7 ECONOMIC EVALUATION

7.1 Economic Cost

(1) Basic Conditions

Basic conditions for economic evaluation including the hydropower development are made as same manner of without the hydropower development.

(2) Economic Benefit

Economic benefits for the Project with small-scaled power generation, are composed of the benefit by power generation and the incremental benefit due to increase of crop production through irrigation. The average revenue per KWH is estimated at US$ 0.0795 which is derived from the Feasibility Study on Small-Scale Hydroelectric Power Development Project in Kilimanjaro Region in 1989 by JICA. The estimated total revenue from No.1 and No.2 Hydropower plants are US$539 thousand and US$1,631 thousand per year, respectively

(3) Economic Cost

The economic cost with the hydropower development is estimated and summarized as follows:

Economic Cost

Area	Direct Cost	O&M Equipment	Engineering Service	Administration Cost	Physical Contingency	Total
(a) Project Whole Area	33,559	1,000	5,500	1,020	4,108	45,187
(b) Existing Lower Moshi Area	11,685	500	2,516	467	1,517	16,685
(c) Expanded & Extension Area	21,874	500	2,984	553	2,591	28,502

7.2 Economic Evaluation

(1) Economic Internal Rate of Return

The economic internal rate of return is calculated on the basis of the flows of economic benefits and costs under the hydropower development and result is as follows:

Economic Internal Rate of Return (EIRR)

Case	Project Area	EIRR(%)
(a) Case-1 :	Whole Project Area(4,700ha)	15.5
(b) Case-2 :	Existing Lower Moshi Area(2,150ha)	19.2
(c) Case-3 :	Expanded and Extension Area(2,250ha)	13.2

The evaluation results show that the development plan with hydropower is economically feasible and even EIRR for the Expanded Area and New Extension Area combined show still feasible value with 13.2%.

(2) Sensitivity Analysis

A sensitivity analysis for each area individually and for the whole area is made to evaluate the soundness of the project against unexpected adverse changes in future for the following cases:

(a) If the project cost runs over the price and physical contingencies by 10%

(b) If the market prices of the crops decrease by 10%

(c) Combination of (a) and (b)

The effects of these changes in EIRR are summarized as follows:

Result of Sensitivity Analysis

Analysis Case	Analysis Case	Existing Lower Moshi Area	Expanded and Extension Area	Whole Project Area
(a) Case1:	10% increase of cost	17.6	12.2	14.2
(b) Case2:	10% decrease of cost	17.4	12.1	14.1
(c) Case3:	Combination of (a) and (b)	15.9	11.1	12.9

The results indicate that the Project even under the most sever case of cost increase and benefit decrease, is still viable.

7.3 Financial Evaluation

(1) Cash Flow Statement Analysis

The financial sustainability of the Project was assessed using a cash flow statement analysis which presents the financial soundness of the Project by comparing all revenues collected from the benificial farmers with the fund requirement for the project operation. For the assessment, the following assumptions have been applied:

(a) The capital funds of the project works and tractor hiring services will be arranged by the Government of Tanzania.

(b) The cash flow statement analysis was prepared from the viewpoint of CHAWAMPU.

(c) Revenue sources for the project operation are:1) annual water charge of Tsh.62,000/ha (US$ 100) in the 1st stage and Tsh.55,800/ha (US$ 90), and 2) tractor hiring services fees of Tsh.50,000/ha for paddy cultivation and Tsh.12,500/ha for alfalfal cultivation. The water charge consists of replacement cost and O & M cost of the project facilities including O & M equipment, administration cost, etc. as shown in Clause 6.4. The tractor hiring service fees includes the O & M cost and replacement cost of tractors.

On the basis of these assumptions, the cash flow statement of the project implementation and operation stages was tabulated as shown in Table M.7.1. The results of the analysis indicated that the anticipated revenues collected from the beneficial farmers would be able to provide sufficient funds for O & M cost and replacement cost of O & M equipment and tractors for the Project, and thus the financial sustainability of the Project for CHAWAMPU.

(2) Farm Budget Analysis and Capacity to Pay

The payment capacity is defined as the ability of the beneficiary farmers to bear the expenses required for operation and maintenance of the Project facilities. The analysis results for respective cases are summarised in the following table.

Results of Farm Budget Analysis

(Unit:Tsh.)

Description	Ex Lower Moshi Project Area			Expanded Area			New Extension Area		
	Marginal 0.5 ha	Small 1.5 ha	Medium 3.0 ha	Marginal 0.5 ha	Small 1.5 ha	Medium 3.0 ha	Marginal 0.5 ha	Small 1.5 ha	Medium 3.0 ha
(1) Income Structure									
(a) Net farm crop income									
- Gross farm income	885,500	2,656,500	5,313,000	819,900	2,459,600	4,919,300	885,500	2,656,500	5,313,000
- Production cost*	237,600	712,800	1,425,500	231,200	693,600	1,387,300	237,600	712,800	1,425,500
- Net farm crop income	647,900	1,943,700	3,887,500	588,700	1,766,000	3,532,000	647,900	1,943,700	3,887,500
(b) Livestock income	99,600	83,000	66,400	213,600	178,000	142,400	51,600	43,000	34,400
(c) Homestead income	12,500	12,500	12,500	61,000	61,000	61,000	35,000	35,000	35,000
(d) Non-farm income	290,000	130,000	0	250,000	221,000	0	290,000	153,000	0
(e) Household income	1,050,000	2,169,200	3,966,400	1,113,300	2,226,000	3,735,400	1,024,500	2,174,700	3,956,900
(2) Living Expenditure	854,000	915,800	1,089,900	950,000	1,078,000	1,293,600	872,000	1,003,000	1,203,600
(3) Net Reserve	196,000	1,253,400	2,876,500	163,600	1,148,000	2,441,800	152,500	1,171,700	2,753,300
- in US$	316	2,022	4,640	263	1,852	3,938	246	1,890	4,441
(4) Water Charge	31,000	93,000	186,000	31,000	93,000	186,000	31,000	93,000	186,000
- in US$	50	150	300	50	150	300	50	150	300
(5) Payment Ratio(4/5)	16 %	7 %	6 %	19 %	8 %	8 %	20 %	8 %	7 %
(6) Balance	165,000	1,160,400	2,690,500	132,600	1,055,000	2,255,800	121,500	1,078,700	2,567,300
- in US$	266	1,872	4,340	214	1,702	3,638	196	1,740	4,141

**: Production cost consists of farm inputs cost, chemicals cost, labour cost, O&M costs of tractors.*

The analysis result shows that the payment ratio ranges from 6 % to 20% of net reserve, and comes to about 8 % in average as a whole since the average farm size in the whole Project Area is about 1.5 ha. From this analysis, it is apparent that the water charge including O & M cost could be covered even by the marginal farmers and would not represent a heavy financial burden.

As mentioned in Item (2) of Sub-section 7.2 of this ANNEX, the total revenue from both Hydro-power Stations is estimated at US$ 2,170,000/year (Tsh.1,345 million/year). It is also possible that not only the water charge (Tsh.262 million/year), but also the tractor hiring services fee (Tsh.372 million/year) will be covered by this revenue can cover.

Tables

Table M.6.1 Construction Costs of No.1 Power Station

No	Work Description	Foreign Currency (US $)	Local Currency (Tsh.)	Equivalent (US $)
1	Preparatory Works	20,000	3,200,000	25,161
2	Earth Works	94,684	11,513,200	113,254
3	Structure Works	292,973	52,653,191	377,898
4	Electrical and Metal Works	1,848,000	122,592,000	2,045,729
5	Transmission Line	180,000	11,200,000	198,065
	Total	2,435,657	201,158,391	2,760,106

Table M.6.2 Construction Costs of No.2 Power Station

No	Work Description	Foreign Currency (US $)	Local Currency (Tsh.)	Equivalent (US $)
1	Preparatory Works	40,000	7,000,000	51,290
2	Earth Works	203,730	25,063,200	244,155
3	Structure Works	583,807	119,936,731	777,253
4	Electrical and Metal Works	3,080,000	213,000,000	3,423,548
5	Transmission Line	67,500	4,200,000	74,274
	Total	3,975,037	369,199,931	4,570,521

Table M.7.1 Cash Flow Statement of Project Implementation and Operation with Small Scale Hydropower Development Plan

Year	(1) Cash Outflow (Tsh.1,000)								(2) Cash Inflow (Tsh.1,000)							Balance	
	Capital Costs 1/			O&M Works		Tractor Hiring Services		Total Cash Outflow	Capital Investment 1/			Revenue			Total Cash Inflow	Annual (II - I)	Cummulative
	Project Works	Tractor Hiring Services	Total	Total O&M Cost	Replacement Costs	Operation Costs	Replacement Costs		Project Works	Tractor Hiring Services	Total	Water Charge 2/	Tractor Hiring Service Fees 3/	Total			
1998	616,280		616,280					616,280	616,280		616,280			0	616,280	0	0
1999	10,063,840		10,063,840					10,063,840	10,063,840		10,063,840			0	10,063,840	0	0
2000	10,236,200		10,236,200					10,236,200	10,236,200		10,236,200			0	10,236,200	0	0
2001	7,670,640	154,700	7,825,340	61,318		48,913		7,935,571	7,670,640	154,700	7,825,340	133,300	75,250	208,550	8,033,890	98,319	98,319
2002	6,093,980	136,400	6,230,380	61,318		121,996		6,413,694	6,093,980	136,400	6,230,380	133,300	187,688	320,988	6,551,368	137,674	235,993
2003	5,208,000	221,000	5,429,000	61,318		148,841		5,639,159	5,208,000	221,000	5,429,000	133,300	228,988	362,288	5,791,288	152,129	388,122
2004		66,300	66,300	134,044		163,076		363,420		66,300	66,300	291,400	250,888	542,288	608,588	245,168	633,290
2005		445,800	445,800	134,044		214,277		794,121		445,800	445,800	291,400	329,675	621,075	1,066,875	272,754	906,044
2006		154,700	154,700	120,714		226,854		502,268		154,700	154,700	278,070	349,025	627,095	781,795	279,527	1,185,571
2007		73,900	73,900	120,714		236,739	41,000	472,353		73,900	73,900	278,070	366,300	644,370	718,270	245,917	1,431,488
2008				120,714		236,739	95,000	452,453				278,070	369,000	647,070	647,070	194,617	1,626,105
2009				104,904		236,739	95,000	436,643				262,260	369,000	631,260	631,260	194,617	1,820,722
2010				104,904	310,000	236,739	95,000	746,643				262,260	369,000	631,260	631,260	-115,383	1,705,339
2011				104,904		236,739	95,000	436,643				262,260	369,000	631,260	631,260	194,617	1,899,956
2012				104,904		236,739	117,100	458,743				262,260	370,295	632,555	632,555	173,812	2,073,768
2013				104,904	310,000	236,739	153,100	804,743				262,260	371,905	634,165	634,165	-170,578	1,903,190
2014				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,046,697
2015				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,190,014
2016				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,333,521
2017				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,476,838
2018				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,620,345
2019				104,904		236,739	153,100	494,743				262,260	371,905	634,165	634,165	139,422	2,759,767
2020				104,904	620,000	236,739	153,100	1,114,743				262,260	371,905	634,165	634,165	-480,578	2,279,189
2021				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,422,506
2022				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,566,013
2023				104,904	310,000	236,739	149,000	800,643				262,260	371,700	633,960	633,960	-166,683	2,399,330
2024				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,542,837
2025				104,904	750,200	236,739	149,000	1,240,843				262,260	371,700	633,960	633,960	-606,883	1,935,954
2026				104,904		236,739	153,100	494,743				262,260	372,095	634,355	634,355	139,612	2,075,566
2027				104,904		236,739	153,100	494,743				262,260	371,905	634,165	634,165	139,422	2,214,988
2028				104,904	310,000	236,739	149,000	800,643				262,260	371,890	634,150	634,150	-166,493	2,048,495
2029				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,191,812
2030				104,904	310,000	236,739	149,000	800,643				262,260	371,700	633,960	633,960	-166,683	2,025,129
2031				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,168,446
2032				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,311,953
2033				104,904	310,000	236,739	153,100	804,743				262,260	371,905	634,165	634,165	-170,578	2,141,375
2034				104,904		236,739	153,100	494,743				262,260	372,095	634,355	634,355	139,612	2,280,987
2035				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,424,304
2036				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,567,811
2037				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,711,128
2038				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	2,854,635
2039				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	2,997,952
2040				104,904	310,000	236,739	153,100	804,743				262,260	371,905	634,165	634,165	-170,578	2,827,374
2041				104,904		236,739	153,100	494,743				262,260	371,905	634,165	634,165	139,422	2,966,796
2042				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	3,110,303
2043				104,904	310,000	236,739	149,000	800,643				262,260	371,700	633,960	633,960	-166,683	2,943,620
2044				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	3,087,127
2045				104,904	310,000	236,739	149,000	800,643				262,260	371,700	633,960	633,960	-166,683	2,920,444
2046				104,904		236,739	149,000	490,643				262,260	371,890	634,150	634,150	143,507	3,063,951
2047				104,904		236,739	153,100	494,743				262,260	371,905	634,165	634,165	139,422	3,203,373
2048				104,904		236,739	153,100	494,743				262,260	372,095	634,355	634,355	139,612	3,342,985
2049				104,904		236,739	149,000	490,643				262,260	371,700	633,960	633,960	143,317	3,486,302
2050				104,904	2,108,000	236,739	149,000	2,598,643				262,260	371,700	633,960	633,960	-1,964,683	1,521,619
2051				104,904		236,739	149,000	490,643				262,260	371,905	634,165	634,165	143,522	1,665,141
2052				104,904	1,267,900	236,739	149,000	1,758,543				262,260	372,095	634,355	634,355	-1,124,188	540,953

1/: Cpital funds of the project works and tractor hiring services are arranged by the Government of Tanzania
2/: Revenue from water charge to be collected from the beneficiaries
3/: Tractor Hiring Service fees to be collected from the beneficiariespaddy cultivation Tsh. 50,000/ha & alfalfa cultivation Tsh. 12,500/ha) + salvage value of machinery(5%)
Note: This analysis is made until 2052 when the replacement cost for No.1 Power Station occurs.

Figures

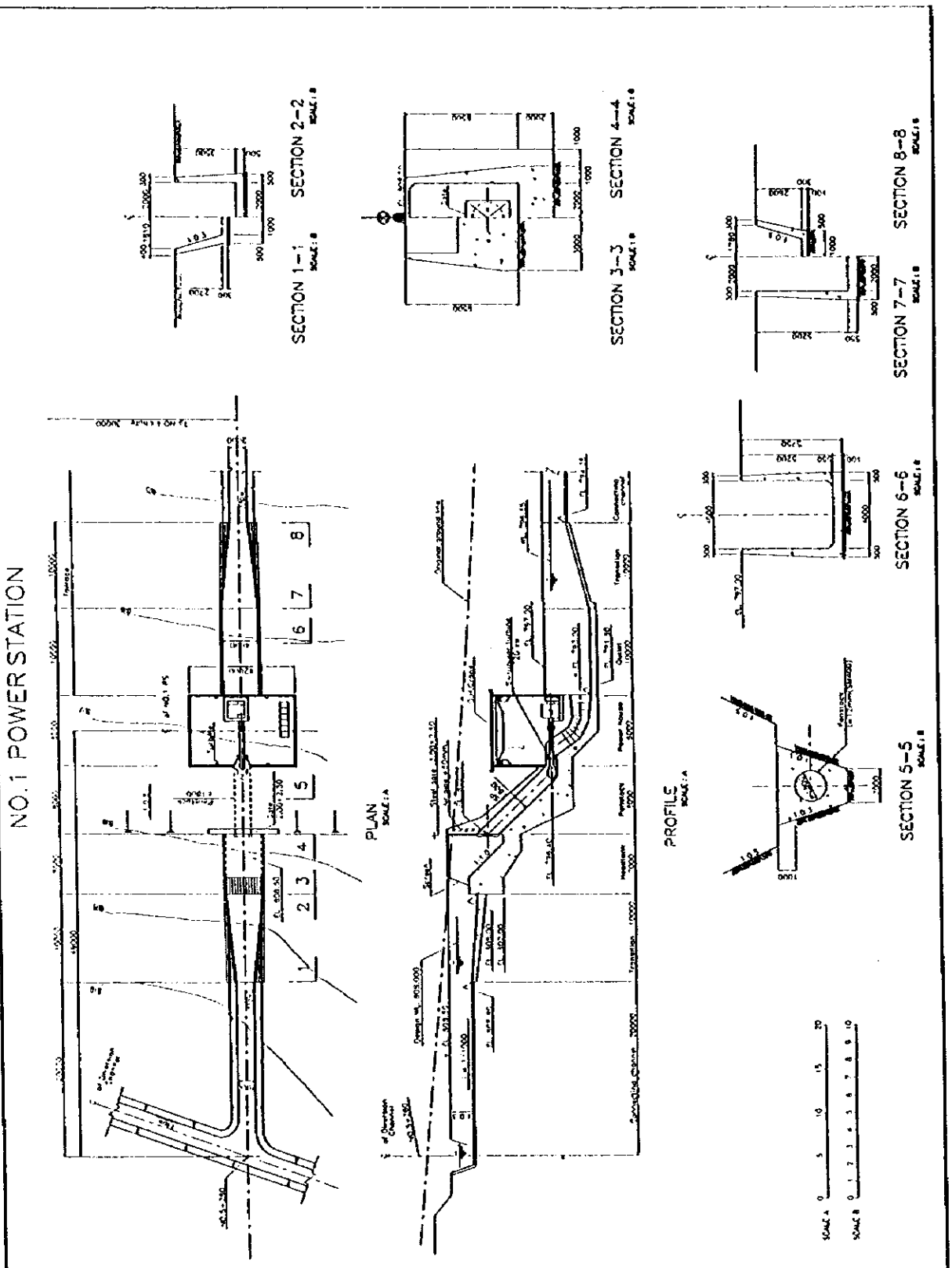


Figure M.4.1
General Layout of No.1 Power Station

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

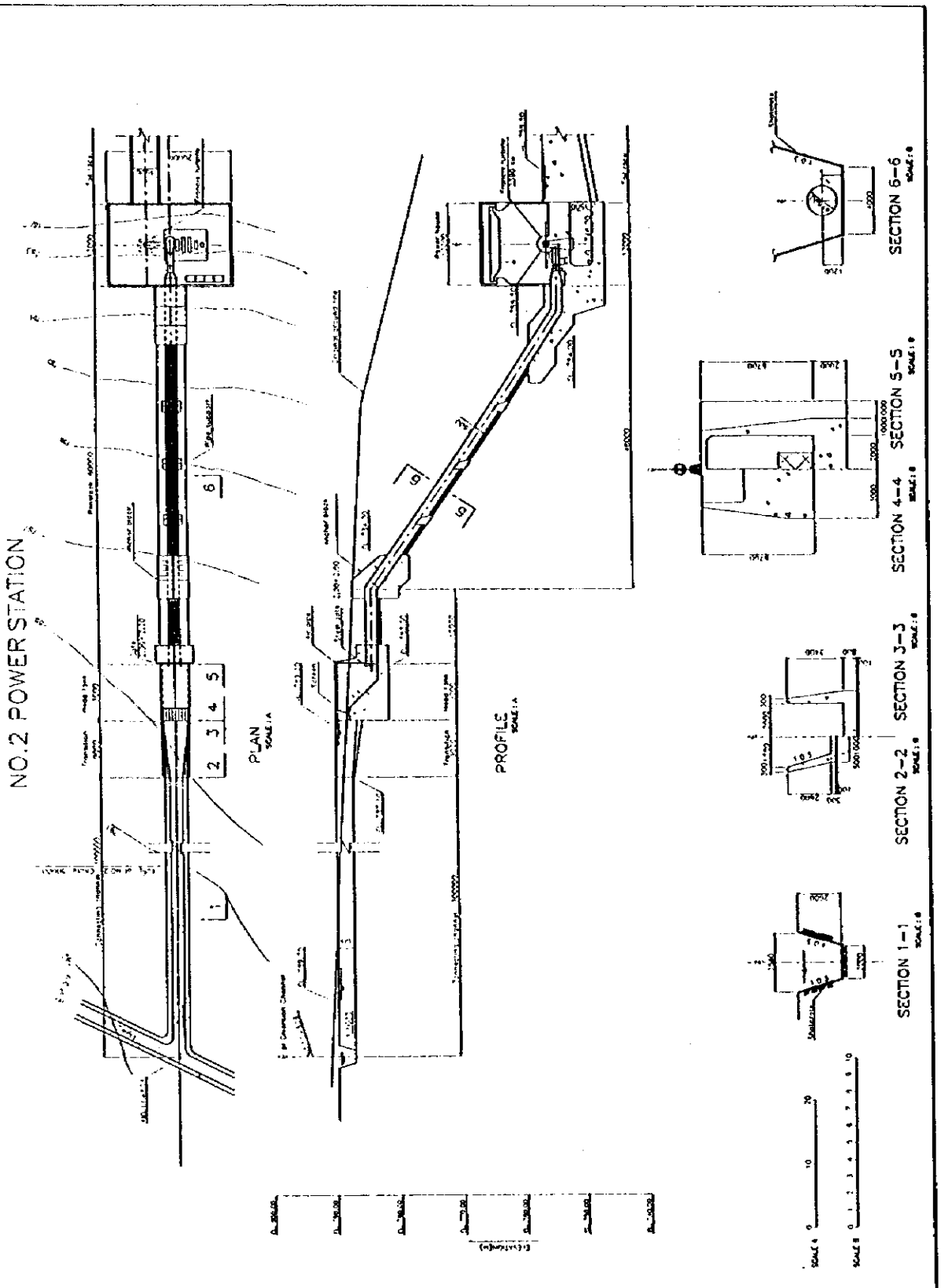


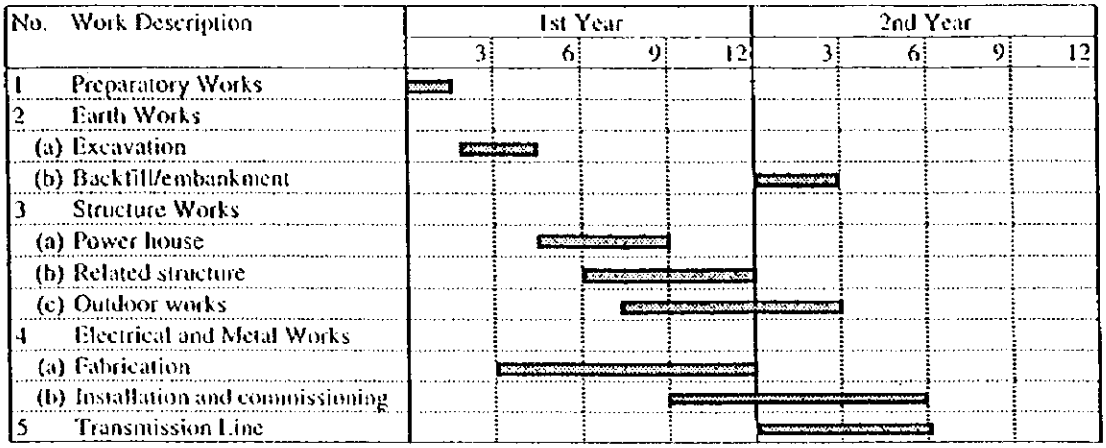
Figure M.4.2

General Layout of No.2 Power Station

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

Work Schedule of No.1 Hydropower Station(Phase-II)



Work Schedule of No.2 Hydropower Station(Phase-I)

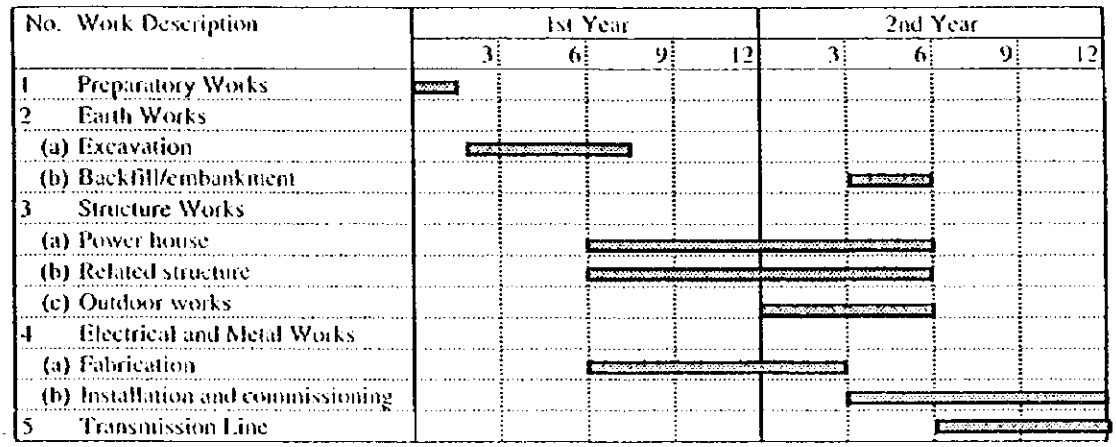


Figure M.6.1
Construction Schedule of
No.1 and No.2 Power Station

The Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania

Japan International Cooperation Agency

ANNEX-N

O & M AND WATER MANAGEMENT

ANNEX - N

O & M AND WATER MANAGEMENT

Table of Contents

Page

List of Tables

List of Figures

List of Attachment

ANNEX - N

O & M AND WATER MANAGEMENT

1. INTRODUCTION

This ANNEX presents the development plan on O & M and water management which has been elaborated based on the results of the study and analysis on data and information collected through inventory survey, field inspection, interview with farmers and the government agencies concerned.

Chapter 2 shows the present conditions of O & M and water management activities which have been examined mainly through interview with staff in charge. The problems envisaged with the existing project facilities have been also clarified and mentioned in this chapter.

Chapter 3 offers the development plan of O & M and water management, which has been formulated mainly based on the study results on those for the Existing Lower Moshi Project Area, and also considering lessons learnt from the actual operation in the Existing Lower Moshi Project Area. The Plan includes not only the government organisation and staffing, operation and maintenance plans but also the required O & M equipment and monitoring works. In the monitoring works, re-start of discharge observation is also recommended from their importance. The O & M cost for the Project is also estimated considering the stagewise handing-over schedule of O & M works.

Chapter 4 discusses the existing by-law on O & M works which is applied for the Existing Lower Moshi Project Area, and proposed the modified by-law especially considering the change of project scale and contents.

2. PRESENT CONDITIONS

2.1 General

At present, O & M and water management activities are executed only in the Existing Lower Moshi Project Area and the Expanded Area, although those in the Expanded Area are unsystematic and primitive. Accordingly, the present conditions of O & M works and water management are discussed for the Existing Lower Moshi Project Area and the Expanded Area, especially putting a focus upon those in the Existing Lower Moshi Project Area.

2.2 O & M Works

2.2.1 Organisation and Staffing

(1) Existing Lower Moshi Project Area

KADP was established in 1986 with an aim of undertaking O&M of the project facilities and also providing guidance and assisting the farmers in on-farm works. The Implementation Committee under the jurisdiction of then Regional Development Director (RDD), presently Regional Administrative Secretary (RAS) of the Kilimanjaro Region was also organised in the same year. The present organisation chart of the KADP office is given in Figure N.2.1. KADP is headed by a director. Under him, there are 4 sections i.e. Administration Section, Irrigation Section, Machinery Section, and Extension Service Section. As of December 1997, KADP has a staff of 67 composed of the following:

- Director Office	: one director and 4 office staff
- Administration Section	: one officer, 7 attendants, 11 office staff
- Irrigation Section	: one agriculture field officer, 3 irrigation technicians, one gate keeper, and one office staff
- Machinery Section	: 4 officers, 8 technicians, 12 tractor operators, and 4 office staff
- Extension Services Section	: 5 officers and one office staff

The Irrigation and Machinery Sections are in charge of O & M works for the project facilities. Major duties for these sections on O & M works are as follows:

(a) Irrigation Section

- Operation and maintenance of irrigation facilities
- Technical assistance and guidance to CHAWAMPU on O & M works at tertiary canal and watercourse level
- Preparation of maintenance plan and cost estimates through periodical inspections

(b) Machinery Section

- Preparation of operation schedule of tractors and O & M equipment
- Supervision of operation of tractors and O & M equipment
- Estimate of running costs and expenditures for tractors and O & M equipment
- Maintenance and repair of tractor and equipment and inventory required spare parts

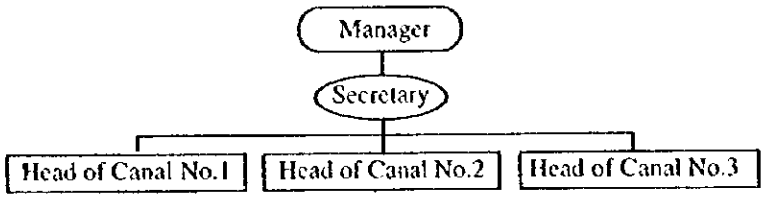
KADP still keeps the ownership of the irrigation system, O&M equipment, farm machinery, workshop, etc., except water rights. The water rights of the Mabogini intake (804 l/s) and the Rau Ya Kati intake (1,135 l/s) were transferred to CHAWAMPU in 1995. The O & M of the project facilities have therefore been carried out by KADP and CHAWAMPU in close co-operation with each other. The implementation relation between KADP and CHAWAMPU is illustrated in Figure N.2.2. An O&M Manual was prepared in 1985. The O & M works have been executed mainly based on this Manual although some modifications have been made based on actual activities.

(2) Expanded Area

In the Expanded Area, there are 2 irrigation systems: namely the Njoro Kwa Goa and Mandaka systems as described in ANNEX-K. The Njoro Kwa Goa irrigation system and the Mandaka Mnono irrigation system are operated by the Water Users Association (WUA). Present Organisations of WUA are explained below:

(a) Njoro Kwa Goa WUA

1) Organisation chart

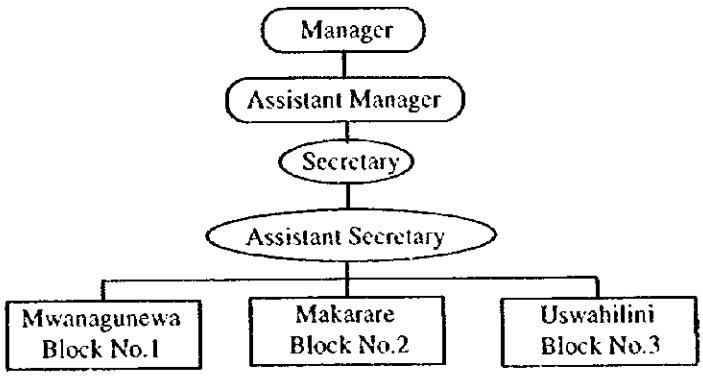


2) Functions

-To ensure irrigation water supply and equal distribution to farmers;
-To prepare and amend by-laws;
-To collect water charge from the beneficiaries;
-To operate and maintain properly farm canals; and
-To network with other similar organisations such as CHAWAMPU.

(b) Mandaka WUA

1) Organisation chart



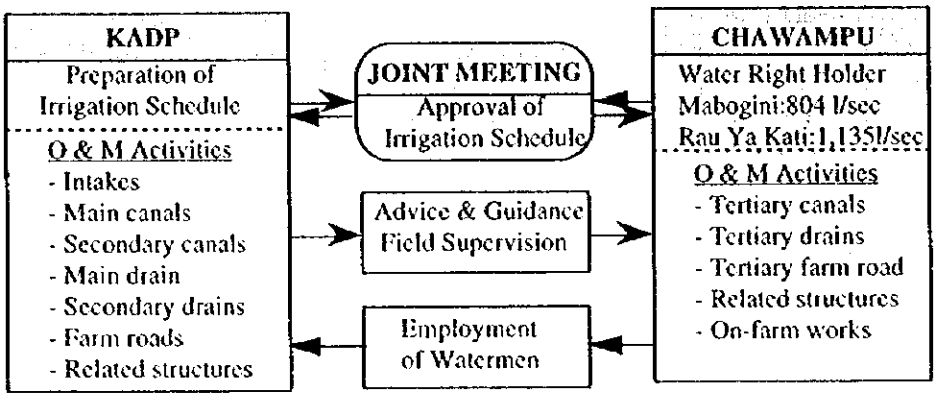
2) Functions

- To ensure adequate water for irrigation purpose;
- To supply water to paddy farmers in the village;
- To purchase and amend by-laws;
- To prepare a time table for water use in paddy farms; and
- To collect water charges for operation and maintenance of irrigation facilities.

2.2.2 Operation and Maintenance Works

(1) Existing Lower Moshi Project Area

The project operation is carried out by KADP and CHAWAMPU on a co-operative basis. KADP is in charge of operation of major facilities down to turnouts on tertiary irrigation canals, and CHAWAMPU is responsible for operation of watercourses and respective irrigation blocks under instruction and guidance of KADP. The coordination chart between KADP and CHAWAMPU on project operation is illustrated below.



KADP also provides tractor hiring services to CHAWAMPU for land preparation for paddy fields. Mentioned below are the major activities on the irrigation and tractor operation:

(a) Irrigation operation

1) Preparatory works

- Orientation of irrigation schedule
- Confirming whether related facilities are properly maintained and in good conditions
- Confirming whether tertiary canals and watercourses are well maintained and repaired as required

2) Regular operation

- Operation of intake gates in accordance with the irrigation schedule
- Operation of gates down to tertiary canals
- Adjustment of gate opening to water demand
- Supervision and advice to CHAWAMPU in water management
- Record and analysis of field measurement for preparation of proper irrigation schedule for next crop cultivation

(b) Tractor operation

- Preparation of the detailed operation plan in accordance with the irrigation schedule
- Check and maintenance of tractors
- Supervision of field works
- Check of work progress and adjustment of the operation schedule to catch up with the planned schedule
- Recording operation hours and fuel consumption, etc.

The maintenance of the project facilities is carried out by both KADP and CHAWAMPU. The Irrigation Section of KADP is responsible for maintenance works down to tertiary canals in collaboration with other sections and for issuance of the maintenance schedule to CHAWAMPU. Since the commencement of the project operation, KADP and CHAWAMPU jointly executed maintenance works for all canal systems in Mabogini and Rau in 1991 and repairing work for the damaged flood protection dike and main canal in Mabogini in 1995. At present, the irrigation and drainage systems are mostly in good condition although some minor repairs such as spindle damage of gates, cracks on concrete block lining, and removal of grasses and sediment, etc., are required.

(2) Expanded Area

The O&M works for both irrigation systems are executed by farmers themselves within their capability. Presently, the following constraints are faced by them:

- Organisational weakness;
- Financial constraints; and
- Lack of technical know-how in O&M of irrigation facilities.

2.2.3 O & M Equipment

O & M equipment kept by KADP is divided into maintenance equipment for facilities and roads, farm machinery and vehicles and motorcycles for office use. The Machinery Section of KADP is responsible for operation of O & M equipment. Running costs of this equipment except salary of operators are mostly borne by CHAWAMPU.

In 1985, 35 tractors with 40 HP tractors were procured under KR-II, and in 1986, 31 O&M equipment were procured under OECF loan. In addition, 35 tractors with the same capacity of 40 HP were procured in 1985 and 12 tractors with 50 HP in 1994 under KR-II. To date, about 85 % of the O & M equipment, and 40 % of tractors are in unworkable condition and/or scrapped due to deterioration. Table N.2.1 shows the list and present conditions of O & M equipment procured so far.

2.2.4 O & M Cost

(1) Existing Lower Moshi Project Area

O & M costs for the Existing Lower Moshi Project Area are divided into two portions. One is for KADP consisting of staff salary and office running cost, and the other is for water charge for water right, project facilities and operation of equipment including operators' salary. The former O & M cost has been totally subsidised by GOT by 1993, but GOT has largely reduced the subsidisation for office running cost since 1994. The latter has been paid by CHAWAMPU. According to the KADP's information, the O & M cost for office running and facilities maintenance excluding salary of KADP staff, is as follows:

(Unit : Tsh.)

Year	Office Running Cost	O & M of Facilities*	Total
1982	164,425		164,425
1983	241,435		241,435
1984	2,304,800		2,304,800
1985	2,576,150	111,000	2,687,150
1986	4,180,390	1,278,000	5,458,390
1987	5,141,200	3,014,000	8,155,200
1988	12,449,215	6,560,000	19,009,215
1989	17,890,000	7,293,000	25,183,000
1990	18,312,826	10,362,000	28,674,826
1991	38,624,380	11,472,000	50,096,380
1992	12,110,889	12,472,000	24,582,889
1993	10,475,960	23,652,000	34,127,960
1994	1,353,000	36,747,000	38,100,000
1995	295,000	35,288,000	35,583,000
1996	190,000	62,878,000	63,068,000

Source : KADP and CHAWAMPU

(2) Expanded Area

In the Mandaka irrigation system, farmers pay Tsh. 500 per year. In the case of further need of repairing cost for canals, such cost is shared by farmers time to time through the decision of WUC.

2.3 Water Management

2.3.1 Organisation and Staffing

(1) Existing Lower Moshi Project Area

The planning and implementation of water management of the project are presently conducted by the Irrigation Section of KADP in collaboration with other sections. The Irrigation Section is composed of 6 staff: one Agriculture Field Officer, 3 Irrigation Technicians, one Gate Keeper, and one Office Attendant.

(2) Expanded Area

In the Expanded Area, there are 2 irrigation systems built by farmers. Both irrigation systems have been operated by WUA/WUC, however, no technical staff is available for water management.

2.3.2 Diversion Water Requirement

(1) Existing Lower Moshi Project Area

Since 1986, field water requirement for paddy cultivation have been measured by KADP. Taking into consideration the results of actual field water requirement measurement, KADP has applied the following diversion requirements at headwork sites:

(Unit : l/s/ha)

Year	Rainy Season	Dry Season	Year	Rainy Season	Dry Season
1986	3.2	-	1992	No crop	3.8
1987	2.9	3.6	1993	3.3	4.0
1988	2.2	3.0	1994	3.0	3.5
1989	2.3	2.9	1995	3.0	3.5
1990	2.1	2.8	1996	3.0	3.5
1991	No crop*	3.4	1997	3.0	3.5

*Source: KADP, * : 1st season paddy in Mabogini system area and 2nd season paddy in Rau system.*

(2) Expanded Area

There are no diversion requirements in both existing farmers' built irrigation systems. Water is abstracted from a spring and/or river on their demand basis time to time or based on available water.

2.3.3 Irrigation Schedule

(1) Existing Lower Moshi Project Area

An irrigation schedule is prepared and announced to farmers in the following procedure;

(a) Estimate of water availability based on the river discharge
(b) Determination of the irrigation area
(c) Estimate of the diversion requirement at the headworks referring to field measurement results obtained so far.
(d) Preparation of the irrigation schedule.
(e) Approval of the irrigation schedule in a joint meeting consisting of KADP, Ward councillors, CHAWAMPU, and representatives of each village
(f) Announcement of the approved irrigation schedule to farmers in a joint meeting consisting of KADP, Ward councillors, CHAWAMPU, and representatives of each village

It is noted that the irrigation area determined is allocated to the respective villages based on the following criteria which was approved in the joint meeting:

Irrigation Area	Ratio (%)
Mabogini	43
Rau	57
- Rau Ya Kati	(45)
- Chekereni	(39)
- Oria	(16)

Table N.2.2 presents the record of cultivation area from 1985 to 1997 which was determined in the manner mentioned above.

(2) Expanded Area

The basic and prevailing cropping calendar of paddy in the Expanded Area is the originally recommended cropping calendar for the Existing Lower Moshi Project Area as follows;

- Rainy season paddy : January/February to June/July
- Dry season paddy : July/August to December/January

However, the Expanded Area is susceptible to seasonal inundation in April and May. When the seasonal inundation lasts to June, the start of dry season paddy is apt to delay to some extent, and thus irrigation calendar is obliged to follow this cropping calendar.

2.3.4 Irrigation Method

(1) Existing Lower Moshi Project Area

Water distribution is continuously made down to tertiary canals covering the selected area. In the tertiary block, a rotational water supply is applied for 2 watercourses at 10-day interval at the puddling time, and 2 watercourses at 5-day s at the remaining crop growing time.

(2) Expanded Area

No irrigation is systematically practised in the Kaloleni and Mandaka Mnono areas. A water supply is made on a farmers' demand basis only.

2.3.5 Measuring Devices

(1) Existing Lower Moshi Project Area

The Existing Lower Moshi Project Area is provided with two measuring devices: Parshall flume and movable weir type slide gate. A Parshall flume is installed at the headworks, and the movable weir type slide gate at all turnouts. Discharges at the headworks have been measured by the Irrigation Section since 1986, but the measurement was discontinued in 1995 due to serious water conflicts among villages.

(2) Expanded Area

No measurement of the intake and distribution of irrigation water is executed due to lack of measuring device.

2.3.6 Collection of Cultivation Charge

(1) Existing Lower Moshi Project Area

CHAWAMPU has collected cultivation charge from the farmers and sent to national treasury. Amounts of the cultivation charge collected since 1994 are summarised as follows:

Year	Cultivation Charge (Tsh.)	Cultivated Area (ha)	Average per ha (Tsh.)
1994	380,324	645	590
1995	380,324	495	847
1996	760,803	783	972

Source : KADP

(2) Expanded Area

As mentioned above, farmers in the Mandaka Mnono area pay Tsh.500 per year for repairs of canals, but the Kaloleni farmers do not pay any money for repairs. Instead, they offer labour force to canal repairs. WUC for the Njoro Kwa Goa irrigation system paid water charge of Tsh. 40,000 in 1996 and Tsh. 70,000 in 1997 based on its customary water right, but WUA for the Mandaka irrigation system has not paid any water charge because it has no water right.

2.4 Problems in O & M and Water Management

Through site inspection and interview with farmers and government agencies concerned, there have found the following problems which are presently facing to O & M and water management activities:

(1) Existing Lower Moshi Project Area

(a) O & M works

- Comparatively weak organisation;
- Insufficient number of capable staff
- Shortage of O & M equipment

(b) Water management

- Comparatively weak organisation;
- Insufficient number of capable staff
- Constant water shortage
- No observation of irrigation calendar by Upper Mabogini area
- Insufficient number of gate keepers
- No proper filing of data

(2) Expanded Area

(a) O & M works

- Weak organisation
- No capable staff

(b) Water management

- Lack of technical know-how
- No capable staff
- No measuring device and control facilities
- Low irrigation efficiency due to poor canals

3. O & M AND WATER MANAGEMENT PLAN

3.1 Basic Strategies to Establishment of O & M and Water Management Plan

(1) Emphasis Point in Formulation of O & M and Water Management Plan

The lesson learned from the Existing Lower Moshi Project showed a need of execution of timely and adequate water supply which is essential for sustainable irrigated agriculture development. In the establishment of O & M and water management plan for the Project, therefore, an emphasis point shall be placed on not only the application of proper O & M activities and water management technologies, but also the strengthening of the organisation necessary for smooth execution of such activities and technologies, based on the results of analysis on the collected data and information from the actual operation of the Existing Lower Moshi Project.

(2) Full Use of Lessons Learned from Existing Lower Moshi Irrigation Project Area

The Study Area is broadly divided into three areas with different agricultural conditions, namely 1) Existing Lower Moshi Project Area, 2) Expanded Area and 3) New Extension Area. In the Existing Lower Moshi Project Area with agricultural infrastructure developed under the Existing Lower Moshi Project, O & M and water management activities have been implemented under the guidance of KADP for about 10 years in the past and farmers have substantial experiences in irrigated farming in the Area. However, in the Expanded Area with poor physical infrastructure, O & M and water management activities are still at a primitive or traditional level. Accordingly, the lessons learned from the Existing Lower Moshi Project Area will be fully incorporated into the formulation of O & M and water management plan for the entire Project Area.

(3) Proper Handing-Over Plan of O & M Activities to Farmers' Organisation

The handing-over of the responsibility on O&M of irrigation facilities to farmers' organisation is one of the main government policy issues for irrigation development as stated in the National Irrigation Development Plan of MAC. Accordingly, the handing-over plan of O&M from KADP to farmers' organisations shall be studied for facilitating the more practical way. In the light of handing-over plan proposed, a clear and applicable demarcation of the responsibility of KADP and farmers' organisations in O&M of the Project facilities shall be prepared for the formulation of the O&M and water management plan for ensuring sustainable development of the Project.

(4) Stagewise Development of O & M Organisations

At present, O & M and water management in the Existing Lower Moshi Project Area are carried out cooperatively by KADP and CHAWAMPU. For ensuring efficient water management in the Project which will be larger in scale than the Existing Lower Moshi Project, however, it is indispensable to establish the Water Users' Association which has compulsive force its members, since CHAWAMPU has no such force in water management issues. The establishment of Water Users' Association is proposed to be made in stagewise manner, because of the limitation of manpower sources for the immediate organisation and in order to avoid confusion among farmers. Namely, the O&M and water management functions of the present organisation (CHAWAMPU) will be strengthened in the 1st stage and the Water Users' Association will be established in the 2nd stage by separating O&M and water management functions of CHAWAMPU.

3.2 Project Area

The Project area is largely divided into four areas which shall be considered as for O & M and water management activities, that is 1) Headworks and Diversion Channel sites, 2) Existing Lower Moshi Project Area, 3) New Extension Area, and 4) Expanded Area. The

Headworks and Diversion Channel sites will not include water distribution activity since there is no irrigation area to be committed in these sites.

3.3 Project Facilities

The Project facilities to be constructed are summarised as follows:

(1) Headworks and Diversion Channel Sites (new construction works)

(a)	Headworks	:	1 no.
(b)	Diversion channel	:	24 km
(c)	Hydropower station	:	2 places
(d)	Major related structures	:	130 nos.

(2) Existing Lower Moshi Project Area (2,150 ha : rehabilitation and enhancement works)

(a)	Headworks	:	2 nos.
(b)	Main canal	:	10.4 km
(c)	Secondary canal	:	25.0 km
(d)	Tertiary canal	:	65.6 km
(e)	Main drain	:	16.6 km
(f)	Secondary drain	:	32.0 km
(g)	Tertiary drain	:	40.9 km
(h)	Major related structures	:	509nos.

(3) New Extension Area (2,090 ha : new construction work)

(a) System-A (181 ha)

1) Main canal	:	0.1 km
2) Secondary canals	:	3.1 km
3) Tertiary canals	:	7.2 km
4) Main drain	:	- km
5) Secondary drains	:	5.0 km
6) Tertiary drains	:	6.8 km
7) Farm roads	:	10.2 km
8) Major related structures	:	111 nos.

(b) System-B (1,569 ha)

1) Main canal	:	7.4 km
2) Secondary canals	:	18.9 km
3) Tertiary canals	:	52.2 km
4) Main drain	:	10.5 km
5) Secondary drains	:	19.0 km
6) Tertiary drains	:	43.6 km
7) Farm roads	:	100.4 km
8) Major related structures	:	779 nos.

(b) System-C (340 ha)

1) Main canal	:	2.1 km
2) Secondary canals	:	3.0 km
3) Tertiary canals	:	10.9 km
4) Main drain	:	- km
5) Secondary drains	:	3.6 km

6) Tertiary drains	:	10.1 km
7) Farm roads	:	14.6 km
8) Major related structures	:	61 nos.

(4) Expanded Area (460 ha: improvement works)

(a) Kaloleni Area

1) Intake facilities	:	6 nos.
2) Supply canals	:	0.3 km
3) Main canals	:	- km
4) Secondary canals	:	- km
5) Tertiary canals	:	5.9 km
6) Secondary drains	:	1.3 km
7) Tertiary drains	:	2.9 km
8) Farm roads	:	5.9 km
9) Major related structures	:	39 nos.

(b) Mandaka Mnono Area

1) Intake facilities	:	2 nos.
2) Supply canals	:	1.6 km
3) Main canals	:	1.2 km
4) Secondary canals	:	10.3 km
5) Tertiary canals	:	12.1 km
6) Secondary drains	:	6.1 km
7) Tertiary drains	:	10.5 km
8) Farm roads	:	23.6 km.
9) Flood dike	:	15.1 km.
10) Major related structures	:	221 nos.

Details of these facilities are given in Tables N.3.1 to N.3.4.

3.4 Government Organisation and Staffing

3.4.1 General

At present, O & M and water management for the Existing Lower Moshi Project Area are conducted cooperatively by KADP and CHAWAMPU. KADP is in charge of operation and maintenance of major facilities down to turnouts on secondary irrigation canals, and CHAWAMPU is responsible for operation and maintenance of tertiary canals, watercourses and respective irrigation blocks under instruction and guidance of KADP. This cooperative institution is currently functioning, so that any severe problem has not been found. Accordingly, the proposed organisation and staffing for O & M and water management have been worked out by fully making reference with the present institution.

3.4.2 Handing-Over of O & M of Project Facilities to Farmers' Organisation

(1) Executing Agency

In compliance with the government policy, the handing-over of O&M of project facilities to farmers' organisation shall be planned under the Project. KADP will execute the necessary jobs for the handing-over of O & M of project facilities such as preparation of schedule, monitoring of O & M activities by farmers, preparation of inspection report, etc. The Project Implementation Committee will review the report and other supporting data submitted, and will make a final decision on handing-over of O & M of project facilities to farmers' organisation.

(2) Project Facilities to be handed-over and Time Schedule

Although no serious O&M problems were encountered in the Existing Lower Moshi Project Area since the handing-over of facilities after tertiary canals to CHAWAMPU in 1993, CHAWAMPU has no experience in O&M of secondary and main canals. In principle, therefore, O&M of the proposed headworks and diversion channel, which are large in scale and located outside Moshi District, will be placed under the jurisdiction of KADP. The handing-over of O & M of project facilities, accordingly, will involve intakes, main and secondary canals and the actual handing-over will be implemented after the scheduled transitional period of five years. If the technical and financial capability of the Water Users' Association is assessed as unsatisfactory by the Project Implementation Committee, the transitional period will have to be extended.

3.4.3 Coordination Chart for O & M and Water Management of the Project

(1) Coordination Chart

As mentioned above, O & M and water management of the Existing Lower Moshi Project are jointly executed by KADP and CHAWAMPU, under the Implementation Committee jurisdictionaly belonging to RAS. In this study, this institution system will follow, although roles of respective organisation will be modified in line with recent government policy. The proposed coordination chart of government agencies and farmers' organisation for O & M and water management is given in Figure N.3.1.

(2) Project Implementation Committee

The Project Implementation Committee was already established as the highest execution body of the project management and for the formation of major linkage of all interested bodies involved in the project management. Taking into consideration change of project scale and re-structuring of government organisation, the Project Implementation Committee will be re-organised under the Regional Administrative Secretary and will consist of the following:

- Chairman : Regional Administrative Secretary
- Secretary : Director of KADP
- Member : Regional Agriculture Development Officer
  : Zonal Irrigation Officer
  : District Cooperative Officers of Moshi and Hai
  : District Executive Directors of Moshi and Hai
  : District Irrigation Officers of Moshi and Hai
  : District Agriculture and Livestock Development Officers of Moshi and Hai
  : District Administrative Officers of Moshi and Hai
  : Councillors of District Council
  : Councillors of the Project area
  : General Manager of KNCU
  : Representative of CHAWAMPU
  : Representative of Water Users' Groups

The Committee will play a coordinating and supervisory role in the project management, including the following:

- Examine and approve annual plan on the project management.
- Review the plan executed.
- Examine and approve annual budget of KADP.
- Approve amount of water charges to be collected from water users.
- Approve the irrigation schedule.
- supervise marketing of a agricultural products of the Project.
- Approve a handing-over plan on O & M of project facilities to farmers' organisation.

(3) KADP

As mentioned previously, KADP was established on March 13, 1986 under agreement between the Government of Japan and the Government of Tanzania , aiming to develop agricultural techniques and to extend the techniques through training of personnel concerned based on the KADC experiences, and thus contribute to the agricultural development in Kilimanjaro Region. Accordingly, KADP shall be presently responsible for the O & M and water management for not only the Existing Lower Moshi Project, but also the Ndung Agricultural Development Project.

In this O & M and water management plan, it is proposed that KADP shall take an initiative for O & M and water management activities although O & M of the project facilities will be transferred to farmers' organisation based on the handing-over program mentioned later. After implementation of the Project, the technical irrigation and drainage system will cover 4,700 ha instead of 2,150 ha. This means that the role of KADP on O & M and water management activities will largely increase. After completion of the handing-over program, however, that of KADP will be reduced. Thus, it is necessary that the KADP organisation shall be modified in the light of the required roles in volume, aiming to reduce the financial burden of GOT on time.

3.4.4 Proposed O & M Office

It is proposed that KADP will function as an O & M Office for the Project. The proposed O & M and water management activities will be carried out by KADP and CHAWAMPU in the 1st stage, and KADP and Water Users' Association in the 2nd stage as discussed in Section 3.1. In this sub-section, the organisational issue of KADP is only discussed, and the farmers' organisation such as CHAWAMPU and Water Users' Association is discussed in ANNEX-G.

(1) 1st Stage

(a) Organisation

Presently, KADP is composed of 6 sections : Administration, Irrigation, Machinery, Extension, Hydropower and Handing-over Sections. Water management issue is under the jurisdiction of the Irrigation Section and includes activities such as irrigation planning, O&M of facilities, and guidance to CHAWAMPU. However, monitoring activities on basic data for irrigation planning are not performed satisfactorily because of financial and staffing constraints. Accordingly, the Irrigation Section shall be strengthened by dividing it into 3 Sub-sections, namely 1) Water Management Sub-section, 2) O&M Sub-section and 3) Monitoring Sub-section as shown in the organisation structure for the 1st stage in Figure N.3.2.

If two small-scaled hydropower stations are constructed under the Project, it is essential to establish a Hydropower Section for operation and maintenance works of them.

In order to execute the actual handing-over job, a section in charge of handing-over shall be established within KADP immediately after the commence of the project implementation. The Handing-over Section shall consist of two sub-sections, Legal and Training Sub-section. The Legal Sub-section will be responsible for all the administrative matters relating the handing-over such as legal procedures and other administrative issues. The Training Sub-section will be responsible for the preparation of training and education programs for farmers and farmers' groups and for the implementation of such programs during the transitional period (in the 1st stage).

The Extension Section shall change its name to the Agronomy section. The Agronomy Section shall be divided into 3 Sub-sections; namely Experimental, Extension and Training and CHAWAMPU Sub-sections, aiming to strengthen the extension activities,

and the experimental activities such as various verification tests for rice varieties and seed multiplication, as well as CHAWAMPU and water users groups.

(b) Staffing

The proposed staffing for respective Sections/Sub-sections are 136 persons, of which breakdown are as follows:

1) Director	:	1 person
2) Administration Section	:	1 person
- Manpower Sub-section	:	15 persons
- Account Sub-section	:	2 persons
- Store Sub-section	:	2 persons
2) Irrigation Section	:	1 person
- Water management Sub-section	:	4 persons
- Monitoring Sub-section	:	2 persons
- O & M Sub-section	:	2 persons
3) Machinery Section	:	1 person
- O & M Equipment Sub-section	:	10 persons
- Workshop Sub-section	:	3 persons
4) Tractor Hire Sub-section	:	72 persons
5) Agronomy Section	:	1 person
- Extension Sub-section	:	2 persons
- Experimental Sub-section	:	5 persons
- CHAWAMPU Sub-section	:	2 persons
6) Hydropower Section	:	1 person
- No.1 Power Station Sub-section	:	2 persons
- No.2 Power Station Sub-section	:	2 persons
7) Handing-over Section	:	1 person
- Legal Sub-section	:	2 person
- Training Sub-section	:	2 persons

(2) 2nd Stage

(a) Organisation

The water management and O&M works shall be handed over by KADP to the farmers' organisation (Water Users' Association) under the agreement of the Joint Committee for Handing-over after the completion of the transitional period. O & M works by the farmers' organisation shall cover all the project facilities except for the headworks and diversion canal, of which O&M should better be undertaken by KADP because of their location and size. The organisation structure of KADP in the 2nd stage will consist of 3 sections: Administration, Hydropower and O & M Sections as illustrated in Figure N.3.3. The O&M Section will be composed of the headworks, diversion channel and O & M Equipment Sub-sections.

(b) Staffing

The required staffing for respective Sections/Sub-sections are proposed to 35 persons, whose breakdown are as follows:

1) Director	:	1 person
2) Administration Section	:	1 person

- Manpower Sub-section : 14 persons
- Account Sub-section : 2 persons
- Store Sub-section : 1 persons

2) Hydropower Section : 1 person

- No.1 Power Station Sub-section : 2 persons
- No.2 Power Station Sub-section : 2 persons

3) O & M Section : 1 person

- O & M Equipment Sub-section : 5 persons
- Headworks Sub-section : 2 persons
- Diversion Sub-section : 3 persons

3.4.5 Roles of O & M Office

The roles of each section of KADP are explained stage by stage as follows:

(1) 1st Stage

(a) Administration Section

The Administration Section consists of Manpower, Account and Store Sub-sections. Major functions of the Section will include:

1) Manpower Sub-section

- Employ and make payment to temporary staff and labours, and

2) Account Sub-section

- Prepare annual budget of Project office,
- Record and report accounting,
- Ensure collection of water charges from farmers, and
- Sell electricity to TANESCO.

3) Store Sub-section

- Procure equipment and materials necessary for running the Project office, and
- Keep and record stationary, construction materials, survey equipment and office facilities.

The chief of Administration Section should prepare monthly, quarterly, and annual activity reports.

(b) Irrigation Section

The Irrigation Section consists of Water Management, Monitoring and O & M Sub-sections. Out of them, Monitoring and O & M Sub-sections are proposed to be newly established. This section will be in charge of O & M and water management of the headworks, diversion channel and irrigation canals down to heads of tertiary systems. The main functions of the Section will include the following:

1) Water Management Sub-section

- Prepare annual and monthly irrigation plans and schedule,
- Observe daily discharge of Kikuletwa, Njoro and Rau rivers,
- Observe intake discharge from Kikuletwa, Njoro river, Rau river, and major springs
- Execute various field tests such as field water requirement, percolation, and conveyance loss.

- Gives instructions and guidance to CHAWAMPU on water management within tertiary blocks,

2) Monitoring Sub-section (newly established)

- Input and Keep various data and information on not only engineering matters but also administrative matters in computer system, and
- Update list of data and information collected

3) O & M Sub-section (newly established)

- Control and regulate intake discharges and canal flows in accordance with the approved irrigation schedules,
- Review and revise water requirements and irrigation schedules based on data and information obtained through actual operation and observation,
- Collect and prepare data and information for review and revision of the Operation manual, and
- Prepare annual programs for routine maintenance and minor repairs of the project facilities,
- Plan and design major repairs needed, and estimate required cost,
- Execute maintenance and repair works in accordance with the said programs and plans,
- Execute periodic and routine inspection of the project facilities,
- Gives instructions and guidance to CHAWAMPU on maintenance works within tertiary blocks,

The chief of Irrigation Section should prepare monthly, quarterly, and annual activity reports.

(c) Machinery Section

The Machinery Section will be responsible for managing and supervising the use of farm machinery and for repairing and maintaining all machinery and equipment, including O & M equipment owned by the Project. The major functions of this Section are listed as follows:

1) O & M Equipment Sub-section (newly established)

- Operate O & M equipment for maintenance and repair of the project facilities,
- Update conditions of O & M equipment, and
- Record use of O & M equipment.

2) Workshop Sub-section

- Overhaul, repair and maintain farm tractor and implements,
- Overhaul, repair and maintain O & M equipment,
- Record overhaul and repair of farm tractor and implements and O & M equipment,
- Update list of equipment and spare parts kept, and
- Update conditions of equipment

The chief of Machinery Section should prepare monthly, quarterly, and annual activity reports.

(d) Tractor Hire Section

- Execute tractor hire services to farmers,
- Update conditions of tractor,
- Record tractor hire services, and
- Recommend tractor hire charge to be collected from farmers

(e) Hydropower Section (if implementated)

The Hydropower Section will be responsible for operation and maintenance of No. 1 and No.2 micro-scale hydropower stations. The contents of operation work is discussed in

Sub-section 3.5.5. As for maintenance of them, it is proposed to employ the contract basis, and supervision of maintenance work will be required accordingly. The chief of Hydropower Section should prepare monthly, quarterly, and annual activity reports.

(f) Agronomy Section

This Agronomy Section will be directly responsible for not only agricultural extension services to farmers, but also experimental activities and strengthening to CHAWAMPU and water users groups, covering the following activities:

1) Experimental Sub-section

- Execute examination tests for selecting new promising rice varieties replacing IR54,
- Conduct verification trials to test adaptability of newly introduced rice and alfalfa seeds before multiplication,
- Execute multiplication of seeds which has passed through adaptability tests , and
- Provide appropriate guidance to CHAWAMPU in managing farm operations like seed multiplication.

2) Extension and Training Sub-section

- Prepare short and medium training programs to village extension workers and farmers in the Project Area,
- Implement the programs under the collaboration with KATC,
- Disseminate information on the improved methods of farming as developed by research work from time to time,
- Conduct demonstrations using the Pilot farm and farmers fields, and
- Conduct yield survey in the Project Area.

3) CHAWAMPU Sub-section

- Sensitise and mobilise beneficiaries into participating effectively in the Project socio-economic activities,
- Strengthen CHAWAMPU and water users groups,
- Ensure participation of women in the Project activities by encouraging them to form and work in socio-economic groups, and
- Transfer technical and managerial skills to CHAWAMPU.

The chief of Agronomy Section should prepare monthly, quarterly, and annual activity reports.

(g) Handing-over Section

This Section is proposed to be newly established in KADP, in order to execute the handing-over of O & M of project facilities to farmers' organisation. The Handing-over Section shall consist of two sub-sections, Legal and Training Sub-section. The Legal Sub-section will be responsible for all the administrative matters relating the handing-over such as legal procedures and other administrative issues. The Training Sub-section will be responsible for the preparation of training and education programs for farmers and farmers' groups and for the implementation of such programs during the transitional period.

(2) 2nd Stage

After handing-over of O & M of project facilities except Kikuletwa headworks, diversion channel and related structures including No.1 and No.2 micro-scale hydropower stations. O & M for Kikuletwa headworks, diversion channel and related structures including No.1 and No.2 small-scale hydropower stations, should be made by KADP because of their locations and size. The proposed Sections are 1) Administration Section, 2) Hydropower Section, and 3) O & M Section. The works for respective sections are mentioned below:

(a) Administration Section

There will be no change in organisation and roles at 2nd stage although work volume will be largely reduced.

(b) Hydropower Section (if implementated)

This Section will play the same roles at 2nd stage with 1st stage.

(c) O & M Section

This Section will consist of three Sub-sections: Headworks Sub-section, Diversion Channel Sub-section and O & M Equipment Sub-section . Major roles of these Sub-sections are as follows:

1) Headworks Sub-section

- Control intake gates and scouring sluice gates,
- Observe and record daily discharge of Kikuletwa river,
- Observe and record intake discharge
- Prepare annual programs for routine maintenance and minor repairs of the Kikuletwa headworks,
- Plan and design major repairs needed, and estimate required cost,
- Execute maintenance and repair works in accordance with the said programs and plans,
- Execute periodic and routine inspection of the Kikuletwa headworks.

2) Diversion Channel Sub-section

- Observe and record diverted discharge to branched canals.,
- Observe and record released discharge at wasteway to Kikafu river ,
- Prepare annual programs for routine maintenance and minor repairs of the diversion channel,
- Plan and design major repairs needed, and estimate required cost,
- Execute maintenance and repair works in accordance with the said programs and plans,
- Execute periodic and routine inspection of the diversion channel

3) O & M Equipment Sub-section

- Operate O & M equipment for maintenance and repair of the Kikuletwa headworks and diversion channel,
- Update conditions of O & M equipment, and
- Record use of O & M equipment.

3.4.6 Farmers' Organisation

As discussed in ANNEX-G, farmers' organisation for O & M of project facilities will be developed on the stagewise basis in the light of handing-over of O & M of project facilities. In the 1st stage, O & M for tertiary block will be conducted by CHAWAMPU as it is, although some strengthening work will be executed. In the 2nd stage, O & M works for project facilities except Kikuletwa headworks, diversion channel and related structures including No.1 and No.2 small-scaled hydropower stations, will be carried out by Water Users' Association which will be independent from CHAWAMPU. These mattes are detailed in ANNEX-G.

3.5 Operation and Water Management Plans

3.5.1 General

The objectives of the operation and water management plan are to: 1) deliver water in a timely and equitable manner to all farmers in the project area so that they fairly share available

supplies and 2) so far as possible, adopt the irrigation schedule to the water demand. To achieve these objectives, it is necessary to make a well-established operation program particularly for the projects where water sources are limited.

3.5.2 Irrigation Plan

(1) Water Sources

(a) Existing Lower Moshi Project Area

A water source for the Existing Lower Moshi Project Area is the Njoro and Rau rivers. As mentioned in ANNEX-A, the river discharge has decreased year by year. This tendency is remarkably observed on the Rau river. The average monthly discharge in the dry season in 1994 became to 0.56 m^3/s which is so lower than 1.13m^3/s of the authorised water right. The reason of discharge decrease is due to unplanned water tapping at upstream area where paddy cultivation has been vigorously conducted by observing the success of the Existing Lower Moshi Project Area. The Existing Lower Moshi Project Area has subsequently envisaged severe water shortage and was consequently involved in the serious water conflict in 1995. In order to cope with such severe situation, it is proposed to exploit the Kikuletwa river. According to a hydrological analysis. 80% dependable flow of the Kikuletwa river at IDD54 is calculated as follows:

(Unit : m^3/s)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
10.4	10.5	10.6	13.2	16.4	11.8	11.1	11.0	10.7	10.9	10.4	10.3

(b) New Extension Area

The New Extension Area of 2.090 ha in net will be irrigated using the water from the Kikuletwa river through the diversion channel.

(c) Expanded Area

The Expanded Area is divided into two areas: Kaloleni area and Mandaka Mnono area. The Kaloleni area is further divided into three areas by the Njoro and Mamba river, that is Northern Kaloleni area, Western Kaloleni area, and Southern Kaloleni area. The existing water sources for these areas are as follows:

1) Northern Kaloleni area : Three springs
2) Eastern Kaloleni area : Spring
3) Southern Kaloleni area : Goa spring and Njoro river.

As the results of field inspection of these springs and interview with farmers concerned, it has been confirmed that these water sources have been enough for these areas:

On the other hand, a water source for irrigation of the Mandaka Mnono area is the Mwananguruwe spring. According to the discharge measurement, its discharge is approximately 300 l/s which is not enough to irrigate all the Mandaka Mnono area of 360 ha in net. Therefore, it is proposed that supplemental water shall be supplied from the Mamba river.

(2) Cropping Pattern

The proposed cropping pattern should be fitted to the natural environment of the project area. In addition, it should be an optimum pattern for the effective use of water and land, and should be profitable to individual farmers. In this study, the following cropping pattern is recommended, which details in ANNEX-E:

(a) Rainy season : Paddy (100%)

(b) Dry season : Paddy (50%) + Alfalfa (20%)

(3) Unit Irrigation Water Requirements

The unit irrigation water requirement for paddy and upland crop was estimated as mentioned below. The details of the estimate are discussed in ANNEX-K.

(a) Paddy

The field water requirements of rainy and dry season paddies are determined as follows:

1) Crop evapotranspiration of rainy and dry season paddies

Tabulated below are the potential evapotranspiration estimated by the modified Penman method.

(mm/day)

Station	Elev.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Moshi	813m	6.5	6.6	6.7	4.8	3.6	3.4	3.6	4.2	5.7	7.1	6.8	6.1
TPC	701m	5.9	6.0	5.6	4.6	3.8	3.4	3.5	4.0	4.9	5.5	5.6	5.6

As the elevation of the Study Area ranges from 715m to 760m, the potential evapotranspiration estimated using data at TPC is applied to this study.

2) Determination of percolation rates

Percolation rates for rainy and dry season paddies are calculated by deducting the said crop evapotranspiration from the measured data of KADP. The calculated percolation rates and the measured ones by KADC in 1982 and 1984 and by KADP in 1997 are plotted. From the analysis on these plotted positions, and also taking it into consideration that percolation rate would lower if continuous cultivation is realised, a percolation rate is conservatively determined at 8 mm/day for all areas.

3) Determination of field water requirements of rainy and dry season paddies

Field water requirements of rainy and dry season paddies are estimated by adding the estimated crop evapotranspiration and the percolation rate of 8 mm/day as follows:

- Rainy season paddy

Description	Feb.		Mar.		Apr.		May		Jun.		Jul.	
Crop ETc (mm/day)	6.4	6.8	6.2	6.3	5.4	5.6	4.7	4.7	4.2	4.2	4.2	-
Percolation (mm/day)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	-
FWR (mm/day)	14.4	14.8	14.2	14.3	13.4	13.6	12.7	12.7	12.2	12.2	12.2	-
FWR (mm/month)	409		442		405		394		366		378	-

- Dry season paddy

Description	Aug.		Sept.		Oct.		Nov.		Dec.		Jan.	
Crop ETc (mm/day)	4.2	4.5	5.4	5.5	6.4	6.7	7.0	7.0	6.9	6.9	7.0	-
Percolation (mm/day)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	-
FWR (mm/day)	12.2	12.5	13.4	13.5	14.4	14.7	15.0	15.0	14.9	14.9	15.0	-
FWR (mm/month)	383		404		451		450		462		465	-

(b) Upland crop

In the Project area, alfalfa is proposed as the upland crop. Since no actual measurement data are available, crop water consumption is estimated as a product of potential evapotranspiration calculated from climatic data and crop coefficients relating to crop growth stages. The modified Penman method is employed because the climatic data necessary for applying it is adequate in and around the Study Area. The crop coefficient of maize is cited from the FAO Publication No.24, and then consumptive use is calculated as follows:

	Oct.		Nov.		Dec.		Jan.		Feb.	
Potential Eto (mm/day)	5.5	5.5	5.6	5.6	5.6	5.6	5.9	5.9	6.0	6.0
Kc	0.40	0.45	0.60	0.80	1.00	1.13	1.12	0.98	0.74	0.60
Cu (mm/day)	2.2	2.5	3.4	4.5	5.6	6.3	6.6	5.8	4.4	3.6

Note: Kc = Crop Coefficient, Cu= Consumptive Use (mm/half month)

(c) Effective rainfall

1) Paddy fields

Effective rainfall in paddy fields is calculated on the basis of the daily water balance using daily rainfall data. A daily balance study is made on the following assumption :

- Ineffective rainfall : less than 5 mm/day
- Maximum depth of tank : 80 mm

Based on the results of daily water balance study, correlation between the 10-day rainfall and effective rainfall is estimated for long term run. Figure N.3.4 shows the 10 days rainfall -effective rainfall curves at the Chekereni stations, respectively.

2) Upland crop fields

The U.S. Department of Agriculture Soil Conservation Service has developed a procedure for estimating effective rainfall by processing long term climatic and soil moisture data from 50 years of rainfall records at 22 experimental stations. A study on daily balance in the soil profile is carried out, and the following relationship is derived from monthly rainfall and crop consumptive use.

$$ER = 0.2 \times R^{0.95} \times ETc^{0.31}$$

Where,

ER : Average monthly effective rainfall in mm
R : Monthly rainfall in mm
ETc : Monthly crop evapotranspiration (consumptive use water) in mm

Table N.3.5 gives the average monthly effective rainfall at the Chekereni station.

(d) Puddling, nursery and pre-irrigation water requirements

1) Puddling water requirement for paddy

Puddling water requirement for paddy depends on soil type, moisture content, etc. and varies from time to time. Porosity of soil in the cultivable layer (approximately 0 to 30 cm) is estimated to be about 40% on an average. The observed evaporation in February and March for rainy season paddy is 7mm/day, and that for dry season paddy is 5 mm/day. On the other hand, percolation is 8mm/day as discussed above. From these figures, the puddling water requirement is calculated as follows:

Description	Unit	Rainy Season Paddy	Dry Season Paddy
Soil depth	mm	300	300
Porosity	%	40	40
Soil vapour phase	%	5	5
Soil moisture before water supply	%	25	20
Water to be supplied:			
Saturation of soil profile	mm	30	50
Evaporation	mm	70	30
Percolation	mm	80	80
Standing water	mm	40	40
total	mm	220	215
say	mm	220 for both paddies	

2) Nursery water requirement

Nursery water requirement for paddy is composed of puddling water for nursery bed, consumptive use and percolation during nursery period. The nursery water requirement was estimated under the following conditions:

- Area required for nursery bed : 1/20 of paddy field area
- Nursery period : 25 days
- Required water for 25 days
  Preparation of nursery bed : 220 mm
  Consumptive use : 7 mm/day
  Percolation : 8 mm/day

3) Pre-irrigation requirement for upland crop

Pre-irrigation is required just before commencement of upland crop cultivation in case of dry field condition. The soil test results show the average field capacity of 32 % for the necessary layer for germination assumed to be 20 cm. From these figures, the pre-irrigation water requirement is estimated at 64 mm, say 60 mm.

(e) Irrigation efficiency

The Existing Lower Moshi Project applies the overall irrigation efficiency of 72% for paddy and 53% for upland crops. In this Study, the Kikuletwa river is planned as an additional water source in addition to the Njoro and Rau rivers. According to the water source development plan, the New Extension Area and the Existing Lower Moshi Project Area, except the Upper Mabogini Area and a part of the Lower Mabogini Area and Rau Ya Kati Area, are planned to be supplied with water from the Kikuletwa river by constructing headworks and a diversion channel of about 24 km. On the other hand, the Expanded Area and the remaining Existing Lower Moshi Project Area will be irrigated with the Njoro and Rau river water. In consideration of such water source development plan and the results of field measurements of canal seepage loss, the following irrigation efficiency is estimated:

Efficiencies	Water Supply by Kikuletwa		Water Supply by Njoro and Rau	
	Paddy field	Upland crops field	Paddy field	Upland crop field
Application efficiency	95%	70%	95%	70%
Operation efficiency	85%	85%	85%	85%
Conveyance efficiency	85%	85%	90%	90%
Overall efficiency	69%	51%	72%	53%

(f) Unit irrigation water requirement

Unit irrigation water requirement for paddy and is estimated based on the field water requirements mentioned above, effective rainfall, and irrigation efficiency. Since there are two irrigation efficiencies depending on water sources as mentioned above, the following 2 unit irrigation water requirements at water abstraction points are proposed:

1) Area to be supplied from Njoro and Rau Rivers

(Unit : l/s/ha)

Crop	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Rainy Season Paddy	0.1	1.2	2.2	1.9	1.8	1.0	0.1	-	-	-	-	-
Dry Season Paddy	0.2	-	-	-	-	-	0.1	1.6	2.1	2.3	2.2	1.2
Upland Crop (Alfalfa)	1.3	0.4	-	-	-	-	-	-	-	0.3	1.0	1.2

2) Area to be supplied from Kikuletwa River

(Unit : l/s/ha)

Crop	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Rainy Season Paddy	0.1	1.4	2.3	2.0	1.8	1.0	0.1	-	-	-	-	-
Dry Season Paddy	0.2	-	-	-	-	-	0.2	1.2	2.3	2.4	2.3	1.2
Upland Crop (Alfalfa)	1.4	0.5	-	-	-	-	-	-	-	0.3	1.0	1.2

(g) Design discharge

As mentioned above, two unit irrigation water requirements were proposed depending on water sources. These were used for water balance study, to determine the irrigable area to be supplied from respective water sources: Njoro, Rau and Kikuletwa river. Finally, the irrigable area was determined at 4,700 ha in net excluding 150 ha of pilot farm and sugar estate, by supplying additional water of $9m^3/s$ in the rainy season and $5 m^3/s$ in the dry season from the Kikuletwa river.

Taking into consideration two unit irrigation water requirements, the results of water balance study, water supply method, and simplification of design, design discharge for each irrigation canal is proposed as follows:

1) Diversion channel

A diversion channel will be operated on a 24-hour basis. Its flow capacity will be the same from the intake point to the release point at the Rau river in consideration of maintenance of branched main/secondary canals and more effective use of limited water. Design discharge of the diversion channel is therefore proposed to be $9m^3/s$.

2) Main irrigation canal

A peak water requirement in the rainy season are 2.2 l/s/ha and 2.3l/s/ha. Judging from small difference in these peak requirements, a unit design discharge for main irrigation canal is proposed to be 2.3 l/s/h for both areas.

3) Secondary irrigation canal

As well, a unit design discharge for secondary irrigation canals is proposed to be 2.4 l/s/ha in the same consideration above and also taking into account a possibility of whole area commanded by one secondary irrigation canal being cropped with dry season paddy at one time.

4) Tertiary irrigation canal

The design capacity of tertiary irrigation canal is determined in view of rotational irrigation along tertiary canal. The applied design capacities are as follows:

Command Area of Tertiary Canal	Design Capacity of Tertiary Canal (l/s/ha)
Less than or equal 25 ha	60 l/s/ha
More than 25 ha, but less than or equal 50 ha	120 l/s/ha
More than 50 ha, but less than or equal 75 ha	180 i/s/ha

3.5.3 Water Distribution Method and Schedule

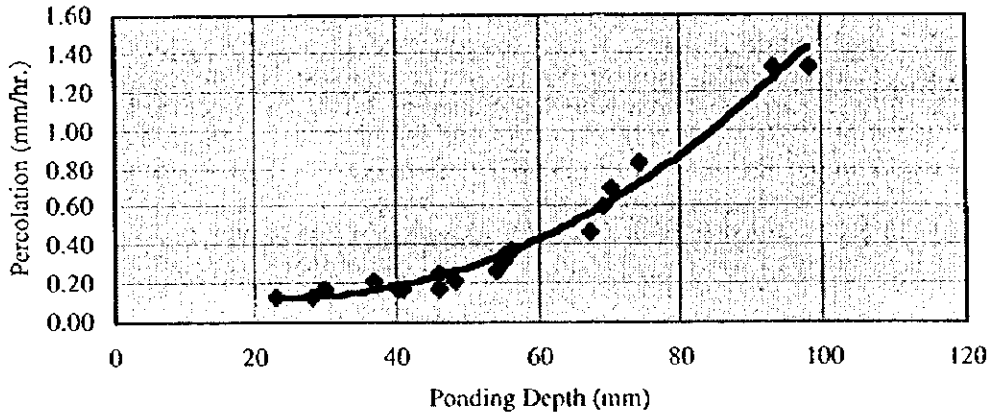
(1) Water Distribution Method

The irrigation system was planned to be operated to deliver water on schedule-demand and 24 hours-a day basis

(a) Paddy

Water is continuously supplied down to tertiary canals. In the tertiary block, a rotational water supply is made. Irrigation of paddy field is to be made by means of a basin method under which the fields will be continuously submerged with water. In principle, the water depth in paddy fields shall be maintained to be as shallow as possible, in order to avoid excessive percolation losses of water. The results of field investigation by KADC indicate that the percolation rate increases when the flooding depth is deeper than 60 mm as shown in the following figure.

Ponding Depth - Percolation Curve



From this result, the basic application of irrigation water is proposed to be 6 cm in depth. The maximum allowable water depth should be set at 8 cm so as to utilise rainfall effectively.

(b) Upland crop

1) Water supply method

Alfalfa is proposed as a main upland crop after rainy season paddy. According to the proposed cropping pattern, alfalfa will be rotationally cultivated for 20% of the Project area from the middle of October to the end of February since the dry season paddy is grown for 50% of the Project area.

Alfala as well as other upland crops, will be intermittently supplied with irrigation water. The basin irrigation method is proposed for alfalfa, using a field plot for paddy although further field ridges are required for effective water use.

2) Water supply amount at one time

Water supply amount at one time is calculated on the following conditions in this study:

- Effective root depth : 60 cm
- Soil moisture extraction pattern : Standard type (4 layers of 15 cm each)
- Available moisture : 10%

From these conditions, Total Readily Available Moisture (TRAM) is calculated at 56mm, which corresponds to water amount at one time.

3) Irrigation interval

Daily consumption use is computed at 6.6 mm/day at peak time. With this daily consumption use and TRAM mentioned above, an irrigation interval at peak time is calculated at 8.5 days. For easy operation of water supply, it is proposed to apply 7 days irrigation interval at peak time and its multiple days at other growing stage, in the light of calendar week.

(2) Irrigation Schedule

As mentioned in Sub-section 2.3.3, an irrigation schedule is prepared and announced to farmers in the following procedure;

(a) Estimate of water availability based on the river discharge

(b) Determination of the irrigation area

(c) Estimate of the diversion requirement at the headworks referring to field measurement results obtained so far.

(d) Preparation of the irrigation schedule.

(e) Approval of the irrigation schedule in a joint meeting consisting of KADP, Ward councillors, CHAWAMPU, and representatives of each village

(f) Announcement of the approved irrigation schedule to farmers in a joint meeting consisting of KADP, Ward councillors, CHAWAMPU, and representatives of each village

After implementation of the Project, the irrigable area will become more than 2 times, and the number of villages concerned will also come to 8 in total. And also, O & M of project facilities shall be transferred to farmers' organisation according to the government policy. Therefore, it is proposed that this procedure shall be modified as follows:

(a) 1st Stage

1) Estimate of water availability based on the river discharge by KADP

2) Determination of the irrigation area by KADP

3) Estimate of the diversion requirement at the headworks referring to field measurement results obtained so far by KADP

4) Preparation of the draft irrigation schedule by KADP

5) Approval of the draft irrigation schedule in a joint meeting consisting of KADP, Ward councillors, CHAWAMPU, and representatives of each village

6) Final approval of the draft irrigation schedule in the Project Implementation Committee.

7) Announcement of the finally approved irrigation schedule to farmers by RAS.

(b) 2nd Stage

1) Estimate of water availability based on the river discharge by Water Users Association

2) Determination of the irrigation area by Water Users Association

3) Estimate of the diversion requirement at the headworks referring to field measurement results obtained so far by Water Users Association

4) Preparation of the draft irrigation schedule by Water Users Association

5) Approval of the draft irrigation schedule in a joint meeting consisting of KADP, Ward councillors, Water Users Association, and representatives of each village

6) Final approval of the draft irrigation schedule in the Project Implementation Committee.

7) Announcement of the finally approved irrigation schedule to farmers by RAS.

3.5.4 Headworks and Diversion Channel

(1) Headworks

(a) Kikuletwa headworks

According to the result of water balance study, water of 9 m3/s in the rainy season from November to May, and 5 m^3/s in the dry season from June to October, can be abstracted from the Kikuletwa river. On the other hand, a diversion channel is planned to cross with the Kikafu river on the way, which joins with the Kikuletwa river about 10 km downstream from the water abstraction point. From such route plan, location of rivers, economical viewpoint, and taking it into consideration that the diversion channel is designed to have 9 m^3/s of flow capacity from the beginning to end points, it is proposed that water abstraction of 9 m^3/s shall be made throughout a year.

Opening of intake gates shall be controlled based on the water level in the Kikuletwa river. The mean monthly discharge data at IDD54 presents that river discharge has not large fluctuation in a year except three months from April to June. All the intake gates at the Kikuletwa headworks are therefore in full open position except those three month. Extra intake water sill be automatically returned back to the river through a side spillway constructed downstream. For the remaining three months, all the intake gates will be opened for 50 %, and adjustment shall be made by observing the Parshall flume constructed nearby. Such pre-set gate opening shall be determined based on the monitored data every year. As the water abstraction of water is constant at 9 m^3/s, the required water level shall be marked on the side wall of the Parshall flume in red paint for easy operation.

(b) Njoro, Mamba, Rau and Mabogini headworks

In addition to the existing Rau and Mabogini headworks, the Njoro and Mamba headworks will be newly constructed for supply irrigation water to the Kaloleni and Mandaka Mnono area, respectively. These intake gates will be operated strictly in accordance with the irrigation schedule by observing the measuring device such as Parshall flume and broad crested weir provided downstream. In case of emergency such as flood and damages of irrigation canals branched off, all the intake gates shall be fully closed by special order of the O & M Sub-section of KADP at the 1st stage and by the Water Users' Association at the 2nd Stage.

(c) Intake facilities at GOA, Mwananguruwe,and other springs

In the Expanded Area, irrigation water mostly depends upon the springs. As these springs provide almost constant water throughout a year, all the intake gates will be opened in line with the irrigation calendar by checking intake discharge at measuring device. A special consideration will not be required for gate operation due to no flood occurrence.

(2) Diversion Channel

A diversion channel is divided into two portions from type of lining: shotcrete lining for 12 km of upstream side, and concrete block lining for 12 km of downstream side. The diversion channel was designed to have a flow capacity of $9m^3/s$ from the beginning point to the end point. In the upstream side of 12 km, there are no branched-off canals except approach

channels to No.1 and No.2 small-hydropower stations, although large-scale structures such as Longoi siphon, Kikafu siphon and Weruweru aqueduct are constructed.

Water abstraction throughout a year is planned to be 9 m^3/s. All water flowing in the diversion channel will be diverted into No.1 and No.2 hydropower stations at one time for maximisation of electricity generation, and then return to the diversion canal again so that any complicated operation will not be required. However, water to be used for irrigation will be 9 m^3/s in the rainy season and 5 m^3/s in the dry season according to the water balance study result. Accordingly, in the dry season, 4 m^3/s shall be released into the Kikafu river using wasteway after No.2 hydropower station. This operation will be conducted using the sluice gates and Parshall flume constructed immediately downstream from the wasteway. In order to simplify the gate operation, it is proposed to paint two red marks corresponding to water levels of 5 m^3/s and 9 m^3/s, on the side wall of the Parshall flume because flow discharge to downstream diversion channel are only for these two cases.

In the downstream side of 12 km, there are five off-taking sites on the diversion channel. These are System -A, System-B and System-C for the New Extension Area, and two off-taking for the existing Manbogini main canal and Rau Ya Kati main canal. At all these sites, diversion facilities with a measuring device, such as turnouts and bifurcation structure equipped gates will be constructed. Discharge division will be therefore made using the gate(s) and measuring device in accordance with the irrigation calendar. Even after diversion of water required for irrigation, if there will remain certain water in the diversion channel, it will be released into the Rau river.

3.5.5 Irrigation Facilities

The irrigation area of the Project is composed of the Existing Lower Moshi Project Area (2,150ha), New Extension Area (2,090ha) and Expanded Area (460ha). These areas will be totally covered with technical irrigation and drainage canal network as mentioned in Section 3.3. As mentioned in Sub-section 3.5.2, the irrigation system was planned and operated to deliver water on schedule-demand and 24 hours-a day basis. Accordingly, water will flow in main canal to tertiary canal continuously. All the gates shall be regulated by the nominated persons such as gatekeepers strictly in accordance with the approved irrigation schedule. Canal system operation down to tertiary canal is planned for the under normal condition and unusual condition as follows:

(1) Canal System Operation under Normal Condition

The main, secondary and supply canals shall be operated by the nominated persons only such as water masters and gatekeepers. The nominated persons shall set all the gates at proper positions according to the planned discharge. In an emergency case where canal flow overtops canal banks, gates of spillways shall be opened fully so that water in the canals is drained. When water levels of canals are too low to divert required water amount water at turnouts, the check gates shall be controlled adequately so that the diversion to secondary or tertiary canals could be maintained as per the irrigation schedule.

(2) Canal System Operation under Unusual Condition

Unusual conditions such as the discrepancy of demand and supply, droughts, floods and bank failures, may occur from time to time during the long run of the operation works. Such conditions shall be therefore given to special treatment.

(a) Discrepancy of demand and supply

In case farming activities can not meet the irrigation schedule, the following action shall be taken:

1) If a quaternary block (a commanding area of each watercourse) needs more water

than the scheduled amount, reduction of water allocation to other blocks shall be checked. If possible, the saved water shall be delivered to the block which needs additional water. The excess and deficit of irrigation water shall be as far as possible adjusted and balanced within a tertiary irrigation block.

2) If it is found that adjustment can not satisfy the needs of all quaternary blocks in the tertiary blocks, an overall review of the irrigation schedule shall be executed, and adjustment shall be made for all areas.

(b) Drought

In case the available water amount of the river is less than the scheduled discharge, the re-allocation of the discharge shall be made on secondary block basis, Such re-allocation shall be made in proportion to the net irrigation area of each block. In each secondary block, the rotational irrigation shall be made in order to distribute the limited discharge equitably.

(c) Heavy rainfall and floods

In case of heavy rain, the supply irrigation water can either be reduced or entirely cut off.

(d) Bank failure

Failures of canal banks may occur in case canal flow overtops canal banks due to 1) excessive drawing of water from intakes, 2) case of check gates and turnout gates without adjusting intake discharge, 3) inflow of flood water to canals from intakes or 4) clogging or trash racks with grasses and other trashes. In such cases, causes for flow overtopping canal banks shall be removed as quickly as possible.

3.5.6 On-Farm Facilities

(1) Principal Features

The Project area is divided into about 200 irrigation blocks (tertiary blocks) for the proper irrigation water distribution. the coverage area of tertiary are about 30 ha in an average. Each tertiary block is served with one tertiary irrigation canal, drain and road. Each tertiary block is further divided into a number of farm plots. A farm plot faces a watercourse, field drain and field road which are branched off from the said tertiary canal, drain, and road respectively. A typical farm plot is designed to have an acreage of 0.3 ha (30m x 100m).

(2) Method of Water Distribution

In the tertiary block, a rotational use of irrigation water is proposed for the following advantages of rotational irrigation:

(a) It can meet peak water requirements, especially in land preparation period or paddy when more water supply is required in a short time period.

(b) Equitable water distribution can be made for all farm plots.

(c) Rotational irrigation will maximise effective rainfalls.

The tertiary block is divided into several irrigation units, so-called quaternary blocks. The quaternary block is defined as the area commanded by a watercourse. The rotational irrigation will be made by combination of the quaternary blocks. Irrigation period of a quaternary block can be decided based on the acreage of the commanding area of the watercourse.

(3) Irrigation Schedule

The irrigation schedule will be prepared based on the results of following activities:

(a) Check the maps which show the route of the tertiary canal, watercourse, location of diversion boxes, boundary of quaternary blocks and farm plots.

(b) Check the land ledger. If there is a change in land ledger, the original land ledger should be revised.

(c) Collect the information on crops, cropping area, cropping date and cropping area.

(4) Irrigation Operation

(a) Confirm the actual starting date of irrigation and distribution schedule just before the irrigation season.

(b) Distribute irrigation water rotationally on the quaternary block basis in accordance with the irrigation schedule.

(c) Cease irrigation at the early ripening stage (about 15 days before start of harvesting).

(d) Execute maintenance work of facilities after harvesting.

(5) Maintenance

All maintenance works within the tertiary block is the farmers' responsibility. The maintenance works consist of clearing and desilting of canals and drains, repairing of the canal section, structures and roads.. Especially, maintenance work for watercourse shall be executed properly in order to avoid leakage prior to start irrigation. These maintenance works should be performed by the voluntary service of the farmers concerned.

3.5.7 Small-Scale Hydropower Plants

As mentioned above, water abstraction at the Kikuletwa headworks will be $9m^3/s$ throughout a year. Accordingly, No.1 and No.2 hydropower stations will be operated using 9 m^3/s. All the canal flow of 9 m^3/s will be diverted into both stations by full opening of intake gates and full close of check gates installed on the diversion channel. When the maintenance of these hydropower stations is carried out, operation of these gates will be made just reversely.

Operation of small-scaled hydropower plant shall be conducted in accordance with the operation procedure rule. In the operation, however, careful attention shall be paid on the following items:

(a) Trash condition at intake screen

(b) Temperature conditions at bearing, winding and elsewhere

(c) Presence of vibration or abnormal sound at rotating machines

(d) Load conditions such as voltage, current, output and power factor of generator

(e) Occurrence of abnormal situation at equipment inside and outside the power station and at other structures concerned

3.6 Maintenance Plan

3.6.1 General

In parallel with proper operation, suitable and continuous maintenance of the headworks, diversion channel, irrigation and drainage facilities of the Project is indispensable to secure that

the facilities function properly ad constantly and to ensure that the economic life of the facilities is realised.

The maintenance works broadly consist of :

(a) Regular maintenance works which are performed regularly to maintain and improve the project facilities,

(b) Periodic maintenance works which include repair of minor damages.

(c) Emergency repair works which are concluded to repair the occasional damages of the project facilities caused by flood, heavy rainfall or other causes, and

(d) Annual maintenance which involves a large work quantity or requires special skill.

All these works will be checked and listed up through a patrol along the channel and canals.

In the Project, since small-scaled hydropower power is proposed, its required maintenance work is also separately explained in this section.

3.6.2 Inspection for Maintenance

For the irrigation patrol, it is necessary to make daily patrol of canals and structures. Inspection for maintenance should also be made during the patrol. Items of inspection for maintenance during the O & M patrol should be the part of canals and structures easily detected by visual observation. These items are tabulated below:

Facilities	Items to be inspected by O & M patrol for maintenance
Lining canal	Sinking and cracking of lining
Unlined canal	Sloughing of slope, settlement of bank, erosion of canal bottom, piping in canal bank, silting and grasses in canal
Structures	Silting in structure, cracking of structures
Gates	Greasing of spindle and hoist, leakage through gate, staff gauge
Trash rack	Floating debris
Farm road	Road surface

3.6.3 Regular Maintenance

The regular maintenance refers to the day to day maintenance of irrigation drainage facilities to be carried out by regular workers of maintenance labor group without needing skills. It includes routine repair of embankment, clearance of silt, weeding, filling of holes on the farm roads with earth and gravel, oiling gates etc. Satisfactory implementation requires an intensive daily inspection of the headworks, canals and appurtenant structures as well. Daily report of regular maintenance should be made by the inspectors concerned.

The maintenance groups consisting of 3 to 4 labors in a group, are to be assigned to their daily maintenance work in taking up 3 km to 5 km of canal per day. A weekly schedule and a responsible length of canal can be assigned to each group referring to the hectometer stones provided in field.

3.6.4 Periodic Maintenance

The periodic maintenance is defined as the repair of minor damages which do not cause immediate danger or malfunction to the canal system and which need special skill to have the damages repaired. The periodic maintenance will be carried out by skilled workers and/or mechanicians. Minor improvements to the existing facilities of the systems are also included in the periodic maintenance.

3.6.5 Emergency Repair

Damages to the project facilities will hamper the normal practices of the irrigation. Therefore, repair of damaged facilities should be quickly and effectively carried out under the category of the emergency repair. The damages to the project facilities may be resulted from flood, heavy rainfall, violation acts and destruction by animals and vehicles.

3.6.6 Annual Maintenance

Maintenance works which involves a large work quantities or requires special skill should be carried out under the category of annual maintenance. These works are executed based on the annual maintenance program which will be prepared by the O & M Sub-section.

3.6.7 Small-Scale Hydropower Plants

(1) Water Turbine and Ancillary Equipment

Maintenance works of water turbine and ancillary equipment are divided into three inspections such as daily inspection, external inspection and internal inspection.

(a) Daily inspection

(b) External inspection

(c) Internal inspection

Frequency of these inspections are as follows:

(a) Daily inspection : Every day

(b) External inspection : Every 6 months

(c) Internal inspection : Every 5 years.

(2) Electric Facilities

Maintenance works for electric facilities are executed by the external ad internal inspections in addition to daily visual inspection. The external inspection will include inspections and tests mainly performed from outside to confirm and maintain equipment functions well, and the internal inspection will aim at function recovery through disassembling of electric facilities. Standard frequency of these inspections are as follows:

Equipment	External Inspection	Internal Inspection
Generator and exciter	One year	5 years
Main transformer	6 years	3 years
Main circuit breaker	One year	4 to 5 years
Switchboard	6 months	4 to 5 years
Other switchboard and housing device	6 months	4 to 5 years

(3) Execution of Maintenance Works

As for maintenance of No.1 and No.2 micro-scaled hydropower stations, there are two methods. One is to hand over all of them to TANESCO, and the other is to operate and maintain them by KADP. The former method is easier since TANESCO has much experience in operation and maintenance of hydropower station, but it is reported that TANESCO is one of candidated agency to be privatised. Accordingly, it is proposed that No.1 and No.2 micro-scaled hydropower stations shall be operated by KADP, and their maintenance shall be executed on the contract basis.

3.7 O & M Equipment

3.7.1 Radio-Communication System

An internal network will support the management and operation of the commissioned canal system. For this purpose, an internal radio- communication network will be installed connecting the O & M office with control house of the Kikuletwa headworks and Water Users Association office.

3.7.2 Vehicles and Equipment

In principle, the major repairs of project facilities will be carried out by contractors on the contract basis. For the regular maintenance, periodic maintenance and annual maintenance, however, a certain number of construction equipment will be required and kept at the O & M office. In addition to these construction equipment, vehicles and motor cycles will be required for the staff movement for the operation and maintenance purposes. Below tabulated are the required vehicles and equipment.

Equipment	Specification	Required Q'ty
(1).Backhoe	0.4 m3	1 no.
(2).Bulldozer	12 ton,swampy type	1 no.
(3) Motor grader	3.1 m	1 no.
(4) Tire roller	8 - 20 ton	1 no.
(5) Dump truck	6 ton	2 nos.
(6) Pickup Truck	2 ton	2 nos.
(7) Cargo truck	6 ton	1 no.
(8) Cargo truck with crane	4 ton/2 ton	1 no.
(9) Inspection car	4WD/3000cc	4 nos
(10) Motor cycle	125 cc	15 nos
(11) Bicycle	-	50 nos
(12) Workshop equipment & tools	-	L.S.
(13) Radio-communication system	-	L.S.
(14) Computer system	-	L.S.
(15) Spare parts (10%)	-	L.S.

3.8 Monitoring and Data Collection

3.8.1 Need of Monitoring and Data Collection

For ensuring the effective use of the limited water sources and for maintaining the project facilities at the maximum workable condition, an elaborated O & M manual is of a paramount importance. In the Existing Lower Moshi Project, there is an Operation and Maintenance Manual for Project Facilities prepared in April 1985. However, this Manual will be required for revision and updating because the project scale is totally different and also circumstances around the Project is largely changed. For the revision and updating of the Manual, the following data should be monitored and collected through the actual operation and maintenance work.

(1) Data Needed for Irrigation Operation

(a) Meteorological and rainfall data,

(b) Data on water level and discharge of the Kikuletwa, Mamba, Njoro and Rau rivers,

(c) Data on discharge of Goa and Mwananguruwe springs and other springs related to water sources for the Project area,

(d) Records of daily intake discharge from the intake gate of the headworks of the

Kikuletwa, Mamba, Rau and Njoro rivers,

(e) Records of daily releasing discharge from the dam/weir of the headworks to the downstream of the Kikuletwa, Mamba, Njoro and Rau rivers,

(f) Records of daily releasing discharge from the spillway after No.2 hydropower station to the Kikafu river,

(g) Records of daily releasing discharge at the spillway after No.2 hydropower station to the downstream of diversion channel,

(h) Records of daily diversion discharge at the bifurcation structures,

(i) Records of daily diversion discharge from the diversion channel to respective main canals branched off,

(j) Records of daily releasing discharge from the diversion channel to the Rau river,

(k) Data on planted crops and cropped area In the project area, and

(l) Data on canal conveyance losses of canals.

(2) Data Needed for Maintenance Works

(a) Reports on daily O & M patrol,

(b) Reports on periodic inspection,

(c) Reports on damages of project facilities, and

(d) Commodity and labor costs.

(3) Data Needed for Study, Evaluation and Improvement on Irrigation Operation

(a) Records of operation of intake gates of the respective headworks,

(b) Records of operation of scouring sluice gates of the respective headworks,

(c) Records for all the diversion channel, supply canal, main canal and secondary canal on the following data:

- Records of operation of check gates on the diversion channel, main canals and secondary canals, and
- Records of spilled out discharge through spillways.

(4) Data Needed for Study, Evaluation and Improvement for Maintenance Works

(a) Records and reports of regular maintenance,

(b) Records and reports of periodic maintenance,

(c) Records and reports of emergency repairs, and

(d) Records and reports of annual maintenance,.

(5) Data Needed for Evaluation of Project Benefit

(a) Records and reports of power generation at No.1 and No.2 Hydropower Plants,

(b) Data of crop yields for all crops planted in all the project area, and

(c) Surveyed data and reports on living conditions of farmers' families in the project area.

3.8.2 Computer File for Storing Monitored Data

In order to cope with huge volume of data collected, it is essential to establish computer file at the O & M office. Such data will be not only systematically stored, but also can easily and conveniently be retrieved. Studies, evaluation and improvement plans will greatly be benefited using computer file.

3.8.3 Re-start of Discharge Observation at IDC5 and IDC35 Stations

IDC5 and IDC35 are old discharge measurement stations installed at Rau and Njoro rivers, respectively. Discharge observation at IDC5 and IDC35 were discontinued in 1960 and 1980. As these data is very important for discharge analysis, it is proposed to re-start the discharge observation urgently.

3.9 O & M Cost Estimate

As mentioned previously, the O & M works will be jointly executed by KADP and farmers' organisation. At first, KADP will conduct the O & M works for all project facilities except the tertiary canal system and on-farm works. And then, these O & M works except the kikuletwa headworks, small-scaled hydropower stations, diversion channel and related structures, will be handed over to the farmers'organisation. The O & M cost is therefore estimated based on such handing-over schedule, say expecting 5 years after completion of all project facilities.

(1) 1st Stage (for 5 years after completion of all project facilities)

(a) KADP office

1) Irrigation and drainage facilities

a) Salary of project staff

Figure N.3.2 shows the proposed organisation chart and staff of KADP office at the 1st stage as an O & M office. Based on this figure and the collected data on government staff salaries, the required salary of project staff is estimated at Ths.42.4 million (US$ 68,400) /year as shown Table N.3.6.

b) Office running cost

The office running cost consisting of electricity charge, water supply charge, telephone charge, purchase of stationaries, etc., is calculated at Ths.22.3 million (US$ 36,000) / year considering past data for KADP.

c) Cost for running, repair and maintenance of O & M equipment

The proposed O & M equipment is listed in Sub-section 3.7.2. From this list, their hourly cost for running, repair and maintenance of the equipment and the assumed operation hour, the required cost for running, repair and maintenance of O & M equipment is calculated at Tsh.29.0 million (US$ 46,800) / year as shown below:

Equipment	Specifications	Operation hour	Hourly cost	Amount
(1) Backhoe	0.4 m3	300	9,300	2,790,000
(2) Bulldozer	12 ton	150	13,600	2,040,000
(3) Motor grader	3.1 m	300	11,800	3,540,000
(4) Tire roller	8 - 20 ton	150	8,700	1,305,000
(5) Dump truck	6 ton	600	14,300	8,580,000
(6) Cargo truck/crane	6 ton	150	14,300	2,145,000
(7) Inspection car	4WD/3000 cc			2,480,000
(8) Pickup truck	2 ton			930,000
(9) Motor cycle	125 cc			2,480,000
Sub-total				26,290,000
(10) Others	(10% of the above)			2,710,000
Total				29,000,000
				US$ 46,800

d) Labor cost

In order to execute minor repairs for major project facilities except tertiary canal system and on-farm works, it is essential to keep labor cost as O & M cost. In this study, the labor cost is estimated at Tsh.2.9 million (US$ 4,700) / year to the total length of major canals, drains and farm roads assuming one labor per 5 km for 30 working days in a year.

e) Material cost

Material cost is also required for O & M works. Out of O & M activities for structures, concrete block lining may be given more activities. Accordingly, the material cost is considered for concrete block lining. It is estimated at Tsh.1.4 million (US$ 2,300) / year using the unit rate of Tsh.9,300 /m2 for concrete block lining and assuming 0.05 % of total concrete block lining area for major canals.

2) Small-scaled hydropower plant

The O & M cost for small-scaled hydropower plants is calculated at Tsh. 30.8 million (US$ 49,700) / year assuming 0.8 % of the total cost of electricity and mechanical facilities.

3) Total O & M cost by KADP

a) Salary of project staff	:	Ths.42.4 million
b) Office running cost	:	Ths.22.3 million
c) O & M equipment	:	Tsh.29.0 million
d) Labor cost	:	Tsh. 2.9 million
e) Material cost	:	Tsh. 1.4 million
(Sub-total)	:	(Tsh. 98.0 million)
f) Small-scaled hydropower plant	:	Tsh. 30.8 million
(Total)	:	(Tsh. 128.8 million)
	:	(US$. 207,700)
	:	(US$. 44/ha)

(b) Farmers' organisation

1) Irrigation and drainage facilities

a) Labor cost

In order to execute minor repairs for project facilities for tertiary canal system and on-farm works, it is essential to keep labor cost as O & M cost. In this study, the labor cost is estimated at Tsh.4.1 million (US$ 6,600) / year to the total length of tertiary canals, tertiary drains and tertiary farm roads assuming and opportunity cost of 0.75 x Tsh. 1,500 / labor, one labor per 10 km, and one labor for 60 ha for 30 working days in a year.

b) Material cost

Material cost is also required for O & M for structures for tertiary canals, tertiary drains and tertiary farm roads. As well, the material cost which is considered for concrete block lining, is estimated at Tsh.0.9 million (US$ 1,500) / year using the unit rate of Tsh.9,300 /m2 for concrete block lining and assuming 0.05 % of total concrete block lining area for minor canals.

2) Total O & M cost by farmers' organisation

a) Labor cost	:	Tsh. 4.1 million
b) Material cost	:	Tsh. 1.5 million
(Total)	:	(Tsh. 5.6 million)
	:	(US$.9,000)
	:	(US$. 2/ha)

(c) Total O & M cost by KADP and farmers' organisation

a) Salary of project staff	:	Ths.42.4 million
b) Office running cost	:	Ths.22.3 million
c) O & M equipment	:	Tsh.29.0 million
d) Labor cost	:	Tsh. 7.0 million
e) Material cost	:	Tsh. 2.9 million
(Sub-total)	:	(Tsh. 103.6 million)
f) Small-scaled hydropower plant	:	Tsh. 30.8 million
(Total)	:	(Tsh. 134.4 million)
	:	(US$. 216,800)
	:	(US$. 46/ha)

(2) 2nd Stage (for remaining project period)

(a) KADP office

1) Irrigation and drainage facilities

a) Salary of project staff

Figure N.3.3 shows the proposed organisation chart and staff of KADP office at the 1st stage as an O & M office. Based on this figure and the collected data on government staff salaries, the required salary of project staff is estimated at Ths.11.3 million (US$ 18.300) /year as shown Table N.3.6.

b) Office running cost

The office running cost for electricity charge, water supply charge, telephone charge, purchase of stationaries, etc., is calculated at Ths.11.1 million (US$ 17,900) / year considering the reduced organisation and staffing.

c) Cost for running, repair and maintenance of O & M equipment

The required cost for running, repair and maintenance of O & M equipment is Tsh.29.0 million (US$ 46,800) / year. Out of the cost, Tsh.2.9 million (US$ 4,700) will be needed for O & M of Kikuletwa headworks, small-scaled hydropower stations, diversion channel and related structures.

d) Labor cost

In order to execute minor repairs for Kikuletwa headworks, small-scaled hydropower stations, diversion channel and related structures, it is essential to keep labor cost as O & M cost. In this study, the labor cost is estimated at Tsh.0.2 million (US$ 300) / year to the total length of major canals, drains and farm roads assuming one labor per 5 km for 30 working days in a year.

e) Material cost

With the same manner mentioned above, material cost is estimated at Tsh.0.4 million (US$ 600) / year using the unit rate of Tsh.9,300 /m2 for concrete block lining and assuming 0.05 % of total concrete block lining area for diversion channel.

2) Small-scaled hydropower plant

The same O & M cost for small-scaled hydropower plants with the 1st Stage, say Tsh. 30.8 million (US$ 49,700) / year, is applied.

3) Total O & M cost by KADP

a) Salary of project staff	:	Ths.11.3 million
b) Office running cost	:	Ths. 11.1 million
c) O & M equipment	:	Tsh. 2.9 million
d) Labor cost	:	Tsh. 0.2 million

e) Material cost	:	Tsh. 0.4 million
(Sub-total)	:	(Tsh. 25.9 million)
f) Small-scaled hydropower plant	:	Tsh. 30.8 million
(Total)	:	(Tsh.56.7 million)
	:	(US$. 91,500)
	:	(US$. 19/ha)

(b) Farmers' organisation

1) Irrigation and drainage facilities

a) Salary of farmers' organisation staff

Salary for administrative staff in the farmers' organisation office such as chief, secretary, accountant, typist watchman and watermen shall be paid by the farmers' organisation, and other positions will be served as volunteers of farmers' beneficials. Especially, the tractor operation shall be trained during the handing-over period. The required cost for them is estimated at Tsh.12.1 million (US$ 19,5000) / year.

b) Office running cost

The running cost for farmers' organisation office including rental charge, is calculated at Ths.3.7 million (US$ 6,000) / year.

c) Cost for running, repair and maintenance of O & M equipment

The required cost for running, repair and maintenance of O & M equipment is Tsh.29.0 million (US$ 46,800) / year. Out of the cost, Tsh.26.1 million (US$ 42,100) will be needed for O & M of the project facilities except Kikuletwa headworks, small-scaled hydropower stations, diversion channel and related structures. This amount will be paid by the farmers' organisation.

d) Labor cost

In order to execute minor repairs for Kikuletwa headworks, small-scaled hydropower stations, diversion channel and related structures, it is essential to keep labor cost as O & M cost. In this study, the labor cost is estimated at Tsh.5.0 million (US$ 8,100) / year to the total length of all canals, drains and farm roads except diversion channel assuming one labor per 10 km for 30 working days in a year.

e) Material cost

With the same manner mentioned above, material cost by the farmers' organisation is estimated at Tsh.1.9 million (US$ 3,100) / year using the unit rate of Tsh.9,300 /m2 for concrete block lining and assuming 0.05 % of total concrete block lining area for the canals except diversion channel.

2) Total O & M cost by farmers' organisation

a) Salary of project staff	:	Tsh.12.1 million
b) Office running cost	:	Ths. 3.7 million
c) O & M equipment	:	Tsh.26.1 million
d) Labor cost	:	Tsh. 5.0 million
e) Material cost	:	Tsh. 1.9 million
(Total)	:	(Tsh. 48.8 million)
	:	(US$. 78,700)
	:	(US$. 17/ha)

(c) Total O & M cost by KADP and farmers' organisation

a) Salary of project staff	:	Ths.23.4 million
b) Office running cost	:	Ths.14.8 million

c) O & M equipment	:	Tsh.29.0 million
d) Labor cost	:	Tsh. 5.2 million
e) Material cost	:	Tsh. 2.3 million
(Sub-total)	:	(Tsh. 74.7 million)
f) Small-scaled hydropower plant	:	Tsh. 30.8 million
(Total)	:	(Tsh. 105.5 million)
	:	(US$. 170,200)
	:	(US$. 36/ha)

In case of "without hydroelectric development plan", salary of project staff for Hydropoer Section and O & M cost for hydro-power plants are exculded from the O & M cost estimated above. Thus, the O & M cost "without hydroelectric development plan" is as follows:

(Unit:Tsh.million)

Stage	KADP	Farmers'Organisation	Total	Total in US$	Per ha in US$
1st	96.3	5.6	101.9	164,400	35
2nd	24.2	48.8	73.0	117,700	25

4. BY-LAW FOR O & M WORKS

4.1 Existing By-Law

As for operation and maintenance of project facilities, there is the By-Law issued on June 16, 1995, aiming to effect efficient and rational operation and maintenance of project facilities. According to the By-Law, the Project Office of which KADP is presently in charge, shall be responsible for O & M of major project facilities and provision of project beneficiaries with full technical assistance.

At present, O & M works are conducted by KADP and CHAWAMPU in accordance with the By-Laws. However, there has found some unclear descriptions in the By-Law. For example, KADP is presently functioning as an "O & M office for the Existing Lower Moshi Project. But, the By-Law does not mention KADP on operation and maintenance of the project facilities, and defines only the Project Office which means an office established for the purpose of "the operation and maintenance of the Project". If so, it is deemed that a relation between "the Project Office" and KADP shall be precisely mentioned in the By-Law. As well, it shall present the relation between "the Project Office" and CHAWAMPU, too. Furthermore, the By-Law relates that "the Project Office" shall have a duty on operation and maintenance for the major project facilities only, but does not mention that for minor project facilities.

Anyhow, the By-Law will require a large modifications if the Project is implemented because the contents and scale of the Project are largely different from the present one.

4.2 Proposed By-Law

From the findings obtained through field investigation and lessons learnt from actual operation in the Existing Lower Moshi Project Area, and also considering the change of project scale after implementation, it is deemed essential to modify the existing By-Law. The modification on the existing By-Law was executed for the following conditions:

(a) The By-Law was modified for the KADP and farmers' organisation in the 1st stage.

(b) The Project area will be administratively extended over the Moshi and Hai districts, but all the irrigation areas and most of the Project facilities will be located in the Moshi district. Taking into consideration such Project situations, it is proposed that the application of the modified By-Law be submitted to the Moshi District Office.

The proposed By-Law (draft) is given in Attachment N.1.

Tables

Table N.2.1 List of O & M Equipment and Tractor under KADP

(As of December1997)

Equipment	Capacity	Q'ty	Present Conditions	Year Stationed
I. O & M Equipment				
Hydraulic Excavator	0.4 m3	1	Unworkable/spareparts & repair	1986/OECF
Crawler Tractor	11 ton	1	Unworkable/spareparts & repair	1986/OECF
Wheel Loader	1 m3	1	Unworkable/spareparts & repair	1986/OECF
Motor Grader	9 ton	1	Working condition	1986/OECF
Plate Compactor	3 HP	2	Working condition	1986/OECF
Concrete Mixer	0.1 m3	2	Unworkable/spareparts & repair	1986/OECF
Submersible Pump	50 mm	2	Scrapped	1986/OECF
Diesel Generator	3 kVA	2	Unworkable/spareparts & repair	1986/OECF
Pickup Truck	1 ton	3	All scrapped	1986/OECF
Station Wagon(4WD)	6 person	7	All scrapped	1986/OECF
Dump Truck	6 ton	2	All scrapped	1986/OECF
Cargo Truck w/crane	6 ton	1	Unworkable/spareparts & repair	1986/OECF
Motorcycle	100cc	6	2 nos. unworkable, 4 nos. scrapped	1986/OECF
II. Tractor				
Tractor	40 HP	35	Work cond.;12, need repair;18, scrapped; 5	1985/KR-II
Tractor	50 HP	16	All working condition	1994/KR-II
III. Others				
Station Wagon(4WD)	6 person	6	Working cond.; 4, need repair; 2	1988/JICA

Source : KADP

Table N.2.2 Cultivation Record of Paddy(1985to1997)(1/3)

Name of Block	Area (Ha.)	Nos. of Plot	1985	1986		1987		1988			1989		
			Dry	Rainy	Dry	Rainy	Dry	I	II	III	I	II	III
MABOGINI													
MS 1-1	21.24	73	*		*	*			*			*	
1-2	20.21	64			*	*		*			*		*
1-3	21.52	71			*	*		*		*		*	
2-1	20.80	74	*		*	*			*			*	
2-2	27.31	92	*		*	*			*			*	
2-3	24.17	87	*		*		*			*		*	
3-1	17.64	68			*	*		*			*		*
3-2	26.65	87			*		*			*		*	
4-1	20.85	72			*	*			*		*		*
4-2	31.82	112			*		*		*			*	
5-1	39.67	138		*	*		*			*			
5-2	27.59	92			*	*		*			*		*
5-3	28.89	96			*	*		*			*		*
6-1	32.07	116			*	*		*			*		
6-2	21.29	76			*	*		*		*		*	
6-3	11.80	44			*	*			*		*		*
7-1	39.63	140		*	*			*			*		*
7-2	39.82	137		*	*			*		*		*	
MS Total	472.97	1,639	94	119	473	271	122	249	134	173	199	235	177
Yearly Total			94		592		393			556			611
Rau													
RS 1-1	15.18	50				*		*			*		*
1-2	28.82	98				*		*		*			*
1-3	28.45	98				*			*			*	
1-4	25.56	90				*			*		*		
1-5	22.35	76				*			*		*		*
1-6	21.87	77				*			*		*		
1-7	21.78	77					*				*		*
1-8	10.88	39					*		*			*	
1-9	10.81	39					*		*			*	
3-1	20.28	68						*		*			*
3-2	23.81	82						*		*		*	
3-3	28.63	97						*		*		*	
3-4	25.41	88						*			*		*
4-1	34.78	122					*		*		*		
4-2	13.54	45					*		*		*		*
4-3	41.11	137					*		*		*		*
4-4	29.80	102					*		*			*	
4-5	22.27	77					*			*		*	
4-6	18.80	63					*		*		*		*
4-7	22.06	77						*			*		*
4-8	18.75	63						*		*		*	
4A-1A	21.17	70					*			*		*	
4A-1B	21.17	70					*			*		*	
8-2A	25.20	81					*		*		*		
8-2B	12.05	39					*		*		*		*
8-3	33.41	117					*			*		*	
8-4	32.66	106					*		*			*	
RS Total	630.60	2,148	0	0	0	142	349	183	328	218	300	282	241
Yearly Total			0	0	0		491			729			823
Total	1,103.57	3,787	94		592		884			1285			1434

Souce : KADP

Table N. 2. 2 Cultivation Record of Paddy(1985to1997)(2/3)

Name of Block	Area (Ha.)	Nos. of Plot	1990			1991			1992			1993		
			I	II	III	I	II	III	I	II	III	I	II	III
MABOGINI														
MS 1-1	21.24	73	*		*			*				*		
1-2	20.21	64		*			*			*		*		
1-3	21.52	71		*			*				*			*
2-1	20.80	74	*		*			*				*		
2-2	27.31	92	*				*				*			*
2-3	24.17	87		*			*			*			*	
3-1	17.64	68		*			*					*		
3-2	26.65	87	*		*		*			*		*		
4-1	20.85	72		*			*			*			*	
4-2	31.82	112	*		*		*				*			
5-1	39.67	138		*			*				*			*
5-2	27.59	92		*			*			*			*	
5-3	28.89	96	*		*			*				*		
6-1	32.07	116	*		*		*				*			
6-2	21.29	76		*			*			*			*	
6-3	11.80	44			*		*				*			*
7-1	39.63	140		*			*			*			*	
7-2	39.82	137	*				*				*			*
MS Total	472.97	1,639	229	233	173	0	402	71	0	180	204	135	134	140
Yearly Total					635			473			384			409
Rau														
RS 1-1	15.18	50		*		*					*			*
1-2	28.82	98		*				*				*		
1-3	28.45	98		*		*				*			*	
1-4	25.56	90	*			*				*			*	
1-5	22.35	76			*			*			*			
1-6	21.87	77	*		*			*				*		
1-7	21.78	77		*		*				*			*	
1-8	10.88	39	*		*			*			*			*
1-9	10.81	39	*		*			*			*			*
3-1	20.28	68		*		*				*			*	
3-2	23.81	82	*		*			*			*			*
3-3	28.63	97		*		*					*		*	
3-4	25.41	88	*	*		*				*		*		
4-1	34.78	122	*			*		*			*			*
4-2	13.54	45		*		*				*			*	
4-3	41.11	137		*		*				*			*	
4-4	29.80	102	*		*			*				*		
4-5	22.27	77		*		*		*				*		
4-6	18.80	63		*				*			*			*
4-7	22.06	77		*		*				*			*	
4-8	18.75	63	*		*			*			*			
4A-1A	21.17	70	*		*			*				*		
4A-1B	21.17	70	*		*			*			*			*
8-2A	25.20	81	*		*					*			*	
8-2B	12.05	39			*			*			*			*
8-3	33.41	117		*		*				*		*		
8-4	32.66	106	*		*			*			*		*	
RS Total	630.60	2,148	302	320	251	332	0	330	0	257	250	183	259	127
Yearly Total					873			662			507			569
Total	1,103.57	3,787			1,508			1135			891			978

Source : KADP

Table N. 2. 2 Cultivation Record of Paddy(1985to1997)(3/3)

Name of Block	Area (Ha.)	Nos. of Plot	1994			1995			1996			1997		
			I	II	III	I	II	III	I	II	III	I	II	III
MABOGINI														
MS 1-1	21.24	73		*		*			*					
1-2	20.21	64		*		*			*					
1-3	21.52	71			*	*			*				*	
2-1	20.80	74		*				*				*		
2-2	27.31	92			*						*			
2-3	24.17	87			*				*				*	
3-1	17.64	68		*		*		*			*			
3-2	26.65	87			*						*			
4-1	20.85	72					*					*		
4-2	31.82	112		*						*				
5-1	39.67	138						*					*	
5-2	27.59	92					*				*			
5-3	28.89	96		*						*				
6-1	32.07	116		*						*				
6-2	21.29	76					*				*			
6-3	11.80	44						*				*		
7-1	39.63	140					*						*	
7-2	39.82	137							*					
MS Total	472.97	1,639	0	173	100	80	109	90	127	93	120	53	166	
Yearly Total					273			279			340			
Rau														
RS 1-1	15.18	50						*				*		
1-2	28.82	98		*					*				*	
1-3	28.45	98			*					*				
1-4	25.56	90					*				*			
1-5	22.35	76		*						*				
1-6	21.87	77		*						*				
1-7	21.78	77					*				*			
1-8	10.88	39							*				*	
1-9	10.81	39							*				*	
3-1	20.28	68			*						*			
3-2	23.81	82						*					*	
3-3	28.63	97					*					*		
3-4	25.41	88		*						*				
4-1	34.78	122		*				*					*	
4-2	13.54	45					*				*			
4-3	41.11	137					*						*	
4-4	29.80	102		*						*				
4-5	22.27	77		*						*				
4-6	18.80	63		*					*					
4-7	22.06	77			*						*			
4-8	18.75	63		*						*				
4A-1A	21.17	70			*						*			
4A-1B	21.17	70		*					*			*		
8-2A	25.20	81		*					*				*	
8-2B	12.05	39						*				*		
8-3	33.41	117		*			*				*			
8-4	32.66	106			*					*			*	
RS Total	630.60	2,148	0	249	125	0	164	86	116	202	158	77	208	
Yearly Total					374			250			476			
Total	1,103.57	3,787			647			529			816			

Source : KADP

Table N.3.1 List of Project Facilities for Headwork and Diversion Channel

Facilities	Designed Dimensions
(1) Headworks	
(a) Dam	
- Type	: Concrete gravity
- Height	: 28 m
- Length	: 72 m
- Scouring sluice gates	: 2 nos. (2m wide x 3 m high each : manual operation)
- Stillinng basin	: Ski jump type
(b) Intake facility	
- Gates	: 2 nos.(2m wide x 3m high each: manual operation)
- Screen	: 10 m long x 4.6 m high
- Parshall flume	: 1 no.
(2) Diversion Channel	
(a) Design Discharge	: 9 m3/sec
(b) Upstream side of 12 km	
- Type	: Shotcrete lining
- Bottom width	: 2.0 m
- Height	: 2.6 m
- Side slope	: 1:0.3
- Longitudinal slope	: 1:1,000
(c) Downstream side of 12 km	
- Type	: Concrete block lining
- Bottom width	: 2.0 m
- Height	: 1.9 m and 2.0 m
- Side slope	: 1:1.25
- Longitudinal slope	: 1:1,500 and 1:2,000
(d) Village link road	: 13.2 km
(e) Related structures	
- Parshall flume	: 3 nos.
- Cross drain	: 15 no.
- Foot bridge	: 32 nos.
- Chute	: 2 nos.
- Bridge	: 3 nos.
- Wasteway with Parshall flume	: 1 no.
- Bifurcation with Parshall flume	: 1 no.
- Turnoutt	: 4 nos.
- Drop	: 8 nos.
- Box culvert	: 16 nos.
- Syphon	: 4 nos.
- Aqueduct	: 1 no.
- Water facility for domestic use	: 10 nos.
- Livestock trough	: 5 nos.

Table N.3.2 List of Project Facilities for Existing Lower Moshi Project Area

Facilities		Mabogini Canal System	Rau ya Kati Canal System
(1) Headworks			
- Type	:	Concrete gravity	Concrete gravity
- Height	:	1.8 m	2.3 m
- Length	:	21.5 m	24.5 m
- Scouring sluice	:	1.5 m x 1.9 m x 1 no.	1.5 m x 2.1 m x 1 no.
(2) Main canal			
- Design discharge	:	0.6 m3/s to 2.2 m3/s	1.0 m3/s to 3.1 m3/s
- Type	:	Concrete block lining	Concrete block lining
- Length	:	4.9 km	5.5 km
- Bottom width	:	0.5 m to 0.6 m	0.3 m to 0.6 m
- Height	:	0.75 m to 1.20 m	0.75 m to 1.20 m
- Side slope	:	1:1.25	1:1.25
(3) Secondary canal			
- Design discharge	:	0.1 m3/s to 0.5 m3/s	0.1 m3/s to 1.0 m3/s
- Type	:	Concrete block lining	Concrete block lining
- Total length	:	6.8 km	18.2 km
- Bottom width	:	0.3 m	0.3 m to 0.4 m
- Height	:	0.35 m to 0.75m	0.50 m to 0.85m
- Side slope	:	1:1.0	1:1.0
(4) Tertiary canal			
- Design discharge	:	60 l/s to 180 l/s	60 l/s to 180 l/s
- Type	:	Concrete block lining	Concrete block lining
- Total length	:	27.8 km	37.8 km
- Bottom width	:	0.3 m	0.3 m
- Height	:	0.35 m to 0.55m	0.35 m to 0.55m
- Side slope	:	1:1.0	1:1.0
(5) Main drain			
- Design discharge	:	4.2 m3/s	0.7 m3/s to 7.0 m3/s
- Type	:	Unlined	Unlined
- Length	:	12.2 km	4.4 km
- Bottom width	:	1.2 m	1.2 m to 7.0 m
- Height	:	1.2 m	1.2 m to 2.0 m
- Side slope	:	1:1.5	1:1.5
(6) Secondary drain			
- Design discharge	:	0.1 m3/s to 1.4 m3/s	0.2 m3/s to 1.5 m3/s
- Type	:	Unlined	Unlined
- Total length	:	14.7 km	17.3 km
- Bottom width	:	0.6 m to 1.0 m	0.6 m to 1.0 m
- Height	:	0.6 m to 1.0 m	0.6 m to 1.0 m
- Side slope	:	1:1.5	1:1.5
(7) Tertiary drain			
- Design discharge	:	65 l/s to 305 l/s	65 l/s to 955 l/s
- Type	:	Unlined	Unlined
- Total length	:	17.1 km	23.8 km
- Bottom width	:	0.4 m	0.4 m
- Height	:	0.6 m	0.6 m
- Side slope	:	1:1.5	1:1.5
(8) Farm road			
- Main farm road	:	7.4 km	10.3 km
- Secondary farm road	:	16.2 km	22.5 km
- Tertiary farm road	:	20.6 km	35.0 km
(9) Major structures			
- Bifurcation structure	:	0	1
- Turnout	:	24	40
- Check drop	:	16	31
- Drop	:	9	9
- Culvert	:	145	201
- Spillway	:	2	1
- Syphon	:	1	1
(10) On-farm works (completed totally)	:	885 ha	1,265 ha

Note : 150 ha of sugar estate and pilot farm is not included although the required water for irrigation is ensure

Table N.3.3 List of Project Facilities for New Extension Area

Facilities		System-A	System-B	System-C
(1) Irrigable area	:	181 ha	1,569 ha	340 ha
(2) Main canal				
- Design discharge	:	0.4 m3/s	0.6 m3/s to 3.6 m3/s	0.8 m3/s
- Type	:	Concrete block lining	Concrete block lining	Concrete block lining
- Length	:	0.1 km	7.4 km	2.1 km
- Bottom width	:	0.3 m	0.4 m to 0.8 m	0.4 m
- Height	:	0.75 m	0.85 m to 1.60 m	0.85 m
- Side slope	:	1:1.00	1:1.25	1:1.25
(3) Secondary canal				
- Design discharge	:	60 l/s to 270 l/s	60 l/s to1,200 l/s	140 l/s to 430 l/s
- Type	:	Concrete block lining	Concrete block lining	Concrete block lining
- Total length	:	3.1 km	18.9 km	3.0 km
- Bottom width	:	0.3 m	0.3 m to 0.6 m	0.3 m
- Height	:	0.50m	0.50m to 1.20m	0.60m to 0.75m
- Side slope	:	1:1.00	1:1.00	1:1.00
(4) Tertiary canal				
- Design discharge	:	60 l/s to 180 l/s	60 l/s to 120 l/s	60 l/s to 120 l/s
- Type	:	Concrete block lining	Concrete block lining	Concrete block lining
- Total length	:	7.2 km	52.2 km	10.9 km
- Bottom width	:	0.3m	0.3m	0.3m
- Height	:	0.45 m	0.45 m	0.45 m
- Side slope	:	1:1.0	1:1.0	1:1.0
(5) Main drain				
- Design discharge	:	-	4.6 m3/s to 6.3 m3/s	-
- Type	:	-	Unlined	-
- Total length	:	-	10.5 km	-
- Bottom width	:	-	2.0 m	-
- Height	:	-	1.0 m	-
- Side slope	:	-	1:1.5	-
(6) Secondary drain				
- Design discharge	:	0.1 m3/s to 0.7 m3/s	0.3 m3/s to 2.6 m3/s	0.4 m3/s to 1.0 m3/s
- Type	:	Unlined	Unlined	Unlined
- Total length	:	5.0 km	19.0 km	3.6 km
- Bottom width	:	0.6 m	0.6 m to 1.0 m	0.6 m to 0.8 m
- Height	:	0.6 m	0.6 m to 1.0 m	0.6 m to 0.8 m
- Side slope	:	1:1.5	1:1.5	1:1.5
(7) Tertiary drain				
- Design discharge	:	40 l/s to 145 l/s	20 l/s to 260 l/s	120 l/s to250 l/s
- Type	:	Unlined	Unlined	Unlined
- Total length	:	6.8 km	43.6 km	10.1 km
- Bottom width	:	0.4 m	0.4 m	0.4 m
- Height	:	0.6 m	0.6 m	0.6 m
- Side slope	:	1:1.5	1:1.5	1:1.5
(8) Farm road				
- Main farm road (7 m wide)	:	0.1 km	13.2 km	1.7 km
- Secondary farm road (6m wide)	:	4.4 km	34.5 km	1.5 km
- Tertiary farm road (4m wide)	:	6.1 km	52.7 km	11.4 km
(9) Major structures				
- Diversion structure	:	1	1	1
- Turnout	:	9	52	9
- Check drop	:	6	45	7
- Drop	:	1	9	1
- Culvert	:	60	413	95
- Spillway	:	0	2	1
- Syphon	:	0	0	0
- Division box	:	22	191	41
- Cross drain	:	0	3	0
- Junction structure	:	12	63	6
(10) On-farm works		181 ha	1,569 ha	340 ha

Table N.3.4 List of Project Facilities for Expanded Area

Facilities		Kaloleni Area: Northern Area	Kaloleni Area: Eastern Area	Kaloleni Area: Southern Area	Mandaka Mnono Area
(1) Irrigable area	:	4 ha	27 ha	69 ha	360 ha
(2) Intake Facilitis					
- Water source	:	Springs	Springs	Spring/Njoro river	Spring/Mamba river
- Type	:	Concrete weir	Concrete weir	Concrete weir	Concrete weir
- Number	:	3 nos.	1 no.	2 nos.	2 nos.
(3) Supply canal					
- Design discharge	:	60 l/s	60 l/s to 70 l/s	60 l/s to 90 l/s	300 l/s to 490 l/s
- Type	:	Concrete block lining	Concrete block lining	Concrete block lining	Concrete block lining
- Total length	:	0.1 km	0.1 km	0.1 km	1.6 km
- Bottom width	:	0.3 m	0.3 m	0.3 m	0.3 m to 0.4 m
- Height	:	0.45 m to 0.55 m	0.45 m to 0.55 m	0.45 m to 0.55 m	0.6 m to 0.85 m
- Side slope	:	1:1.0	1:1.0	1:1.0	1: 1.0 to1:1.25
(4) Main canal					
- Design discharge	:	-	-	-	640 l/s to 780 l/s
- Type	:	-	-	-	Concrete block lining
- Total length	:	-	-	-	1.2 km
- Bottom width	:	-	-	-	0.4 m to 0.5 m
- Height	:	-	-	-	0.85 m to 1.0 m
- Side slope	:	-	-	-	1:1.25
(5) Secondary canal					
- Design discharge	:	-	-	-	60 l/s to 380 l/s
- Type	:	-	-	-	Concrete block lining
- Total length	:	-	-	-	10.3 km
- Bottom width	:	-	-	-	0.3 m to 0.5 m
- Height	:	-	-	-	0.5 m to 1.0 m
- Side slope	:	-	-	-	1: 1.0 to1:1.25
(3) Tertiary canal					
- Design discharge	:	60 l/s	60 l/s	60 l/s	60 l/s to 120 l/s
- Type	:	Concrete block lining	Concrete block lining	Concrete block lining	Concrete block lining
- Total length	:	0.8 km	1.9 km	3.2 km	12.1 km
- Bottom width	:	0.3 m	0.3 m	0.3 m	0.3 m
- Height	:	0.45 m	0.45 m	0.45 m	0.45 m
- Side slope	:	1:1.0	1:1.0	1:1.0	1:1.0
(5) Secondary drain					
- Design discharge	:	-	-	70 l/s to 270 l/s	170 l/s to 1,650 l/s
- Type	:	-	-	Unlined	Unlined
- Total length	:	-	-	1.3 km	6.1 km
- Bottom width	:	-	-	0.6 m	0.6 m to 1.0 m
- Height	:	-	-	0.6 m	0.6 m to 1.0 m
- Side slope	:	-	-	1:1.5	1:1.5
(6) Tertiary drain					
- Design discharge	:	-	50 l/s to 100 l/s	40 l/s to 100 l/s	20 l/s to 170 l/s
- Type	:	-	Unlined	Unlined	Unlined
- Total length	:	-	0.8 km	2.1 km	10.5 km
- Bottom width	:	-	0.4 m	0.4 m	0.4 m
- Height	:	-	0.6 m	0.6 m	0.6 m
- Side slope	:	-	1:1.5	1:1.5	1:1.5
(7) Farm road					
- Main farm road	:	-	-	-	1.2 km
- Secondary farm road	:	0.1 km	0.1 km	0.1 km	10.3 km
- Tertiary farm road	:	0.8 km	1.9 km	3.2 km	12.1 km
(8) Major structures					
- Turnout	:	1	2	2	28
- Check drop	:	0	0	0	20
- Drop	:	0	0	0	0
- Culvert	:	2	2	8	74
- Spillway	:	0	0	0	1
- Syphon	:	0	0	0	-
- Dividsion box	:	2	4	9	49
- Flood dike (km)	:	-	-	-	16
- Cross drain	:	-	0	0	20
- Junction structure	:	-	2	5	13
(9) On-farm works		4 ha	27 ha	69 ha	360 ha

Table N.3.5 Effective Rainfall of Upland Crop

(1) Monthly rainfall

Locati : Chekereni (Unit:mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct.	Nov	Dec	Total
1981										58.5	17.9	58.7	135.1
1982	12.8	8.4	4.1	74.8	267.3	56.7	35.9	7.8	23.8	137.6	119.3	43.9	792.4
1983	11.4	27.7	12.4	130.0	116.0	16.7	4.8	0.0	1.7	4.3	2.7	89.6	417.3
1984	11.0	5.8	14.8	228.5	45.5	29.8	49.4	4.0	4.0	5.5	54.6	57.0	509.9
1985	43.0	138.9	86.0	58.0	100.5	6.0	12.0	1.0	0.5	20.1	46.0	55.5	567.5
1986	86.5	58.5	11.0	98.2	159.8	1.2	0.0	7.8	0.0	11.5	7.8	154.2	596.5
1987	48.0	6.6	57.7	72.1	79.0	10.7	33.1	40.6	3.5	1.0	48.8	0.0	401.1
1988	18.7	0.0	165.8	200.1	41.1	2.0	3.4	23.0	18.1	0.0	19.6	53.7	545.5
1989	67.4	22.2	53.0	336.6	35.1	2.1	0.0	5.5	15.6	23.5	8.7	87.2	656.9
1990	36.5	34.5	268.3	456.3	19.9	1.9	0.0	0.0	3.0	30.6	40.9	40.4	932.3
1991	148.3	0.0	34.5	91.9	138.4	1.6	12.1	18.4	12.1	0.0	22.4	89.0	568.7
1992	0.0	0.0	34.0	235.5	95.7	7.0	1.9	0.0	0.0	1.4	0.0	43.4	418.9
1993	90.5	100.5	56.8	36.4	117.1	0.0	0.0	0.0	0.0	11.1	35.6	42.4	490.4
1994	0.0	0.0	104.9	114.7	143.3	14.6	0.0	0.0	4.4	0.0	31.9	111.5	525.3
1995	7.5	46.8	20.9	166.6	134.6	0.0	0.0	35.9	0.0	22.0	17.5	38.2	490.0
1996	28.0	116.2	93.6	119.0	0.0	112.4	0.0	0.0	0.0	4.5	0.0	0.0	473.7
Average	40.6	37.7	67.9	161.2	99.6	17.5	10.2	9.6	5.8	20.7	29.6	60.3	559.1

(2) Crop Evapotranspiration (Consumptive Use Water) of Crops

Crop : Alfalfa

	Oct		Nov		Dec		Jan		Feb	
ETo (mm/day)	5.5	5.5	5.6	5.6	5.6	5.6	5.9	5.9	6.0	6.0
Kc	0.40	0.45	0.60	0.80	1.00	1.13	1.12	0.98	0.74	0.60
ETc (mm/day)	2.2	2.475	3.36	4.48	5.6	6.328	6.608	5.782	4.44	3.6
Ave. (mm/month)	72		118		185		192		113	

(3) Effective Rainfall for Upland Crops

ER = 0.2 x R**0.95 x ETc**0.31

Where, ER : Average Monthly effective rainfall in mm
R : Monthly rainfall in mm
ETc : Monthly crop water requirement in mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct.	Nov	Dec	Total
1981	-	-	-	-	-	-	-	-	-	35.9	13.6	48.3	135.1
1982	11.5	6.5	-	-	-	-	-	-	-	81.0	82.4	36.7	218.1
1983	10.3	20.3	-	-	-	-	-	-	-	3.0	2.3	72.2	108.1
1984	10.0	4.6	-	-	-	-	-	-	-	3.8	39.2	47.0	104.6
1985	36.4	94.0	-	-	-	-	-	-	-	13.0	33.3	45.8	222.5
1986	70.6	41.3	-	-	-	-	-	-	-	7.7	6.2	120.9	246.7
1987	40.4	5.2	-	-	-	-	-	-	-	0.8	35.3	0.0	81.6
1988	16.5	0.0	-	-	-	-	-	-	-	0.0	14.8	44.4	75.7
1989	55.7	16.5	-	-	-	-	-	-	-	15.1	6.9	70.4	164.5
1990	31.1	25.0	-	-	-	-	-	-	-	19.4	29.8	33.9	139.3
1991	117.9	0.0	-	-	-	-	-	-	-	0.0	16.8	71.7	206.4
1992	0.0	0.0	-	-	-	-	-	-	-	1.0	0.0	36.3	37.3
1993	73.7	69.1	-	-	-	-	-	-	-	7.4	26.1	35.5	211.9
1994	0.0	0.0	-	-	-	-	-	-	-	0.0	23.5	88.9	112.4
1995	6.9	33.4	-	-	-	-	-	-	-	14.2	13.3	32.1	100.0
1996	24.2	79.3	-	-	-	-	-	-	-	3.1	0.0	0.0	106.7
Ave.	33.7	26.4	-	-	-	-	-	-	-	12.8	21.5	49.0	142.4
1/5	6.6	0.2	-	-	-	-	-	-	-	0.0	2.1	20.5	29.4

Table N.3.6 Salary of Project Staff for O & M Works

(Unit: Tsh)

Grade of Staff	Required Nos.	Annual Salary	Amount
1. 1st Stage*			
(1) Director	1	600,000	600,000
(2) Administration section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	19	300,000	5,700,000
Sub-total	20		6,180,000
(3) Irrigation section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	8	300,000	2,400,000
Sub-total	9		2,880,000
(4) Machinery section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	13	300,000	3,900,000
Sub-total	14		4,380,000
(5) Tractor Hire section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	71	300,000	21,300,000
Sub-total	72		21,780,000
(6) Agronomy section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	9	300,000	2,700,000
Sub-total	10		3,180,000
(7) Hydropower section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	4	300,000	1,200,000
Sub-total	5		1,680,000
(8) Handing-over section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	4	300,000	1,200,000
Sub-total	5		1,680,000
Total	136		42,360,000
		US$	(68,400)
2. 2nd Stage**			
(1) Director	1	600,000	600,000
(2) Administration section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	17	300,000	5,100,000
Sub-total	18		5,580,000
(3) Hydropower section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	4	300,000	1,200,000
Sub-total	5		1,680,000
(4) O & M section			
(a) Senior staff	1	480,000	480,000
(b) Junior staff	10	300,000	3,000,000
Sub-total	11		3,480,000
Total	35		11,340,000
		US$	(18,300)

*: See Figure N.3.2

**: See Figure N.3.3