3.6 Agro/Socio-Economy

3.6.1 Demographic Situation

According to the population census of 1988 the total population of the Study Area was 21,004 with 4,302 households. The annual growth rate in the District from 1978 to 1988 was estimated at 2.2%. Using this estimated annual growth rate of 2.2%, the population of the Study Area in 1997 is calculated at 25,540 persons. The populations of the three areas in 1997 is also calculated on the area basis and by making reference to the Farmers Interview Survey results.

Estimated Populations in the Study Area

(Unit: persons)

Village	Population 1998	Population 1997	LMP Area	Exp. Area	Ext. Area
Mabogini	4,105	5,990	3,330	-	1,660
Rau Ya Kati	1,695	2,060	2,060	-	-
Chekereni	2,851	3,470	1,910	-	1,560
Oria	3,783	4,600	4,600	-	-
Mandaka Mnono	1,444	1,760	-	1,760	-
Kaloleni	2,568	3,120	-	3,120	-
Mtakuja	2,713	3,300	-	-	3,300
Mvuleni	1,845	2,240	-	-	2,240
Total	21,004	25,540	11,900	4,880	8,760
		(100%)	(47%)	(34%)	(19%)

Source: Figures for 1988 are from Population Census (1988), and figures for 1997 are estimated.
Note: 1) LMP Area: Existing Lower Moshi Project Area, 2) Exp. Area: Expanded Area
3) Ext. Area: New Extension Area

3.6.2 Food Situation

The Kilimanjaro Region has often suffered from food shortage due to weather conditions. In the Study Area, the majority of households in the New Extension Area and some households in the Existing Lower Moshi Project Area and the Expanded Area are also in food shortage. During 1994 and 1995, GOT provided food aid to the Study Area under the World Food Programme (WFP). Even in 1997, it was reported that about 35% of the population in the Kilimanjaro Region was in food shortage and 9% of the entire population was totally unable to buy foods due to drought. Limited fodder and water affected the livestock production too.

3.6.3 Economic Activities

There are seven villages and one ward of the Moshi municipality in the Study Area, namely Mabogini, Rau Ya Kati, Chekereni, Oria, Mandaka Mnono, Mtakuja, Mvuleni villages and Kaloleni Ward as described before. Each village is composed of sub-villages. The majority of the people are from Chagga, Pare, Sambaa, and Kahe tribes. In Mtakuja village about 20% of the people are from Masai tribe. Most of the people except Masai are engaged in agriculture and the main products in the Exiting Lower Moshi Project Area and Expanded Area are maize and paddy. In the New Extension Area maize cultivation is predominant. The people from Masai tribe are mainly pastoralists and their culture and social heritage are bound to livestock. A large number of livestock is the symbol of wealth and social status for them. Previously the

people from Kahe tribe used to engage in bee keeping, but presently they have shifted to agriculture.

Livestock keeping is a general phenomenon in the Study Area for supplementary income and for supply of dairy products and meat. It is regarded as a source of wealth and an insurance against crop failure or any other problems. During the rainy season, livestock are well fed owing to abundant grass in grazing land , but they lose weight during the dry season.

Other economic activities in the Study Area are small trade, i.e. buying and selling of cereal crops, operation of small shops, bars, mills, and labour works. Especially the Existing Lower Moshi Project Area is exposed to business opportunities, like small trade, construction, transportation, etc. There is an influx of small traders who trade in paddy and other daily use commodities.

Each village except Mandaka Mnono has a primary school. Only three villages, Mabogini, Chekereni, and Mtakuja, have dispensaries. NGOs like Roman Catholic Mission, Red Cross, Muslim Association (BAKWATA) provide some health and education services in the Study Area. Diseases commonly prevailing in the Study Area include malaria, bilharzia, diarrhoea, etc.

The majority of villagers fetch drinking water from canals or wells. Transportation is comparatively available in the Existing Lower Moshi Project Area, but poor in the New Extension Area and the Expanded Area. According to the results of hearing survey by engineers, the priority needs of the Study Area are irrigation and drinking water supply.

3.6.4 Land Tenure System

The main land ownership in Tanzania is either held through Customary Law or Leased under the 'Right of Occupancy'. According to Land Ordinance Chapter 113 of 1959 and amended in 1974, land in Tanzania is public property and no individual has the right to own land. Instead the Government grants the 'Right of Occupancy' to the user for a given time, normally 33 or 99 years but subject to renewal. According to the results of verbal inquiries to the village officials in the Study Area, the dominant land tenure system is 'Customary'. In the Study Area agricultural land had been distributed to farmers by local/tribal chiefs before the chiefdom was abolished in 1963. After the abolition of chiefdom, the land has been distributed by the Village Development Committee. Such holdings are also considered under Customary Law. Land held under 'Customary Law' does not have term limit. Such land belongs to the family head and it is handed down to male children when they have grown up, when they marry or when the head of the family (father) dies. GOT does not interfere with such land held under 'Customary Law'. The land held under 'Customary Law' can be sold with the permission of the clan members and notification to the village office.

3.6.5 Farm Management Size

The farming system in the Study Area is characterised by small individually owned farm and by cereal crops production. According to the Farm Interview Survey in 1997, the average total cultivated land per household is 1.63 ha in the Existing Lower Moshi Project Area, 1.50 ha in the Expanded Area, and 1.54 ha in the New Extension Area. The average size of irrigated land per household in the Existing Lower Moshi Project Area is 0.60 ha and that in the Expanded Area is 0.75 ha.

3.6.6 Crop Budget

The crop budget for each area under the present conditions is calculated as summarised below. As can be seen in the table, paddy is the most profitable crop in the Area, and thus farmers are motivated to cultivate paddy more and more if irrigation water is available.

Per Hectare Financial Crop Budget under Present Conditions

(Unit: Tsh)

Description	Existing Lower Moshi Project Area[1]	Expanded Area	New Extension Area[2]
(a) Dry season paddy			
- Gross income	1,155,000	787,500	-
- Production cost	305,050	186,950	-
- Net income	849,950	600,550	-
(b) Dry season paddy			-
- Gross income	-	612,500	
- Production cost	-	170,750	-
- Net income	-	441,750	-
(c) Maize			-
- Gross income	230,000	230,000	138,000
- Production cost	92,700	92,700	69,200
- Net income	137,000	137,000	68,800

Note: 1) Figures for the Existing Lower Moshi Project Area are the whole season average
2) Presently, paddy is not cultivated in the New Extension Area
Source: House holds Survey (1997) and verbal inquiries to with the farmers and extension workers

3.6.7 Farm Household Budget

Concerning the income of the households in the Study Area, presently, there are a lot of variations from village to village and between crops grown. Under the present condition, the important source of income in the Study Area is agriculture, however households in the New Extension Area are obliged to earn income from non agricultural activities because of low agricultural productivity. The estimated household income and expenditure are summarised below.

Farm Household Budget under Present Conditions

(Unit: Tsh)

Description	Ex.LMP Area	Expanded Area	New Ext. Area	Whole Area
(a) Household Size (persons)	5.6	4.0	5.0	5.0
(b) Farm Size (ha)				
Paddy Land	0.60	0.75	0.0	0.45
Upland	1.03	0.75	1.54	1.11
(c) Income Structure				
Net farm Income	684,300	656,500	106,000	482,300
Homestead Income	12,600	61,300	34,800	36,200
Livestock Income	83,500	178,400	43,800	101,900
Non-Farm Income)	291,000	383,900	521,400	398,700
Total Income	1,071,400	1,280,000	705,900	1,019,100
(d) Living Expenditure	854,700	950,300	675,600	826,900
(e) Net Reserve	216,700	329,700	30,300	192,200
US$	350	530	50	310

Source: For Farm Size, Income and Expenditure, Household Survey (1997), Verbal inquires to the Extension Officers and Village officials.
Family size and population are cited from Census, 1988.

3.6.8 Agricultural Labourers

Permanent and seasonal unemployment is a common phenomenon in the Study Area. However, labour shortage is experienced during planting, weeding and harvesting seasons. Comparatively large farmers in the Study Area hire labourers. The estimated labour force is summarised in the following table. Per household available agricultural labour in the Study Area ranges from 1.7 to 2.4 persons, and averages 2.1 persons per household.

Available Agricultural Labour Force

Labour	Existing LMP Area	New Extension Area	Expanded Area	Study Area
Agricultural Labour Nos.	4,977	3,660	2,038	10,675
Per Household	2.4	2.1	1.7	2.1

Note: Agewise labour ratio is based on the Statistics of Kilimanjaro Region (Kilimanjaro Region Statistical Abstract 1993) and in the Study Area 90% of the total labour force was estimated as agricultural labourers which is based on the verbal inquries (1997). 3 child labours (10-14 years old) are calculated as equivalent to 2 adult labours.

3.7 Marketing of Agricultural Products and Inputs

3.7.1 Marketing of Agricultural Products

The marketing system of all agricultural products has been fully liberalised. The marketing of food crops including vegetables, fruits and livestock products is dominated by private small traders. Agricultural marketing is characterised by a very large number of small traders who operate both from and outside the Study Area including Moshi, Arusha, and other parts of the country. The procurement at village level is typically direct contact between traders and farmers. The majority of farmers sell paddy to middlemen immediately after harvest. Modern standard measures are not in practice. Individual farmers and individual traders are making deals in small volumes and price, are decided through bargaining. Farmers negotiate prices according to the size of the bags brought by the middlemen and sometimes middlemen made more profit by using over compacting technique when filling the bags. Prices fluctuate over short time periods and wide seasonal variations are observed.

Farmers who sell rice to traders take paddy to mill for drying and milling and sell it after milling. Paddy coming from the farm usually has a moisture content of 20% to 24%, which should be reduced at 14% for milling. The rice mill in the Study Area which is possessed by KPHC provides its premises to dry paddy. In the case of maize, after harvesting farmers shell it, or dry it in the sun mainly on mats and floors. Most of the farmers store maize at home and sell it when the price rises. The exact volume of agricultural and livestock products exported from the Study Area is difficult to verify statistically, because there are no records. According to the traders in Moshi markets, about 70% of rice transacted in the Moshi markets comes from the Existing Lower Moshi Project Area. The flow of agricultural commodities and livestock products is shown in Figure 3.4.

In the Study Area there are two minor markets, Chekereni and Oria, which are open once a week and most of the local agricultural products are sold there. Some retailers from the markets of Moshi municipality get contact with those markets for vegetable and other food grains collection. In Moshi city local pretty traders are found in many localities. There are

eleven comparatively big markets in Moshi city. The daily buying of fresh vegetables by most consumers in the local markets is the prominent feature of vegetable marketing. The main problems pointed out by farmers are high prices with fluctuations in the market over short time periods and wide seasonal variations.

3.7.2 Marketing of Agricultural Inputs

GOT started to phase out the subsidy on fertilisers from the late 1980s and completely stopped it in 1994/95. The move and the regular devaluation of the Tanzanian Shilling to the US Dollar sparked off an extreme rise in prices of inputs. In 1990, GOT liberalised the seed industry and the private sector was allowed to entry into the production, distribution, and marketing of seeds. The marketing systems of both agricultural and livestock commodities and inputs have been fully liberalised. The Government's roles are confined to provision of market information , monitoring of market performance, quality control, research and promotion, etc.

Most of the inputs which are imported from foreign countries by authorised institutions or individuals, are acquired from different sources. The main authorised institutions in the Moshi area are the Tanzania Farmers' Association (TFA), Tanzania Coffee Board (TCB) and KNCU. There are private companies who import inputs directly from foreign countries or buy from the main suppliers and sell them in retail. Farmers in and around the Study Area obtain inputs and other agricultural tools from a rural shop known as "Uwanja Wa Mbuni Farmer's Shop" in Chekereni and other shops in Mabogini. Some farmers purchase inputs from private stockists or from the dealers in Moshi municipality.

3.8 Agricultural Support Services

3.8.1 Agricultural Support System

MAC provides agricultural support services throughout the country. In addition to the agricultural support services executed by MAC, KADP has carried out aggressive agricultural research, extension and training activities with Japanese technical assistance in the Existing Lower Moshi Project Area.

3.8.2 Research, Extension and Training

The trial and pilot farms of KADC were completed in 1982/83 with the purpose of conducting verification trials and experiments to find the best seed varieties adaptable to the Kilimanjaro area. Through the verification trials about 40 types of seeds were tested and IR-54 was selected as a promising variety. The IR-54 variety has been widely adopted by farmers not only in the Existing Lower Moshi Project Area but also in many places in northern Tanzania where irrigation water can be obtained.

KADP, succeeding KADC, has concentrated on expanding technological know-how in the Existing Lower Moshi Project Area. The paddy cultivation technique developed by KADP/KADC reflects the main components of paddy farming methods. The five main components are:

(a) Variety: Improvement of the productivity from 1.8 - 2.5 tons/ha of the traditional varieties to 6 tons/ha using IR-54.

(b) Fertilisation: Using fertilisers at the current rate of 40 kg of P_2O_5/ha and 150 kg of N/ha which are necessary and compatible with IR-54.

(c) Modern Irrigation: Moving from furrow irrigation to the modernised irrigation system.

(d) Extension: Utilising an intensive agricultural extension system in order to help farmers to change their attitude and apply improved farming practices.

(e) Farmers' Organisation: Establishing formal groups and creating abilities of operating and managing the Project infrastructure.

KADP draws its professionally trained staff from MAC through the Regional Agricultural and Livestock Development Officer (DALDO). There is a close connection between the KADP's staff and the staff of other related offices under MAC for exchange of basic information regarding their day-to-day extension activities. Information is exchanged during routine meetings in which they discuss technical matters for mutual benefit. DALDO has assigned one village extension officer (VEO) in each of the four villages in the Existing Project Area. These officers cooperate with the staff of KADP on the matters concerning the development of the Existing Lower Moshi Project.

Training of farmers and extension staff in and outside the Existing Lower Moshi Project Area started from 1982, and continued up to 1991. The following table shows the number of trainees and courses conducted at KADC/KADP. The training activities have contributed greatly to the development of the Existing Lower Moshi Project Area.

Training Courses and Trainees (October 1982 to March 1991)

Name of Course	No. of Courses	No. of Trainees
(a) Rice Cultivation Course	11	254
(b) Irrigation Course	11	137
(c) Upland Course	8	142
(d) Agricultural Machinery Course	13	263
Total	44	805

Source: KADP

In 1994 the Kilimanjaro Agricultural Training Centre (KATC) started its activities with Japanese technical assistance. Its principal objective is to strengthen the technical capability of extension personnel and key farmers on irrigated rice farming over the whole country, using the Existing Lower Moshi Project Area.

KATC has been operating in collaboration with MAC and JICA. Since commencement of its activities, 16 courses have been conducted and 433 trainees trained at KATC.

Land preparation works in the paddy fields in the Existing Lower Moshi Project Area are carried out mechanically with the support of tractor hiring services provided by the Tractor Hiring Service Section of KADP. The tractor hiring service are basically rendered only for rice cultivation purposes. All farmers in the Existing Lower Moshi Project Area can receive such land preparation services by paying a plot charge (one plot: 0.3 ha), which covers land preparation charge, water charge, and canal maintenance charge. The plot charge in 1997 was Tsh. 26,000 for members of CHAWAMPU and Tsh. 30,000 for non-members.

Tractors and major implements possessed by the Tractor Hiring Service Section were supplied under the KR-II Program by the Japanese Government as follows:

Number of Tractors Kept by KADP

Type of Tractor	No. of Units	Procurement Year
4-wheel tractor/40 HP	35	KR-II 1985 (operational: 12 units)
4-wheel tractor/50 HP	16	KR-II 1994 (all operational)
Rotary tiller	51	KR-II 1985:35 & KR-II 1994:16

3.8.3 Agricultural Credit

Financial institutions in the public sector which deal with agricultural loans include the Cooperative and Rural Development Bank (CRDP),etc. However, smallholders' access to formal lending mechanisms through the existing financial institutions is limited due to the high transaction costs associated with the lending of small amounts of money to a large number of smallholders, and due to the lack of collaterals, such as land tittle.

In order to test the mechanism of providing formal credit directly to smallholders, a number of initiatives are now underway, such as IDA financing through CRDB for projects intended to increase agricultural exports, and a scheme to test alternative lending mechanisms for small-holders. The later scheme is now ongoing under the title " Rural Credit and Saving Schemes". There are some 444 cooperative rural savings and credit schemes operating mostly in Arusha, Kilimanjaro, Mbeya, and Iringa. In the Kilimanjaro Region, some 31 cooperative rural savings and credit schemes are operating. They have a total of about 22,500 members, and aggregate savings of Tsh. 174.4 million with outstanding loans of Tsh. 46.7 million.

In the Study Area, the Rural Credit and Savings Schemes had been operated only by the Tella and Mandaka Agricultural Cooperatives. However, the operation of the scheme failed and collapsed due to cash shortage.

At the beginning of establishment of its CHAWAMPU had operated a credit facility system. CHAWAMPU then learned that the scheme had problems: farmers were allowed to take loans and pay for them when they harvest their crops but many farmers failed to pay, and the scheme has been abandoned to date. CHAWAMPU has a plan to revise the system after consultation with other organisations operating the same schemes.

Other credit sources are informal ones such as those from relatives, friends, and informal money lenders. Credit terms vary with the sources. Interest rates can range from 0% for loans from families and friends up to 100% for short-term credit loans from money lenders.

The Farmers Interview Survey carried out by the Moshi Cooperative College under a contract with the JICA Study Team reveals that some 98 % of the respondent farmers have no credit from any sources and operate their farming with their own money.

The problems on agricultural credit in the Study Area are summarised as follows:

(a) There is no formal credit line providing production loans to smallholders.

(b) Small-scale farmers cannot access commercial banks because they lack adequate financial and physical collaterals acceptable to those banks.

(c) Some farmers prefer to work on a cash basis even though it curtails their ability to expand productive activities.

3.9 Irrigation and Drainage

3.9.1 Irrigation Canal System

(1) Water Sources

The water source of the Existing Lower Moshi Project Area is the Njoro and Rau rivers. The Rau river discharge has decreased year by year due to unplanned water tapping in upstream areas where paddy cultivation has been vigorously conducted following the success of the Existing Lower Moshi Project Area. It was subsequently anticipated that the Existing Lower Moshi Project Area has severe water shortage and the area was consequently involved in serious water conflicts in 1995. In order to cope with such a severe situation, it is essential to exploit an additional water source urgently.

The Expanded Area is divided into two areas: Kaloleni area and Mandaka Mnono area. The existing water sources for the Kaloleni area consisting of the Northern Kaloleni area, Western Kaloleni area, and Southern Kaloleni area, are mostly springs. The results of field inspection of these springs and interview with farmers concerned confirmed that these water sources are enough for irrigation of these areas. On the other hand, the water source for irrigation of the Mandaka Mnono area is the Mwananguruwe spring. According to the results of discharge measurement, the spring discharge is approximately 300 l/s which is not enough to irrigate all the Mandaka Mnono area of 360 ha net. Therefore, securing a supplemental water source is essential.

(2) Irrigation Canal Network

Two irrigation canal systems commanding the 2,300 ha of the Existing Lower Moshi Project Area including 150 ha of the sugar estate and pilot farm, were constructed in 1987 with financial assistance of GOJ (OECF). At present, these canals are generally in good condition, therefore only minor repairs such as small scale embankment and replacement of damaged concrete blocks and filling of joints between concrete blocks are required.

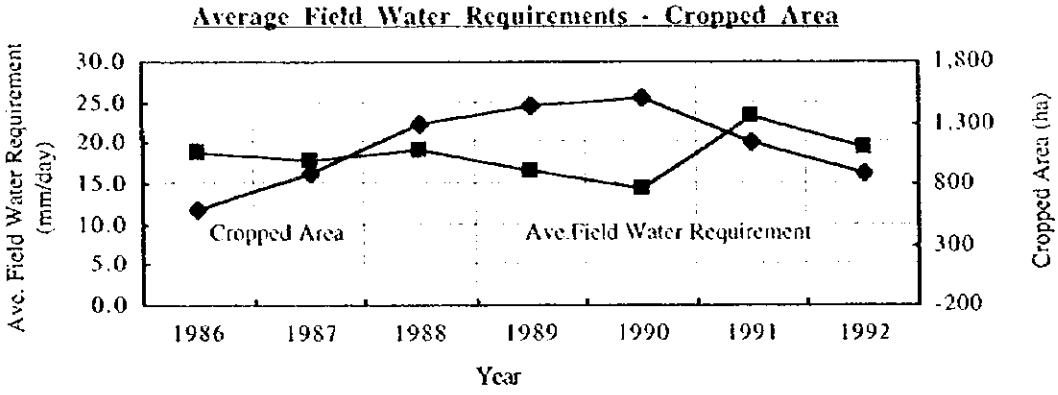
In the Expanded Area, there are three existing irrigation systems : The Njoro Kwa Goa irrigation system in the upper reaches of the Njoro river, administratively located in Kaloleni ward, Moshi urban district; 9 farmers' built irrigation systems in the same ward; and the Mandaka irrigation system located in Mandaka Mnono village. There are a few permanent structures in these existing irrigation systems and their condition is poor. These structures shall be replaced totally.

(3) Field Water Requirement

(a) Analysis of observation data

Data on field water requirement of paddy are available only for the Existing Lower

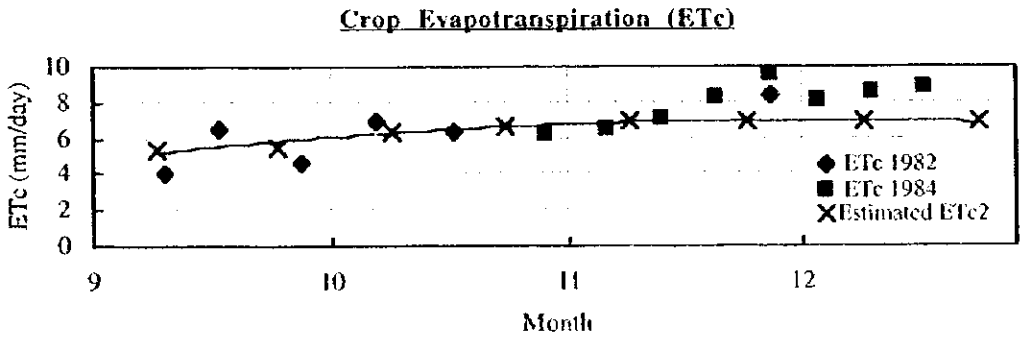
Moshi Project Area, where many field tests on water requirement of paddy were carried out by KADC, KADP, and KATC. In order to make a cross check of the test results, the JICA Study Team also conducted field tests using paddy fields in the Existing Lower Moshi Project Area. According to the KADP measurement data from 1986 to 1992, the field water requirements in the four years from 1987 to 1990 showed a small fluctuation, but those in the first year of 1986, and latter two years of 1991 and 1992 a large fluctuation. It was deemed that such a general tendency in data from 1991 and 1992 would be due to the occurrence of cracks in soils as a result of long fallow periods caused by water shortage. This tendency was also found from the relation between the average field water requirement and cropped area as shown below. The figure shows that the larger the cropped area is, the smaller the field water requirement is.



The measurement data obtained by KADC in 1982 and 1984, KATC in 1997 and the JICA Study Team in 1997, presented generally lower values than KADP.

(b) Comparison of Measured and Estimated Consumptive Use of Paddy (ETc)

The consumptive use (ETc) of dry season paddy was measured by KADC in 1982 and 1984 as shown in Table 3.3. These values except largely deviated ones, were compared with the estimated ones by the modified Penman method. The comparison graph is illustrated below:



The consumptive use measured in 1997, which ranged from 4.1 to 9.2 mm/day in the 2 months of September and October, is not largely different from this estimated consumptive use curve although the crop growing stage is slightly different. From this comparison study result, it was judged that the estimated consumptive use curve by the modified Penman method is applicable to the Study Area.

(d) Canal capacity

The main and secondary irrigation canals in the Existing Lower Moshi Project Area are designed using the unit design discharges of 1.34 lit./s/ha and 1.85 lit./s/ha, respectively, and the tertiary irrigation canals using the discharge of 46 lit/s/25 ha, aiming to ensure flexible operation of canal systems.

There are no data on the flow capacity of the existing canals in the Expanded Area. According to the field investigation, the flow capacity of existing canals in the Kaloleni area ranges from 10 lit/s to 40 lit/s, and that for the Mandaka Mnono from 10 lit/s to 200 lit/s.

3.9.2 Drainage Canal System

In the Study Area, only the Existing Lower Moshi Project Area only has been provided with a well-planned drainage system consisting of main, secondary, tertiary and field drains, and related structures, to drain the excess water from the Existing Lower Moshi Project Area into rivers flowing nearby. In addition, flood protection dikes were constructed along the Njoro and Rau rivers, to protect the Existing Lower Moshi Project Area and facilities from floods. The dikes were provided with flap gates so as to drain the internal excess water to the rivers when the water level in the rivers is lower.

There are two drainage requirements: One is for upland crop fields and the other for paddy fields. The former is so estimated as to remove the excess runoff from 5-year, one hour storm rainfall, say 30 mm/h. The latter is estimated at 5 l/s/ha on the conditions that 5-year, 24-hour storm rainfall is to be evacuated from paddy fields within 48 hours.

The drainage system designed and constructed according to these drainage requirements, has not presented any drainage problems concerning its network and capacity since its construction in 1986. From this fact, it is deemed that the applied drainage requirement is quite satisfactory.

As mentioned above, there are no drainage systems in the Expanded Area. Some areas become swampy in the rainy season every year. In particular, such swampy condition is remarkable in the Kaloleni area. In order to improve such a condition, it is indispensable to construct a proper drainage network in the Kaloleni area. A proper drainage network can be also expected to produce certain return flow.

In the New Extension Area, no drainage network nor the irrigation canal network has been established. The southern part of the New Extension Area is suffering from poor drainage condition and salinity accumulation is observed as discussed in ANNEX-D.

3.9.3 O & M Works

(1) Organisation and Staffing

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 the then Regional Development Director (RDD), presently

Regional Administrative Secretary (RAS) of the Kilimanjaro Region was also created in the same year. The present organisation chart of the KADP office is given in Figure 3.5. KADP is headed by a director. Under him, there are 5 sections: Administration Section, Irrigation Section, Machinery Section, Tractor Service Section, and Extension Service Section. As of December 1997, KADP has a staff of 67.

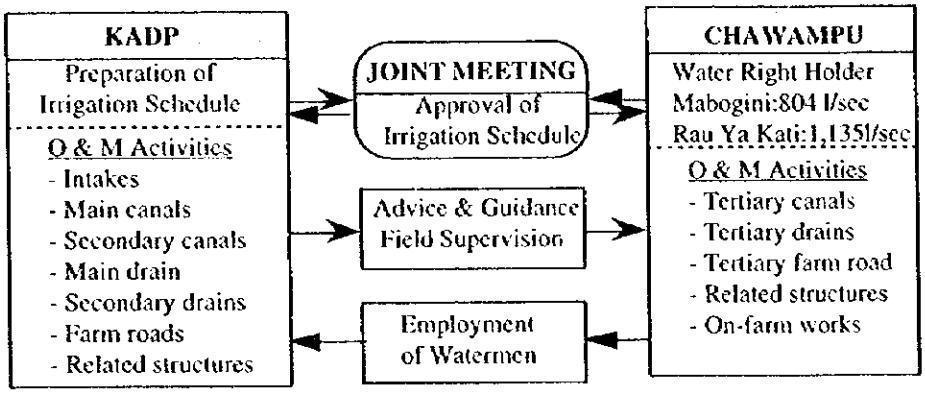
In the Expanded Area, there are 2 irrigation systems: The Njoro Kwa Goa and Mandaka systems as described in ANNEX-K. The Njoro Kwa Goa irrigation system and the Mandaka Mnono irrigation system are operated by WUA. Functions of WUAs are as follows:

- To ensure irrigation water supply and equal distribution to field plots;
- To prepare and amend by-laws;
- To collect water charge from the beneficiaries; and
- To operate and maintain farm canals properly.

(2) O & M Works

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 to tertiary irrigation canals, and CHAWAMPU is responsible for operation of tertiary irrigation canals, watercourses and respective irrigation blocks under instruction and guidance of KADP. The coordination chart between KADP and CHAWAMPU on Project operation is illustrated below.

Coordination Chart between KADP and CHAWAMPU



In the Expanded Area, the O&M works for both irrigation systems are executed by farmers themselves within their capability, but could not be executed well due to organisational weakness, financial constraints, and lack of technical know-how in O&M of irrigation facilities.

(3) O & M Cost

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 had been totally subsidised by GOT until 1993, but GOT has largely reduced the subsidisation for office running cost since 1994. The latter cost has been paid by CHAWAMPU.

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

3.9.4 Water Management

(1) Diversion Water Requirement

In the Existing Lower Moshi Project Area, field water requirement for paddy cultivation was measured by KADP from 1986 to 1992. Taking into consideration the results of actual field water requirement measurement, KADP has applied the average diversion requirements of 3 lit./s/ha at the headworks site. On the other hand, there are no diversion requirements in both existing farmers' built irrigation systems in the Expanded Area. Water is abstracted from a spring and/or river from time to time on their demand basis or based on the available water quantity.

(2) Irrigation Schedule

An irrigation schedule for the Existing Lower Moshi Project Area has been prepared and announced to farmers in the following procedure:

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

In the Expanded Area, the basic and prevailing paddy cropping calendar is the originally recommended one for the Existing Lower Moshi Project Area. However, the Expanded Area is subjected to seasonal inundation in April and May. When the seasonal inundation lasts to June, the start of dry season paddy cultivation may be delayed to some extent, and thus the irrigation calendar is obliged to follow this cropping calendar.

(3) Irrigation Method

In the Existing Lower Moshi Project Area, irrigation water is distributed continuously to tertiary canals covering the selected area based on the irrigation schedule. In the tertiary blocks, rotational water supply is applied for 2 watercourses at a 10-day interval at the puddling time, and 2 watercourses at a 5-day interval at the remaining crop growing time.

No irrigation is systematically practised in the Expanded Area. Water supply is made on a farmers' demand basis only.

(4) Collection of Cultivation Charge

CHAWAMPU collects cultivation charge from farmers and send to the national treasury. The amounts of the cultivation charge collected since 1994 are summarised in the next page:

Collected Cultivation Charge

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

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 for canal repairs.

3.9.5 Field Measurements

(1) Canal Seepage

Canal seepage was measured for the secondary canal (RS-4), tertiary canal (RS-4-2), and watercourse (RS-4-7, No.1), by the ponding method. The results indicated that the conveyance loss of the secondary canal, tertiary canal, and watercourse was 3%, 2% and 10% respectively. In addition, the same watercourse was tested again in the same manner, but after repairs were done by farmers as one of the routine maintenance works. The test result showed a seepage loss of 6%.

(2) Return Flow

In order to know whether water supply is effectively executed, and also to grasp the approximate water supply discharge, a return flow measurement was carried out in the RS 4-3 tertiary block in one cropping season from June 1997 to October 1997 when water supply was discontinued. The results of return flow measurement showed that about 4% of supplied water was released into drains throughout one cropping season. It was deemed that this water management was satisfactorily executed if judging from this value. The peak water supply was 2.6 l/s/ha in June at the puddling time, and 2.4 l/s/ha in August when no rain was observed.

3.9.6 Review of By-Law

A by-law was issued on June 16, 1995, with an aim of ensuring efficient and rational operation and maintenance of the Project facilities. In accordance with the by-law, O&M works are conducted by KADP and CHAWAMPU. However, some unclear descriptions have been found in the by-law. Taking into consideration such unclear descriptions and the large change in the development scale , it is proposed that the existing by-law be modified.

3.10 Rural Infrastructure

3.10.1 Existing Road Network

(1) General

The roads which compose the existing road network in and around the Study Area are classified as follows:

Road Classification in the Study Area

Classification	Location	Agency in charge
National highway	Route A23 (Arusha- Moshi-Himo-Tanga)	Ministry of Works
Municipal road	Around the Study Area	Moshi D.C
District road	Around the Study Area	District (Moshi & Hai Districts)
Project road	In the Existing Lower Moshi Project Area and TPC area	KADP, TPC
Ward road	In the Study Area	Ward
Village road	In the Study Area	Village

The structural conditions of the respective roads are 1st grade asphalt pavement (Route A23), secondary level asphalt pavement (TPC main roads), gravel pavement (KADP trunk road), laterite pavement (main and secondary farm roads), and unpaved roads (village and tertiary farm roads).

The district and municipal roads are maintained by the Road Sections of Moshi District and Moshi Municipal Council, respectively. These departments also provide technical support for the repair of all ward and village roads when the need arises. The ward and village roads are managed by the ward and village offices, and are only repaired once or twice a year after the rainy season by the inhabitants' work groups. These maintenance works consist mainly of manual banking and clearing.

(2) Existing Lower Moshi Project Area

The Existing Lower Moshi Project Area covers four villages: Mabogini, Rau Ya Kati, Chekereni, and Oria. The road network in the Area is composed of the roads classified in the following 4 classes:

Road Classification in the Existing Lower Moshi Project Area

Class	Effective width(m)	Number	Length (km)	Pavement
Trunk road	9	1	16.1	Gravel
Main farm road	6	3	17.7	Laterite
Secondary farm road	5	12	38.6	Unpaved
Tertiay farm road	3	76	55.6	Unpaved

The volume of traffic on the trunk road was surveyed to grasp the existing traffic condition in the Area. The average daily volume of traffic was 150 nos. during the survey conducted on two representative days of the week, Monday and Friday, from 6:00 to 18:00. The condition of the roads cited above was also surveyed, and the results are summarised as follows:

(a) Trunk road:

- very rough surface with deep ruts and holes with standing water;
- zigzag traffic course;
- muddy and slipping condition after rain
- poor drainage condition; and
- partially gravel paved and other portions are lost or disappeared.

(b) Farm roads:

- narrow road width due to grass growing which obstructs smooth traffic;
- rainwater flowing into irrigation canals at several places due to the reverse gradient of the road surface caused by lack of maintenance,
- others conditions are almost the same as the trunk road.

Especially, pipes in culverts related with secondary and tertiary canals are exposed due to erosion of road surface by rainfalls.

The O&M works of the Project roads are undertaken by the Machinery Section of KADP in collaboration with the Irrigation Section. Maintenance equipment such as motor grader, dump truck, wheel loader was provided in 1986 (refer to Section 3.9), however, most of them are in unworkable condition due to the lack of spare parts and deterioration.

(3) New Extension Area

There are 4 villages in the New Extension Area: Mtakuja, Chekereni, Oria and Mvuleni. There are some village roads with a total length of about 28 km in the Area. The road width is generally 3 m, but the main village road from Mvuleni to the trunk road via Chekereni village is in average 5 m wide on average. The road conditions are very poor, and even in the dry season, the roads are passable only for 4-WD vehicles. No vehicles can pass during the rainy season. Roads maintenance works are mostly carried out once a year after the rainy season. In Chekereni village, a motor grader from KADP is used to repair the main road. The rental charge with operator is Tsh.3,000 /day. All of the cost including fuel is collected from the villagers. The road width is almost 3 m, and the estimated traffic volume per day is less than 10 nos.

(4) Expanded Area

The Expanded Area includes a part of Mandaka Mnono village and Kaloleni ward. In the Mandaka Mnono area, only two village roads are available. One road leads to Msaranga and the other to Chekereni and their total length is estimated at 4.7 km. The road conditions are almost the same as those in the New Extension Area. The Kaloleni Area is served only by ward roads with a total length of 1.7 km and their average width is 3 m. The road conditions are slightly better than in the Mandaka Mnono area because of their proximity to town. Roads are maintained by the inhabitants themselves once a year after the rainy season.

Paddy harvested in the Expanded Area is transported to the market in the Existing Lower Moshi Project Area (Chekereni village) across the Rau river by bicycle or by poor transportation means. During the survey, most farmers urged the construction of bridge(s) even small one(s) across the Rau river, so that they can transport agricultural products and access to the market in Chekereni village and to Moshi city.

(5) Proposed Diversion Channel Route Area

The TPC farm and five villages, Kawaya, Mkalama, Longoi, Kikafu Chini and Mijongweni are lived along the proposed diversion channel route. Two roads are providing access to the proposed Diversion Channel Route Area: The northern road branches off from Route A23 on the way to Arusha, and the southern route connects the area with the TPC farm

crossing the Kikafu river. On the proposed diversion channel route through the TPC farm, only village roads with total length of about 8 km are available. These roads are in very rough conditions and practicable only in a limited period each year due to obstruction by stagnant water on the roads and river flow crossing the roads, etc. In Kikafu Chini and Mijongweni villages, road maintenance works are done only by manpower once or twice in every two weeks. In Mkalama village, road maintenance works are mostly carried out once a year after the rainy season as same as in other villages.

3.10.2 Domestic Water Supply

(1) General

In the Study Area, water for the domestic use is supplied to villages from various sources such as public water supply system, canals, wells, rivers and springs.

There are two public water supply systems in the Study Area: One is extended until Mabogini, Chekereni, Oria, Rau, Mtakuja and Mvuleni villages, the other covers Kaloleni ward. The former is under the control of the Water and Works Department of Moshi District. Operation and maintenance of the facilities down to the main pipes are under the control of the District through the said Department. After the main pipes, the system is controlled by the respective villages and households. The water source is the Coffee Curing spring (called Njoro spring). Water supply is made through community taps and/or house taps. The latter are given particular attention in item (4) of this sub-section.

Villages located far from the public water supply systems and/or far from residential areas, depend on irrigation canals, wells, rivers and springs for their water supply. Most of these water supply sources are insufficient in quantity and poor in quality. For drinking, water should be boiled in order to get rid of the impurities and pathogenic germs. These conditions in each area are explained in the following sub-sections.

(2) Existing Lower Moshi Project Area

The number of households which are provided with water through the pipeline network (Mabogini - Kahe Water Supply System) in the area, is 130 out of 800 households in Mabogini, 16 out of 400 in Rau Ya Kati, 7 out of 710 in Chekereni, and 10 out of 840 in Oria village. There are 47 community taps in the area, and 300 villagers share one tap on an average. Water supplied at the community taps is free of charge, but the households supplied with water have to pay a charge of 900 Tsh./month per household. Shallow wells, KADP irrigation canals and the Rau river are also main sources of drinking water, however they are still insufficient. Water for other domestic uses including washing, bathing and animal drinking is mostly provided by the same canals and river. In this area, there are 9 shallow wells, however in the dry season their water level falls and they cannot supply a sufficient water quantity. Recently, a tube well owned by KATC has been transferred to Chekereni village for public use following a strong request of the villagers.

(3) New Extension Area

A public water supply system is also provided in this area. However, there are 2 private and 9 public taps for 720 households in Mtakuja village, and only 1 public tap for 550

households in Mvuleni village. Tap water discharge is insufficient because of low pressure due to the location of these villages in the downstream portion of the pipeline. Domestic water including drinking water is thus been obtained mainly from either canal water of the Existing Lower Moshi Project at the boundary of the eastern side, or from stream water coming in from the TPC farm. Also there exist over 20 wells maintained by villagers and individuals in the area, which are used principally for washing, bathing, etc. Most of these wells are shallow with less than 5 m depth, and are difficult to get water in the dry season. Villagers drink the water without boiling it, and as a result, the rate of diseases caused by bacteria and/or amoeba is high. Therefore, the living standards in this area are very low. Urgent remedial measures are essential. No development plan for the water supply system in these villages is available.

(4) Expanded Area

Only Kaloleni ward has a public water supply system in the area. This system is under the control of the Works Department of Moshi Municipality. The number of households using this water supply system is 50 out of 850 households, or a ratio of 6 %. These households pay water charge according to their consumption volume counted by water meters. For example, a household of 10 people pays about Tsh 4,000 /month. There are no public taps, so most villagers buy water for drinking and other domestic uses from private taps at a cost of Tsh 10 /20 lit. The water source is the Msere spring located 12 km from Moshi town, which also constitutes the water source for the town. There are 2 springs, Goa and Dobi, which supply 30% of the water use in Kaloleni village. These 3 springs are also the main sources of irrigation water in the Expanded Area. On the other hand, the Mwananguruwe spring is the main water source for Mandaka Mnono village. All these water sources are sufficient in quantity and fair in quality.

According to the investigation results, installation of a new piped water supply system in Mandaka Mnono village was requested to the District, but there is so far no response due to the lack of budget. Villagers have plans to apply some flood protection measures using their own fund in order to stop the sedimentation and the inflow of residues into the springs in Kaloleni village.

(5) Proposed Diversion Channel Route Area

In the area, mainly all villages take domestic water directly from the closest rivers and local canals, with the exception of Kikafu Chini village where a few community taps are used for water distribution. Springs also constitute water sources of all villages except Mijongweni village.

The Longoi river serves in Kawaya and Longoi villages, and 3 rivers (Weruweru, Kikafu and Karanga) serves Mijongweni village. Some rivers are seasonal and are hence insufficient in quantity, their water quality is also poor. These rivers also constitute the sources of canal water as explained below, but the discharges of some rivers decrease in the dry season from August to February as shown in Section 3.3.

The Mapacha canal was constructed by the Government in 1971 and conveys water from the Lundugai river to Kawaya and Mkalama villages for irrigation and domestic purposes in the dry season. The canal is managed by a main committee composed of representative

members of the 2 villages. In addition, a committee established in each village is responsible for operating and maintaining the part of the canal related to their village. Maintenance works are carried out once a week by the villagers after the rainy season.

In Longoi village, there are 2 canals taking water from the Longoi river: One is the Nguzonne Pacha canal which includes an intake constructed by the Community Development Trust Fund and a 8 km long canal built by the villagers in 1993; the other is the Mferej B Longoi canal with a local weir and an old canal. Both canals are used for agricultural purpose. The former is managed by the Water and Works Department of Moshi District and the latter by the villagers. In Mijongweni village, a canal from the Weruweru river was constructed by the Kilimanjaro Zonal Irrigation Office, and is now maintained by the villagers once a week.

There are 2 shallow wells used in Kawaya village, which were dug by a group of interested villagers and are maintained by the group. In Mkalama village, there exist 2 shallow wells which are maintained by the villagers. All these wells are only useful in the rainy season, therefore their water quantity is insufficient. Their water quality is as bad as that in the New Extension Area.

In the area there exist the Mapacha spring in Kawaya village, Mkalama spring in Mkalama village, and Nguzonne spring in Longoi village. The Nguzonne spring is the biggest among the three. It is located near the Longoi river, at the boundary between Longoi and Kikafu Chini villages. Villagers gather along the banks of the stream flowing from this spring and use its water for drinking, washing, bathing, etc. The place plays the role of a kind of community place.

The sources of domestic water supply mentioned above are generally insufficient in quantity except for some rivers, but fair in quality. Urgent measures are required to address these problems.

Longoi village has a project to develop a water source for drinking. A hydrogeological survey was carried out by the Water and Works Department in Moshi District, but no further works have been performed after that. There is no other development plan for water supply in these villages.

3.10.3 Relevant Village Development Plan

Moshi District has formulated the extension/rehabilitation projects for water supply systems to raise the coverage of the population supplied with clean and safe drinking water from 45% to 90%. Main and branch pipelines of the Mabogini-Kahe Water Supply System will be improved depending on the projects, but there is no response of the Government to the proposal. The development plans of the public water supply systems for the respective villages have been prepared or are under implementation by the District to improve the existing conditions, however, all plans are delayed or postponed due to financial constraint.

In Oria village, there is a plan to rehabilitate the existing well and construct a new pipeline for domestic water supply. The said well has been already constructed and water quality has already been checked so far. Presently, the village is collecting money to purchase and install a pump.

A new pipeline system is planned to run from the Mwanangurwe spring in Mandaka Mnono village and connect the main pipe in Oria village to Rau Ya Kati village. An 8 inch pipeline is designed and the cost is estimated at Tsh.210 million. Though the drawings have been completed, the actual works have not yet started.

3.11 Farmers' Organisations

3.11.1 General Background

Under the present legislation system in Tanzania, there are two methods of establishing farmers' organisations that acquire the juridical status through registration with the Government; One method is in conformity with Societies Ordinance of 1954; and the other is in conformity with Cooperative Societies Act No. 51 of 1991. The former is applied to the case of non-profit legal persons for implementing public services, and the latter is applied to associations of persons that have voluntarily joined together for the purpose of achieving common needs.

Generally, farmers' organisations may be divided into two categories: Organisations registered with the Government in accordance with Cooperative Societies Act of 1991; and organisations which have not been registered yet, but deemed to be able to register under the same Act. In the Study Area, the farmers' organisations included in the former category are agricultural marketing cooperatives and the Paddy Growers Association (CHAWAMPU), and those in the latter category are water users' associations/groups in existing irrigation schemes and women's and youth groups, etc.

3.11.2 Paddy Growers Association (CHAWAMPU) in Existing Lower Moshi Project

(1) Historical Background

In connection with KADP's activities, farmers involved in the Existing Lower Moshi Project organised voluntarily 4 WUAs, one each in Mabogini, Chekereni, Rau Ya Kati, and Oria villages, and one Central Water Users' Committee. The main duties of these WUAs and Committee are to collect money for land preparation and water charge from the farmers, and to convey necessary information from KADP to the farmers. The money collected from the farmers is sent to the Treasury through KADP.

Under the Economic Recover Programme, GOT decided to withdraw from providing assistance to economic generating activities including the Existing Lower Moshi Project. To cope with the situation, KADP encouraged the establishment of a new farmers' organisation with enough qualifications to take over the Project facilities and their operation. In 1993, the existing four WUAs were dissolved to form a new organisation named CHAWAMPU. CHAWAMPU was registered as a cooperative society in March 1993.

(2) Activities of CHAWAMPU

CHAWAMPU has actually dual functions: One is an agricultural marketing cooperative and the other a water users' association. The present CHAWAMPU's by-law seems to be

rather suitable for the agricultural marketing cooperative than for the water users' association. The activities of CHAWAMPU laid down in its by-law are as follows:

(a) Procurement, storage, and supply/selling of agricultural inputs and all essential commodities required for the economic development of CHAWAMPU;

(b) Procure, operate, and ensure efficient utilisation of crop processing machines;

(c) Establishment and management of crop plantation;

(d) Collection, processing and selling of crops;

(e) Advice to members on the importance of applying modern agricultural techniques;

(f) Maintenance and development of lands to be distributed to the members for agricultural production;

(g) Advice to members on the proper utilisation of land for agricultural production;

(h) Operation and maintenance of farm machinery and equipment for their better use by the members and CHAWAMPU; and

(i) Execution of all beneficial activities essential for the fulfilment of the CHAWAMPU's objectives.

(3) Organisation of CHAWAMPU

The organisation chart of CHAWAMPU is shown in Figure 3.6. The highest administrative organ of CHAWAMPU is the General Meeting of members held at least once a year.

A board as an executive organ has been organised. The board consists of 15 members allocated to Mabogini, 6; Rau Ya Kati, 4; Chekereni, 3; and Oria, 2. These board members are elected by CHAWAMPU's members in each village.

Under the executive board, 3 standing committees are organised: Finance and Planning Committee; Agriculture and Water Management Committee; and Machinery and Construction Committee. Apart from the standing committees mentioned above, a Sub-committee under the Executive Board is organised in each village.

(4) Membership of CHAWAMPU

Under the CHAWAMPU's by-law, the membership of CHAWAMPU is open to any person who: a) possesses farmland in CHAWAMPU area; b) is 18 years old or older; c) agrees with the conditions and regulations of CHAWAMPU; and d) participates effectively in the socio-economic activities carried out by CHAWAMPU. The actual membership, however, is strictly limited to those who have irrigated paddy land in the Existing Lower Moshi Project Area. Of the total number 1,876 of beneficiary farmers in the Existing Lower Moshi Project Area, the number of CHAWAMPU's membership was only 783 as of February 1997.

The reasons why the number of members is limited are considered to be the following: a) The present CHAWAMPU's by-law lacks an article for the mandatory participation of beneficiaries in the organisation of CHAWAMPU; b) farmers have complained of little supply of water to KADP; and c) farmers can't expect high income, and they don't want to make contribution of share and member's fee, etc.

(5) Actual Activities of CHAWAMPU

CHAWAMPU undertakes such activities as a) all activities related to paddy production, i.e. farm preparations, plowing, seedling, and transplanting; distribution of irrigation water; collection of water charges; operation and maintenance of canals; and procurement of fuel for farm machinery and vehicles; b) marketing of agricultural inputs; c) coordinating its activities with the agencies concerned including KADP, RAS, DALDO, WUAs etc.; and d) settling the troubles among CHAWAMPU members.

With regard to commercial activities, CHAWAMPU has established a retail shop for selling agricultural inputs. The fund for the shop was raised from the capital and member fees. The agricultural inputs procured by CHAWAMPU include fertilisers and agro-chemicals. The inputs are procured from the Tanzania Fertilisers Company (TFC) and Tanzania Farmers Association (TFA) all situated in Moshi town. Due to liberalisation policy enacted in 1990 several shops are dealing competitively on the same business.

(6) Countermeasures against Infringement of Water Right, and Penalties on Offenders

The cropped areas in the Existing Lower Moshi Project Area have suffered from severe shortage of irrigation water combined with farmers' selfish use of water, especially in Mabogini area. In order to cope with this situation, KADP and CHAWAMPU considered together a plan keeping closed contact with lawyers and authorities concerned.

As a result of the efforts of all the authorities concerned, the Moshi District Council By-Laws of 1995 titled "Regulation of Agriculture in the Lower Moshi Irrigation Development Project" has been formulated on June 16, 1995, in accordance with the Local Government Act No. 7 of 1982.

The purpose of the by-law is to ensure efficient and rational operation and maintenance of the facilities, agricultural land and water sources created under the Existing Lower Moshi Irrigation Project. While all legalistic preparations have been completed there are still many offenders who break the cropping plan and schedule, pay no water charge, etc. Up to the end of 1996, 64 Project beneficiaries particularly in Upper Mabogini area were sued as offenders of the by-law by CHAWAMPU, and 13 of the said 64 beneficiaries were ruled the by-laws as unconstitutional.

3.11.3 Water Users' Associations (WUAs)

In the Expanded Area, there are two existing irrigation systems, namely the Njoro Kwa Goa irrigation system in the upper reaches of the Njoro river, administratively located in Kaloleni ward, Moshi municipality; and the Mandaka irrigation system located in Mandaka Mnono village.

The farmers in both the Mandaka Mnono and Njoro Kwa Goa irrigation schemes have a long experience in irrigated farming. The irrigation systems were constructed by the farmers themselves. WUAs were organised after the construction of irrigation facilities, and these 2 WUAs have functioned and carried out O&M of the facilities within their capability. The general functions of these WUAs are as follows:

(a) To ensure equitable irrigation water distribution to farmers;

(b) To prepare and amend by-laws,

(c) To collect water charge from beneficiaries, and

(d) To operate and maintain farm canals properly.

These 2 WUAs, however, have faced many problems that prevent them from carrying out O&M effectively. The following are the major constraints commonly faced by the two existing WUAs;

(a) Organisational weakness,

(b) Financial constraints, and

(c) Lack of technical know-how in O&M of irrigation facilities.

3.11.4 Farmers' Marketing Cooperatives

In the Study Area, there exists one primary agricultural cooperative named Tella Mandaka Agricultural Cooperative (TMAK) in Mandaka village. TMAK, which covers Tella and Mandaka villages, was established in 1984 with the purpose of providing marketing services to farmers, such as supply of farm inputs and storage of crops including paddy, maize, cotton, etc. The membership of TMAK was 1,010 as of February 1996. Since 1994 up to date, however the organisation has remained dormant due mainly to insufficient capital and strong competition with many dealers.

The reasons why so few cooperatives exist in the Study area are conjectured to be the following:

(a) Earlier agricultural cooperatives were rather collective agricultural production societies with more bureaucratic colour than ones under the international cooperatives' concept. Farmers are generally not so positive to reorganise agricultural cooperative societies.

(b) The Study Area is located in the immediate vicinity of Moshi town where many agriculture related traders engage in commerce.

(c) Paddy and maize are usually traded through traders who go to the villages.

(d) The Study Area covers 8 villages, of which the farmers cultivated paddy in Mabogini, Chekereni, Rau Ya Kati, and Oria villages have established CHAWAMPU mentioned previously.

3.12 Environment

3.12.1 Procedural Background of Environmental Study

To achieve the goal of "sustainable development", the National Environmental Action Plan (NEAP), adopted by GOT in June 1994 lists EIA as one of 5 priority policy instruments.

However, authorised standards and guidelines of IEE / EIA are not available in Tanzania, although the "Environmental Impact Assessment Guidelines for Tanzania" (Draft) is being prepared by GOT. Therefore, IEE and EIA could only be conducted in accordance with the

existing Japanese "Guideline for Environmental Consideration on Agricultural & Rural Development Projects" (Dec. 1992) as well as "Guideline on Environmental Consideration for Main Project Studies" (July 1992) authorised by JICA.

IEE and EIA for the Project were conducted not only in accordance with the JICA approved guidelines, but also with agreement of the responsible staff of the National Environment Management Council, therefore IEE / EIA contents and procedures could even meet policies described in the drafted Tanzanian guideline.

3.12.2 Present Environmental Conditions

Table 3.4 is a summary description of the social and natural situations in and outside the Project sites. In particular, the Nyumba Ya Mungu (NYM) reservoir site located downstream of the Project area could be identified as an environmentally fragile area from both social and natural points of view.

3.12.3 Ecological Regions under Environmental Study

In order to closely examine environmental impacts of the Project implementation on the related areas of different ecological natures, the areas in and outside the Project area were divided into 6 ecological regions as shown in Figure 3.7. It is because that environmental impacts depend significantly upon ecological characteristics, especially hydrology and topography of each area. The 6 ecological regions are :

(a) Ecological Region 1: The Project irrigation areas consisting of the Existing Lower Moshi Project Area, Expanded Area, New Extension Area, related villages, village facilities and the Rau river ;

(b) Ecological Region 2: The construction site and the area directly upstream of the planned headworks on the Kikuletwa river ;

(c) Ecological Region 3: The construction trail along the planned diversion channel from the new headworks to the existing Mabogini intake weir ;

(d) Ecological Region 4: The downstream area along the Kikuletwa river from the new headworks to its inflow point at the NYM reservoir ;

(e) Ecological Region 5: The downstream area of the Rau and Ruvu rivers from the irrigation drain end to its inflow point at NYM reservoir ; and

(f) Ecological Region 6: The areas in and outside the NYM reservoir

3.12.4 Results of IEE

(1) Environmental Items

Environmental items subject to IEE were divided into 13 social impacts and 10 natural impacts.

(2) Predicted Significant and Negative Impacts

Environmental impacts were examined, using checklist matrixes for all the 6 ecological regions and for all the environmental items from social and natural points of view,.

Tables 3.5 and 3.6 summarise the significant negative impacts of the Project on the social and natural environment of the Project, based on the IEE study results. Some impacts are definite (marked with 'O'), while the others are likely but still in question (marked with '?'). The tables also mention possible countermeasures thinkable only at this IEE stage against each definite or questionable impact.

The areas the most effected by the Project are the Ecological Region 1 (direct agricultural development sites) and the Ecological Region 6 (the NYM reservoir site), from both the social and natural environmental points of view. However, the other 4 ecological regions were also assessed to be more or less affected adversely.

(3) Recommendation of Further EIA Study

As IEE clarified that some significant negative impacts would be definitely or most likely brought about by the Project if no appropriate mitigation measures are introduced before its implementation, an EIA study is strongly recommended to be carried out in the Phase-II study stage.

3.12.5 Results of EIA

(1) Selected Environmental Items

Based on the results of the IEE, only 16 environmental items (9 social items and 7 natural items) were selected out of the 23 ones for IEE.

(2) Results of Impact Prediction and Assessment

EIA clarified both positive and negative impacts of the selected environmental items of the Project during its construction and operation stages. These results are summarised in Table 3.7, which also shows the necessity of protective / mitigative countermeasures and monitoring for each item. The environmental impacts predicted and assessed to be negative under EIA are shown in the next table.

Results of Impact Prediction and Assessment

Environmental Item	Affected Area *	Affected Phase
(a) Involuntary resettlement	Ecological Region 3	Construction
(b) Population increase	Ecological Region 1	Construction & Operation
	Ecological Region 3	Construction
(c) Outbreak and prevalence of diseases	Ecological Region 1	Operation
(d) Increase of solid wastes	Ecological Region 1	Operation
(e) Proliferation of hazardous species	Ecological Region 3	Operation

*Note : * The Ecological Regions are sketched in Figure 3.15.*

The reasons why these items were assessed to be negative impacts are briefly explained below:

(a) Involuntary resettlement

Households to be resettled under this Project is very few, if any. However there is a possibility of some private assets such as the cultivated land and fruit trees to be compensated especially along the diversion route close to the populated area.

(b) Population increase

The Project area is expected to expand almost twice as large as the present area. This means that the human resource requirements for the whole Project area will be more than double, and that labourers will have to come from outside areas as it is already happening. Besides, population will be increased during the construction stage, in particular in the Ecological Regions 1 and 3, due to the influx of workers. Domestic infrastructural services and facilities should be properly arranged to meet the population increase should be properly arranged without causing adverse environmental impacts.

(c) Outbreak and prevalence of diseases

It is clearly seen that the increase of the Project area will obviously accelerate the water-borne disease cases such as schistosomiasis and malaria. But, due to lack of biological and pathological researches to predict the case increase rates, the impact and level of increase of diseases can only be determined by continuous monitoring.

(d) Increase of solid wastes

The generated rice husks will be piled more as rice production increases, especially around the existing central rice mill and village area. This will disturb air quality due to wind. Beside domestic wastes resulting from the population increase will deteriorate the canals' function and water quality. All these affect the surrounding people and livestock.

(e) Proliferation of hazardous species

The planned headworks and diversion channel will promote further proliferation of crocodiles in the river and perhaps in the inundated areas of the new headworks on the Kikuletwa river. This is because the growth of littoral macrophytes along the river banks will become intensive with time, hence creating suitable habitats for crocodiles to proliferate. So crocodile intrusion into the channel, even by terrestrial migration, will be harmful in the Ecological Region 3.

3.12.6 Conclusion of Environmental Study

As mentioned above, major adverse impacts related to the five items could be predicted. Necessary protective / mitigative measures against them should be taken for environmental conservation. But the results of the EIA study generally showed that the Project activities would have no significant negative impacts on most of the social and natural environmental items.

It can therefore be concluded that, within the limitations of the prediction and assessment methods employed during the EIA study, the Project is considered to be environmentally viable, provided that some mitigation measures be implemented (these measures are described in Chapter 8 : Environmental Conservation Plan).

Finally, it is recommended that the contents of the EIA report be reflected during the detailed design and other pre-project undertakings to ensure environmental sustainability of the Project during its construction and operation stages.

3.13 Women in Development

3.13.1 Introduction

Women in the Study Area constitute half the number of the population. They are responsible for agricultural works at all seasons. However, according to traditional laws and

customs existing in the Area, women are not allowed to own, purchase or inherit properties, though they are the main producers.

The situation of women in the Study Area is worse both socially and economically. The recent information on the literacy rate for women and infant mortality rate in the Kilimanjaro Region was no available, but those in 1978 were 67% and 7.6%, respectively.

3.13.2 Women's Workload

The Study revealed that women work longer hours than men. Women perform 60% to 80% of agricultural work. The table below shows women's workload per day:

Women's Workload per Day

Time	Activities	Hours
5.00 - 6.00	Waking up, washing, cooking, eating, feeding cattle, milking	1.00
6.00 - 6.45	Walking to the fields (12 km)	0.45
6.45 - 15.00	Working in the fields	8.45
15.00 - 16.30	Collecting firewood and return home	1.30
16.30 - 17.00	Fetching water (approximately 1km to source)	0.30
17.00 - 19.00	Lighting fire/cooking meal for family	2.00
19.00 - 20.00	Serving meal and eating	1.00
20.00 - 21.00	Washing children, herself, and dishes	1.00
21.00	Going to bed	

Source: Regional Community Development Office, Kilimanjaro

A woman works at least 17 hours a day. She doesn't have any chance to participate in other activities such as attending public meetings, training, group discussion, etc. This tight activity schedule is the major setback for women development.

3.13.3 Present Condition in the Study Area

(1) The Role of Men and Women in Farm Work/Side Work

The table below shows the participation of men and women in agricultural production in the Kilimanjaro Region.

Role of Men and Women in Farm Work

Agriculture	Men	Women	Boys	Girls
Cleaning (farm preparation)	*	*		
Hoeing/Cultivation	*	*	*	*
Seeding		*		*
Weeding		*	*	*
Carrying manure to the farm		*		
Carrying harvest to storage	*	*	*	*
Preserving crop		*		*
Processing crop		*		*
Subsistence farming (gardening)		*		*

Source: Community Development Department, 1996

Due to insufficient income from agricultural activities, some men are engaging in other activities in and outside the village to supplement the meagre income in order to meet the living

expenses. The activities include employment as civil servant in government offices, parastatal and private organisations, petty trader, etc.

There are few women engaged in activities similar to men. Their activities mostly include clerical work, receptionist, nurse, teacher, petty trader, etc. Women workers account for only 5% of the total population.

(2) Source of Water for Households

Women carry the burden of water collection for family use. The sources of water available in the Study Area are domestic and public taps, irrigation canals, wells, rivers and springs. However, only a few households (about 10%) are supplied tap water. Those who do not have water supplied to their houses, spend an average of half to one hour daily collecting water for their family. This represents a great deal of energy and time loss for women who take responsibility for sustaining the security of their families and production from the land.

As women and girls primarily fetch water (occasionally assisted by boys), children and particularly girls will be affected by low performance in schools due to tiredness and time spent collecting water that could otherwise be spent on study.

(3) Women's Contribution to Agriculture

Ninety five percent of all women in the Study Area engage in agricultural activities, the remainder work as petty traders, art crafts, and wage earners employed in small holdings. Despite women's major contribution to both food and cash crop production for local consumption, the survey revealed that they do not reap the direct rewards of their workload.

In the Study Area, land ownership is governed by customary law and practices; men according to this arrangement are heads of families and owners of the land; women only enjoy residual rights. To a very large extent this situation has contributed to the subordinate position of women and to underdevelopment of the economy.

(4) Participation of Women in the Cooperatives

In the Study Area, there is a CHAWAMPU. The cooperative has 783 members of whom 136 or 17% are females. No women are holding leadership posts in this farmers' cooperatives from the headquaters to branches. Of the rest of the women in the Study Area who are not members of CHAWAMPU, some are eager to recognise themselves and form socio-economic groups to generate income and meet their daily family requirement. There is a need to induce women to join cooperatives and to hold necessary leadership posts.

(5) Women and Public Participation

The Study envisaged that heavy workload and child care responsibilities prevent women from participation in public meetings, training, etc. and that they need first to get permission from their husband before attending. Some taboos and customs are the factors contributing to low participation of women in public arenas as women are regarded as inferior to their male counterparts.

3.14 Public Meetings

3.14.1 General

Public meetings were held under the sponsorship of GOT with the assistance of the JICA Study Team. The objectives of the public meetings were to explain and discuss the development plan of the Project.

A total of 8 public meetings were held including one for women only in accordance with MAC's suggestion (ref. Minutes of Meeting on November 17, 1997).

3.14.2 Outline of Public Meetings

The meetings were held from December 22, 1997 to January 3, 1998 under the chairmanship of Mr. John Mahenda, Acting District Commissioner of Moshi District. The officials concerned such as Divisional Secretary, Ward Officer, VEO, Village Chairman, and Chairman of CHAWAMPU attended at the meetings.

Explanation was made by KADP Director on the basis of the Explanation Note prepared by the Study Team. In order to get the full understanding of attendants, a leaflet showing the outline of the plans in Swahili was distributed to all village leaders, and the development areas and location of the main facilities were presented by the use of the Project layout map.

The total number of attendants the eight meetings were about 2,100 farmers These consisted of farmers, women, and leaders of villages. The details of the attendance are as follows:

Attendance at Public Meetings

Area	Village	Attendants
(a) Existing Lower Moshi Project Area	Chekereni	550
	Mabogini	300
	Rau & Oria	300
	Women's only	70
(b) New Extension Area	Mtakuja	300
	Mvuleni	300
(c) Expanded Area	Mandaka Mnono	200
	Kaloleni	10

Before finishing the explanation, beneficiaries' opinions were assessed by asking the following questions to which they were supposed to say "Yes" or "No" by just raising their hands.

(1) Do you accept the development plan of the Project as explained to you ?

(2) Do you accept farmers' duties outlined and presented to you ?

(3) Do you participate in the construction works implemented under the farmers' participation program free of charge?

The replies of all attendants were unanimously "yes" to all the 3 questions.

3.14.3 Results of Public Meetings

Discussions were made by allowing beneficiaries to ask questions, suggestions, criticism or modifications to the proposed development plan. Many speakers firstly expressed thanks to GOJ for having supported the Existing Lower Moshi Project. Useful suggestions and requests with their well understanding of the Project were obtained through the meetings. The major suggestions and requests are summarised as follows:

- The environment is polluted by rice husks from paddy milling machine, so the Project authority is requested to consider how to process rice husks into charcoal briquettes, compost manure, livestock feeding, etc.
- A new paddy milling machine is requested to be procured to supplement the existing one when the Project is operated at its maximum.
- Water for domestic use is insufficient, therefore the Project authority is requested to assist in supplying tap water to households.
- The Project authority should construct necessary bridges to ease communication and transportation of paddy.

The specific suggestions and requests for respective areas raised in the meetings, are as follows:

(1) Existing Lower Moshi Project Area

In this area, there were 4 public meetings including one for women only. The relative 4 village people made strong desires for the implementation of irrigated rice cultivation through exploitation of new water source, being anxious about the present severe water shortage. Especially, the Chekereni village people were keenly eager for urgent implementation of the Project since they had provided watercourses with concrete block lining at their own cost, so as to cope with constant water shortage.

In the women's public meeting, lots of opinions were centred on the need of training toward promotion of the women's independence. For the Project, most of women wished for its earlier implementation because of increase of income leading to enhancement of living standard in spite that their workload would be increased.

(2) Expanded Area

The rice production in this area has arrived at certain level by introducing the same variety and cropping pattern of paddy with the Existing Lower Moshi Project Area , however it would be stalled due to lack of irrigation and drainage facilities. From such situations, the village people in the Expanded Area were much interested in technical irrigation and drainage system to be provided under the Project. In addition, the Mandaka Mnono village people gave their concern to the flood protection scheme since this village is frequently attacked by flood.

(3) New Extension Area

The village people in this area, are presently cultivating maize, sunflower, etc. under rainfed condition, so that agriculture production is much influenced by the weather condition. Even drinking water is not sufficient for them. From such present situations, they offered their strong wishes on the Project implementation which would enable to provide stable water supply for irrigation and domestic use.

CHAPTER 4 FORMULATION OF DEVELOPMENT PLANS

4.1 Problems and Constraints to Profitable Agriculture Development

In the Study Area, agricultural activities are presently executed in the Existing Lower Moshi Project Area, the Expanded Area, and the New Extension Area at respective levels. These activities were reviewed through site inspection, discussion with the government agencies and farmers' organisations concerned, and study of data and information collected. As a result, many problems and constraints were clarified as shown in Table 4.1, which shall be adequately examined and reflected upon the formulation of the respective project development plans. The major problems and constraints common in the agronomy and agro-economy in the Study Area are 1) restricted cropping season due to low temperature; 2) absence of a quality rice seed supply system; 3) less intensive farming practices for upland crops; and 4) poor cooperative and economic activities such as farm inputs supply and marketing of farm products. In addition, the specific problems and constraints in other fields in the respective areas are as follows

(1) Existing Lower Moshi Project Area

- Shortage of irrigation water.
- Low participation rate in CHAWAMPU.
- Imperfect CHAWAMPU's By-Law.
- Poor maintenance of farm roads and drainage canals.
- Need of strengthening of O&M and water management organisation.

(2) Expanded Area

- Organisational weakness of WUAs.
- Poor canalisation system.
- Poor drainage condition.
- Lack of technical know-how in O&M and water management.
- Poor road density

(3) New Extension Area

- Presence of salt affected areas.
- Extremely poor financial status of farmers.
- Absence of irrigation and drainage system.
- Poor road density and less maintenance of existing roads.
- Very limited water sources for domestic use.

Table 4.1 presents in detail the problems and constraints in the Study Area.

4.2 Basic Development Concept

(1) Development Objectives

As mentioned in Chapter 2, GOT has repeatedly declared the needs of attainment of self-sufficiency in food and the allevation of poverty through rural development in the relevant national development plans. On the other hand, the Study Area is facing 1) the decrease in food production and water conflicts among farmers due to constant water shortage; 2) a gap in

farmers' income caused by different level and/or lack of irrigation and drainage facilities; and 3) also another gap in rural life level due to non equitable availability of rural infrastructure. Taking into consideration the above, the integrated agriculture and rural development in the Study Area aims at increasing food production, raising the living standards of rural people, stabilising and developing rural agriculture, and finally contributing to the attainment of self-sufficiency in food as mentioned above.

(2) Strategies for Sustainable Development Plan

The Existing Lower Moshi Project in the Study Area where a well-planned irrigation and drainage system had been provided, has brought about execellent results exceeding the targeted crop production, under cooperation of GOT and GOJ and also due to enthusiasm of farmers in irrigated paddy cultivation. However, the study results on the agricultural activities in the Existing Lower Moshi Project Area relate the needs of strengthening and improvement of soft aspects such as O&M, agricultural extension services, agricultural support services, and farmers' organisations, to maintain such execellent results. It is anticipated that these would come about when the development plan is implemented in the future. Thus, taking into account the lessons learned from the actual operation of the Existing Lower Moshi Project Area and development constraints faced in the Expanded Area and the New extension Area, the integrated agriculture and rural development plan for the Study Area is formulated focusing on the following points:

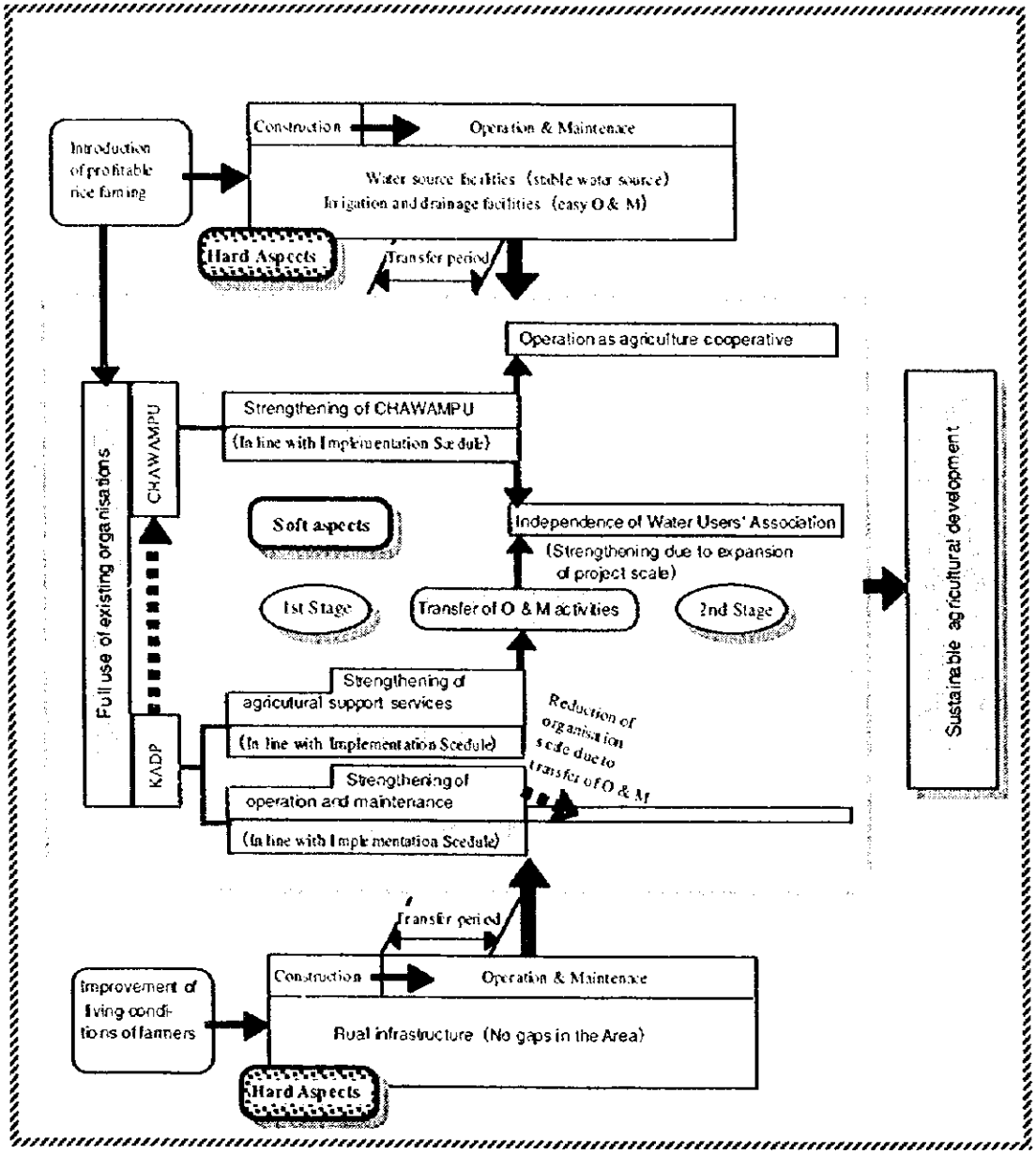
(a) Hard aspects

- Exploitation of stable water sources
- Introduction of irrigation and drainage system with easy O&M
- Equitable provision of rural infrastructure in the Study Area

(b) Soft aspects

- Introduction of profitable irrigated paddy cultivation
- Application of the practical strengthening plan of KADP and farmers' organisations by full use of the present system under relevant law and act.
- Application of the strengthening plan of agricultural support services in line with the project implementation plan.
- Preparation of the O&M plan considering handing-over of O&M activities to the farmers' organisations.

In addition, it is necessary to adopt a well-harmonised approach for both the hard aspects and soft aspects mentioned above, to implement a sustainable rural agricultural development by increasing food production and raising the living standards of farmers. In this Study, it is proposed to implement stepwise strengthening of farmers' organisations and agricultural support services, in line with the implementation schedule as shown below:



Furthermore, there find the different agricultural activities in the Existing Lower Moshi Project Area, the Expanded Area and the New Extension Area. In the formulation of the development plan, therefore, the following attention shall be given to the respective areas:

4.3 Agriculture Development Plan

4.3.1 Basic Approach

The existence of high potential for irrigated agricultural development in the Study Area has been proved by the past integrated development efforts of GOT and GOJ. Aiming to rationally exploit this potential and to ensure efficient and sustainable use of land, water and human resources for agricultural development in the Area and for improvement of the living standards of rural people, the basic concepts for agricultural development and specific areawise

approaches to the development are established by incorporating the lessons learned from the past experiences in agricultural development in and around the Study Area as follows:

- To envisage integrated agriculture development well synchronised with engineering and institutional development;
- To take areawise approaches to ensure that development approaches will duly address specific development constraints in the respective areas;
- To formulate the rice cropping calendar so as to avoid low temperature injury; the critical period of about 20 days from the booting stage to 5 days after heading should not coincide with the period of cool temperature in July and August;
- To formulate the agricultural development plan paying due attention to soil and water management to prevent soil degradation and also paying due attention to animal husbandry;
- To use the existing rice fields in the Existing Lower Moshi Project Area as the nucleus area of the whole Project Area and make the best use of the Area for extension and training purposes; and
- To strengthen and expand supporting services based on actual needs and well synchronised with the progress of the Project implementation.

The specific areawise approaches so established are explained below:

(a) Existing Lower Moshi Project Area

The introduction of paddy base cropping pattern in the entire area is planned. The subject area will not encounter any serious technical constraints in the agricultural land use when irrigation water supply is ensured. The majority of farmers in the area have experiences in paddy cultivation, including those in existing upland fields who obtained such experiences as farm labours.

(b) Expanded Area

Drainage conditions present constraints in the Expanded Area. In addition, the urban development plan of Moshi Municipality will restrict the development option in the Kaloleni area located in Moshi Urban District. Accordingly, the basic development approaches to the area are 1) to improve or develop drainage systems; 2) to expand irrigated area in the Mandaka Mnono area through the rehabilitation/upgrading of irrigation system and the introduction of improved water management system; and 3) to formulate the development plan for the Kaloleni area respecting the urban development plan of Moshi Municipality (proposed site for oxidation pond for sewerage treatment).

(c) New Extension Area

When irrigation water supply is ensured, no serious technical constraints for agricultural development will be encountered in the area except for the southern part of the area which is affected by salt accumulation. The salt accumulated area is presently utilised for grazing and the requirement for grazing land, especially for the Maasai pastoralists in Mtakuja, as well as land suitability of the areas are to be considered in the formulation of the development plan for the area. It addition, no irrigation farming is practised in the entire area and the primary constraint for irrigated agriculture is farmers' capability to adopt irrigation farming technology. The approaches to agricultural development in the area therefore, are, 1) to introduce a rice-based cropping pattern within the availability of

irrigation water supply; and 2) to formulate the land use plan based on land suitability and taking the requirement for grazing land into account.

4.3.2 Land Use Plan

(1) Basic Approaches

The basic approaches for agricultural land use planning have been established taking into account 1) land suitability for irrigation farming, 2) present land use, 3) results of irrigation and drainage study, 4) requirement for grazing land, and 5) the urban development plan for the Kaloleni area as follows:

- Exclusion of strongly salt affected areas covered with Eutric Cambisols, Saline/Sodic Phase, which are assessed currently not suitable for irrigation farming, from the Project Area;
- Consideration of the present land use which reflects existing needs for specific land use as grazing land;
- Results of irrigation and drainage study;
- Location of the proposed site of the oxidation pond in the urban development plan of Moshi Municipality; and
- Future expansion of village yards under the implementation of the Project in the New Extension Area.

(2) Project Area

In accordance with the basic approaches for agricultural land use planning, a target area of 6,181 ha (73% of the Study Area) has been delineated for irrigated agriculture development. Based on the result of calculation of water balance between this irrigated agriculture development area which could support the proposed cropping pattern, and the application of a water right of 9 m^3/s in the rainy season and 5 m^3/s in the dry season, the target area for agricultural development under the Project (the Project Area) is estimated to be 4,700 ha net or 5,809 ha gross as discussed in Sub-section 4.7.5 and summarised below:

Present Land Use in the Delineated Project Area

(Unit : ha)

	Study Area	With Project		Outside Project
Land Use	Gross	Gross	Net	Gross
Irrigated Paddy Fields	2,002	1,927	1,495	75
Irrigable Upland Fields	1,162	1,162	1,046	0
Rainfed Upland Fields	4,160	2,650	2,103	1,510
Grassland/Grazing Land	970	70	56	900
Village Yards	150			150
Total	8,444 (100%)	5,809 (69%)	4,700	2,635 (31%)

(3) Land Use Plan

The proposed areawise land use plan in the Study Area was formulated based on the basic approaches for land use planning. The plan aims at increasing the area of irrigated paddy fields by 3,882 ha gross by converting 3,812 ha of upland fields and 70 ha of grassland/grazing land. The overall proposed land use plan for the entire Study Area and the Project Area in comparison with the present land use is summarised in the next page:

Proposed Land Use (gross)

(Unit : ha)

Land Use	Present/Study Area	With-Project/Study Area		Change
		Project Area	Outside Project Area	
Irrigated Paddy Fields	2,002	5,809	75	+ 3,882
Irrigable Upland Fields	1,162	0	0	- 1,162
Rainfed Upland Fields	4,160	0	1,510	- 2,650
Grassland/Grazing Land	970	0	900	- 70
Village Yards	150	0	150	0
Total	8,444	5,809	2,635	-

As mentioned above, the net irrigation command area (irrigated paddy fields) in the Project Area under the "With Project" condition is estimated at 4,700 ha or about 80% of the gross area. The increase of area of irrigated paddy fields is 1,046 ha in the Existing Lower Moshi Project Area, 69 ha in the Expanded Area, 2,090 ha in the New Extension Area, totalling 3,205 ha or 314 % of the present area of irrigated paddy fields in the Area as detailed below:

Increase of Net Irrigation Command Area under With Project Condition

(Unit : ha)

Area	Project Area	Project Area/With-Project		Increase
	Present (net)	Gross Area	Net Are Area	in Net Area
Existing Project Area	1,104 (100%)	2,654	2,150 (195%)	+ 1,046
Expanded Area	391 (100%)	542	460 (118%)	+ 69
New Extension Area	0	2,613	2,090	+ 2,090
Total	1,495 (100%)	5,809	4,700 (314%)	+ 3,205

4.3.3 Crop Production Plan

(1) Proposed Cropping Pattern

In the cropping pattern under the Project, the cultivation of paddy and alfalfa as a soil amelioration crop is proposed in accordance with the basic approaches for agricultural development.

The proposed cropping pattern at the full development stage which is shown in Figure 4.1, envisages paddy cultivation with a 100 % cropping intensity (4,700 ha) in the rainy season, and paddy cultivation with a 50 % cropping intensity (2,350 ha) and alfalfa cultivation with a 20% (940 ha) in the dry season. Alfalfa is planned to be cultivated in rotation with paddy once in every 5 years.

Proposed Cropping Pattern/Cropped Area & Intensity

Project Area	Paddy		Alfalfa	Annual
	Rainy Season	Dry Season	Dry Season	
Ex. LM Project Area*	2,150 ha (100%)	1,075 ha (50%)	430 ha (20%)	3,655 ha (170%)
Expanded Area	460 ha (100%)	230 ha (50%)	92 ha (20%)	782 ha (170%)
New Extension Area	2,090 ha (100%)	1,045 ha (50%)	418 ha (20%)	3,553 ha (170%)
Project Area Total	4,700 ha (100%)	2,350 ha (50%)	940 ha (20%)	7,990 ha (170%)

**: Existing Lower Moshi Project Area*

(2) Anticipated Crop Yields and Crop Production Plan

The crop yields under the "With Project" condition are estimated on the basis of the past crop cut survey records in the Existing Lower Moshi Project Area in the case of paddy, however that of alfalfa is estimated based on the yield level at NAFCO neighbouring the Project Area in the south.

(a) Anticipated crop yields

1) Paddy

The target yields of paddy in the Existing Lower Moshi Project Area and New Extension Area are conservatively set at 6.5 t/ha in the rainy season and 7.0 t/ha in the dry season, which are similar to the present yields in the Existing Lower Moshi Project Area. Those in the Expanded Area are estimated at 6.0 t/ha in the rainy season and 6.5 t/ha in the dry season.

2) Alfalfa

The target yield of alfalfa is conservatively set at 3.0 t/ha under the Project.

(b) Anticipated crop production

On the basis of the anticipated crop yields, the anticipated crop productions at the full development stage are estimated as presented in Table 4.2 and shown below:

Crop Production under Present and With Project Conditions

(Unit:ton)

Crops	Present	With Project	Increment
Paddy	7,700	46,700	+ 39,000
Maize	5,800		- 5,800
Alfalfa		2,800	+ 2,800
Total Food Crops	13,500	46,700	+ 33,200

(3) Crop Production Plan

In accordance with the estimated build-up periods of crop yields and cropping intensity and the implementation schedule of the Project construction works, the crop production plans for the entire Project Area were formulated. The full development will be achieved in 2006 in the Existing Lower Moshi Project Area, and in 2009 in the New Extension Area and Expanded Area. The time series crop production plan is summarised in the following table.

Crop Production Plan under With Project Condition

(Unit : 1,000 tons)

Year	Rainy Season Paddy	Dry Season Paddy	Annual Paddy	Alfalfa
2001	-	8.7	8.7 (19%)	
2002	10.6	10.7	21.3(46%)	0.17(6%)
2003	14.3	12.1	26.5(57%)	0.17(6%)
2004	16.6	12.1	28.7(62%)	0.17(6%)
2005	23.4	14.0	37.4(80%)	1.40(50%)
2006	27.2	14.9	42.0(90%)	1.46(52%)
2007	29.4	15.4	42.0(90%)	2.82(100%)
2008	30.3	15.9	46.2(95%)	2.82(100%)
2009	30.3	16.3	46.7(100%)	2.82(100%)

(4) Farming Practices

The farming practices for irrigated paddy recommended by KADP have been successfully practised with the average yield of over 6 t/ha in the Existing Lower Moshi Project Area. Accordingly, application of the said practices in the entire Project Area as the basic farming practices is recommended. However, introduction of other varieties than IR 54 in rotation is to be promoted urgently in order to avoid huge crop losses because of the outbreak of certain pests or diseases induced by the continuous cultivation of a single variety. Farming practices for alfalfa should be established through the verification trial.

(5) Tractor Requirements

In the proposed farming practices, utilisation of 4-wheel tractors for land preparation is proposed in order to ensure proper land levelling and observance of cropping schedule by farmers, as well as for efficient water management and rational use of irrigation water. The number of tractors required for land preparation at the full development stage is estimated at 72 units.

(6) Labour Requirements

The labour balance study indicates that labour shortage would occur in the transplanting and harvesting periods in the rainy season when all the paddy fields are under cultivation. The labour shortage in transplanting is estimated at 11 man-days and that in harvesting is 18.5 man-days for a typical farm of 1.0 ha. Such shortage will have to be made up through labour exchange among villagers or by employing casual labours within or from outside the Project Area.

(7) Post-harvest Facilities

Presently most paddy produced in the Project Area is sold to traders after harvest generally at fields except for a portion kept for family consumption or else. Such marketing practices by farmers will continue as the activity of traders or business-minded individuals has become substantially intensive in and around Moshi since the privatisation of marketing of farm products. Further, it is expected that such business-minded individuals or private sectors will positively participate in the marketing of increased rice products under the Project, and marketing constraints of farm products in terms of volume will not be encountered in the future. However, provision of drying yards and storage facilities for short time storing prior to shipment will be highly required in order to avoid degradation of paddy quality during transportation. It is strongly proposed to promote timely participation of the private sector in such paddy procurement, drying and marketing operations.

The rice mill plant of KPHC is presently operated below its capacity. With the expansion of paddy production in the Project Area, a substantial increase of the handling volume of the plant is expected and it will become necessary to share the increasing demand for processing of paddy. The expansion of handling volume will improve the financial status of KPHC. Due consideration of the management of KPHC and KNCU for this subject is highly recommended.

4.4 Agricultural Support Services Strengthening Plan

4.4.1 Agricultural Support System

While, institutionally, agricultural support services under the Existing Lower Moshi Project are implemented by MAC and KADP, the greater part of the services has been done through KADP.

The contribution of well programmed and intensive agricultural support programs implemented by KADC/ KADP as shown in Table 4.3 to the successful rice production in the Existing Lower Moshi Project Area has been highly evaluated by various sectors both in Tanzania and Japan. The present agricultural support programs are formulated in accordance with the basic recognition of the needs for strengthening agricultural support services and by making reference to the services rendered in the past and the suggestions given by the JICA experts in KADP and KATC. The proposed system for agricultural support activities is worked out in line with the Project implementation schedule.

4.4.2 Research, Extension and Training

(1) Experimental Programs

(a) Program and approach

The proposed experimental programs executed by KADP in cooperation with KATRIN and KATC include varietal selection of rice and verification trials. The primary objective of the varietal selection of paddy is the selection of optimal varieties having similar characteristics to IR54 and adaptable to the environmental conditions in and around the Project Area. In addition, the selection of varieties having low temperature tolerance and varieties having tolerance of high pH and sodium content is also to be made in preparation for the worst. The proposed verification trials include the following:

- Variety Adaptability Trial	: Adaptability trial of selected rice varieties
- Crop Adaptability Trial	: Adaptability trial of selected crops/varieties (in farmers' fields)
- Fertilisation Trial	: Effects of P_2O_5 and K, effects of Urea and Ammonium Sulphate, amount of fertiliser, etc.
- Trials on Soil Management	: Effects of organic matters (including farmyard manure) on yield and soil permeability, etc.
- Trials on cultivation practices	: Planting density, direct sowing, plant protection, etc.

The varieties selected through varietal selection are to be tested in farmers' fields through verification trials. Then, if such varieties receive farmers' approval, multiplication of the seeds and demonstration of the varieties are to be carried out in succession. Further, the adaptability of alfalfa as a rotation crop with paddy is to be tested and alfalfa varieties suitable to the conditions in the Project Area are to be selected before the introduction of the crop in the cropping pattern.

(b) Implementation schedule

The implementation of the experimental programs is scheduled to start in 1999 in parallel with the commencement of the detailed design of the Project by placing priority

in the varietal selection of paddy, variety adaptability trial (paddy), and crop adaptability trial (alfalfa). The varietal selection of paddy and variety adaptability trial (paddy) are scheduled to be carried out continuously in order to meet the urgent need for the introduction of new varieties which will be brought about by the outbreak of pests and diseases. Table 4.4 shows the detailed implementation schedule of experimental programs.

(2) Extension Programs

(a) Requirements and approaches

The requirements for extension subjects and the proposed approaches by target area are examined as shown in Table 4.5.

Summary of Proposed Extension Programs

Area	Subjects to be addressed	Proposed Approach
Existing Lower Moshi Project Area	- Training and extension on O&M, plant protection, soil management. - Introduction of new varieties and new crops - Strengthening of farmers' organisations	- Field extension activities (T&V system) - Demonstration field for new varieties and crops, and soil management - Mass guidance and campaign
Expanded Area	- Training and extension on rice farming from seeding to harvesting, due to limited experience of farmers - Training and extension on O&M, plant protection, soil management - Introduction of new varieties and new crops - Strengthening of farmers' organisations	- Demonstration plot of recommended farming practices and extension activities (T&V system) - Demonstration plot for new varieties and crops, and soil management - Mass guidance and campaign
New Extension Area	- Training and extension on rice farming from seeding to harvesting, due to less experience of farmers - Training & extension on O&M, plant protection, soil management - Introduction of new varieties and new crops - Establishment of farmers' organisations	- Demonstration plot of recommended farming practices and extension activities (T&V system) - Demonstration plot for new varieties and crops, and soil management - Mass guidance and campaign

(b) Implementation schedule

The proposed extension programs include demonstration activities, mass guidance to farmers and field extension activities(T&V system) by KADP extension staff. The implementation of the programs should better be planned in accordance with the progress of the Project implementation and is scheduled to be started 1 cropping season or 1 year prior to the completion of the Project works. The implementation schedule of the extension programs is given in Table 4.6. The requirements for extension subjects and the proposed approaches by target area are examined as shown in Table 4.6.

(3) Training Programs

(a) Requirements and proposed approaches

The requirements for training programs are similar to the requirements for extension programs. The proposed approaches are training of selected target groups in class for the entire Project Area and, especially for beneficiary farmers of the current upland fields in the Existing Project Area and New Extension Area, field practical training in advanced farmers fields.

(b) Proposed training programs and schedule

The proposed training programs for the subjects to be addressed are explained below.

1) Farmer training

- Objectives and activities : Training of representative farmers on general subjects and specific subjects as required in class such as recommended farming practices, O&M, and group activities
- Target group : Tertiary block leaders or other representatives of farmers
- Participants/duration : 25 participants per course; basic course 5 days (depending on subjects)

2) Field practical training

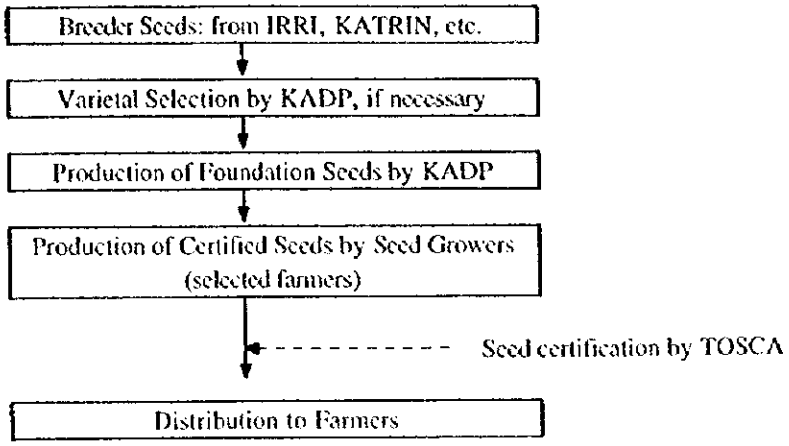
- Objectives and activities : Practical induction training of beneficiary farmers having no experiences in management of irrigated rice farming by having them engaged in rice farming from seeding to harvest in existing paddy fields in the Existing Project Area under the guidance of advance farmers in the Area
- Target group : Preferably all beneficiary farmers having no paddy fields in the target area (current upland fields in the Existing Lower Moshi Project Area and New Extension Area)
- Timing/duration : One season prior to the start of rice cultivation in paddy fields of beneficiary farmers; 1 cropping season

The annual requirements for such training programs corresponding to the progress of development works or the proposed implementation schedule of training programs are estimated as shown in Table 4.6.

(4) Seed Multiplication Programs

(a) Proposed system for seed multiplication

The system for rice seed multiplication tentatively proposed for the Project Area is as follows:



(b) Seed multiplication plans

The multiplication of seeds should be continued to meet the demand for seed replacement in the Project Area and its surroundings. The proposed seed multiplication plan is formulated as shown in Table 4.4.

In addition to the multiplication of rice seed, the multiplication of alfalfa seed is also necessary to supply farmers seed resources at the initial stage of introduction of the crop and to provide seeds for periodical replacement. The multiplication of the seed is to be made after the verification of it as a rotation crop with paddy. The land requirements for alfalfa seed multiplication farms operated by KADP are estimated at 2 ha in 2001 and 2005, and 9 ha in 2004 and 8 ha in 2007.

(5) Strengthening Plan for Agricultural Machinery Services

Tractor hiring services rendered by KADP have been a key supporting activity leading to the remarkable achievement of paddy cultivation in the Existing Project Area. In order to ensure a rational utilisation of valuable irrigation water, mechanisation of land preparation as is practised in the existing area and other fields is considered essential. Tractors procurement and operation plans are proposed in accordance with the stagewise development plan as shown in Table 4.4. In this plan, the required number of tractors (50Hp) is estimated at 72 nos. at peak time. Operators required for these tractors will be trained centring on the present 16 operators of KADP through "on-the-job training" for 3 years from 1999 to 2001.

4.4.3 Strengthening Plan of Agricultural Credit

The development of effective agricultural credit has more or less confronted difficulties in many developing countries. The reasons may generally be that the commercial banking system is not suitable for small credit and in the case of commercial credit banking system, the interest rate tends to be high and troublesome documents are requested. In order to cope with the problems mentioned above, numerous countries have introduced some institutional banking systems specialising in agricultural and small farmers' credit with governmental assistance.

GOT has also been under the same situation. Once banks used to furnish funds to agricultural cooperatives and agricultural parastatals such as NMC and NAFCO under the GOT direction. However, GOT which was unable to bear huge debts, has enacted the Banking and

Financial Institutions Act in 1991 to help establish the framework for a healthy and competitive banking system. Under the Act, the banks were to become strictly autonomous institutions operating solely on the basis of commercial criteria and with no interference from GOT. This policy change led to huge debts of long standing for the commercial banks that lent to agricultural cooperatives and agricultural parastatals. Commercial banks are now indifferent about agricultural and small farmers credit through agricultural cooperatives, due to the default of past loans.

Under the above circumstances, establishing a plan for strengthening agricultural credit is a sort of work that is easy to say but difficult to do. The following plan, therefore, is rather a recommendation to GOT and CHAWAMPU for future action concerning agricultural credit than an actual implementation plan for improving agricultural credit

(1) GOT

GOT should not leave agricultural credit completely to the care of commercial banks, but should examine the necessity/possibility of establishing a new governmental credit institution on agriculture and/or some fastening measures on agricultural credit to commercial banks.

(2) CHAWAMPU

When CHAWAMPU implements agricultural credit activity, the following matters should be duly considered:

(a) CHAWAMPU should firstly strengthen/improve its financial position as well as financial system including auditing.

(b) In order to strengthen CHAWAMPU's financial position, selling and buying activities of agricultural produce/inputs should firstly be given high priority for a while.

(c) When CHAWAMPU considers the implementation of agricultural credit within the present institutional framework, it would be more realistic to apply the Rural Saving and Credit Scheme. In order to implement the scheme, CHAWAMPU has to open a Group Saving Account on behalf of the scheme members. To raise fund for this Account, CHAWAMPU should consider to invoke Article 17 of Moshi District By-Laws stipulating that "every project beneficiary shall sell to CHAWAMPU a portion of the paddy produced from the Agricultural Land as may be determined by CHAWAMPU".

(d) The agricultural credit activity should be initiated under the consensus of the members.

(e) In implementing agricultural credit, CHAWAMPU should make the observance of repayment and its term known to everyone without exception.

4.5 Institutional Development for the Project

4.5.1 Administrative Organisation

KADP has authority to operate and manage the Existing Lower Moshi Project, and has

technical staff familiar with irrigated paddy farming as well as technical know-how for managing the Existing Lower Moshi Project. KADP, definitely, has control over the paddy farmers in the Existing Lower Moshi Project Area through planning and management of irrigation water allocation and paddy farming under the conditions of water shortage. Apart from the above control, KADP has supported the paddy farmers through delivering technical know-how on modern paddy farming and providing tractor hiring services, etc. Furthermore, KADP has acted as a substitute for rural community through the assistance/promotion of the establishment of farmers' organisations such as WUAs and CHAWAMPU to accelerate the cooperation among the beneficiaries of the Existing Project.

On the other hand, CHAWAMPU, established as a farmers' organisation, has played a very important role in the operation and management of the Existing Lower Moshi Project by bearing the running cost of the Existing Lower Moshi Project on the principle that beneficiaries should pay for part of the cost concerned.

A governmental agency established with specific objectives should be dissolved basically when it has successfully accomplished its intended objectives. Once GOT has decided to transfer the management of the irrigation projects to farmers' organisations, it is desirable in the interest of GOT that CHAWAMPU as the beneficiaries' organisation takes over the responsibility of management of the Project from KADP. Furthermore, it is also desirable and ideal that CHAWAMPU has enough capability for the management of the Project and then becomes an economic and social nucleus in the rural community.

However, it is very difficult and inappropriate for KADP to transfer the O&M of the Project to CHAWAMPU at present stage.

Under the basic understanding mentioned above, the basic approach to the institutional development plan for the Project is as follows:

(a) The proposed plan shall take a stagewise approach: The 1st stage is a preparatory period for handing over the responsibility for management of the Project to farmers' organisations. In the 2nd stage, water management, O&M activities, and agricultural machinery service, etc. shall be handed over to farmers' organisations after full completion of the preparatory period.

(b) KADP shall take more progressive and substantial activities for managing and operating the Project, particularly in terms of O&M irrigation facilities, agricultural support activities, and strengthening of farmers' organisations including CHAWAMPU in the 1st stage. KADP, therefore, shall be strengthened in terms of its organisational structure and staffing. The time of handing over KADP's responsibility for the Project management is tentatively assumed to be 5 years after the completion of the final phase of the Project implementation.

(c) KADP shall make best efforts to strengthen farmers' organisations and to transfer the necessary relevant technology to the technicians concerned so that the operation and management of the Project can be transferred to the farmers' organisations as quickly as possible.

(d) CHAWAMPU shall be strengthened/developed in its financial, organisational and

human structure so as to take over the management of the Project through solving the problems it faces now.

4.5.2 Strengthening Plan of KADP

(1) Stagewise Strengthening of Organisation

KADP's organisation will be changed in line with the transfer plan of O&M activities for the Project facilities to farmers' organisations from KADP.

(a) 1st Stage

Presently, KADP is composed of 5 sections : Administration, Irrigation, Machinery, Extension, and Handing-over Sections. The 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, activities of monitoring of 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 4.2.

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-sections. The Legal Sub-section will be responsible for all the administrative matters relating to 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 be transformed into the Agronomy Section. The latter shall be divided into three sub-sections, namely Experimental, Extension and Training, and CHAWAMPU Sub-sections, aiming to strengthen not only the extension activities, but also the experimental activities such as various verification tests for rice varieties and seed multiplication, and CHAWAMPU and water users' groups. The proposed staff for the respective Sections/Sub-sections is 136.

(b) 2nd Stage

Water management and O&M works shall be handed over by KADP to WUAs/WUF under the agreement of the Joint Committee for Handing-over after the completion of the transitional period. O&M works by the WUAs/WUF 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 organisational structure of KADP in the 2nd stage will consist of 2 sections: Administration and O&M Sections as illustrated in Figure 4.3. The O&M Section will be composed of the Headworks, Diversion Channel, and O&M Equipment Sub-sections. The required staff for the

respective Sections/Sub-sections is proposed to be 35.

After substantial completion of agricultural supporting services by KADP, the extension and training works will be transferred to ZIE or DALDO, and experimental and seed multiplication works to KATRIN experimental farm in Morogoro district.

(2) Coordination Chart for O&M and Water Management of the Project

As mentioned above, O&M and water management of the Existing Lower Moshi Project are jointly undertaken by KADP and CHAWAMPU, under the Implementation Committee jurisdictionaly belonging to RAS. In this Study, this institutional system will be maintained, although the Committee will be re-organised in line with the recent government policy and also considering that the Project is extended over 2 districts of Hai and Moshi. The re-organised Committee will consist of a Regional Agriculture Development Officer, Zonal Irrigation Officer, District Cooperative Officers of Moshi and Hai. District Executive Directors of Moshi and Hai, Councillors of District Council, etc. Representatives of CHAWAMPU and Water Users Associations will be also members of the Committee (refer to ANNEX-N).

(3) Training of KADP Staff

The number of KADP staff members will become 136 at the peak time in the 1st stage. About half of them, say 72, will be tractor operators. The agriculture and water management staff will increase by about 5 workers each. Their training is proposed as mentioned below:

(a) Training period

The training of KADP staff will be executed for 3 years from 1999 to 2001.

(b) Tractor operator

Tractor operators will be trained through "on-the-job training" centring on the present 16 tractor operators of KADP in the Existing Lower Moshi Project Area.

(c) Agriculture, O&M, water management staffs

The required number of agriculture, O&M and water management staff members will be assigned following the re-structuring plan of GOT. These government employees have basic knowledge with some experience, however, it is necessary to further upgrade their knowledge to ensure successful and effective implementation of the Project. For this purpose, it is necessary to assign the following several specialist/experts:

1) Agricultural Machinery Expert (including trainer of tractor operators)

- Preparation of the training program for tractor operators
- Technical guidance on agricultural machinery use
- Training on O&M of agricultural machinery
- Technical guidance on the use of O&M equipment

2) O&M Expert

- Review and updating of the O&M manual

- Preparation of training materials for O&M and farmers' on-farm development
- Training of KADP staff involved in O&M and farmers' on-farm development
- Providing necessary advice for improving supporting activities
- Monitoring and evaluation of agricultural support services for O&M and on-farm development
- Follow-up training of officers

3) Institutional Expert

- Advice on strengthening of CHAWAMPU
- Modification of CHAWAMPU' By-Law
- Preparation of training materials for CHAWAMPU
- Training of KADP staff involved in supporting services to CHAWAMPU
- Monitoring and evaluation of agricultural support services for CHAWAMPU
- Advice on establishment of WUAs
- Follow-up training of KADP staff

4) Agronomist / Agricultural Extension Expert

- Technical advice on preparation of training programs coordinated by DALDO
- Technical advice on participation approach in the field training programs
- Implementation of workshop for senior staff (DALDO, ZIE, etc.)
- Technical advice on field training of DIVEO and VEO coordinated by DALDO
- Technical advice on field training of aggressive farmers managed by VEO
- Technical advice on field training of general farmers managed by VEO
- Technical advice on monitoring and review of the training programs and extension services
- Technical advice on improvement of farming practices
- Technical advice on preparation of guideline for proposed farming practices

4.5.3 Strengthening Plan of CHAWAMPU

(1) 1st Stage

(a) Plan of CHAWAMPU organisation

CHAWAMPU will maintain its two major functions in the 1st Stage; the first is an executing body for water management and O&M of the Project, and the other is a farmers' organisation for agricultural marketing. The outline of the strengthening plan of CHAWAMPU is shown in Figure 4.4 and described below:

1) The CHAWAMPU's jurisdiction area should expand over the 8 villages' areas. As a result, the Board of Executives should be increased from 15 to 20 or more members .

2) In order to provide advice and suggestions as requested from the Board of Executives, two Consultative Committees on Cooperative and Water Management should be established.

3) Under the Board of Executives, four divisions shall be established: Administrative, Agricultural Cooperative, Water Management, and Machinery Management Divisions. The major tasks of each division are as follows:

- Administrative Division

  The Administrative Division will be in charge of the secretariat of the Board of Executives, accounts, and other works not belonging to other divisions.

- Agricultural Cooperative Division
  The Division will be in charge of agricultural marketing, agricultural inputs supply and paddy seed multiplication activities.
- Water Management Division
  This Division will undertake water management and O&M works for the facilities after the tertiary level under the guidance of KADP.
- Machinery Management Division
  This Division's activities will be focused mainly on the operation and maintenance of transportation equipment possessed/purchased by CHAWAMPU. The Division secretary should make effort to train/bring up repairmen and operators of agricultural machinery and O&M equipment to cope with the handing over of those machinery and equipment.

4) A CHAWAMPU Village Office shall be established in each village concerned and staffed with a chairperson, a shop manager in charge of agricultural cooperative, and a supervisor in charge of water management and O&M works. The shop manager will actually be responsible for a shop operated by the Village Office directly, and the supervisor will be responsible for water management and O&M works in the command area concerned and liaison/coordination with WUGs in the area under his jurisdiction.

(b) Proposed O&M activities of CHAWAMPU

The present water management and O&M system in which KADP and CHAWAMPU execute on a cooperative basis is also to be continued. The systematic organisational chart for water management and O&M works is shown in Figure 4.5. The proposed strengthening plan of CHAWAMPU for water management and O&M is as follows:

1) CHAWAMPU shall be responsible for operation of the facilities after tertiary canals as it is at present.

2) A WUG shall be established in each tertiary block having a command area of around 50 ha. WUG as a voluntary group shall establish its customary rules and carry out O&M of watercourses and irrigation blocks. The customary rules should include at least the following items:

   - Any person who has land in the tertiary block shall be member of the WUG concerned.
   - Irrigation water shall be provided only to the fields of the WUG's members.
   - The member shall obtain WUG's approval before lending his land to others.
   - All the members of WUGs shall be collectively responsible to the WUA concerned for observing the cropping calendar and O&M of tertiary irrigation facilities. When members of WUGs offend against the Moshi District Council by-laws, the CHAWAMPU through the related CHAWAMPU's Village Office shall have the right to stop water supply to the tertiary blocks concerned.

3) The supervisor in each CHAWAMPU Village Office will be responsible for water management and O&M of the facilities after the tertiary level and WUGs under his jurisdiction. The CHAWAMPU Village Office together with the Water Management

Division of the Headquaters shall execute the following activities effectively:

- Participating in the Joint Committee on the Lower Moshi Integrated Agriculture and Rural Development Project;
- Preparing the village's O &M plan and its monitoring.;
- Preparing a proposed cropping calendar covering its beneficiary area; and
- Collecting water and cultivation charges from beneficiaries through the WUGs and sending them to CHAWAMPU's headquarters.

(c) Agricultural marketing activities of CHAWAMPU

The proposed plan for strengthening agricultural marketing of CHAWAMPU is as follows:

1) CHAWAMPU's jurisdiction area shall be expanded over the 8 villages.

2) In each of the villages, a village's branch office shall operate a shop under a shop manager. The economic activities of each branch are, for the time being, strictly limited to agricultural inputs and daily necessaries supply activities. The branch's activities, then, shall be gradually expanded to other areas with the strengthening of the institutional and economic capacity of CHAWAMPU. The activity of selling agricultural produce shall be given high priority . On the other hand, agricultural credit shall be initiated with the consensus of members and careful examination of its practicability because of the requirement of highly skilled managerial staff and the risky nature of agricultural credit.

3) With regard to the agricultural inputs purchasing activities, CHAWAMPU should make best efforts to minimise selling prices by procuring materials directly from wholesale dealers and/or producers under an annual purchasing program prepared by the Agricultural Cooperative Division.

4) As for the agricultural selling activities mainly for rice, CHAWAMPU should construct needful post-harvest facilities in each Village Office. These facilities, which are ill equipped at present, include drying yards, small milling facilities, and storage facilities for short time storing prior to shipment.

5) CHAWAMPU shall make efforts to invite farmers to join the organisation by establishing its sound administrative foundation, providing good services like carriage service, etc., and expanding its economic activities corresponding to the farmers' needs.

(2) 2nd Stage

(a) Plan of CHAWAMPU organisation

In the 2nd stage, CHAWAMPU will be transformed into two new farmers' organisations. One is the Water Users' Federation (WUF) that will be established in accordance with a new mandatory legislation like Japanese Land Improvement Law. WUF will be composed of WUAs that are also established under the new mandatory legislation in each village concerned. WUF together with WUAs is to execute water management in the entire Project Area and O&M of all the Project facilities other than headworks, diversion channel, and related structures. WUF will also manage and

operate the agricultural machinery and O&M equipment.

The other is the Agricultural Cooperative that is an independent farmers organisation specialising in agricultural marketing and agricultural credit, etc.

(b) O&M activities of WUF and WUAs

1) Under the new mandatory legislation, a WUA shall be established in each village to replace the CHAWAMPU Village Office. In order to execute a part or parts of water management and O&M of the Project facilities jointly with another WUA, any WUA may organise a federation of WUAs which has functions similar to those of the Water Management Division of CHAWAMPU. WUGs established in the 1st stage shall continue their activities under the new O&M system. The organisation set-up is as shown in Figure 4.6.

2) All the costs incurred in water management and O&M of the Project facilities shall be paid from irrigation fees collected from all the beneficiary farmers. The fees collected should immediately be deposited in a bank account of each WUA. As a means to ensure fair collection of irrigation fees, certain rules for penalty and reward should better be included in the articles of WUA.

3) The success of agricultural development in the Project Area will largely depend on the availability of supporting services. To ensure coordination of the supporting services and agricultural activities of farmers, coordination meetings of all people concerned are proposed to be held periodically. Furthermore, for strengthening the capability of WUAs and WUGs, education and training of these organisations should better be programmed and implemented in cooperation with KATC.

(c) Agricultural marketing activities of the Agricultural Cooperative

Crops production will increase sharply after the full completion of the Project. The demand for agricultural inputs and agricultural credit will also increase due to the increase in the number of beneficiary farmers. Thus, the Agricultural Cooperative will be much more necessary and useful in the Project Area.

Like WUF and WUAs, the Agricultural Cooperative Division will be independent as a real agricultural cooperative. While the farmers' organisations are basically organised to meet the farmers' spontaneous needs, CHAWAMPU has already established and performed economic activities. The proposed plan for agricultural marketing activities will give more priority to the development of existing CHAWAMPU than to the establishment of new organisation. In this case, whether the name CHAWAMPU will continue to be used or should be changed is not a matter of great concern.

Since the actual O&M works for the Project will be carried out by WUF and WUAs under the proposed plan, CHAWAMPU can afford to engage in economic activities only. In this connection, CHAWAMPU should endeavour to take a more positive attitude for tackling new economic activities revealed through the Farmer Interview Survey, namely input supply, machinery service, selling of produce, and extension and information for marketing. In proportion to the expansion of economic activities, the administrative organisation and facilities of CHAWAMPU should be strengthened as

needed.

The working funds of CHAWAMPU will basically be covered by members' contribution, commissions/profits accruing from economic activities like purchasing and selling of agricultural produce/inputs, and loan from banking institutes such as banks and cooperatives' unions. In order to facilitate loan through the agricultural credit system, CHAWAMPU shall join KNCU which is the Agricultural Cooperative Union covering Moshi district.

4.5.4 Handing-over of O&M of Project Facilities to WUAs/WUF

In compliance with the Government policy, the handing-over of O&M of Project facilities to farmers' organisations shall be planned under the Project. The O&M works will be handed over 5 years after completion of all facilities although the 6 years of construction time are preparatory time for handing-over work. The Handing-Over Section of KADP will execute the necessary jobs for the handing-over of O&M of the 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 the facilities to WUAs/WUF. Judging from the past experience of CHAWAMPU in O&M and water management activities, it is proposed that the Project facilities except the Kikuletwa headworks, and diversion channel, be handed over to the farmers' organisations eventually. The handing-over period is provisionally determined to be 5 years after completion of the Project.

4.6 Irrigation and Drainage Plan

4.6.1 Basic Approach

The irrigation development plan for the Project shall be formulated taking into consideration the lessons learned from the Existing Lower Moshi Project and the currently envisaged problems and constraints to the Project Area, aiming to establish a sustainable irrigation system. In the plan formulation, a special focus shall be given to the following matters:

(a) Application of the irrigation water requirement estimated based on the actual measurements, soil conditions, and irrigation method.

(b) Design of the irrigation and drainage canal systems, paying attention to the introduction of administrative boundaries into canal layout for easy establishment of farmers' organisations.

(c) Design of the canal system which conveys irrigation water from the main canal to respective field plots through secondary canals, tertiary canals and watercourses in turn as much as possible, for easy water management.

(d) Provision of simple irrigation and drainage facilities including measuring devices, for easy operation, maintenance and water management by farmers' organisations in the future.

4.6.2 Basic Figures for Irrigation and Drainage Plan

(1) Field Water Requirements

(a) Paddy

As the estimated crop evapotranspiration (Etc) by the Penman method almost coincided with the measured values, it is proposed that the field water requirement of paddy estimated according to the following procedure:

1) The crop consumptive use of rainy and dry season paddies is estimated using the modified Penman method and crop factor.
2) Percolation rates in the rainy and dry season are calculated by deducting the estimated crop evapotranspiration from the measured data of KADP for 4 years from 1987 to 1990, and then the average ones are taken. The estimated percolation rate is 8 mm/day throughout the year.
3) Field water requirements for rainy and dry season paddies are calculated adding the estimated crop evapotranspiration and the determined percolation rates.

(b) Upland crop

Using the modified Penman method, climatological data and the crop coefficient of alfalfa as cited in the FAO Publication No.24, its consumptive use was calculated.

(2) Unit Irrigation Water Requirement

The unit irrigation water requirement for paddy 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:

Unit Irrigation Water Requirements

(Unit : l/s/ha)

Crop	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
(a) Area to be supplied from Njoro and Rau rivers												
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
Alfalfa	1.3	0.4	-	-	-	-	-	-	-	0.3	1.0	1.2
(b) Area to be supplied from Kikuletwa river												
Rainy Season Paddy	0.1	1.4	2.3	2.0	1.8	1.0	0.1	-	-	-	-	-
Dry Season Paddy	0.2	-	-	-	-	-	0.1	1.2	2.3	2.4	2.3	1.2
Alfalfa	1.4	0.5	-	-	-	-	-	-	-	0.3	1.0	1.2

(3) Design Discharge of Irrigation Canals

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

- Diversion channel : 9 m^3/s
- Main irrigation canal : 2.3 lit./s/ha
- Secondary irrigation canal : 2.4 lit./s/ha
- Tertiary irrigation canal : 60 lit./s/25ha

(4) Drainage Water Requirements

As mentioned previously, no technical problem has been found in the drainage system provided in the Existing Lower Moshi Project Area. Accordingly, the same approach to the drainage plan including calculation of the drainage requirement, was applied to this Study although the rainfall data were updated.

(a) Paddy fields

The drainage water requirement for paddy fields is estimated under the condition that a 5-year probable daily rainfall could be drained allowing a 48-hour retardation in the fields. The following equation is employed for calculation:

$$Q = q \times A$$

$$q = (R_{24} \times 10^{-3} \times 10^{4})/(3,600 \times 48)$$

where, Q : design drainage requirement (l/s)
q : unit drainage requirement (l/s)
A : drainage area (ha)
R_{24} : 5-year probable daily rainfall (mm/day)

Since the 5-year probable daily rainfall is 87mm/day, the unit drainage requirement for paddy fields is estimated at 5 l/s/ha.

(b) Upland crop fields

The drainage water requirement for upland crop fields is estimated based on the 5-year probable hourly rainfall of 30mm/hr, using the McMath formula:

$$Q = 20.7 \times S^{1/5} \times A^{4/5}$$

where, Q : flood discharge (l/s)
S : fall of main drain between the farthest point and the connection point
A : drainage area (ha)

4.6.3 Irrigation Plan

(1) Irrigation Method

(a) Paddy

In the Existing Lower Moshi Project Area, water is supplied continuously down to tertiary canals, and then, a rotational water supply is made within the tertiary blocks. Considering the fact that there was no substantial problem with such irrigation method in the past and that the same irrigation canal system will be adopted, water supply under this Project is also planned by combining the continuous supply and rotational supply systems.

(b) Upland crops

Irrigation water for alfalfa will be supplied intermittently by the basin irrigation method, using a field plot for paddy. The proposed irrigation interval is 7 days at peak time and its multiple days like 14 days and 21 days at other growing stage, in the light of calendar week.

(2) Irrigation Canal System

In the Existing Lower Moshi Project Area, the existing irrigation canal system will be used as it is. However, the design discharge will be increased by about 70% for main canals, and 30% for other canals and, therefore, heightening works will be required as described in ANNEX-K.

The New Extension Area is located around the Existing Lower Moshi Project Area. Irrigation water is planned to be supplied from the Kikuletwa river through a diversion channel. The irrigation system in this Area will be designed independently as much as possible, so as not to interfere with that of the Existing Lower Moshi Project Area although the same system design criteria are applied. The irrigation canal layout is planned taking into consideration not only the topographic condition but also the village boundaries, for easy operation and maintenance by farmers' organisations. The New Extension Area will be provided with three irrigation systems: System-A, System-B, and System-C. Each system will be composed of main, secondary and tertiary canals. Irrigation water will be delivered to each field through these canals in the respective order, that is not main to tertiary canals or the fields and secondary canals to fields, taking into due account easy water management.

The Expanded Area consists of Kaloleni and Mandaka Mnono villages, located separately from each other. These ward and village are partly covered by the existing farmers' irrigation system. Accordingly, the irrigation system plan is worked out by following this existing system as much as possible. Kaloleni village is divided into three areas by the Njoro and Mamba rivers: Northern Kaloleni, Western Kaloleni, and Southern Kaloleni areas.

The Northern Kaloleni area (4 ha) is irrigated from three springs. Since spring water is enough to irrigate the area, two small supply irrigation canals will be so constructed as to connect with them. The Western Kaloleni area (27 ha) is presently irrigated from a large spring using small excavated canals. Since this spring has a sufficient discharge for irrigating this area with the existing irrigation system, the proposed irrigation canal system will follow this system as much as possible. The proposed irrigation canal will consist of two small supply canals. The Southern Kaloleni area (69 ha) is presently irrigated from the Goa spring and the Njoro river. Taking into account the water volume of the spring which is about 100 lit./s, this area will be divided into two areas: one area of 32 ha will be supplied with water from the Goa spring, and the other of 37 ha from the Njoro river. The former will be provided with one small supply canal, and the latter with two small supply canals.

The Mwananguruwe spring is the water source for the Mandaka Mnono area of 360 ha net. The discharge of this spring was measured to be less than 300 lit./s, which could not cover all the Mandaka Mnono area. Accordingly, the deficit will be made up with water to be supplied from the Mamba river by constructing an intake structure and a supply canal. The existing canal will be improved and linked with this supply canal. The proposed canal system consists of one main canal, two secondary canals, and 27 tertiary canals.

4.6.4 Drainage Plan

(1) Drainage Method

According to topographic conditions, excess water can be eliminated by gravity from the Project Area to the rivers/streams flowing nearby. In the Existing Lower Moshi Project Area where a gravity type drainage system was constructed, there has not been any technical problem since 1986. Accordingly, the same gravity drainage system will be applied to the other areas too.

(2) Drainage Canal System

In the Existing Lower Moshi Project Area, no major repairs and/or rehabilitation will be needed for the existing drainage canal system. Removal of grasses and sediments from drains will be necessary for keeping a smooth flow condition in the drains.

The Expanded Area consists of Kaloleni and Mandaka Mnono villages. Both areas are provided with a primitive irrigation system, but no drainage system. A drainage canal system is therefore planned in connection with the improvement of the existing irrigation system. In the Kaloleni village area, the Njoro river will function as the main drainage canal, considering its topographical condition. One secondary drain will be joined with it at the northern end of the Kaloleni area. Tertiary drains are planned to be directly connected with the Njoro river and the secondary drain.

The drainage canal system in the Mandaka Mnono area is also planned following the improvement plan of the existing irrigation system. No main drain will be required due to the long and narrow area. Instead, a secondary drain will run around the centre of the Mandaka Mnono village, from the south to the north, and will flow into the Rau river. The tertiary drains in the upstream area are planned to flow into the Rau river directly, but the remaining ones through the secondary drain. An intercepting drain will be required along the left side of the main canal and left secondary canal, in order to cut floods from the hilly area and to protect the project facilities from such floods accordingly.

The New Extension Area extends around the Existing Lower Moshi Project Area. Two main drains are required for the New Extension Area. The first is the existing main drain (MD-3) flowing in the eastern part of the New Extension Area, and the second is a new main drain to be located in the western part. Four new secondary drains will be connected with MD-3, to evacuate the excess water from the western area. The second new main drain will be joined with the four new secondary drains and two sub-secondary drains. The two main drains will finally pour themselves into the Nyumba Ya Mungu reservoir.

4.6.5 Irrigation and Drainage Facilities

(1) Design Criteria

Since the Existing Lower Moshi Project Area has been well operated, in this Study the irrigation and drainage facilities are designed using those of the Existing Lower Moshi Project.

(2) Required Irrigation and Drainage Facilities

The required irrigation and drainage facilities determined from the canal layout designed on 1:5,000 topographic maps are as follows:

List of Required Irrigation and Drainage Facilities

Item	Ex. LM Project Area	Expanded Area	New Extension Area
Main and supply canals	10.2 km	3.1 km	9.6 km
Secondary canal	25.0 km	10.3 km	25.0 km
Tertiary canal	65.6 km	18.0 km	70.3 km
Main drain	16.6 km	-	10.5 km
Secondary drain	32.0 km	7.4 km	27.6 km
Tertiary drain	40.9 km	13.4 km	60.5 km
Structures	1,077 nos.	193 nos.	309 nos.

4.6.6 Flood Protection

(1) Need of Flood Dikes

The Mandaka Mnono area extends along the left bank of the Rau river. According to the site inspection and interview with farmers in the Mandaka Mnono area, some parts of the area are suffering from floods by the Rau river and also some small streams from the hilly side every year. In order to protect the crops and the irrigation and drainage facilities to be constructed under the Project, it is essential to provide flood protection dikes. In the canal layout plan for the Mandaka Mnono area, the main canal and the secondary canal No.2 will run on the eastern side, and the secondary canal No.1 on the western side. The flood protection dikes were therefore designed using the embankments of these canals, so as to save construction cost.

(2) Design Criteria for Flood Protection Dikes

The designed section of the dike has a crest width of 2.5 m, inner side slope of 1: 2.0 and outer side slope of 1:1.5, which is the same as the present section because the existing dike is functioning satisfactorily. The proposed length and height of the dike are as follows:

Proposed Length and Height of Dikes

Dike	Length (km)	Height (m)
Northern Flood Protection Dike	7.7	1.0
Southern Flood Protection Dike	8.4	0.3 - 2.3

4.6.7 Farm Roads

All the irrigation canals in the Existing Lower Moshi Project Area are provided with the following farm roads for O&M of the Project facilities and transportation of agricultural inputs and outputs:

- Main farm road : along the main irrigation canal, 7 m wide and laterite-paved
- Secondary farm roads : along secondary irrigation canals, 6 m wide and unpaved
- Tertiary farm roads : along tertiary irrigation canals, 4 m wide and unpaved

Based on the design criteria mentioned above and the feasibility level canal layout on the 1:5,000 topo-maps, new farm road networks will be established for the Expanded Area and the New Extension Area, and the farm road network of the Existing Lower Moshi Project Area will be rehabilitated. The newly established farm road networks for the Expanded Area and the New Extension Area are as follows:

Required Length of Farm Roads

Farm road	Ex.LM Project Area*	Expanded Area	New Extension Area
Main farm road	17.7 km	1.2 km	10.0 km
Secondary farm road	38.7 km	8.4 km	29.7 km
Tertiary farm road	55.6 km	18.0 km	82.3 km

**: Existing Lower Moshi Project Area. The required length means that of the farm roads already constructed.*

4.6.8 On-farm Works

On-farm works consist of watercourses, field drains, field roads, and their related structures. Land levelling for paddy fields and construction of farm ridges are also included in on-farm works. The on-farm works for the Existing Lower Moshi Project Area were executed satisfactorily and no problem has been found so far, therefore the same design criteria are applied for the upland crop area in the Existing Lower Moshi Project Area, the Expanded Area, and the New Extension Area. The required on-farm works cover an area of 3,600 ha in total consisting of 1,050 ha in the Existing Lower Moshi Project Area, 460 ha in the Expanded Area, and 2,090 ha in the New Extension Area. However, the land levelling work is planned with a tolerance of $\pm$ 10 cm instead of $\pm$ 7.5 cm, because further levelling is expected to be done by farmers themselves through land puddling activities on a participatory basis.

4.7 Water Source Development Plan

4.7.1 Basic Approach

In order to solve the water shortage problem in the Existing Lower Moshi Project Area, and also to relieve the surrounding areas from unstable rainfed cultivation and insufficient domestic water condition, it is essential to look for a new additional water source near these areas, say the Study Area. The basic concept for preparation of the water source development plan is as follows:

(a) The first priority shall be placed upon the maximum use of the existing water source of the Njoro and Rau rivers.

(b) The water deficit after the maximum use of the existing water source shall be supplemented through exploitation of new water sources, to minimise costs.

(c) The exploitation of new water source shall be considered from the viewpoint of application of gravity irrigation to the Study Area.

There exist five rivers near the Study Area : The Kikuletwa river, Kikafu river and its tributaries; the Karanga, Weruweru, and Kware rivers. Based on the results of hydrological analysis, new water sources would be narrowed down to the Kikuletwa and Kikafu rivers since

other rivers have a small annual runoff of 20 to 40 million m^3. The Kikuletwa river's minimum monthly discharge observed at IDD54 is 10 m^3/s because much spring water flows into this river. On the other hand, the Kikafu river shows a considerable annual variation in runoff reflecting the rainfall pattern, and its mean monthly discharge becomes 1.5 m^3/s only in October at IDD8 while in May it is 18 m^3/s. This means that the Kikafu river cannot be expected as a new water source if a dam with an enough regulatory capacity is not available. A study on the possibility of constructing a dam with regulatory function was executed using the available topographic map on a scale of 1/50,000 and through site inspection. The results indicate that the topographic and morphological conditions of the Kikuletwa and Kikafu rivers do not present any suitable dam site where the expected reservoir capacity can be created.

4.7.2 Water Demand

(1) Irrigation Water

The unit irrigation water requirements for the respective crops are discussed in Sub-section 4.6.2. In addition, the sugar estate and pilot farm including KATC shall be supplied with irrigation water at a rate of 70 l/s and 130 l/s, respectively.

(2) Domestic Water

Domestic water demand is calculated based on the forecast population and livestock in the year 2015. The demands are 40 lit./s, consisting of 20 lit./s for human use, 10 lit./s for cattle, 4 lit./s for goats and sheep, and some allowance for further demand for human use in the future.

4.7.3 Water Balance Study

A water balance study was conducted based on the river discharge data of the Rau, Njoro, and Kikuletwa rivers, and the water demand estimated above, to assess the irrigation area relative to the available water source.

In the Kaloleni area, three intake weirs will be constructed near the springs while one intake will be on the Njoro river. The Mwananguruwe spring, the primary water source for the Mandaka Mnono area, will be fully utilised for irrigation of the area, supplementing water from the Rau river in the event that the water demand exceeds the discharge of the spring. Thus, an intake weir is proposed to be constructed on the Rau river in the Rau Forest Reserve. The Existing Lower Moshi Project Area, Mabogini, Rau Ya Kati, Chekereni, and Oria areas will depend primarily on the Rau and Njoro rivers for water source . The water deficit after the maximum use of the water of these rivers will be supplemented with the Kikuletwa river water by constructing a new intake and a diversion channel. The irrigation water for the Extension Area including the Mtakuja and Mvuleni areas will be diverted from the Kikuletwa river.

The monthly discharge records from 1967 to 1992 (26 years) were used for the study taking into consideration the availability of the discharge data. The proposed cropping pattern for the water balance study is 100% for paddy in the rainy season and 50% for paddy and 20% for alfalfa in the dry season. The maximum irrigable area is set at 5,010 ha as discussed in

Sub-section 4.3.2, which consists of 360 ha of the Mandaka Mnono area, 100 ha of the Kaloleni area, 885 ha of the Mabogini area, 1,265 ha of the Rau Ya Kati and Oria areas, and 2,400 ha of the Mtakuja and Mvuleni extension area.

Aiming at the maximum use of available water source, the irrigable area of each abstraction point is estimated. Based on the aforementioned conditions, the irrigation area with a 80% dependability was estimated for both the Rau and Njoro rivers, and the Kikuletwa river. The water balance study results indicate that the whole area of 5,010 ha would be irrigated in the rainy season and 3,507 ha in the dry season, of which 4,133 ha would be irrigated in the rainy season and 2,711 ha in the dry season from the Kikuletwa river.

The diversion water requirement from the Kikuletwa river, in March and November exceeds the discharge applied for the provisional water right under the Project, which is 9 m^3/s in the rainy season, and 5 m^3/s in the dry season. Thus, the balance study was carried out again so that the diversion water requirement from the Kikuletwa river is not over the water right. The water balance study results indicate that the whole area of 4,700 ha would be irrigated in the rainy season and 3,290 ha in the dry season, of which 3,823 ha would be irrigated in the rainy season and 2,494 ha in the dry season from the Kikuletwa river.

The result of water balance study with the diversion water requirement at each location is shown in Table 4.7. For effective operation of the small-scale hydropower at the diversion channel, it is proposed that the diversion from the Kikuletwa river be set at 9 m^3/s throughout the year, and then 4 m^3/s will be returned to the Kikuletwa river via the Kikafu river in the dry season from June to November.

4.7.4 Delineation of the Project Area

After estimating the maximum irrigable area per abstraction point as mentioned in the previous sections, a study on water allocation from the water sources, the Rau and Njoro rivers, and Kikuletwa river, was carried out as described in this sub-section. Firstly, the Expanded Area and the Existing Lower Moshi Project Area are to be irrigated by water from the Rau and Njoro rivers. Secondly, the Existing Lower Moshi Project Area is to be developed with water from the Kikuletwa river so as to attain the maximum development. Finally, the remaining water from the Kikuletwa river would be utilised to irrigate the Extension Area. The following table presents the calculated irrigation development areas by area and water source.

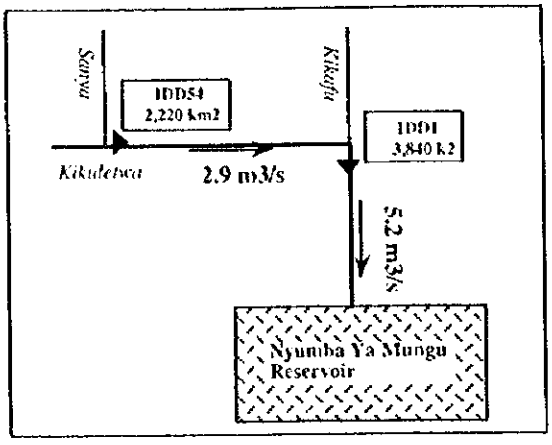
Irrigation Development Areas by Area and Water Source

(Unit : ha)

Area		Rainy Season (paddy)			Dry Season (paddy + alfalfa)		
		Rau & Njoro	Kikuletwa	Total	Rau & Njoro	Kikuletwa	Total
Expanded Area	Mandaka Mnono	360	0	360	252	0	252
	Kaloleni	100	0	100	70	0	70
Ex.Lower Moshi	Mabogini	257	628	885	180	440	620
Project Area	Rau Ya Kati	160	1,105	1,265	294	591	885
Extension Area		0	2,090	2,090	0	1,463	1,463
Total		877	3,823	4,700	796	2,494	3,290

Note: Irrigation water will also be supplied to 70 ha of the sugar estate through the Mabogini Intake and 80 ha of the KATC farm through the Kikuletwa Intake

4.7.5 River Discharge Change with the Project



Mean Minimum Discharge of Kikuletwa River after Implementation of the Project

The mean minimum flow, which may take place in February, at the measurement point in IDD54 station will be decreased to 2.9 m^3/s. The mean annual discharge will also be decreased to 7.7 m^3/s. As for the station IDD1, the mean minimum flow, which may take place in February, will be decreased to 5.2 m^3/s and the mean annual discharge will also be decreased to 16.1 m^3/s. The monthly mean minimum flow of the Kikuletwa river, in summary, is graphed in the figure on the left.

There exist some water users between the proposed intake site and the Nyumba Ya Mungu reservoir. However, the sum of water abstraction of about 200 lit./s will be much lower than the minimum monthly discharge of the Kikuletwa river even after the Project is implemented. Thus, it is deemed that no problem would occur in these areas after water abstraction from the Kikuletwa river for the Project Area.

4.7.6 Return Flow

The gross irrigation water requirement consists of evapotranspiration (ET), percolation (P), and overall irrigation efficiency (IE). ET is consumed by crops and P and IE are supplied to groundwater. According to the measurement results for paddy at the pilot farm of KADP, the ratio of ET to (ET + P) would be about 60% on an average, and the overall irrigation efficiency is 69% for paddy. With these figures, the actual water consumption by paddy is calculated to be about 40% of the supplied water amount, and the remaining 60% would be supplied to groundwater and finally to the Nyumba Ya Mungu reservoir located downstream.

Regarding the required time for the percolation water to reach the Nyumba Ya Mungu reservoir as the time lag between inflow and outflow and the outflow amount, a water balance study of the aquifer was conducted, setting a model of vertical soil column of unit area cross-section, which consists of upper an unsaturated zone, a lower unsaturated zone, and a saturated zone in descending order from the ground surface. Deep percolation from the upper unsaturated zone to the lower unsaturated zone takes place when the moisture contents in the upper unsaturated zone exceeds the field capacity of the soil. Based on the irrigation requirement, rainfall, evapotranspiration estimated in the Project, it is simulated that the soil moisture content reaches the field capacity and the deep percolation takes place 13 days after the irrigation starts, assuming that the initial soil moisture content before irrigation is 20% and the field capacity 30%.

The outflow amount of excess water from the upper unsaturated zone to the lower unsaturated zone decreases exponentially from time to time. Based on the daily hydrograph at IDC6, where the flow comes mostly from the Miwaleni spring through the aquifer and it is

deemed to represent the outflow pattern from the aquifer in the Study Area, the decreasing factor of discharge was determined. For single seepage, the time that water takes to leave 90% of the aquifer is estimated to be some 40 days. Next, an analysis was conducted for the period of one year based on the proposed irrigation schedule proposed for the Project. Based on the analysis results, the duration between the date on which deep percolation reaches a certain amount and the date on which the cumulative amount reaches that amount is estimated to be also around 30 to 40 days. Thus, the estimated time lag between inflow and outflow is some 40 days at the maximum.

4.7.7 Effect on the Nyumba Ya Mungu Reservoir

Based on observed records in the period from 1987 to 1996, the effect of water abstraction from the Kikuletwa river on the Nyumba Ya Mungu reservoir was examined taking into consideration the inflow of the Kikuletwa and Ruvu rivers, the outflow from the reservoir, salient features of the reservoir, evaporation from the reservoir, return flow effect, and so on.

The result shows that the water abstraction for the Study Area would never obstruct the dam operation because the simulated water storage in the reservoir is always larger than the minimum volume, which corresponds to the minimum water level for the dam operation under the condition of a 14 m^3/s outflow from the reservoir. Then, a maximum 26 m^3/s outflow from the reservoir could be utilised for power generation throughout the year while sustaining water abstraction for the Study Area with the aforementioned discharge. The reservoir operation results with the Project are given in Figure 4.7, which also indicates the results of water balance study for the cases of 1) outflow from the reservoir: 14 m^3/s, and 2) maximum water release from the reservoir without water abstraction for the Project. The result indicates that a maximum 28 m^3/s outflow could be released from the reservoir.

A comparison was made between the "with abstraction" and "without abstraction" cases as explained above. The result shows that there is only a small difference between them. The annual mean inflow to the reservoir will be decreased by 2 m^3/s in total.

4.7.8 Water Source Facilities

The water supply facilities consist of headworks and a diversion channel to lead irrigation water from the Kikuletwa river to the New Extension Area and the Existing Lower Moshi Project Area, and finally into the Rau river for conservation of the downstream eco-system. A comparative study was executed for the weir type, canal lining type, locations of diversion weir site and diversion channel route, and diversion weir height, from technical and economic viewpoints The results are explained below.

(1) Headworks

A comparative study was conducted for five alternatives on location of diversion weir site, diversion channel route and diversion weir height. As a result, Alternative-C was selected from technical and economic viewpoints. The selected location of the headworks is approximately 4 km downstream of the existing TANESCO power station. The average gradient of the Kikuletwa river at the headworks site is 1/30, and the riverbed elevation is EL.

780.0 m. The abutment at the site is characterised by a steep slope almost vertical or with a gradient of 1 : 0.1 to 1 : 0.2. In particular, the right side abutment is very steep. The site is composed of tuff breccia, and bedrock and basement rocks are found to be hard. The Kikuletwa headworks are broadly divided into 2 components, namely a diversion weir and an intake structure.

The concrete gravity type was adopted considering workability, diversion work during the construction period, and topography of the proposed site. The non-gated type spillway with roller bucket type stilling basin was applied taking into account the topographic and geological conditions of the site. As foundation treatments against cracks/seams and permeability, consolidation grout and curtain grout will be required for the foundation rock. The intake structure consists of intake gates, a connecting channel to the diversion channel and a measuring device at the end portion of the structure.

The principal features of the headworks are summarised below:

Principaal Features of Headworks

(a) Diversion weir		(b) Intake structure	
- Design flood	: 234 m3/s(100-yr. probability)	- Type	: Gravity intake
- Type	: Concrete gravity	- Operation	: Manual operation
- Height	: 28 m	- Intake Water Level	: EL. 813.9m
- Length	: 72 m	- Nos of intake gate	: 2nos.
- Crest elevation	: EL. 817.0 m	- Dimension of gate	: 3.0 m high
- Stilling basin	: Ski jump type		2.3 m wide

(2) Diversion Channel

The topographic and geological conditions of the diversion channel routes are broadly classified into two portions. The upstream portion of the channel (highland area) with a length of 12 km, passes through a gently sloped tableland with elevation from EL. 840.0 m to EL. 760.0 m. This portion is composed of tuff breccia which is generally hard. Unconsolidated deposits and alluvium soils are observed on the route, however, they are extremely thin with a maximum depth of less than 1 m. The downstream portion of the channel (lowland area) with elevation from EL. 755.0 m to EL. 740.0 m is about 12 km long. The route is fully covered with hard alluvium deposits followed by gravel /sand layer.

As for lining, it was decided to employ shotcrete lining for the channel portion in the highland area and precast concrete block lining for that in the lowland area, to reduce the channel section and maintenance cost during operation. The water level of the channel is principally lower than the original ground level to prevent illegal water tapping by inhabitants, especially on the route in the lowland area. Further, an inspection road is to be provided for easy operation and maintenance of the diversion channel. The major related structures of the diversion channel are the Longoi river siphon, Kikafu river siphon, Weruweru river aqueduct, road crossing structures, railway crossing structure, drop and chute, bifurcation, cross drains, footpath bridge, wasteway and end structures, and bridges.

The principal features of the diversion channel are summarised below:

Principal Features of Diversion Channel

Design discharge	:	Q=9.0 m^3/s
Total length	:	24.5 km
Concrete lining	:	Shotcrete lining in highland area
		Precast concrete block lining in lowland area
Canal section	:	Trapezoidal
		width = 1.90 - 2.00 m
		height = 1.90 - 2.60 m
Longitudinal gradient	:	1/1,000 - 1/2,000
Design flow velocity	:	less than 1.50 m/s
Related structures	:	93 nos.

4.8 Rural Infrastructure Development Plan

4.8.1 Basic Approach

(1) General

The rural infrastructure planned in the Project Area is aimed at improving the social environment and stabilising agriculture. It is important that the rural infrastructure be maintained directly by villagers, the prime users, who are aware that the system belongs to their community and that it is necessary to preserve it for sustainable and effective use. Therefore, consideration shall be given to an easily operational and maintainable system in formulating the rural development plan.

This rural infrastructure development plan is formulated mainly based on the results of field investigation, study of data and information collected from the agencies concerned, which are mentioned in Section 3.10, and applying the following basic approach:

(a) Maximum use of the existing facilities.

(b) Appropriate size and potential usage in the future.

(c) Application of the same criteria adopted in the Existing Lower Moshi Project Area.

(d) Simple structures for easy operation and maintenance by villagers.

(e) Coincidence with respective development plans at village, district, regional and central levels, if any.

(f) Reflection of opinions, suggestion and wishes of villagers within the framework of the agreed Scope of Work.

(2) Rural Road Network

Rural road development aims at smooth carriage of agricultural products and inputs, and improvement of living conditions of the rural people. In order to attain this aim, the proposed inspection road along the diversion channel will be furnished with functions of a rural road and regarded as a main road for the Project Area as same as the trunk road and the existing main

farm roads. Consequently, the existing village roads connected to these main roads will be improved as village linking roads, and incorporated into the planned road system. In this Project, new village roads will not be constructed and developed, and only the existing village roads will be improved and repaired.

(3) Domestic Water Supply

The development plan, which is formulated for the purpose of improving domestic water supply and providing a multi-purpose canal with water facilities for domestic and livestock uses, is based on the basic approaches described below.

(a) The water facilities for domestic and livestock uses should be developed according to the number of users and livestock in the future.

(b) The water facilities for domestic and livestock uses should be constructed with materials available near the site to reduce cost; such materials are to be selected taking into consideration operation and maintenance in the future.

(c) The water facilities for domestic and livestock uses are designed to be simple structure, which can be maintained by villagers themselves.

(d) The water facilities for domestic and livestock uses in the new diversion channel are designed taking into consideration safety and convenience factors related to the channel depth.

4.8.2 Rural Road Network Plan

(1) General

(a) Criteria of selection

The proposed village linking roads are selected based on the following criteria:

- Village roads with heavy traffic for passage and transportation of agricultural products and inputs.
- Village roads being in bad conditions in the rainy season and having potential for good access to the main roads through improvement.
- Village roads with heavy traffic running through centres of villages and having a role as main roads.
- Village roads connected to schools and hospitals and playing an important role for social life.

(b) Design of village linking roads

The existing village roads will be improved as village linking roads based on the following basic design concept:

- Application of the same criteria adopted in the Existing Lower Moshi Project.
- Maximum use of existing village roads as village linking roads.
- Provision of related structures such as drain, cross culvert and side drain, and/or protection works such as slope protection, if needed.

(2) Existing Lower Moshi Project Area

The results of inventory survey show that the existing road system in this area can sufficiently satisfy the said criteria, but rehabilitation and improvement of roads is required. The rehabilitation and enhancement works for the existing road system are discussed as works for farm roads along the irrigation and drainage canals in ANNEX-K, and thus no such works are considered within the rural development works in this Study.

(3) New Extension Area and Expanded Area

In the New Extension Area, the existing road network is composed of a few village roads which are in very poor condition and are passable only for several months during the dry season. Therefore, road networks composed of new farm roads and village roads should be planned using the same criteria as those for the Existing Lower Moshi Project Area. The existing village roads will be improved as linking roads to connect the villages and the farm roads to realize smooth traffic. But some village roads will be developed as farm roads according to the irrigation and drainage canal system plan.

In accordance with the development concept, the total length of village roads connected to the proposed main roads is about 1.0 km and these village roads will be rehabilitated and improved in the New Extension Area. The same criteria as mentioned above will be applied for the road works to be executed in the Expanded Area, and 0.7 km of roads in the Kaloleni area and 3.1 km in the Mandaka area will be rehabilitated and improved. In addition, 2 simple bridges will be built over the Rau and Njoro rivers to connect the Existing Lower Moshi Area with Moshi city.

The works will consist mainly of reshaping of the road surface. The location and length of road works are shown in Table 4.8.

(4) Proposed Diversion Channel Route Area

From the viewpoint of road network in this area, the absence of village roads reaching directly the town and/or parent roads such as trunk roads constitutes a great inconvenience for villagers. Therefore, the inspection road proposed along the diversion channel is considered to be a main road in the area, and village roads will be linked to the inspection road for establishment of the road network.

The proposed diversion channel will cross about 30 existing village roads in total. In line with the development concept mentioned above, 10 village linking roads will be rehabilitated and improved as village linking roads including related structures. The range of rehabilitation and improvement will vary from 400 m to 1,000 m on both the right and left sides of the channel. Rehabilitation and improvement of village roads connected with the proposed diversion channel will be executed using the same criteria as those for other areas and cover a total length of 4.9 km. The location and length of road works are shown in Table 4.8.

4.8.3 Domestic Water Supply Plan

(1) General

As mentioned in Section 3.10, a public water supply system is available only in the

Existing Lower Moshi Project Area, but its coverage rate is low. All other areas are supplied with domestic water from shallow wells, springs, and rivers. Thus, the quality of life in these areas is still very poor and urgent measures are necessary to improve the living standards and sanitation condition. On the other hand, as can be observed in the Existing Lower Moshi Project Area, the irrigation canals play the role of not only irrigation water supply but also domestic water supply for such purposes as cooking, bathing, washing, and livestock drinking. From these findings, it is deemed indispensable that water tapping facilities like washing steps shall be provided as important domestic water supply facilities in the New Extension Area, the Expanded Area, and also the Proposed Diversion Channel Route Area.

Due to insufficient number of public water supply facilities, villagers in and around the Project Area are depending on irrigation water and the Rau river water . For the convenience of villagers, a total of 12 places equipped with washing steps will be provided in the Existing Lower Moshi Project Area. According of CHAWAMPU's By-Law, washing steps can only be used for drawing water and any other use is prohibited. However, villagers are using the irrigation water for washing body, clothes, vegetables, not only on the washing steps provided for that purpose but at any other places of convenience, namely near houses. In addition, cattle and other animals can drink water at any places. Due to the aforementioned reasons, irrigation water is contaminated and contains very high values of BOD as mentioned in Sub-section 3.3.4.

(2) Selection Criteria

The proposed water facilities for domestic and livestock uses are selected based on the following criteria.

(a) Water facilities for domestic use

- The water facilities for domestic use are to be provided near the communities.
- The water facilities for domestic use are to be planned near road crossings with many pedestrians.
- The water facilities for domestic use are to be located near the villages which have no other water sources.
- The water facilities for domestic use are to be located at a maximum distance of 2 km from villages (2 km is adopted as the maximum school distance for children in some standards).

(b) Water facilities for livestock use

- The livestock troughs are to be located depending on the number of livestock using the area, difficulty of access, and proximity of agricultural lands.
- The livestock troughs are to be located near the communities and/or the road crossings with many pedestrians.

(3) Estimate of Population and Number of Livestock in Year 2015

The water demands of villager and the number of livestock in the Project Area are estimated based on the Water Development Plan in Moshi District and the population census in 1988. Details of the estimates are shown in Table 4.9. In the table, the livestock number in the Proposed Diversion Channel Route Area is computed from the population census taken between 1978 and 1988, but that in the other three areas is based on the information from

RALDO. The ratio of canal users in the Existing Lower Moshi Project Area is determined based the results of verbal enquiries. For the other three areas, the estimate is based on the ratio of users of springs, rivers and other water sources.

(4) Water Facilities for Domestic Use

Water facilities equipped with places for domestic use will be provided along the diversion channel and irrigation canals near communities. The structures of these facilities will consist of an inlet, a suction pit with hand pump, and a washing place. The number of facilities proposed to be installed in the respective areas is as follows:

(a)	Existing Lower Moshi Project Area	:	24 places
(b)	New Extension Area	:	25 places
(c)	Expanded Area		
	- Kaloleni	:	3 places
	- Mandaka Mnono	:	5 places
(d)	Proposed Diversion Channel Route Area	:	10 places
	Total	:	67 places

(5) Water facilities for livestock use

Facilities equipped with livestock troughs will be provided along the diversion channel and irrigation canals depending on the number of livestock using the area, difficulty of access, and proximity of agricultural land. The structures of there facilities will consist of an inlet, a suction with hand pump, and a drinking manger of 30 m long. The number of facilities proposed to be provided in the respective areas is as follows:

(a)	Existing Lower Moshi Project Area	:	4 places
(b)	New Extension Area	:	6 places
(c)	Expanded Area		
	- Kaloleni	:	3 places
	- Mandaka Mnono	:	2 places
(d)	Proposed Diversion Channel Route Area	:	5 places
	Total	:	20 places