5.3.4 Muruthawela Reservoir Scheme

(1) Scheme Background and Description

The scheme comprises 3 sub-schemes. In the case of the Urubokka Oya and Kirama Oya sub-schemes, prior to construction of Muruthawela reservoir in 1971, each scheme diverted water for irrigation from independent river sources under traditional agricultural practices. The new LB intake works in conjunction with construction of the Muruthawela Reservoir were designed for diversion of discharge to the combined Muruthawela LB sub-scheme (a new settlement project area) and the originally existing Urubokka Oya sub-scheme. The RB intake works were intended to divert discharge along a newly constructed canal to the Kirama Oya sub-scheme. These 3 sub-schemes together became referred to overall as the Muruthawela Reservoir scheme. It is said that this scheme is essentially representative of irrigation and drainage schemes in the Southern Province, both in terms of scheme characteristics and problems affecting it. The scheme combines irrigation by conventional river diversion via anicut with irrigation from an upstream tank facility, and incorporates a drainage system into a another basin. However, the scheme suffers from such problems as water shortages at the tank, the need to re-incorporate the new settlement area of Tract I into the scheme, and deterioration of irrigation facilities.

(2) Benefit Area

Total benefit area of the 3 sub-schemes is 5,472 ha.

Sub-scheme	Unit	Area (ha)	Remarks
Muruthawela LB			*It was agreed between the ID and the Study Team in discussions on March 6, 1996 to incorporate Tract-I into the sub-scheme.
	*Tract - I	424.9	
	Tract - II	583.3	
	Tract - III	691.9	
Sub-total		1,700.1	
Urubokka Oya	Urubokka	1,746.0	
	High Level	515.9	
		2,261.9	
Kirama Oya		1,510.5	
Muruthawela Reservoir Scheme			
Total		5,472.5	

(3) Present Canal Length

Total canal length at present in the scheme area was calculated utilizing S = 1/5000 topomapping prepared during the Phase II study period, and based on field survey.

Present Canal Length

Sub-scheme	Main canal (m)	D-canal (m)	Total
Muruthawela LB	14,443	33,938	48,381
Urubokka Oya	-	77,900	77,900
Kirama Oya	-	44,300	44,300
Total	14,443	156,138	170,581

(4) Overall Irrigation System Diagram

Figure 5.3.4-1 diagrams the overall irrigation system for the Muruthawela Reservoir scheme.

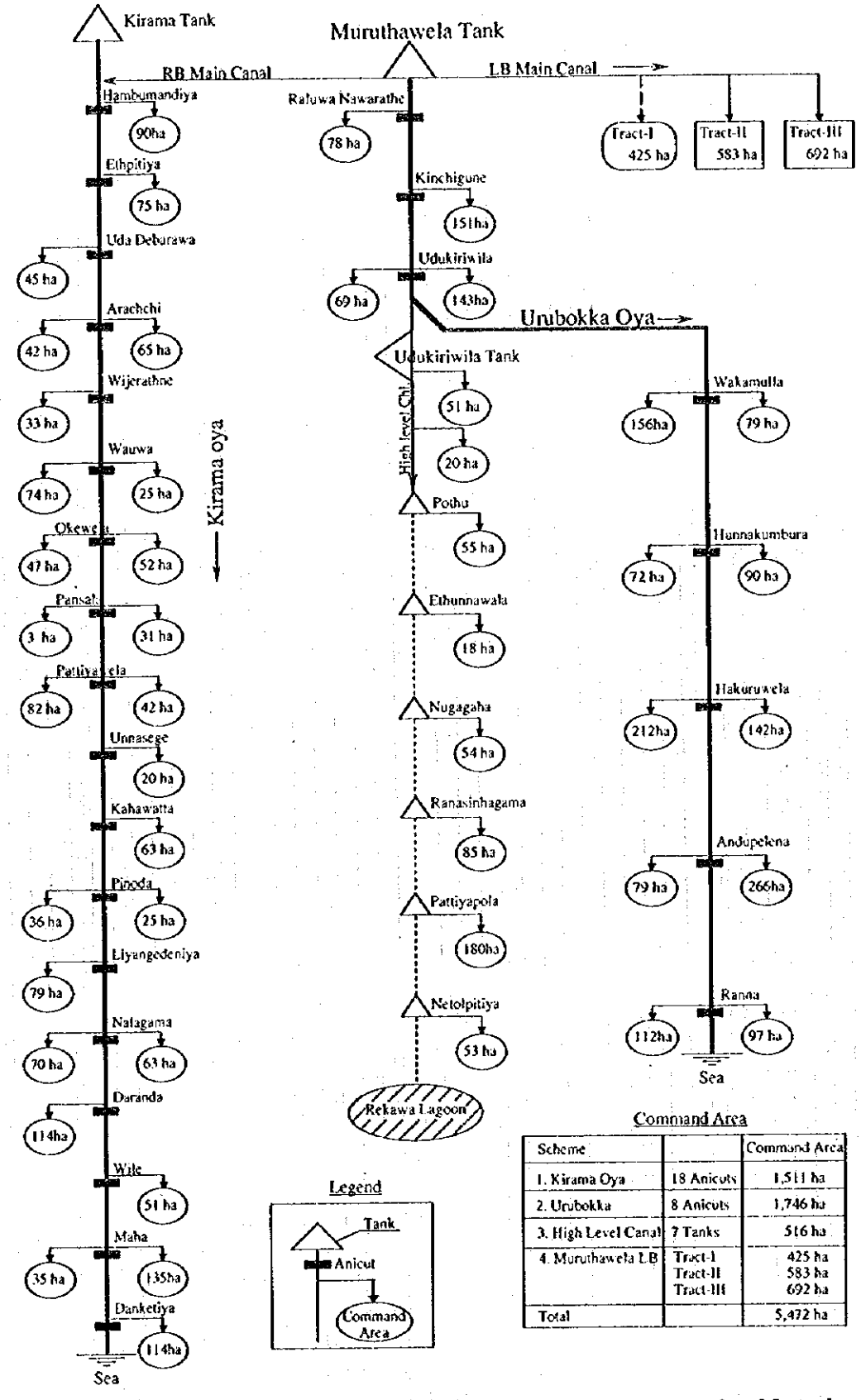
The diagram was prepared on the basis of Phase II study.

(5) Muruthawela Reservoir Facilities

1) Year of construction

	Year constructed	No. of years since construction
Muruthawela Reservoir	1971	25
Muruthawela LB	1970s	25
Urubokka Oya	1789 (Reconstructed in 1859)	137
Kirama Oya	1805~1812 (* Partially reconstructed in 1980~1984)	16~12

*under HIRDP (Hambantota Integrated Rural Development Project)



Command Area

Scheme		Command Area
1. Kirama Oya	18 Anicuts	1,511 ha
2. Urubokka	8 Anicuts	1,746 ha
3. High Level Canal	7 Tanks	516 ha
4. Muruthawela LB	Tract-I Tract-II Tract-III	425 ha 583 ha 692 ha
Total		5,472 ha

Figure 5.3.4-1 ***Diagram of Overall Irrigation System for Muruthawela Reservoir Scheme***

2) Salient features of main facilities

<Muruthawela Reservoir>

Facility	Design features	Design value
Reservoir	dam type	earth dam
	storage capacity	48 MCM
	crest length, crest width	L=164m, B=6.0m
	embankment slope gradient	1:2.75 (up/down stream)
	base elevation	61.0m (MSL)
	dam height	H=31.5m
Flood spillway	gate type	5 nos. of radial arm gate L=30.5m (B=6.1m × H=3.8m)
	spillway	3.8 m
	design flood discharge	625 m³/s
	spillway elevation	85.5m (MSL)
	HFL	90.2m (MSL)
Intake gate		
LB	intake facility	RC intake tower and feeded culver (W=1.1m × H=11.5m×2 gates)
	design discharge	Q = 7.0 m³
	gate sill height	74.4m (MSL)
	max. depth	H = 15m
RB	intake facility	same as LB
	design discharge	Q = 3.5m³/s
	gate sill height	same as LB

<Muruthawela LB and RB main canal>

Facility	Design features	Design value
Main canal	design discharge	Q = 2.1 m³/s (for Tract-II, III)
	canal gradient	i = 0.0003 (≅ 1/3,300)
	base width	B = 3.66 m
	design depth	H = 0.85 m
	slope gradient	n = 1:1.0
	freeboard	Fb = 0.9m
	length	L = 14.5 km
Branch canal	no. of canals	18 total (9 in Tract II, 9 in Tract III)
	width / total length	B=0.6~1.8: ΣL = 33.9km
(D-canal)	cross-section	All simple section, unlined
Field canal	no. of canals	275 total
	total length	L = 240km (Tract II, III)
	min. design discharge	Q = 0.03 m³/s

<RB main canal>

Facility	Design features	Design value
Main canal	design discharge	Q =3.50 m³/s
	canal gradient	i = 0.0003 (≅ 1/3,300)
	base width	B = 3.66 m
	design depth	H = 1.20 m
	slope gradient	n = 1:2.0
	freeboard	Fb = 0.9m
	length	L = 7.2 km

<Urubokka scheme>

- High Level unit

Tank name		Udukiriwila	Pothuwewa	Ethunneuwela	Nugagaha	Ranasingha	Pattiyapola	Natolpitiya
Tank								
Catchment area	(km²)	25.9		13.8	19.2	32.0	42.2	47.7
Capacity	(m³)	3,978,000	74,000	59,000	43,000	54,000	705,000	149,000
FSL storage area	(m³)	2,631,000	80,000	96,000	60,000	96,000	468,000	288,000
Irrigation area	(ha)	67 (RB canal)	23	16	6	30	182	81
Canal length	(km)	1.3 (Low level canal)+ 3.8 (High level canal)	2.6	1.0	2.4	2.8	4.4	1.0
Embankment								
Embankment length	(feet)	3,300	750	1,000	1,330	1,400	3,900	2,500
Crest width	(feet)	15	6	8	8	6	12	8
Crest elevation	(feet)	130.5	104	108	104.75	55.75	113	102
Slope gradient	(feet)	1 on 2	1 on 2	1 on 2	1 on 2	1 on 2	1 on 2	1 on 2
FSL	(feet)	125.24	100.00	104.36	100.00	49.00	109.00	98.55
HFL	(feet)		102.40	107.24	132.20	53.57	112.50	101.65
Flood spillway (1)								
Type		masonry weir	concrete weir + gate	stoplog	concrete weir	Skin type	overflow embankment	masonry weir
Overflow crest length	(feet)	68.50	40	120	200	75	250	295
Flood spillway sill height	(feet)	12.54	100.00 (Assumed)	104.36	100.00	49.00	109.00	98.55
Flood spillway (2)								
Type				Clear over fall type	Concrete, clear overfall	Co type spill	Clear overflow with 6 planted bays	Co type spill
Overflow crest length	(feet)			40	40	125	66	125
Flood spillway sill height	(feet)			104.36	100.00	49.00	109.00	49.00
Sluice gate		No 1 / No 2						
Type			Hume pipe tower sluice	Dressed rubble masonry	Rubble Masonry	VT type sluice		
Diameter	(inches)	23.5	9.0	1.5		9.0		
Opening		3.0"+4'-3"						
Sill height elevation	(feet)	112.84 / 122.84		100.00	94.08	45.25		

- Urubokka unit

Anicut	Anicut features						RB		LB	
	location (km)	gate crest height (m)	gate sill height (m)	no. of gates	gate material	gate size B × H (m)	gate sill height (m)	gate size B × H (m)	gate sill height (m)	gate size B × H (m)
Urubokka Oya										
2 Way Head Regulator	0.0	75.3	73.8	2	W	1.5 × 1.5				
Raluwa Nawarathe	2.7	57.6	56.9	2	P	1.5 × 0.6	57.0	1.2 × 0.6		
Kinchigunew	4.8	49.3	48.5	2	P	1.2 × 0.8			48.7	1.4 × 0.8
Udukiriwila	10.5	38.8	37.2	3	S	4.6 × 1.5	37.7	3 ways	37.8	1.9 × 0.9
Wakamulla	13.9	31.5	29.3	5	W	2.0 × 2.2	30.7	2.0 × 1.4	30.6	1.2 × 0.8
Hunnakumbura	16.9	26.7	24.5	5	W	1.8 × 2.2	30.7	NA	NA	NA
Hakuruwela	19.4	22.7	20.5	5	W	1.9 × 2.2	NA	1.7 × 1.7	NA	1.7 × 1.0
Andupelena	27.2	11.6	9.2	5	W	2.0 × 2.4	10.8	1.4 × 0.8	10.6	2.0 × 1.2
Ranna	35.0	4.2	1.8	5	W	2.0 × 2.4	3.3	1.0 × 0.4	3.4	1.0 × 0.4

note: for gate material, W = wood; P = plank (stoplog); S = steel

- Udukiriwila tank

Features	Design value
Storage volume	40 MCM
Effective storage	3.7 MCM
Crest length	106.5 m
Crest height	5.2 m
Flood spillway type	masonry

<Kirama Oya sub-scheme>

- Kirama tank (rehabilitated in 1979)

Features	Design value
Storage volume	1.4 MCM
Effective storage	1.3 MCM
Crest length	228.75 m
Crest height	6.71 m
Flood spillway type	sluice gate + overflow type
FSL	286.03

- Anicut

Anicut	Anicut features						RB		LB	
	location (km)	gate crest height (m)	gate sill height (m)	no. of gates	gate material	gate size B × H (m)	gate sill height (m)	gate size B × H (m)	gate sill height (m)	gate size B × H (m)
Spill Cum Regulator	0.4	90.2	85.5	2	W	1.8 × 1.7				
Hammbumandiya	7.9	64.5	63.0	4	W	1.7 × 1.5			63.7	1.2 × 0.9
Ethpitiya	9.5	59.2	57.4	6	W	1.3 × 1.8			58.0	1.3 × 1.3
Uda Debarawa	13.6	42.3	39.7	4	W	1.6 × 2.5	41.7	1.2 × 0.9		
Arachchi	14.7	39.6	37.8	3	P	2.4 × 1.8	38.4	1.2 × 1.2	38.6	1.2 × 1.2
Wijerathne	17.3	31.2	28.8	1	S	4.4 × 2.4	30.87	0.9 × 0.9		
Wauwa	18.9	27.9	26.0	5	W	1.5 × 1.9	27	1.2 × 1.0	27.2	1.4 × 1.2
Okewela	21.5	22.4	20.4	4	W	1.7 × 2.0	21.7	0.6 × 0.8	21.9	0.6 × 0.8
Pansala	24.2	18.9	16.3	2	S	4.6 × 2.5	16.2	0.5 × 0.8	18.5	0.4 × 1.0
Pattiyawela	25.7	16.0	14.3	5	W	1.7 × 1.7	15.3	1.7 × 0.8	15.6	1.2 × 0.9
Unnansege	27.4	13.3	11.4	5	W	1.5 × 1.9			12.6	NA
Kathwatta-1	28.7	11.9	8.8	5	W	1.8 × 3.1			11.2	1.2 × 0.9
Kathwatta-2	29.0	10.1		2	W					
Pinoda	30.4		7.5	2	S	4.3 × 2.5	9.4	NA	9.3	1.2 × 1.1
Liyanagedeniya	30.5	NA		4	W	2.0 × 1.7		NA		
Nalagama	32.9	7.6	5.6	5	W	1.8 2.0	6.6	0.6 × 0.9	6.8	1.2 × 1.1
Daranda	34.5	6.1	3.4	2	S	4.6 2.0	4.3	1.5 × 0.8		
Wile	35.5	4.9	2.5	2	S	4.7 × 2.4	4.6	0.9 × 0.9		
Maha	38.3	3.4	0.9	5	W	1.8 × 2.5	3.6	0.6 × 0.9	3.6	0.6 × 0.9
Danketiya	40.5	2.0	0.0	5	W	1.5 × 2.0			1.8	1.8 × 1.9

note: for gate material, W = wood; P = plank (stoplog); S = steel

(6) Current Status of Muruthawela Reservoir command schemes

1) Reservoir command area

Muruthawela Reservoir was originally constructed to irrigate the 6,250 ha indicated below.

Supplemental supply to Kirama Oya sub-scheme has not been in done for the 9 year period from December 1987 to the present (according to Muruthawela Reservoir operational logs). Accordingly, the target command area under this Feasibility Study is 3,962 ha.

- Muruthawela reservoir command area

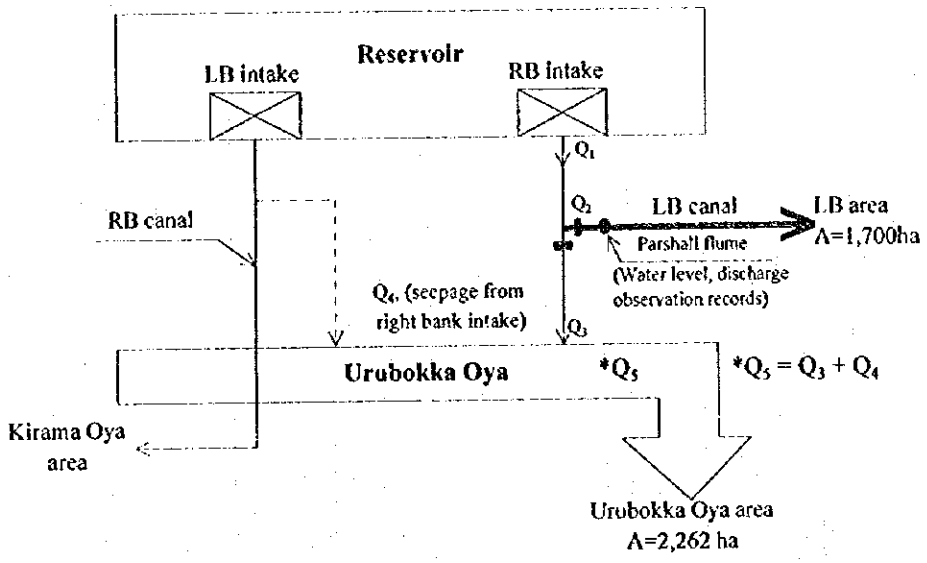
Sub-scheme	Original design area (ha)	Target area under F/S (ha)	Remarks
LB main canal	1,724 (Tract I+II+III)	1,700	
Urubokka Oya	2,226	2,262	
Supplemental supply to Kirama Oya	2,300	0	not done for the past 9 years
Total	6,250	3,962	

2) Calculation of water distribution to Muruthawela LB and Urubokka Oya unit

- Available data with regards to intake discharges are as follows:

Gauging facility	Observation record period	Remarks
Reservoir intake gate	1984~1996 (12 years)	
Turn out works downstream of embankment	no records	
Parshall flume	1991~1995 (4 years)	parshall flume main body is damaged, and facility does not function
Water level markers (LB main canal)		
LB main canal discharge observations	March 1995 (JICA Study Team)	
Observation records at parshall flume site	January~June 1996 (ID) March 1996 (JICA Study Team)	

- Discharge distribution diagram is as follows.



- Calculation of distributed discharge volumes

Applying the observation records for 1991~1995, and the discharge distribution diagram, the Study Team corrected the discharge data. This included correction of the discharge coefficient for the LB intake gate, and computing the H-Q curve according to water level and discharge observation at the parshall flume site. These works were done in collaboration with the ID (March 1996).

Computed distribution volumes of discharge are as per below.

Year		Discharge from reservoir intake (c.ft)	Discharge at diversion works (ac.ft) To LB main canal		To Urubokka	
1991/1992	Maha	21,416	14,404	(67%)	7,012	
	Yala	17,001	9,979	(59%)	7,022	
1992/1993	Maha	17,004	7,923	(46%)	9,081	
	Yala	18,838	15,587	(83%)	3,251	
1993/1994	Maha	23,090	17,373	(75%)	5,717	
	Yala	29,207	18,569	(64%)	10,611	
1994/1995	Maha	23,079	16,841	(73%)	6,238	
	Yala	25,254	16,620	(66%)	8,634	
Average	Maha	16,864	11,308	(67%)	5,610	(33%)
	Yala	18,060	12,156	(67%)	5,903	(33%)
	Year	34,982	23,464		11,513	

3) Irrigation period for Muruthawela Reservoir command area

Irrigation discharge controlled at Muruthawela Reservoir is fed to the Muruthawela LB and Urubokka Oya sub-scheme areas. Utilizing this discharge, irrigation for the 2 sub-scheme areas is as follows.

① Muruthawela LB sub-scheme

23 cases of irrigation period records for the past 12 years were studied and collated (see attached materials).

According to findings, seasonal rotational irrigation has been carried out in the Tract III (Maha season) and Tract II (Yala season) since 1991, and this is still the practice at present. Prior to 1991, this type of irrigation pattern was not done. According to irrigation period records indicated in Figure 5.3.4-2, the following irrigation is typical (with some small variation yearly).

Season	Period	Total irrigation days
Maha	mid September ~ mid February	120 days (including 30 days tilling)
Yala	mid March ~ mid August	120 days (including 30 days tilling)

② Urubokka Oya sub-scheme

Irrigation periods by FO unit for the past 5 years were studied and collated (see figure 5.3.4-3).

This sub-scheme comprises the High-Level unit (small tank cascade system) and the Urubokka unit (river discharge diversion by anicut). It is assumed the irrigation period is simultaneous for both areas. Number of irrigation days is the same as for the Muruthawela LB scheme.

③ Kirama Oya scheme

This area is irrigated by 18 nos. of small anicuts constructed along a 40 km stretch of the Kirama oya. Based on records for 1991~1996 and interview survey, irrigation period is as shown in Figure 5.3.4-4. Start of irrigation period shows little difference for upstream, mid-stream and downstream parts of the sub-scheme area. Number of irrigation days is about the same as ①and ② above.

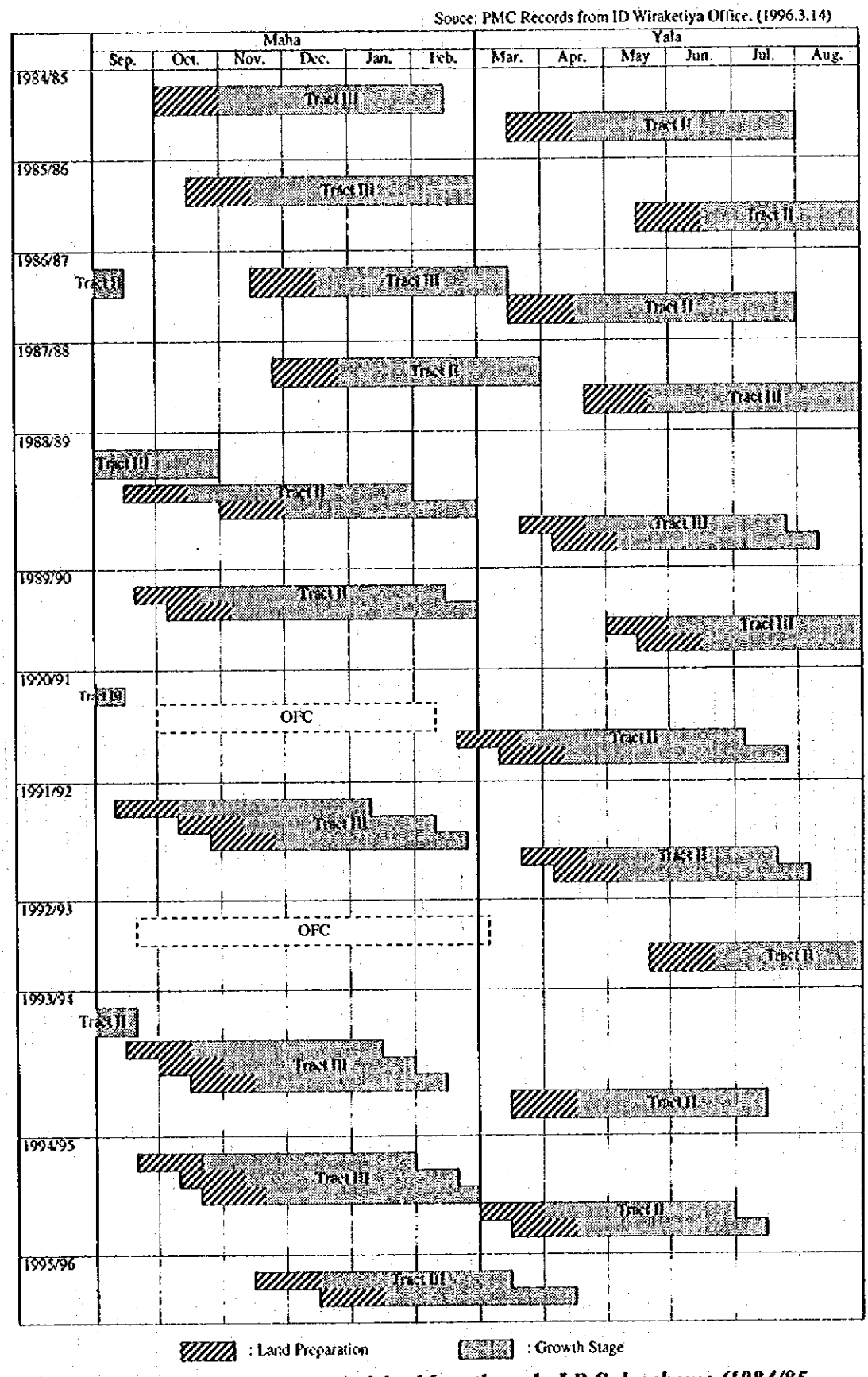


Figure 5.3.4-2 Irrigation Period for Muruthawela LB Sub-scheme (1984/85 ~ 1995/96)

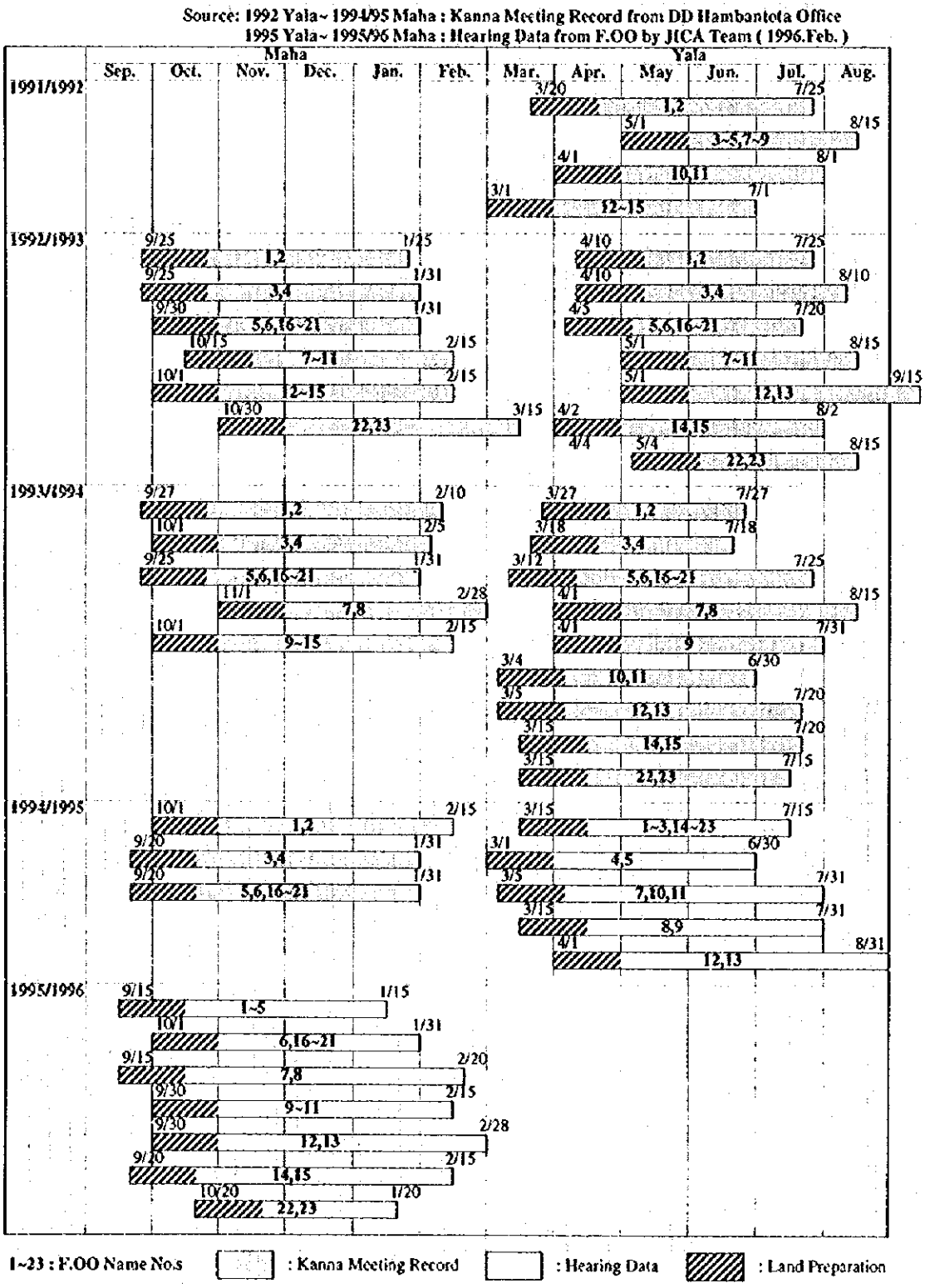


Figure 5.3.4-3 Irrigation Period for Urubokka Oya Sub-scheme (1991/92 ~ 1995/96)

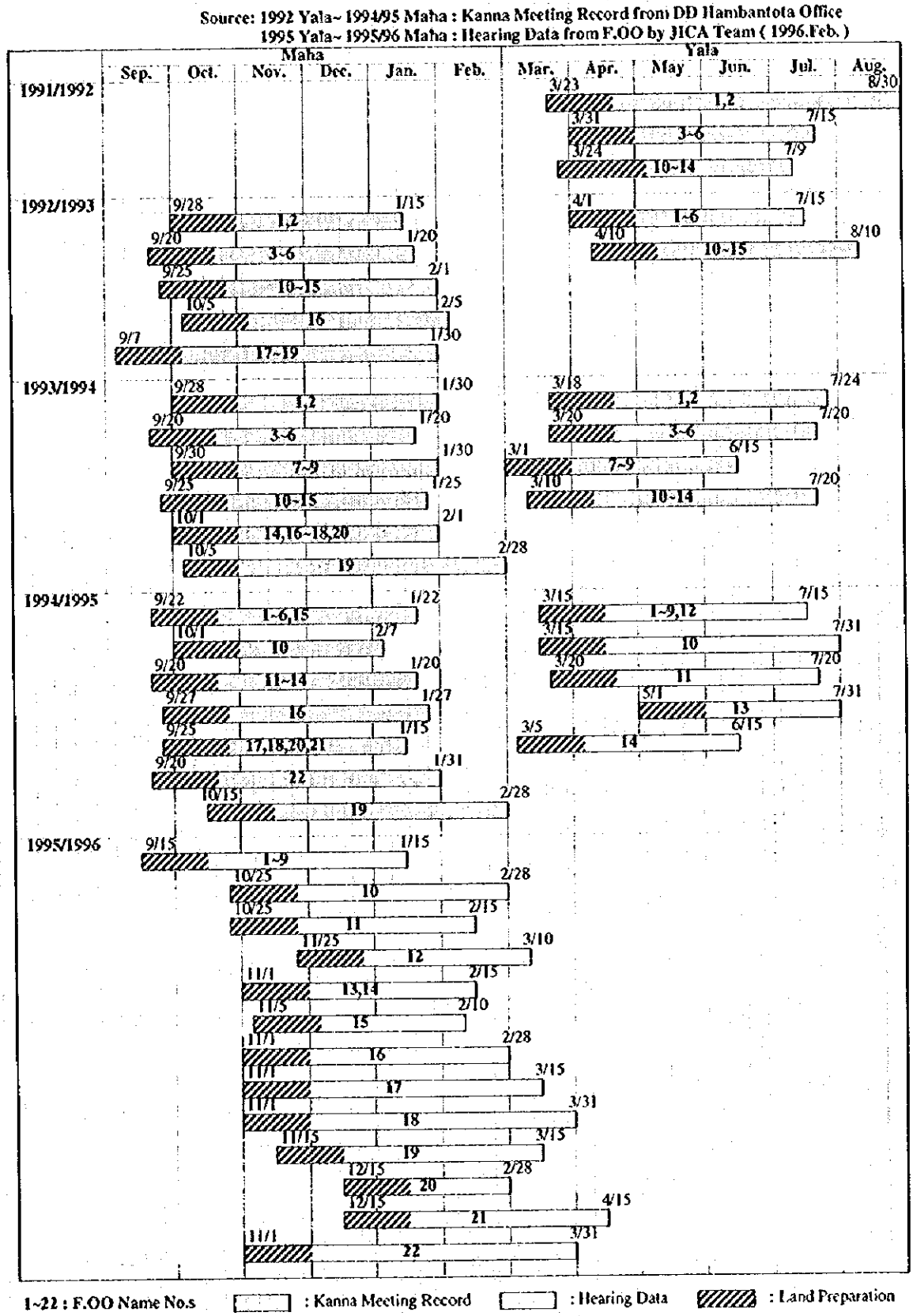


Figure 5.3.4-4 Irrigation Period for Kirama Oya Sub-scheme (1991/92 ~ 1995/96)

(7) Water Balance for Muruthawela Command Area

1) Catchment area features

Catchment area features are as follows.

Catchment name	Total catchment area (km²)	Reservoir	Study area Catchment area (km²)	Storage volume (MCM)	Scheme
Urubokka Oya	348	Muruthawela	109	48.0	Muruthawela LB Urubokka Oya
		Udukiriwila	26	3.7	Urubokka Oya
Kirama Oya	223	Kirama	15	1.3	Kirama Oya

2) Analysis method and results

Analysis for Muruthawela Reservoir has been carried out for the 7 year period 1972~1979) under NORAD. This analysis was done utilizing discharge records, rainfall observations, etc. from nearby areas. It is unclear by examination of the results of this analysis as to what criteria, particularly with regards to verification method, were applied.

There is no discharge gauging station in the area with the specific purpose of observing discharge flow into Muruthawela Reservoir.

On the other hand, the ID has carried out daily observations since 1984 of reservoir water level, degree of discharge gate aperture, etc., and these records are collated in log books. The Study Team further collated this data, applying criteria of rainfall amount, evapotranspiration amount, daily fluctuation in storage capacity, gate aperture records, etc. as discharge inflow analysis data. Results of this calculation were adjusted to irrigation discharge use computed for the reservoir command area (Muruthawela LB and Urubokka Oya).

Inflow discharge volumes so calculated are a per below (for reference, the NORAD analysis values are also included.

- Monthly mean discharge flow into Muruthawela Reservoir

(unit: acre feet = 1,234 m³)

Month / Calculation period	Maha season						Yala season						Total		
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Year	Maha Season	Yala Season
NORAD analysis values (1972~1979)	3,665	8,633	12,618	10,047	4,900	4,904	5,508	7,085	11,541	6,927	3,758	3,164	82,741	44,767	37,983
JICA analysis values (1984~1996)	1,992	5,400	12,084	5,901	37,382	2,804	4,227	4,772	5,033	4,730	2,448	1,902	55,349	32,209	23,140

In light of the fact that the values from analysis by the JICA Study team were computed based on data for a 12 year period, with correction based on actual irrigation discharge use in the benefit area, these were adopted over the NORAD value as inflow data for Muruthawela Reservoir.

- Month-wise discharge flow into Muruthawela Reservoir

(CA = 43 mi²=109km²; unit: acre feet)

	Maha Season						Yala Season						Total		
	9	10	11	12	1	2	3	4	5	6	7	8	Year	Maha Season	Yala Season
19 72/73	9,319	6,609	733	0	0	1,417	2,050	5,993	369	1,848	296	2,239	30,873	18,078	12,795
73/74	2,111	12,581	10,959	21,112	6,031	5,121	4,483	7,060	3,791	5,763	3,745	3,499	86,256	57,915	28,341
74/75	2,481	3,041	11,329	3,537	5,324	5,489	9,739	11,904	16,435	13,855	6,394	6,223	95,751	31,201	64,550
75/76	4,357	4,419	14,814	18,893	10,956	4,659	3,180	4,952	3,339	1,743	0	0	71,312	58,098	13,214
76/77	3,498	5,560	8,727	11,131	2,552	3,691	8,581	8,211	11,821	3,477	5,017	1,955	74,221	35,159	39,062
77/78	62	12,035	27,932	9,549	4,002	7,159	9,616	7,062	38,027	18,745	7,209	6,935	148,324	60,730	87,594
78/79	3,827	16,183	13,922	6,113	5,433	6,789	854	4,412	7,006	3,058	3,648	1,298	72,543	52,267	20,276
Average	3,665	8,633	12,631	10,047	4,900	4,904	5,500	7,085	11,541	6,927	3,758	3,164	82,758	44,778	37,976
19 84/85	2,803	3,104	12,577	7,929	7,366	5,447	8,466	5,539	4,493	14,402	2,435	1,623	76,184	39,226	36,958
85/86	228	6,239	6,863	8,917	4,845	3,262	3,581	4,184	228	228	228	1,270	40,073	30,354	9,719
86/87	1,063	1,943	4,127	2,543	2,834	1,441	4,141	8,740	5,205	2,271	1,168	5,487	40,963	13,951	27,012
87/88	3,530	12,969	9,484	11,670	2,169	3,040	7,684	9,714	3,663	4,175	1,716	963	70,777	42,862	27,915
88/89	4,112	1,196	15,513	4,734	717	228	5,551	905	228	2,640	5,365	2,470	43,659	26,500	17,159
89/90	818	3,073	189	3,077	2,071	3,689	7,545	3,476	6,221	2,374	1,271	1,658	35,462	12,917	22,545
90/91	1,780	6,818	24,518	8,776	2,652	2,047	1,179	6,112	2,396	7,660	2,514	2,211	68,663	46,591	22,072
91/92	228	4,862	8,862	2,152	1,079	825	228	765	3,843	1,895	1,392	419	53,683	30,343	8,542
92/93	2,962	2,996	12,300	4,546	228	2,582	3,915	2,321	14,017	9,499	7,856	1,337	64,559	25,614	38,945
93/94	1,146	9,504	17,183	3,006	6,282	4,546	2,340	2,579	2,236	520	1,401	2,006	52,749	41,667	11,082
94/95	3,356	6,229	17,797	10,798	5,711	2,723	1,869	8,158	12,835	6,671	1,579	1,475	79,201	46,614	32,587
95/96	1882	5,861	5,604	2,666	1,428	3,820								\(21,261\)	
Average	1,992	5,400	11,251	5,903	3,115	2,804	4,227	4,772	5,033	4,758	2,448	1,902	56,907	31,492	23,140

note: 1972/73~78/79 from Hydrological Study of Kirama, Urubokka and Muruthawela Reservoir Report (April 1984, NORAD); 1984/85~95/96 from JICA Study Team Phase II findings.

3) Calculation of Present Water Balance

With the objective of identifying the preliminary water balance for Muruthawela Reservoir and the 3 sub-schemes (LB, Urubokka, Kirama), the following calculations were performed.

a) Reservoir inflow

Discharge inflows into Muruthawela Reservoir and Udukiriwila Reservoir are as follows:

Unit: ac.ft (1,000m³)

	Muruthawela Reservoir (c.a. = 109 km²)		Udukiriwila Reservoir (c.a. = 26 km²)		Total	
Total annual discharge	55,000	\(67,870\)	13,100	(16,165)	68,100	(84,035)
Maha season	32,000	\(39,488\)	7,600	(9,378)	39,600	(48,866)
Yala season	23,000	\(28,382\)	5,500	(6,787)	28,500	(35,169)

b) Unit irrigation requirement

Irrigation requirement in the scheme area is calculated as per below. (Calculation applied (i) the 12 records for irrigation period in the LB Main Canal sub-scheme, (ii) and the trial calculation values of the ID. On this basis, the season-wise irrigation requirement calculated for 1993/94 under the Study was adopted for the unit requirement. The requirement for OFCs is assumed at ½ that for paddy.)

Annual irrigation requirement	:	9.0 ac.ft/ac. (2771 mm/year) see attached unit requirement calculation sheets
Maha season (paddy)	:	4.3 ac.ft/ac.
Yala season (paddy)	:	4.7 ac.ft/ac.
OFC (yearly)	:	4.5 ac.ft/ac.

c) Original design irrigated area

Sub-scheme	Irrigated area		Remarks
Muruthawela LB	3,150 Ac.s	(1,275ha)	Total area of Tract II+III
Urubokka Oya	5,590 Ac.s	(2,262ha)	Total area
Kirama Oya	1,500 Ac.s	(604ha)	40% of total area (3,733ac.s × 0.4)
Total	10,240 Ac.s	(4,141 ha)	

The above irrigated area adopts the original design area of the ID. Accordingly, Tract I has not been included under the Muruthawela LB sub-scheme. Also, supplemental discharge to the Kirama Oya sub-scheme area is targeted at irrigating 40% of that area (from ID project data).

d) Water balance calculation

Water balance calculation was carried out for the following 3 cases of cropping rate.

Case	LB			Urubokka	Kirama	Remarks
	Tract I	Tract II	Tract III			
Case I	0%	perennial 100%	perennial 100%	perennial 100%	40% of total area	original plan
Case II	0%	Maha 0% Yala 100%	Maha 100% Yala 0%	Maha 100% Yala 50%	0%	recommended by ID
Case III	Maha 65% Yala 65%	Maha 13% Yala 100%	Maha 100% Yala 6%	Maha 85% Yala 83%	0%	currently in practice

<Case 1>

The results of Case 1 calculation are shown below, and indicated that year round irrigation of the entire area is not possible (shortage of 37.6 MCM per year). As a result, it is concluded that the reservoir irrigation scheme constructed was not of sufficient scale from the outset to irrigated the entire target benefit area.

Case	Possible irrigation discharge (yearly) (Reservoir inflow discharge × irrigation efficiency)	Irrigation requirement for entire area (yearly)	Shortage (yearly)
CASE 1	34,050 ac.ft (68,100 × 0.50)	64,512 ac.ft (10,240×9.0×0.70 ac.ft/ac)	30,462 ac.ft (37.6 MCM)

note: Irrigation efficiency is assumed at 50%. Effective rainfall is assumed at 950 mm/year (which represents the average value for the 10 year period 1984/85 - 1994/95), and this was deducted from the unit irrigation requirement of 2771 mm/year.

<Case 2>

As clearly seen by the results of Case 1 calculation, a water shortage occurs in the LB area. To address this, in 1992 the ID began instructing farmers in the area regarding introduction of a seasonal rotation system.

- LB Main Canal : Tract-II (Yala season only), Tract-III (Maha season only)
- Urubokka Oya : Maha season (100% irrigation), Yala season (50% irrigation)
- Kirama Oya : no supplemental discharge

On the basis of the above, a perennial water shortage results as indicated below.

(unit: ac.ft)

Case	Season	Possible irrigation discharge	Irrigation requirement	Surplus
CASE 2	Maha	19,800	21,967	- 2,167 (2.6 MCM)
	Yala	14,250	13,940	+ 310 (0.4 MCM)
	Total	34,050	35,907	- 1,857 (approx. 2.2 MCM)

note 1: Possible irrigation discharge:
Maha = 39,600 × 50%; Yala = 28,500 × 50% = 14,250

note 2: Irrigation requirement calculation applied the following criteria:
Maha season: Tract III + Urubokka = (1,708 + 5,590) × 4.3 ac.ft/ac × 0.70
Yala season: Tract-II + Urubokka × 50% = (1,442 + 5,590 × 50%) × 4.7 × 0.70 ac.ft/ac

<Case 3>

However, including illegal diversion in Tract I (1,046 ac.s), the following cropping rate and irrigation are being practiced.

Area	Maha (%)		Yala (%)		Maha (ac.s)		Yala (ac.s)	
	Paddy	OFC	Paddy	OFC	Paddy	OFC	Paddy	OFC
Tract- I	65	-	65	-	680	-	680	-
II	-	13	100	-	-	187	1,442	-
III	100	-	-	6	1,708	-	-	102
Urubokka	85	-	83	-	4,750	-	4,640	-
Total	250	13	248	6	7,138	187	6,762	102

Preliminary water balance calculation based on the above indicates a water shortage.

(unit: ac.ft)

Case	Season	Inflow discharge to reservoir	Irrigation requirement	Surplus
Case 3	Maha	19,800	21,900	- 2,100 (2.6 MCM)
	Yala	14,250	22,500	- 8,250 (10.2 MCM)

note: Maha irrigation requirement: $(7,138 \times 4.3 \times 0.70) + 187 \times 2.2$
Yala irrigation requirement: $(6,762 \times 4.7 \times 0.70) + 102 \times 2.3$

<Conclusion>

- On the basis of the above, it is necessary to upgrade irrigation efficiency through rehabilitation of irrigation facilities, and formulate an irrigation plan based on the cropping pattern under the present Case 3.

Table 5.3.4-1 ***Typical Existing Water Requirement for Muruthawela Reservoir Scheme Muruthawela LB***

(Paddy 3.5 Month Variety)

				Maha						Yala					
KC:		Maha	Yala	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Grouwth Stage and Crop Factors	1st Stagger	30%	100%		1.00	1.15	1.20	0.90			1.00	1.15	1.20	0.90	
	2nd Stagger	40%	0%			1.00	1.15	1.20	0.90						
	3rd Stagger	30%	0%				1.00	1.15	1.20	0.90					
ETo (Evapotranspiration of Reference Crop)				5.14	4.81	3.82	3.96	4.13	4.21	4.88	4.32	5.18	5.06	5.14	5.95
1. LP	Ls (4.0inch/5days)			1.20	1.60					4.00					
					1.20										
(Land Preparation)	Lt (7.5inch/25days)			0.90	1.35					3.00	4.50				
					3.00										
					0.90	1.35									
	Total LP			2.10	8.05	1.35				7.00	4.50				
2. E				0.77	0.72					2.44	2.16				
					1.92										
(Evapo. during LP)					0.72	0.76									
(E=ETo)	Total Evapo			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
3. Sd (Standing Water)	(3.0inch)				2.10	0.90					3.00				
4. ETc	ETc (S_1)			0.31	1.08	0.29	0.23	0.25			3.24	1.30	0.97	1.03	
Crop Water Requirement				1.39		1.10	1.19	1.12				4.96	5.06	4.63	
	ETc (S_2)					1.53	1.21	1.32							
(ETc=ETo x KC)						0.59	0.63	1.49							
	ETc (S_3)					0.86	0.30	0.24	0.25						
							1.14	1.24	1.14						
	Total ETc			1.70	1.08	4.36	4.70	5.65	1.39	0.00	3.24	6.26	6.03	5.65	0.00
5. Farm Loss at ETc (Farm Loss = ETc)	Total ETc/50%			3.39	2.16	8.72	9.40	11.30	2.78	0.00	6.48	12.52	12.06	11.31	0.00
6. FWR (1+2+3+5)	(inch)			5.49	12.31	10.97	9.40	11.30	2.78	7.00	13.98	12.52	12.06	11.31	0.00
(Field Water Requirement)	(mm)			140	313	279	239	287	71	178	355	318	306	287	0

Total FWR = 2,771 mm

5.3.4.1 Muruthawela LB Sub-scheme

(1) Area-wise Irrigated Area and Canal Length

Area-wise irrigated areas and canal lengths for the sub-scheme are as follows based on field survey.

Area	Irrigated area (ha)	Canal length (m)	
		Main canal	D-canal
Tract - I	424.9	11,735	-
Tract - II	583.3	2,708	15,334 (D-1~D-9)
Tract - III	691.9	-	18,604 (D-1~D-9)
Total	1,700.1	14,443	33,938

(2) D-canal Length and Command Areas in Tract-II, Tract III

Canal length and command areas are as indicated below. Canal densities are 31 m/ha for Tract-II and 27 m/ha for Tract-III.

In Tract I, there are no D-canals; irrigation is done by field overflow utilizing F-canals (field canals).

D-canal	Tract - II		Tract - III	
	Canal length (m)	Command area (ha)	Canal length (m)	Command area (ha)
D - 1	4,504	149.2	8,750	286.2
D - 2	1,500	19.0	2,214	71.7
D - 3	600	26.7	1,320	53.5
D - 4	800	33.6	650	41.8
D - 5	400	44.9	970	29.2
D - 6	1,100	59.9	1,900	71.7
D - 7	750	31.6	1,100	34.4
D - 8	2,450	72.0	1,200	62.8
D - 9	3,230	146.4	500	40.6
Total	15,334	583.3	18,604	691.9

(3) Irrigation / Drainage System

The irrigation / drainage system for the sub-scheme is diagrammed on the page after next. The diagram was prepared based on S = 1/5,000 topomapping, field reconnaissance, and discussions with FOs.

1) Main canal and benefit area layout

Muruthawela reservoir is the water source for this sub-scheme. Irrigation discharge from the reservoir is split to the LB main canal (total length: 14.43 km) and to Tract-I~II~III at diversion works immediately below the reservoir.

Canal-wise layout of benefit area along the total main canal length of 14.43 km is as indicated below.

Location along main canal	Segment distance (km)	Benefit area	Size (ha)
STA0 ~ STA11+735	11.735	Tract - I	424.9
STA11+735 ~ STA14+430(EP)	2.695	Tract - II	583.3
STA0 ~STA3+228 (D-1 canal)	3.228	Tract - III (No. 1 turnout point)	691.9

2) Main canal and turnout points for each tract

① Tract-I farmers draw their water from the right bank main canal by siphon, etc. at 14 locations along an 11 km segment. Due to pending land issues, this tract has not been formally incorporated into the scheme; however, the following type of diversion has been the practice over the years. This diversion is unofficially consented to by the farmers in the downstream Tract-II, III areas. Nevertheless, there are no D-canals in the Tract I and irrigation is by field overflow.

② Tract-II draws water from 3 points along the main canal. These are D-1 (STA11 + 735), D-8 (STA13 + 035), and D-9 (STA13 + 267).

③ Tract-III draws water from 7 points along the D-1 canal (total length: 8.75 km) which has its start point at drop works at the terminus of the main canal.

3) Discharge gauging facilities on main canal

There is a parshall flume at the 200 m point downstream from the start point of the canal, which is the sole discharge gauging facility for the sub-scheme. However, the inflow wall and invert portions area damaged, and the facility is non-functioning. The ID has attempted to identify distribution volume to the LB main canal by calculating the H-Q curve based on discharge and water level observations at the RB canal.

4) Water level regulating facilities on main canal

There are no water level regulating facilities on the 13.035 km segment of main canal from its start point to the no. 1 turnout point for Tract-II. Along the stretch of main canal from this no. 1 turnout to the canal terminus (STA + 443), there are two locations of regulating gate to control diversion volume to Tract-II. Along the D-1 canal (total length: 8.75 km; solely for irrigation of Tract-III) which starts from the terminus of the main canal, there are 5 locations of regulating gate to control diversion volume to Tract-III.

In summary, there are a total of 7 locations of water level regulating gates along the total canal length (14.4 km of main canal + 8.7 km of D-1 canal) in the sub-scheme, which control discharge to 1,275 ha of benefit area (excluding Tract-I).

5) Main structures on main canal

Main structures identified through field survey are as follows.

Structure	Location	
Turnout	Start point of LB main canal (STA 0)	1 location (diversion works for LB area and Urubokka Oya area)
Parshall flume	STA 0 + 200	1 location (discharge gauging facility)
Aqueduct	STA 0 + 905	total length: 130 m (15 spans, 14 piers)
Intake	STA11+735~STA13+267	3 locations (for Tract-II)
Drop works	STA14+443 (EP)	1 location
Drainage crossing works	STA 0~STA11+735	10 locations (for Tract-I irrigation)

6) The present irrigation / drainage system for sub-scheme is diagrammed in Figure 5.3.4.1-1.

(4) Present water balance calculation for Muruthawela LB scheme

Calculation of present water balance was done based on discharge volumes from Muruthawela Reservoir (September 1991 ~ August 1995). Calculation criteria were as follows:

Target area	:	1,275 ha (Tract-II = 583 ha, Tract-III = 692 ha)
Irrigation requirement	:	based on actual irrigation period for each studied year
Conveyance efficiency	:	assumed at 50% based on degree of damage of D-canals, and various applicable design values (by ID and FAO)

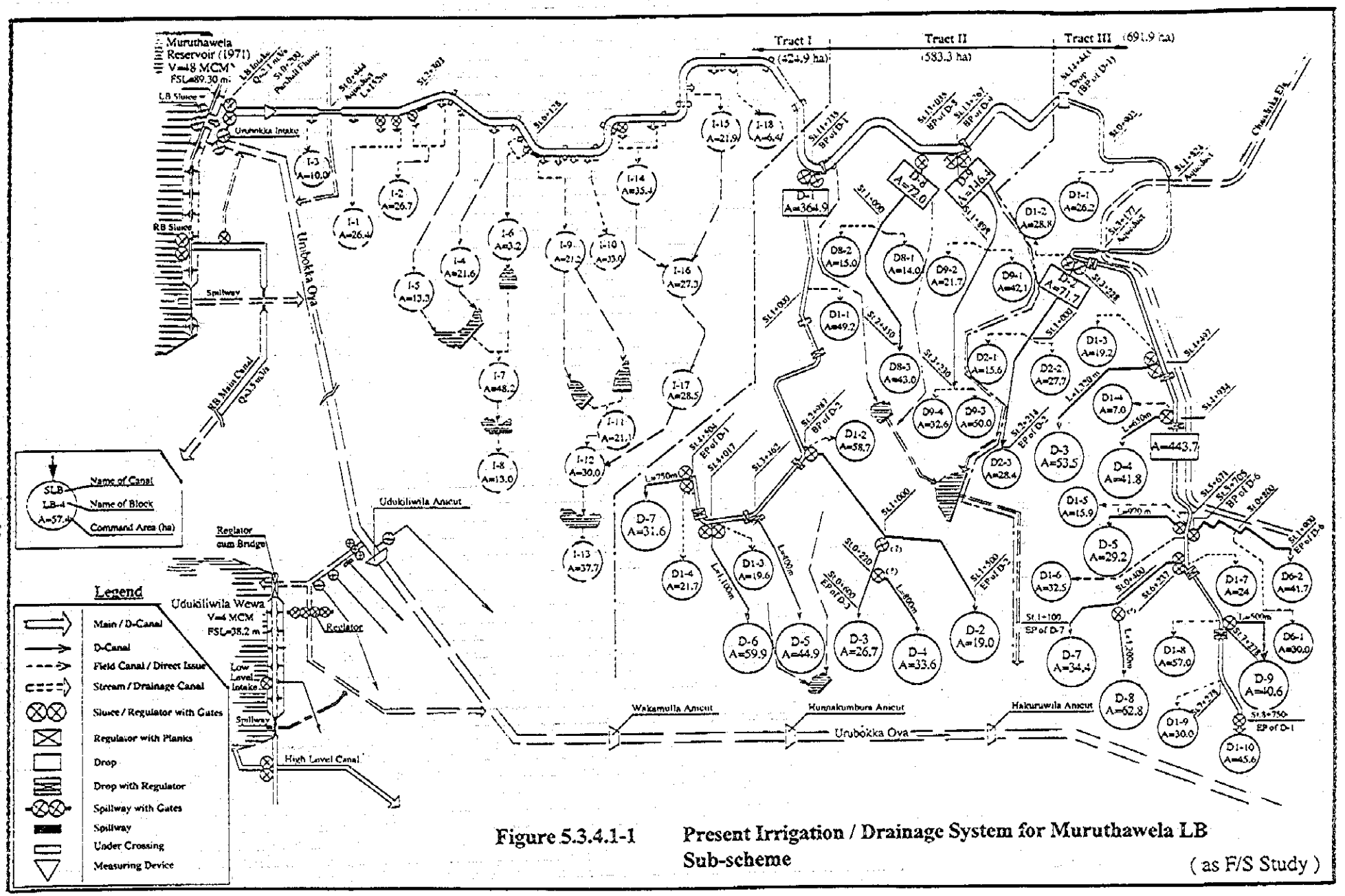


Figure 5.3.4.1-1 **Present Irrigation / Drainage System for Muruthawela LB Sub-scheme**

(as F/S Study)

<Results of calculation>

Seasonal rotational irrigation was factored into the calculation (Tract-II in the Yala season, and Tract-III in the Maha season). According to results of calculation, a slight water shortage is seen during the Maha seasons; however, as long as the present season-wise rotational irrigation is practiced, single cropping is possible in Tract-II and Tract-III.

Also, calculations indicate that a further 300 ha can be irrigated, and this is assumed to correspond to the illegal diversion in the upstream area of Tract-I.

Results of calculation are shown below:

Results of Calculation of Irrigable Area (Present)

(unit: %)

Period	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	Ave.
Maha	100	100	96	100	100	100	100	100	100	100	100	100
Yala	100	81	69	100	100	100	95	95	100	100	100	95

(5) Assessment of Present Irrigation / Drainage System for Muruthawela LB Scheme

1) Diversion ratios for Muruthawela LB and Urubokka Oya sub-schemes

- Muruthawela Reservoir is the water source for the downstream Muruthawela LB and Urubokka Oya sub-schemes. Diversion works directly downstream of the reservoir split discharge to the respective sub-scheme areas. However, there are no design data or project records available on the original design discharge values for this diversion.

- According to analysis by the Study Team of diversion amounts to each sub-scheme for the past 5 years, discharge diversion ratios are 67% to the Muruthawela LB and 33% to Urubokka Oya. (Average values for 1991~1995 are the same for both Maha and Yala seasons.)

- Total benefit area for the Muruthawela LB and Urubokka Oya sub-schemes is 3,537 ha. Respective land area ratios are 36% for the Muruthawela LB and 64% for Urubokka Oya, which are the reverse compared to diversion ratios above. Accordingly, it is concluded that split of discharge at the diversion works is not done according to proportion of land area size.

- The Urubokka Oya sub-scheme is located downstream of Muruthawela Reservoir, while immediately upstream of the sub-scheme is the Urubokkawila reservoir. Both of these reservoirs must be taken into account when assessing the scheme. Total annual inflow into both reservoirs is indicated below.

unit: ac.ft (1,000 m³)

	Muruthawela Reservoir	Udukiriwila Reservoir	Total
Annual total inflow	55,000 (67,870)	13,100 (16,165)	68,100 (84,035)
	80%	20%	100%

From the above, it is seen that 20% of total inflow is used solely for irrigation under the Urubokka Oya sub-scheme. Accordingly, it is calculated that 1,809 ha (2,262 ha × 80%) of the Urubokka Oya sub-scheme is dependent upon Muruthawela Reservoir for irrigation discharge. Thus, total area under both sub-schemes which relies on Muruthawela Reservoir for water is 3,084 ha (1,275 ha + 1,809 ha). Diverted discharge ratios on the basis of the foregoing land area proportions computes to 40% for the Muruthawela LB and 60% to Urubokka Oya. Taking this corrected dependency ratio as well, it can be seen that diversion ratios at the works directly downstream of Muruthawela Reservoir is not done according to proportionate benefit area size.

2) Discharge diversion to Muruthawela LB

- The LB main canal is designed for discharge of Q = 2.1 m³/s. Actual irrigation use in the benefit area is calculated at 55% of this volume (average for 1991/92 Maha ~ 1993 Yala). Accordingly, the Muruthawela LB receives a greater amount of diverted discharge per size of benefit area than the Urubokka Oya sub-scheme; however, actual use vis à vis design discharge is only 55% in the case of the former.

- This conforms to the ID's implementation of season-wise rotational irrigation in the Muruthawela LB area.

3) Cropped area ratios based on reservoir water balance

Current cropped area ratios are as follows.

Area	Maha (%)		Yala (%)	
	Paddy	OFC	Paddy	OFC
Muruthawela LB				
Tract- I	65	-	65	-
Tract- II	-	13	100	-
Tract- III	100	-	-	6
Urubokka	85	-	83	-

- As water resources at the reservoir are limited, increase of cropping rate for paddy area is not foreseen.

- As diversion at Tract-I is not official sanctioned, there are no D-canals in the tract.

- In light of suitable soil conditions, introduction of OFCs is possible for the LB Main Canal area. An appropriate cropping rate for these should be determined on the basis of marketability, and efficient use of reservoir discharge. In the case of Urubokka Oya, soil conditions are not suitable for OFCs, and instead irrigated area of paddy should be increased through facility rehabilitation.

4) Main canal and major facilities

- Original design of main canal cross-section

The following data was recovered as original design criteria for the main canal cross-section. However, there is no existing data indicating basis for irrigation discharge calculation nor design criteria for canal cross-sections in the Tract-II and Tract-III areas.

Criteria	Design value	Remarks
Design discharge	Q = 2.10m³/s	Irrigation for Tract-II + Tract-III (ID data)
Design depth	H = 0.85m	
Base width	B = 3.66m	
Embankment gradient	1 : 1.0	
Canal gradient	i = 0.0003	
Roughness coefficient	n = 0.025	By reverse calculation by Manning's formula
Flow velocity	V = 0.549 m/s	
Freeboard	F_6 = 0.90m	

- Water conveyance capacity of present canal cross-section

The Study Team carried out discharge observations on the canal segment from its start point (STA0) to upstream of the canal aqueduct (STA0 + 944) Results indicated conveyance capacity for this segment of the canal despite deterioration in the segment STA0 ~ STA0 + 994. (see table below)

Discharge observation point	Observed value	Freeboard	Time of observation
STA0 + 200 (upstream of parshall flume)	Q = 2.00 m³/s	0.90 m	3-96
STA0 + 312 (at connecting bridge pier)	Q = 2.75		3-95
STA0 + 944 (at start point of canal aqueduct)	Q = 2.33	0.30m	3-95
" "	Q = 2.02	0.39m	3-96

- Main canal discharge gauging facilities

The diversion works and the parshall flume facility at the start point of the main canal do not function due to deterioration, and urgent rehabilitation is necessary to control discharge distribution to the Muruthawela LB and Urubokka Oya areas.

- A discharge conveyance capability in line with the original design discharge of Q = 2.10 m³/s was confirmed at the aqueduct (STA0 + 344; L = 152 m) at the upstream part of the main canal; however, the present condition of the aqueduct is extremely dangerous, as field survey confirmed seepage at the joints for the 15 spans of the aqueduct main body, insufficient strength of the base slabs between piers, exposure of rebar of the interior walls of the aqueduct, dislocation of joints along the raised portion of aqueduct walls, and peeling off of concrete reinforcement on the inside walls of the aqueduct. In light of the importance of this aqueduct structure, its rehabilitation is urgent.

- Main canal cross-section

Of the total main canal length of 14 km, roughly 7 km is unlined. Along this segment, the toe of the canal embankment wall has suffered progressive damage, and a portion of O&M road parallel to the canal has experienced shoulder collapse. It is considered necessary to reinforce the canal cross-section with masonry, etc., and secure sufficient width for the O&M road.

- Tract-I intake

Direct intake from the main canal is by siphon. As this diversion is small scale, it has as yet not caused serious damage to the main canal structure. However, water diversion at these 19 intakes locations should be managed in a systematic

manner. Location of facilities to effect such controlled management need to be studied in terms of a practical D-canal layout.

- Tract-II turnout facilities (D-1, D-8 and D-9 canals)

Canal and turnout gate facilities are damaged. Furthermore, there are no discharge gauging facilities. An integrated system through gate rehabilitation and adequate gauging facilities must be established in order to effect appropriate diversion of discharge to the Tract-II area.

- Tract-III turnout facilities

The main turnouts at 6 locations require rehabilitation. The reasons for this are the same as for Tract-II.

5) D-canals and appurtenant facilities in Tract-II and Tract-III.

Distribution of irrigation discharge to the field level in Tract-II and III is via 18 D-canals with total length of 34 km (servicing 1,275 ha of irrigated area). D-canal density is 27 m/ha, which is considered about right for the benefit area. However, these unlined canals have not maintained their design cross-sections. Canal wall collapse and loss of O&M road shoulders has occurred, resulting in sediment buildup in the canal bottoms and obstruction of discharge flow downstream. These D-canals and parallel roads are crucial to farming operations at the field level, and the desire among farmers for their rehabilitation is greatest. This rehabilitation is thus considered urgent.

From an overall system standpoint, D-canals with highest urgency for rehabilitation are as follows.

	Tract - II	Tract - III
D-canal	D - 1 (L = 4.5km)	D-1 canal (STA3 + 228 ~ STA7 + 278, L = approx. 4.05 km)
	D - 8 (L = 2.45km)	
	D - 9 (L = 3.23km)	

5.3.4.2 Urubokka Oya Sub-scheme

(1) Irrigation / Drainage System

The Urubokka Oya scheme was incorporated under the Muruthawela Reservoir scheme in 1971. Present irrigated area was identified under the Study as A = 2,262 ha. The scheme is a very old one, being first constructed in 1789. Records show that it was partially rehabilitated in 1859. Since then, no substantial rehabilitation works have been carried out over the last 130 years.

Water source for the scheme is the Urubokka oya. The irrigation distribution system comprises the following 2 units.

Unit	Irrigation distribution system	Major facility	Irrigated area (ha)
Urubokka Oya	Diversion (by anicut) type	8 anicuts	1,746 \(77%\)
High Level	Small scale tank cascade type	6 tanks	516 \(23%\)
		Total	2,262 \(100%\)

note: Irrigated area was calculated on the basis of S = 1/5,000 topomapping.

- Urubokka Oya unit

1,746 ha of irrigated farmland extends from an upstream point at the lower catchment of the Muruthawela Reservoir for 35 km to a downstream point near the sea. There are 8 anicuts along this stretch, from which extend irrigation canals on both banks for a total distance of 54.4 km. The 2 upstream anicuts are the fixed type (concrete) while the remaining 6 are full-section gate type structures. Irrigation discharge diverted by these anicuts ultimately drains into the Urubokka oya. The drainage discharge is again utilized for irrigation downstream.

- High Level unit

This unit comprises 516 ha starting from the Udukiriwila reservoir which draws its water from the Urubokka oya. From the reservoir, irrigation discharge is conveyed along the so called High Level canal (total length: 3.8 km) to the no. 1 tank at Pothu. This discharge is successfully utilized via a cascade system of 5 tanks downstream, ultimately draining into Rekawa lagoon. With the exception of Udukiriwila reservoir, these tanks are of small scale storage capacity (average: 180,000 m^3) in relation to embankment length (1.0~3.9 km), and are shallow dish-like ponds which have undergone transformation into marshland. The system is characteristic of the small scale, tank cascade irrigation systems that are traditional in Sri Lanka.

The irrigation system for the sub-scheme is diagrammed in Figure 5.3.4.2-1.

(2) Irrigation Canal Length and Benefit Area

Irrigation canal length and benefit area identified through field survey are shown below. (Canal length and size of benefit area were confirmed from S = 1/5,000 topomapping prepared by the Study Team, and based on discussions with ID staff and representatives of FOs during survey of March 1996.)

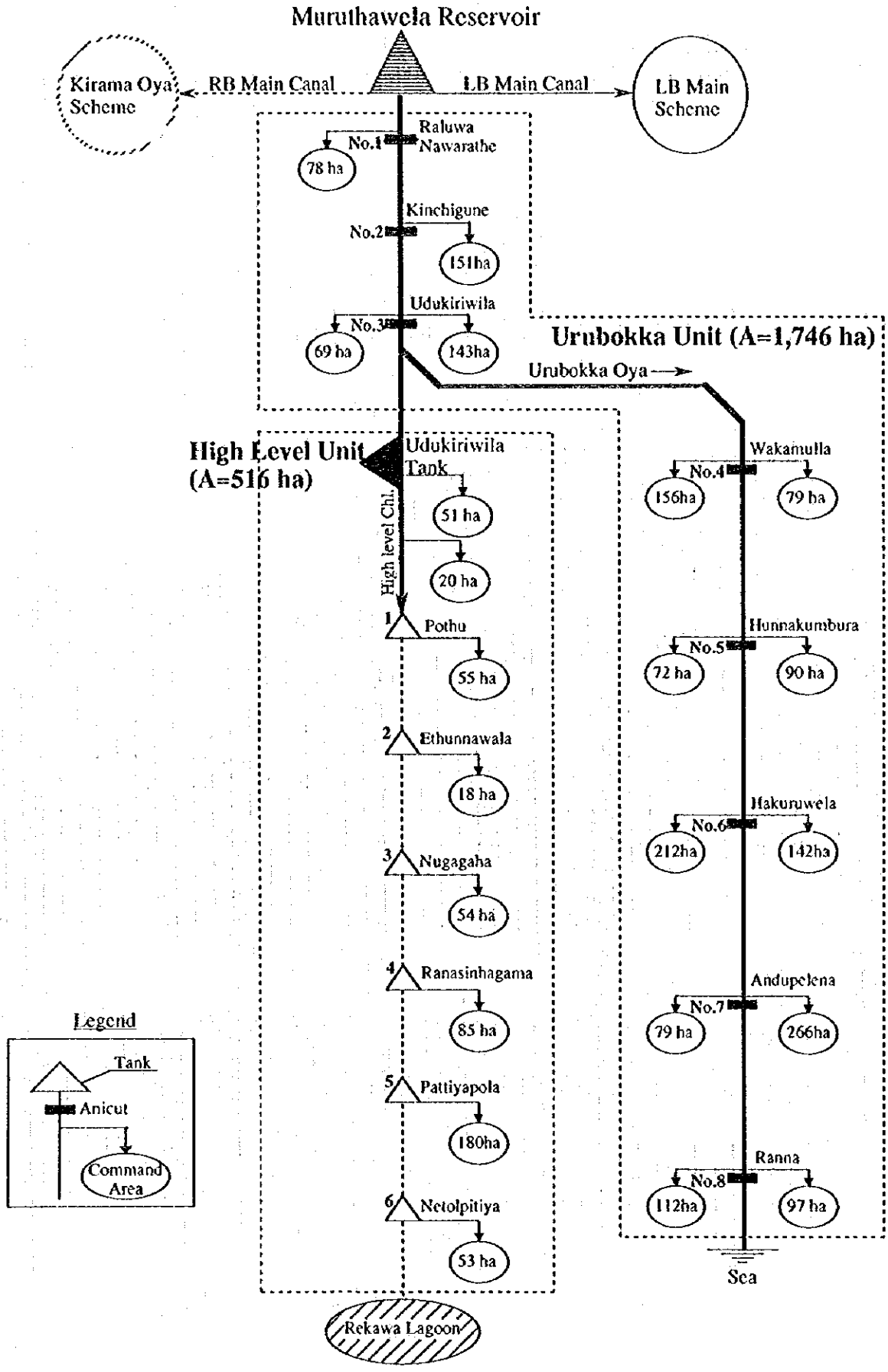


Figure 5.3.4.2-1 Irrigation System for Urubokka Oya Sub-scheme

<Urubokka Oya sub-scheme>

Anicut	D-canal length (m)			Irrigated area (ha)			Canal density
	Total	RB	LB	Total	RB	LB	(m/ha)
Urubokka							
1. Raluwa Nawarathe	3,700	3,700		78	78		
2. Kinchigune	5,100		5,100	151		151	
3. Udukiriwila	2,600	1,800	800	212	69	143	
4. Wakaniulla	10,500	5,500	5,000	235	156	79	
5. Honnaumbura	2,200	2,200	0	162	72	90	
6. Hakuruwela	17,500	8,600	8,900	353	211	142	
7. Andupelena	10,100	5,500	4,600	346	80	266	
8. Ranna	6,900	3,400	3,500	209	112	97	
Sub-total	58,600	30,700	27,900	1,746	778	968	33.6
High Level							
1. Udukiriwila Low Level	1,800			51			
2. Udukiriwila High Level	3,900			20			
3. Pothu	2,700			55			
4. Ethunnawala	900			18			
5. Nugagaha	3,000			54			
6. Ranasinhagama	3,600			85			
7. Pattiyapola	7,900			180			
8. Netolpitiya	1,500			53			
Sub-total	25,300			516			49.0
Total	83,900 (m)			2,262 (ha)			37.1

(3) Present Water Balance Calculation

Water balance calculation was carried out according to the following criteria.

1) Calculation period

The 11 year period from the 1984/85 Maha season to the 1995 Yala season.

2) Inflow discharge

Based on records of discharge from the Muruthawela diversion works to the Urubokka oya, plus a 15% discharge reuse rate for irrigation.

3) Irrigation efficiency

Under this sub-scheme, discharge is diverted directly from a natural river. Diverted discharged is distributed to the field level via D-canals (unlined) constructed over 200 years ago. Field survey indicated seepage at the anicuts, and

collapse of the D-canal cross-sections. In light of this condition, canal conveyance efficiency (taking into consideration ID and FAO criteria) is assumed at 40%.

4) Irrigation period

This is based on ID records and interview of FO representatives. Specifically, record for the past 5 year period from the 1992 Yala season to the 1995/96 Maha season were used; for the period before that, 5 year representative values were applied.

5) Irrigation success rate

According to discussions with ID staff, irrigation success rates are around 90% in the Maha season and 75% in the Yala season. Also based on data from the ID, cropping intensities over the past 5 years have averaged 85% in the Maha season and 75% in the Maha season.

6) Water Balance Calculation

Under the above conditions, irrigable are rates are computed as follows.

Computed Irrigable Area Rates (at present)

unit: %

Calculation Period	1984/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	Average
Maha	101	85	65	91	81	96	58	78	79	101	111	86
Yala	85	56	61	81	67	87	62	71	67	74	88	73

(4) Major structures

Features of major structures identified through field survey are as follows:

- High Level unit

Tank name		Udukiriwila	Pothuwewa	Ethunneuwela	Nugagaha	Ranasingha	Pattiyapola	Natolpitiya
Tank								
Catchment area	(km²)	25.9		13 8	19 2	32 0	42 2	47 7
Capacity	(m³)	3,978,000	74,000	59,000	43,000	54,000	705,000	140,000
FSL storage area	(m²)	2,631,000	80,000	96,000	60,000	96,000	468,000	288,000
Irrigation area	(ha)	67 (RB canal)	23	16	6	30	182	81
Canal length	(km)	1 3 (Low level canal)+ 3 8 (High level canal)	2 6	1 0	2 4	2 8	4 4	1 0
Embankment								
Embankment length	(feet)	3,300	750	1,000	1,330	1,400	3,900	2,500
Crest width	(feet)	15	6	8	8	6	12	8
Crest elevation	(feet)	130 5	104	108	104 75	55 75	113	102
Slope gradient	(feet)	1 on 2	1 on 2	1 on 2	1 on 2	1 on 2	1 on 2	1 on 2
FSL	(feet)	125 24	100 00	104 36	100.00	49.00	109 00	98 55
HFL	(feet)		102.40	107.24	132 20	53 57	112 50	101 65
Flood spillway (1)								
Type		masonry weir	concrete weir + gate	stoplog	concrete weir	Skin type	overflow embankment	masonry weir
Overflow crest length	(feet)	68 50	40	120	200	75	250	295
Flood spillway sill height	(feet)	12 54	100.00 (Assumed)	104 36	100 00	49 00	109 00	98 55
Flood spillway (2)								
Type				Clear over fall type	Concrete, clear overfall	Co type spill	Clear overflow with 6 planted bays	Co type spill
Overflow crest length	(feet)			40	40	125	66	125
Flood spillway sill height	(feet)			104 36	100 00	49 00	109 00	49 00
Sluice gate		No 1 / No 2						
Type			Hume pipe tower sluice	Dressed rubble masonry	Rubble Masonry	VT type sluice		
Diameter	(inches)	23 5	9 0	1 5		9 0		
Opening		3 0"×4'-3"						
Sill height elevation	(feet)	122 84 / 122 84		100 00	94 08	45 25		

- Urubokka unit

Anicut	Anicut features						RB		LB	
	location (km)	gate crest height (m)	gate sill height (m)	no. of gates	gate material	gate size B × H (m)	gate sill height (m)	gate size B × H (m)	gate sill height (m)	gate size B × H (m)
Urubokka Oya										
2 Way Head Regulator	0.0	75.3	73.8	2	W	1.5 × 1.5				
Raluwa Nawarathe	2.7	57.6	56.9	2	P	1.5 × 0.6	57.0	1.2 × 0.6		
Kinchigunew	4.8	49.3	48.5	2	P	1.2 × 0.8			48.7	1.4 × 0.8
Udukiriwila	10.5	38.8	37.2	3	S	4.6 × 1.5	37.7	3 ways	37.8	1.9 × 0.9
Wakamulla	13.9	31.5	29.3	5	W	2.0 × 2.2	30.7	2.0 × 1.4	30.6	1.2 × 0.8
Hunnakumbura	16.9	26.7	24.5	5	W	1.8 × 2.2	30.7	NA	NA	NA
Hakuruwela	19.4	22.7	20.5	5	W	1.9 × 2.2	NA	1.7 × 1.7	NA	1.7 × 1.0
Andupelena	27.2	11.6	9.2	5	W	2.0 × 2.4	10.8	1.4 × 0.8	10.6	2.0 × 1.2
Ranna	35.0	4.2	1.8	5	W	2.0 × 2.4	3.3	1.0 × 0.4	3.4	1.0 × 0.4

note: for gate material, W = wood; P = plank (stoplog); S = steel

- Udukiriwila tank

Features	Design value
Storage volume	40 MCM
Effective storage	3.7 MCM
Crest length	106.5 m
Crest height	5.2 m
Flood spillway type	masonry

(5) Assessment of Urubokka Oya Sub-scheme Irrigation / Drainage System

1) Discharge from Muruthawela Reservoir and irrigable area

This sub-scheme has discharge from the Muruthawela Reservoir as its major water source, and as such water excess / shortage cannot be assessed in terms of the scheme by itself. Nevertheless, rough calculation indicates an irrigable area of 86% in the Maha season and 73% in the Yala season. These figures are in agreement with values elicited in discussions with ID and AD staff. Accordingly, it is considered necessary that the current water distribution ratio from Muruthawela Reservoir be continued, and in addition anicuts and D-canal facilities be rehabilitated to expand the irrigated area.

2) Urubokka unit

On the basis of field survey, the following facility rehabilitation is necessary.

Anicut no.	Results of assessment
No.1 ~ No.3	As the fixed concrete anicuts no. 1 and 2, and the no. 3 steel gate anicut ha already been rehabilitated, further repair of main anicut structures is not considered necessary. However, rehabilitation of D-canals and parallel O& roads is necessary.
No.4 ~ No.8	Replacement of anicut gates and downstream river bank protection works a necessary. As in the case of anicuts no. 1~3, D-canal rehabilitation is also required.

3) High Level unit

- High Level canal rehabilitation (L = 3.8 km)

At Udukiriwila reservoir, intake sill elevation is high and design intake discharge cannot be achieved. It is necessary to cut the canal bottom deeper in order to reduce the intake sill height. Farmers strongly desire that these rehabilitation works be done.

- It is necessary to rehabilitate the D-canals between tanks no. 2 and 5, and establish an irrigation canal system linking the same. In this manner, operation and management of the system will be integrated, making possible efficient water use.

- No outstanding rehabilitation of tank facilities is considered necessary. However, it is recommended that portions showing worse deterioration be appropriately repaired.

5.3.4.3 Kirama Oya Sub-scheme

(1) General

The Kirama Oya scheme was constructed during the period 1805~12. The Kirama tank at the extreme upstream of the scheme was built to serve as the water source for the scheme. The Kirama oya itself has an average river gradient of I = 1/640, and bifurcates at the point of the 2 anicuts (Daketiya and Waladola) downstream to flow into its estuary at the coast.

As the paddy field in the around these downstream anicuts is below the mean sea level (+0.70 m), simple sea water exclusion structures have been established. The sediment buildup each year which blocks the river mouth is naturally washed away by flooding during the Maha season.

(2) Irrigation and Drainage Network

The principal water source is the Kirama oya.

The originally planned supplemental supply of irrigation discharge from the Muruthawela Reservoir via the right bank main canal has not been carried out for the past 9 years. Furthermore, the results of water balance analysis indicate that such supplemental discharge supply can be expected in the future.

The average spacing interval for the 18 anicuts on the Kirama oya is 1.9 km. Also, average D-canal length per anicut is calculated at 2.4 km. Irrigation method in the sub-scheme area is natural gravity flow by anicut diversion.

There are roughly 5 types of irrigation period in the sub-scheme area. (These area indicated in the following irrigation system diagram (Figure 5.3.4.3-1) in terms of blocks 1 to 5 moving from the upstream to the downstream.

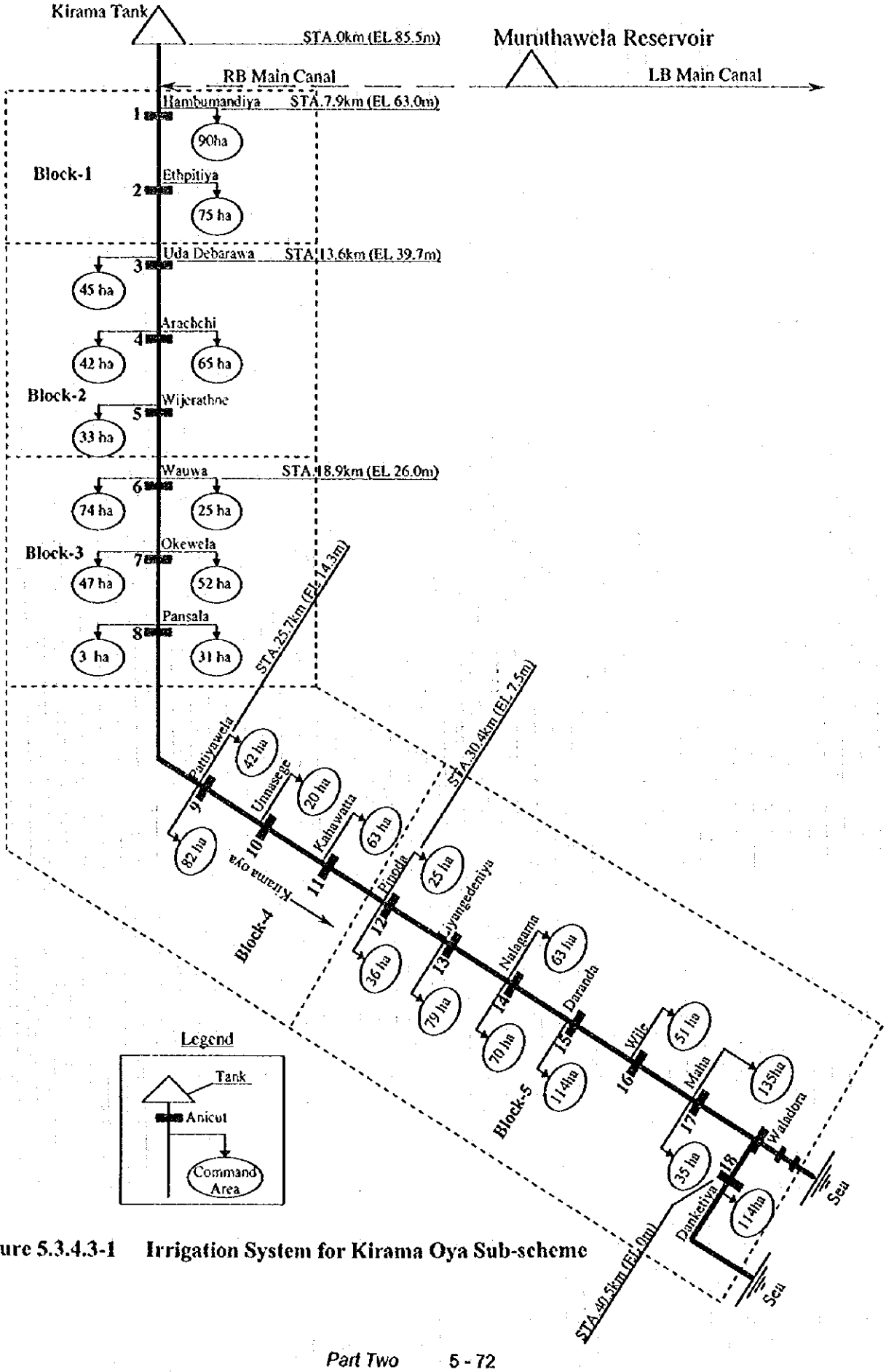


Figure 5.3.4.3-1 Irrigation System for Kirama Oya Sub-scheme

(3) Rehabilitation under HIRDP

Anicut and canal rehabilitation for the Kirama Oya scheme was done under the Hambantota Integrated Rural Development Project (HIRDP) during the 1980s. According to HIRDP records, 13 anicut schemes where rehabilitated. The 4 downstream anicut schemes, however, have not been rehabilitated as yet. Since 15 years have elapsed since these works, there is already some deterioration seen in these previously rehabilitated facilities, and discussions with farmer organizations indicated that farmers strongly desire that renewed rehabilitation of facilities be carried out.

(4) Canal Length and Irrigated Area

Canal lengths and irrigated areas confirmed through Phase II study are indicated below. These figures were determined from S = 1/5,000 topomapping prepared by the Study Team, and in consultation with the FOs and irrigation staff.

<Kirama Oya sub-scheme>

Anicut	D-canal length (m)			Irrigated area (ha)			Canal density (m/ha)
	Total	RB	LB	Total	RB	LB	
1. Hambumandiya	4,700		4,700	91		91	
2. Ethpitiya	900		900	75		75	
3. Uda Debarawa	1,300	1,300		45	45		
4. Arachchi	5,200	2,000	3,300	107	42	65	
5. Wijerathne	700	700		33	33		
6. Wauwa	4,400	2,600	1,800	99	74	25	
7. Okewela	5,200	2,100	3,100	99	47	52	
8. Pansala	1,300	800	500	34	3	31	
9. Pattiyawela	4,800	1,700	3,100	124	83	41	
10 Unnansege	1,300		1,300	20		20	
11 Kahawatta	800		800	63		63	
12 Pinoda	1,200	500	700	59	34	25	
13 Liyanagedeniya	1,500	1,500		79	79	0	
14 Nalagama	5,700	3,200	2,500	133	70	63	
15 Daranda	2,200	2,200		115	115		
16 Wile	1,100		1,100	51		51	
17 Maha	5,300	1,700	3,600	169	35	134	
18 Danketiya	600		600	115		115	
Total	48,300	20,300	28,000	1,511	660	851	32.0

(5) Kirama Tank and Diversion Facilities

Salient features of sub-scheme structures as a result of field survey are as follows.

<Kirama Oya>

- Kirama tank features (rehabilitated in 1979)

Features	Design value
Storage volume	1.4 MCM
Effective storage	1.3 MCM
Crest length	228.75 m
Crest height	6.71 m
Flood spillway type	sluice gate + overflow type
FSL	286.03

- Anicut features

Anicut	Anicut features						RB		LB	
	location (km)	gate crest height (m)	gate sill height (m)	no. of gates	gate material	gate size B × H (m)	gate sill height (m)	gate size B × H (m)	gate sill height (m)	gate size B × H (m)
Spill Cum Regulator	0.4	90.2	85.5	2	W	1.8 × 1.7				
Hammbumandiya	7.9	64.5	63.0	4	W	1.7 × 1.5			63.7	1.2 × 0.9
Ethpitiya	9.5	59.2	57.4	6	W	1.3 × 1.8			58.0	1.3 × 1.3
Uda Debarawa	13.6	42.3	39.7	4	W	1.6 × 2.5	41.7	1.2 × 0.9		
Arachchi	14.7	39.6	37.8	3	P	2.4 × 1.8	38.4	1.2 × 1.2	38.6	1.2 × 1.2
Wijerathne	17.3	31.2	28.8	1	S	4.4 × 2.4	30.87	0.9 × 0.9		
Wauwa	18.9	27.9	26.0	5	W	1.5 × 1.9	27.0	1.2 × 1.0	27.2	1.4 × 1.2
Okewela	21.5	22.4	20.4	4	W	1.7 × 2.0	21.7	0.6 × 0.8	21.9	0.6 × 0.8
Pansala	24.2	18.9	16.3	2	S	4.6 × 2.5	16.2	0.5 × 0.8	18.5	0.4 × 1.0
Pattiyawela	25.7	16.0	14.3	5	W	1.7 × 1.7	15.3	1.7 × 0.8	15.6	1.2 × 0.9
Unnansege	27.4	13.3	11.4	5	W	1.5 × 1.9			12.6	NA
Kathwatta-1	28.7	11.9	8.8	5	W	1.8 × 3.1			11.2	1.2 × 0.9
Kathwatta-2	29.0	10.1		2	W					
Pinoda	30.4		7.5	2	S	4.3 × 2.5	9.4	NA	9.3	1.2 × 1.1
Liyanagedeniya	30.5	NA		4	W	2.0 × 1.7		NA		
Nalagama	32.9	7.6	5.6	5	W	1.8 2.0	6.6	0.6 × 0.9	6.8	1.2 × 1.1
Daranda	34.5	6.1	3.4	2	S	4.6 2.0	4.3	1.5 × 0.8		
Wile	35.5	4.9	2.5	2	S	4.7 × 2.4	4.6	0.9 × 0.9		
Maha	38.3	3.4	0.9	5	W	1.8 × 2.5	3.6	0.6 × 0.9	3.6	0.6 × 0.9
Danketiya	40.5	2.0	0.0	5	W	1.5 × 2.0			1.8	1.8 × 1.9

note: for gate material, W = wood; P = plank (stoplog); S = steel

(6) Present Water Balance Calculation

Water balance calculation was done according to the following criteria.

1) Calculation period

The 11 year period from the 1984/85 Maha season to the 1995 Yala season.

2) Discharge inflow

Discharge inflow to the Kirama Oya sub-scheme and to Muruthawela Reservoir in both cases originates from the Urubokka oya catchment. Accordingly, assuming that the inflow pattern in the case of the Kirama Oya sub-scheme resembles that for Muruthawela Reservoir, the inflow discharge for the reservoir was applied, with correction of the value on the basis of proportional size of respective catchment areas.

Reuse rate of drainage runoff for irrigation, as in the case of the Urubokka Oya scheme is assumed at 15%.

3) Present irrigation success rate

According to data from the ID, AD and FOs, it is assumed that irrigation success rate is 82% for the Maha season and 65% for the Yala season.

4) Irrigation efficiency

As with the Urubokka Oya sub-scheme, due to similarity of natural conditions, 40% is adopted in line with ID and FAO standards.

5) Irrigation period

This is based on ID records and interview of FOs. Data and interview findings for the past 5 years (1992 Yala ~ 1995/96 Maha) were applied, with representative values for the 5 year period being used for the period before that.

6) Results of water balance calculation

Calculation of irrigable area rates is as follows.

Computed Irrigable Area Rates (at present)

unit: %

Calculation Period	1984/ 85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	Average
Maha	100	94	54	100	77	86	91	62	74	100	100	85
Yala	100	55	82	82	73	100	67	52	74	43	85	74

(7) Assessment of Irrigation System for Kirama Oya Sub-scheme

1) Water source

From the results of present water balance calculation, their is an absolute water shortage occurring at the scheme water source. Since irrigation success rates average 80% in the Maha season and 68% in the Yala season, 100% cropped area for irrigated paddy can not be expected. Accordingly, in light of this water shortage at the source, cropped area could be expanded by introduction of upland crops.

2) Lack of farm roads

The length of the Kirama Oya from the most upstream anicut to no. 18 anicut downstream is 33 km. Along this stretch of river, there are 7 motorable bridges across the river. Farmers transport across these bridges the farm products which are produced in the command areas of the said 18 anicuts. Conveyance routes (farm roads) to these branch roads run parallel to the D-canals; however, canal slope collapse has left insufficient bund width for these roads.

Accordingly, it is necessary to rehabilitate these roads in the course of canal rehabilitation. On the basis of field survey and map study (S = 1/1,5000), total length of this road is estimated at 26.9 km including 6 crossing points of the Kirama oya.

Breakdown is as follows.

Anicut No.	Necessary farm road (km)	No. of crossings of Kirama oya
1	-	
2	3.2	1
3	1.4	
4	3.2	
5	0.5	1
6	1.2	2
7	3.7	
8	1.0	
9	1.0	
10	0.65	
11	0.75	
12	0.7	1
13	1.4	
14	2.8	1
15	1.4	
16	1.6	
17	-	
18	2.4	
Total	26.9	6 locations

3) Flood damage in the downstream basin

Rehabilitation (bund height raising) of the 2.0 km long river embankment between anicut no. 17 and 18 would mitigate flood damage to the LB main canal benefit area.

Also, rehabilitation of the drainage canal cross-section in the downstream direction from Waladora anicut would mitigate flood damage to farm land on both banks of the canal.

5.3.5 Badagiriya Scheme

(1) Background and Current Problems

- The water source for the scheme is the Badagiriya tank constructed in 1957. The command canal system was completed in the following year, upon which settlement was commenced. The irrigation system has been in operation for 40 years.

- Salient features of the Badagiriya tank are as follows.

Design features	Design value
Catchment area	A= 345 km²
Storage volume	V= 11 MCM
FWL	FSL= 23.90m (78.05 ft)
Effective depth	H= 4.27m (14.00 ft)
Intake gate	Sill height= 19.67 m (64.50 ft), ø 900 mm

note: Badagiriya tank is the only major tank in the Malala oya basin which is under the jurisdiction of the ID. (Bund height has been raised 3 feet.)

- Annual rainfall in the tank catchment area is around 800 mm, which is less than the average annual rainfall of 1,000~1,400 mm in the Southern Province Dry Zone. In the 40 years since completion of the tank facility, 34 minor irrigation schemes and 23 minor tanks have been constructed upstream. The canals of the Badagiriya scheme area are unlined and deteriorated, with discharge failing to reach the field level. The reduction in discharge into the tank due to the foregoing construction of irrigation facilities upstream, and the deteriorated nature of the canals within the scheme area itself have led to a serious water shortage problem for the area farmers.

- In 1986, the scheme was incorporated into a major tank irrigation project (KOISP) constructed in a separate basin (Kirindi oya basin). By extension of the terminus of the RB main canal via a newly constructed Feeder Canal No. 1 (L = 6.4 km), supplemental irrigation supply to the Badagiriya scheme was effected (5,000 ac.ft = 6.2 MCM per year).

Although the above supplemental supply of irrigation discharge was commenced from 1987, the scheme continues to suffer water shortage.

The reason for this is that the water conveyance capacity of the canal cross-section has been reduced due to canal slope collapse and seepage in to the permeable layer upon which the feeder canal was originally constructed. Also, the main canal of the scheme area (total length: 8.6 km) has suffered serious deterioration. The water shortage under the scheme is thus attributed to a fundamental reduction of the discharge inflow into the tank catchment, compounded by water losses along the deteriorated canals.

A short cut canal (using a natural drainage channel) was constructed in 1993, which has its start point at a turnout gate on the left bank of the feeder canal. This canal bypasses the Badagiriya tank to lead directly to the minor tank (Keliyawalana Wewa) immediately upstream of the scheme area. The canal is referred to as the Feeder Canal No. 2. The minor tank connects to the scheme main canal about 800 m downstream of Badagiriya tank.

- The above described scheme background is summarized in the table below.

Year	Event	No. of years elapsed
1957	Completion of Badagiriya tank	39
1958	Start of farmer settlement in the area upon completion of canal system	38
1958~1986	Area suffers water shortages. Severe shortages result in abandonment of 92 ha of cultivated land.	38~10
1986	Incorporation into KOISP project	10
1989	Completion of Feeder Canal No. 1 (supplemental irrigation discharge supply)	7
1993	Construction of shortcut feeder canal (Feeder Canal No.2)	1
1996	Present irrigated area A = 594 ha	0

- The irrigation system diagram is given in Figure 5.3.5-1.

(2) Present Irrigated Area and Canal Length

Irrigated area and canal lengths by GR (gate regulator) are as follows on the basis of field survey.

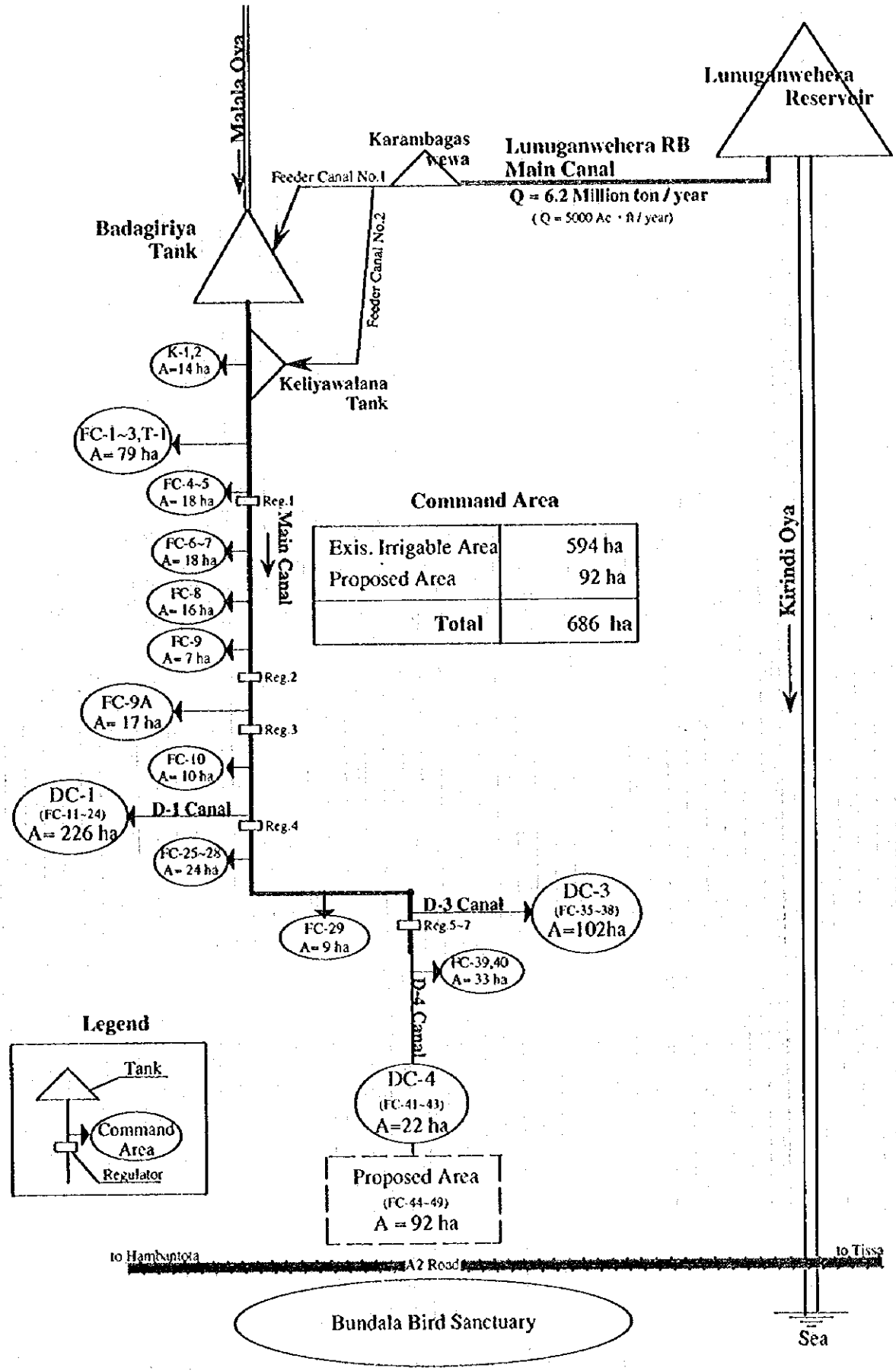


Figure 5.3.5-1 Irrigation System Diagram for Badagiriya Scheme

GR No.	Location on main canal	Distance (m)	GR command area (ha)	Canal length (m)		
				Main canal	D-canal	F-canal
Badagiriya tank	STA 0	0	-	-	-	-
GR - 1	STA 1 + 629	1,629	110.7	1,629	1,880	4,540
GR - 2	STA 2 + 983	1,354	33.2	1,354	-	1,850
GR - 3	STA 4 + 165	1,182	6.7	1,182	-	800
GR - 4	STA 5 + 222	1,057	252.5	1,057	1,698	8,208
GR - 5	STA 6 + 832	1,610	135.5	1,610	844	5,613
GR - 6	STA 8 + 360	1,528	32.9	1,528	0	2,420
GR - 7	STA 8 + 604	1,244	22.4	1,244	400	1,300
Total		9,604	593.9	9,604	4,822	24,731

(3) Design Irrigated Area

The block (92 ha) at the downstream terminus of the main canal has experienced irrigation discharge shortages since its settlement in 1958. As a result, farmers were forced to abandon cultivated land, which has now reverted to jungle. Farmers and the ID strongly desire that water delivery to this block be made possible through rehabilitation of the existing canal system.

The design irrigated area under the Study includes this abandoned area:

- Present irrigated area: 594 ha
- Design irrigated area: 594 ha + 92 ha = 686 ha

(4) Diagram of Present Irrigation and Drainage Canal

The present irrigation and drainage canal system is diagrammed in Figure 5.3.5-2 based on field survey using S = 1/5,000 topomapping.

(5) Calculation of Present Water Balance

1) Calculation period

The 11 year period from 1984/85 Maha season to the 1995 Yala season

2) Inflow discharge

The following discharge data was applied:

Badagiriya tank gauge return: 1983~1985
Feeder Canal No. 1 discharge: November 1993 ~
Feeder Canal No. 2: July 1994 ~

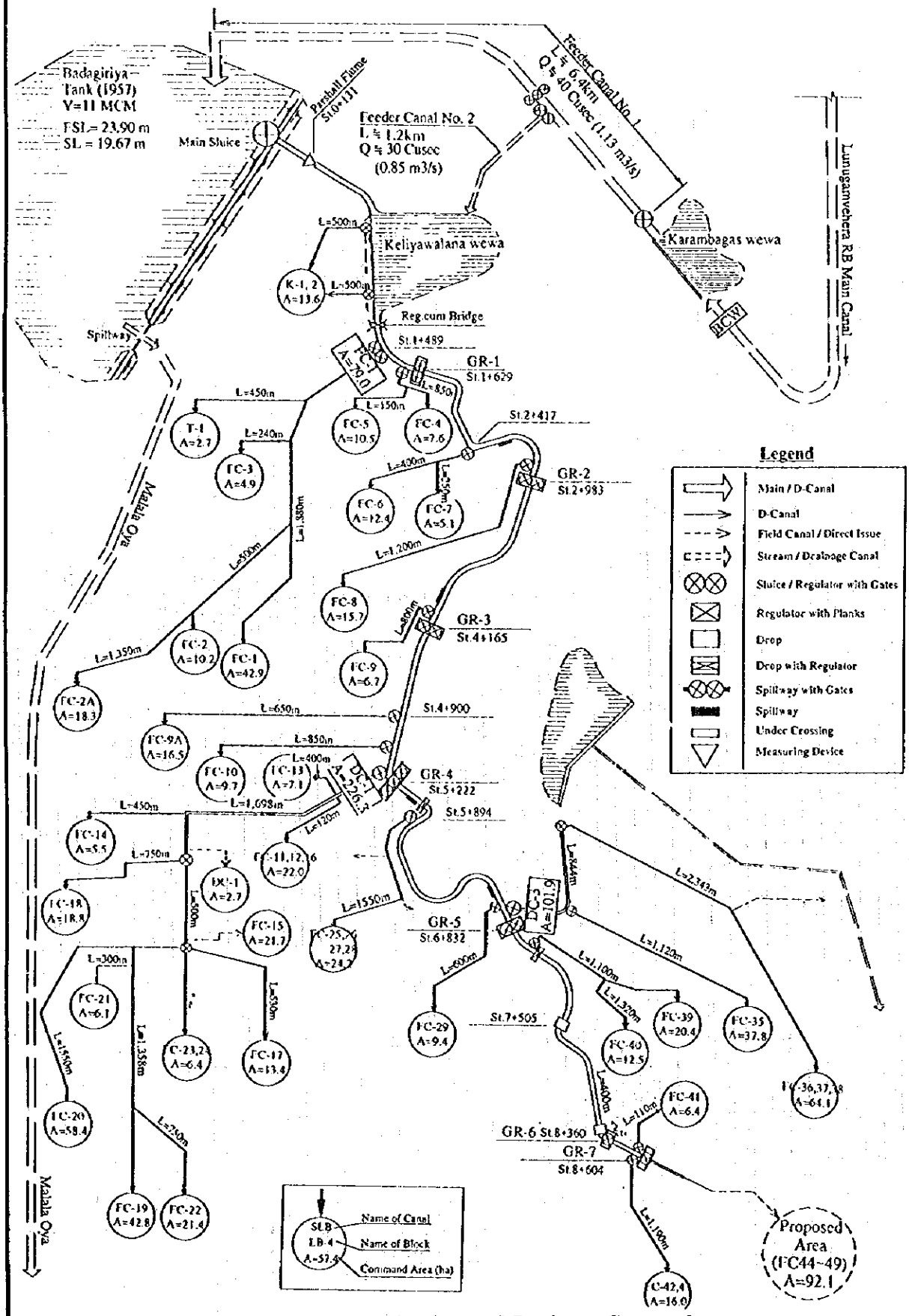


Figure 5.3.5-2 Present Irrigation and Drainage System for Badagiriya Scheme

(as F/S Study)

3) Irrigation efficiency

Ec = 50%

4) Irrigation period

The irrigation period (1984/85 Maha ~ 1995 Yala) is shown in Figure 5.3.5-3 based on discharge records at Badagiriya tank (1984 ~ 1995) and interview of FOs.

5) Present irrigation success rate

78% for the Maha season and 54% for the Yala season according to AD data (for the past 5 years)

The following discharge data was applied.

Computed Irrigable Area Rates (at present)

unit: %

Calculation Period	1984/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	Average
Maha	100	90	62	76	83	62	100	62	100	100	83	83
Yala	78	46	56	54	53	62	70	56	62	56	53	59

(6) Assessment of Badagiriya Irrigation Scheme

1) Water source

Water balance calculations indicate an absolute water shortage occurring at the scheme water source. Since irrigation success rate is 88% in the Maha season and 59% in the Yala season, 100% copping with irrigated paddy in the scheme area cannot be expected. Accordingly, it is recommended that irrigation success rate be upgraded by introduction of upland crops utilizing the present discharge available at the water source.

2) Facility deterioration

Field survey indicated that significant deterioration has occurred to the feeder and main canals. D-canals as well have suffered deterioration; however, the degree is less. Given ground conditions in the scheme area, it is considered a precondition that feeder and main canal cross-sections be rehabilitated in order to expand irrigated area.

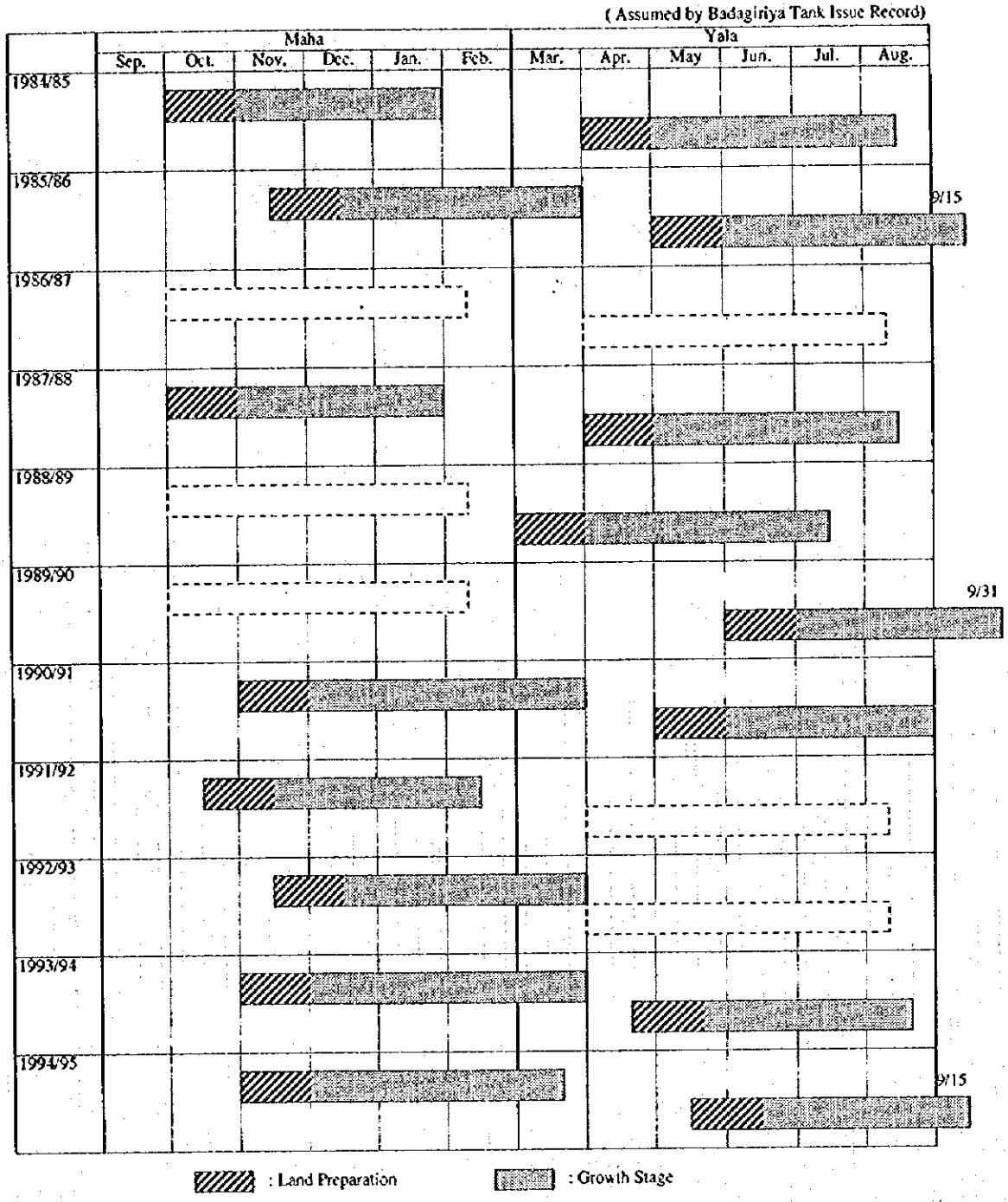


Figure 5.3.5-3 Irrigation Period for Badagiriya Scheme (1984/85 ~ 1994/95)

Cross section collapse is significant on Feeder Canal No. 1 (total length: 6.45 km) for the segment downstream from the diversion point to Feeder Canal No. 2.

Canal shape has not been maintained in and around STA2 + 700 and STA6 + 600 on the main canal, and stagnant pools have formed at these points. Rehabilitation of the main canal is thus necessary, including under crossing facilities to drain off drainage runoff from the left bank side. Erosion of the main canal cross-section is serious in the downstream segment from STA7 + 200 ~ EP, and cross-section rehabilitation is accordingly necessary along with drop works construction.

3) Water level regulating gates (GR)

It is necessary to rehabilitate the water level regulating gates at their present locations along the main canal in conjunction with main canal rehabilitation. These gates at present are inoperable. It is also considered necessary to install discharge gauging equipment at the gates on the turnout side. However, the possibility of dismantling the GR-3 and GR-6 facilities should be studied as the command areas for these are almost none. In such case, it is important to maintain the present turnout water level through attention to the layout for dropworks.

5.4 Agriculture

5.4.1 Liyangastota Scheme

(1) Farm Household Number and Land Holdings

Number of farm household in the scheme area total 5,700 for both the RB and LB including landholders and tenants. The results of agricultural survey under this Study indicate that tenant farmers account for 66% of the farm households on the RB and 50% on the left bank. On this basis, total landholder households are estimated at 2,400 and total tenant farmer households at 3,300. In addition, a further 3,000 household of landless farmers exist, who either work the paddy fields of landholder farmers or borrow paddy land as sub-tenants from tenant farmers.

Paddy field area, including uncultivated fields, totals around 5,000 ha (2,454 ha on the right bank and 2,554 ha on the left bank). Land holdings per owner household average 2.1 ha. Breakdown by size of holdings is 18% for under 0.4 ha, 48% for 0.4~1.2 ha, and 34% for over 1.2 ha. Owners with land holdings over 1.2 ha lend their land to tenant farmers. Size of land cultivated by tenant farmers averages 2 ac (0.8 ha) of which another 0.3 ha is lent to sub-tenants (landless farmers).

Accordingly, size of land cultivated per farm household is calculated at 1.0 ha for land holder farmers, 0.5 ha for tenant farmers and 0.3 ha for landless farmers. Total average (5,000 ha / 8,700 farm households) is computed at 0.57 ha.

	No. of farm households	Size of holdings	Cultivated area	Area per household
Landholder farmers	2,400 (28%)	5,000 ha	2,400 ha	1.0 ha
Tenant farmers	3,300 (38%)	--	1,700 ha	0.5 ha
Landless farmers	3,000 (34%)	--	900 ha	0.3 ha
Total	8,700	5,000 ha	5,000 ha	0.57 ha

(2) Land Use and Cropping Pattern

According to Agricultural Department Statistics, cropped area for paddy in both rainy and dry seasons was 4,677 ha in 1991~93, and 4,913 ha in 1994. Accordingly, the average annual cropped area of paddy per year for the 5 year period 1991~95 was 9,542, with a land use ratio of 191% for the irrigated paddy area of 5,000 ha.

In limited open spaces in paddy fields, okra, bitter gourd, chilies, banana and other upland crops are observed cultivated; however, precise statistics are not available and the amount of area so cropped is considered negligible for the purposes of planning under the project. Partial cultivation of the area in the dry season with upland crops by temporary pump irrigation is also seen (branch canal of Ridiyagama tank). Also, perennial crops such as coconut and fruit are widely cultivated in home gardens.

		Land use rate
Rainy season paddy cropping (5 year average)	4,771 ha	95%
Dry season paddy cropping (5 year average)	4,771 ha	95%
Annual cropping of 5,008 ha	9,542 ha	191%

(3) Seeding Method, Unit Yield and Production

1) Paddy planting and seeding method

Possession of tractors is greatest among second generation landholder farmers, with a 20% overall possession rate in the Study area. The great majority of farmers (80%), however, rely on tractor rental for tilling. The broadcast method of seeding is most common, with the transplantation method accounting for less than 10%.

2) Seed

As water is abundant, 4.5 month varieties account for 20% in both the rainy and dry seasons. The 3~3.5 NIV (new improved) varieties account for 50~55% in both seasons which is 2 fold that for OIV (old improved) varieties at 20~30%. Red rice of the AT variety (Ambalantota rice research station) is highly popular.

To address the shortage of superior seed supply, the Department of Agriculture and cooperatives are developing seed production farmers.

Farmers presently seed and amount of 150~200 kg/ha which is in excess of that recommended by the Agricultural Department of 100 kg/ha.

3) Fertilizer and Agro-chemicals

Average fertilizer application in both seasons is 345 kg/ha. Fertilizer cost is Rs 3,453 / ha in the rainy season and Rs 3,240 / ha in the dry season.

According to farmers in the area, the use of organic fertilizers (mulch, manure, rice straw) is almost nil.

Weedicide use is 9.5 ℓ in the rainy season and 7.9 ℓ in the dry season. Use of pesticides is 2.3 ℓ in the rainy season and 1.9 ℓ in the dry season. The cost for these agro-chemicals is Rs 2,705 / ha in the rainy season and Rs 2,663 in the dry season.

4) Unit yield

On the basis of the results of agricultural survey, average unit yields are estimated at 3.9 t in the rainy season and 3.8 t in the dry season. Notable in comparison to other areas is the high ratio of cultivation of the 4.5 month variety (20%) due to greater use of fertilizer and agro-chemicals.

- Constraints to paddy production:

① Lack of good quality seed
② Inadequate use of fertilizer

5) Production

Annual paddy production in the Study area is estimated as follows based on the above unit yield and cropped area.

Rainy season:	unit yield (3.9 t) × cropped area (4,770 ha) = paddy production (18,600 t)			
Dry season:	unit yield (3.8 t) × cropped area (4,770 ha) = paddy production (18,100 t)			
Annual total:	3.85 t	×	9,540 ha =	36,700 t

(4) Crop Production Cost and Farmer Income

On the basis of agricultural survey, current crop production cost for each season (average) is shown below (per ha).

Inputs:			
1. Seed	150 kg	Rs	1,300
2. Fertilizer	345 kg	Rs	3,450
3. Agro-chemicals	10.8 lit./kg	Rs	2,684
4. Farm equipment	ha	Rs	6,336
5. Employed labor	58 man-days	Rs	5,800
Family labor	80 man-days	--	
Income:			
1. Yield	kg		3,850 kg
2. Farm gate price	Rs/kg	Rs	9.4
3. Gross income	Rs	Rs	36,190
4. Production cost	Rs	Rs	19,570
5. Net income	Rs	Rs	16,620

On the basis of the above, net annual income per household for farmers from paddy cultivation is calculated as shown below.

	No. of households	Paddy holdings	Cultivated area	Per household	Annually cropped area	Annual income
(1) Landholder farmers	2,400	5,000 ha	2,400 ha	1.0 ha	1.8 ha	Rs 29,900
(2) Tenant farmers	3,300	--	1,700 ha	0.5 ha	1.0 ha	Rs 16,600
(3) Landless farmers	3,000	--	900 ha	0.3 ha	0.6 ha	Rs 10,000

(Annual income does not account for tenancy obligations in the case of tenant farmers.)

(5) Farmer Support System and Farmer Aspirations

Support for farmer organizations is provided by project managers appointed within the ID for the right bank and left bank. Assistance in the procurement of agricultural inputs is extended by the ASC and the cooperatives, while technical assistance if forthcoming from the Agricultural Department. In the case of cooperatives with branches in Ambalantota, strong efforts are being put into seed production, with 6 designated seed production farms in the scheme area.

The Inter-provincial Agricultural Extension Office established jointly at the District Agricultural Office by the DOA oversees extension activities for paddy in the area. An AO is assigned to the office, with a staff of 3 AIs assigned permanently to each of the ASCs.

The DOA is promoting the production and extension of good quality seed; however, there is no observed collaboration with Ambantota cooperatives. The DAS distributes certified seed to the FOs under its jurisdiction.

Farmers show resistance to introducing OFC into paddy fields. Main reasons for this include an abundance of water, over half of the farmers are tenants, production costs for OFC are high due to lack of manpower. It is concluded that the introduction of OFC into the scheme area would be difficult.

- Constraints to farmer support:

  ① Cooperatives under the ID due not work in concert with the Agricultural Department
  ② Liaise between the ID, ASC and the cooperatives is weak

(6) Female Labor and Animal Husbandry

According to agricultural survey, 34% of farmers own cattle, 27% own goats, 16 % own hogs, and 17% own poultry. Most of the labor related to animal husbandry is performed by women. As there was not a single case of cattle being used as beasts of burden according to the responses to the questionnaire survey, it is assumed that the

above cattle are beef and dairy cattle as opposed to water buffalo. As the area farmers are Buddhist, livestock are sold rather than butchered at home.

As the area has been a major rice producing center for many years, their are numerous large landholder farmers and on average the rural community is relatively affluent. In the case landowner and tenant farmers, 58% of households have TVs, 90% have bicycles. Also, as 22% of households have access to wells, and 26% use oil or LP gas stoves, women from the more affluent households have a lightened burden with regards to arduous household tasks such as water fetching and firewood collecting.

Number of agricultural labor days put in by women (1.5 persons / household) average 160 days per years, with breakdown by type of activity being 47 days for upfield farming, 40 days for paddy farming, 38 days for home vegetable gardening, 18 days for animal husbandry, and 7 days for marketing of farm products.

Non agricultural labor by women includes reed weaving (mats, etc.), public works and other day labor, commercial sewing (in garment factories), etc.

- Breakdown of labor by women:

  ① Agricultural labor: average of 160 days per year per family (paddy cultivation, upland crop cultivation, home vegetable gardening, animal husbandry, farm product marketing)

  ② Non-agricultural labor: reed weaving (25% of households), public works · day labor (20%), commercial sewing (5%)

  ③ Type of preferred work: farm product marketing (41%), animal husbandry (18%), commercial sewing (18%)

(7) Problem Issues which need to be Addressed, and Mitigation Strategy for the Same

1) Water Management Improvement

Due to abundant discharge, in a part of the scheme areas cropping cannot be effectively done due to excessive drainage runoff. It is necessary that that the ID carry out training targeted at the FOs in order to improve the efficiency of rehabilitation works, and collaborate with the Agricultural Department regarding drainage discharge during the cropping season.

2) Extension of Good Quality Seed

At present, paddy seed production including that by the cooperatives should be sufficient; however, there is no system for seed extension to FOs and farmer groups. It is necessary that the Agricultural Department utilize the FOs to extend good quality seed to the farmers. Encouragement of cultivation of the 4.5 month variety would be anticipated to greatly improve productivity.

3) Fertilizer Application

In contrast to the fertilizer application amount of 450 kg/ha recommended by the Agricultural Department, actual amounts used are observed at 94 kg/ha in the rainy season and 116 kg/ha in the dry season. Cultivation loans to FOs are necessary.

5.4.2 Muruthawela Reservoir Scheme

The scheme area comprises the Muruthawela LB, Urubboka Oya and Kirama Oya sub-schemes. The Muruthawela LB scheme is located in sparsely populated area near the Dry Zone, and the other 2 schemes are in more heavily populated Wet Zone area.

The Muruthawela LB scheme underwent settlement in relatively recent years, while the Urubboka Oya and Kirama Oya sub-schemes are traditional rural areas. In terms of water use, the Muruthawela LB scheme suffers from water shortage while the other two sub-schemes enjoy relatively abundant water resources. While in the case of the Muruthawela LB sub-scheme all farmers are landholders, only 20% are such in the other 2 sub-schemes, with the remaining vast majority being tenant or lease farmers.

As a result, average farm holdings in the Muruthawela LB sub-scheme area are 0.8 ha, while those in the other 2 sub-scheme areas are 0.4 ha ~ 0.5 ha due to widespread tenancy and fragmentation of land holdings due to splitting of land among surviving family members upon the decease of the original landholder.

Due to the above described fundamental difference in the nature of the sub-scheme areas, they are subsequently classified in terms of farm management analysis and agricultural development plan for the purposes of discussion in this section (5.4) and section 6.3 into (i) Muruthawela LB sub-scheme and (ii) Urubboka Oya and Kirama Oya sub-schemes.

(1) Farm Household Number and Land Holdings

1) Muruthawela LB sub-scheme

Settlement of 1,634 households began in the area in 1968. Each household was given 0.8 ha of paddy and 0.2 ha of homestead lot, and under this program Tract II and III were completed. Tract I is located on the left bank of the 11 km long main canal, and the farmers in this area have for many years carried out unmanaged diversion of water from the canal by siphon (pipe). The FOs report that there are 870 farm households in Tract I. As the benefit area in this Tract I was determined by the Team in collaboration with the ID to be 1,700 ha, the per household paddy field holdings average 0.68 ha. Average holdings in Tract II and III are 0.8 ha.

- Irrigated paddy area: 1,700 ha
- Current number of paddy farmer households: 2,128
- Total number of households (Tract I [870] + Tract II, III [registered settlers]): 2,504

- Per household paddy holdings: 0.68 ha for Tract I, 0.8 ha for Tract II, III

2) Urubokka Oya · Kirama Oya sub-schemes

These 2 schemes comprise rural communities which have been engaged in traditional agriculture since the 19th century. Farmers include a variety of categories (landholder, tenant, sub-tenant, lease, etc.), however precise statistics are not available. Total paddy field area is estimated at 3,773 ha, and total paddy farmer households at 7,800. Landholder farmers, however, account for only 18% (1,400) of the households. Breakdown of these by size of holdings is 25% for under 0.4 ha, 49% for 0.4~1.2 ha and 26% for over 1.2 ha. In the case of landholdings in excess of 0.4 ha, in almost all cases these are actually cultivated by tenant farmers. Average holdings per landholder farmer household are 2.7 ha, however, in the case of the large landholders (under 400 households), holdings per household are 5~10 ha).

- Irrigated paddy area: 3,773 ha
- Number of paddy farmer households: 7,800
- Number of landholder households (estimated): 1,400
- Per household paddy holdings: 0.48 ha

3) Muruthawela scheme (overall)

The number of farm households and landholdings for the Muruthawela scheme overall are as follows.

- Irrigated paddy area: 5,473 ha
- Number of paddy farmer households: 10,300
- Total number of households: 3,900
- Per household paddy holdings: 0.53 ha

(2) Land Use and Cropping Pattern

1) Muruthawela LB sub-scheme

According to the Project Office, average figures for cropping achievement over the 3 year period 1991~93 for paddy and OFCs are as follows. Both design and present cropping patterns are described in 6.3.2 (1).

[rainy season]				<Land use rate>
Paddy	948 ha			
OFCs	214 ha	Total cropped area:	1,198 ha	70.5%
[dry season]				<Land use rate>
Paddy	915 ha			
OFCs	101 ha	Total cropped area:	1,016 ha	59.8%
Annual cropping of 1,700 ha:			2,214 ha	130.0%

OFCs comprise a variety of green gram, cowpea, maize, chilies, peanut, green vegetables, etc.; however precise statistics are not available.

In Tract I, paddy is cropped (278 ha) during both planting seasons. In Tract II, OFCs are cropped in the dry season and paddy in the dry season; and in Tract III paddy in the rainy season and OFCs in the dry season under a managed water distribution system to adjust for water shortages.

2) Urubokka Oya · Kirama Oya sub-schemes

In this area, paddy alone is cropped in both seasons. Based on responses from FO representatives regarding cropping rate it is estimated that total cropped area is 3,162 ha in the rainy season and 2,859 ha in the dry season for an annual total of 6,021 ha. Land use rate for irrigated paddy of 3,733 ha is 160%. The cropping rate in the Kirama Oya sub-scheme is particularly low during the dry season at 65%, and this is judged to be the result of water shortages at the field level. With regards to cropping calendar, design and present calendar are shown together in 6.3.2 (1)

		<Land use rate>
Rainy season paddy (estimated):	3,162 ha	84%
Dry season paddy (estimated):	2,859 ha	76%
Annual cropping of 3,773 ha:	6,021 ha	160%

3) Muruthawela scheme (overall)

Cropping pattern for the overall Muruthawela scheme is as follows.

		<Land use rate>
Rainy season paddy:	4,168 ha	77%
Rainy season OFCs:	214 ha	4%
Dry season paddy:	3,734 ha	68%
Dry season OFCs:	101 ha	2%
Annual cropping of 5,473 ha:	8,235 ha	156%

(3) Tilling Method and Unit Yield · Production

In this section, discussion will cover the Study area as whole, with specific differences by scheme area indicated where considered significant;

1) Transplanting and seeding

Tractor ownership rate is 15%, with the majority of farmers (84%) renting tilling equipment when necessary. In the case of small farmers, tilling by beast of burden

or manually is a small 1%. Broadcast method of seeding is by far the most prevalent, with transplanting being only 5%.

2) Seed

The 3~3.5 month varieties of paddy account for 95% of cultivation in both seasons. Cultivation of 4.5 month varieties is under 5%. Around 40% is old improved varieties (OIV), and 60% is new improved varieties (NIV). BG rather than AT varieties are popular as they are easier for the farmers to obtain. Extension of superior seed is the responsibility of the Agricultural Department, however farmers generally use their own seed. Seeding amount is over 150 kg per ha which exceeds the 100 kg/ha amount recommended by Department of Agriculture.

3) Fertilizer and Agro-chemicals

Application amounts of fertilizer are 280 kg /ha in the rainy season and 270 kg /ha in the dry season under the Muruthawela LB sub-scheme, and 252 kg/ha in the rainy season and 246 kg/ha in the dry season under the Urubokka Oya · Kirama Oya sub-schemes.

Average application of weedicides in both seasons is 2.3 ℓ/ha in the Muruthawela LB area, and 2.0 ℓ/ha in the case of the Urubokka Oya · Kirama Oya sub-schemes. Pesticide use is 1.2 ℓ/ha under the Muruthawela LB sub-schemes, and 1.0 ℓ/ha in the case of Urubokka Oya · Kirama Oya.

4) Unit Yield

Unit yields are estimated as follows based on the results of agricultural survey, questionnaire responses from AIs and representatives of FOs, and application amounts for fertilizer, etc.

	Muruthawela LB	Urubokka Oya · Kirama Oya	Overall Project area
Rainy season yield / ha	3.8 t / ha	3.2 t / ha	3.53 t/ha
Dry season yield / ha	3.5 t / ha	3.1 t / ha	3.26 t/ha
Weighted average	3.7 t / ha	3.2 t / ha	3.3 t/ha

5) Production

Total paddy production in the Study area is estimated as follows based on unit yield and cropping areas indicated above.

	Unit yield	Cropping area	Paddy production
Muruthawela LB	3.7 t	1,900 ha	7,000 t
Urubokka Oya · Kirama Oya	3.2 t	6,000 ha	19,000 t
Overall	3.3 t	7,900 ha	26,000 t

- Constraints to paddy production:

  ① Water shortage
  ② Lack of good quality seed
  ② Inadequate use of fertilizer

(4) Crop Production Cost and Farmer Income

Crop production cost and farmer income for paddy cultivation are indicated as per below on the basis of agricultural survey.

(per ha)	Muruthawela		Urubokka · Kirama Oya		Overall	
Inputs:						
1. Seed (kg)	150	Rs 1,280	150	Rs 1,280	150	Rs 1,280
2. Fertilizer (kg)	275	Rs 2,750	250	Rs 2,500	256	Rs 2,560
Vmix	115		100			
TDM	80		75			
Urea	80		75			
3. Agro-chemicals (lit./kg)	3.5	Rs 840	3.0	Rs 720	3.1	Rs 740
Weedicides	2.3		2.0		2.1	
Pesticides	1.2		1.0		1.0	
4. Farm equipment (ha)		Rs 6,670		Rs 6,670		Rs 6,670
Tilling						
Others						
5. Employed labor (m-d)	19	Rs 1,900	19	Rs 1,900	19	Rs 1,900
Family labor (m-d)	111		111		111	
Income:						
1. Yield (kg)		3,700		3,200		3,300
2. Farm gate price (Rs/kg)		9.4		9.4		9.4
3. Gross income (Rs)		34,780		30,080		31,020
4. Production cost (Rs)		13,440		13,070		13,150
5. Net income (Rs)		21,340		17,010		17,870

On the basis of the above, farmer income from paddy production is computed at Rs 18,990 per household for Muruthawela LB, and Rs 13,100 per household for Urubokka Oya · Kirama Oya. Average for the Project area as whole is Rs 14,260. Also, results of agricultural survey indicate that OFC (including chena cultivation) income for the overall Muruthawela scheme averages 1/3 of income from paddy production.

(5) Farmer Support System and Farmer Aspirations

The INMAS program was started in the Muruthawela LB area in 1987, under which FOs have been promoted to address water shortages. Two IOs have been assigned to provide guidance in canal maintenance, introduction of OFCs and rotational paddy cropping in Tract II and Tract III. A Project Manager is responsible for overall supervision and management.

The 2 IOs and the Project Manager maintain a project office at the Weeraketiya ASC, where they are on duty on a daily basis. With the assistance of the ASC, the FO for Tract III, D-09 have been able to purchase 2 wheel tractors on an installment basis with money from the FO fund. DOs (agrarian service Divisional Officer) and AIs (Agricultural Instructor) are also assigned to the ASC and on the occasions when the Study Team visited the project office it was observed that farmers where availing themselves of the office's services for consultation.

According to records compiled by the previous Project Manager, unit yield for paddy showed significant increase from the 1990s as a result of success with optimum timing of water allocation under rotational cropping and introduction of OFCs.

In the case of the Urubokka Oya · Kirama Oya sub-schemes, it was revealed in discussions with the FOs in 10 areas that extension of agricultural technology was inadequate, with the only source of the same being from the fertilizer merchants and agro-chemical salesmen. There are 4 AIs responsible for the Urubokka Oya area and 7 responsible for the Kirama Oya area. Another factor is the that 0% of the farmers are tenants. Also, 20% of farmers responded that water shortages were experienced at the field level, while in the case of the Muruthawela LB sub-scheme, the number was relatively less at 17%. This is considered due to the fact that in the case of the latter, bi-weekly meetings are held with the FOs for instructional support under the INMAS program. In general in the case of the Urubokka Oya · Kirama Oya sub-schemes over 80% of farmers are tenants with fragmented farm scale, and as a result they show a weak sense of organizational unity under the FOs and low incentive towards agricultural activity. This is particular so in the Kirama Oya sub-scheme area.

(6) Female Labor and Animal Husbandry

According to agricultural survey, 74% of farmers own cattle, 2% own goats, 2 % own hogs, and 24% own poultry. Most of the labor related to animal husbandry is performed by women.

In the case of small farms in the Urobokka Oya · Kirama areas, some tilling is still done by beast of burden or manually, and accordingly some of the cattle in the area are assumed to be water buffalo. The sub-scheme areas are in Wet Zone with perennial grazing areas available making the husbandry of cattle relatively easy.

Number of agricultural labor days put in by women (1.5 persons per household) average 167 days per years, with breakdown by type of activity being 42 days for

upfield farming, 36 days for paddy farming, 34 days for marketing of farm products, 33 days for home vegetable gardening, and 22 days for animal husbandry.

Non agricultural labor by women includes reed weaving (mats, etc.) (34%), palm frond weaving (27%), public works and other day labor (12%), commercial sewing (10%), and marketing activities (5%), etc.

Type of preferred work by women are commercial sewing (28%), animal husbandry (24%), farm product marketing (15%), and home vegetable gardening (14%).

- Breakdown of labor by women:

  ① Agricultural labor: average of 167 days per year (paddy cultivation, upland crop cultivation, farm product marketing, home vegetable gardening, animal husbandry,)

  ② Non-agricultural labor: reed weaving, palm frond weaving, public works · day labor, etc.

  ③ Type of preferred work: commercial sewing, farm product marketing, animal husbandry, home vegetable gardening, etc.

(7) Problem Issues which need to be Addressed, and Mitigation Strategy for the Same

1) Muruthawela LB sub-scheme

As uncontrolled diversion of water in Tract I is a cause of water shortage in the area, it is recommended that the Project Office take the lead in training FOs towards implementation of a rational water management plan in Tract I, II, and III, with balanced cropping of paddy and OFCs. Introduction of OFCs should focus on crop profitability, and promote the active participation of women in agricultural activities.

2) Urubokka Oya · Kirama Oya sub-schemes

Due to the large number of tenant farmers and fragmented farm size, a significant improvement of paddy production will be difficult. However, smaller amounts of good quality seed use and appropriate timing for fertilizer application should be promoted. In the case of 3~3.5 month varieties, the optimum number of days for fertilizer application is small, and it is essential to focus guidance and training towards those areas where water is either in excess or shortage.

5.4.3 Badagiriya Scheme

(1) Farm Household Number and Land Holdings

The Badagiriya settlement plan began with a part of the Kirindi Oya project in the 1960s. In 1986, the Lunugamwehera branch canal was constructed. Paddy field in the overall settlement area was confirmed at 686 ha in discussions between the ID and the Study Team (April 1996). Each settler household was granted 1 ha of paddy field and 0.2 ha of homestead land. Registered no. of households is estimated at 686.

Of the above 686 ha of paddy field, 60 ha are uncultivated due to water shortage. Another 100 ha of Maha season rainfed paddy are also virtually abandoned. As a result, the number of farmers who go outside the area to pursue agricultural activities total 100 households.

As a result FO survey carried out twice by the Team, farm households were determined at 557 and 594, respectively. This discrepancy is concluded to be the result of the fact that farmers from 30~40 households move in and out of the area depending on the cropping conditions for a particular season. Accordingly, it is assumed that the total of actual farm households in the area is 686 as per the registered number indicated above, and total paddy field holdings are 686 ha (1 ha per household).

Agricultural survey findings indicate that average upland field cultivated per household is 0.4 ha. According to the report from the ASCs in the relevant GNs, farm households depend on a total of 270 ha of upland cropped area.

· Paddy field area: (including 160 ha of water shortage field)	686 ha
· Upland field area:	270 ha
· Settler farm households (registered):	686 ha
· Present no. of farm households:	557 ha (1996)
· Paddy field area per household:	1.0 ha
· Upland field area per household:	0.4 ha

(2) Land Use and Cropping Pattern

According to AD statistics, average paddy cropped area for the 7 year period 1989~1995 was 536 ha in the rainy season and 367 ha in the dry season. The highest figure was for the 1990/91 rainy season at 650 ha, and the lowest for the 1992 · 93 · 95 dry seasons at 0 ha. Accordingly, the land use rate for the said 7 year period is computed at (536 + 367) / 686 = 132%.

The AD attempted targets of cropping for green gram, soybean, maize and other OFC at 200 ha respectively for the 1989/90 rainy season and the 1992 · 93 · 95 dry seasons; however, cooperation from farmers was weak and the said targets were not achieved. The AD indicates the following reasons for this failure.

1) Farmers are unwilling to bear production costs given the uncertain of yield under conditions of water shortage.

2) Marketability of produce does not have the guarantee that paddy does.

3) Farmers resist the idea of planting crops in paddy field that can be cultivated by chena.

Actual cropped area of OFCs (total 4 times) for the above targeted seasons is estimated at 300 ha, which averages 40 ha in the dry season and is equivalent to 6% of the total paddy area of 686 ha. The design and present cropping calendars are shown together in 6.3.3 (1).

Use of upland field is mainly for rainfed upland crop cultivation (green gram, cow pea, maize, peanut, chilies) in the rainy season. However, since this also includes chena cultivation, precise statistics are unavailable. Upland field cultivation in the dry season is limited to a small amount of chili, gourd and other vegetable by pump irrigation. Dry season income from upland cultivation is only 20% that during the rainy season. In home gardens, coconut, papaya, banana and other fruits are the main crop.

			<Land use rate>
Rainy season paddy (7 year average):	536 ha	0.78 ha per household	78%
Dry season paddy (7 year average):	367 ha	0.54 ha per household	54%
Dry season OFCs (7 year average):	40 ha	0.06 ha per household	6%
Annual cropping of 686 ha:	943 ha	1.38 ha per household	138%

(3) Tilling Method and Unit Yield · Production

1) Transplanting and Seeding

The majority (70%) of tilling is done with rented equipment. Rate of private tractor ownership is 30%. Broadcast seeding is generally practiced (90%).

2) Seed

The 3~3.5 month varieties account for 95% of the cultivated paddy in the rainy season. The 4 month varieties account for only 5%. Only 3~3.5 month varieties are cultivated in the dry season. In both seasons, the NIV (new improved varieties) account for 60%, with the production of this seed being done by seed production farmers (10 households; 3.2 ha) designated by the AD.

Due to lesser quality of the seed so produced, application amount is as much as 150 kg/ha (broadcast method).

3) Fertilizer and agro-chemicals

Average amounts of fertilizer application are 368 kg/ha in the rainy season and 275 ha in the dry season. Fertilizer costs are Rs 3,616/ha in the rainy season and Rs 2,658 in the dry season.

Response from farm households indicates around 10% use of organic fertilizers (compost, cow dung, rice straw, etc.).

Weedicide use is 7.6 ℓ/ha in the rainy season and 6.1 ℓ/ha in the dry season. Pesticide application is 2.1 ℓ/ha in the rainy season and 2.0 ℓ/ha in the dry season. Cost for these agro-chemicals are Rs 2,363/ha in the rainy season and Rs 1,853 in the dry season.

4) Unit Yield

Results of agricultural survey indicate average unit yields of 3.6 t/ha in the rainy season and 3.0 t/ha in the dry season. The low yield levels are attributed to water shortages and low amounts of fertilizer application.

- Constraints to paddy production:

① Water shortage
② Lack of good quality seed
③ Inadequate use of fertilizer

5) Production

On the basis of the above yields and cropped area, paddy production is estimated as follows:

	Unit yield	Cropped area	Production
Rainy season paddy	3.6 t / ha	536 ha	1,930 t
Dry season paddy	3.0 t / ha	367 ha	1,100 t
Yearly total (average)	3.2 t / ha	943 ha	3,030 t

(4) Crop Production Cost and Farmer Income

Present crop budget on the basis of agricultural survey is computed as per below (average per ha for both cropping seasons).

Inputs:		
1. Seed	150 kg	Rs 1,840
2. Fertilizer	330 kg	Rs 3,300
3. Agro-chemicals	9 lit./kg	Rs 2,155
4. Farm equipment	ha	Rs 7,925
5. Employed labor	29 man-days	Rs 2,900
Family labor	114 man-days	--
Income:		
1. Yield	kg	Rs 3,200
2. Farm gate price	Rs/kg	Rs 94
3. Gross income	Rs	Rs 30,080
4. Production cost	Rs	Rs 18,120
5. Net income	Rs	Rs 11,960

Income per farm household for paddy production is estimated on the basis of current cropping achievement of 1.69 ha / year / household at: 1.69 ha × Rs 11,960/ha = Rs 20,200.

On the basis of agricultural survey, income from OFC cultivation (including chena) is 26% that for paddy which equates to a per farm household income of Rs 25,450.

(5) Farmer Support System and Farmer Aspirations

FO support is managed from the IDs project office (Kirindi Oya project branch). The ASCs provide assistance in the procurement of agricultural inputs and the ID and regional agricultural research center are responsible for technical support. There are 4 D-canal groups per D-canal in the scheme area. Coordination between the groups is good, and the overall FO representative for the area also serves as the chairman of the FO association for the entire Hambantota district.

The Project Office is located with good access along the national highway, however, lack of permanent staff hinder its operations. The ID and the regional agricultural research center maintain branch offices under the Kirindi Oya project, but despite good facilities are basically empty outside of office day (Wednesday) due to lack of staff.

This geographic isolation of the area has a strong impact on water management under the scheme, with poor communication and reporting with regards to water shortages at the field level.

Farmers indicated their desire, provided sufficient water is available, to double crop paddy during the year to the extent possible. With regards to shift to upland crop

cultivation, there is seen some interest in banana cropping, however there is almost no interest in inter-cropping of upland crops in paddy field due to the fact that a sufficient amount of this can be done by chena during the rainy season in upland fields. Outside of making a certain percentage of OFC cropping mandatory to offset water shortages, introduction of OFCs is perceived as difficult.

- Constraints to farmer support:

  ① Geographical isolation
  ② Lack of permanent support staff
  ③ Lack of communication network to report on water shortages at the field level

(6) Female Labor and Animal Husbandry

Cattle raising is common around the scheme area due to the large expanses of grassland and land cultivated by chena. Nevertheless, number of farmers responding under the survey that they raised cattle was only 25%. Two farm households were seen to be raising around 300 nos. of egg producing poultry, however, generally the number per household is 5~10 for home consumption.

The labor for this animal husbandry is mainly provided by women, and some wives engage in the production yogurt, a major product of the region.

Household chores are performed by women, with such tasks as cooking, water fetching and firewood collection being 70% done by females.

Number of agricultural labor days put in by women (2.0 persons per household) average 195 days per year, with breakdown by type of activity being 56 days for upfield farming (including chena), 49 days for paddy farming, 41 days for home vegetable gardening, 29 days for marketing of farm products, and. 20 days for animal husbandry.

Non agricultural labor by women includes reed weaving (mats, etc.), commercial sewing, etc.

- Breakdown of labor by women:

  ① Agricultural labor: average of 195 days per year (paddy cultivation, upland crop cultivation, home vegetable gardening, animal husbandry, farm product marketing)

  ② Non-agricultural labor: commercial sewing (50% of households), reed weaving (50%), etc.

  ③ Type of preferred work: commercial sewing (40%), farm product marketing (40%), animal husbandry (30%)

(7) Problem Issues which need to be Addressed, and Mitigation Strategy for the Same

1) Improvement of paddy production

As their is a disproportionate occurrence of water shortage in certain areas at the field level, it is of utmost importance to improve the water usage system through rehabilitation of facilities and better water management by FOs.

Also, there is no existing system to effectively extend good quality seed to the FOs throughout the scheme area. In recent years, the AD has put effort into seed production, however it is further necessary to establish specific mechanisms to liaise with the cooperatives and FOs in this regard.

Fertilizer application in the scheme area is 80 kg/ha in the rainy season and 180 kg/ha in the dry season which is well below the 450 kg/ha recommended by the AD. To address this, it is important that the FOs actively secure cultivation loans. It is also necessary that guidance be provided in the optimum timing for fertilizer application.

2) Agricultural extension (water management technology, OFC introduction, etc.)

Under the present farmer support structure, there is not sufficient linkage between the activities of the ID, AD and ASCs. Due to lack of transportation, farmers cannot access the various local branch offices of the concerned agencies, and even when access is possible lack of staffing at the offices precludes effective consultation.

In order to improve paddy production and promote the introduction of OFCs, it is necessary that the ID, AD and ASCs function in a coordinated and unified manner, and that a structure for FO training and extension to farmers be established.

5.5 Farmer Organization and Institutional Aspects

5.5.1 Identification of FOs in the Schemes

(1) General

The formation of FOs in the study area started nearly 10 years ago under the INMAS and MANIS programs; most of the FOs have been registered in the early 1990's. The study area is covered by 129 FOs. in Muruthawela LB scheme Tract I area which however is not as yet incorporated into the Muruthawela system.

These FOs are distributed as follows.

Scheme	No. of FOs
Liyangastota scheme	
1) Walawe LB	30
2) Walawe RB	24
Sub total	54
Muruthawela Reservoir scheme	
1) Muruthawela LB	27
2) Urubokka Oya	22
3) Kirama Oya	22
Sub total	71
Badagiriya scheme	4
Total	129

At the beginning of the Feasibility Study all FO representatives were invited to WLAC meetings at which information was obtained from FOs about the condition of the scheme and the rehabilitation needs. Notes of WLAC meetings are given in the attached annex. To get a better understanding of the problem and to obtain the participation of FOs in the planning and design it was necessary to identify the FO areas of operation on ground. Based on recently prepared topographic maps (1/5,000 scale), therefore the study team with the assistance of ID staff demarcated the FO areas on maps. Thereafter, each FO area was visited on agreed dates and the study team met with FO representatives in the command area. The tentative demarcation was shown to the FOs and where necessary the boundaries were adjusted. In this way the present FO areas have been clearly identified.

(2) Methodology

The methodology adopted comprised of the following main components:

- Review of current national policy and programs for institutional development for irrigation management from secondary sources.

- Administering a questionnaire on all FOs through Project Staff to gather information through official channel.
- To build a component, on institutional development into the Participatory Rural Appraisal (PRA) exercise.
- To build into the baseline sample survey of individual farmers a section of the questionnaire devoted to FOs and institutions.
- From the data available to the agricultural specialist to gather information about the public sector institutions which interact with farmers and FOs
- To assess the performance of PMC as observers at PMC monthly meetings.
- Interviews with senior government officials, farmer leaders and other persons, at random on specific issues.

(3) National Policy

The current policy and program for strengthening institutions evolved over a period of nearly 2 decades. Promotion of FOs, acceptance of participatory management as a policy, setting up of PMC for INMAS and later for MANIS projects, system turnover, legal changes, and establishing linkages between public sector institutions and farmers, were all part of this evolutionary process. This process has been formulated, revised and evaluated in many official meetings, seminars and workshops. The government and irrigation agencies at present are firmly committed to a policy of participatory management. The program is reviewed regularly at the Central Co-ordinating Committee (CCC) on irrigation management and necessary changes made.

The current national policy with regards to participatory type management is summarized below:

- Participatory management is accepted as policy by Government with the objective of improving overall management and performance:
- To adopt the management principle of the village tanks in larger systems in the turnout areas, field channels and the distributory channels respectively;
- To develop village level institutions to provide for active farmer participation and involvement;
- To encourage farmers to manage the operation and maintenance of the distributory systems by contributing their labour and other resource. It is expected that such a development would enable the exemption of farmers from payment of O&M fees:
- That government funds continue to be made available to maintain and manage the Main System, namely the headworks and main canals; it is estimated that this would amount to approximately 50 percent of the total cost of maintenance;
- To provide a legal framework to recognize the rights and obligations of farmers' organizations through amendments to the Irrigation Ordinance and to the Agrarian Services Act, as required;

- To enact legislation to transfer, over a period of time, the ownership of the irrigation network below the D-channel level to farmer's organizations, when they are found to be ready to take on that responsibility.

(4) Assessment of FO Organizational Strength and Management Capacity

Information about the current status of FOs were gathered from 4 other sources.

- A questionnaire administered through agency staff to assess the institutional capacity of each FO.
- Participatory Rural Appraisal (PRA) sessions with some 30 representative FOs covering all aspects including institutional aspects.
- Perceptions of individual farmers about the FOs gathered under the baseline sample survey.
- Interviews with senior government officials and farmer leaders.

Data obtained through the above are as follows.

1) Questionnaire

The assessment of FOs was carried out by way of a questionnaire administered through the Project Management Staff (IMD and ID). The field officers have filled the questionnaire based on their knowledge, experience and judgment.

The information was analyzed by the team and six critical items were selected.

They are;

- Membership strength
- Participation level
- O&M & Support Services
- Physical Assets
- Financial Assets
- Management Capacity

The information gathered through the questionnaire was given marks having regard to the importance of particular items. Accordingly the marking system was adopted.

2) Participatory Rural Appraisal: (PRA)

These sessions were held with farmer groups of randomly selected FO areas, at a public place with in the FO area. 3 to 4 Team Members had semi-structured discussions with farmers about their institutional strength, irrigation and agricultural problems, socio-economic and environmental issues. Government officials were not present at these meetings. Because of the informal nature, farmers came out with frank views about their problems and aspirations.

The above sessions are summarized scheme-wise below

(i) Liyangastota Scheme

(Liyangastota LB sub-scheme)

Farmer Organizations met at PRA sessions

Walawe LB	*Name*	*FO No.*	*Attendance*	
			M	*F*
Ridiyagama unit	Neela	5	40	-
	Pubudu	7	12	-
Bolana unit	Gaminee	6	15	-
	Walawe	14	7	-
	Dimuthu	2	2	-

At these meetings farmers stated that due to system deterioration, their incomes and profits are low, which makes it difficult for them to contribute cash to develop the FO.

(Liyangastota RB sub-scheme)

Farmer Organizations met at PRA sessions

Walawe RB	*FO Name*	*FO No.*	*Attendance*	
			M	*F*
	Ihala Junsgama	4	11	-
	Samagi	1	18	-
	Hanganwagura	3	6	-
	Puhulyaya	16	18	-
	Puhujulgada	20	18	-
	Deniya perakum	30	16	-

A major problem identified by these FOs was the regular delay in cultivation due to delays in water issues for the RB as priority is always given to LB. This increases pest and other damages and depresses yields. Damage by stray cattle, boundary disputes are other problems they face. In the lower reaches drainage is a major problem.

(ii) Muruthawela Scheme

FOs met with under the PRA and numbers of attendees are as follows.

Farmer Organizations met at PRA sessions
Muruthawela Scheme

	Name	*FO No.*	*Attendance*	
			M	*F*
Muruthawela L.B	Tract I		23	-
	Tract II		25	-
	Tract II		24	-

At the PRA sessions farmers explained mostly about water scarcity, lack of land for households and for grazing cattle, damage by cattle and lack of co-operation from some FO members.

Farmer Organizations met at PRA sessions

	Name	FO No.	Attendance	
			M	F
Urubokka Oya	Udukiriwila	4	25	-
	Andupelena	12&13	14	-
	Ranna LB&RB	14&15	14	-
	Nugagahawewa	19	9	-

Farmers explained their problems about tenancy, high cost of agricultural inputs and difficulties about getting the FO members to cooperate.

Farmer Organizations met at PRA sessions

	Name	FO No.	Attendance	
			M	F
Kirama Oya	Ethpitiya	2	19	2
	Wauwa	7	20	3
	Kahawatta	14	5	-
	Pinodaya	15	5	-
	Liyannagedeniya	16	4	-

Farmers complained about inadequacy of irrigation water for Yala, and the poor condition of the irrigation system both of which they thought resulted in low yields and low incomes.

(iii) Badagiriya Scheme

Farmer Organizations met at PRA sessions
Badagiriya Scheme

Badagiriya	*Name*	*FO No.*	*Attendance*	
			M	*F*
	D.C. 1	1	20	5
	D.C. 2	2	14	4
	D.C. 3	3	10	-
	D.C. 4	4	14	-

Of the 4 FOs; those in DC 1 and DC 2 are working extremely well. They have substantial assets both physical and financial, have taken responsibility for O&M, undertaken ID contracts, and engage in supply of credit, inputs and marketing of produce. They also have plans to expand their activities including the installation of a rice mill.

FOs in DC 3 and 4 are not so strong, the former due to internal management problems and the latter due to inadequate income as they do not have irrigable land (which will be irrigable under the Project).

Overall the chairman of the SPMC provides excellent leadership and is able to conceptualize and plan a medium term development program.

3) Baseline Survey

The Baseline Sample Survey gathered views of individual farmer about their perception of FO activities in 2 specific areas:

- Existence and effectiveness of FOs
- Membership and participation level
- Activities: i.e. water management, input supplies, processing, storage and marketing

Results of the survey are given in Annex.

5.5.2 Assessment of Present Status

(1) General Findings

FO Area of Operations

- All FOs are formed according to hydrological boundaries as distinct from those formed according to administrative boundaries in unirrigated areas.
- The areas of most FOs and the average size is smaller than the national average of 500 ac. adopted in major irrigation schemes; hence many FOs are not viable.

Membership

- In all FOs more than 60% of farmers have enrolled as members. It was noted however that in many FOs members are not up to date in paying their membership fee. Also not all members are equally active.

Registration of FOs

- All FOs are registered under section 56A of the Agrarian Services Act., but very few are registered under 56B which enables them to engage in business and development activities. This is largely due to lack of awareness and inadequacy of resources with the DAS to cope with the demand. Most FOs however are registered with ID and IMD enabling them to undertake ID contracts and other business activities.

Regularity of Meetings

- The large majority of FOs hold regular meetings of the Committee to discuss and resolve ongoing problems and also hold annual general meetings as required by each constitution. Generally speaking business is transacted in a very transparent manner. Committee meetings are held at least once a month.

Operation and Maintenance

- Nearly all FOs co-operate in irrigation water distribution within their area and in seasonal maintenance - weeding and desilting of canals. This is done mostly through voluntary labour-shramadana - usually each member contributes 2 days of labour in a season. Since ID does not have adequate resources to maintain the system, this kind of O&M work by FOs is crucial to keep the system working. Hence most farmers co-operate with the FO in this activity.
- Many FOs undertake ID contracts for repairs to the canal system for which special concessions have been extended to FOs by government.
- FOs though they are expected to undertake other support service activities - e.g. input supply and marketing of produce, only a few FOs have the capacity to venture into such areas.

Assets - Physical and Financial

- The above mentioned activities are meant to enable FOs to build up their physical and financial assets which is quite critical for their sustainability. Yet only a few FOs have as yet organized themselves to build up their assets.

Management

- FOs since they have to develop as co-operate bodies, should have sound management system. Only very few FOs in the study area have good management capacity. This aspect needs much attention.
- In schemes which have PMC/SPMC FOs nominate representatives to be members of the PMC/SPMC.

At the PRA sessions the common problems identified by all FOs were

- the difficulties in improving irrigation efficiency due to the serious physical deterioration of the system
- need to restore canal and agricultural road reservations
- need to reduce input costs to increase profitability of agriculture.

(2) Assessment of FOs in each Scheme

1) Liyangastota Scheme

i) Walawe LB sub-scheme

In Walawe LB there are 24 FO with 194 FCG and a total membership of 1,698 equivalent to 95% of the total households in the area. FOs were formed in early 1992 as part of the INMAS program. Each FO is represented in the PMC which meets once a month to decide on operational matters. DCOs too meet once a month. The average size of an FO area is 185 ac, while four FO areas are below 100 ac which make them non-viable and difficult to manage. The irregularity of the canal system and their physical deterioration probably account for this situation.

It is noted that most FOs participate in water distribution and ID contracts while about 40% of FO do not participate actively in other voluntary services. 9 FOs have participated actively in trading activities like input supplies and marketing. This is very much related to the organizational strength and management capacity of the FOs. In Walawe LB 5 FO have physical assets, 6 have good financial assets and the management capacity of 10 can be considered as above average. There are several FOs which are very weak in all respects.

ii) Walawe RB sub-scheme

In Walawe RB there are 31 FOs with a total membership of 1,727 which is 85% of the total number of households. There is one area at the tail end of the scheme in Lunama unit for which a FO has not been established. It appears that farmers have not been able to reach agreement. At the time of rehabilitation steps should be taken to form a FO for this are a of 542 ac. There are 64 FCG in 15 FO; the others do not have FCG. This is a major shortcoming as FCG are essential to ensure good water management.

The FOs were initially established in 1990, but the project was taken under the MANIS program at a later stage.

Institutional development is done by a Project Manager (Additional Irrigation Engineer) appointed in 1995 with the assistance of ID staff-Technical Assistants and Work supervisors.

It is noted that the operational areas of each FO is quite small, the average size being 178 ac; which is far below the accepted norm and national average. In 13

FO the number of households is below 50 which makes the membership very low. The FOs nominate representatives to the PMC chaired by the Project Manager which meets once every two months for discussions on scheme management.

It is noted that most FOs are reported as participating in voluntary activities, but the level of participation is highly variable. About 65% of FOs participate in water distribution and ID contracts; however there seem to be a few FO which do not make any contribution. None of the FOs have any physical assets while 3 FO have modest financial assets. Management capacity of the majority of FOs is below average and participation in higher level organizations is few. This situation is due to the fact that the MANIS program was started only recently; further ID does not have adequate human and other resources as yet, for institutional development work.

2) Muruthawela Reservoir Scheme

i) Muruthawela LB Sub-scheme

There are 18 FO./DCO in Tracts II and III with a total membership of 1,342 representing 83% of all households. Altogether there are 294 FCG. The FOs were formed in 1987 under the INMAS program by an IMD Resident Project Manager (RPM) who was also chairman of the PMC. Tract I which has 9 FOs is not incorporated into the systems as yet: but they siphon off water for irrigation, based on an informal agreement with ID

In Tracts II and III FOs are formed according to DCO boundaries, yet due to the terrain of the land each DC area is quite small. The average size of the FO area therefore is 233 ac., the smallest being 79 ac and biggest 426 ac. The present division is all right for water management but for management and development purposes the units are too small.

The PMC meets once a month to decide on operational matters. FOs have participated actively in water management, crop diversification and system maintenance. Although FOs have informally taken over the maintenance of D canals they have declined to take over formally until such time the system is rehabilitated. FOs have undertaken ID contracts and provide tractor hire services to farmers through which they have built up modest reserves.

Current activity status of the FOs in the scheme areas is as follows.

- Membership level and participation is fairly uniform
- All FOs participate in water distribution and in ID contracts when available
- 4 out of the 18 FO have participated in input supplies and related marketing activities
- Only 1 FO has physical assets of 2 wheel tractor

- All FOs have reasonable financial assets and have assets above the average level. This is commendable for a scheme where incomes are very low.

- 60% of FO show above average management levels.

ii) Urubokka Oya Sub-scheme

There are 23 FOs with over 2,000 members. The FOs are organized under each tank or anicut; there are no FCG. In some cases each anicut may have 2 FOs one for LB and another for the RB. Hence each FO is independent; currently there is no PMC to coordinate the operations of the entire scheme. Average size of an FO is 234 ac.

Most operational decisions on the allocation of water to each anicut are taken by the Irrigation Engineer. Kanna meetings for seasonal allocation of water are held under the chairmanship of the Divisional Secretary for a cluster of 2-3 anicuts.

FOs manage the internal distribution of water, maintain the canals mainly through Shramadana and some of them undertake Irrigation Department contracts for maintenance works. There is no evidence of their participation in input supplies and marketing. The MANIS program was started only recently; hence the FOs are institutionally weak.

PRA sessions were held with 4 FO groups at which their institutional problems were discussed.

iii) Kirama Oya Sub-scheme

There are currently 22 FOs inclusive of Thangalu Welyaya area with over 2,000 members. The FOs are organized under each anicut or under each main canal of an anicut; there are no FCG. Each FO operates independently as there is no PMC. Average size of a FO is 169 ac.

Operational decisions for the allocation of water to each anicut are made by the IE. Kanna meetings for seasonal allocation of water are chaired by the Divisional Secretary. These Kanna meetings are organized for a cluster of 2 or 3 anicuts.

FOs manage the internal distribution of water, maintain the canals and undertake ID contracts for maintenance work. FOs are not institutionally strong enough to undertake other activities. PRA sessions were held with 5 FO groups at which their institutional problems were discussed.

3) Badagiriya Scheme

FOs in the Badagiriya scheme were formed as part of the institutional development program in the Kirindi Oya scheme. According to the survey 482 out of 552 (87%) farmers in the scheme are members of 4 FOs. They are represented in the Sub-

Project Committee for Badagiriya and in the PMC for Kirindi Oya. Badagiriya sub-project committee is chaired by a farmer.

These committees have been functioning for over 5 years. FOs have women members but not as committee members. The Sub-project committee meets at least once a month and other committees meet as often as is necessary.

Main functions of the FOs are water management, organization of Shramadana, handling ID contracts, input supplies and marketing. They plan to embark on post harvest processing, value added products and marketing. The FOs and SPMC have played an active role in project management, in determining water allocation and sharing, cropping patterns, maintenance programs and so forth. FOs have taken over the O&M of D canals downwards on an informal basis.

FO Representatives are also represented in higher level organizations like the District Agricultural Committee (DAC) and Div. Ag. Committee. The leaders have a good understanding of the issues, and maintain close rapport with public officials.

All scheme F's have physical and financial assets; DC 1, and 2 particularly have substantial assets built up from membership fees, ID contracts, savings through Shamadana and from trading activities.

The SPMC participates actively in the Kirindi Oya PMC. Despite the physical constraints the SPMC is facing, they have prepared many plans including strategies to overcome their present difficulties.

FO 1 and 2 have substantial assets and excellent management capacity while FO 3 and 4 have the potential for improvement.

5.5.3 Evaluation of FO Capacities

(1) Critical Items

The evaluation of FOs capacity is based an assessment of the following critical items.

They are;

- Membership strength
- Participation level
- O&M & Support Services
- Physical Asset
- Financial Assets
- Management Capacity

The information gathered through the questionnaire was given marks having regard to the importance of particular items. Accordingly the marking system was adopted. The scoring system is also given under each item.

(2) Marking Criteria

1) Membership

Percentage is arrived at from information of number of members divided by total number of farmers. Since a high level of membership is essential for the FO to be effective, minimum membership requirement is assessed as 70% and the maximum score for 100% membership is kept at 3.

Membership %	Points
90-100	3
80 - 89	2
70 - 79	1
below 70	0

2) Participation Level

This was assessed on the information gathered from questions 2(vii), 3, and 4(i) FOs reported under 4(i) as "Fair" receive 10 marks per item, while those reported as good receive 20 marks; those reported as unsatisfactory receive 0.

In addition FO who have office bearers in other recognized village level organizations under 2 (vii) get a bonus 5 marks.

Participation level however cannot be strictly quantified. It depends largely on the judgment of reporting officials. Hence the maximum score is kept at 3 points.

Participation Level	Points
60 and over	3
50 - 59	2
40 - 49	1
below 40	0

3) O&M and Support Services

This is based on question No.5(i) and (ii).

5(i) is given 25 marks i.e. 10 marks for water distribution and 15 for handling ID contracts.

Additional marks are given for activities under 5(ii), around 15 for each activity, as these activities reflect the organizational and financial strength of the FO The maximum score is fixed at 5 to reflect the importance of participating in O&M and Services.

O&M & Support Services	Points
60 and over	4
50 - 59	3
40 - 49	2
20 - 39	1
below 20	0

4) Physical Assets

Physical Assets are a clear indication of an FOs financial and management strength. Very few FOs have physical assets. Hence those who have assets such a 2 wheel tractor and trailer, or a building are given a minimum of 50 marks, while one FO which had modest assets e.g. building material was given 20. The maximum score is kept at 4.

Assets - Physical	Points
60 and over	4
50 - 59	3
40 - 49	2
20 - 39	1
below 20	0

5) Financial Assets

Financial assets indicate FOs management capacity and interest in long term viability. Marks were given on a sliding scale as follows:

Reserves	Points
Rs 2,000 ~ 10,000	10 ~ 25
Rs 10,000 to 50,000	25 ~ 75
over Rs100,000	100

Assets -Financial	Points
60 and over	5
50 - 59	4
40 - 49	3
30 - 39	2
25	1
below 25	0

6) Management Capacity

This assessment is based on several factors, obtained from question 6, 7, 8 and 9. Physical and financial assets, participation in higher level organizations measures taken to handle threats to the FO and self regulation mechanisms are indicators of good management. The reporting officers assessment is also taken into account. Accordingly marks were given on a sliding scale; 25 marks being the minimum required to the considered as a reasonable level of management. Those reported as "unsatisfactory" in the questionnaire are given 0 marks.

Management Capacity	Points
60 and over	5
50 - 59	4
40 - 49	3
30 - 39	2
25	1
below 25	0

(3) Overall Rating

Points have been weighted to reflect the importance of each set of activities for the overall performance of the FO

Overall Rating according to score

19	-	25	=	Very good
12	-	18	=	Good
6	-	11	=	Fair
0	-	5	=	Weak

The information is reliable though not perfect. Some allowance has to be made for the judgment of the reporting staff; nevertheless the assessment is scientific. The discussions at PRA sessions and WLAC meetings also confirm to a great extent the results of this assessment. To understand the real working of FOs however a more in-depth assessment by an independent team is recommended immediately prior to rehabilitation.

All FOs in Muruthawela L.B Scheme, Tract II and III, Liyangastota Scheme and Badagiriya Scheme were evaluated based on the above criteria; the result are given in the following pages.

Adequate information was not available for a proper evaluation of FOs in Muruthawela L.B, Tract I, Urubokka Oya Scheme and Kirama Oya Scheme.

A example of Questionnaire is shown in the next pages.

FEASIBILITY STUDY ON THE REHABILITATION OF IRRIGATION SYSTEMS - SOUTH SRI LANKA

BENCHMARK SURVEY - INSTITUTIONAL ASPECTS

1 (i) Name of Farmer Organization: Doa Sinhagiri Farmer Organizati

(ii) Divisional Sectaries Division: Agunakolapalassa.

(iii) GN Division: Dimbulgoda.

(iv) Irrigation Scheme: Muruthawela.

(v) Area of Authority of F.O: Track II

(vi) Whether F.O formed according to hydrological boundaries? Yes ✓ No 2

(vii) No. of F.C. groups [1][8]

(viii) No. of D.C.Os [ ][ ]

(ix) Date of Formation [87][07][29]

(x) Whether registered under AS Act Section 56 A / 56 B — Yes ✓ No 2

2 (i) Present No. of Members in F.O [8][1][ ][ ] 93%

(ii) Total No. of farmers within F.O. area? 87

(iii) Process followed in formation of F.O? according to hydrological boundaries

(iv) Role of I.O. (Catalyst): not I.O.s

(v) Process adopted for electing representatives and office bearers?
Open election 1
Secret Ballot 2
Consensus ✓3

(vi) Whether the F.O. members are office bearers of other village level organizations? Yes ✓1 No 2

(vii) If yes, please specify. "sanasa" (secretary)

3 (i) Frequency of meetings

	Weekly	Monthly	Quarterly	Half Yearly	Other (specify)
Main Organization	1	2	3	4	5 } according to needs
Committees	1	2	3	4	5 } according to needs
F.C. groups	1	2	3	4	5 } according to needs

(ii) Whether proceedings are documented? Yes ✓1 No 2

(iii) Whether by laws and regulations have been adopted? Yes 1 ✓ No 2

(iv) Other measures adopted to ensure transparency?

.....

.....

(v) Names of issues discussed and decisions made?

.....

.....

4 (i) Level of participation by farmers

	Good	Fair	Unsatisfactory
In group activities eg. Shramadana	1	2 ✓	3
In remunerative activities	1	2 ✓	3
In welfare activities	1	2 ✓	3
Conflict resolution	1	2 ✓	3
Contribution to F.O. activities in kind/cash/other	1	2 ✓	3

5 Activities undertaken by F.O

(i) Water related activities eg. water distribution, ID contracts ✓ ✓

(ii) Support services

a) Credit ✓

b) Input supplies

c) Marketing

d) Storage

e) Other (specify) .....

(iii) Other income generating activities (specify).

.....

.....

6 Representation in parallel and higher level organizations

	Yes	No
District Agricultural Committee	1	2
Divisional Agriculture Committee	1	2
Co-op Society/R.D.S	1	2
Banking	1	2
Marketing etc.	1	2

7 Assets Physical assets .....—.....

Financial Resources Rs. 4 0 0 0 0 0 0

8 (i) Measures adopted to handle internal and external threats? .....

.....

.....

(ii) Degree of success in self regulating to ensure sustainability and independence?

Good 1
Fair 2
Unsatisfactory 3

9 Management

	Excellent	Good	Fair	Unsatisfactory
Financial	1	2	3 ✓	4
Other assets	.....—.....			

10 P.M.C (i) Whether P.M.C has been formed and is functional? Yes ✓ No 2

(ii) Membership Farmer representatives 15

Officials 1

(iv) Issues discussed

	Yes	No
(a) Seasonal planning	✓	2
(a) Water management	✓	2
(b) Farmer participation	✓	2
(c) Income generating Activities	✓	2
(d) Conflict resolution	✓	2

Table 5.5.3-1 Evaluation of F.O.Organizational Strength and Management Capacity(1/3)

Liyangastota Scheme

No.and Name of F.O.		Membership %	F.O.Activities		Assets		Management Capacity	Rating
			Participation level	O&M Support Services	Phisycal	Financial		
WRB Scheme								
MAMADALA UNIT	1 SAMAGI	88	40	0	0	10	0	3
	2 WILE ELA	78	10	25	0	40	25	6
	3 HANGANWAGURA EAST	89	20	0	0	0	20	2
	4 IHALA JUNSGAMA	95	60	25	0	25	25	9
	5 PAHALA JUNSAGAMA	93	50	10	0	0	20	5
	6 DI-RBI	89	20	25	0	0	0	3
	7 DI/7-ELA	73	50	25	0	15	25	5
	8 DI/8-ELA	71	50	10	0	0	20	3
	9 DI/14,15	91	50	25	0	0	20	6
	10 MAIN CANAL CPO-8 TO CPO-11 AND D2 CANAL	42	50	25	0	25	25	5
	11 PARANAGAMA YAYA	100	60	25	0	20	25	8
	12&13 KABALDETTA YAYA	85	30	25	0	0	20	3
OLUWILA UNIT	14 ROTA WALA	83	40	25	0	20	20	4
	15 WALAWE WATTA-THREESINGNE	87	40	25	0	0	20	4
	16 PUHUL YAYA	100	30	10	0	0	10	3
	17 WATA ELA	83	30	25	0	10	20	4
	18 D4 SEETHAWAKA-ROTAWALA	86	40	25	0	10	20	4
	19 D3 WICKRAMANAYAKE ELA	96	40	25	0	10	10	5
	20 PUHUJULGODA (Wdibatanwila LB Canal)	100	40	0	0	10	10	4
	21 WELIPATANWILA RB	83	40	25	0	10	10	4
	22 OLUWILA RB THENNAKOONGAMA	76	40	20	0	0	0	2
	23 OLUWILA LB	85	30	25	0	0	0	3
LUNAMA UNIT	24 LUNAMA ELA	100	30	25	0	0	20	4
	25 PITTENI YAYA	83	50	25	0	0	25	6
	26 AKKARA 12 -YAYA	84	40	20	0	0	20	3
	27 ALUTH YAYA	95	50	25	0	0	20	6
	28 PINGAMA	86	30	25	0	0	20	4
	29 32 -ELA	90	30	25	0	0	20	4
	30 DENIYA PERAKUM	73	50	25	0	0	20	4
	31 ETHBATUWA - KIRIMETIYA	65	30	25	0	10	25	2
	NOT FORMED							
WLB Scheme								
RIDIYAGAMA UNIT	1 MAHANAGA	100	20	25	0	0	20	4
	2 PARAKUM	86	55	55	0	35	45	13
	3 GAJABA	91	0	10	0	10	0	3
	4 EKAMUTHU	90	20	25	0	10	0	4
	5 NEELA	94	55	65	50	35	60	20
	6 RUHUNU	95	10	10	0	0	0	3
	7 WEERA	100	30	40	50	60	60	20
	8 PUBUDU	94	0	20	0	0	0	3
BOLANA UNIT	1 SENANAYAKA	97	0	10	0	0	0	3
	2 WIJAYA	100	35	40	0	40	30	11
	3 PRAGATHI	90	50	25	0	0	25	7
	4 ISURU	91	0	25	0	0	0	4
	5 SAMAGI	91	50	40	0	0	0	8
	6 GAMINEE	70	0	15	0	10	0	1
	7 KAWANTISSA	95	55	40	0	20	60	13
	8 SARUKETHA	100	55	55	50	25	60	18
	9 EKSATH	100	0	20	0	10	20	3
	10 DIMUTHU	100	70	40	0	40	70	17
	11 AKBAR	100	0	10	0	0	0	3
	12 MAHASEN	100	30	25	20	20	50	9
	13 SUHADA	100	0	25	0	35	50	10
	14 WALAWE	93	60	65	50	35	60	20
	15 GOTABHAYA	92	0	20	0	20	0	3
	16 THERAPUTTHA	90	20	20	0	0	0	3

Table 5.5.3-1 Evaluation of F.O.Organizational Strength and Management Capacity(2/3)

Murathawela Reservoir Scheme

No.and Name of F.O.			Membership %	F.O.Activities		Assets		Management Capacity	Rating
				Participation level	O&M Support Services	Phisycal	Financial		
Murathawela I.B Scheme									
Tract I	1	WEERA No.1							
	2	WEERA No.2							
	3	BALASAKTHI							
	4	PUBUDO							
	5	EKSATH							
	6	PRIYAKARU							
	7	EKAMUTHU							
	8	KUDA VIVULA LIGHT							
	9	MEEGASARA							
Tract II	1	IHALA SAMAGI (D-1A)	87	50	25	0	25	25	7
	2	PAHALA PARAKUM (D-1B)	84	50	25	0	40	25	9
	3	THISARA (D-2,3)	97	50	25	0	50	30	12
	4	SAMAGI (D-4)	95	50	25	0	45	30	11
	5	GOUISANVIDANAYA (D-5)	86	50	25	0	25	25	7
	6	PARAKUM (D-6)	92	50	25	0	50	30	12
	7	SINGHEGIRI (D-7)	93	55	40	0	65	30	15
	8	EKSATH (D-8)	86	50	25	0	50	25	10
	9	D-9 (D-9)	83	50	25	0	65	30	12
Tract III	10	D-1 DCO (D-1)	74	60	25	0	25	50	10
	11	D-2 DCO (D-2)	77	55	40	0	35	30	10
	12	D-3 DCO (D-3)	89	55	25	0	25	25	7
	13	D-4 DCO (D-4)	72	55	25	0	45	30	9
	14	D-5 DCO (D-5)	69	55	25	0	25	25	5
	15	D-6 DCO (D-6)	75	50	25	0	50	30	10
	16	D-7 DCO (D-7)	78	50	40	0	65	30	13
	17	D-8 DCO (D-8)	73	70	25	0	35	25	8
	18	D-9 DCO (D-1,9)	79	50	40	50	20	35	11

Table 5.5.3-1 Evaluation of F.O.Organizational Strength and Management Capacity(3/3)

Badagiriya Scheme

No.and Name of F.O.	Membership %	F.O.Activities		Assets		Management Capacity	Rating
		Participation level	O&M Support Services	Phisycal	Financial		
1 Badagiriya No.1	100	80	65	100	100	65	25
2 Badagiriya No.2	70	55	40	40	100	60	18
3 Badagiriya No.3	100	55	25	0	100	30	11
4 Badagiriya No.4	100	55	20	0	25	25	7

5.5.4 Farmers' Perception of FO Performance

The baseline sample survey had a section on "FOs and farmer participation". The information gathered gives the individual farmer's perception of the performance of FOs on the following aspects.

Survey items in this regard are as follows:

- Existence and effectiveness of FOs
- Membership and Participation level.
- Activity level in
  - water management
  - input Supply
  - processing
  - storage
  - marketing

The findings are summarized in the tables in the next pages.

Table 5.5.4-1 Farmer's Perception of F.O. Performance

Liyangastota Scheme

Existence & Effectiveness	No.	%	Membership & Participation	No.	%	Activities	No.	%
Existence			Membership			Water Management		
Yes	78	91.8%	Yes	78	97.5%	Yes	30	38.5%
No	8	8.2%	No	8	2.5%	No	48	61.5%
Total	86	100.0%	Total	86	100.0%	Total	78	100.0%
Effectiveness			Participation			Input Supply		
Very effective	9	11.5%	Yes	66	82.5%	Yes	10	13.7%
Effective	39	50.0%	No	12	17.5%	No	63	86.3%
Not effective	30	38.5%			100.0%			
Total	78	100.0%	Total	78		Total	73	100.0%
						Processing		
						Yes	3	4.1%
						No	71	95.9%
						Total	74	100.0%
						Storage Activities		
						Yes	1	1.4%
						No	73	98.6%
						Not reported		
						Total	74	100.0%
						Marketing		
						Yes	3	3.9%
						No	73	96.1%
						Total	76	100.0%

Moruthawela Reservoir Scheme

Existence & Effectiveness	No.	%	Membership & Participation	No.	%	Activities	No.	%
Existence			Membership			Water Management		
Yes	186	93.5%	Yes	163	85.8%	Yes	78	47.9%
No	14	6.5%	No	37	14.2%	No	85	52.1%
Total	200	100.0%	Total	200	100.0%	Total	163	100.0%
Effectiveness			Participation			Input Supply		
Very effective	27	14.5%	Yes	145	82.4%	Yes	23	14.5%
Effective	104	56.0%	No	18	17.6%	No	136	85.5%
Not effective	55	29.5%		163	100.0%			
Total	186	100.0%	Total			Total	159	100.0%
						Processing		
						Yes	7	4.5%
						No	148	95.5%
						Total	155	100.0%
						Storage Activities		
						Yes	3	2.0%
						No	145	97.3%
						Not reported	1	0.7%
						Total	149	100.0%
						Marketing		
						Yes	8	5.2%
						No	147	94.8%
						Total	155	100.0%

Badagiriya Scheme

Existence & Effectiveness	No.	%	Membership & Participation	No.	%	Activities	No.	%
Existence			Membership			Water Management		
Yes	21	100.0%	Yes	19	90.5%	Yes	13	72.2%
No			No	2	9.5%	No	5	27.8%
Total	21	100.0%	Total	21	100.0%	Total	18	100.0%
Effectiveness			Participation			Input Supply		
Very effective	1	5.0%	Yes	18	94.7%	Yes	3	20.0%
Effective	14	66.0%	No	1	5.3%	No	12	80.0%
Not effective	6	29.0%						
Total	21	100.0%	Total	19	100.0%	Total	15	100.0%
						Processing		
						Yes	2	14.3%
						No	12	85.7%
						Total	14	100.0%
						Storage Activities		
						Yes	1	6.7%
						No	14	93.3%
						Not reported		
						Total	15	100.0%
						Marketing		
						Yes	2	13.3%
						No	13	86.7%
						Total	15	100.0%

(Source: Base Line Sample Surveys)

5.6 Operation and Maintenance

5.6.1 Study Method and Study Results

In order to assess the present situation with regards to operation and maintenance of the systems in the scheme areas, the following method was applied.

- Collect data from the regional Irrigation Offices and branches related to the scheme areas

- Directly sound from the farmers, through WLAC and FO (unit) meetings, the status of their participation in O/M activities, and their views and aspirations regarding the same.

- Conduct field reconnaissance, to assess actual conditions at the field level.

(1) O&M Cost

Outlays by the ID and IMD for O&M of the schemes (1993~1995) are indicated in Table 5.6.1-1.

Table 5.6.1-1 O&M Costs

DDI Hambantota (Unit : Rs)

Items \ Schemes		Muruthawela Reservoir Scheme			Liyangastota Scheme		Total
		L B	Urubokka	Kirama	Walawe L B	Walawe R B	
Operation	1993	247,115	387,167	317,613	380,364	369,005	1,701,264
	1994	254,619	404,286	333,811	443,171	418,634	1,854,521
	1995	293,357	459,537	376,949	452,726	439,219	2,021,788
Maintenance	1993	313,914	434,015	399,242	436,184	507,338	2,090,743
	1994	320,987	446,788	411,551	471,898	537,835	2,189,059
	1995	336,177	469,134	427,841	471,274	541,038	2,245,464
Construction Materials (Structures)	1993	98,138	123,964	123,964	126,836	166,463	639,365
	1994	105,838	133,690	133,690	136,787	179,524	689,529
	1995	105,825	133,674	133,674	136,771	179,502	689,446
Construction Materials (Roads)	1993	6,961	8,793	9,793	8,997	11,807	46,351
	1994	7,593	9,591	9,591	9,813	12,879	49,467
	1995	7,475	9,442	9,442	9,660	12,678	48,697
Improvements /Repairs	1993	207,124	205,361	920,535	175,000	394,658	4,902,678
	1994	501,462	283,876	332,732	315,982	527,561	1,961,613
	1995	1,532,726	116,000	382,576	347,092	660,832	3,039,226
General Charges	1993	193,649	244,609	244,609	250,276	328,469	1,261,612
	1994	194,802	246,065	246,065	251,766	330,425	1,269,123
	1995	174,438	220,343	220,343	225,448	295,884	1,136,456
Grand Total	1993	1,068,054	1,405,366	2,016,213	1,379,147	1,779,746	7,648,526
	1994	1,364,938	1,498,575	1,441,718	1,603,099	1,972,316	7,880,646
	1995	3,343,615	2,593,153	3,346,694	2,796,671	3,613,016	3,613,016

Source of Funds- I D& I MD

Breakdown of main items from the above table is as follows.

1) Operation

Labor costs, night watcher salaries, transportation costs, overtime allowances, etc.

2) Maintenance (labour)

ID staff salaries, allowances, etc.

Work content includes vegetation cutting and removal (including aquatic plants), sediment removal, repair of scoured and eroded areas along canals, repair of structures (foundation excavation, concrete works, masonry, fume pipe laying, stoplog manufacture, gravel spreading, etc.)

3) Construction materials

Cement, sand, metal works, crushed stone, gravel, paint materials, gunny sacks, stoplog timber, hume piping, rebar, gates, etc.

4) General charges

Salaries and allowances for supervisory personnel.

Travel costs for work supervisors and technical assistants, equipment operator and driver fees, fuel costs, vehicle repair costs, etc.

Responsibility for budget outlay lies with the IMD in the case of O&M costs for major irrigation schemes, and with the ID in the case of salaries for work supervisors and laborers.

Of the items in the above table, construction materials and improvement / repairs are aimed at deteriorated facilities (partial rehabilitation), it is considered that factoring in 50% general charges to the annual operation and maintenance cost is in line with actual conditions, and as such the O&M cost at present in the scheme areas is around Rs 500 / ha.

(2) O&M Capacity

Deployment of personnel from the regional Irrigation Office with jurisdiction over the scheme areas, ID staff and labor directly engaged in O&M works in the field is as shown in Table 5.6.1-2. In addition to the target schemes under this Project, ID staff are responsible for all irrigation projects in their area of jurisdiction; however, as can be seen from the table, ID permanent laborers are assigned to specific schemes, with responsibility for a set area of maintenance. All labor tasks are manually performed using various agricultural implements and are performed on an individual basis. As a result, removal of sediment from deep canals is virtually impossible, and vegetation

cutting works along canal slopes are inefficient. embankment slopes. Also, although ID laborers reside near or in the scheme areas, there are cases where the distance to work sites is far requiring much time either on bicycle or on foot, further reducing work efficiency.

(3) Farmer Participation in System O&M

In order to assess the status of farmer participation in system O&M, the Study Team interviewed farmers in the FOs with regards to such participation over the past year. Table 5.6.1-3 collates the said status of participation in the Liyangastota LB, RB, Urubokka Oya and Kirama Oya schemes.

In some areas (25% of the total area), the participation by farmers takes the form of contract with the ID under which the FOs receive payment for construction cost from the ID; however, this income goes to the FO and not the individual farmer.

Farmer participation is high and with farmers carrying out O&M works of 1 week or more during a planting seasons in those areas where water carrying capacity of canals has severely deteriorated due sedimentation, etc. The fact that the ID has given priority to these areas for contract of O&M works to the farmers has contributed to O&M efficiency.

Table 5.6.1-2 Present Deployment of ID Staff

Scheme	Area (ha)	Irrigation Office (IO)	ID Personnel					Permanent Laborers for O/M				ha/Laborer
			IE	Add. IE	DA	TAA	WSS	Head Works	Anicut	Canal	Total	
Muruthawela		IO Wiraketiya	1	1	1	7	8					
LB	1,700.1							3		9	12	141.2
Urubokka Oya	2,261.9								12	4	16	141.4
Kirama Oya	1,510.5							2	15		17	88.9
Total	5,472.5										45	121.6
Liyangastota		IO Ambalantota	1	1	1	4	4					
LB	2,553.4									18	18	141.9
RB	2,454									18	18	136.3
Total	5,007.4										36	139.1
Badagiriya	686.0	CRE	1		1	3	1			6	6	114.3
Total	686.0										6	

CRE : Chief Resident Engineer
RE : Resident Engineer
IE : Irrigation Engineer
Add. IE : Additional Irrigation Engineer
DA : Divisional Assistant (Payment & Accounts)
TAA : Technical Assistants
WSS : Work Supervisors (Permanent)

Table 5.6.1-3 Farmers' contribution to Maintenance Works of Liyangastota Scheme(1/2)

No.	Name of F.OO	House-holds	Acreage	Farmer No.s of participated Family	Working times per season		Working days per season	Works done by F.OO (DC, FC, Drainage)
					Yala	Maha		
Liyangastota WRB								
	MAMADALA UNIT							
1	SAMAGI	72	244	72	2	2	0.5	FC, desilting, jingle clearing
2	WILE ELA	65	180	64	2	2	1	do
3	HANGANWAGURA EAST	150	160	100	1	1	2~3	Clearing, desilting of FC and part of DC
4	IHALA JUNSGAMA	207	315	100	2	2	10	Disilting and clearing of drainage, DC and FC
5	PAHALA JUNSAGAMA	28	148	30	2	2	4~5	do
6	D1-RB1	80	110	100	2	2	2	Desilting and clearing of DC and FC
7	D1/7-ELA	35	100	35	2	2	1	Desilting, Clearing of FC and part of DC
8	D1/8-ELA	50	102	50	2(4)	2(4)	1	DC, FC clearing, desilting and weeding
9	D1/14,15	32	66	10~15	2	2	3~4	Clearing and desilting of DC, FC, and drainage
10	MAIN CANAL CPO-8 TO CPO-11 AND D2 CANAL	200	375	150	2	2	5	Clearing and desilting of DC, FC/ Weeding of Drainage
11	PARANAGAMA YAYA	68	119	68	2	2	2	Desilting and clearing of FC and Drainage
12 +13	KABALDETTA YAYA	100	250	100	1	1	2~3	do
	OLUWILA UNIT							
14	ROTA WALA	200	275	100	1	1	2~3	Desilting and clearing of FC
15	WALAWE WATTA-THREESINGNE	17	51	17	2	2	6	Desilting clearing and earth work of FC
16	PUHUL YAYA	35	90	30	2	2	7	Desilting and bund repairing of FC
17	WATA ELA	60	180	40~50	2~3	2~3	7	Repairing bunds, desilting and clearing of FC and Wata Ela
18	D4 SEETHAWAKA-ROTAWALA	75	180	75	3	3	1.5	Desilting and clearing of FC and DC
19	D3 WICKRAMANAYAKE ELA	63	133	47	1	1	5	Desilting and clearing of FC and Drainage
20	PUHUJULGODA (Wdibatanwila LB Canal)	43	302	43	1	1	5	Desilting and clearing of FC and LB Main
21	WELIPATANWILA RB	50	200	30	1	1	1	Desilting and clearing of FC, DC and Drainage Canal
22	OLUWILA RB THENNAKOONGAMA	50	85	20	2	2	2~3	Desilting and clearing of FC and DC
23	OLUWILA LB	100	250	90	2	2	2	do
	LUNAMA UNIT							
24	LUNAMA ELA	105	225	105	1	1	7	Desilting and clearing of FC and DC/ Tank dredging and drainage clearing
25	PITTENI YAYA	125	300	75	1	1	15	Jungle clearing of DC and clearing and desilting of FC
26	AKKARA 12 YAYA	50	125	90	1	1	6~8	Desilting of FC and DC
27	ALUTH YAYA	80	121	76	2	2	3	Desilting and clearing of FC, DC and drainage
28	PINGAMA	95	137	50	1	1	15	do
29	32 -ELA	70	157	10	1	1	2	n.a.
30	DENIYA PERAKUM	300	300	150	FC 2 MC 1	2 1	7	Desilting and clearing of FC and MC
31	ETHBATUWA - KIRIMETIYA	60	100	60	4~5	4~5	3~4	do
Liyangastota WLB								
	RIDIYAGAMA UNIT							
1	MAHANGA	60	190	50	2	2	3	Shrub clearing, Closing leakage of Canal
2	PARAKUM	150	315	40	2	2	2	do
3	GAJABA	130	260	60	3	3	1	Clearing and repairing, Drainage clearing
4	EKAMUTHU	150	125	20	2	2	2	Desilting, Shrub clearing, Closing of leaking
5	NEELA	75	515	25	2	2	3	Desilting, Shrub clearing
6	RUHUNU	100	300	30	2	2	2	do
7	WEERA	88	280	25	2	2	2	Clearing Canal, Canal bund and Farm road repairing
8	PUBUDU	80	211	40	2	2	1	Desilting, Shrub clearing
	BOLANA UNIT							
1	SENANAYAKA	66	130	8	1	1	3	Deeping and widing of Drainage Canal
2	WIJAYA	65	247	22~25	2	2	7	Clearing Channel and grass cutting
3	PRAGATHI	48	156	48	2	2	1~2	FC clearing, Earth work, Drainage clearing
4	ISURU	85	460	85	2	2	1~2	Desilting, grass cutting
5	SAMAGI	100	200	75	2	2	1	FC,DC and Drainage clearing Earth work, concerete work
6	GAMINEE	120	350	90	2	2	2~3	Clearing FC and Drainage
7	KAWANTISSA	228	785	228	2	2	1~2	Disilting, Clearing weeds
8	SARUKETHA	350	426	350	2	2	7	Closing of leakage and earth work
9	EKSATH	35	100	28	1(2)	1(2)	2~3	Desilting, Clearing weeds
10	DIMUTHU	400	360	25~30	2	2	7~8	do
11	AKBAR	25	60	20	1	1	1	Clearing, Disilting of Drainage and FC
12	MAHASEN	37	85	37	2	2	2~3	Desilting, Bund repairing and grass cutting
13	SUHADA	250	650	250	2	2	7	Desilting, Clearing weeds, Repairing weeds
14	WALAWE	380	630	380	2	2	1~2	Repairing, Disilting of FC Drainage Canal
15	GOTABHAYA	48	75	n.a.	n.a.	n.a.	n.a.	
16	THERAPUTTHA	40	165	40	1	1	6~7	Disilting, Weeds clearing

Survey in 1996, Feb. by JICA Team

Table 5.6.1-3 Farmers' Contribution to Maintenance Works of Muruthawela Reservoir Scheme(2/2)

No.	Name of F.OO	House-holds	Acreage	Nos. of participated Family	Working times per season		Working days per season	Works done by F.OO
					Yala	Maha		
LB Main, Tract II & III								
	TRACT II							
1	IHALA SAMAQI	52	102	47	1	-	10	Weeding, Disilting and properly Channel bunds in DC and FC
2	PAHALA PARAKUM	52	115	31	2	-	10	Weeding, Disilting and repairs in DC bunds
3	THISARA	62	130	16	1	-	5	Weeding, Disilting and filling in covers of DC and FC
4	SAMAGI	402	124	161	2	-	4	Bed clearing and reforming of beside structure on DC and FC
5	GOUISANVIDANAYA	30	68	18	1	-	3	Weeding, Disilting and properly bund forming of DC and FC
6	PARAKUM	60	180	30	2	-	10	do
7	SINGHEGIRI	92	184	37	1	-	7	do
8	EKSATH	105	120	84	1	-	15	do
9	D-9	174	348	157	1	-	10	do
	TRACT III							
10	D-1 DCO	64	128	32	-	2	4~5	Desilting and weeding of DC
11	D-2 DCO	146	294	146	-	1	2	Desilting and shrub clearing of DC
12	D-3 DCO	76	150	38	-	1~2	2~4	Shrub clearing and desilting of DC
13	D-4 DCO	48	96	4	-	7	7	do
14	D-5 DCO	35	70	35	-	1	1	Shrub clearing, desilting and repairing bunds of DC
15	D-6 DCO	112	336	39	-	4	4	do
16	D-7 DCO	72	144	72	-	1	1	do
17	D-8 DCO	93	210	93	-	2	2	do
18	D-9 DCO	260	560	260	-	3	3	do
Urubokka Oya								
	URUBOKKA							
1	RALUWA NAWARATHE RB	100	180	100	1	1	7	Desilting and clearing on Main and FC
2	KINCHIGUNE LB	160	400	160	1	1	5	do
3	UDUKILIWILA LB (Halmilla Ela)	300	400	300	1	1	7	Desilting, clearing and repairs on FC only
4	UDUKILIWILA RB (Marakadaharthis)	100	202	100	1	1	7	Bed clearing, repairs Chl. bund on DC and FC
7	WAKAMULLA LB	69	120	30~40	1	1	1~2	Desilting and clearing from 2nd Mile on Main and FC
8	WAKAMULLA RB	500	720	35~40	1	1	2~3	do
9	HUNNAKUMBURA LB/RB	300	400	50	1	1	5	Desilting, clearing and earth work for leaking on Main
10	HAKUREWALA LB	200	640	200	1	1	2~3	Desilting and clearing from 2nd Mile on Main and FC
11	HAKUREWALA RB	360	470	360	1	1	15	do
12	ANDUPELENA LB	250	750	250	1	1	4~5	do
13	ANDUPELENA RB	65	190	60	2	2	4~5	Desilting and clearing on Main and FC
14	RANNA LB	110	400	110	1	1	3	do
15	RANNA RB	200	475	150	2	2	2	do
	HIGH LEVEL							
5	UDUKILIWILA LOW (Mandaraduwa)	75	150	75	1	1	5	Clearing and repairing on Main and FC
6	UDUKILIWILA HIGH (Mamadadumulawa)	19	34	n.a.	1	1	0.5	Clearing and desilting on Main and FC
16 -a	POTHU							
16 -b	THALAKANATHU YAYA	150	111	75	1	1	1	n.a.
17	KADAWALA YAYA							
18	ETHUNNSWQALA	26	56	26	2	2	3	Tank clearing, High Level and FC repairs
19 -a	NUGAGAHA WEWA							
19 -b	GALWALA YAYA	72	90	36	1	1	2	Tank bund clearing, desilting and clearing of FC and High Level Canal
19 -c	KULASINGEWELA							
20	RANASHINHAGAMA	16	58	16	1	1	1	do
21	ROTE YAYA	300	220	25	1	1	2	Desilting and clearing on FC
22	PATTIYAPOLA MAHA	350	700	210	1	1	1	Clearing and repairing Chl. bunds of FC, High Level Chl. and Tank
23	NETOLPITIYA							
Kirama Oya								
1	HAMBUMANDIYA LB	450	345	450	1	1	10	Desilting, weeding and small repairing on Main Canal and FC
2	ETHPITIYA LB	400	250	400	1	1	10	do
3	UDA DEBARAWA RB	386	141	290	1	1	15	do
4	ARACHCHI LB	150	200	150	1	1	10	do
5	ARACHCHI RB	200	300	200	1	1	10	do
6	WIJERATHNE PUBUDU	250	185	125	1	1	10	do
7	WAUWA	500	215	375	1	1	7	do
8	OKEWELA LB	60	160	60	1	1	7	Clearing and desilting on Main and FC
9	OKEWELA RB	90	100	90	1	1	7	do
10	PANSALA (LB/RB) Dewamedimeya	125	150	16	1	1	2	do
11	PATTIYAWELA (LB/RB) Dammulla Yaya	200	90	16	1	1	3~4	Clearing Main and desilting on Main
12	WARAKAWARA RB (Proposed)	133	286	27	1	1	3~4	Clearing and desilting on Main and FC
13	UNNANSEGE LB	150	150	26	1	1	2	do
14	KAHAWATTE LB	75	220	75	2	2	1	Clearing and desilting on FC, Drain. Chl.
15	PINODA	60	150	12	1	1	5~6	Clearing and desilting on FC
16	LIYANAGEDENIYA	55	230	10	1	1	2~4	Clearing and desilting on Main and FC
17	NALAGAMA LB	35	76	35	1	1	1~2	do
18	NALAGAMA RB	150	350	125	1	1	7	do
19	DARANDA EKSATH	150	350	150	1	1	2	do
20	WILE	60	185	60	1	1	2	do
21	MAHA	40	110	15	1	1	1	do
22	DANKETIYA	400	610	20	1	1	1	do

Survey in 1996, Feb. by JICA Team

5.6.2 Assessment of Present Status of Operation and Maintenance

(1) Field Reconnaissance

Field reconnaissance was carried out to assess the present status of operation and maintenance in the scheme areas. Conditions were evaluated according to the following criteria:

Level	Condition of maintenance	Evaluation criteria
1	Excellent	The system has been been maintained at a level commensurate with the original project design, and beneficary farmers are satisfied with the present situation.
2	Good	The system functions well. Vegetation and sediment removal is done for 70~80% of the canal system. The majority of farmers are satisfied with the
3	Adequate	The system functions at a level that basically causes no damage to crops. Vegetation and sediment removal is done for 40~50% of the canal system. One in 3 farmers is dissatisified with the level of operation of the system.
4	Poor	System operation is inefficient, and in some cases crop damage occurs as a result. Maintenance is carried out only in limited areas, and almost all farmers are dissatisfied with the current level of operation.
5	Very poor	The system is close to non-functional

Detailed assessment according to on foot reconnaissance of the scheme areas is in accordance with the results of system deterioration, function, and capacity survey (section 5.3 of this Report).

(2) Farmer Opinion

In the course of the WLAC meetings, discussion was held with the representatives of the farmer organizations, and based on the system diagrams and field reconnaissance, it was concluded that with regards to present system function, status of canal sedimentation, O&M etc. the 3 target schemes all fall into the "poor" category.

5.7 Environment

On the basis of findings of IEE study undertaken during Phase I, and the issues were cited by the Hambantota District Environmental Committee as of particular concern in terms of negative environmental impact from the 3 target schemes, problem points are raised as follows.

1) Water borne diseases
2) Impact from agro-chemical use

Of the above, 1) water borne diseases endemic to Dry Zone, and 2) chemical uses for agricultural purposes are considered to be serious problems district-wide by the Hambantota DEA, and the deputy director of the Southern Provincial Health Services and the Deputy Director, Agricultural, Hambantota participate as members in the committee expressly set up to deal with these issues. Incidences of disease and countermeasures to mitigate the same are discussed below.

5.7.1 Malaria

(1) Anti-malaria Campaign

Incidence of malaria in Sri Lanka is not simply a sanitation and health problem, but has socio-economic ramifications as well. Since around 1977, malathion has been sprayed to control the problem with a short-term effect of having reduced the amount of outbreak of malaria, however, with growing mosquito resistance to the chemical agent, there has again been an increase in malaria patients. According to blood film testing in 1994 of 1.37 million persons, 270,000 tested positive for malarial infection (20%). Although incidence of the disease is particularly high in the northern Dry Zone, Hambantota district showed a high number of infected persons in the area extending form the Lunugamwehera reservoir to Tissa and Kataragama.

Since 1989, an anti-malaria campaign has been pursued including a project to wipe out malaria, monitor new outbreaks, and educate the population regarding the disease. In 1993, under the WHO world-wide strategy to suppress malaria, the measures to control the disease in the country were modified to include the following:

- Insecticide spraying indoors (50% solution of Malathion)
- Blood film survey in the field
- Self protection by insecticide impregnation of bed nets.
- Education in health and sanitation
- A program to wipe out malaria with citizen participation

In Hambantota district, there is an emergency malaria office established at the Divisional Director's Office of Health Services (DDHS) at Ambalantota city which

carries out various measures to control malaria, including early detection of patients still in the latency stage of infection, spraying to kill mosquitoes and prevent larvae propagation, etc. Patients suffering from the disease are treated at the regional hospital.

Trend in number of patients (visiting hospitals) suffering from malaria in Hambantota district has essentially been horizontal as follows in recent years:

1991	1992	1993	1994
2,364	2,018	1,464	1,576 (1 death)

Also, according to the base line survey of the 3 scheme areas (Table 3-7-1), malaria is the most common disease suffered by farmers. Incidence of the disease in Badagiriya is twice that for the Muruthawela Reservoir and Liyangastota scheme areas.

	Muruthawela	Liyangastota	Badagiriya	Total
Malaria patients:	44	19	9	72
Ratio	30.0%	35.2%	75.0%	34.1% (1995)

(2) Example of Countermeasures taken in Tissa

Numbers of blood film test performed by the Sanitation Bureau at Tissamaharama adjacent to the east of the Badagiriya scheme area, and number of persons identified as infected with malaria are given below. Although the number of infected persons in 1995 shows a large increase over 1994, however, this is attributed to (i) increase in numbers of blood film tests and better identification of patients still in the incubation stage of the disease as a result of field survey works, and (ii) weather conditions occurring in the first half of 1995. Number of persons testing positive in the latter part of 1995 dropped to a level close to that of 1994.

	1993	1994	1995
Nos. of blood film test	6,966 persons	9,869 persons	20,526 persons
Positive (PV + PF)	853	1,580	6,186
No. of PV positive	663	1,242	4,730
No. of PF positive	190	338	1,456
Ratio	12.2 %	16.0 %	30.1 %

note: PV and PF are species of mosquito

Measures against malaria being taken in Tissamaharama are as follows.

- Anti-malaria program: distribution of pamphlets and education program on malaria targeted at all citizens

- Spray program: regular insecticide spraying by professional spray teams
- Fish release into tanks and still water bodies
- Blood film testing
- Maintenance flow release into canals: to prevent stagnant pools in canals, however, this is not possible in the Badagiriya scheme area due to water shortage
- Promotion of mosquito coil and mosquito net use in the home
- Promotion of livestock raising: avoidance of infection by the presence of livestock

5.7.2 Use of Agro-chemicals and Chemical Fertilizers

(1) IPM

Excessive use of agro-chemicals and chemical fertilizers not only directly affects humans, but also contaminates the overall basin and impacts adversely on the eco-system. The issue of controlling the use of these substances is taken up under the national environmental action plan. As one part of this action plan, the IPC (Integrated Pest Control) program was begun in 1984 to promote the proper timing and application amounts for agro-chemical use; however it was temporarily halted in 1988 due to ethnic disturbance. It was revived again in 1994 as the IPM (Integrated Pest Management) program. Behind the program, in addition to environmental concerns, is the desire to reduce farming costs, and produce chemical and additive free food products.

In the case of Hambantota district which is particularly dependent on the use of agro-chemicals, the following problems are cited, giving impetus to the need to promote the IPM program.

1) Population increase and the limit to cultivable land.
2) Farmers apply amounts of agro-chemicals and fertilizer far in excess of those recommended by the government.
3) Increase in cost of agro-chemicals.
4) Increased subsidies for the import of agro-chemicals.
5) Crop production cost increases as a result of indiscriminate agro-chemical use.
6) Danger to the health of the general population due to indiscriminate agro-chemical use.

Background of the IPM program in Hambantota district is as follows.

1994	First IPM field school (targeted nation-wide)	30 participants (1 per district) from all over the country (including 1 from Hambantota). Demo-fields at 6 locations by the AD In-service Training Institute at Angunakorapressa.
1995 Yala season	Field school held in Hambantota district	Participant in the previous year's school acts as instructor for 10 participants from the district. Held at 2 locations: Liyangastota and Kirama Oya.
1995~1996 Maha season	Training demonstration at 6 locations in the district	Held at Urubokka oya, Kirama oya (2 locations), Urubokka HC, Weerawila, Liyangastota with the participation in each case of 20~25 farmers. FAO extends Rs 8,000 of funding for the program at each
1996 (projected)	Training demonstration planned for 34 locations	Cost per demo is Rs 1,000 to be covered by subsidy from the provincial government. The 34 locations have not yet been selected; however, priority will be given to locations where use of insecticides is greatest, access is good and good farmer participation can be expected. Participation is voluntary.

Under the IPM demonstration program, 1 time each week for 1 planting seasons farmers collect insects by net, learn to recognize beneficial and harmful varieties, record the weather conditions on that day. When beneficial varieties are in more abundance than harmful varieties, farmers are taught not to apply insecticide, and conversely, to apply appropriate amounts of insecticide when harmful varieties are more in abundance.

Under the program, farmers empirically learn to apply insecticide on the basis of the balance between beneficial and harmful varieties of insect.

Staff from the Agricultural Office are present at the demonstration and monitor the results thereof. Under the Hambantota program there has been success in reducing 50% of the insecticide use by participant farmers. Crop yields have been good, and their is strong desire among farmers for access to the training. It is planned to extend the program throughout the entire district.

Since the field school in 1994, other districts have not carried out the demonstration program, and the case in Hambantota has been well acclaimed as a pioneering example of the potential success of the IPM program.

(2) Use of Paddy Straw

Distribution of paddy straw in fields during tilling and mixing with the soil is a traditional method which can reduce the use of weedicide by preventing weed propagation. Decomposed straw also adds nutrients to the soil. Although this practice has steadily been abandoned with expanded use of agro-chemicals and chemical fertilizers in modern years, benefits of straw use are being reexamined in light of current heightened concern about quality of life and conservation of the natural environment.