.22	5.56	11.11
Kiulekada Kudawewa	0	0	0	0	100	0	0
Kiulekada	0	0	0	0	50	50	0
Nawagha wewa	0	0	0	100	0	0	0
Pahala Tammanawa	0	0	16.67	16.67	16.67	8.33	41.67
Puliyankulam Kudawewa	0	20	20	20	20	0	20
Puliyankulam	3.85	19.23	42.31	11.54	3.85	7.69	11.54
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	2.78	12.70	21.03	11.11	18.65	13.49	20.24

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, CSDPP (JICA 2017)

(2) Other Tanks in the Cascade

In addition to the command area of the main tank, 5% of the farmers cultivate irrigable lands under four other tanks, Gonahathdenawa and Kudawewa, Ikirigollewa and Pahala Tammanawa located within the cascade. The land area per farmer averaged to 2.4 acres.

Table 2.2.2 Land Holdings under Other Tanks in the Cascade (Acres)

Tank	Percent Households					
	<0.5	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Galkadawala Kudawewa	0	0	0	0	0	0
Galkadawala Mahawewa	0	0	0	0	0	0
Kudagama	0	25.00	12.50	12.50	25.00	25.00
Gonahathdenawa	33.33	00	33.33	0	0	33.33
Halmillawatya	0	0	0	0	0	0
Ihala Tammanawa	0	0	0	0	0	0
Ikirigollewa	0	0	100.00	0	0	0
Kiulekada Kudawewa	0	0	0	0	0	0
Kiulekada	0	0	0	0	0	0
Nawagha wewa	0	0	0	0	0	0
Pahala Tammanawa	0	0	0	100.00	0	0
Puliyankulam Kudawewa	0	0	0	0	0	0
Puliyankulam	0	0	0	0	0	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	7.69	15.38	23.08	15.38	15.38	23.08

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

(3) Akkarawela

The number of households and extents cultivated in Akkarawela land is negligible in Kiulekada cascade. Only three farmers (1%) in the survey sample possess Akkarawela lands at an average of 1.3 acres.

Table 2.2.3 Distribution of Akkarawela Lands by Extent (Acres)

Tank	Percent Households		
	0.5-1.0	1.5-2.0	2.0-2.5
Galkadawala Kudawewa	0	0	0
Galkadawala Mahawewa	0	0	0
Kudagama	0	0	0
Gonahathdenawa	0	0	100
Halmillawatya	0	100	0
Ihala Tammanawa	0	0	0
Ikirigollewa	100	0	0
Kiulekada Kudawewa	0	0	0
Kiulekada	0	0	0
Nawagha wewa	0	0	0
Pahala Tammanawa	0	0	0
Puliyankulam Kudawewa	0	0	0
Puliyankulam	0	0	0
Kiulekada Ihala wewa	n.a	n.a	n.a
Cascade	33.33	33.33	33.33

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

(4) Home Gardens

Extent of individual home gardens varies between less than 0.5 and 2 acres with an average of 1.1 acre per household. Mixed cropping is practiced in the home garden where permanent crops such as coconut and fruit trees with annuals such as vegetables and OFCs are established. As with Akkarawela lands,

crop production, mainly the OFCs and vegetables in home gardens is under lift irrigation and/or rain-fed condition. The distribution of land area among householders in the cascade is shown in the table below.

Table 2.2.4 Distribution of Home Gardens by Land Extent (Acres)

Tank	Percent Households						
	<0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Galkadawala Kudawewa	0	0	100	0	0	0	0
Galkadawala Mahawewa	0	20	28	8	36	0	8
Kudagama	5.88	26.47	52.94	5.88	5.88	2.94	0
Gonahathdenawa	0	15.52	67.24	12.07	1.72	3.45	0
Halmillawatya	0	21.05	73.68	5.26	0	0	0
Ihala Tammanawa	0	9.09	45.45	0	45.45	0	0
Ikirigollewa	0	11.76	76.47	5.88	5.88	0	0
Kiulekada Kudawewa	0	100	0	0	0	0	0
Kiulekada	0	0	0	0	100	0	0
Nawagha wewa	0	100	0	0	0	0	0
Pahala Tammanawa	0	40	60	0	0	0	0
Puliyankulam Kudawewa	0	0	100	0	0	0	0
Puliyankulam	0	25	58.33	12.5	4.17	0	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	0.95	19.91	59.24	7.58	9.95	1.42	0.95

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

(5) Chena Lands

26 percent of the farmers in the samples possess hena lands at an average of 1.8 acres each. There was no Chena land reported in the Galkadawala Kudawewa, Ihala Tammanawa and Kiulekada areas.

Table 2.2.5 Distribution of Chena Lands by Land Extent (Acres)

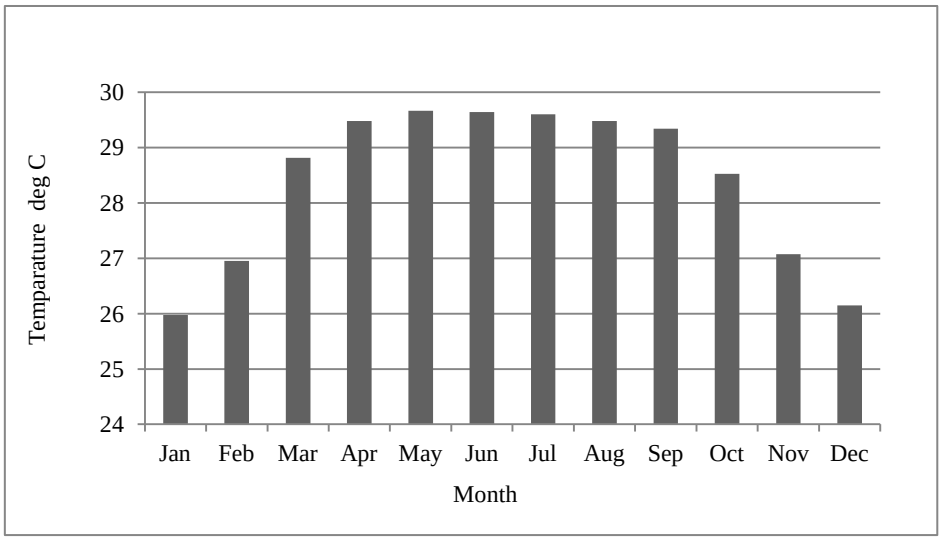
Tank	Percent Households					
	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Galkadawala Kudawewa	0	0	0	0	0	0
Galkadawala Mahawewa	25.00	12.50	0	62.50	0	0
Kudagama	8.33	41.67	4.17	12.50	20.83	12.50
Gonahathdenawa	0	50.00	10.00	30.00	10.00	0
Halmillawatya	20.00	20.00	0	40.00	20.00	0
Ihala Tammanawa	0	0	0	0	0	0
Ikirigollewa	0	44.44	0.00	22.22	11.11	22.22
Kiulekada Kudawewa	0	0	0	0	0	0
Kiulekada	0	0	0	0	0	0
Nawagha wewa	100.00	0	0	0	0	0
Pahala Tammanawa	100.00	0	0	0	0	0
Puliyankulam Kudawewa	0	100.00	0	0	0	0
Puliyankulam	0	33.33	0	11.11	44.44	11.11
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	10.29	36.76	2.94	23.53	17.65	8.82

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

2.3 Meteorology and Water Resources

2.3.1 Temperature and Humidity

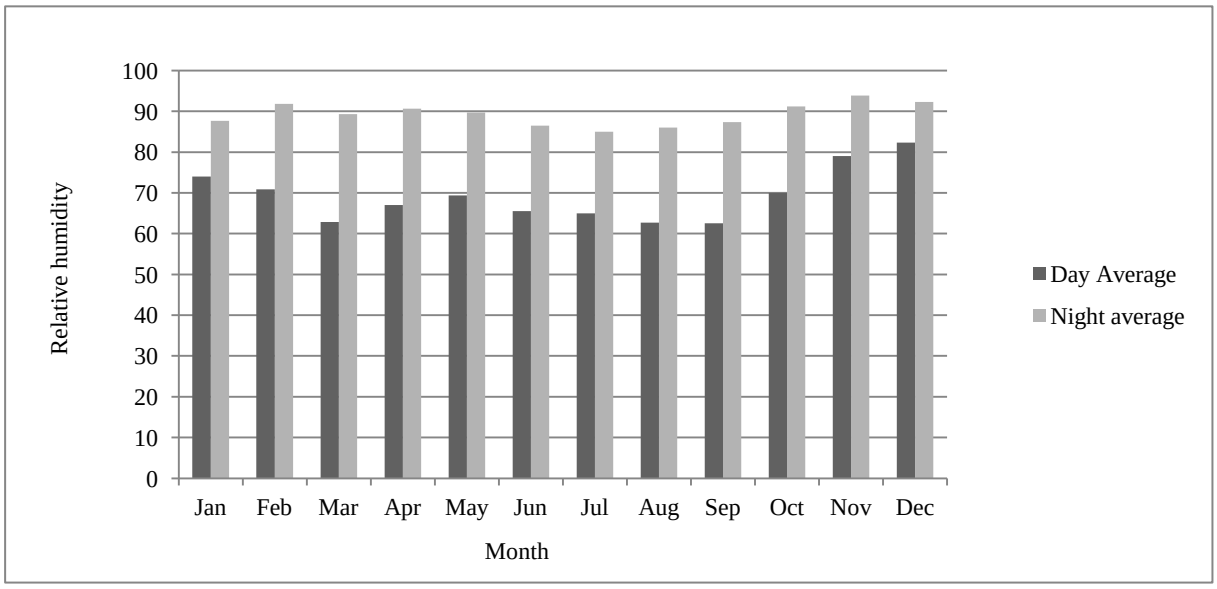
The mean annual temperature over the area is about 28°C as in many parts in dry zone of Sri Lanka. Lower temperatures are experienced in December, January and February and range between 25.9°C and 26.1°C. The highest temperatures(range between 28.5°C and 29.5°C) that are above the annual average 28°C are experienced in March, April, May, June, July, August, September and October.



Source: Statistical Abstract/Department of Census and Statistics

Figure 2.3.1 Monthly Average(2008-2016) Temperature - Kiulekada

Relative humidity in the area varies generally from about 62% to 82% during day time and about 85% to 94% during night time over the year. Annual average values have recorded as about 69% during day time and 89% during night time. Lower relative humidity values are experienced in March, April, June, July, August and September during day time and in January, June, July, August and September during night time. Higher Relative Humidity values are experienced in January, February, October, November and December during day time and February, March, April, May, October, November and December during night time.

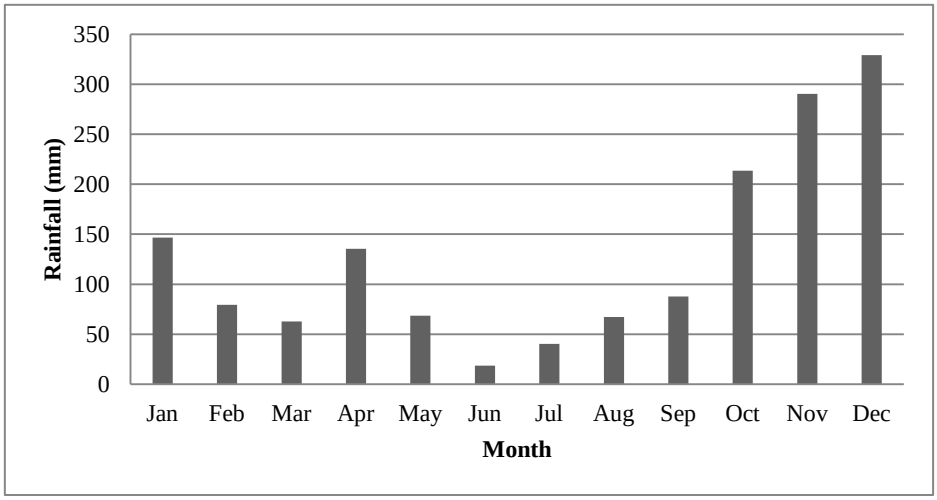


Source: Statistical Abstract/Department of Census and Statistics

Figure 2.3.2 Monthly Average(2010-2016) Relative Humidity - Kiulekada

2.3.2 Rainfall

The closest rainfall gauging station of Kiulekada cascade is Kebithigollewa. The monthly rainfall data is obtained from meteorological department of Sri Lanka. According to the data, the annual rainfall of Kebithigollewa ranges from 868.0mm to 1869.5mm, and average of it is 1544.5mm. The monthly rainfall is at the lowest in July and at highest in November.



Source: Department of Meteorology, Sri Lanka

Figure 2.3.3 Average (1977-2016) Monthly Rainfall

2.4 Agriculture and Agro-economy

2.4.1 Farm Land Holdings and Ownership

(1) Farm Holding

The average total land holding size of households in Kiulekada cascade varies between 2.5 acres and 4.4 acres with an average holding size of 3.77 acres. This comprise of extents held under different land categories of irrigable (main tank and other tanks), Akkarawela, Chena and home garden.

Table 2.4.1 Average Land Holding of Households by Category

Tank	Average Landholding (Acres)					
	Main Tank	Other Tank	Akkara-wela	Chena	Home Garden	Total Landholding
Galkadawala Kudawewa	3.60	0	0	0	0.8	4.40
Galkadawala Mahawewa	2.09	0	0	0.44	1.54	4.07
Kudagama	1.40	0.41	0	0.81	0.59	3.20
Gonahathdenawa	2.81	0.09	0.03	0.25	0.97	4.15
Halmillawatya	2.13	0	0.07	0.40	0.85	3.45
Ihala Tammanawa	3.51	0	0	0	0.86	4.38
Ikirigollewa	1.53	0.08	0.03	1.05	0.92	3.61
Kiulekada Kudawewa	2.00	0	0	0	0.50	2.50
Kiulekada	2.25	0	0	0	2.00	4.25
Nawagha wewa	1.50	0	0	0.5	0.50	2.50
Pahala Tammanawa	4.15	0.17	0	0.04	0.71	5.06
Puliyankulam Kudawewa	1.70	0	0	0.20	1.00	2.90
Puliyankulam	1.53	0	0	0.81	0.90	3.24
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	2.24	0.12	0.02	0.48	0.91	3.77

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

(2) Land Ownership and Tenure

A number of traditional land ownership and tenure systems operate in the cascade. The main categories are identified as owned, pangu and ande lands. Owned lands are legal holdings while pangu refer to fragmented portions inherited by the children of the original owners. Land extent in each pangu portion is decided by mutual agreement without physical partitioning. Ande system, a form of share-cropping, is reported in the cascade system. Cultivation of lands obtained on seasonal lease agreement and is less common. About 90% of the households owned their irrigated paddy lands followed by ande farmers who accounted for 8.6%. Leased and pangu lands are insignificant with less than 1% in each category. The percent distribution of households by type of land ownership in the command areas is shown in table below.

Table 2.4.2 Distribution of Land Ownership and Tenure Systems

Tank	Percent Households			
	Ande	Leased in	Own	Pangu
Galkadawala Kudawewa	0	0	100.00	0
Galkadawala Mahawewa	3.70	3.70	92.59	0
Kudagama	25.45	0	74.55	0
Gonahathdenawa	4.76	0	95.24	0
Halmillawatya	4.76	0	95.24	0
Ihala Tammanawa	0	0	100.00	0
Ikirigollewa	10.53	0	84.21	5.26
Kiulekada Kudawewa	0	0	100.00	0
Kiulekada	0	0	100.00	0
Nawagha wewa	100.00	0		0
Pahala Tammanawa	0	8.33	91.67	0
Puliyankulam Kudawewa	0	0	100.00	0
Puliyankulam	0	0	100.00	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a
Cascade	8.63	0.78	90.20	0.39

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

2.4.2 Crop Production

(1) Cropped Extents, Production and Yields

Like all cascade systems, Kiulekada is a predominantly paddy producing area. Other crops are grown in smaller extents and they are mostly confined to rain-fed highlands during the Maha season.

(a) Paddy

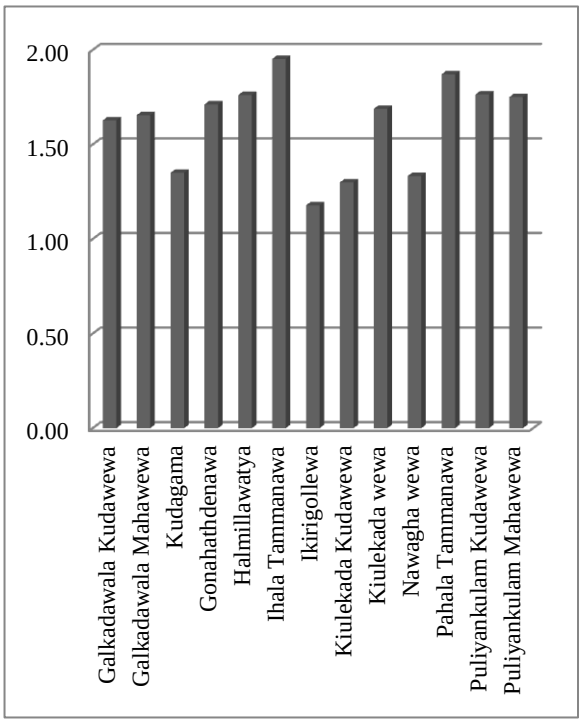
Maha is the main production season. Only four out of the 13 tanks in the cascade system, namely, Gonahathdenawa, Kudagama, Halmillawatya, Puliyankulam and Puliyankulam Kudawewa are cultivated during the Yala season. The cultivated extent in the Yala season amounts to 16.5% of the extent cultivated in the Maha season. Cultivation of paddy in other land categories such as Akkarawela during Yala and Maha seasons is insignificant.

Average yields of 1.67 MT/acre (4.1 MT/Ha) and 1.8 MT/acre (4.5 MT/Ha) are reported for the Maha and Yala seasons respectively.

Table 2.4.3 Paddy Extents, Production and Yield by Season

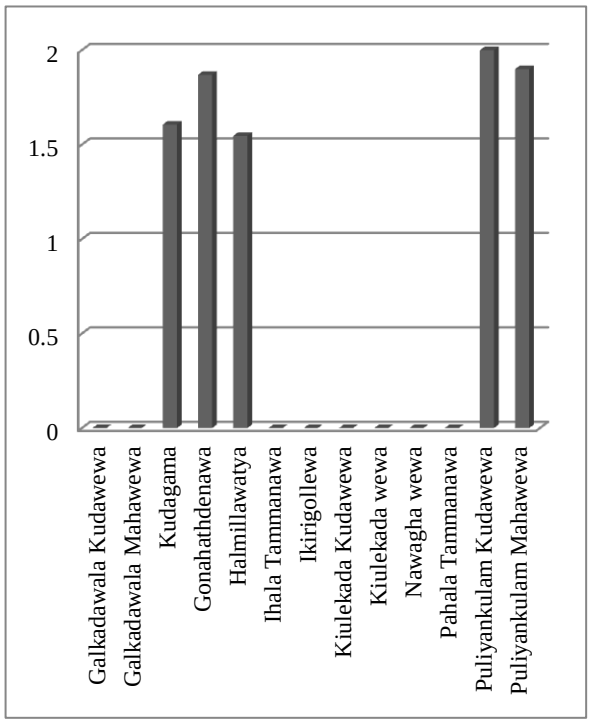
Tank	Maha Season			Yala Season		
	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)	Extent (Acs)	Production (MT)	Average Yield (MT/Ac)
Galkadawala Kudawewa	18	29.3	1.63	0	0	0
Galkadawala Mahawewa	56.5	93.52	1.66	0	0	0
Kudagama	79	106.7	1.35	15.75	25.3	1.61
Gonahathdenawa	176.75	302.58	1.71	69.25	129.48	1.87
Halmillawatya	44.75	78.84	1.76	3.75	5.8	1.55
Ihala Tammanawa	63.25	123.5	1.95	0	0	0
Ikirigollewa	30.5	35.94	1.18	0	0	0
Kiulekada Kudawewa	2	2.6	1.30	0	0	0
Kiulekada	4.5	7.6	1.69	0	0	0
Nawagha wewa	1.5	2	1.33	0	0	0
Pahala Tammanawa	49.75	93.1	1.87	0	0	0
Puliyankulam Kudawewa	8.5	15	1.76	1	2	2
Puliyankulam	39.75	69.6	1.75	5	9.5	1.9
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	574.75	960.28	1.67	94.75	172.08	1.82

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017



** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.1 Average Paddy Yield (Maha)



** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.2 Average Paddy Yield (Yala)

(b) Other Crops Cultivation

Maize (coarse grain) is the main crop cultivated during the Maha season under rain-fed conditions. The cropped area of other crops such as coarse grains and vegetables is very small and the produce is mainly for home consumption. Small extents of sesame are grown during the Yala season.

Table 2.4.4 Cultivated Extents of Other Crops under Rain-fed Conditions in Maha Season

Tank	Acres			Production (MT)			Average Yield (MT/Ac)		
	Coarse Grain	Grain Legume	Vegetables	Coarse Grain	Grain Legume	Vegetables	Coarse grain	Grain Legume	Vegetables
Galkadawala Kudawewa	0	0	0	0	0	0	0	0	0
Galkadawala Mahawewa	22.5	0	0	13.25	0	0	0.59	0	0
Kudagama	42	0	0.5	8.35	0	0	0.20	0	0
Gonahathdenawa	29	1	0	13.2	0.08	0	0.46	0.08	0
Halmillawatya	12.5	0	0	7.5	0	0	0.6	0	0
Ihala Tammanawa	8	1	0	1.28	0.16	0	0.16	0.16	0
Ikirigollewa	25	1.5	3	13.9	0.5	0.1	0.56	0.33	0.03
Kiulekada Kudawewa	0	0	0	0	0	0	0	0	0
Kiulekada	0	0	0	0	0	0	0	0	0
Nawagha wewa	0.5	0	0	0.1	0	0	0.2	0	0
Pahala Tammanawa	2	0	0	1	0	0	0.5	0	0
Puliyankulam Kudawewa	4	0	0	2.15	0	0	0.54	0	0
Puliyankulam	31	0	0.25	16.3	0	0	0.53	0	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	176.5	3.5	3.75	77.03	0.74	0.1	0.44	0.21	0.03

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

(c) Fruit Cultivation

Banana, mango, guava and papaya are the main fruit crops grown mainly in homesteads in a mixed cropping system

(2) Input Supply

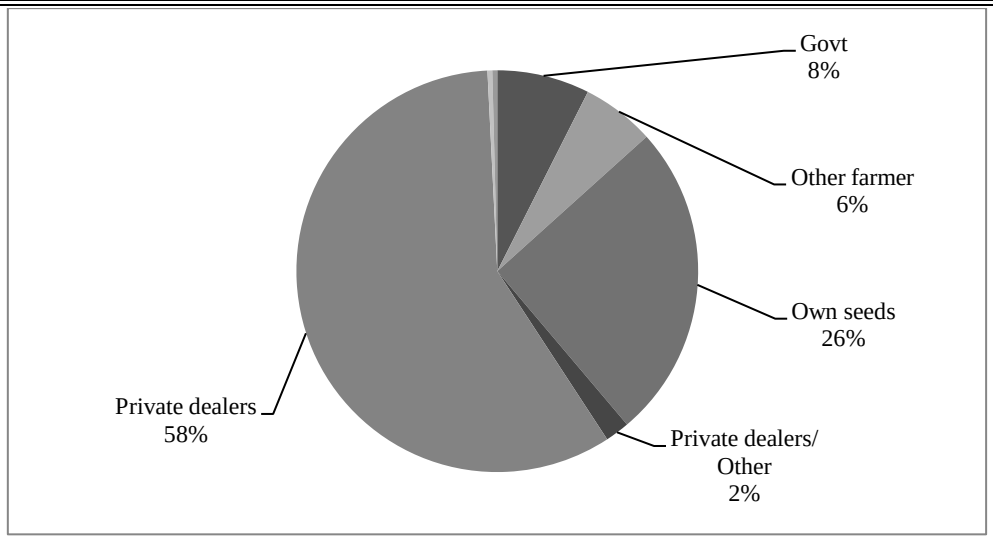
(a) Seeds and Planting Material

Fifty-eight percent of the farmers in Kiulekada cascade depend on private seed dealers as suppliers of seeds paddy while 25% use self-produced seeds. Relatively a small percentage of farmers use seed paddy produced by Government supply sources. It is also noted that farmers use own seeds produced from the certified seeds for several seasons before renewal with certified seeds. The percent distribution of seed paddy by source is shown in the table below.

Table 2.4.5 Sources of Seed Paddy Supply (% Households)

Tank	Govt	Other Farmer	Own Seeds	Private Dealers/ Other	Private Dealers	Other Farmer / Contractor	Own Seeds / Govt
Galkadawala Kudawewa	20.00	40.00	0	0	40.00	0	0
Galkadawala Mahawewa	0	7.41	25.93	3.70	59.26	3.70	0
Kudagama	9.09	5.45	23.64	0	61.82	0	0
Gonahathdenawa	7.94	4.76	25.40	4.76	55.56	0	1.59
Halmillawatya	14.29	0	28.57	4.76	52.38	0	0
Ihala Tammanawa	0	5.56	11.11	0	83.33	0	0
Ikirigollewa	5.26	15.79	10.53	0	68.42	0	0
Kiulekada Kudawewa	0	0	100	0	0	0	0
Kiulekada	0	0	0	0	100.00	0	0
Nawagha wewa	100.0	0	0	0	0	0	0
Pahala Tammanawa	8.33	0	41.67	0	50.00	0	0
Puliyankulam Kudawewa	20.00	0	20.00	0	60.00	0	0
Puliyankulam	3.85	3.85	46.15	0	46.15	0	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	7.45	5.88	25.49	1.96	58.43	0.39	0.39

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.3 Sources of Seed Paddy Supply

(b) Farm Labour

In the cascade, 68% of the farmers are engaged in farm work on full time while 23% work on part-time basis. The labour contribution made by members of the households is nearly 70% on part-time basis and 30% on full-time basis. About 9% of the households totally depend on hired labour while the majority or 92% used hired labour only at times of need.

Table 2.4.6 Percent Contribution to Farm Work by Different Labour Category

Tank	Head of households		Household members		Hired Labour	
	Full time	Part time	Full time	Part time	Only	Sometime
Galkadawala Kudawewa	60	40	0	100	0	100
Galkadawala Mahawewa	77.78	22.22	20	80	11.54	88.46
Kudagama	80	20	13.46	86.54	16.36	83.64
Gonahathdenawa	68.25	31.75	33.93	66.07	9.84	90.16
Halmillawatya	52.38	47.62	40	60	0	100
Ihala Tammanawa	61.11	38.89	46.67	53.33	0	100
Ikirigollewa	68.42	31.58	38.89	61.11	5.26	94.74
Kiulekada Kudawewa	0	100	100	0	0	100
Kiulekada	50	50	0	100	50	50
Nawagha wewa	100	0	0	100	0	100
Pahala Tammanawa	41.67	58.33	60	40	16.67	83.33
Puliyankulam Kudawewa	40	60	60	40	0	100
Puliyankulam	73.08	26.92	31.58	68.42	7.69	92.31
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	68.24	31.76	30.40	69.60	9.52	90.48

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Major problem related to hired labour faced by 65% of households is their high wage rate which tended to rise by season. On average, each hired labour unit cost the farmer Rs.1,200-1,300 per day plus meals and refreshments. Twenty-eight percent of the farmers find there is a shortage of hired labour at peak farm operational times when they are needed most. The combination of shortage and the high rates charged by hired labour is cited by 88% of the households as a major concern in crop production.

Table 2.4.7 Problems Related to Hired Labour

Tank	Percent Households			
	High Rate	None	Shortage/ High Rate	Shortage
Galkadawala Kudawewa	100.00	0	0	0
Galkadawala Mahawewa	92.59	0	0	7.41
Kudagama	65.45	0	0	34.55
Gonahathdenawa	59.02	9.84	8.20	22.95
Halmillawatya	85.71	4.76	0	9.52
Ihala Tammanawa	27.78	5.56	5.56	61.11
Ikirigollewa	50.00	0	5.56	44.44
Kiulekada Kudawewa	0	0	0	100.00
Kiulekada	50.00	0	50.00	0
Nawagha wewa	100.00	0	0	0
Pahala Tammanawa	50.00	0	8.33	41.67
Puliyankulam Kudawewa	20.00	0	0	80.00
Puliyankulam	84.00	0	0	16.00
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a
Cascade	65.34	3.19	3.59	27.89

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

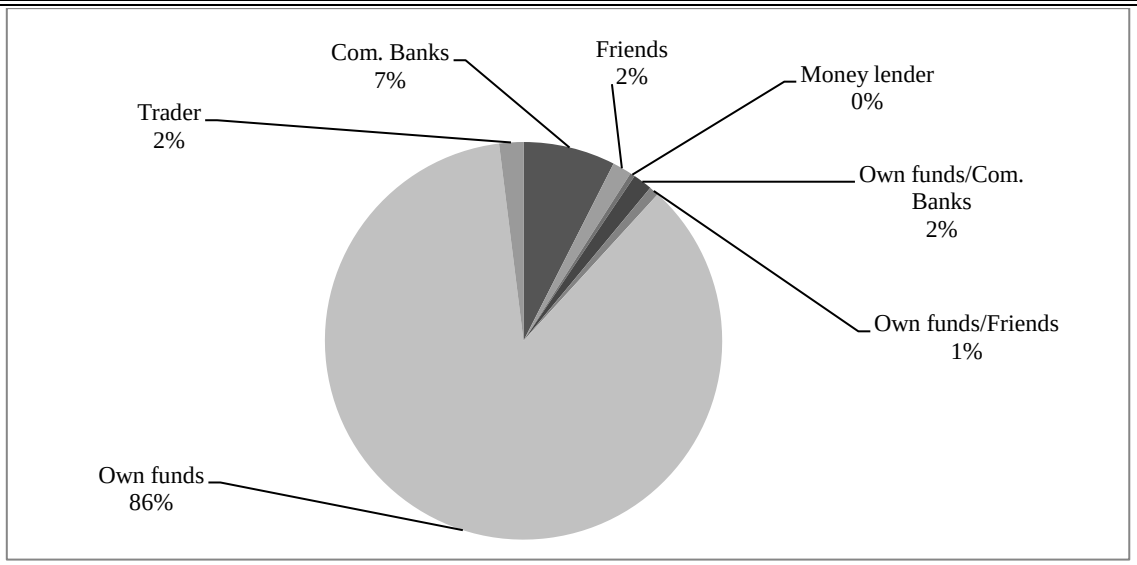
(c) Production Capital

Majority of the households in the cascade (86%) use their own savings as production capital. Dependence on cultivation loans from commercial banks is only 7%. Farmers may not be able to raise cultivation loans from formal lending sources due to default or they apply low investment on cultivation due to high risk factors. Credit inflow from other sources is minimal.

Table 2.4.8 Sources of Capital for Cultivation (%HH)

Tank	Com. Banks	Friend	Money lender	Own / Com. Banks	Own funds /Friends	Own funds	Trader
Galkadawala Kudawewa	20.00	0	0	0	0	60.00	20.00
Galkadawala Mahawewa	25.93	3.70	0	3.70	0	66.67	0
Kudagama	3.64	1.82	0	1.82	1.82	90.91	0
Gonahathdenawa	6.35	0	1.59	3.17	0	84.13	4.76
Halmillawatya	0	10.00	0	0	0	90.00	0
Ihala Tammanawa	0	0	0	0	0	100.00	0
Ikirigollewa	0	0	0	0	5.26	94.74	0
Kiulekada Kudawewa	0	0	0	0	0	100.00	0
Kiulekada	100.00	0	0	0	0	0	0
Nawagha wewa	0	0	0	0	0	100.00	0
Pahala Tammanawa	8.33	0	0	0	0	91.67	0
Puliyankulam Kudawewa	0	0	0	0	0	100.00	0
Puliyankulam	7.69	0	0	0	0	88.46	3.85
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	7.48	1.57	0.39	1.57	0.79	86.22	1.97

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.4 Sources for Cultivation Capital

(d) Irrigation water

In the Maha season, 42% of the farmers were satisfied with the quantity of water they received while in Yala season, all farmers responded negatively on the adequacy. 53% percent of the farmers found the irrigation water in the Yala season insufficient and the balance 46% stated that they did not receive any water.

Table 2.4.9 Percent of Householders by Adequacy of Irrigation Water

Tank	Maha		Yala		
	Sufficient	Insufficient	Sufficient	Insufficient	No water
Galkadawala Kudawewa	20.00	80.00	0	0	100.00
Galkadawala Mahawewa	3.70	96.30	3.70	0	96.30
Kudagama	3.64	96.36	0	94.44	5.56
Gonahathdenawa	98.41	1.59	0	100.00	0
Halmillawatya	19.05	80.95	0	15.00	85.00
Ihala Tammanawa	0	100.00	0	0	100.00
Ikirigollewa	63.16	36.84	0	15.79	84.21
Kiulekada Kudawewa	0	100.00	0	0	100.00
Kiulekada	50.00	50.00	0	50.00	50.00
Nawagha wewa	0	100.00	0	0	100.00
Pahala Tammanawa	16.67	83.33	0	0	100.00
Puliyankulam Kudawewa	60.00	40.00	0	0	100.00
Puliyankulam	76.92	23.08	0	50.00	50.00
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a
Cascade	42.35	57.65	0.40	52.78	46.83

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Seventy-nine percent of the farmers stated that they commenced land preparation for cropping with the onset of seasonal rains while the balance delayed till the tanks are adequately filled up because of the uncertainty of rainfall.

(e) Agro-wells

Thirty-four percent of the households in the cascade area own agro-wells and they are located mainly in their in home gardens. About 3.5% of the agro-wells were located in the command areas.

Table 2.4.10 Distribution of Agro-wells by Location

Tank	% of farmers having agro-wells	% of agro-wells by Location	
		Command area	Home garden
Galkadawala Kudawewa	40	50	50
Galkadawala Mahawewa	48.15	0	100
Kudagama	25.45	7.14	92.86
Gonahathdenawa	50.79	3.33	96.67
Halmillawatya	9.52	0	100
Ihala Tammanawa	11.11	0	100
Ikirigollewa	64.71	0	100
Kiulekada Kudawewa	100	0	100
Kiulekada	50	0	100
Nawagha wewa	100	0	100
Pahala Tammanawa	16.67	0	100
Puliyankulam Kudawewa	20	0	100
Puliyankulam	23.08	0	100
Kiulekada Ihala wewa	n.a	n.a	n.a
Cascade	34.78	3.49	96.51

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

2.4.3 Technology Transfer

The major providers of extension services are the ARPA and the AI and their combined contribution is recognized by 90% of the respondents. The combination of contractors having market linkages with farmers and the AI served about 3% of the households.

Table 2.4.11 Agricultural Extension Providers

Tank	Percent Households						
	ARPA	Contractors	DoA/ ARPA	DoA/Contractors	DoA	Other	Media
Galkadawala Kudawewa	80.00	0	0	0	0	20.00	0
Galkadawala Mahawewa	77.78	0	11.11	0	0	11.11	0
Kudagama	30.91	0	67.27	1.82	0	0	0
Gonahathdenawa	68.25	4.76	9.52	3.17	0	14.29	0
Halmillawatya	90.48	0	4.76	0	0	4.76	0
Ihala Tammanawa	38.89	5.56	44.44	0	11.11	0	0
Ikirigollewa	15.79	0	84.21	0	0	0	0
Kiulekada Kudawewa	0	0	0	0	0	100.00	0
Kiulekada	0	0	50.00	0	0	0	50.00
Nawagha wewa	100.00	0	0	0	0	0	0
Pahala Tammanawa	83.33	0	16.67	0	0	0	0
Puliyankulam Kudawewa	80.00	0	0	0	0	20.00	0
Puliyankulam	96.15	0	0	0	0	3.85	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	60.39	1.57	29.02	1.18	0.78	6.67	0.39

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

The specific areas that the farmers wished to learn more on agricultural innovations are identified as plant protection and crop production which together ranked high at 94%. Other areas of interest are the combination of crop and livestock which accounts for 5.5%.

Table 2.4.12 Training Needs Identified by Farmers (Percent Households)

Tank	Crop / Livestock	Crop / Marketing	Crop production Protection	Crop production	Live stock	None	Protection
Galkadawala Kudawewa	20.00	0	0	80.00	0	0	0
Galkadawala Mahawewa	7.41	0	22.22	59.26	11.11	0	0
Kudagama	0	3.64	60.00	36.36	0	0	0
Gonahathdenawa	6.35	0	9.52	82.54	1.59	0	0
Halmillawatya	0	0	0	100.00	0	0	0
Ihala Tammanawa	5.56	0	22.22	61.11	0	0	11.11
Ikirigollewa	0	0	84.21	10.53	0	0	5.26
Kiulekada Kudawewa	0	0	0	100.00	0	0	0
Kiulekada	50.00	0	0	50.00	0	0	0
Nawagha wewa	0	0	100.00	0	0	0	0
Pahala Tammanawa	0	0	8.33	75.00	8.33	8.33	0
Puliyankulam Kudawewa	0	0	0	100.00	0	0	0
Puliyankulam	0	0	0	100.00	0	0	0
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	3.53	0.78	26.27	65.88	1.96	0.39	1.18

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

2.4.4 Crop Diversification

(1) Farmer Response to Crop Diversification

Majority of the farmers in Kiulekada cascade do not wish to diversify their irrigated paddy fields during the Maha season. However, during the Yala season, 83% of the households expressed their willingness to total or partial diversification while over 9% remains undecided. Only 7% of the farmers do not wish to diversify their paddy lands in the Yala season.

With regard to preferred crops for diversification, 48% of the willing farmers identify grain legumes followed by 27% for maize and 13% for vegetables.

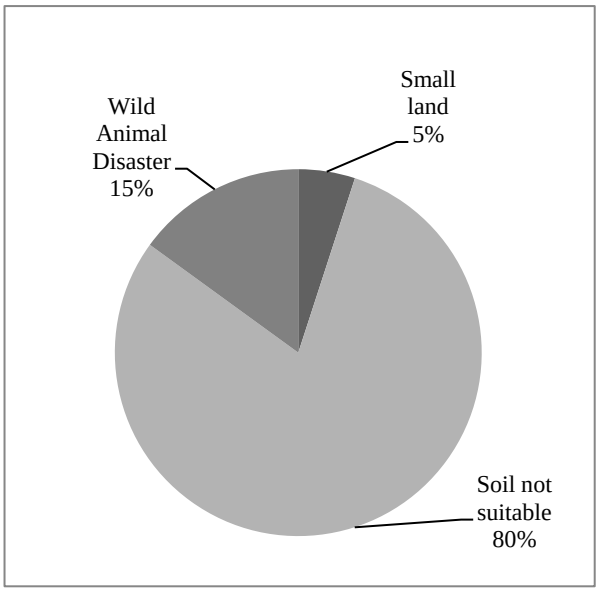
Table 2.4.13 Farmer Response to Crop Diversification (Percent Households)

Tank	Maha			Yala		
	Yes	No	Undecided	Yes	No	Undecided
Galkadawala Kudawewa	0	100	0	80	20	0
Galkadawala Mahawewa	0	100	0	92.59	0	7.41
Kudagama	0	100	0	87.27	12.73	0
Gonahathdenawa	1.59	85.71	12.70	69.84	7.94	22.22
Halmillawatya	0	100	0	85.71	4.76	9.52
Ihala Tammanawa	0	100	0	100	0	0
Ikirigollewa	5.26	94.74	0	89.47	10.53	0
Kiulekada Kudawewa	0	100	0	100	0	0
Kiulekada	0	100	0	100	0	0
Nawagha wewa	0	100	0	100	0	0
Pahala Tammanawa	0	75	25	66.67	0	33.33
Puliyankulam Kudawewa	0	100	0	60	40	0
Puliyankulam	0	92.31	7.69	92.31	0	7.69
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	0.78	94.12	5.10	83.53	7.06	9.41

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

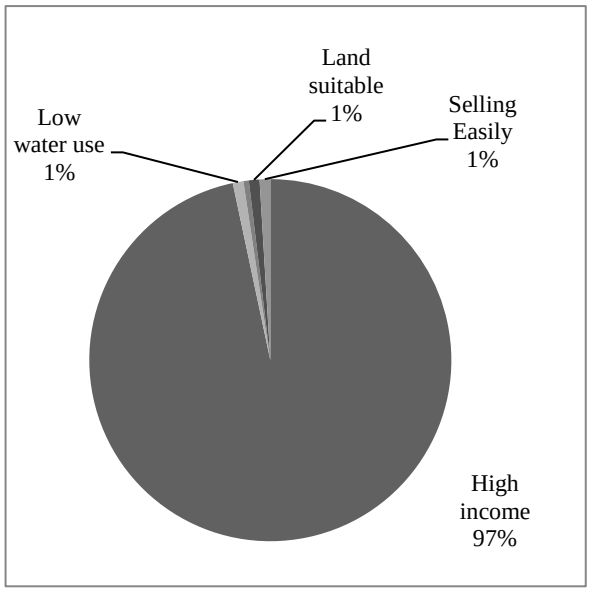
(2) Reasons For and Against Crop Diversification

The main seasons in support of crop diversification during the Yala season were identified as higher farm income by 97% of the farmers. In the Maha season, 80% of the farmers find the soil is not suitable for crop diversification. The Percent response by the famers is shown in the following figure.



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.5 Reasons For Reluctance to Diversification



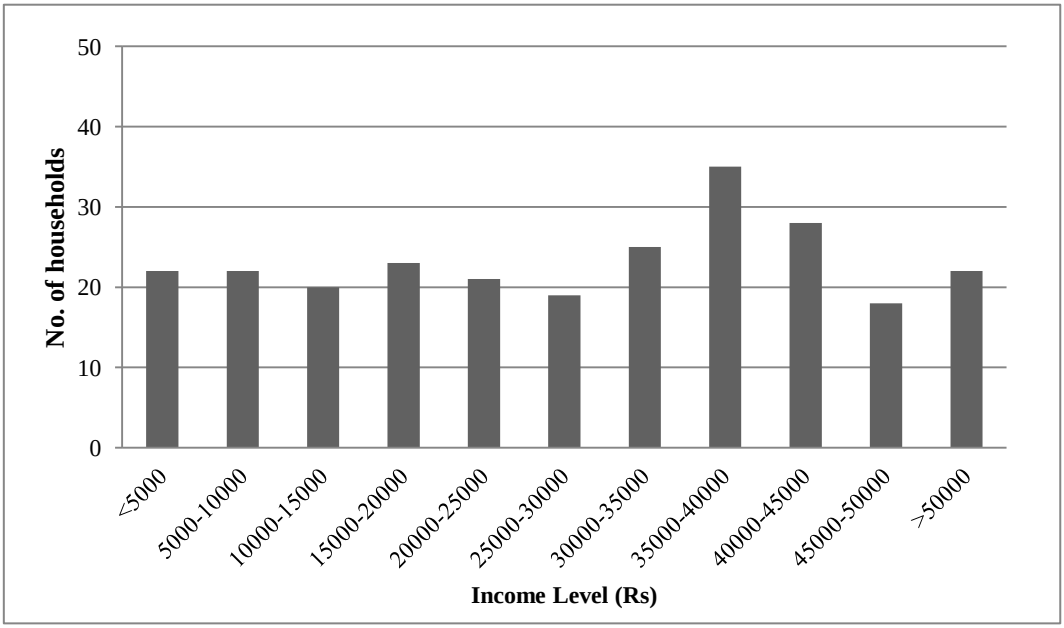
Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.6 Reasons For Willingness to Diversification

2.4.5 Household Income

(1) Total Income

The total monthly income of households in Kiulekada cascade varied between less than Rs.5,000 and Rs.50,000 and averaged to Rs.28,600. About 50% of the households earned a monthly income of over Re.30,000. Earnings from regular employment in state/private sector and crop production as primary source of income are divided equally among the households at 47%.



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.7 Household Monthly Income Distribution

(2) Farm Income

Crop production constituted the primary income source of 47% of households and the secondary source of income of 59% of the balance households. The calculated monthly income from crop production varied between Rs.3,300 and Rs.16,200 with an average of Rs.9,162.

Table 2.4.14 Farm Income from Crop Production (Rs)

Tank	Average Income-Maha	Average Income-Yala	Average Annual Income	Average Monthly Income
Galkadawala Kudawewa	106,800	0	106,800	8,900
Galkadawala Mahawewa	93,481	0	93,481	7,790
Kudagama	50,507	11,576	62,084	5,174
Gonahathdenawa	113,643	50,148	163,790	13,649
Halmillawatya	88,952	7,286	96,238	8,020
Ihala Tammanawa	150,689	0	150,689	12,557
Ikirigollewa	66,500	0	66,500	5,542
Kiulekada Kudawewa	40,000	0	40,000	3,333
Kiulekada	40,400	0	40,400	3,367
Nawagha wewa	50,000	0	50,000	4,167
Pahala Tammanawa	153,333	42,083	195,417	16,285
Puliyankulam Kudawewa	82,600	10,000	92,600	7,717
Puliyankulam	76,746	10,462	87,208	7,267
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a
Cascade	91,210	18,729	109,939	9,162

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

2.4.6 Marketing

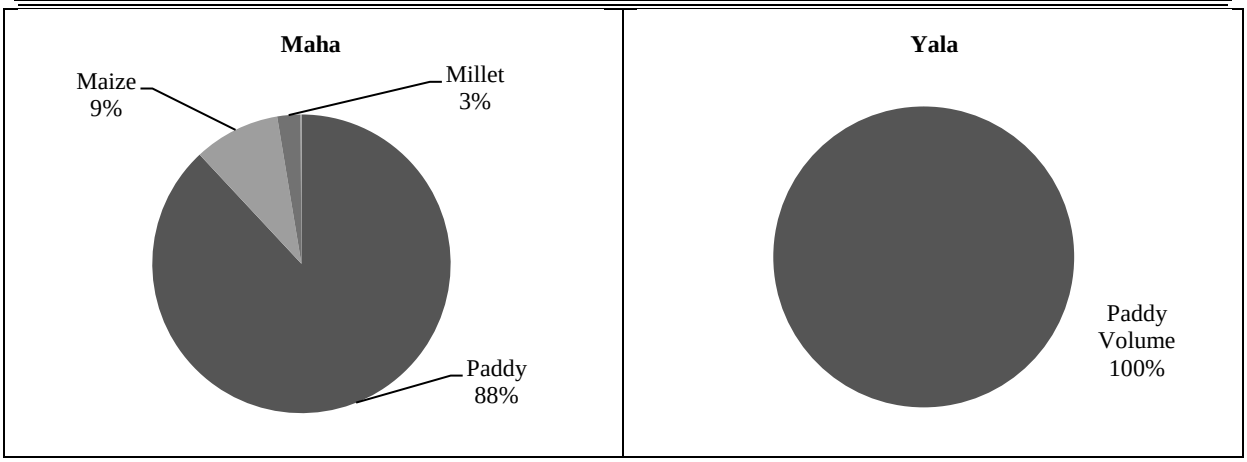
(1) Major Cash Crops: Paddy-centred

Table 2.4.15 and Figure 2.4.8 show the quantity of crops sold in the Maha and Yala season, in Kiulekada cascade. In the cascade, diversity of crops is limited to paddy, maize and millet in the Maha and only paddy in the Yala.

Table 2.4.15 Cash Crops in Kiulekada Cascade

Crops		Maha season	Yala season
Paddy	Volume (kg)	556,250	107,740
	Number	207	74
Maize	Volume (kg)	59,000	0
	Number	66	0
Millet	Volume (kg)	15,750	0
	Number	42	0
Black gram	Volume (kg)	130	0
	Number	2	0
Cowpea	Volume (kg)	175	0
	Number	3	0
Groundnut	Volume (kg)	100	0
	Number	2	0
Sesame	Volume (kg)	225	0
	Number	2	0
Vegetables	Volume (kg)	100	0
	Number	1	0

Source: Farm Household Survey, JICA Project Team 2017



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.4.8 Crop Diversification in Kiulekada cascade

(2) Paddy

Both in the Maha and Yala, millers and collectors are the major buyers of paddy. Unlike the other targeted cascades, PMB does not purchase paddy from the cascade.

Table 2.4.16 Paddy Sales in Maha Season

Buyer	Volume sold (kg)	Average Volume (kg)	Price (Rs/kg)
Miller	261,050	3,035.47	30.77
Collector	207,850	2,886.81	30.14
N/A	86,850	1,809.38	30.50
Contract	500	500.00	33.00
Total	**556,250**	**2,687.20**	**30.50**

Source: Farm Household Survey, JICA Project Team 2017

Table 2.4.17 Paddy Sales in Yala Season

Buyer	Volume sold (kg)	Average volume (kg)	Price (Rs/kg)
Miller	50,450	1,483.82	35.29
Collector	46,800	1,509.68	33.90
Total	**97,250**	**1,496.15**	**34.63**

Source: Farm Household Survey, JICA Project Team 2017

(3) Others

Maize and millet are the other important cash crops in Maha. 66 farmers sell maize and 42 sell millet in the season. All transaction are individually conducted. Neither collective selling nor contract faming is observed. A limited number of farmers earn by selling his/her mangoes, too.

Table 2.4.18 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

2.5 Livestock

2.5.1 General Situation of Livestock Activities in the Area

During the past several decades, most of the farmers focused on crop cultivation activities as the demand for crop-based food increased. With rainfall and irrigation facilities farmers found there was sufficient water to cultivate almost all the land in their area during Maha. The excess water was saved in tanks and used during the Yala season. Meanwhile till the government prohibited use of pastureland and forestland for grazing the cattle herders in these areas allowed their cattle to freely graze in those areas. This prohibition had an effect on cattle herding. The number of people keeping cattle reduced and the number of cattle kept by individuals also reduced to a manageable level. The extension sector finds it difficult to attract newcomers to livestock rearing activities.

These families keeping indigenous chicken types rear not only for their nutrition but also to support the conservation of indigenous genetic resources of Sri Lanka. This activity has a major impact on the family nutrition of these families. These types are mainly kept as free roaming scavenging types in their home gardens. Majority of the households in Kiulekada have less than one and a half acres home garden area. This area is not big enough to maintain this type of birds as these households grow vegetables and food crops within these premises. Hence, alternative methods have to be introduced.

Table 2.5.1 Characteristics of the Cattle Farming System in Kiulekada Cascade

Issues on farming system	Situation
1. Cattle keeping is a family tradition	Yes
2. Genetic value of cattle	Local and Crossbred cattle
3. Feed resource	Free grazing, tethered and stall feeding
4. Knowledge on technology	Insufficient for this level of management
5. Reproductive management	No
6. Health management	No
7. Access and ability to financing	No
8. Labour	Family

Source: Farm Household Survey, JICA Project Team 2017

2.5.2 Livestock Farming Population and Income

The proportion of households holding livestock in Kiulekada cascade is only 7.5% as shown in the table below. Those livestock farmers are found only in Galkadawala Kudawewa, Galkadawala Mahawewa, Kudagama, Gonahathdenawa, Ihala Tammanawa, Kiulekada, Puliyankulam Kudawewa and Puliyankulam. Among those, only one household in Gonahathdenawa keeps poultry.

The average income from livestock of the farmers who have rare livestock as their income source is Rs.18,100. The range of the income from livestock at individual household level is between Rs.5,000 and Rs.35,000.

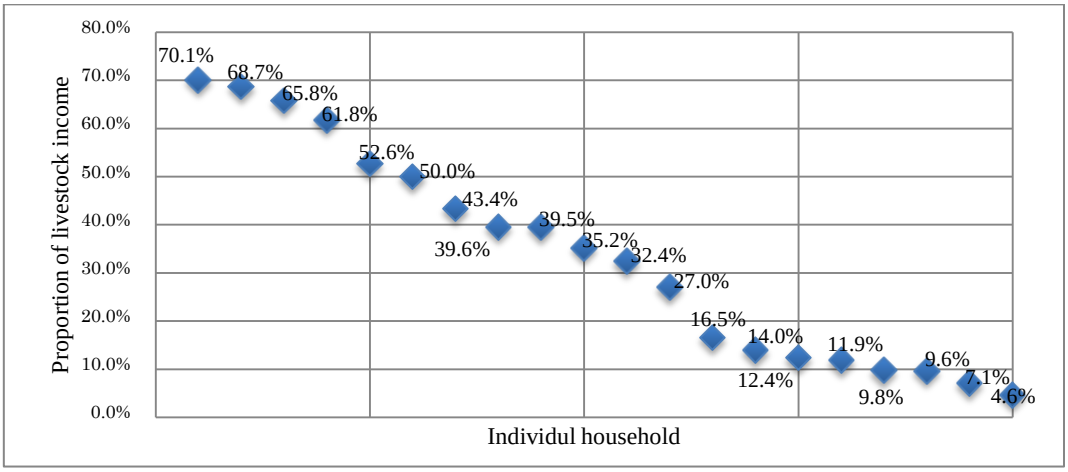
Table 2.5.2 Livestock Farmers and Average Monthly Income from Livestock per Tank

Tanks	Total Surveyed	Cattle Farmers		Poultry Farmers		Average Monthly Income From Livestock
	(no. HH)	(no. HH)	%	(no. HH)	%	(Rs.)
Galkadawala Kudawewa	5	1	20.0%		0.0%	8,000
Galkadawala Mahawewa	27	7	25.9%		0.0%	18,000
Kudagama	55	4	7.3%		0.0%	
Gonahathdenawa	63	3	4.8%	1	1.6%	22,188
Halmillawatya	21		0.0%		0.0%	
Ihala Tammanawa	18	1	5.6%		0.0%	
Ikirigollewa	19		0.0%		0.0%	
Kiulekada Kudawewa	1		0.0%		0.0%	
Kiulekada wewa	2	1	50.0%		0.0%	5,000
Nawagha wewa	1		0.0%		0.0%	

Pahala Tammanawa	12		0.0%		0.0%	
Puliyankulam Kudawewa	5	1	20.0%		0.0%	30,000
Puliyankulam	26	1	3.8%		0.0%	13,650
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	255	19	7.5%	1	0.4%	18,100

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

The following indicate the distribution of income from livestock of each livestock farmers. Around 60% of the livestock farmers in this cascade who operate livestock as their income source receive over 25% of their income from livestock, and 25% of them receive more than 50% of their income from livestock. Despite the fact that they are in the subsistence level of production. Although the percentage of the household that have livestock is small in this area, many of them rely highly on livestock for their revenue.



Source: Farm Household Survey, JICA Project Team 2017

Figure 2.5.1 Distribution of Proportion of Annual Income from Livestock

2.5.3 Livestock Population and Breed

The following indicate the livestock population in the Kiulekada cascade area

Table 2.5.3 Livestock Population

Tank	Cattle				Poultry			
	Dairy Cows	Dry cows	Heifers	Bulls	Calves	Cattle Total	Layers	Pullets
Galkadawala Kuda wewa	1				1	2		
Galkadawala Maha wewa	13	13	6	8	14	54		
Kudagama		2	13	1	3	19		
Gonahathdenawa	15	14	1	3	11	44	15	
Halmillawatya						0		
Ihala Tammanawa		4	2	1	1	8		
Ikirigollewa						0		
Kiulekada Kudawewa						0		
Kiulekada wewa	2	2	2	1	3	10		
Nawagha wewa						0		
Pahala Tammanawa						0		
Puliyankulam Kudawewa		1		1		2		
Puliyankulam	2	1			1	4		
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Total	33	37	24	15	34	143	15	

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

It is observed that 61% of the cattle are local breeds as shown in the following table. This implies that these households had a history of maintaining cattle herds of local breeds for meat. Some of those households are gradually transforming by including crossbreds into their herds. System change from meat to milk is happening very slowly. Only one household in Kiulekada cascade has solely crossbred cattle, others have mixed herds of locals and crossbreds. Indigenous poultry keeping is found in one household in Gonahathdenawa area.

Table 2.5.4 Livestock Population by Breed

Tank	Cattle				Poultry			
	Crossbred		Local		Local		Farm	
	(no.)	(%)	(no.)	(%)	(no.)	(%)	(no.)	(%)
Galkadawala Kudawewa		0%	2	100%				
Galkadawala Mahawewa	32	59%	22	41%				
Kudagama		0%	19	100%				
Gonahathdenawa	14	32%	30	68%	15	100.0%		0.0%
Halmillawatya								
Ihala Tammanawa		0%	8	100%				
Ikirigollewa								
Kiulekada Kudawewa								
Kiulekada	10	100%		0%				
Nawagha wewa								
Pahala Tammanawa								
Puliyankulam Kudawewa		0%	2	100%				
Puliyankulam		0%	4	100%				
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Cascade	56	39%	87	61%	15	100.0%	0	0.0%

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

2.5.4 Livestock Production

The total milk production of this cascade is 121 litres per day and the average production of their herd is 3.7 litres per cow per day. The average productivity in this cascade is higher than that of Northern province (average of about 1 litre/day/cow for local breed and 2 litres/day/cow for crossbred), though it is much lower than the average of other area of Sri Lanka (Department of Animal production and Health, 2008). It means milk production in this cascade is still in the subsistence level. The cost of production of a litre of milk is as low as Rs 5 to 10. Hence, the daily CoP of this amount of milk is Rs 60 to 120. It will make income of Rs.8,107 per day when they sale the milk at price of Rs 67 per litre. This means monthly, the total milk profit in the cascade is Rs 240,000. The turnover is 570%.

Table 2.5.5 Livestock Production

Tanks	Total Daily Milk Production (litres/day)	No. of Dairy Cows	Average Milk Productivity (litres/day/cow)	Production eggs/day
Galkadawala Kudawewa	5	1	5.0	
Galkadawala Mahawewa	57	13	4.4	
Kudagama	0	0		
Gonahathdenawa	42	15	2.8	10
Halmillawatya	0	0		
Ihala Tammanawa	0	0		
Ikirigollewa	0	0		
Kiulekada Ihalawewa	0	0		
Kiulekada Kudawewa	0	0		
Kiulekada	10	2	5.0	
Nawagha wewa	0	0		
Pahala Tammanawa	0	0		
Puliyankulam Kudawewa	0	0		

Puliyankulam	7	2	3.5	
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a
Cascade	121	33	3.7	10

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Milking twice per day can produce more milk than milking only once a day. However, milking once a day is the most popular form in the area. There are many reasons for adopting this procedure according to Kiulekada cascade farmers.

Table 2.5.6 Milking Once versus Twice

Reason	Once	Twice
Milk Production	Less milk production	25% more milk production
Difficulty	Easily fit into daily farmers' chores	Create problems - requires cleaning and washing twice
Time	Sufficient time available	No extra time as more time is set aside for cropping activities
Milk collecting	Milk collecting transport from the village milk collecting point to chilling centre is available only in the morning.	No transport for milk collecting and no cool storage facilities at the village milk-collecting centre.
Inputs for milk production	Fits the current grazing management system for feed management	Increased milk production require extra feed and the cost of production of milk increases
Replacement calf nutrition	Is better and the calf grows faster	Calf is allowed limited milk consumption during the first three months can affect lifetime growth and productivity

Source: Farm Household Survey, JICA Project Team 2017

2.5.5 Livestock Management System

Livestock productivity highly depends on the management of the livestock. Most of these farmers are not yet aware of importance of adequate management to increase milk production. Transformation of management has to be supported through an attitudinal change. Furthermore, stall-feeding is initiated in one household in Galkadawala Mahawewa. These are indications of change and it has to be supported by the extension service.

Table 2.5.7 Livestock Management Structure (no. HH)

Tank	Cattle			Poultry	
	Free range	Stall fed	Tethered	Free range	Deep litter
Galkadawala Kudawewa			1		
Galkadawala Mahawewa	1	1	5		
Kudagama	4				
Gonahathdenawa	1		1	1	
Halmillawatya					
Ihala Tammanawa	1				
Ikirigollewa					
Kiulekada Kudawewa					
Kiulekada			1		
Nawagha wewa					
Pahala Tammanawa					
Puliyankulam Kudawewa					
Puliyankulam			1		
Kiulekada Ihala wewa	n.a	n.a	n.a	n.a	n.a
Cascade	7	1	9	1	0

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

The table below shows that both male and female householders take care of cattle rearing even though it is considered as a male activity. This situation indicates that women can also handle free grazing and tethering system of management in this area. Moreover, it implies that, in consideration of the fact that a substantial proportion (20%) of the families is women headed, the women headed families have started rearing livestock in this area.

Table 2.5.8 Gender in Livestock Rearing

Tank	Cattle		
	Female	Male/Female	Male
Galkadawala Kudawewa			1
Galkadawala Mahawewa	4	1	2
Kudagama			4
Gonahathdenawa		1	2
Halmillawatya			
Ihala Tammanawa			1
Ikirigollewa			
Kiulekada Kudawewa			
Kiulekada	1		
Nawagha wewa			
Pahala Tammanawa			
Puliyankulam Kudawewa	1		
Puliyankulam	1		
Kiulekada Ihala wewa	n.a	n.a	n.a
Cascade	7	2	10

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Keeping and selling livestock enable the low-income rural families (in particular women) to enter the cash economy. In this way, livestock production provides increased stability in income for the family without disrupting other food producing activities. In Kiulekada cascade those rearing livestock own a small number of animals. In most cases, feeding this livestock does not cost these farmers anything. Their diet is mostly made up of the livestock graze and scavenges on common or wasteland except during the Maha season when they resort to feed collected crop residue of low quality. Small-scale producers do not feed their livestock with food that is otherwise used for human consumption.

2.5.6 Crop Residue and Livestock Feed

These farmers have been free-grazing livestock for generations. Hence, most of them are not familiar with purchasing grass or feed for cattle. Willingness of purchasing livestock feed was investigated through farm household survey. A shown in the following table, over 88% of the farmers are not willing to purchase animal feeds.

Table 2.5.9 Response to Purchase of Livestock Feed

Tank	No	Yes
Galkadawala Kudawewa		1
Galkadawala Mahawewa	6	
Kudagama	4	
Gonahathdenawa	3	
Halmillawatya		
Ihala Tammanawa	1	
Ikirigollewa		
Kiulekada Kudawewa		
Kiulekada		1
Nawagha wewa		
Pahala Tammanawa		
Puliyankulam Kudawewa	1	
Puliyankulam	1	
Kiulekada Ihala wewa	n.a	n.a
Cascade	16	2

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

The stocking-density of this area is 200 livestock units. In a normal Maha season in the Kiulekada cascade, the whole land is cultivated. Currently 200 acres of grazing area is available for cattle during the Yala season. However, this grazing area will not be available after the introduction of NCPC water by 2024. Furthermore, even though 115 acres of maize are currently cultivated in the area, its crop residue or stalk is hardly used. The following indicate estimated potential benefit of maize crop residue both for maize cultivators and dairy farmers.

Table 2.5.10 Estimated Potential Production and Income from Maize Crop Residue

Tank	Highland Maha Maize		Income for Maize Crop Farmers (Rs.)	Stocking Density (Livestock Units)/Year	No. Milking Cows (60%)	No. Cows in Milk	Milk / Day (8 lts /cow)	Monthly Income from Milk (Rs.)
	Area (Acres)	Crop Residue (Kg)						
Galkadawala Kudawewa		-	-	0.00	0.0	0.0	0.0	-
Galkadawala Mahawewa	19.5	351,000	351,000	48.08	28.8	24.0	192.3	386,581
Kudagama	21	378,000	378,000	51.78	31.1	25.9	207.1	416,318
Gonahathdenawa	19	342,000	342,000	46.85	28.1	23.4	187.4	376,668
Halmillawatya	10.5	189,000	189,000	25.89	15.5	12.9	103.6	208,159
Ihala Tammanawa	3.5	63,000	63,000	8.63	5.2	4.3	34.5	69,386
Ikirigollewa	22	396,000	396,000	54.25	32.5	27.1	217.0	436,142
Kiulekada Ihalawewa		-	-	0.00	0.0	0.0	0.0	-
Kiulekada Kudawewa		-	-	0.00	0.0	0.0	0.0	-
Kiulekada		-	-	0.00	0.0	0.0	0.0	-
Nawagha wewa		-	-	0.00	0.0	0.0	0.0	-
Pahala Tammanawa	2	36,000	36,000	4.93	3.0	2.5	19.7	39,649
Puliyankulam Kudawewa	2	36,000	36,000	4.93	3.0	2.5	19.7	39,649
Puliyankulam	16	288,000	288,000	39.45	23.7	19.7	157.8	317,195
Cascade	115.5	2,079,000	2,079,000	284.79	170.9	142.4	1139.2	2,289,748

** Ihala Tammanawa and Pahala Tammanawa are not included in the revised cascade boundary*
Source: Farm Household Survey, JICA Project Team 2017

Use of crop residue for animal feed has to be promoted, as it can bring an extra income to maize cultivators as well. This area can produce 2,000 metric tons of maize. The opportunity cost of selling a substantial quantity (75%) of the maize stalk for livestock feed and other (25%) as fertilizer can be considered a good option for maize growers. The maize cultivator could make an additional income of Rs.18,000 per acre by selling crop residue. Utilization of crop residue will result in 1,500 metric tons of maize crop residues as cattle feed. This amount of feed can maintain 170 livestock units under stall-feeding for one year. Current population of 37 dairy cows providing only 121 liters of milk can be transformed in to a system with 170 milking cows providing 1,360 liters of milk a day. However, the current genotypes have to be changed in to high producing cattle.

2.6 Irrigation, Drainage and Other Rural Infrastructure

2.6.1 Irrigation, Drainage and Farm Road

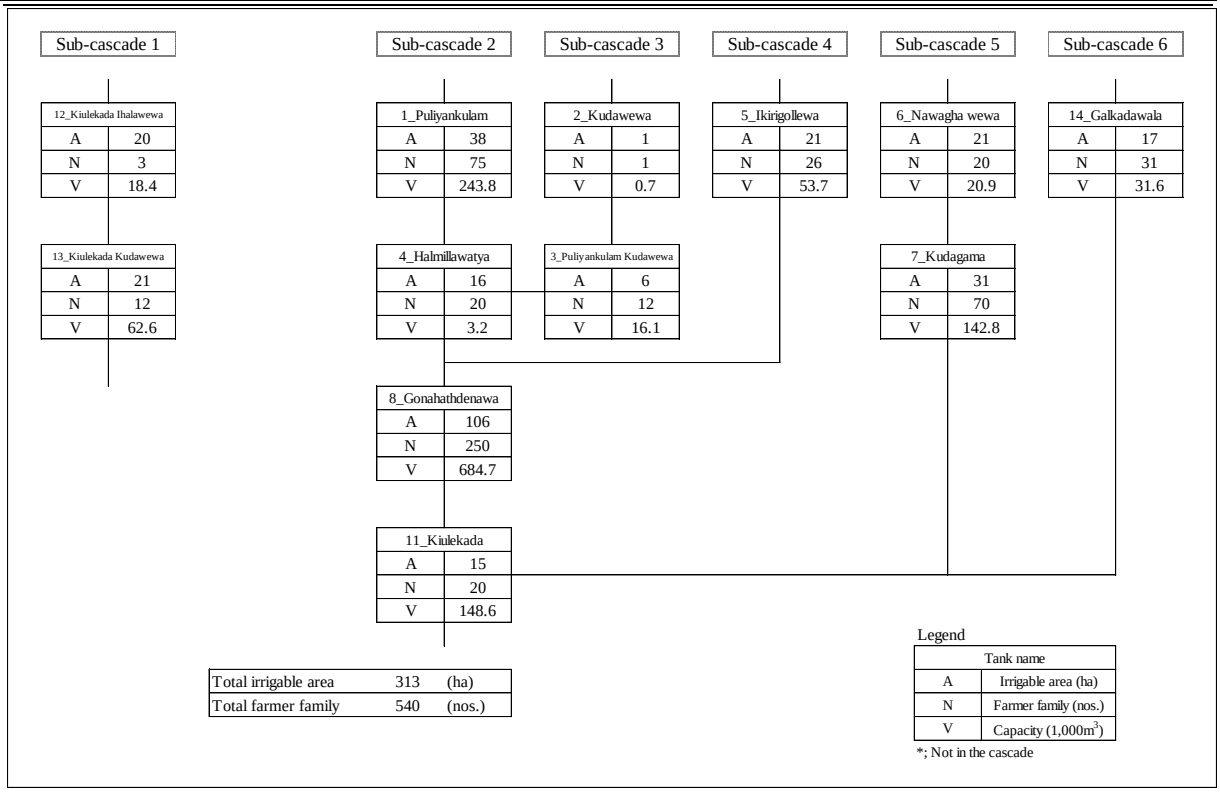
(1) Diagram for Irrigation Drainage

In Kiulekada cascade, there are 13 existing irrigation schemes, with an extent of 338 ha of cultivation field.

The cascade consists of seven sub-catchments, namely, sub-cascades. Each sub-cascade has several irrigation schemes. Those tanks are inter-linked by natural stream. Water spilled from upstream tank during the Maha season and returned flow from its commanding area flow into tank located at downstream.

Gonahathdenawa irrigation scheme, being categorised into a medium irrigation scheme, has the largest commanding area of 106 ha while the remaining schemes are minor irrigation schemes with their command areas of less than 80 ha.

Irrigation diagram of the cascade is shown in Figure 2.6.1.

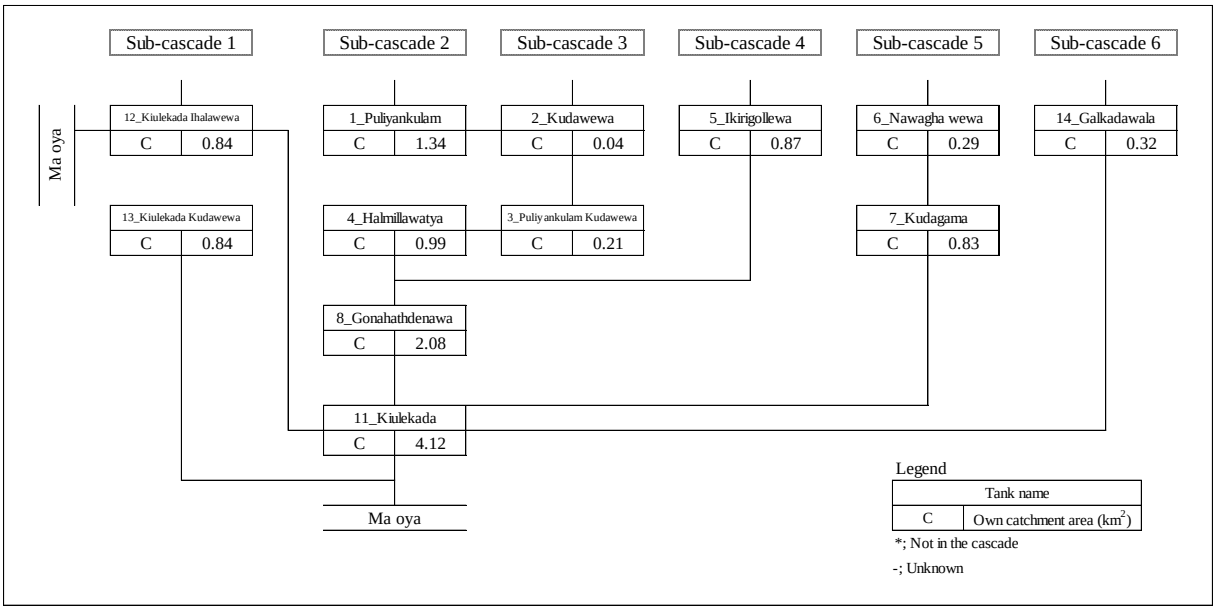


Source: JICA Project Team

Figure 2.6.1 Irrigation Drainage Diagram of Kiulekada Cascade

(2) Diagram for Spillway Drainage

Kiulekada cascade is located in the Ma Oya Basin. As indicated in Figure 2.6.1, most of drainage water in the cascade flows into Kiulekada tank.



Source: JICA Project Team

Figure 2.6.2 Spillway Drainage Diagram of Kiulekada Cascade

(3) Existing Irrigation Facilities

Irrigation facilities in the cascade, such as tanks, irrigation canals, and rural road, are maintained by the FO under technical guidance of the Provincial Department of Irrigation, NCP.

A tank under Gonahathdenawa irrigation scheme has the longest tank bund with a length of 1,515 m. A spillway is equipped to protect tank bund against flood. While the number of the structure is basically one per tank, there are several tanks with two or more spillways so that the flood water can be flown safely to downstream. Each irrigation scheme has two or three irrigation canals to feed the fields.

Existing irrigation facilities in the irrigation scheme under Kiulekada cascade are outlined in Table 2.6.1.

Table 2.6.1 List of Facilities of Kiulekada Cascade

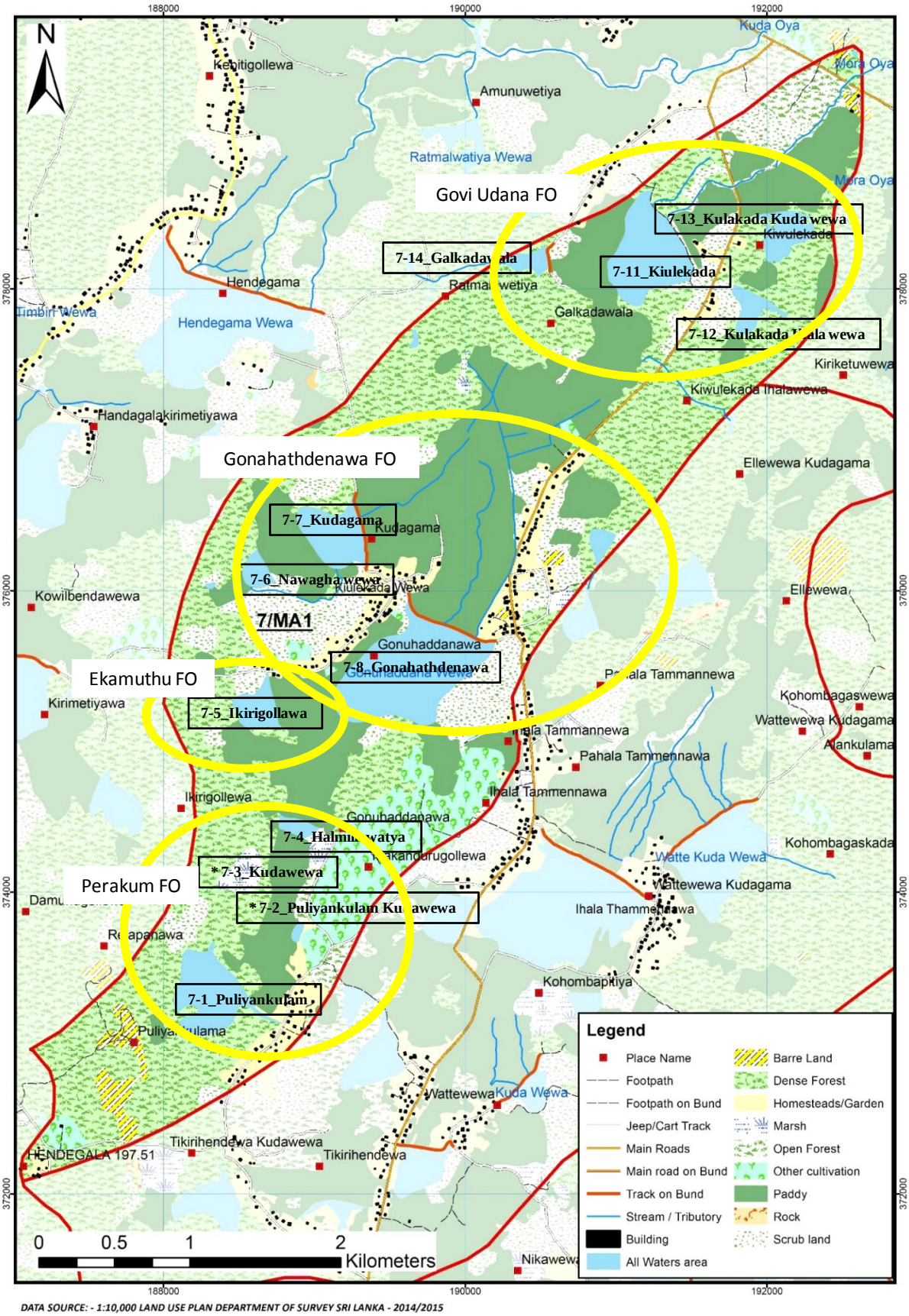
Tank No.	Name of Tank	Tank bund		Spillway			Sluice			Canal			Farm road
		L (m)	H (m)	Location	Type	L (m)	Location	Type	Number	Location	Type	L (m)	L (m)
1	Puliyankulam	730	1.7	LB 1	Drop	16	LB	Tower	1	LB	Earth	725	1,000
				LB 2	Channel	2	CN	Tower	1	CN	Earth	525	
							RB	Wall	1	RB	Earth	450	
2	Kudawewa	150	1.2	LB	Channel	10				-	Earth	50	1,200
3	Puliyankulam Kudawewa	320	2.0	LB	Channel	15	LB	-	1	LB	Earth	60	
4	Halmillawatya	332	3.0	LB	Channel	15	LB	Wall	1	LB	Earth	356	1,000
				RB	Channel	18	RB	Wall	1	RB	Earth	375	
5	Ikirigollewa	482	2.1	LB	Drop	17	LB	Wall	1	LB	Earth	350	
							CN	Wall	1	CN	Earth	325	
							RB	Wall	1	RB	Concrete	257	
6	Nawagha wewa	364	2.4	RB	-	10	LB	Tower	1	LB	Earth	296	2,000
							RB	Tower	1	RB	Earth	180	
7	Kudagama	890	2.4	LB	Drop	30	LB	Wall	1	LB	Earth	250	1,500
							CN	Tower	1	CN	Earth	2,220	
							RB	Tower	1	RB	Earth	670	
8	Gonahathdenawa	1,515	3.1	RB 1	Drop	31	LB	Tower	1	LB	Earth	450	3,250
				RB 2	Drop	23	CN	Tower	1	CN	Earth	9,070	
							RB	Tower	1				
10	Kiulekada	933	3.0	LB	-	12	LB	Tower	1	LB	Earth	990	
				CN	Drop	26	RB	Wall	1	RB	Earth	665	
				RB	-	6							
11	Kiulekada Ihalawewa	583	3.0	RB	Drop	38	LB	Wall	1	LB	Earth	170	2,000
							RB	Wall	1	RB	Earth	527	
12	Kiulekada Kudawewa	614	1.5	RB	Drop	11	LB	Wall	1	LB	Earth	289	200
							RB	Wall	1	RB	Earth	518	
13	Galkadawala	490	2.5	LB	Drop	10	LB	Wall	1	LB	Concrete	33	1,500
							RB	Tower	1	RB	Earth	550	
Total		7,403				290			25			20,351	13,650

Remarks: Location; LB (Left bank), CN (Centre), RB (Right bank), W (Width), - (Unknown)
Source: JICA Project Team

2.7 Farmers' Organization and O&M Activities for Irrigation Facilities

2.7.1 General Features of FOs under Kiulekada Cascade

Four FOs are managing tanks under Kiulekada cascade, namely Perakum, Ekamuthu, Gonahathdenawa, and Govi udana. About a half of the total cultivators under Kiulekada cascade belongs to one FO (Gonahathdenawa FO), which manages 12 tanks in total. Even though Gonahathdenawa tank is under medium irrigation scheme with a separate FO under irrigation department, almost the same farmers as Gonahathdenawa FO of minor schemes manage the medium tank, as the farmers under the Gonahathdenawa tank overlap with other surrounding tank users. Perakum FO was formed in 2014, which was separated from another FO caller Ekamuthu (different from the one for Ikirigollewa tank under this cascade). The following figure indicates boundaries of areas managed by the FOs under Kiulekada cascades.



Source: JICA Project Team (Source of Map: 1:10,000 Land Use Plan Department of Survey Sri Lanka – 2014/2015)

Figure 2.7.1 FO Boundary in Kiulekada Cascade

2.7.2 Organisational Functions of FOs

(1) Basic Feature of FOs

Summary of the basic feature of each FO under the cascade is as follows.

Table 2.7.1 Basics of the FOs under Kiulekada Cascade

Name of FO	GN division	ASC Division	Members			Total No. of the Tank under the FO	Tanks under the Cascade
			Male	Female	Total		
Perakum	Wattewewa	Kebithigollewa	24	14	38	3	Puliyankulam Kudawewa Puliyankulam Kudawewa Halmillawatya
Ekamuthu	Gonahathdenawa	Kebithigollewa	22	4	26	1	Ikirigollewa
Gonahathdenawa	Gonahathdenawa	Kebithigollewa	132	18	150	12	Nawagha wewa Kudagama Gonahathdenawa
Govi udana	Gonahathdenawa	Kebithigollewa	15	40	55	4	Galkadawala Kiulekada Kiulekada Ihala wewa Kiulekada Kudawewa

Source: JICA project team based on the questionnaire survey

Basic functions of the FOs are precisely organised by DAD. All the FOs follow the Constitution prepared by DAD based on the Agrarian Act, but no their own written roles.

(2) FO Meetings

Regarding organisation of meetings, all FOs conduct Kanna meetings and some other meetings. Apart from Gonahathdenawa FO, for which Kanna meetings are conducted every season, Kanna meetings are conducted only in Maha season in normal years. In those FOs, Kanna meetings for the Yala seasons are conducted only when water is available in their tanks. In the Kanna meetings, they discuss timing of land preparation and sawing, water distribution, fertilizer distribution, fencing, clearing bund and canals, and selection of seed variety, most of which are instructed by DAD as meeting agendas. Meetings other than Kanna meetings vary by FOs. Two FOs have periodical committee meetings. Frequency of general meetings differs ranging from once a year to four times per year. Additional need-based meetings are also conducted. Issues discussed in the additional ad-hoc meetings are assessment of flood/drought damage, emerging issues, and development activities raised . Details of the meetings conducted by each FO is shown in the following table.

Table 2.7.2 Practice of Meetings of the FOs under Kiulekada Cascade

Name of FO	Kanna meetings			Committee meeting			Other Meetings / Remarks
	Base	Times/ year	Participation	Base	Times/ year	Participation	
Perakum	Yearly	1	78%	Need base	1	27%	Annual general meeting once a year, and emergency meetings
Ekamuthu	Yearly	1	85%	Yearly	1	65%	Meetings in case of emergencies and emerging issues such as development activities
Gonahathdenawa	Seasonal	2	35%	Need base	1	62%	Proper meetings are only Kanna meetings. Others are small informal meetings
Govi udana	Seasonal	1	n.a	Yearly	1	75%	General meeting 4 times a year. And committee meetings as per needs

Source: JICA project team based on the questionnaire survey and FO meeting

From the view point of the DO and ARPA, most of the officers in-charge of the model cascades do not have any difficulty in organising meetings with the FOs, apart from those in Kallanchiya ASC. The reasons for the difficulties in organising meetings with FOs as mentioned in Kallanchiya are the poor

participation of the FO members and the lack of involvement of the community leaders. The majority of officers in-charge of the six model cascades evaluated that theFOs are organising meetings by themselves only on a few occasion while about 30% answered FOs always organise without help of officers. The following table indicates the result of questionnaire interview to DOs and ARPAs in the target ASCs regarding organisation of meetings by FOs.

Table 2.7.3 Evaluation of the FOs by the DO and ARPA on Conducting Meetings

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Those having difficulties in organising meeting with FOs		0%	0%	0%	0%	0%	67%	0%	11%
Reasons of difficulties		Poor participation of members, Leaders are not fully involved							
Do you think FOs organise meeting by themselves when necessary without help of ARPA	always	50%	50%	0%	40%	50%	0%	33%	32%
	only few occasion	50%	50%	100%	60%	50%	67%	67%	63%
	no	0%	0%	0%	0%	0%	33%	0%	5%
	Reason for no.	Leaders have no capacity							

Source: JICA Project Team based on the questionnaire survey

(3) Problem Solving Capacity of FOs

Regarding conflict management, most of them conduct a committee meeting or small meeting to come up with solutions. Gonahathdenawa FO mentioned that they simply call the relevant people and discuss with consultation of the ARPA instead of organising a meeting. This might be because the FO is too large to call members together for small issues. Water master (water controller) is involved in case of issues related to water distribution.

Issues that cannot be solved within FOs are referred to ARPAs. Analysing from the interview survey to DOs and ARPAs in the target cascades, frequencies of the ARPAs and DOs to intervene conflict resolution ranging from once to twice a year to almost every month. Forty-two percent of the DO/ARPA in the whole model cascades answered they are involved in the conflict solving once in 2-3 months. Major problems that the DO/ARPA attend are issues in water distribution, maintenance works and problem in cultivation. Almost 80% of the DO/ARPA interfere problem of water distribution. There are also some conflicts between members consulted to the DO/ARPA.

Table 2.7.4 Involvement of DO and ARPA in Conflict Resolution

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Frequency of consultation in the conflict solving of FO	almost every week	50%	0%	0%	0%	0%	0%	0%	5%
	almost every month	0%	100%	50%	20%	0%	33%	0%	26%
	once in 2-3 month	50%	0%	50%	80%	50%	0%	33%	42%
	1-2 in a year	0%	0%	0%	0%	50%	67%	67%	26%
Problems FO consult the officers (multi answer)	Problem in water distribution	50%	100%	50%	60%	100%	100%	100%	79%
	Problem in maintenance works by members	50%	100%	100%	60%	0%	67%	33%	58%
	Problem in major rehabilitation	0%	50%	50%	0%	0%	0%	33%	16%
	Conflict among members	100%	0%	0%	60%	0%	0%	67%	37%
	Conflict between tanks	50%	50%	0%	0%	0%	0%	0%	11%
	Conflict with other FOs	50%	50%	0%	0%	0%	0%	0%	11%
	Problem in financial management	50%	0%	50%	20%	0%	0%	33%	21%
	Problem in cultivation	100%	50%	50%	60%	100%	67%	67%	68%
	Other	50%	0%	0%	20%	0%	33%	33%	21%

Source: JICA Project Team based on the questionnaire survey

(4) Financial Capacities of FOs

Concerning financial capacity of the FOs, all the FOs charge membership fees of Rs.120 per year, although one FO stopped collecting. The FO not collecting membership fee mentioned as the reason why they stopped collection that the membership fee is deposited to FOs' bank account and procedures to withdraw from the bank takes time. Therefore, currently they manage maintenance works with their manpower contribution of members without bearing any expenses. While most of the FOs maintain financial records that are under inspection of the DO, the FO that stopped collecting membership fee has not been keeping financial record. For expenses of FO from their bank account, they should conduct committee meeting to get a consent from the committee, based on which the FO submits a proposal to the DO for approval. Technical officers of the ASC assess its appropriateness of the proposal in case of any rehabilitation expenses.

Details of the financial situation of each FO are described in the following table.

Table 2.7.5 Financial Status of the FOs under Kiulekada Cascade

Name of FO	Member ship fee	Bank balance (as of Jan 2017)	Financia l record	Major income source	Major expenditure
Perakum	Rs.120/year	Rs.23,000	Yes	Membership fee, profit of contract work (5%)	n.a
Ekamuthu	Rs.120/year (currently not collecting)	Rs.100,000	No	Profit of contract work from government (5%) acre-wise fee that is paid to government	No major expenses, managing with their manpower
Gonahathdenawa	Rs.120/year	Rs180,000	Yes	Membership fee, profit of contract work (5%)	Small scale repairing works with the approval of DO
Govi udana	Rs.120/year	Rs.230,000	Yes	Membership fee, profit of contract work (5%) (received contract works of 1M, 3M, 10lakh*2)	n.a

Source: JICA project team based on the questionnaire survey

According to the interview survey conducted to the DOs and ARPAs, financial records, as well as other relevant records are inspected by the DO/ARPAs. Even though most of the DO/ARPAs evaluated the records maintained by the FOs ware good or fair, 95% of the officers feel some improvement is required in the financial records keeping. The following summarises the practice of records inspection and evaluation of the record kept by FO based on the interview survey to DOs and ARPAs in the model cascades.

Table 2.7.6 Evaluation by DO/ARPA on Record Keeping by FOs

ASC		Madukan da	Kovilkul am	Omanthai	Horowpot hana	Kebithigo llewa	Kallanc hiya	Galenbindu nuwewa	Total
Record inspections		100%	100%	100%	100%	100%	67%	100%	95%
Type of records inspected	Meeting minutes	100%	100%	100%	100%	50%	33%	67%	79%
	Financial record	100%	100%	50%	100%	100%	67%	100%	89%
	Membership register	50%	100%	100%	80%	50%	33%	100%	74%
	Other	0%	0%	50%	0%	0%	0%	0%	5%
Quality of their record keeping	Very good	0%	0%	0%	0%	0%	0%	0%	0%
	good	50%	100%	0%	100%	100%	67%	67%	74%
	fair	50%	0%	100%	0%	0%	0%	33%	21%
	poor	0%	0%	0%	0%	0%	0%	0%	0%
	very bad	0%	0%	0%	0%	0%	0%	0%	0%
Improve ment required	Meeting minutes	50%	50%	50%	40%	50%	0%	33%	37%
	Financial record	100%	50%	100%	100%	100%	100%	100%	95%
	Membership register	50%	50%	50%	0%	0%	0%	33%	21%
	Other	0%	50%	0%	0%	0%	33%	0%	11%

Source: JICA Project Team based on the questionnaire survey

2.7.3 Water Management and O&M Activities of FOs

Summary of O&M performance of each FO under the cascade is indicated in the above table.

Table 2.7.7 O&M of the FOs under Kiulekada Cascade

Name of FO	Water Management				O&M	Participation in O&M Work				Valid Answer
	Water Master	Payment to Water Master	Mode of Payment	Bethma Practice	Contract Work Received	Canal Cleaning	Bund Clearing	Desilting	Labour Contribution	
Perakum	Yes	Yes	In kind	98%	n.a	100%	100%	0%	69%	52
Ekamuthu	Yes	Yes	In kind	61%	No	100%	100%	0%	89%	18
Gonahathdenawa	Yes	Yes	In kind	98%	Yes	99%	56%	0%	46%	149
Govi udana	Yes	Yes	In kind	100%	Yes	94%	97%	0%	60%	35

Source: JICA project team based on the questionnaire survey and HHS

In the Kiulekada cascade area, water spill out from tanks in almost every Maha season. However, some tanks do not have enough water even for Maha cultivation, where people cultivate half with rain water. All FOs under this cascade appoint water masters, persons to control water delivery, who are paid in kind by the members. Water is distributed in rotation controlled by the appointed water masters. However, some FOs face problem in water distribution. There was an issue raised that some farmers do not allow water to pass their field to send water to downstream field during a particular period of cultivation. This situation should be carefully examined when people prefer to cultivate different varieties of crops when they diversify their cultivation.

During the Yala season, only limited tanks have water for cultivation. Gonahathdenawa and Kiulekada Mahawewa never dry up while most of other tanks do not have water for Yala cultivation. In the area where there is some water in the tank for Yala cultivation, people cultivate through Bethma with limited land allocated to each farmers. Depending on availability of water, they decide how many acres to cultivate, normally in the land they call as ancient land, and equally divide it to each farmer regardless their landholdings. Apart from Ekamuth FO, Bethma is practiced by more than 90% of members.

Table 2.7.8 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

As shown in the Table 2.7.7, ordinal maintenance works are fairly done before seasons by FOs based on the decision in the Kanna meetings. Canal cleaning works are almost fully attended in all FOs, for which portions of works are allocated based on landholdings of the members. Participation in bund clearing is comparatively lower in Gonahathdenawa FO, which account for as low as 56%. Ratio of labour contribution varies between 46% and 89% depending on the FO. Desilting works have never been attended by members. Maintenance of boundary structures between paddy fields are under responsibility of concerned farmers.

Minor rehabilitation works and urgent repairs are managed by FOs with their fund and labour contribution. Generally soil works can be managed by FOs with labour contribution of farmers. Perakum FO collects emergency fund from members for repairing instead of using FO's savings as it takes time and a long procedure to withdraw from their account.

Major rehabilitation works are expected to be done by government, although one FO mentioned there has been no rehabilitation works done for last 40 years. All the FOs mentioned that they manage with their resources for emergency repair instead of waiting for Government fund allocation that takes time. Regarding major rehabilitation works, Govi udana FO stated that although they rely on government fund for major rehabilitation and works are sub-let to contractors as they do not have enough skills, they still monitor the works of contractors based on the BOQ of the works, with help of DAD technical officers. On the other hand, Ekamuth FO revealed that they have a bad experience with an outside contractor in contracted rehabilitation works.

Flood mitigation actions have been taken by the FOs in the area. Some FOs have taken action by hiring machineries to cut tank bund to release water when they observed flood alert. They also manage damaged part with piling up sand bags provided by disaster management unit of DS office.

Practice of O&M activities by FOs was assessed through interview to DOs and ARPAs as well. Officers evaluate that general maintenance works are conducted to some extent by FOs. While about 20% assess FOs always carry out those maintenance works, almost 80% feel 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 done by FOs are satisfactory. The following table summarise evaluation by the concerned officers on O&M activities by FOs.

Table 2.7.9 Evaluation by DO/ARPA on O&M Activities by FOs

ASC			Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
General maintenance works conducted by FOs	Canal cleaning	always	0%	50%	0%	20%	50%	0%	33%	21%
		only a few occasion	100%	50%	100%	80%	50%	100%	67%	79%
		no	0%	0%	0%	0%	0%	0%	0%	0%
	Bund cleaning	always	0%	50%	0%	20%	50%	0%	33%	21%
		only a few occasion	100%	50%	100%	80%	50%	100%	67%	79%
		no	0%	0%	0%	0%	0%	0%	0%	0%
	Minor repair of facilities	always	0%	0%	0%	20%	50%	0%	33%	16%
		only a few occasion	100%	100%	100%	80%	50%	100%	67%	84%
		no	0%	0%	0%	0%	0%	0%	0%	0%
Evaluation of quality of maintenance by FOs	Canal cleaning & bund cleaning	very good	0%	0%	0%	0%	0%	0%	0%	0%
		Satisfactory	50%	100%	100%	100%	100%	100%	100%	95%
		not satisfactory	50%	0%	0%	0%	0%	0%	0%	5%
		poor	0%	0%	0%	0%	0%	0%	0%	0%
	Reason for not satisfactory	Lack of coordination among members Farmers do not recognize importance Because there is no penalty for disobedience								
	Minor repair of irrigation facilities	very good	0%	0%	0%	0%	50%	0%	0%	5%
		Satisfactory	50%	100%	100%	100%	50%	100%	100%	89%
		not satisfactory	50%	0%	0%	0%	0%	0%	0%	5%
		poor	0%	0%	0%	0%	0%	0%	0%	0%
	Reason for not satisfactory	Farmers lack skills and capacity to do Lack of fund in FO savings Farmers do not recognize importance Farmers depend on government support								

Source: JICA Project Team based on the questionnaire survey

Apart from the irrigation management, there is no particular activities conducted by the FOs in the area. However, a FO plays a role of certifying the members for them to sell their paddy to the paddy marketing board.

Chapter 3 Needs for Development in Kiulekada Cascade

3.1 Agriculture Production and Marketing

3.1.1 Agriculture Production

The project envisages improvement of the livelihood of cascade communities in the target area by promoting agricultural activities. The overall development direction falls within the purview of the National Food Production Program: 2016-2017, which 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.

(1) Paddy

Sri Lanka has reached self-sufficiency level in the production of rice with its existing land area and productivity levels under normal rainfall distribution. However, unpredictable weather patterns, attributed to climate change associated with global warming, have resulted into wide fluctuations in the national production level of paddy during the recent years causing severe shortages and slight excesses in the supply. Thus, there is an urgent need to stabilise and increase the production level to meet the present national requirements as well as the future "natural increase" in the demand. Being the major crop in the project area, paddy has traditionally played a pivotal role shaping the socio-economic backdrop of the farming communities living in the villages.

In Kiulekada cascade, all irrigated areas under the tanks are cultivated with paddy in the Maha season while in the Yala season only 16.5% of the irrigable area is cultivated due to shortage of water. Almost all the households wish to continue cultivation of paddy during the Maha season, and 83% are willing to diversify the paddy lands fully or partially during the Yala season. Under the circumstances, it would appear that paddy would continue to be the dominant crop in the project area even with the anticipated qualitative changes in the cropping system after delivery of water through the NCPC. The needs for enhancing the farm income generated from paddy cultivation is reviewed under three perspectives.

(a) Paddy Productivity

Average paddy yield in the cascade command area is 4.1 MT/ha and 4.5 MT/ha in the Maha and Yala seasons, respectively. The yield level is below the averages reported for the major irrigation schemes, e.g., Mahaweli System H at 6.26 MT/ha (Department of Census and Statistics 2014-2015 Maha). Inadequacy in the supply of irrigation water was cited by 57% and 52% of the farmers for Maha and Yala cultivation, respectively. 46% of the farmers do not receive water for crop production in the Yala season. An assured supply of water after the project completion would encourage the farmers to adopt recommended production technologies with confidence leading to higher productivity levels. The following recommendations are made by the Department of Agriculture (DoA) to bridge the present yield gap.

i) Select appropriate cultivar
ii) Use quality seeds
iii) Undertake collective and timely cultivation
iv) Improve and sustain soil fertility
v) Practice effective crop management including weed, pest, and disease and nutrient management
vi) Add value to the produce.

(b) New Improved Paddy Varieties

The Rice Research and Development Institute (RR&DI) of the Department of Agriculture releases new improved paddy varieties having yield potential and possessing special quality attributes on a regular basis. Two such varieties were identified during the study period, namely At 311 (yield potential 7.7MT/ha, low glycaemic index and known as Niroga Red) and At 373 (yield potential 6.7 MT/ha, distinctive aroma and known as Suwanda Samba).

Paddy varieties having location specific adoptability, high yield potential, special quality attributes that fetch high market prices need to be identified and actively promoted among farmers in the project area for enhancing their farm incomes.

(c) Traditional Paddy Varieties

Traditional paddy essentially targets a niche market that appears to be undersupplied. It is stated that a monthly market deficit of about 1,000 MT of traditional rice exist in Colombo and suburbs alone. (Market Survey of the JICA Project Team 2017). This indicates an immediate need to bridge the current gap of 75% in the supply level for Colombo markets and to cater to the expected natural growth in demand. In fact, few of the farmers have already established themselves as producers of traditional paddy with own marketing linkages. The recommended varieties are Suwandel, Kuruluthuda, Pachchaperumal, Kalu Heeneti, and Madthuwalu which are in demand among the consumers and fetch higher market prices. Although the potential yield of traditional paddy is low, which is less than MT/ha compared with that of new improved varieties, which are greater than 6 MT/ha, it is amply compensated by the lower input use and higher produce prices.

However, it is necessary to provide the farmers with high quality seed paddy, particularly of high varietal purity status, as the material used by the farmers at present is highly mixed. This would enable the farmers to establish some degree of regional specialization for selected traditional paddy varieties.

(2) Crop Diversification

The concept of crop diversification in the irrigable fields, as applied to minor irrigation systems, is to overcome the problems of water shortage and low farm profitability of paddy cultivation. It implies a shift from regional dominance of one crop to a regional production of number of crops to meet the increasing demand for OFCs, vegetables, fruits and fodder/grasses. Through the process, it is anticipated that the water use efficiency, cropping intensities as well as farm incomes are increased. The main factors relating to the establishment of a sustainable basis for crop diversification are highly interrelated and are discussed below.

(a) Willingness of Farmers

Farmers' response to diversify the paddy lands into other crops during the Yala season in Kiulekada cascade was evident from the findings of the Farm Household Survey. Over 80% of the farmers expressed their readiness to diversify their irrigated farm holding during the Yala season fully or partially. The main reasons attributed by the farmers as to why they favoured crop diversification are i) high farm income, ii) high water use efficiency, iii) suitability of land, (iv) available previous experience and (v) existence of ready market in that order.

(b) Irrigation Management

Majority of the farmers in the survey area were not contented with the quantity of water they received for cultivation of paddy, particularly in the Yala season. Nearly 47% of the farmers did not receive any water during the Yala season and the lands are left fallow. After diversion of water from NCPC, it is presumed that the problems relating to water shortage faced by the paddy farmers would be adequately resolved. However, this does not imply that an adequate quantity would be available for cultivation of the entire irrigable area with paddy in both seasons. For successful cultivation of other crops, strict control and regulation for management of the water delivery system is essential and the framers need to adopt stringent practices and extend their cooperation as a group to optimise water use and thereby increase the cropping intensities. Households in Kiulekada cascade show high level of cohesiveness with regard to sharing of water during periods of drought by resorting to 'Bethma' system of land use. Based on the quantity of water available in the tank, Bethma system involves selection of proportionate land extent in the command area and allocating plots to farmers by consensus for cultivation for the particular season. The cooperation among the farmers could be built-up to the best advantage in irrigation management.

(c) Soils

It was generally presumed that the irrigable land under cascade systems comprised mainly of poorly drained LHGs associated with tracts of imperfectly-drained and well-drained RBEs. Poorly drained

soils were not suitable for growing most of the OFCs and vegetables unless appropriate provisions are made to improve soil drainage conditions. In the Yala season, nearly 16% of the irrigable land area in the Kiulekada cascade is not cultivated due to shortage of water and these lands provide an opening to promote cultivation of crops other than paddy during the Yala season leading to increased cropping intensities and farm incomes. However, it is prudent to appraise the soil drainage characteristics in order to establish its suitability before planning for crop diversification in these fields.

(d) Crops

The potential seasonal crops for a diversification program include OFCs and vegetables and often grouped as low-risk and high-risk crops. Paddy, coarse grains (maize, kurakkan, and sorghum), grain legumes (green gram, black gram, and cowpea), and most traditional vegetables are low-risk crops while condiments and exotic vegetables come under high-risk crops. Selection of specific crops as an alternative to paddy depend on a number of factors such as its profitability, adoptability to the agro-ecological conditions, production costs, availability of inputs, technical competency and market conditions among others. In Kiulekada cascade, pulses (grain legumes) and others such as maize, vegetables and condiments in small extents as the main crops identified by the households for diversifying their paddy lands. It is apparent that the farmers' preference for the crops is influenced by the familiarity with their cultivation in the past, low perishability of the product and market stability. Cultivation of these crops having less water requirement would increase cropped extents and thereby the cropping intensities and the farm income. However, the net income realized from cultivation of these crops is in the same range as that of paddy and the effect on the farm income would be marginal with simple augmentation of current situation even with NCPC water.

On the other hand, net returns from cultivation of condiments and exotic vegetables are several times higher than the other possible crops. Taking other determining factors into consideration, promotion of high value crops is highlighted as means of any significant increases in the farm income. Labour requirement, total cost of production, and net returns for the selected crops are shown in the Table 3.1.1.

Table 3.1.1 Comparison of Labor Use, Total Cost and Net Returns of Selected Crops

Crop	Labour Man (days)	Total Cost(Rs/ha)	Net Return (Rs/ha)	Crop	Labour Man (days)	Total Cost(Rs/ha	Net return (Rs/ha)
Paddy	52.5	116,762.5	101,737.5	Bitter Gourd	317.5	604,820.0	775,180.0
Maize	92.5	151,467.5	141,032.5	Big Onion	447.5	678,092.5	1,121,907.5
Green Gram	130	171,195.0	68,805.0	Chilli	275	367,487.5	507,512.5
Black Gram	86.25	105,260.0	114,740.0	Cabbage	342.5	524,845.0	675,155.0
Cowpea	115	158,677.5	75,622.5	Capsicum	410	489,192.5	1,295,807.5
Soya Bean	130	178,000.0	122,000.0	Tomato	357.5	475,587.5	784,412.5
Okra	215	301,395.0	86,105.0	Pole Bean	300	389,530.0	735,470.0
Beet Root	305	531,970.00	143,030.00	Carrot	310	489,950.0	1,084,848.0

Source: Crop Enterprise Budgets (DoA 2015) - Modified

(e) Labour

One hindrance for diversifying into other crops would be the shortage of farm labour. In Kiulekada cascade, nearly all the paddy farmers are already facing difficulties with hired labour due to their shortage and high wage rates.

All condiments and vegetables in general require high labour input for their cultivation as shown in Table 3.1.1. Options such as mechanization and staggered cultivation for minimizing and spreading out the labour requirement need concerted assessment for promotion.

(f) Capital Requirements

Working capital requirement for cultivation of high value crops are high and involve capital investment as well. Over 46% households in the Kiulekada cascade showed a monthly income in excess of Rs. 30,000 and about 86% used their own financial resources for agricultural investments. Dependence on the combination of commercial banks and own funds was 9%. Households need to be encouraged to seek agricultural credit from formal lending institutions such as commercial banks to meet the additional

cash flow requirements when undertaking cultivation of high investment crops. Government intervention to simplify the procedures and thereby enhance accessibility to agricultural credit from formal lending agencies needs careful consideration.

(g) Extension and Training

Crop diversification is looked as a process that evolves to a sustainable system through stages over a period of time. As with any innovation, it passes through the adoption stages of awareness, persuasion, decision and implementation before the field adoption takes place on a sustainable basis. In this situation, the extensionists required to play a key role in introducing, promoting and thereby accelerating the adoption process. 90% of the farmers in Kiulekada cascade recognise AIs and ARPAs as the grass-root level providers of extension services. Over 90% of the farmers wished to learn more on crop production and plant protection.

It was apparent at the training program on cultivation of high value traditional and new paddy varieties, organised by the project and conducted by the Rice Research and Development Institute, Bathalagoda, that the subject matter presented and discussed was a new learning experience to most of the participants. The trainees expressed their desire to apply some of the practices and techniques learned during the next crop season. The program was, however, symbolic as only a few farmers from each cascade could attend the session. Further, farmers' interest on cultivating selected exotic vegetables was boosted through field demonstration and training on high value vegetables conducted at the CIC Seed Farm, Pelwehera. As with the paddy training, only a few farmers representing each cascade participated in the program. Demonstrations and training of this nature need to be conducted on a continuous basis at training centres as well as in farmers' fields to reach more farmers and accelerate the adoption process.

In addition to the establishment of demonstration plots and training sessions, the extensionists need to ensure availability of production inputs such as seed and planting materials, fertilisers, agro-chemicals, etc., in adequate quantities at the right time in order to realize the objectives of crop diversification and its sustainability.

To improve the competency of the extensionists to take up the challenge with confidence, their knowledge, and skills base need constant upgrading through refresher training and exposure to current and new production technologies.

3.1.2 Marketing

(1) Towards Profitable Agriculture

The Project proposes qualitative changes to the current agricultural system in the target cascades to enable profitable agriculture. Profitable agriculture requires appropriate marketing strategy wherein production, processing and distribution are strategically designed to meet market needs in order to reap the full benefits of the market economy. Assuming that the NCPCP significantly increase the quantity and quality of crop production in the target cascades through improvements in irrigation infrastructure and water supply, this section will highlight areas that will enable the cascades to achieve profitable agriculture in a financially and environmentally sustainable manner.

(2) Introduction of New and Traditional Paddy Varieties

According to the marketing study conducted by the Project from December to March 2017, there is a high-demand niche market for new and traditional rice varieties in urban areas, including Colombo. The study indicated that traditional paddy varieties such as Suwandel, Pachchaperumal, and Madathawalu are purchased at one and half to two times higher than the price of ordinal varieties. The study also reveals that 88% of targeted retailers in this niche market prefer to purchase the traditional variety of rice directly from farmers. Currently, majority of farmers plant only the ordinal variety, which was purchased solely by the government. Introducing new and traditional paddy to target cascade are a low-risk strategy that will increase market access and opportunities for direct selling (from farmer directly to buyer, reducing the transaction cost by shortening the supply chain).

However, it is important to consider that most farmers sell in a form of paddy because they have no access to milling facilities. Noting that buyers from this niche market, particularly from Colombo, purchase mostly rice (and not paddy), post-harvest support is central to facilitate market access. Given

that the process of milling paddy and transporting rice significantly affects rice quality, together with the introduction of the new and traditional paddy varieties, post-harvest support is crucial in creating linkage to new markets.

In the Kiulekada cascade, paddy is the dominant cash crop both in the Maha and Yala season. In the Yala season, however, only 16.5 % of the paddy farm is activated. Introducing new and traditional paddy varieties is a potential option for profitable agriculture since farmers in the said cascade are already accustomed to the planting methods. Moreover, paddy farming can be more profitable if farmers choose high valued varieties and create linkages with buyers from Colombo.

A farmer in Kanthale, Trincomalee District, accounts that he sells the traditional paddy called Kalu heenati, to Keels supermarket in Colombo. His paddy price is 102.4 Rs/kg against the 30-40 Rs/kg price of ordinal paddy. He mills his own paddy and sends them to buyers by train.

In Kiulekada cascade, since the only available millers and collectors are two major buyers, farmers are not familiar with rice transactions. As such, they require a step-by-step training and support on how to establish and strengthen linkages with new buyers and how to produce quality traditional paddy or rice that buyers require. Establishing an alliance with millers and logistics providers is essential in ensuring the success of this marketing approach.

(3) Introduction/Expansion of OFCs with Contract Farming

OFCs such as coarse grains (maize, and sorghum) and grain legumes (green gram, black gram, and cowpea), are another potential source of profitable agriculture in the cascade. A notable number of farmers have indicated their keen interest in starting grain legumes in both of the Mala and Yala seasons, mainly due to familiarity and experience in planting the crops.

In the cascade, where maize and millet are well transacted in the Maha season, farmers are willing to expand their crop portfolio provided that the NTPCP supply sufficient water during the Yala season.

To ensure profits from OFCs, farmers can engage in contract farming. While there is no experience in contract farming of OFCs in the cascade, a number of farmers in Anuradhapura district have successfully secured their markets through contract farming. These farmers enjoy a sense of security as they practice contract farming to secure their minimum selling price for their OFCs, particularly soya, maize, and onion, to name a few. Most agri-business enterprises also offer support packages with contractors. For instance, Maliban Dairy and Agri Products Ltd. in Dambulla provide training and farming inputs such as seeds, agrochemicals, and bags with a forward minimum price to purchase. Based on the marketing study conducted by the Project, contract farming is a feasible market strategy not only because there are already successful farmers but also because it reduces risks for farmers, as the price was determined by the contracting parties before the cropping season, and huge fall in market price will not affect the farmers' profits.

The marketing study notes, however, that there are cases of contract violations that typically stems from low quality of crops and when there is a higher bidder for the crops. A classic example is when contracting company refuses to purchase the product because it does not meet the required quality. Farmers, however, contend that their products are of "quality" and demand that the contract must be honoured. In other cases, the farmers violate contracts by selling to other buyers who offer a higher price than what was previously contracted. Given these typical cases, the agreement process should be thoroughly understood by both parties and carefully monitored in order to avoid contract violations. Knowledge on market price and trends, for example, will help farmers in contract negotiations as well as appreciating the importance of trust in strengthening and maintaining market linkages.

(4) Introduction of High-value Vegetables/Fruits

Vegetable and fruits are another potential source of profit for farmers. Vegetable farming offers good profitability for farmers as cash flow is faster, which the farmers can earn within three to four months. Moreover, if the crops are strategically and timely managed to meet market preference, profits are easily attainable. Unfortunately, very few farmers in Kiulekada cascade show interest in these crops, arguably due to lack of knowledge and experience in marketing of vegetable.

The Project's marketing team interviewed a total of 171 middle and high class hotels in the Anuradhapura and Sigiriya areas and identified high valued crops that hotels and restaurants in the area

are willing to purchase at premium prices. These include cantaloupe melon (69.53%), bell pepper (51.58%) and, baby corn (41.43%). Most hotels currently purchase vegetables and fruits at open markets and wholesale markets but more than 65% of those hotels prefer to purchase directly from farmers to lessen damage in crops due to improper handling and ensure freshness.

Considering that the Anuradhapura and Sigiriya areas, surrounded by ancient heritages, which was visited by over 50 million foreign tourist in 2015 alone (Sri Lanka Tourism Development Authority; "Annual Statistical Report 2015"), it captures a huge market that farmers can directly access, provided they meet the market preference.

In order to optimise market benefits, support in farming, post-harvest and marketing will significantly enable farmers to access this market. Formulating cooperation schemes with hotels show promise as hotels are open to establish partnerships with farmers.

3.2 Livestock

Needs on livestock sector development in Kiulekada can be summarised and categorised as follows;

i) Enhancement of livestock production system in the area
ii) Improvement of productivity of livestock
iii) Overcoming constraints in livestock farm management
iv) Needs on institutional frameworks and supporting system, and
v) Potential on poultry sector development

The following sections discuss these needs identified in Kiulekada for further development

3.2.1 Issues in Livestock Production System in Kiulekada Cascade

In Kiulekada cascade, 7.5% of the households rear cattle. While the average monthly income from crop is Rs.9,162, the average monthly income from livestock of the household rearing cattle is Rs.18,100 while the monthly average income solely form crops is Rs.9,197. Unlike other model cascades, Kiulekada livestock farmers earn more from livestock activities. This indicates that milk economics can prop up farm income levels as well as stability in farming. The following table describes contribution of livestock activities in Kiulekada cascade compare with other cascades.

Table 3.2.1 Monthly Average Income of Crop and Livestock Farm

Tanks	Average Monthly Income (Rs.)			Proportion of Livestock Farmers	Operational Economical Land Holdings (Acres)
	Crop Only	Livestock only	Total Average Income		
Alagalla	9,575	5,000	40,229	8.1%	2.17
Ichchankulama	18,408	20,332	33,699	17.2%	4.07
Kiulekada	9,162	18,100	28,667	7.5%	2.74
Naveli kulam	15,410	13,438	41,872	31.6%	3.46
Rathmalawewa	9,747	32,500	31,190	1.5%	4.32
Siyambalagaswewa	13,705	11,075	23,581	6.0%	2.50
Project Total	12,514	15,337	32,527	10.8%	3.33

Source: Farm Household Survey (JICA Project Team 2017)

The operational economical land holdings area is 2.74 acres in Kiulekada cascade. Hence, to increase crop income, these farmers can cultivate more area under maize cultivation. Maize farmer can sell both the cobs and corn stalk. The maize stalk will give an additional income of Rs 18,000 per acre to the Rs 50,000 by selling maize cobs. Silage from maize stalks can transform the management system of free grazing to stall-feeding for the sustenance of the economically powerful milk production sector in the cascade system after the arrival of NCPC water. Water availability could increase cultivation of another 2 acres in the Yala season.

Increasing the number of farmers with livestock sub-sector will benefit the whole cascade community. There are a group of farmers solely depending on their crop production for their income. These farmers can enhance their farm income and benefit a lot by including livestock sub-sector. More facilitation activities at the farmer level and transfer of technology through farmer owned model units would be useful.

3.2.2 Needs in Increasing Livestock Productivity

Farmers' priority is to increase income from milk sales to generate extra revenue to the farm economy. Whereas, at the national level priority is import substitution. However, if farmers' priority is addressed beforehand, the national objective will automatically be achieved. Therefore, it has sense to address farmers' priority of farming as rural livelihood is now under threat.

Kiulekada dairy cows have relatively high productivity of milk as shown in the below table in comparison with other model cascade, which is even higher than the average of the North Central Province.

Table 3.2.2 Average Milk Production (Litres/cow/day)

Tank	Average Daily Milk Production (Litres/day)	No. of Dairy Cows	Milk Productivity (litre/day/cow)
Alagalla	12	8	1.5
Ichchankulama	269	69	3.9
Kiulekada	121	33	3.7
Naveli kulam	378	198	1.9
Rathmalawewa	17	16	1.1
Siyambalagaswewa	48	23	2.1
Total	845	347	2.4

Source: Farm Household Survey (JICA Project Team 2017)

However, potentials productivities are still high, as average productivities of other areas such as Central Province and highland area achieved 6-10 litres/day/cow. As discussed in the previous chapter, milk productivity still has room for improvement. The social, genetic, and nutritional aspects of the causes of low productivity observed in the household survey of Kiulekada cascade are described below.

(1) Social Aspects Regarding Milk Productivity

The Sinhala peasants are not attracted to cattle rearing unless they descend from traditional cattle headers over the generation. There is a general disinclination of the youth to take up dairying as a profit making enterprise due to the cumbersome manual operations. Moreover, as most of the farmers are focusing on crop cultivation, they find it difficult to attend livestock during the crop cultivation period.

(2) Biological (Genetic) Issues in Milk Productivity

A major problem in the biological aspect of low productivity is poor monitoring of breeding activities. Firstly, replacement of subsequent generations is very slow because of long generation interval due to i) poor nutrition, ii) long calving interval, and iii) no gender selection at early conception that reduces female siblings by 50%. Secondly, milk production of a cow was initiated after calving. Calving results from the completion of pregnancy after ten months. Pregnancy can be achieved only by breeding at the right time, otherwise conception is deferred by another 28 days. This results in longer calving intervals, thus total milk production is reduced.

Good average milk production is recorded in some farmers. These farmers have been using crop residue for a long time and their breeding activities are either Natural breeding or Artificial Insemination (AI) carried out by PDAPH staff. This area should have high quality studs for natural mating. This will allow them to breed more good quality cattle in their herds. Expansion of high quality studs and provision of quality AI is important to maintain and further improve biological aspect of productivities.

Regarding expansion of livestock population with high productivity, it is difficult for new comers to start as crossbred pregnant heifer will cost around Rs 120,000. Counteraction to reduce this hindering factors should be considered.

(3) Biological (Nutritional) issues in milk productivity

Another problem in biological aspect is nutrition of cattle. Variability of supply of quality feed is a problem for cattle farmers.

A new born calf grows at a steady and determined pace to achieve the first calving at the age of 24 months. This activity is supported by the amount of milk received before being weaned to adult feed such as grass. Then the quality and quantity of grass matters if the calf is not provided with concentrated feed, vitamins and minerals. Feeding poor quality herbage through free grazing and tethering will not result in the target calving period. This situation will increase the generation interval of these cattle from two years to four and half years. This prolonged generation interval has happened to cattle in the Kiulekada cascade area.

Farmers are not prepared to address the fact that there will be a shortage of good quality crop-residue between seasons, hence they resort to free grazing. As feeding with crop residue or stalk, especially between seasons, can increase productivity, it should be utilised in this area. Furthermore, additional water from the NCP Canal may allow them to increase maize production in their highland and sometimes in paddy lands.

Sunn Hemp (*Crotalaria juncea*), an annual tropical legume crop that can be used as a green manure, as covering of crops, and also as livestock feed, can be grown in fields at the end of the Maha season. This will increase the stocking density of the available land in the Yala season. Upgrade stock replacement through feeding regime will increase the productivity of the herd. This will control the movement of the cattle and increase market value for crop residue biomass, which is otherwise wasted. However, the usage of natural grasses requires to be improved by planned harvesting.

3.2.3 Needs in Livestock Farm Management System

(1) Crop-Livestock Farming System

An issue identified in ineffectual livestock activities is poor understanding of the impact of crop-livestock production system. The farmers having both crop and livestock in Kiulekada cascade have proved that crop-livestock integration will bring more uniform income distribution as the livestock and crop activities separately contribute to income generation. Furthermore, it was observed that crop-livestock integration increases crop and livestock productivity, while costs of production in both are reduced. Integration of crop and livestock is risk averting as farmers ended up having more capital after the 2016/2017 Maha drought

Household survey data on Kiulekada cascade clearly shows that most farmers are unaware of economic effects of integrating livestock into their crop farms. The existing institutional framework with no collaboration between organizations is at fault for not transmitting this information to farmers, especially to those depending solely on income from crops. The 2016/2017 Maha was a good opportunity to show the value of livestock during such situations.

Training program with a familiarizing excursion to other dairy farms (model farms) in the same area will have an effect on changing the mind-set of the Kiulekada cascade farmers. Exchange of views may give a boost to the fledgling dairy sector. A model farm has to be developed prior to these visits and should be a farmer owned crop-livestock integrated farms.

(2) Livestock Farm Management

The need to improve current practices in management was identified. Upgrading of the genetics of the existing herds in the cascade for milk producing ability is necessary as mentioned above and the upgraded cattle require better management and good practices for maximum potential. Improvements of management by introducing cattle sheds are essential, which shall be included in the project planning. It is important to initiate transformation of management from the current free grazing system activity to stall-feeding prior to the availability of NCPC water, otherwise the livestock sector will have a negative effect with full cultivation in both Yala and Maha seasons.

3.2.4 Needs in Institutional Framework and Supporting System

The expansion of extension staff to increase interactions with farmers is important for the above mentioned expected development of livestock sector, as it requires change of mind set of farmers and close technical supports. In the proposed project, PDAPH and Milco officials would be actively engaged to participate in addition to their current heavy workload and capacity. These officers will

find it easier to handle these activities with extra resources such as, staff, funding, vehicles and training.

Development of the milk collecting centres for extension activities of those who provide services to the farmers (PDAPH) and milk purchasing organizations will also encourage interaction between farmers and extension staff.

3.2.5 Needs in Family Poultry Sector

Family poultry in home gardens has been a traditional concept when land holdings are large. These scavenging birds roam around in these large areas without disturbing or damaging the cultivation of food crops. However, limited land in the most of the household can be a problem to expand poultry activities. Egg is the cheapest protein source with the highest biological value. Hence, its value to family nutrition is immeasurable. This food production system needs to be promoted.

The family poultry sector activities have to be promoted at the household level l, especially to the households depending only on crop cultivation. Artificial incubation and brooding systems have to be developed. In addition, a new system has to be promoted to keep these poultry birds within confined areas. A system of raising maize seedlings of a week old grown on water can be introduced.

3.3 Irrigation System and Rural Road

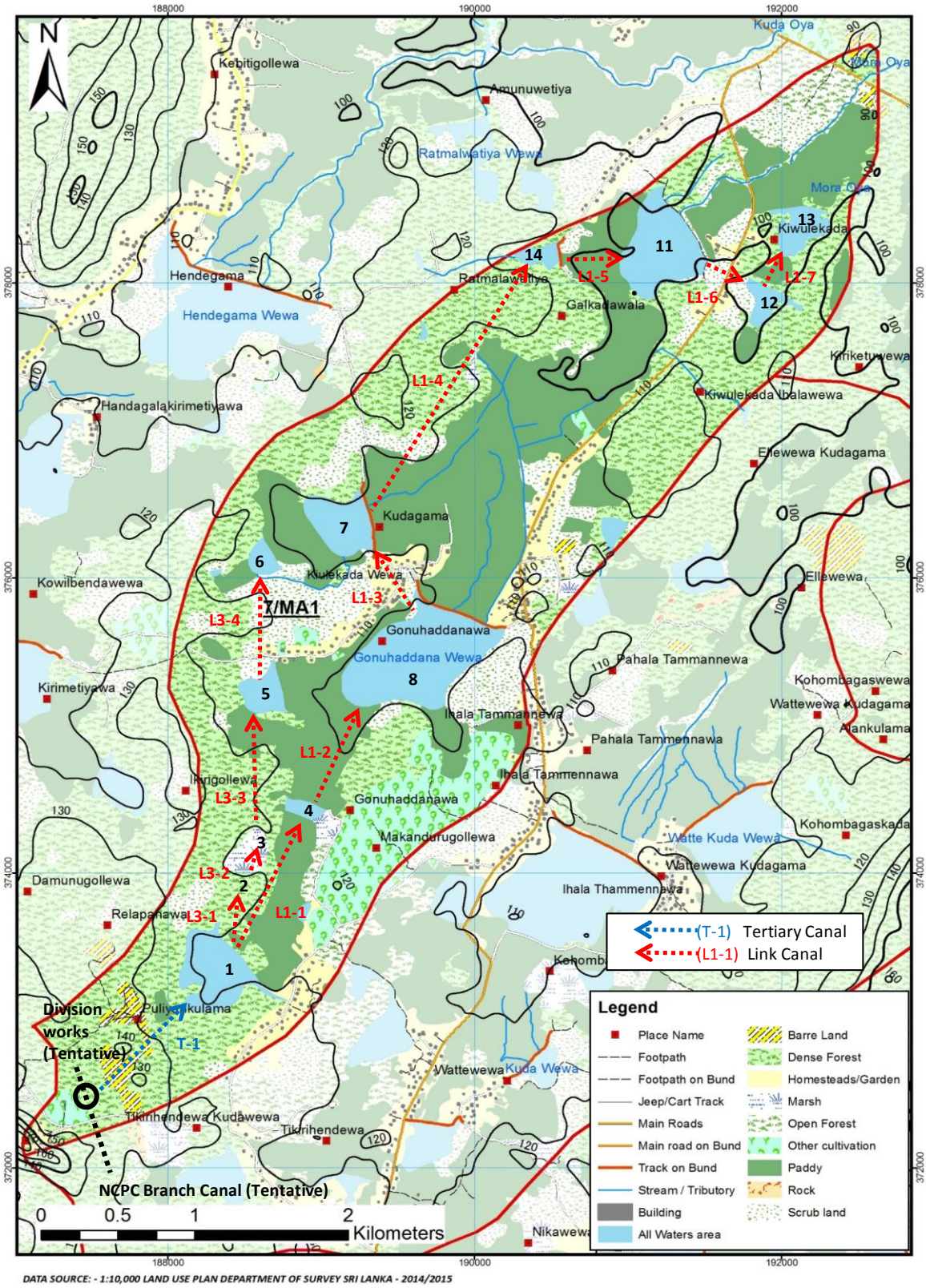
3.3.1 Water Distribution Plan

The water distribution plan was prepared for each tank in the cascade system. The maximum monthly water flow as per the Feasibility Study Report was applied to determine water allocation for each cascade. The allocated water is to be distributed to each tank proportionally according to the command area of the particular tank through a tertiary and link canals.

Although location of off-takes on the main or branch canals is not finalized yet, it is tentatively positioned 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 sub-cascades.

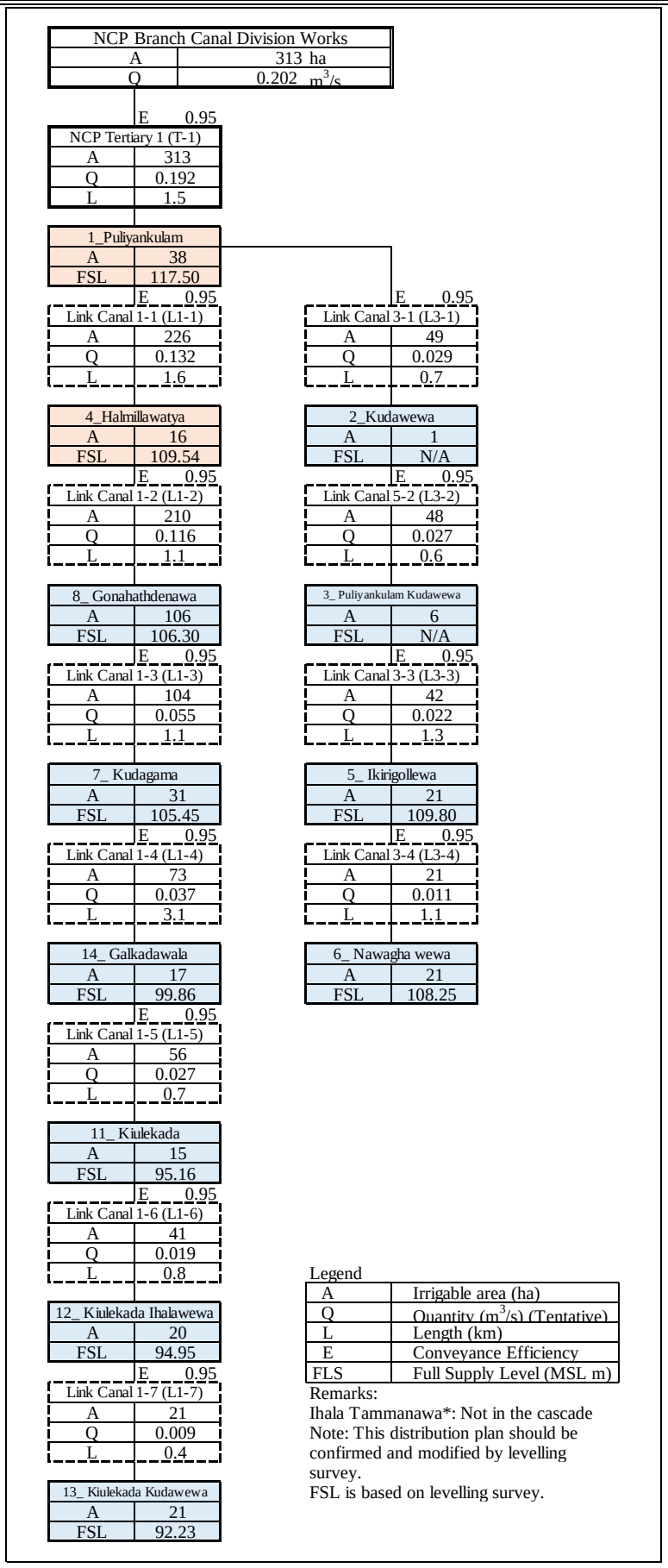
Link canals will be constructed to convey water from upstream tank to downstream tank in the cascade system.

Layout of the tertiary and link canals is indicated in Figure 3.3.1 while water distribution diagram in the cascade is shown in Figure 3.3.2



Source: JICA Project Team (Map data: -1:10,000 Land Use Plan Department of Survey Sri Lanka - 2014/2015

Figure 3.3.1 Distribution Plan in Kiulekada Cascade



Source: JICA Project Team

Figure 3.3.2 Distribution Diagram in Kiulekada Cascade

In the cascade, a tertiary canal is planned to feed the sub-cascades so that the augmented water can reach all the tanks in the cascade. Furthermore, 13 link canals are proposed to distribute water in the Yala season, design discharge of which ranges from 0.008 m^3/sec to 0.161 m^3/sec.

3.3.2 Rehabilitation Plan

To achieve proper water distribution and consequent sustainable irrigation scheme management and market-oriented farming, based on the field investigation, the construction and rehabilitation plan for infrastructure is prepared, which consists of rehabilitation of tanks, irrigation canals and construction of tertiary and link canals.

Rehabilitation work of the tanks covers tank bund forming, repair or reconstruction of sluices, improvement of spill way and provision of washing steps. Capacities of the spillways to release flood water 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 fields to main road.

Taking into consideration of the topography in the area, pipeline system is adopted for the tertiary canals. The canals are to connect off-takes on the main or the 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 utilizing the augmented irrigation water efficiently.

Major construction or rehabilitation work for 13 irrigation schemes under the cascade is presented in Table 3.3.1.

Table 3.3.1 Major Rehabilitation Plan of Kiulekada Cascade (1/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
1	Puliyankulam	Headworks	Tank bund			Reshaping	730 m	H=3.5 m
			LB spillway		Drop	Reconstruction	28 m	
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			CN sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			RB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
			CN canal		Earth	Reconstruction	530 m	
			RB canal		Earth	Reconstruction	450 m	
		Link canal	(L1-1)		Pipeline	New construction	1.6 km	Tentative
		Link canal	(L3-1)		Pipeline	New construction	0.7 km	Tentative
		Tertiary canal	(T-1)		Pipeline	New construction	1.5 m	Tentative
		Farm road			Gravel	Pavement	1,000 m	
2	Kudawewa	Headworks	Tank bund			Reshaping	150 m	H=1.2 m
			LB spillway		Channel	Reconstruction	2 m	
			Sluice	Gate	Wall	New construction	1 nos.	
				Structure		New construction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	Canal		Earth	Reconstruction	50 m	
		Link canal	(L3-2)		Pipeline	New construction	0.6 km	Tentative
		Farm road			Gravel	Pavement	1,200 m	
3	Puliyankulam Kudawewa	Headworks	Tank bund			Reshaping	320 m	H=2.0 m
			LB spillway		Channel	Reconstruction	11 m	
			LB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	60 m	
		Link canal	(L3-3)		Pipeline	New construction	1.3 km	Tentative
4	Halmillawatya	Headworks	Tank bund			Reshaping	340 m	H=3.0 m
			LB spillway		Channel	Reconstruction	34 m	
			RB spillway		Channel	Reconstruction		
			LB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	360 m	
			RB canal		Earth	Reconstruction	380 m	
		Link canal	(L1-2)		Pipeline	New construction	1.1 km	Tentative
		Farm road			Gravel	Pavement	1,000 m	

Source: JICA Project Team

Table 3.3.2 Major Rehabilitation Plan of Kiulekada Cascade (2/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
5	Ikirigollewa	Headworks	Tank bund			Reshaping	490 m	H=2.1 m
			LB spillway		Drop	Reconstruction	31 m	
			LB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			CN sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			RB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	350 m	
			CN canal		Earth	Reconstruction	330 m	
			RB canal		Earth	Reconstruction	260 m	
		Link canal	(L3-4)		Pipeline	New construction	1.1 km	Tentative
6	Nawagha wewa	Headworks	Tank bund			Reshaping	370 m	H=2.4 m
			RB spillway		Channel	Reconstruction	15 m	
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	300 m	
			RB canal		Earth	Reconstruction	180 m	
		Farm road			Gravel	Pavement	2,000 m	
7	Kudagama	Headworks	Tank bund			Reshaping	370 m	H=2.4 m
			LB spillway		Drop	Reconstruction	44 m	
			LB sluice	Gate	Wall	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			CN sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Reconstruction	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	250 m	
			CN canal		Earth	Reconstruction	2,220 m	
			RB canal		Earth	Reconstruction	670 m	
		Link canal	(L1-4)		Pipeline	New construction	3.1 km	Tentative
		Farm road			Gravel	Pavement	1,500 m	

Source: JICA Project Team

Table 3.3.3 Major Rehabilitation Plan of Kiulekada Cascade (3/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
8	Gonahathdenawa	Headworks	Tank bund			Reshaping	1,520 m	H=3.1 m
			RB spillway 1		Drop	Reconstruction	56 m	
			RB spillway 2		Drop	Reconstruction		
			LB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			CN sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	450 m	
			CN canal		Earth	Reconstruction	9,070 m	
		Link canal	(L1-3)		Pipeline	New construction	1.1 km	Tentative
		Link canal	(L2-1)		Pipeline	New construction	1.3 km	Tentative
		Farm road			Gravel	Pavement	3,250 m	
10	Kiulekada	Headworks	Tank bund			Reshaping	940 m	H=3.0 m
			LB spillway		Channel	Reconstruction	64 m	
			CN spillway		Drop	Reconstruction		
			RB spillway		Channel	Reconstruction		
			LB sluice	Gate	Tower	Reconstruction	1 nos.	
				Structure		Replacement	1 nos.	
			RB sluice	Gate	Tower	Replacement	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	990 m	
			CN canal		Earth	Reconstruction	670 m	
		Link canal	(L1-6)		Pipeline	New construction	0.8 km	Tentative

Source: JICA Project Team

Table 3.3.4 Major Rehabilitation Plan of Kiulekada Cascade (4/4)

Tank		Major Rehabilitation Contents						
No.	Name	Facility			Type	Plan	Quantity	Remarks
11	Kiulekada Ihalawewa	Headworks	Tank bund			Reshaping	590 m	H=3.0 m
			RB spillway		Drop	Reconstruction	35 m	
			LB sluice	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	170 m	
			CN canal		Earth	Reconstruction	530 m	
		Link canal	(L1-7)		Pipeline	New construction	0.4 km	Tentative
		Farm road			Gravel	Pavement	2,000 m	
12	Kiulekada Kudawewa	Headworks	Tank bund			Reshaping	620 m	H=1.5 m
			RB spillway		Drop	Reconstruction	10 m	
			LB sluice	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Reconstruction	290 m	
			CN canal		Earth	Reconstruction	520 m	
		Farm road			Gravel	Pavement	200 m	
13	Galkadawala	Headworks	Tank bund			Reshaping	490 m	H=2.5 m
			LB spillway		Drop	Reconstruction	9 m	
			LB sluice	Gate	Wall	Repair	1 nos.	
				Structure		Repair	1 nos.	
			RB sluice	Gate	Tower	Repair	1 nos.	
				Structure		Repair	1 nos.	
			Bathing step		Concrete	New construction	1 nos.	
		Canal system	LB canal		Earth	Repair	40 m	
			CN canal		Earth	Reconstruction	550 m	
		Link canal	(L1-5)		Pipeline	New construction	0.7 km	Tentative
		Farm road			Gravel	Pavement	200 m	

Source: JICA Project Team

3.4 Farmers Organisation and Cascade System Management

3.4.1 Need of Strengthening FO Functions

There is no major problem in general organisational functions observed in the FOs under Kiulekada cascade, even though there is one FO not having financial records nor collecting membership fee. A large FO sometimes faces problem in coordination that might result in low participation in the meeting and difficulty in organise meeting as a whole FO. Since a large FO with many tanks will belong to different cascade, their management within FO needs to be strengthened for smooth operation of cascade level coordination.

Needs on capacity development of FOs were assessed through interview to the concerned officers as well. DO and ARPAs in charge of Kiulekada cascade expressed that the FOs need improvement of capacity in financial management, O&M skills, and flood management, as shown in the below table. Those issues shall be taken into consideration in planning of capacity development programme for individual FOs.

Table 3.4.1 Evaluation of Capacity of FO by DO/ARPA in the Model Cascades

ASC		Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Respondent (DO/ARPA)		2	2	2	5	2	3	3	19
Average number of FO the ARPA covers		2	3	34	2.75	4	2	2	5.17
In which area do you feel FOs are lacking capacity	Finance capacity	0%	50%	50%	80%	50%	100%	100%	68%
	Financial management	0%	0%	50%	100%	0%	67%	67%	53%
	Organising meeting	50%	0%	0%	40%	0%	0%	0%	16%
	O & M skills	50%	50%	50%	20%	50%	67%	100%	53%
	Conflict solving	50%	0%	50%	0%	0%	33%	67%	26%
	Flood management	0%	50%	0%	0%	100%	33%	100%	37%
	Other	0%	0%	0%	0%	0%	33%	0%	5%

Source: JICA Project Team based on interview survey to DO and ARPA

Water distribution is managed at each tank with no major issue raised. However, there was some opinions such as refusal of releasing water through their field that imply conflicts in water distribution. Moreover, ASC officers listed up water distribution and cultivation as the major causes of conflict they intervene in FOs, as described in the Chapter 2. Therefore, water distribution within tanks needs to be further regulated once they receive NCP water.

As per indicated in the following table, ordinal O&M performance such as canal clearing and bund clearing in Kiulekada cascade is fair in comparison with other target cascades, even though practice of bund clearing is slightly lower..

Table 3.4.2 Participation in O&M Works by Cascade

Tank	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: JICA project team based on the HHS

Minor repairing works are carried out by FOs either by using FOs' savings or merely with manpower contribution from members. Some FOs collect fund for emergency repairing trying to attend by themselves instead of waiting for outside supports, while other FOs tends to rely on government support. Difference of maintenance attitudes between FOs may cause disagreement and conflict in managing cascade. Learning opportunities from well performing FOs shall encourage improving management both in each FO and at cascade level. In addition, as pointed out by the officers, there is a room to improve O&M skills of FOs. Capacity building in basic O&M shall be considered in development planning.

3.4.2 Need for Cascade System Management

(1) Water Distribution within Cascade

Needs in cascade level water management and possibility of establishment of cascade management body were discussed with each FO and were asked in HHS to judge different opinions from FOs with different position of tanks. The Table 3.4.3 shows results of HHS regarding the question on preferable water management system to distribute water equally to each tank under the cascade if the uppermost tank of the cascade receives water from the NCPC. Multiple answers were allowed from the options indicated in the questionnaires.

Table 3.4.3 Preferable Water Distribution System in Kiulekada per FO

FO	Government		Individual Tank		Cascade Committee		Fixed Ratio		OTHER		Valid Answer
	no.	%	no.	%	no.	%	no.	%	no.	%	no.
Ekamuthu	0	0%	12	67%	9	50%	5	28%	0	0%	18
Gonahathdenawa	3	2%	4	3%	142	96%	0	0%	0	0%	148
Govi Udana	1	3%	1	3%	32	91%	1	3%	0	0%	35
Perakum	1	2%	0	0%	51	98%	0	0%	0	0%	52
Total	5	2%	17	7%	234	93%	7	3%	0	0%	253

**Options: Government- Government should decide water allocation to each tank*
Individual tank – Farmers in downstream tank should discuss with the farmers in upper most tank for release of 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: JICA project team based on the HHS

93% of the total Kiulekada cascade samples regard water distribution should be decided through cascade committee for effective water distribution although there is some disparity per tank. In Ekamuthu FO, only a half of the members agree on cascade management committee while 67% prefer water distribution through individual negotiation. Only 2% prefer government intervention in water allocation, which is remarkably low. This may imply that Kiulekada cascade has enough confidence in managing by themselves or has some trouble in involving government.

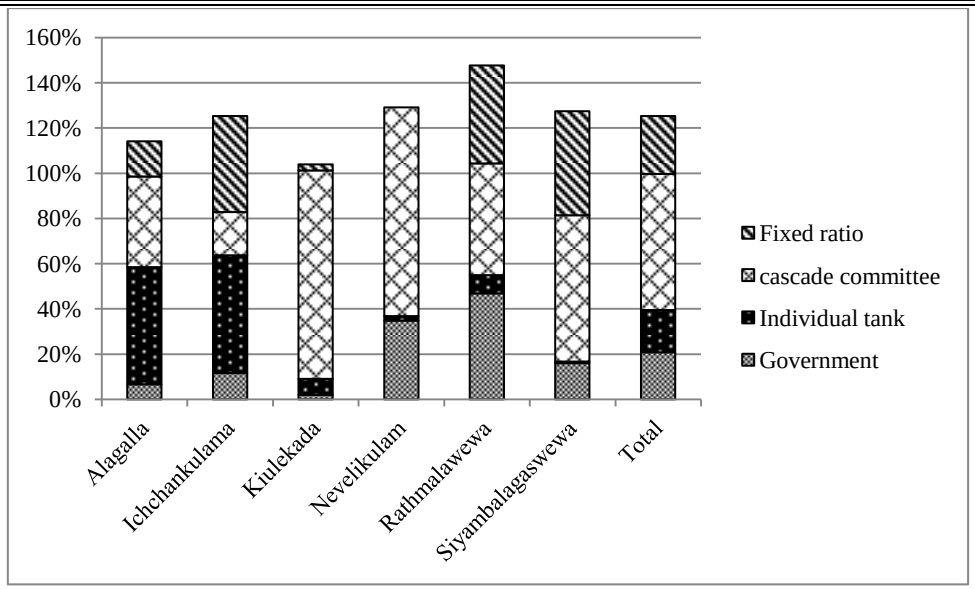
Further detail opinions and concerns were raised during meeting with each FO. Upper tank people want to release water only when it spill out from the tank by using existing system, for which downstream farmers raise concern of upper FOs not releasing water appealing that new system and structure is necessary to release water from upper tank. Some prefer to send water only to limited tanks that most of farmers use. If a limited amount of water is equally divided, farmers need to cultivate small portion of field under different tank, which complicates their work. Others proposed each FO to select one tank to be filled among several tanks they manage. Even though all the FOs agree to establish one cascade level management body, downstream FOs emphasized to involve government authority to make rules and control water distribution.

In comparison with other model cascades, as shown in the below table, Kiulekada cascade has the higher ratio of preference in cascade committee following Naveli kulam. Preference in government intervention is remarkably low. This may be due to homogeny of people in the area without any minority groups. However, since there are some opinions that may cause conflict, such as that upper tank release only spilled water, and some of downstream tank members raised needs of government involvement, it should be carefully investigated to propose adequate level of government involvement.

Table 3.4.4 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 most tank for release of 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: JICA project team based on the HHS



Source: JICA project team based on the HHS

Figure 3.4.1 Comparison of Preferable Water Distribution System by Cascade

Analyzing the preference by location of tanks within cascade, as shown in Table 3.4.5, FOs with tanks at downstream part of the cascades tend to prefer individual negotiation and fixed ratio more than those in mid and upper tanks. Preference in cascade committee's decision in lower tanks is less than others. This may indicate that decision at cascade management might be dominated by upper tank's interest. Further investigation is required to establish fair decision making in the cascade management system. Table 3.4.5 shows summary of the preference of water distribution options by tank location of all the model cascades.

Table 3.4.5 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: JICA project team based on the HHS

Regarding water distribution structures, majority of the farmers except a few in Gonahathdenawa FO agree on construction of link canal between upper tanks and lower tanks, as indicated in the following table. A part of Gonahathdenawa FO members prefer direct distribution of water from NCPC tertiary canal.

Table 3.4.6 Preferable Water Distribution Structure within Cascade

FO name	Existing System	Direct Canal from NCPC	Link Canal between tanks	Other
Ekamuthu	1	5	17	0
Gonahathdenawa		35	114	0
Govi Udana	1		34	0
Perakum			52	0
Total	2	40	217	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 uppermost tank to downstream tank
Source: JICA project team based on the HHS

However, some concerns and opinions were raised during FO meetings regarding water distribution within cascade. Upper tank people concern structure of link canal and where it will be laid. They highlighted that the intake gate to send water to downstream should be higher than a certain level to assure a certain amount of water in their tank. On the other hand, downstream people requested to locate the intake gate at the bottom of the tanks as they may not receive water otherwise.

(2) Possibility of Establishment of Cascade Management Farmers Organisation (CMFO)

Since 93% of the farmers under Kiulekada cascade prefer to decide water distribution through cascade level management body, there is high potential in establishing CMFO. Since people in the area is relatively homogeneous, it seems to be easy to coordinate. However, some power relations between FOs, were observed especially between larger strong FOs and small inactive FOs. Small FOs mentioned that control by GN and ARPA to manage relation between FOs is essential. Moreover, existence of politically powerful land owners in a certain tank can cause political intervention in water management of the cascade. This aspects shall be carefully observed in operation of cascade management and some strategies shall be discussed with relevant stakeholders.

Major opinions raised during FO meetings regarding cascade level management body are as follows.

- One coordination body should be developed to manage cascade and sharing of water shall be decided by the cascade committee.
- Select one organisation represented by all the tanks
- The committee decide which tanks to receive water and send to the limited selected tank and practice Bethma under those tanks
- Since people have separate portions of land under different tanks, they can cultivate a certain area under one tank instead of cultivating small portions of land in different place under different tanks
- Government officers should be involved in the management
- Since this is a kind of scheme, government should make rules and regulation and monitor in the same ways as Mahaweli systems
- Farmers under Gonahathdenawa tank (medium tank) are same as the farmers in the neighbouring tanks, thus not a problem to manage cascade including the major tank
- Distance is not a problem for gathering as a committee
- Gathering from all the tanks is not problem as they can meet at the middle point

Possibility of establishment of CMFO shall be assessed with opinion from relevant officers as well. The following table indicates the expected difficulties stated by DOs and ARPAs in the concerned ASCs. A majority of the officers raised maintenance of inter-tank facilities as a possible problem. Almost a half stated decision making among different FO under the cascade might be difficult. About one-third of officers answered management of FOs that belongs to several cascades and financial contribution for CMFO from each FO shall be problem.

Table 3.4.7 Expected Issues in Formation of CMFO by DAD Officers

	Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Communication between FOs will be problem	0%	0%	0%	20%	0%	33%	33%	16%
Distance to meet periodically	0%	0%	0%	0%	100%	33%	67%	26%
ARPA's boundary and cascade boundary is different and difficult to manage	0%	50%	0%	20%	0%	0%	0%	11%
Decision making among FOs is difficult	50%	50%	100%	20%	50%	67%	33%	47%
Will expect more conflict between FOs and tanks	50%	50%	0%	0%	50%	33%	0%	21%
Difficult to manage FOs that belongs to several cascade	50%	50%	0%	20%	50%	33%	67%	37%
Financial contribution from FOs might be problem	100%	50%	0%	20%	50%	33%	33%	37%
Maintenance of inter - tank facilities might be problem as it is not clear who shall take responsibility	100%	100%	0%	0%	50%	100%	100%	58%
Other	0%	0%	0%	0%	0%	0%	0%	0%

Source: JICA Project Team based on interview survey to DO and ARPA

Further opinions and suggestions raised from DO/ARPA of Kebithigollewa regarding establishment of CMFO are as follows.

- CMFO members should be office bearers and committee members of all FOs.
- It should be a legal organisation
- CMFO should be registered under related government institution, preferably under DAD
- Constitution of CMFO should be formulated
- CMFO members should be selected members of all FOs and representation from each tank should be also considered, and
- Government officers are preferred to be included in CMFO

3.4.3 Need in Administration Structure and Legal Frameworks

A major concern regarding administrative structure in Kiulekada cascade is coordination between minor tanks and medium tank that is included in the cascade. The medium tank is controlled by an FO under Irrigation department, while minor tanks are managed by FO under DAD. Even though Gonahathdenawa medium tank is managed by almost the same farmers as Gonahathdenawa FO that manage minor tanks, coordination between authorities for management of whole cascade shall be critical.

ARPAs are fairly assigned in the Kiulekada area. It seems those in charge of Kiulekada do not have much problem in managing FO, apart from transportation to meet FOs, as shown in the below table. Therefore, existing system of FO management can be applied in cascade management through DAD officer especially for supervision of CMFO.

Table 3.4.8 Difficulties in Managing FO by DAD Officers

	Madukanda	Kovilkulam	Omanthai	Horowpothana	Kebithigollewa	Kallanchiya	Galenbindunuwewa	Total
Communication with FOs is difficult	50%	50%	50%	20%	0%	33%	0%	26%
They do not follow instruction	0%	0%	0%	0%	0%	33%	0%	5%
Difficult to instruct as FO leaders are senior to me	50%	0%	0%	20%	0%	0%	0%	11%
Poor understanding of farmers	0%	0%	50%	0%	0%	0%	0%	5%
Too many FOs to handle (lack of ARPA)	0%	100%	50%	20%	0%	0%	0%	21%
Transportation to meet FOs	50%	50%	100%	60%	100%	0%	67%	58%
Other	0%	0%	0%	0%	0%	0%	0%	0%

Source: JICA project team based on interview survey to DO and ARPA

As proposed by the officers in the above section, legal framework is required to manage cascade management body and legal authority should be defined. From both farmers and government officers, there are opinions to involve government officers in cascade management. Further discussion shall be made with relevant government authority for legal frameworks and involvement of authorities.

Structure of authorities to manage cascade shall be deliberately proposed especially for the cascades that include medium tanks.

ATTACHMENT 1

PRESENT CONDITION OF KIULEKADA CASCADE

Kiulekada Cascade **2 Kudawala**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=150 m H=1.2 m	Unknown	Heavy jungle, Uneven of top width and side slope, Abandoned tank
Left bank spillway	Channel	L=10 m	Unknown	Natural spillway
Canal	Earth	L=50 m	Unknown	Natural canal
Farm road		L=1,200m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Kiulekada Cascade **1 Puliyankulam**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=730 m H=3.5 m	2002	Shrubs jungle, Shortage of top width, Erosion of slope. Water leakage
Left bank spillway	Drop wall	L=16 m	2002	Creeping water, Heavy jungle
Emergency spillway	Channel	L=2 m	Not rehabilitated	No control structure
Left bank sluice	Tower	N=1 nos.	2002	Gate: leakage, Structure: minor deterioration
Center sluice	Tower	N=1 nos.	2002	Gate: leakage, Structure: minor deterioration
Right bank sluice	Wall	N=1 nos.	2002	Gate: leakage, Structure: minor deterioration, Erosion of slope
Left bank canal	Earth	L=725 m	Not rehabilitated	Shrubs jungle, No proper canal cross section, No related structures
Center canal	Earth	L=525 m	Not rehabilitated	Shrubs jungle, No proper canal cross section, No related structures
Right bank canal	Earth	L=450 m	Not rehabilitated	Shrubs jungle, No proper canal cross section, No related structures
Farm road		L=1,000m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Left bank spillway

Left bank sluice

Center sluice

Left bank canal

Center canal

Right bank canal

Kiulekada Cascade **4 Halmillawatya**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=332 m H=3.0 m	Not rehabilitated	Light jungle, Uneven of top width and side slope, Abandoned tank
Left bank spillway	Channel	L=15 m	Not rehabilitated	Natural spillway
Right bank spillway	Channel	L=18 m	Not rehabilitated	Natural spillway
Left bank Sluice	Wall	N=1 nos.	2010	Gate: missing, Structure: minor deterioration
Right bank Sluice	Wall	N=1 nos.	2010	Gate: damage, Structure: minor deterioration
Left bank canal	Earth	L=356 m	Not rehabilitated	Natural canal
Right bank canal	Earth	L=375m	Not rehabilitated	Natural canal
Farm road		L=1,000m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Left bank spillway

Right bank spillway

Left bank sluice

Left bank canal

Right bank canal

Kiulekada Cascade **3 Puliyankulam Kudawewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=320 m H=2.0 m	Unknown	Heavy jungle, erosion of tank bund
Left bank spillway	Channel	L=15 m	Unknown	Natural spillway
Left bank sluice	Unknown	N=1 nos.	Unknown	Natural sluice
Left bank canal	Earth	L=60 m	Unknown	Natural canal
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograoh

Tank bund

Spillway

Sluice

Canal

Kiulekada Cascade **6 Nawagha wewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=364 m H=2.4 m	2005	Shrubs jungle, Shortage of top width, Erosion of slope, Water leakage
Right bank spillway	Unknown	L=10 m	2005	Unknown
Left bank sluice	Tower	N=1 nos.	2005	Gate: damaged, Structure: minor deterioration
Right bank sluice	Tower	N=1 nos.	2005	Gate: minor deterioration, Structure: minor deterioration
Left bank canal	Earth	L=296 m	Not rehabilitated	Natural canal
Right bank canal	Earth	L=180 m	Not rehabilitated	Natural canal
Farm road		L=2,000m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

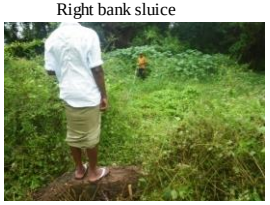
Photograph

Tank bund

Left bank sluice

Right bank sluice

Left bank canal



Right bank canal

Kiulekada Cascade **5 Ikirigollawa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=482 m H=2.1 m	1989	Shrubs jungle, Uneven of top width and side slope, Water leakage
Left bank spillway	Drop wall	L=17 m	1989	Damage
Left bank sluice	Wall	N=1 nos.	1989	Gate: leakage, Structure: minor deterioration
Center bank sluice	Wall	N=1 nos.	1989	Gate: damege, Structure: damaged
Right bank sluice	Wall	N=1 nos.	1989	Gate: leakage, Structure: minor deterioration
Left bank canal	Earth	L=350 m	Unknown	Natural canal, Erosion
Center bank canal	Earth	L=325 m	Unknown	Natural canal
Right bank canal	Concrete	L=257 m	2016	Good
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Spillway

Left bank sluice

Center sluice

Left bank canal

Rigth bank canal

Kiulekada Cascade **8 Gonahathdenawa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=1,515 m H=3.1 m	2001	Heavy jungle, Bud to erosion
Right bank spillway 1	Drop wall	L=31 m	2001	Minor deterioraion
Right bank spillway 2	Drop wall	L=23 m	2001	Minor deterioraion
Left bank sluice	Tower	N=1 nos.	2001	Good
Center bank sluice	Tower	N=1 nos.	2001	Good
Right bank sluice	Tower	N=1 nos.	2001	Good
Left bank canal	Earth	L=450 m	1983	Natural canal
Center bank canal	Earth	L=9,070 m	1984	Natural canal
Farm road		L=3,250m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Right bank spillway 1

Right bank spillway 2

Left bank sluice

Left bank canal

Center canal

Kiulekada Cascade **7 Kudagama**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=890 m H=2.4 m	2014	Shrubs jungle, Uneven of top width and side slope, Water leakage
Left bank spillway	Drop wall	L=30 m	1996	Minor damage
Left bank sluice	Wall	N=1 nos.	1996	Gate: damage, Structure: damage
Center bank sluice	Tower	N=1 nos.	1996	Gate: damage, Structure: damage
Right bank sluice	Tower	N=1 nos.	1996	Gate: damage, Structure: minor damage
Left bank canal	Earth	L=250 m	1983	Natural canal
Center canal	Earth	L=2,220 m	1983	Natural canal
Right bank canal	Earth	L=670 m	1983	Natural canal
Farm road		L=1,500m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Left bank spillway

Left bank sluice

Center sluice

Left bank canal

Right bank canal

Kiulekada Cascade **11 Kiulekada Ihala wewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=583 m H=3.0 m	2014	Shrubs jungle, Uneven of top width and side slope, Water leakage
Right bank spillway	Drop wall	L=38 m	2012	Good
Left bank sluice	Wall	N=1 nos.	2014	Gate: minor deterioration, Structure: good
Right bank sluice	Wall	N=1 nos.	2014	Gate: minor deterioration, Structure: good
Left bank canal	Earth	L=170 m	Unknown	Natural canal
Right bank canal	Earth	L=527 m	Unknown	Natural canal
Farm road		L=2,000m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Right bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Kiulekada Cascade **10 Kiulekada**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=933 m H=3.0 m	2010	Shrubs jungle, Uneven of top width and side slope, Water leakage
Left bank spillway	Unknown	L=12 m	Unknown	Unknown
Center spillway	Drop wall	L=26 m	2010	Good
Right bank spillway	Unknown	L=6 m	Unknown	Unknown
Left bank sluice	Tower	N=1 nos.	1984	Gate: damage, Stucture: damage
Right bank sluice	Wall	N=1 nos.	2012	Gate: damagen, Stucture: minor deterioration
Left bank canal	Earth	L=990 m	Not rehabilitated	Natural canal (part: concrete)
Right bank canal	Earth	L=665 m	Not rehabilitated	Natural canal (part: concrete)
Farm road				

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Center spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Kiulekada Cascade **13 Galkadawala**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=490 m H=2.5 m	2016	Shrubs jungle, Uneven of top width and side slope, Water leakage, Long crack at bund center
Left bank spillway	Drop wall	L=10 m	2016	Good
Left bank sluice	Wall	N=1 nos.	2016	Good
Right bank sluice	Tower	N=1 nos.	2016	Good
Left bank canal	Concrete	L=33 m	2016	Good
Right bank canal	Earth	L=550 m	2016	Natural canal
Farm road		L=1,500m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

Tank bund

Left bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

Kiulekada Cascade **12 Kiulekada Kuda wewa**

Facility	Type	Dimension*	Rehabilitation record	Conditions
Tank bund	-	L=614 m H=1.5 m	Unknown	Shrubs jungle, Uneven of top width and side slope, Water leakage
Right bank spillway	Drop wall	L=11 m	2012	Good
Left bank sluice	Wall	N=1 nos.	2012	Gate: minor deterioration, Structure: good
Right bank sluice	Wall	N=1 nos.	2012	Gate: minor deterioration, Structure: good
Left bank canal	Earth	L=289 m	Unknown	Natural canal
Right bank canal	Earth	L=518 m	Unknown	Natural canal
Farm road		L=2,000m		

Remarks: Dimension*; L (Length), W (Bund top width), N (Number)

Photograph

tank bund

Right bank spillway

Left bank sluice

Right bank sluice

Left bank canal

Right bank canal

ATTACHMENT 2

TANK CAPACITY OF KIULEKADA CASCADE

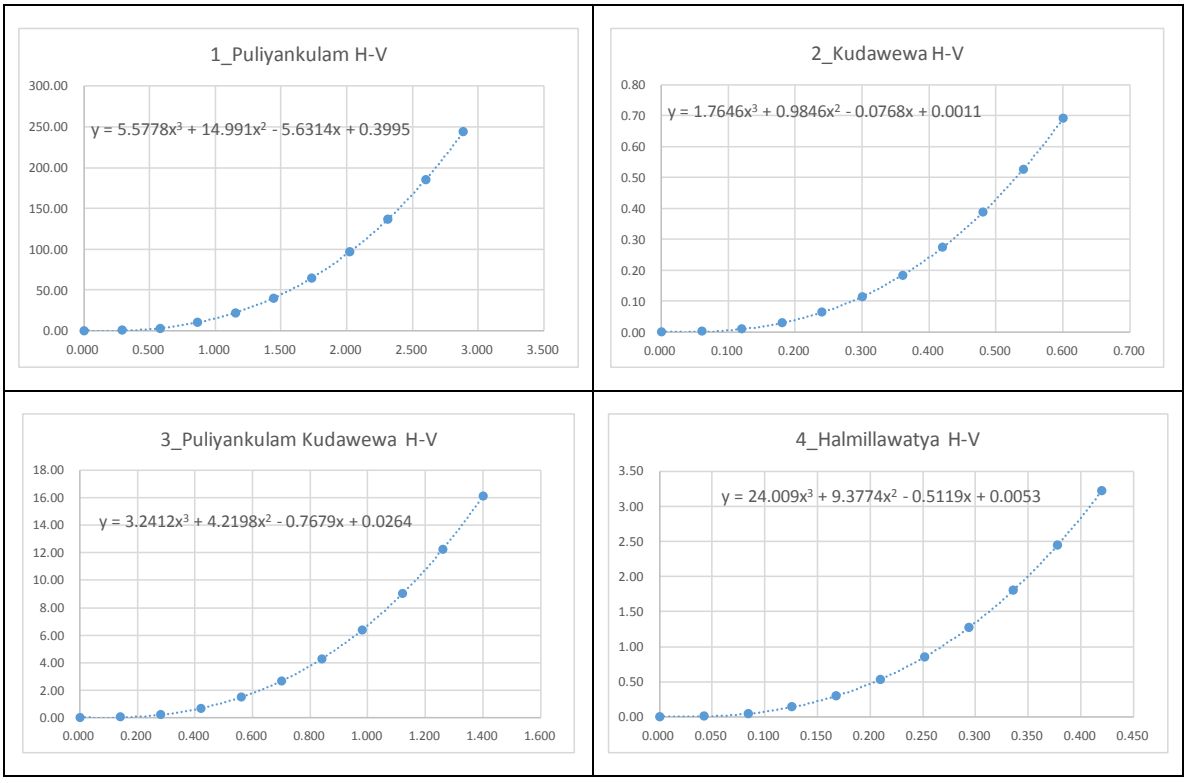
Summary of Tank Capacity

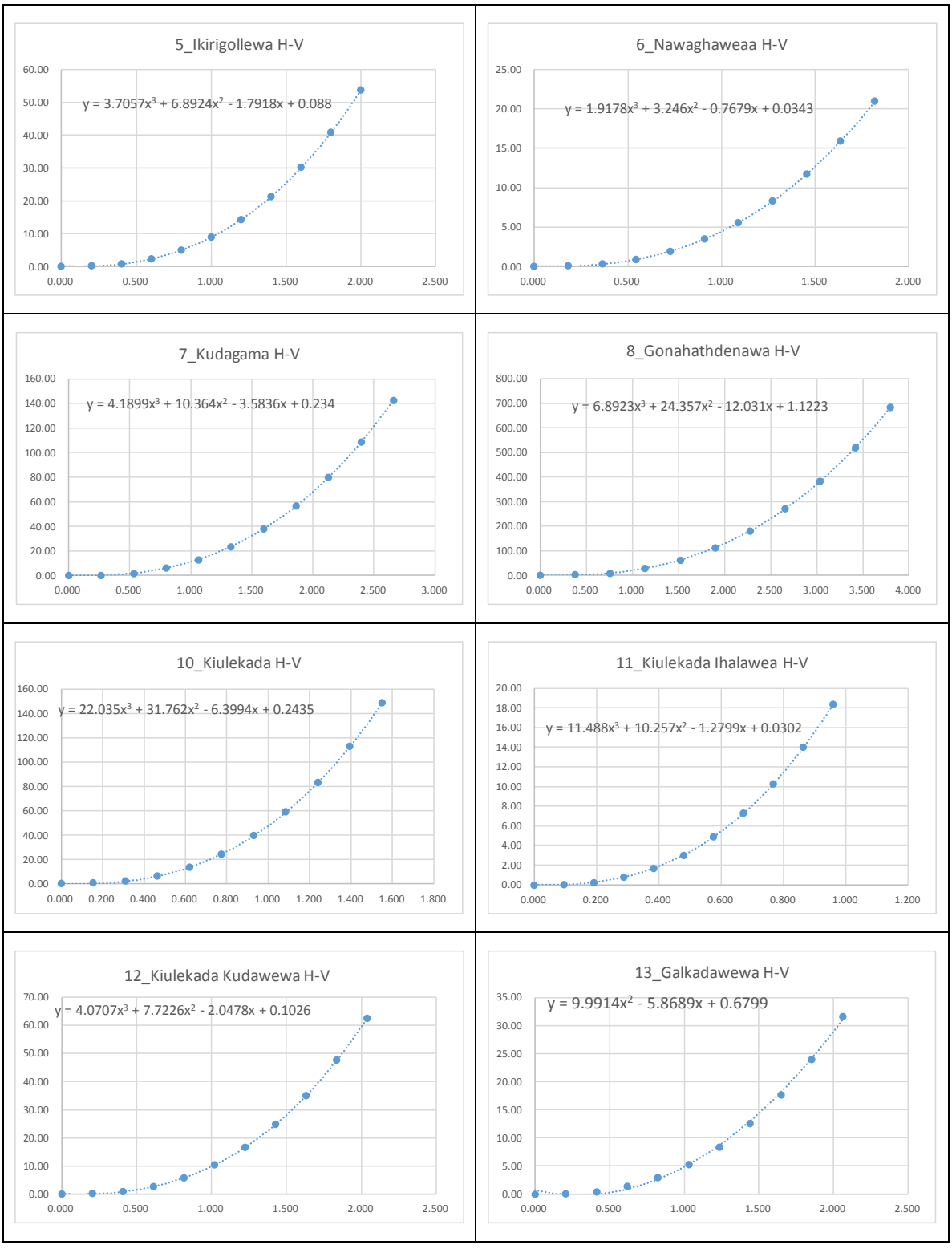
Cascade	Tank		Volume (1,000 m^3)	Renarks
Kiulekada	1	Puliyankulam	243.8	
	2	Kudawala	0.7	
	3	Puliyankulam Kudawewa	16.1	
	4	Halmillawatya	3.2	
	5	Ikirigolla	53.7	
	6	Nawaghawewa	20.9	
	7	Kudagama	142.8	
	8	Gonahathdenawa	684.7	
	11	Kiulekada	148.6	
	12	Kiulekada Ihala wewa	18.4	
	13	Kiulekada Kuda wewa	62.6	
	14	Galkadawala	31.6	

Source: JICA Project Team

Tank Capacity Calculation

H-V Curve





Source: JICA Project Team

ATTACHMENT 3

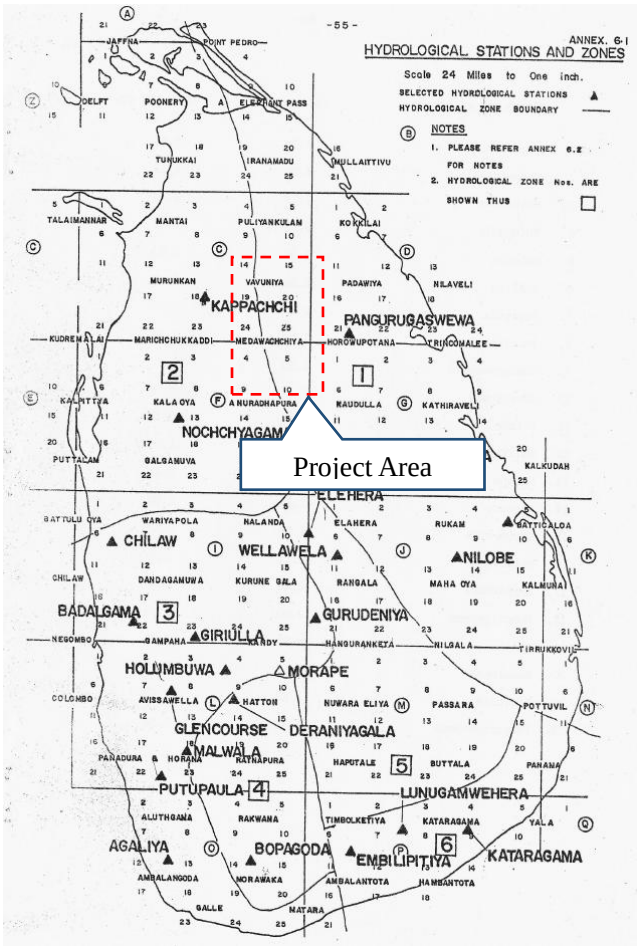
FLOOD DISCHARGE ESTIMATIONF FOR SPILLWAY DESIGN IN KIULEKADA CASCADE

(1) Methodology

By the request of the counterpart, the study for flood discharge estimation follows the Sri Lankan technical standard named "Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah. The guidelines stipulate the methodology of hydrological analysis, design of spillway, bund, and sluice.

(2) Climate Zone

According to the guideline, the country of Sri Lanka is divided to 6 hydrological zones as shown in Figure 2.3.2.1. The project area is fallen to Zone 1 and Zone 2.



Source: "Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

Figure 2.3.2.1 Hydrological Zone in the Irrigation Guidelines

(3) 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 2.3.2.1

Table 2.3.2.1 Probable Rainfall Depth for 24-hour Storm Presented in Irrigation Guideline

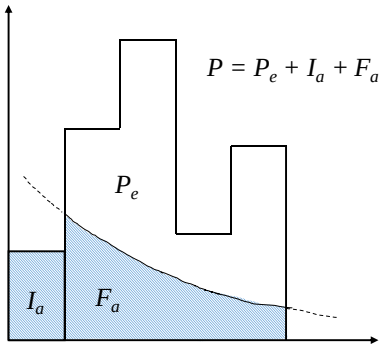
Unit: inches

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	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
25 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

Ref: Technical Guide Lines for Irrigation Works (1989)" by A.J.P. Ponrajah

(4) 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 our study, the rainfall loss is calculated by the SCS(Soil Conservation Services) method.



Source: "Applied Hydrology" Ven Te Chow, et al

Figure 2.3.2.2 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 above equation is the rainfall excess. "*P*" is total rainfall, "*Ia*" is initial loss, "*Fa*" is infiltration loss, and "*S*" is the potential maximum retention. By using 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.

(5) Flood Hydrograph

1) Method to Derivation of Flood Hydrograph

In the guideline, Snyder unit hydrograph is introduced. The coefficients of the Snyder's hydrograph is 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.

2) 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.

$$t_p = C_t(L \cdot L_C)^{0.3}$$

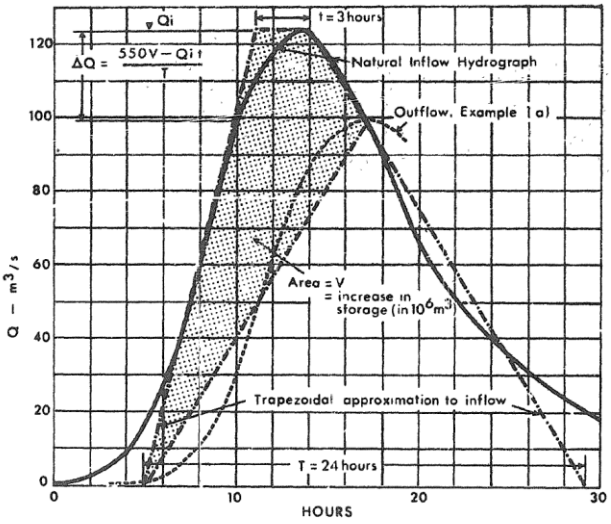
Where, L is length of the longest river course of catchment in miles, and L_c is length from the point of interest to the point on the river course closest to the centroid of the catchment in miles.

C_t and C_p are given to the closest hydrological stations.

For Kiulekada cascade, the closest hydrological station is Pangurugaswewa, C_t and C_p are 1.88 and 0.94, respectively.

3) Flood Routing

The inflow of the flood flow will be released from the spillway but a part of the inflow will be storage 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 isosceles triangle. The fore slope and rear slope of the trapezoid are drawn to fit the tangent of the hydrograph.



Source: M.J.H. West "Flood Control in Reservoirs and Storage Pounds-A Discussion," Journal of Hydrology, 23 (1974)67-71

Figure 2.3.2.3 Flood Routing by J.H.West Method

According to the guideline, the peak outflow is estimated by the following equation.

$$q_d = \frac{555.5V_d - q_{in}}{T}$$

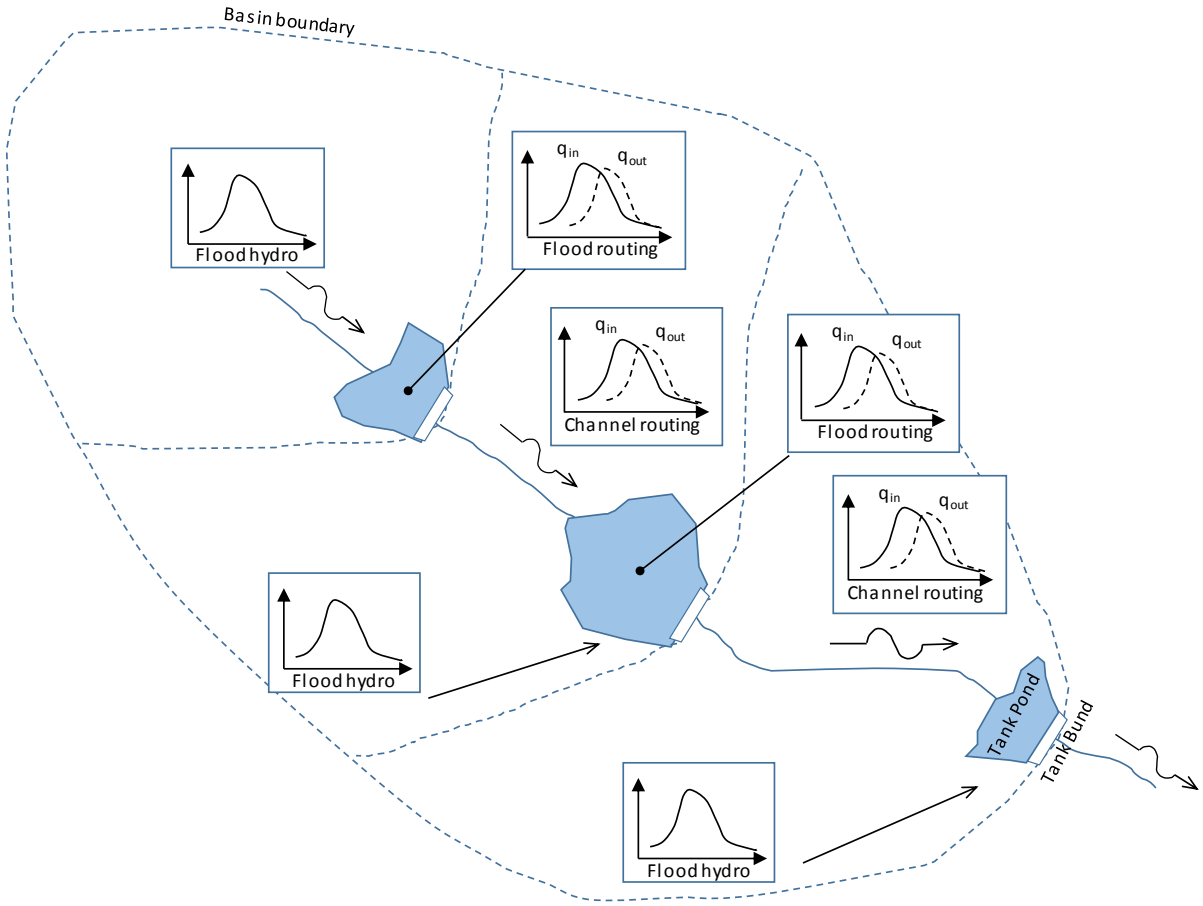
Where, q_d is peak outflow through spillway in cumecs, V_d is stored flood discharge in the reservoir in million m^3, q_{in} is peak inflow, T is base hours of inflow and outflow shown in the Figure 2.3.2.3.

4) 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 is introduced in various guideline and text books such as "Flood Runoff Analysis" of US Army Corps of Engineers, or "Applied Hydrology" by Ven Te Chow, et al.

5) 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 2.3.2.4.



Source: JICA Project Team

Figure 2.3.2.4 Concept of the Flood Analysis for the Cascade System

6) Flood Peak Discharge for Spillway of the Tanks in Kiulekada Cascade

The flood peak discharge is estimated by the method in the aforesaid sections. Result of the peak discharge of the tank is summarized in Table 2.3.2.2.

The calculation spreadsheet for the calculation of peak discharge for the Kiulekada cascade is shown in Annex 1.

Table 2.3.2.2 Summary of Flood Flow Analysis for Kiulekada Cascade

Name of Tank	Catchment Area (km^2)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)
Puliyankulam (13)	1.34	35.9	29.4
Halmillawatya (11)	1.24	53.2	51.9
Ikirigollawa (10)	0.87	38.2	32.1
Nawagha (9)	0.29	14.7	13.2
Gonahathdenawa (8)	2.08	119.6	110.1
Kuadagama (7)	0.83	46.3	41.6
Galkadawala (4)	0.32	16.9	15.0
Kiulekada (3)	4.12	134.0	134.0
Kiulekada Ihala wewa (2)	0.84	72.6	72.6
Kiulekada kuda wewa (1)	0.84	41.3	37.2

Source: JICA Project Team

ATTACHMENT 4

SPILLWAY LENGTH OF TANKS IN KIULEKADA CASCADE

Kiulekada Cascade

No.	Tank	Existing		Design							
		Spill type	Length (m)	Spill type	Design flood (Q') (m^3/s)	C	Length (B) (m)	Depth (H) (m)	Calculation (Q) (m^3/s)	Evaluation Q>Q'	Remarks
1	Puliyankulam	Drop wall	16.0	Drop wall	24.0	3.33	28	0.6	24.2	OK	(1)
2	Kudawala	Channel	10.0	Channel	1.3	2.80	2	0.6	1.5	OK	(2-2)
3	Puliyankulam Kudawewa	Channel	15.0	Channel	7.9	2.80	11	0.6	8.0	OK	(2-2)
4	Halmillawatya	Channel	33.0	Channel	44.1	2.80	34	0.9	45.4	OK	(1)
5	Ikirigollawa	Drop wall	17.0	Drop wall	26.0	3.33	31	0.6	26.8	OK	(1)
6	Nawagha wewa	-	10.0	Channel	10.8	2.80	15	0.6	10.9	OK	(3)
7	Kudagama	Drop wall	30.0	Drop wall	37.3	3.33	44	0.6	38.0	OK	(1)
8	Gonahathdenawa	Drop wall	54.0	Drop wall	87.8	3.33	56	0.9	89.0	OK	(1)
11	Kiulekada	Drop wall	44.0	Drop wall	100.6	3.33	64	0.9	101.7	OK	(1)
12	Kiulekada Ihal wewa	Drop wall	38.0	Drop wall	55.5	3.33	35	0.9	55.6	OK	(1)
13	Kiulekada Kuda wewa	Drop wall	11.0	Drop wall	8.5	3.33	10	0.6	8.6	OK	(1)
14	Galkadawala	Drop wall	10.0	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) (m^3/s/km2)

(2-2) Q'; Assumed by unit flood (per irrigable area) 1.31 (m^3/s/ha)

(3) Spill type; Assumed

C: Coefficient of Discharge (Drop wall type: 3.33, Channel type: 2.80)

Length (B): Spillway length (m)

Depth (H): Overflow depth (m), In case Q>50 m3/s; H=0.9m, In case Q<50 m3/s; H=0.6m

Note: In case Halmillawatya was selected Depth=0.9m based on the site conditions.

Calculation (Q): $Q=CBH^{3/2}$ (m^3/s)

Design of spillway for verification program (based on map of 1: 50,000)

Puliyankulam: Catchment area = 1.34 km2

Discharge = 29.4 m3/s

Sipllway length = 35 m

Halmillawatya: Catchment area = 1.24 km2

Discharge = 51.9 m3/s

Sipllway length = 39 m