CHAPTER III. BASIC APPROACH TO THE PROJECT

3.1 Development Policy and Needs

3.1.1 Political Needs for Smallholder Irrigation Development

GOT has put the highest priority on the agricultural sector development with particular emphasis on attainment of the following objectives as the primary but the most important issues for implementing the current socio-economic development program,.

1) To satisfy subsistence requirement in a large part of the country,

2) To generate the local surpluses of main staple food production, especially maize and rice, in order to facilitate food security either at the villages as well as regional or national levels, and

3) To ensure the production to be much needed for dietary supplement, i.e. vegetables, fruit, oil seeds, etc.

Then, to materialize the above policy objectives, GOT has first launched the irrigation-based agricultural development in line of the strategic framework with emphasizing on "rehabilitation or up-grading of the traditional irrigation schemes" and "up-grading traditional water harvesting technology." To this concern, GOT highly expected that the maximum impact will have to be brought by irrigation beneficiaries themselves, who shall aggressively participate in the above mentioned irrigation development based on a sense of participatory approach.

3.1.2 Development Needs and Wishes of Irrigation Beneficiaries

The development needs and wishes of irrigation beneficiaries are identified through on-field guidance to and technical discussion with the farmers in Mgongola scheme area, and confirmed through the public meeting held with all the irrigation beneficiaries.

All the farmers benefited from the existing irrigation systems attach the highest priority on "rehabilitation-cum-improvement of the irrigation facilities", and then, "expansion of irrigable land" as much as water resources are become available. Concerning the above two points, farmers emphasis on the following assistance for efficient operation and management of the irrigation facilities as well as irrigated farming:

1) Irrigation Development:

- Provision of a concrete intake weir with gate structure so far as to properly manage water diversion as well as to mitigate the costs and/or burden which has been spent for renewal of the traditional-type intake weir every year.
- Provision of the basins in canal system for utilization of domestic water
- Provision of protection measures for roads, canals, etc. against the seasonal flooding.
- Technical assistance for improvement of the irrigation and drainage facilities at the on-farm level as well as guidance for improvement of the irrigation technology for efficient utilization of the water resources.

2) Agricultural Development:

- Steady-cum-timely supply of farm inputs, i.e. qualified seeds, safety-cum-effective agro-chemicals, etc.

- Adjustment of the prices on farm inputs, farming implements and tools, and agricultural production.
- Assistance for introduction of more effective farm machinery and implements, i.e. tractor, thresher, sprayer, light-carrier, etc.
- Provision of an intensive guidance especially on improvement of agricultural technology, i.e. irrigation-based farming practices, weeding as well as pests and diseases control, soil fertilization practices, etc.
- Provision of guidance for crop diversification with particular emphasis on economic crops as well as information on agricultural production markets.

3) Institutional Supporting Services:

- Provision of more opportunity for women's participation to any project activities.
- Extend financial assistance to women's groups for activating their income generation.
- Provision of technical training programs, including study tour not only for men's groups but also women's groups
- Activation of the agricultural extension services, including demonstration of irrigation-based farming technology.
- Provision of technical training courses especially those related to technology for irrigation-based agricultural production as well as operation and maintenance (O&M) of irrigation facilities through rehabilitation-cum-reinforcement of the existing farmer's training centers.
- Provision of guidance for reinforcement of the existing water users' groups and then step forward organization of the water users' co-operatives.
- Provision of opportunities for access to credit services, satisfactorily and success-fully.

4) Supporting Infrastructure for Irrigation-based Agricultural Development:

- Rehabilitation or renewal of facilities to be used for community activities.
- Provision of domestic water supply system in connection to the irrigation facilities.

3.2 Basic Approach to the Project

3.2.1 Fundamental Objectives of the Project

The agriculture in Tanzania continues to play the most important role for maintaining the national economy. However, it has a delicate structure for production against the physical constraints, and improvement of its productive conditions is still at the primary level. Accordingly, to sufficiently support the national food security conditions as well as satisfactorily maintain the foreign trade balance, further expansion and stabilization of the agricultural production are essential and the primary subject of the agricultural sector.

The Mkula scheme is the typical traditional smallholder irrigation scheme on the piedmont plain and fan zone in the Central Wami River Basin. In the upper reaches of the fan formation where the land constitutes of the coarse texture soils, an irrigation efficiency is so poor in the existing facilities due to a large leakage loss of irrigation water because of high permeability of soils. At present, the irrigable land is only limited to few ha. Majority of farm land lies under the rainfed conditions, and accordingly, the agricultural production per farm household is still at a subsistence level.

Dealing with the present agricultural conditions of the scheme area and then to respond to the national needs on the agricultural sector development, the following three

points have set up as the fundamental objectives for the subjected irrigation-based agricultural development in Mkula scheme:

1) To up-lift income level of the smallholder farmers to get out a rural poverty and step forward socio-economic activities in the rural area.
2) To ensure sustainable agricultural development, and then,
3) To contribute to a national food security through increasing staple food production.

3.2.2 Strategy and Development Framework

To successfully accomplish the above objectives, the following programs have been taken up as the strategic approach to development of the scheme.

1) Rehabilitation and expansion of the existing irrigation systems and improvement of drainage conditions.

   Development goal expected by both government and beneficiary farmers in the scheme area is primary to increase and stabilize the staple food production, through ensuring a supplementary irrigation to crops particularly in the drought rainy season, and to improve an agricultural productivity as well as to generate farm economy by promotion of economic crop production in the dry season, and consequently, maintain a sustainable irrigation-based agricultural development in this scheme area.

   For accelerating further increment and stabilization of the crop production, and hence, maintaining a sustainable development of farm economy in smallholder farming, irrigation development and drainage improvement is the basic subject in this scheme.

2) Intensification-cum-diversification of crop production through on-farm development.

   As stated in the preceding Section 1.3.3 of Chapter I, all of the arable land has been reclaimed extensively under the rainfed conditions. Since the soil moisture conditions are relatively well maintained by shallow groundwater even in earlier half of the dry season, many farmers grow maize and/or pulse, twice a year without artificial irrigation. However, the agricultural production is still low at subsistence level due to drought hazard that remains under irregular distribution of the annual rainfall. Rehabilitation and improvement of the existing irrigation system herein conceived in this Project will make possible to stabilize such crop production as well as to generate farm income of the smallholder farmers for more than that at the present poverty line. To achieve the above goal, an extension of irrigation practices as well as irrigated crop farming technology to the farmers is indispensable, accordingly, through reinforcement of the respective institutions for extension services.

3) Community development especially establishment of the water users' group (WUG).

   To organize the beneficiary farmers into the formal cooperative society will much be effective not only for regularization of communal activities on O&M works of the irrigation facilities as well as other agricultural infrastructure, mitigation of social conflicts, access to the group loan in the national credit facilities, but also for empowerment of the co-operative members in marketing of both farm inputs and production. Thus, herein the Project, a community development especially the "Water Users' Group (WUG)" in the scheme area

is one of the essential program for accomplishment of the above tasks of the beneficiary farmers. In organization of WUG, it is also expected to bring about various job opportunities for participation of those women, youth and/or gender groups in the rural area.

4) Social and/or agro-forestry approach to the environmental protection-cum-conservation

As have been stated in the previous Section 1.6 of Chapter I herein above, degradation of the natural vegetation and/or exhaustion of forest resources are ex-tending to a hazardous extent in and around the scheme area due to a heavy population pressure to the land inclusive of those resources. A social and/or agro-forestation approach will highly be effective to maintain, and then, recover the said resources if the present on-going afforestation programs are scheduled in combined with the proposed land use plan prepared hereby.

To formulate the development plan and make preliminary design of this scheme, it is to emphasize that "farmers participatory approach to the Project", "reinforcement of women, youth and gender groups in the development" and "environment-friendly development" shall be the basic concept so as to maintain a sustainable development of this Project.

3.2.3 Basic Issue for Environmental Protection and Conservation

The development plans mentioned above aim at attainment of food crop production increase for the national self-sufficiency and promotion of crop diversification cum intensification for stabilization and up-grading of the farm economy through consolidation of the agricultural land particularly with emphasis on rehabilitation and/or improvement of the traditional smallholder irrigation furrow systems. The environmental impact assessment (EIA) made herein the feasibility study revealed that the following environmentally susceptible elements have been, more or less, affected even under the present conditions with the negative impacts due to "high annual increment of both human and livestock population", "high energy consumption chiefly of the forest resources", "unconsolidated rural sanitation facilities", etc. Among those negative impacts, the following environmental aspects shall be carefully taken into consideration when the proposed development plan will be implemented hereafter.

1) Direct Environmental Impacts

(a) Increment of Water-bone Epidemic Diseases

It is foreseeable that the hydrological regime in the scheme areas would be changed to a certain extent, i.e. appearance of wide impounding area, wet land as well as raising of ground water level, etc. through consolidation of irrigation facilities and its operation, and a new ecological conditions be established accordingly. With such conditions, the negative impacts would increase its potential for expansion of an influence of the water-bone epidemic diseases, such as Malaria, Schistosomiasis, Firariasis, etc., and water contamination. Thus, in the implementation of the Project, particular attention shall be paid to this concern.

(b) Agro-chemical Impacts and Water Contamination

Utilization of chemical fertilizers and agro-chemicals for maintaining the agricultural production at a high level would cause water contamination as

well as accumulation of toxic elements into soils in the scheme areas. Accordingly, those chemical elements bring a risk to human health as well as the natural eco-system especially for the aquatic species in the area. Therefore, special attention shall be paid to utilization of the agro-chemicals.

2) Indirect Environmental Impacts

(a) Deforestation and/or Degradation of Vegetation

When the development is successfully implemented and accomplished the goal of agricultural production, the present living conditions could be upgraded, and consequently, energy consumption per household will largely be increased to a high level. This means that deforestation and/or degradation of vegetation will be accelerated due to increment of the fuel wood collection. Thus, in the land use planning, it shall pay special attention to allocate certain land for afforestation of the fuel wood.

(b) Misgivings of Social Conflict

A social conflict concerning water rights, land tenure system, right of irrigable land occupancy, etc. is one of the misgivings in this scheme. Thus, an allocation of the irrigable land which will be newly consolidated under this Project shall be made through mutual consent amongst the beneficiary farmers.

3.3 Land Use and Agricultural Production Plan

3.3.1 Land Use Plan

The proposed land use in Mkula scheme area is prepared according to the following basic concept:

- To utilize the land resources at possible maximum extent;
- To optimize the present land use for the staple food as well as economic crop production as much as irrigation water resource is available in the scheme area;
- To consider strongly the present land use; and
- To protect/conserve the natural environment and hence to maintain a sustainable agricultural production activities.

With reference to the results of land suitability classification, the present land use has been reviewed precisely, and then, the proposed land use under the conditions with irrigation development is prepared as follows:

Proposed Land Use of Mkula Scheme

(Unit : ha)

Land Use Type	Present	Proposed	Remarks
Paddy field	108	100	upland crops in the dry season
Upland field	42	39	
Sugarcane	11	10	
Forest/Wood lands	10	10	
Right of ways	4	16	canal, roads, drain, etc.
Total	175	175	

The proposed land use in Mkula scheme is practically not changed from the present conditions. Rather than the above, a net cultivation acreage will be reduced to total about 12 ha from the present acreage in each land categories.

The land, which is being used for paddy production at present, shall be consolidated through on-farm development, including field ridge formation and land leveling work. The present upland field shall also be consolidated precisely same to the paddy field, unless and otherwise, efficient operation of irrigation practice, and hence, a sustainable crop production can not be maintained, effectively and successfully.

In use of the farm land, it can be expected to grow paddy and/or upland crops in full acreage in the rainy season under supplementary irrigation. In the dry season, however, it has no chance to grow paddy but upland crops in certain acreage. This is due to a limitation of water resources for irrigation.

3.3.2 Selection of Proposed crops

(1) Group Discussion with Farmers concerning Agricultural Development Plan

In the course of the field study in the Master Plan level which was conducted in Phase-1 last year, farmers' needs, conception, complains, etc. was revealed to some extent and recognized by the Study Team. Considering the information which were collected, the agricultural development plans for the proposed 16 irrigation schemes were individually formulated in the Master Plan.

In Phase-3 for the Feasibility Study, the Study Team tried to identify what the farmers really desired to do in the future development, reach a consensus with farmers, and encourage them to participate in the development project.

The Study Team arranged several group discussions with various type of such villagers as female farmers, male farmers, key persons in the village community as shown in Table 3.3.1. A variety of opinions, conceptions, complains, requests, etc. were emerged in the discussions with farmers. It is indispensable to provide opportunities which villagers speak their minds, opinions, etc. freely. The Study Team carefully arranged such group discussions with various type of villagers so that each attendant could open his / her mind and manifest his / her opinion.

Major topics in group discussions concerning agricultural development in Mkula scheme are summarized as follows;

- A high yielding variety of paddy should be cultivated instead of local one.
- Pulse cultivation is desired, but difficult due to attack of insects and/or diseases.
- Miscommunication between farmers and tractor owners are found.
- Fertilizer is available, but expensive.
- Price of farm products is fluctuated season by season and low.

(2) Selection of Major Crops

The following points are confirmed to select the proposed crops for the Project area through a series of group discussions in the field work of the Feasibility Study.

1) To be major crops which are proposed in the National Agricultural Development Plan

In the National Agricultural Development Plan, increment of food crop production has been proposed, especially maize and paddy. Furthermore, the plan has proposed to increase rice production to 800,000 tons by the year of 2000.

2) To be relatively familiar to the farmers as well as extension officers concerned

Proposed crops and its farming practice should be acceptable to the farmers and extension officers. Even if the crops are more beneficial, it is not recommendable to propose the crops which are not familiar with them.

3) To be acceptable to the farmers in the view of farming practices

Utilization of farm machinery is not common in the Project area, while proper farming technology is also hardly disseminated. Accordingly, it is not practicable to rapidly introduce new crops for which modernized or advanced farming practice is indispensable.

4) To consider the preferable crops of farmers in the Project area

In order to confirm the preference concerning promising crops of the beneficiaries, group discussion was conducted.

5) To effectively use water resources

Water resources should be effectively allocated for the Project. In view of effective water use, it is required to select the promising crops.

6) To contribute maximum benefit to the farmers in the Project area

Project implementation will contribute in benefiting the farmers directly. Their living standard and nutritious condition will be improved through the project implementation. Accordingly, irrigable land in the Project area should be utilized at its maximum.

As mentioned in Section 1.3.3, the farmers are facing to unstable market of sugarcane. It will not be assured to obtain sustainable benefit from sugarcane cultivation unless the Kilombero Sugar Company improve or expand its owned processing capacity. Accordingly, it is thereby proposed that sugarcane in the respective scheme areas should shift to other upland crops such as maize, pulse crops, etc.

Based on the consideration for the points mentioned above, the development plan in this scheme will aim at keeping up increment of sustainable production of such major crops as paddy, maize, pulse crops, etc.

3.3.3 Proposed Cropping Pattern and Cultivated Area

(1) Proposed Cropping Pattern

In preparing the proposed cropping pattern for the Project area, the following points, which were considered through the Master Plan study, were confirmed in the course of a variety of group discussions which was conducted in the field work of the Feasibility Study.

1) To minimize the crop water requirement

The periods of peak water requirement for paddy and upland crops should not be overlapped each other.

2) To consider the existing cropping pattern

The proposed cropping pattern should be acceptable to farmers, considering

the familiarity of the farmers and extension officers concerned. Accordingly, it is not recommendable to introduce new crops in large and drastically change the system of crop rotation.

3) To maximize utilization of irrigation water and the cropping intensity

Effective use of irrigation water is strongly required in order to utilize the limited water resources and extend the irrigation area maximally. Furthermore, cropping intensity is proposed to intensify up to 200 %, aiming at future sustainable prosecution of proposed farming practices. High cropping intensity of over 200 % is not practicable in the Project area, from the view point of occurrence of insects and diseases, farmer's familiarity, labour productivity, and water management, etc.

The proposed cropping patterns which are illustrated in Figure 1.3.1 considerably meet all these requirements and conditions mentioned above.

(2) Cultivated Area and Cropping Intensity

After establishment of irrigation system, habitual flooding in rainy season will be improved, while irrigation in dry season will be realized fully. As a result, the expansion of irrigated cultivation will be realized.

While it is assumed that future situation without project is almost same as the present situation. Because the any activities concerning improvement of present situation will not be carried out.

Cultivated area by crop and cropping intensity without and with project conditions is summarized below.

Cultivated Area and Cropping Intensity in Mkula Scheme

	Without Project Condition				With Project Condition			
	Project Area (ha)	Cultivated Area		Cropping Intensity (%)	Project Area (ha)	Cultivated Area		Cropping Intensity (%)
		RS	DS			RS	DS	
Mkula								
Paddy		108	-			108	-	
Maize/others*1		42	40			-	-	
Maize/Pulse*1		-	-			41	108	
Pulse/		-	-			-	41	
Vegetables*2		-	-			-	-	
Sugarcane		11	11			-	-	
Total	161	161	51	132	149	149	149	200

RS : Rainy season, DS : Dry season
*1 : Maize is a predominant crop.
*2 : Pulse crop is a predominant crop.
Without-Project Condition is the same condition as the present one.

3.3.4 Proposed Farming Practices

The present farming practices carried out in the Project area is likely to be of extensive cultivation, namely no application of fertilizer and agro-chemicals as well as low input of labour force are common. Proper farming practices are adopted to take effect of irrigated agriculture and promote increment of crop production, based on the proper application of farm inputs. That is, it is indispensable to apply certified seeds of high yielding varieties or improved varieties with proper dosage of fertilizer and agro-chemicals under

such sufficient supporting services as extension, credit, research, etc.

It is not practical to recommend ideal farming practices which are entirely different from the prevailing farming practices. Each component of proposed farming practices should be formulated considering the prevailing situation on availability of machinery and animal power, labour requirement, etc., considering the guideline on farming practices which are proposed by the extension office. Furthermore, it is necessary to improve extensive cultivation and disseminate practical farming practices.

Fertilizer and organic materials should be effectively applied rather than in the current situation, from the viewpoint of sustainability of soil fertility and increment of crop production under irrigated condition. Dissemination on application of agro-chemicals to the farmers should be paid careful attention. It is noted that farmers are aware of effect of agro-chemicals, however most of them have no sufficient knowledge on identification of pests and diseases and proper application of agro-chemicals.

Extension officers are required to give the guidance concerning the proper farming practices to farmers and to manifest the effect of proper application of farm inputs under irrigated condition. As one of extension tools, it is strongly recommended that demonstration plot be undertaken to disseminate effectiveness of proper farming practices for farmers concerned.

Proposed farming practices for major crops is given in Table 3.3.2. Guideline of time schedule for crop cultivation is shown in Table 3.3.3. Further, recommendable agro-chemicals and its application dosage are shown in Tables 3.3.4 to 3.3.5, respectively.

(1) Paddy

Advanced paddy cultivation under the technical assistance of Special Programme - FAO has been carried out in Mang'ula"A" village which is near Mkula scheme. In this village, participated farmers have applied the improved cultivation practices such as dibbling method in direct sowing, application of fertilizer, careful management on weeding, and further traditional water management, in order to increase paddy production under rainfed condition.

It is recommended that farmers concerned in Mkula scheme should take mutual communication with farmers in Mang'ula"A" village for getting useful information. Through mutual communication, it is expected that technologies and experience be transferred each other.

In principle, no special practices to be extremely complicated and advanced are not proposed for paddy cultivation as described for Mgongola scheme, but proposed farming practices are similar with certain recommended practices of the Special Programme - FAO. Topics of proposed farming practices for major prospective crops are shown below;

(a) Land preparation of the main field

Land preparation is manually done by using tractor or hand hoe. It is recommended that the popularization of draught cattle be promoted and therefore puddling and/or leveling will be implemented smoothly and effectively. However, dissemination of utilization of draught cattle could not be attained within short time, because farmers concerned have no much experience for grazing cattle and applying them for land preparation.

Ploughing is carried out 3 to 4 weeks before transplanting. That is, land preparation for the main field is commenced when nursery beds are prepared in a part of the main field. After ploughing, puddling is consequently conducted

over the nursery period.

(b) Nursery preparation

Nursery bed is prepared in a part of the main field. Seed amount for the nursery is estimated at around 40 to 50 kg for one ha of the main field and bed size is instructed to be 600 m2 for one ha. It is recommended to follow the procedure of soaking seed through which vigorous seeds could be selected. Nursery period is estimated at around 3 to 4 weeks. 2 kg of Nitrogen per 600 m2 is applied around two weeks after sowing.

(c) Transplanting

One to two seedlings per hill are transplanted with range between 10 cm x 10 cm and 10 cm x 20 cm. As applied in the existing Mkindo Pilot Scheme, it is better use line marker which were introduced to the Mkindo scheme. However, it is necessary to demonstrate some alternative method on planting such as random planting, regular planting, broadcasting, etc. through demonstration activity. As a result, farmers might be able to select proper way which is applied to farmer's situation. It is necessary to carry out gap filling for missing paddy seedlings.

(d) Application of fertilizer and agro-chemicals

Basal fertilizer is applied just before transplanting, or 40 kg of Nitrogen and 25 kg of P2O5 in one ha. Furthermore, top-dressing for 40 kg of Nitrogen should be done around 35 days after transplanting, or the stage of panicle initiation stage.

(e) Plant protection

Regarding diseases, blast, sheet rot, etc. are mainly identified in the are, while stalk eyed sheet fly, stem borer, etc. are major insects. However, those diseases and insects are not so serious. When it seems that serious damages would be appeared, proper agro-chemicals should be applied, referring the recommendable agro-chemicals shown in Tables 3.3.4 and 3.3.5. On ripening stage, it is proposed that bird scaring be an important activity.

(f) Weeding

In principle, weeding should be practiced at least twice during the growth period, depending on the situation of weed growth. Special Programme - FAO has instructed to adopt rotary weeder instead of application of herbicide and manual weeding. However, farmers prefer to conduct manual weeding instead of adoption of rotary weeder, due to low efficiency of this tool. In the Project, it is necessary to demonstrate the function of proper rotary weeder and confirm the work efficiency of several types of weeding methods.

(g) Water management

Basically, irrigation is commenced on preparing nursery beds in a part of the main field. Consequently, puddling is carried out under shallow water. Irrigation is generally conducted once a week until around 20 days before harvesting. Further, when soil is hard for ploughing by hand tractors, there is some cases to impound shallow water to the field in order to soften the soil condition.

(h) Harvesting and post-harvesting activities

Growth period of "Line 88" is estimated at around 120 to 130 days in the area. Harvesting work is commenced during the period from the beginning of November to beginning of December when around two-third of panicle from the top side is changed to yellowish color. Drying activity after reaping is not so common. After reaping, paddy grains are consequently threshed, winnowed, and bagged immediately in the field.

(2) Maize

Land preparation is generally carried out by applying tractor. Seed amount is estimated at around 20 to 25 kg per ha. Planting density is in the range between 70 cm x 90 cm and 90 cm x 100 cm.

As for basal dressing, fertilizer with N:P:K=15:20:0 will be applied before planting. Fertilizer should be applied into each hill. Further, top dressing with N:P:K=15:0:0 should be applied near each hill 40 days after transplanting which is a stage of ear formation. Fertilizer is applied in the surface of field and further incorporated with soil by using small hand hoe.

Weeding is manually carried at least twice during the growth period, by using small hand hoe or just uprooting by hand.

In the scheme, serious damages by insects or diseases are not found so far. Regarding insects, it is recommended to apply proper agro-chemicals as shown in Tables 3.3.4 and 3.3.5.

(3) Pulse crops

(a) Land preparation

Land preparation is manually carried out by using hand hoe. Manner of land preparation is almost similar with cabbage mentioned above.

(b) Major Practices in Main Field

Seed amount is estimated at around 20 kg per ha. Planting density is in the range between 20 cm x 30 cm and 40 cm x 50 cm.

As for basal dressing, fertilizer with N:P:K=40:0:0 will be applied before transplanting. Fertilizer should be applied into each hill. No top dressing should be applied. Weeding is manually carried at least twice during the growth period, by using small hand hoe or just uprooting by hand.

In the scheme, serious damages by insects or diseases are not found so far. Regarding insects, it is recommended to apply proper agro-chemicals as shown in Tables 3.3.4 and 3.3.5.

Based on the proposed farming practices, crop budget is prepared as shown in Table 3.3.6.

3.3.5 Anticipated Crop Yield and Production

When the Project will be implemented, it is expected that the yield of crops will be

sustained in certain higher level under the proper management of irrigation water, application of proposed farming practices, and enhancement of agricultural supporting services. On the contrary, in the case which the project will not be implemented, it is conceived that the present level on yield would not be almost improved, considering the past trend of crop production in Morogoro Region.

The crop yield under the conditions without and with projects is estimated as follows.

Unit Yield of Major Crops in Mkula Scheme

(Unit: ton/ha)

Crops	Present	Without	With
Paddy	2.0	2.0	5.0
Maize	1.5	1.5	3.0
Pulse	-	-	1.5

Target yield of prospective crops described above was estimated, based on the available information obtained from regional office and research stations.

Production in each irrigation scheme under the without and with project conditions is summarized as follows.

Increment of Crop Production of Major Crops in Mkula Scheme

(Unit: ton)

Crops	Present / Without	With	Increment
Paddy	216	540	324
Maize	123	447	324
Pulse / vegetables *1	-	62	62

*1: Pulse crop is applied as representative crop.

3.4 Irrigation and Drainage Development Plan

3.4.1 Development Concept

As stated in previous sections, "Farmers participatory approach to the Project" is a key subject for the irrigation development. "Farmers participatory approach" requires both GOT and beneficiaries to collaborate each other to establish self sustainable schemes. Under this approach, the beneficiaries are principally involved in the scheme study, design, construction activities and full responsibility of operation and management matters. Also, "environment-friendly development" is a key subject to maintain the sustainable schemes.

Based on the above approach to the Project, the following concepts are especially taken into account in the irrigation development of the Mkula scheme

1) Irrigation and drainage works shall be those being able to be easily maintained and operated by beneficiaries themselves.
2) Materials locally obtained in and around the project areas are used as much as possible for construction of facilities.
3) Irrigation and drainage facilities shall be designed and operated and maintained so as to get rid of or not to make causes of water-born diseases as much as possible.
4) Simple design shall be applied as much as possible for easy rehabilitation.
5) Small on-farm facilities made by locally available materials shall be constructed

by beneficiaries.

Based on the above basic concepts and also reflecting the beneficiaries wishes obtained through interviews and field discussion with them, an irrigation development plan for Mkula scheme is formulated. Major matters concretely put to the formulation of development plan are as follows:

(1) Headworks

The most important functions are the control of diversion discharge and the flood release through the weir. If a skilled operator is stationed all day long throughout a year, the diversion discharge can be maintained as required and also flood is safely released to the river downstream under proper operation, but it is not expected so easily in the smallholder irrigation scheme managed by farmers themselves. Thus, the headworks should be designed so as to divert required amount of water within allowable limit without adjusting of inlet opening, even if the river water level fluctuates or raised by flood. From the view point of safely releasing flood to the downstream, the weir should be of fixed overflow type.

(2) Irrigation and drainage canal systems

Canals should be primarily a trapezoidal cross sectional type except the existing flume type reaches, which are to be utilized after rehabilitation. Major irrigation and drainage canals should be designed so as to generate the flow velocity more than 0.6 m/sec as much as possible for preventing the breeding of parasites causing water-bone diseases. Also, from the maintenance point of view, the major irrigation canals should be lined with concrete.

Small canal-related structures should be designed uniformly as much as possible. Offtakes and checks provided on irrigation canals are equipped with stoplog guides only since steel gates require frequent maintenance and are easily ruined without proper maintenance and have actually deteriorated in the most of the schemes.

(3) Operation and maintenance concept

From the view point of maintenance of facilities, a 20-days to 30-days non-water supply period should be set up in October and/or November, when the irrigation water requirements are the least. During this period, all water in the irrigation canal systems should be completely drained and dried up and damaged portions of canal inside should be repaired. Once irrigation water supply is started, water is conveyed at a constant discharge level on the conveyance system without frequent operations of the intake, checks, and offtakes. However, when water resources are insufficient for irrigation water demands, careful water management including rotational irrigation water supply and/or selective use of limited water must be made. These operation and maintenance works including technical and financial matters shall be managed by beneficiaries themselves under technical assistance from government agencies.

(4) Beneficiaries participatory to construction works

Also from the point of beneficiaries participatory approach, small facilities such as field ditches and paddy ridges are expected to be constructed by beneficiaries themselves under technical assistance from the government agencies. Beneficiaries are expected to participate in the construction of irrigation and drainage facilities as a work force and in the arrangement of the right of way for the construction of project facilities.

Based on the above basic criteria, the development plan for the Mkula scheme is being formulated.

3.4.2 Canal System Layout

(1) Canal system layout

The proposed canal system layout is shown in Figure 3.4.1. The project area is classified into two areas based on agricultural utilization and soil characteristics. The right side area of the existing main canal is formed with sandy soil in the lower layer and utilized mainly for upland crop cultivation. The left side area is totally formed with clayey soil and used primarily for paddy cultivation in the rainy season.

The existing headworks and the canal are proposed to be used with improvement works. The existing canal will be extended straight by about 1 km and divert water to both sides through the proposed field canals. Also one major canal having functions of both irrigation and drainage is proposed to diverge from the existing canal for supplying irrigation water to the low-lying area extending in the left side of the existing canal. This canal will run northward along the trunk road B127 about 200 m and turn at almost right angle to right across the road and straight run eastward in the low-lying basin located in the middle part between the Mkula and Nyamigoli rivers. Hereinafter, the existing canal before diversion to the proposed irrigation cum drainage canal is referred as the main canal and after the diversion referred as the Secondary canal-1 including the extension section. The irrigation cum drainage canal is referred as the Secondary canal-2.

Water diverted from the main canal will be conveyed through the Secondary canal -2 and diverted to the left to tertiary canals (field canals) running along the counter lines. The proposed field canals will reach the small stream called Nyamigoli river. During the storm time, the secondary canal and its field canal system will drain excess water. The Secondary canal -2 conveys excess water coming from its right side area and the field canals will drain excess water from their upper area to Nyamigoli river.

Main canal (existing reaches)	0.18 km
Secondary canal-1	
Existing reaches	0.50 km
Proposed reaches	0.55 km
Sub-total	1.05 km
Secondary canal-2	3.00 km
(Irrigation cum drainage canal)	
Tertiary canals (field canal)	
in the right irrigation area of the Secondary canal-1	2.84 km
in the left irrigation area of the Secondary canal-1	1.51 km
in the irrigation area of the Secondary canal-2	5.70 km
Sub total	10.05 km
Total	14.28 km

3.4.3 Irrigation Water Requirements

(1) General

Irrigation water requirement is estimated by using daily rainfall data and climatological data in accordance with the proposed cropping pattern in which double cropping of upland crops are planned in about one-third of the irrigation area in the right side of the project area where clayey soil covers sandy soil and annual rotation of paddy -upland crops is planned in about two-third of the area in the left side of the project area.

Irrigation water requirement is estimated for comparing the irrigation water demand

for crop irrigation with water resources and preliminary design of irrigation canal system. The estimate is carried out on 10-day basis in accordance with the following procedure.

1) To calculate potential evapotranspiration from climate data.
2) To estimate consumptive use of water by multiplying potential evapotranspiration by crop coefficient and in addition to estimate percolation rate in case of paddy.
3) To estimate effective rainfall from daily rainfall.
4) To calculate net irrigation water requirement deducting the effective rainfall from the estimated consumptive use of water plus percolation.
5) To calculate irrigation water requirement taking irrigation efficiency into account.

Besides, puddling water requirement is taken into the calculation in case of paddy. Also, water requirement for land preparation is incorporated into the estimate in case of upland crops which is planted in the dry season.

(2) Potential evapotranspiration

Potential evapotranspiration is estimated from climatological data observed in Morogoro and Ironga Meteorological Stations by using modified Penman method. The estimated potential evaporation is judged to be applied for estimating irrigation water requirements in the Mkula scheme, since the Mkula area seems almost the same as Morogoro and Ironga in the altitude and the climate conditions. As shown in the following table, the estimated potential evaporation is not so different each other between both stations. Thus in this Mkula scheme, the average potential evapotranspiration is employed for the estimation of irrigation water requirement.

Potential Evapotranspiration

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Morogoro	5.2	5.3	4.9	3.5	3.1	3.0	3.1	3.5	4.4	5.3	5.7	5.5
Ironga	4.6	4.7	4.6	3.9	3.5	3.5	3.6	3.9	4.6	5.3	5.5	5.0
Average	4.9	5.0	4.8	3.7	3.3	3.3	3.4	3.7	4.5	5.3	5.6	5.3

(3) Percolation loss

Percolation loss is taken into consideration in paddy fields. It generally changes slightly during the crop glowing stage, but drastically differs between before and after puddling. Summary of field intake rate test results are shown in the following table.

Field Intake Rate

Location	W. Level Reducing Rate (mm/hr)	Evaporation Rate (mm/hr)	Percolation Rate (mm/hr)	Percolation Rate (mm/day)
Ponding Test				
no puddling				
Mk 02 (downstream	1.7	0.7	1.0	24
Cylinder Intake Rate Test				
Mk 02 (downstream	2.8	0.7	2.1	50

The paddy cultivation area is a seasonal swamp formed with clayey soil and high

groundwater table. The area has not experienced puddling works. Paddy is cultivated without ridges. Once puddling works are introduced with provision of paddy ridges, the percolation rate is expected to be small in consideration of the clayey soil and high groundwater table in the rainy season when paddy cultivation is practiced. Hence in this study the percolation rates before and after puddling works are assumed to be 10 mm/day and 3 mm/day, respectively in this estimate of irrigation water requirement.

(4) Puddling water requirement

Land preparation and puddling works are scheduled to be carried out in two-month period from middle January to middle March for paddy in accordance with the proposed cropping pattern.

Land preparation and puddling water requirement consists of water soaking into soil, water standing on the field surface, water consumed during the period from beginning of water inflow to the transplanting of paddy.

Evaporation and percolation for a period from the beginning of water supply to the transplanting of paddy are also taken into the calculation of puddling water requirements. A period from the beginning of water supply to the puddling work is assumed to be five days and then a period from the puddling works to the transplanting of paddy is five days.

According to the field ponding test, water soaking into soil is only about 12 mm at the initial time at Mk 02 point where the field was still wet even in June. In the transplanting season of the paddy scheduled in February and March, the soil is expected to be very wet. Thus soaking water requirement is supposed to be small. Here in this estimate, considering the results of ponding test, the soaking water requirement is assumed to be 20 mm. Water standing depth after water-soaking is assumed to be 30 mm. Evaporation estimated by the modified Penman method is 4.8 mm to 5.0 mm/day in February to March. Thus evaporation loss for the 10-day period is estimated about 50 mm. Under such conditions and assumptions, the puddling water requirement for wet season paddy is expected to be 165 mm.

Water initially soaking into soil =		20 mm
Water standing depth after water-soaking =		30 mm
Water requirement for the 10-day period		
Evaporation	4.8 - 5.0 mm/day x 10 days =	50 mm
Percolation	10 mm/day before puddling =	50 mm
	3 mm/day after puddling =	15 mm
Total		165 mm

Note: During this 10 day period from puddling water supply to transplanting, effective rainfall is not taken into consideration.

(5) Water requirement for land preparation for upland crop planting

Upland crops are scheduled to be seeded in the dry season, July to August after harvest of paddy on the clayey soil. Some amount of water applied for paddy cultivation is expected to be remained in the clayey soil with the high groundwater table and soil is not so hard to be plowed by man power. As for the upland crop area in the right side of the Project area, the soil is not so hard even under the dry condition. Thus no water is required for plowing before planting.

(6) Crop coefficient and consumptive use of water

Crop coefficient of introduced crops are derived from FAO Irrigation and Drainage Paper 14 "Crop Water Requirements." Crop coefficients used in the estimate of irrigation water requirements are as shown in the following table.

Crop Coefficient

Crop Grow. Stage	1	2	3	4	5	6	7	8	9	10	11	12
Paddy	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.05	1.00			
Maize (dry season)	0.60	0.60	0.70	0.80	0.90	1.00	1.05	1.05	1.00	0.90	0.80	0.60
Maize (wet season)	0.50	0.50	0.65	0.80	0.90	1.00	1.05	1.05	1.00	0.90	0.80	0.60
Beans (dry season)	0.60	0.60	0.70	0.80	0.90	1.00	1.05	1.00	0.70	0.30		

One growing stage = 10 days

Consumptive use of water by crop is calculated by multiplying the potential evapotranspiration by the crop coefficient.

(7) Effective rainfall and net irrigation water requirement

In order to estimate effective rainfall to be utilized for crop growing, daily rainfall data for 20 years from 1971 to 1991 except 1990 of Kirombelo rainfall gauge, of which code number is 973729, located near the Mkula scheme are used.

Effective rainfall is estimated by daily water balance in a paddy plot for paddy and by that in a root zone of upland crops on the assumption that :

(a) irrigation water is applied at the time when water level in the paddy plot reaches the specified minimum water level or water content in the root zone of upland crop reaches specified minimum water content.

(b) also when water level in the paddy plot exceeds the upper limit, all water over the upper limit spills out without effective use or similarly when the water content in root zone becomes more than the field capacity, the excess water over the field capacity is not utilized for plant growth.

Here in this calculation, the minimum permissible water level in paddy field is set at 10 mm above the soil surface. The upper limit of paddy field water level is set at 50 mm from the soil surface of paddy field.

In case of upland crops, the minimum water content in root zone is 100 mm supposing that the minimum water content nearly equals to the wilting point, which is generally about 200 mm/m in fine textures soil and that root zone is 50 cm, although it differs from kinds and growing stage of crops. Upper limit in root zone is a product of field capacity and root zone. The field capacity is assumed to be 400 mm/m considering that fine textured soil is dominant in the project area. Root zone is 50 cm. Thus the upper limit in upland crop area is 200 mm. Available moisture contents is 100 mm. Water extraction pattern is different in root zone. Generally, upper layer is bigger than lower layer in water extraction by plant. Thus upper layer reaches to the wilting point faster than lower layer. Considering the different water extraction pattern, it is assumed that irrigation water is applied at 70 % of total available moisture; 70 mm is extracted from the root zone.

As the results of the calculation, the relation between rainfall and effective rainfall on 10 day basis are presented by the following equations.

(a) Paddy

$R < 5$ mm
$ER = 0$
$5 < R < 120$ mm
$ER = 0.7\ R - 5.0$

$R > 120$ mm
$ER = 91$ mm

(b) Upland crop

$ER = 0.47\ R$

ER : effective rainfall (mm)
R : rainfall (mm)

Net irrigation water requirements are calculated deducting effective rainfall calculated by the above equations from crop consumptive use of water plus percolation loss.

(8) Irrigation efficiency

To account for losses of water incurred during conveyance and application to the field, an efficiency factor should be included when calculating the project irrigation water requirements. The irrigation efficiency is subdivided into conveyance efficiency, field canal efficiency, and field application efficiency. The conveyance efficiency is the ratio between water received at the Mkindo headworks and that released to the tertiary canals. The field canal efficiency is the ratio between water received at tertiary canal head and that received at the inlet of the block of fields. Field application efficiency is the ratio between water directly available to the crop and that received at the field inlet.

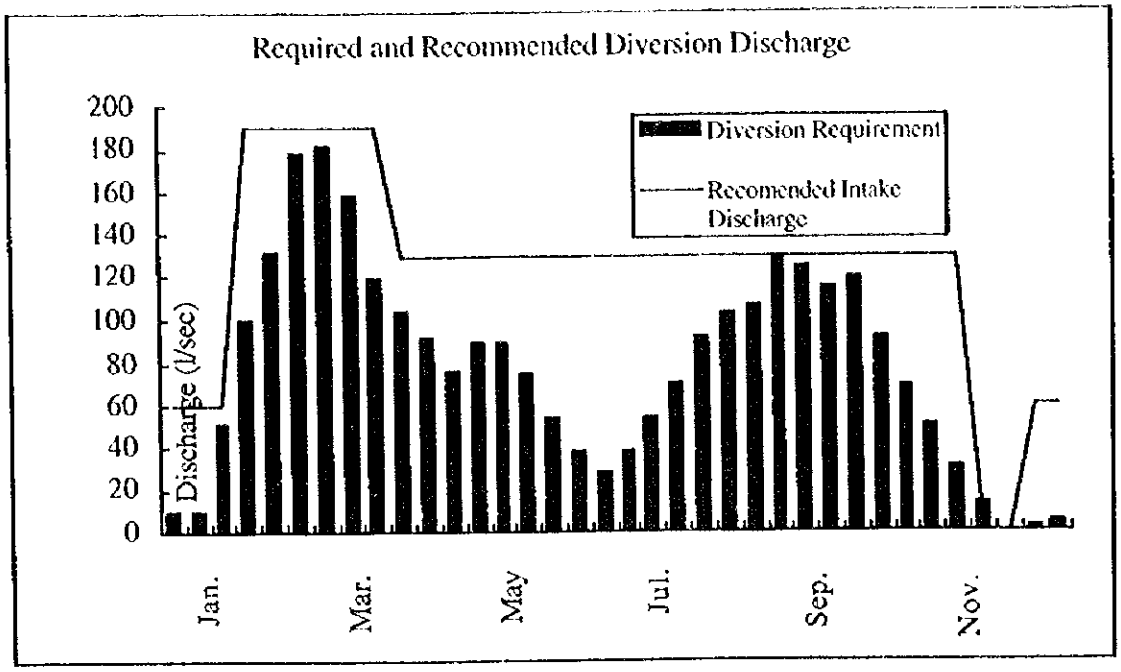
The conveyance efficiency (Ec) is assumed to be 0.9 under the conditions of continuous supply with no substantial change in flow and canal lining. Field canal efficiency (Eb) is assumed to be 0.85 in consideration that canal is earth canal and that the length is not so long. The field application efficiency (Ea), 0.7 is taken for upland crop irrigation and 0.8 for paddy irrigation.

The irrigation efficiency (Ei) is concluded as follows:

$Ei = Ec\ Eb\ Ea =$ 0.54 for upland crops
0.61 for paddy

(9) Irrigation water requirements

Irrigation water requirements are calculated by dividing crop water requirements by irrigation efficiency. The calculation results are shown on 10 day basis in Table 3.4.1 and in the following figure together with the monthly averages.



(Unit: litre/sec)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
20	111	110	42	57	36	46	95	113	77	25	2

The project has two peak seasons; one is February and March when the puddling works for paddy fields are scheduled to be carried out and the other is August to September, which are pollination period of maize.

Peak diversion requirement is estimated at 182 litre/sec (1.22 litre/s/ha) at Mkula headworks at five year provability. Diversion requirements are 76 litre/sec (0.97 litre/s/ha) at the head of the Secondary canal 1 and 115 litre/sec (1.62 litre/s/ha) at the Secondary canal 2, respectively.

Peak diversion requirement
at the head of Secondary Canal 1 :
requirement for paddy 36 ha x 1.62 l/s/ha = 44 litre/sec
requirement for upland crop 41 ha x 0.16 l/s/ha = 32 litre/sec
Total = 76 litre/sec
at the head of Secondary Canal 2 :
requirement for paddy only 71 ha x 1.62 l/s/ha = 115 litre/sec

3.4.4 Drainage Water Requirement and Flood Discharge

(1) Flood discharge of the Mkindo river

The Mkula river flood discharge at the existing Mkula intake was estimated in Phase-I study The flood discharge was estimated at:

Probability Flood (m^3/sec)	
59	at 50 year return period
40	at 20 year return period
28	at 10 year return period
19	at 5 year return period

(2) Drainage requirement on Secondary Canal-2 and its tertiary canals

Secondary Canal No.2 and its field channels are determined in their scale on the basis of the drainage capacity required for safely conveying excess storm water to the downstream.

Secondary canal No.2 conveys excess water not only from the paddy fields mainly located from the right side of the canal, but also coming from the mountainous area across Ifakala - Mikumi road. The catchment area is 42 ha in paddy-dominant area and about 20 ha in the mountainous area.

- Drainage requirement in paddy fields

According to the Master Plan Report, probability rainfall is estimated from Kilombero rainfall station as follows:

Return Period	Probability Rainfall (mm/day)
5	117
10	129
20	138

Heavy rainfall usually comes in March and April, in which paddy is already about 80 cm tall. Considering this situation, drainage requirement is decided to be 7.5 litre/s/ha so that all amount of daily rainfall in 10 year probability is drained within two days. Thus required drainage rate is 0.32 m^3/sec for the secondary Canal -2.

- Flood discharge from mountainous area

The peak flood discharge flowing from the mountainous area of 20 ha is estimated at 1.5 m3/sec at 10 year probability by the following rational formula.

$$Qp = f\ r\ A / 3.6$$

where, Qp : peak flood discharge (m^3/sec)
f : runoff coefficient, 0.7 is adopted.
r : rainfall intensity over a period equal to the time of con centration (mm/hr)
A : catchment area (km^2)

The rainfall intensity, t is estimated by the following Kadoya and Mononobe equations.

$$t = C\ A^{0.22}\ re^{-0.35}$$
$$r = (R24 / 24)\ (24 / t)^{2/3}$$

where, t : the time of concentration (min. for first equa. and hour for second equa.)
C : coefficient of the time of concentration, = 350 for

mountainous area
A : catchment area (km^2)
re : effective rainfall intensity during the time of concentration (mm/hr)
R24 : daily rainfall (mm)

3.4.5 Design Canal Discharge

Design discharges of the Main Canal and Secondary Canal 1 are a product of irrigation area and the peak irrigation water requirements. Design discharge of Secondary canal-2, which is used for drainage as well as irrigation should be a peak drainage requirement which is bigger than the peak irrigation water requirement. The 10 year probability flood; 1.8 m^3/sec for the secondary canal-2 composed of 0.3 m^3/sec from the paddy fields and 1.5 m^3/sec from mountainous area is taken for the design discharge of the Secondary canal-2. and a product of unit drainage requirement of 7.5 litre/sec/ha and the commanding area for each of the field channels.

Field canals provided in the upland crop area of 41 ha is designed with the capacity of 25 l/s. As field canals diverted from Secondary Canal-2 are of irrigation cum drainage type, the design discharge should be a product of the unit drainage requirement of 7.5 litre/sec/ha and the cathement area.

Design discharge for the canal system is shown in Figure 3.4.2.

3.4.6 Engineering Design

The project works consist of improvement works of existing Mkula headworks, reconstruction of the main canal, improvement and extension of Secondary canal-1, and construction of Secondary canal-2 and tertiary canals.

(1) Design Criteria of Canals

(a) Canal type

All proposed canals are of trapezoidal cross section type except for the existing flume section in the Secondary canal-1, which is rehabilitated by plastering and heightening. Main and secondary canal-1 are lined with concrete. Others are of earthen type.

(b) Canal cross sections

Design water depth and canal bottom width is determined so that the ratio of the design water depth (h) / the design canal bottom width (b) should be 0.7 to 1.0.

Canal side slope is determined as follows:

Criteria of Canal Side Slopes

Canal Type	Inside slope	Outside slope
Concrete lining canal	1 : 1	1 : 1.5
Earth canal		
H ≤ 0.5 m	1 : 1	1 : 1
0.5 m < H < 1.5 m	1 : 1.5	1 : 1.5
1.5 m ≤ H	1 : 1.75	1 : 1.75

(c) Canal velocity

In case of a lining canal, the design canal velocity is set at a faster velocity as much as possible under the condition that the canal velocity should be less than 70 % of the critical velocity.

The left side half of the project area is mostly covered by clayey soil, in which the allowable maximum velocity for protecting the canal wetted perimeter against soil erosion by water flowing is 0.9 m/sec. Thus, in case of an earthen irrigation canal, the design permissible canal velocity is set at 0.9 m/sec. In the right half of the project area, tertiary canals are provided with earth lining by materials brought from borrow pits. As the material is suitable for earth lining as explained in subsequent section, the permissible velocity is set at 0.9 m/sec as well as earth canals provided on the left side half area.

In case of an earthen type drainage canal, the permissible canal velocity is set at 1.2 m/sec, since the recurrence of the design flood discharge is only at 10 year return period.

(d) Hydraulic calculation

The hydraulic calculation of irrigation and drainage canals are made by the Manning formula. The roughness coefficient is taken as follows:

Concrete lining canal	0.015
Earth canal	0.030

(e) Canal freeboard

The freeboard of irrigation canals is determined so as to satisfy the following equation.

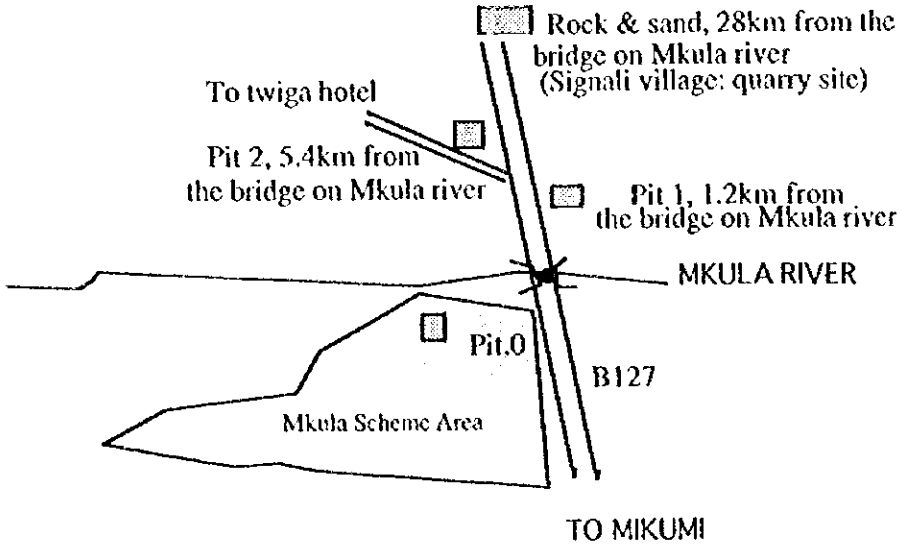
Trapezoidal cross section : $Fb = 0.05 \times h + hv + 0.15$
Rectangular cross section : $Fb = 0.07 \times h + hv + 0.15$

In addition to the freeboard, lining canals are given the height of 0.1 m in the canal bank above the top of the lining.

(2) Availability and Suitability of Major Construction Materials

Major construction materials such as earth materials, stone and sand were investigated in and around the scheme area.

Soils and sand were sampled in the points where their availability is considered to be promising for Mkula scheme. The locations of the sampling points are shown in the following figure. Suitability of earth materials for canal embankment and earth lining is shown in the following table.



Evaluation of Earth Materials

Location	Classification by Unified Soil Classification System and Evaluation			
		Class	Suitability for	
			canal embankment	earth lining
Pit.1	Sample No. 1	MH	marginally suitable	not suitable
	Sample No. 2	CH	marginally suitable	not suitable
	Sample No. 3	SM	marginally suitable	marginally suitable
Pit.2	Sample No. 1	SC	suitable	suitable
	Sample No. 2	SC	suitable	suitable
	Sample No. 3	SM	marginally suitable	marginally suitable
Pit.0	Sample No. 1	SC	suitable	suitable
(Project area)	Sample No. 2	SC	suitable	suitable

Pit.0, which is located in the project area is most advantageous from the hauling distance point of view. The earth materials obtained in the project area (Pit.0) are suitable for both canal embankment and earth lining, however, the materials forms rather thin layer near the ground surface and the lower part is nearly sand. Thus the excavation work for obtaining earth materials in the project area requires careful manners.

The Gologolo mountains, which is located adjacent to the Mkula area totally belongs to the territory of the national park and rock exploitation is prohibited. The nearest rock quarry site is situated at a point of 28 km towards Ifakara town from Mkula scheme. This quarry site was developed by Chinese contractor who had executed the railway construction works so called Tanzan railway. This quarry is considered to be one of the candidates of rock quarry site, taking into account the rock quality, available volume and accessibility, even if the hauling distance is rather long to the project site. Another quarry site is situated in a place called Melela, about 40 km from Morogoro town on the way to Mikumi. This quarry belongs to a Yugoslavian contractor known as Partizanski. The contractor are producing fine and coarse aggregates and various sized stones, and shipping them to Dar es Salaam and other areas.

(3) Design

(a) Improvement of Existing Mkula Intake

The existing head works have to be rehabilitated with a concrete membrane or an equivalent works in front of the existing weir in order to reduce the water

leakage through the bottom of the weir. The intake structure will be removed and a new intake structure will be built.

The 50 year probability flood, which is estimated at 59 m^3/sec is taken as design flood discharge to determine the crest elevation of the inlet wall. The length of the existing overflow weir section is about 40 m. When the design flood comes, the flood water level is estimated at El. 302.4 m with the flood overflow depth of 0.9 m. Considering the freeboard of 60 cm, the crest elevation of the inlet wall will be El. 303.0 m.

The design intake water level is set at El. 301.50 m, the same as the crest elevation of the existing overflow weir.

(b) Canals and related structures

- Main irrigation canal

The existing main canal is replaced with a new canal due to insufficient carrying capacity. The main canal is of flume type in the reaches from the beginning point to the 105 m point having a longitudinal gradient of 1 / 30, almost the same as that of the existing canal. Then the canal is changed to a trapezoidal shape having a gradient of 1 / 500. The reaches of the trapezoidal cross section is 75 m in length. The cross sectional dimensions and flow velocities are as follows:

	Q (m3/sec)	B (m)	H (m)	i (1/x)	V (m/sec)
Flume section	0.18	0.6	0.6	30	2.40
Trapezoidal section	0.18	0.4	0.6	500	0.89

Q: design discharge, B: bottom width, H : canal height, i : canal gradient, V: flow velocity in roughness coefficient of 0.015.

- Secondary canal-1

The secondary canal-1 is rehabilitated in the existing reaches of about 500 m and straight extended to the downstream 500 m. The existing weathered cement mortar is chipped off from the inside surface and then the surface is plastered with cement mortar. The existing walls are raised by 5 to 10 cm so as to become 40 cm to 50 cm in height. The extension reaches are of trapezoidal shape having a bottom width of 0.3 m and a height of 0.6 m. The canal is 1/500 in the longitudinal gradient and provided with drops.

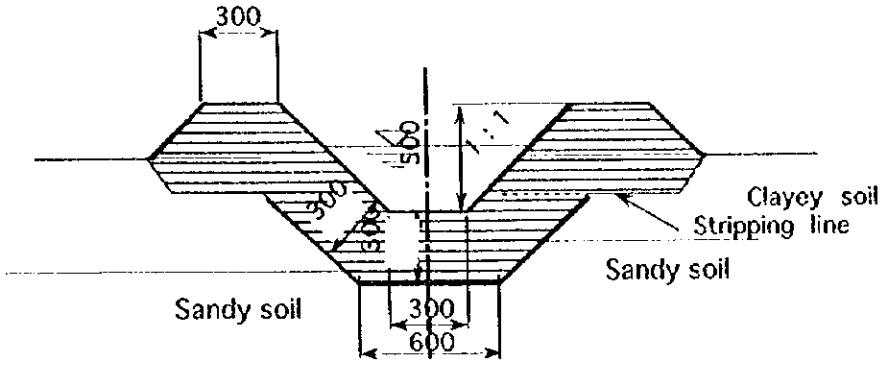
- Secondary canal-2

The secondary canal -2 is of earthen canal type functioning for irrigation cum drainage purposes. Turnouts are provided at eight points to divert irrigation water to the left to tertiary canals. The turnouts have a concrete barrel of 4 m long so that a tractor can pass over the tertiary canals. Every turnouts points, a check cum drop structure is provided. In order to convey excess water to the downstream canal even when the check is completely closed with logs, side spillways will be provided on the check cum drop structures.

- Tertiary canals

The right side area of the Secondary canal -1 is covered with sandy soils in

the lower layer. Thus in order to reduce seepage losses, the tertiary canals diverging from the Secondary canal-1 to the right side area will be constructed with impervious earth materials as shown in the following figure.



Tertiary canals serving the left side area of the Secondary canal-1 are of simple earthen canal type.

Tertiary canals branching off from the Secondary canal -2 are totally of an earthen type. Their outlets to Nyamigoli river is protected with gabion works or equivalent works.

(c) Canal-related structures

Structures to be provided on the irrigation and drainage canal system are listed as follows:

Structure	Main canal	SC-1	SC-2	TC	Total
Turnout	0	10 (2)	8	-	18 (2)
Culvert	0	2 (1)	1	3	6 (1)
Check cum drop	0	0	8	0	8
Drop	0	5	4	0	9

TC is tertiary canals. Figure in parenthesis is numbers of existing structures.

(4) On-farm development works

Small field ditches branched off from the tertiary canals are provided along existing field borders. Present rainfed and prospective paddy fields about 100 ha in net is proposed to be furnished with paddy ridges in parallel and perpendicular to the contour lines so as to store rain and irrigation water in paddy plots. The upstream side banks of the tertiary canals, which branch off from the Secondary canal-2 will play the roll of paddy ridges as well.

3.4.7 Operation and Maintenance

(1) Operation

(a) Operation in conveyance system

The main and secondary canals convey water on 24 hour basis. As shown in the figure attached in Section 3.4.3, it is recommended to change the diversion discharge at only four stages such as a puddling and transplanting stage, the following stage, non water supply period (maintenance period of facilities) and the former stage of puddling and transplanting as follows:

	Period	Recommended Discharge (m3/sec)
Puddling and transplanting stage	Feb. to mid March	0.18
After puddling and transplanting	Late March to mid Nov.	0.12
Maintenance period	Late Nov. to early Dec.	Intake gate is closed.
Former stage of puddl. and transplanting	Mid Dec. to Jan	0.06

During each period of the above stages, river water is constantly diverted through the intake. Excess water in the Secondary canal-1 is drained through tertiary canals to the Secondary canal-2. Excess water in the secondary canal-2 is drained naturally to the downstream.

When river water is insufficient against the above scheduled discharge and further against the irrigation water demands, rotational irrigation water supply should be carried out among tertiary canals.

(b) Operation in on-farm level

All the tertiary canals divert irrigation water to field ditches on rotational basis (ON-OFF basis) in accordance with a pre-determined schedule except to divert on 24 hour basis at a peak irrigation period of puddling and transplanting in those branched off the Secondary canal-2.

- Paddy

Irrigation water supply method should be changed by the situation of water availability and the irrigation water demands. Irrigation water demands are peak in a puddling and transplanting period, in which rotational irrigation water supply should be applied. From the saving of water resources, the puddling works should be carried out right after paddy plot is filled with puddling water. In the normal time after transplanting, continuous water supply is usually adopted. When the water resources are tight against the irrigation water demands or in case that the percolation rate is higher than the expected, water should be supplied all at once by applying the rotational irrigation method in each tertiary block.

- Upland crops

Rotational irrigation water supply is adopted in upland crop fields. When water is abundant against irrigation water demands, water can be diverted from tertiary canals to fields at any water serving time, because the tertiary canals usually convey water more than irrigation water demands. In this time, farmers can take water on a date allocated for irrigation. When irrigation water is insufficient, rotational irrigation water supply should be strictly applied in on-farm level in accordance with a predetermined irrigation schedule.

(2) Maintenance of facilities

Major regular maintenance works are as follows:

- To lubricate the intake gate spindle and paint the intake gate frame and leaf.
- To weed glasses and trees and root trees up from the right of way of canals especially from lining portions at least twice a year. Lining concrete is often

damaged by plant root growing.
- To confirm stop logs and supplement them before irrigation water supply starts.
- To heighten depressing portions of canal embankment with earth materials.

In the maintenance period, all water in the irrigation canal systems should be completely drained and dried up and damaged portions of canal inside should be repaired. Major maintenance works during the maintenance period are as follows:

- To remove deposits from canal insides.
- To repair eroded and damaged portions of canal insides.
- To get rid of snails transmitting schistosomiasis.

3.5 Plan of Community Development and Reinforcement of Farmers' Organization

The basic objectives of the community development and reinforcement of farmers' organization are to increase farmers' crop production and improve farmer's living standard. The major concepts to consider for achieving these objectives are as follows:

1) Strengthening of WUGs

GOT has worked out as a basic policy that the irrigation system should be maintained through the beneficiaries participatory approach. In accordance with this policy, the irrigation facilities rehabilitated or newly constructed by the project should be managed by the farmers themselves. After the completion of the project, it can be expected that the irrigation systems in the schemes will be improved and expanded considerably. To maintain successful and sustainable O&M of the schemes, it is essentially needed in advance to strengthen the existing WUGs or to establish new WUGs.

2) Close Linkage between WUGs and Village Government

Basically, the existing WUGs in the schemes have been organized independently without any legal advantages given by the village government. However, in fact, WUGs have greatly benefited from the village governments. The village government has two roles; one as the government administrative organ and the other one as the representative of the village community. The village government is responsible for encouragement of all the village socio-economic activities including agricultural production, education, health, social welfare, culture, etc. The farmers always follow the decision of the village government, because its decision is made not only by the village administrative government but also as a representative of the village community. It is therefore recommended that WUGs should establish more closer linkages with their own village communities.

3) Strengthening of Government's Supporting Services to the Farmers

To achieve sustainable farming and O&M of irrigation systems of the farmers, there is still the need for a lot of continuos supporting services from the various agencies concerned. It should therefore be required to strengthen those supporting agencies to be involved in the farming and O&M as well as the WUG's activities.

4) Encouragement of Participation of Women in Irrigation Development

The project will propitiate reactivating of crop production, marketing of farm

inputs and products, post harvest, transportation, social services, etc. Together with the above, village women will have many opportunities to join these activities. In this context, farmers' organizations should play an important role on encouraging those opportunities.

3.5.1 Water Users' Group

(1) Objectives of WUG

In Mkula scheme, there is one existing WUG which manages only 4 acres and consists of 5 farmers. This WUG is closed and a new WUG which covers O&M of the all irrigation facilities developed by the Project.

The main objective of WUG which is established in the schemes is to operate and maintain the irrigation facilities. In addition, marketing and credit services are also included in the WUG's objectives. The farmers in the schemes are confronted with various problems such as difficulties in marketing and high prices of farm inputs. In order to increase their agricultural productivity, it is crucial factor to improve the agricultural supporting services such as marketing and credits, as well as the rehabilitation of irrigation facilities. For the improvement of such supporting services, it is proposed to establish an organization having function of such supporting services like that agricultural cooperative in each scheme. In the project areas, there are following two ways for the establishment of such organization from the standpoint of institutional development:

(a) Agricultural cooperatives having function of agricultural supporting services are established in each village related to the irrigation scheme. In this case, a village have two organizations; i.e., WUG which is responsible for O&M of irrigation facilities, and agricultural cooperative handling agricultural supporting services.

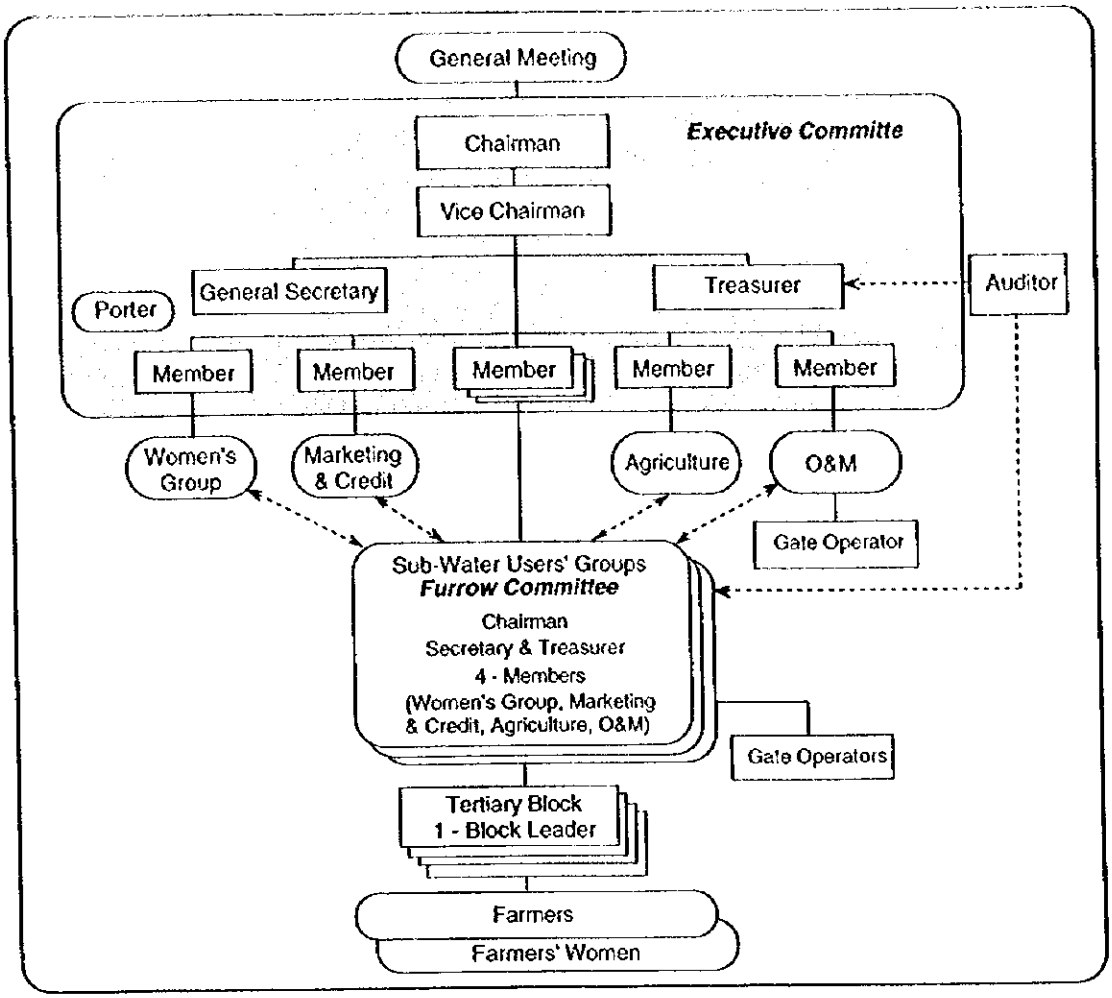
(b) WUGs cover not only O&M of irrigation facilities but also the agricultural supporting services. Namely, WUGs having both functions of O&M of irrigation facilities and agricultural supporting services are established in each village.

In the project areas, it is proposed to take (b), taking the following reasons into consideration. The activities of WUG and agricultural cooperative should be linked closely. The farmers will cultivate crops according to an irrigation schedule decided by WUG, then supporting services such as credits and farm inputs should be supplied on time in accordance with their cultivation schedule. In case of unitary organization, those linkage can be taken easily.

The members of WUG should be the beneficiaries of the irrigation schemes, and its membership should be given to beneficiaries, irrespective of their gender.

(2) Proposed Organization and Activities

The proposed organizational structure of WUG is as follows:



It is recommended that the size of a farmers' group should be less than 100 farmers, so that one of the prime requirements to activate WUG is "face to face" communication among the leaders and the farmers. The farmers are divided into several sub-groups by each irrigation block or each village, and each sub-group links separately with the executive committee of WUG. Each sub-group elects a representative who is the leader of WUG. In addition, an irrigation group is organized by each tertiary block base, and each group elects one block leader. All of the WUG's activities are carried out through these block leaders.

The proposed WUG consists of the following four (4) components; i.e., (i) general meeting, (ii) executive committee, (iii) audit, and (iv) service sections including O&M, agriculture, marketing and credit, and women's group. Each sub-group has also a sub-executive committee and service sections of O&M, agriculture, marketing and credit, and women's group, and is responsible for WUG's activities within the sub-group's area. These main functions and activities are as follows:

1) General Meeting

The general meeting is held at least annually, and has the following main activities:

- Election of the members of executive committee and auditor,

- Acknowledgment of the result of auditing,
- Acknowledgment of the annual management plan and budget,
- Determination of the amount of irrigation service charge,
- Revision of the irrigation service charge,
- Revision and enactment of articles and by-laws,
- Specific items requested from the members and committees, etc.

2) Executive Committee

The committee is comprised of the following members; Chairman, Vice Chairman, General Secretary, Treasurer, and several members who are representatives of the service sections. Several representatives of the sub-groups are included as the committee members. All these posts should be opened to both genders. In addition, one or several porters who are volunteers are appointed in the committee in order to make close communication among the members and between the committee and the farmers. Main tasks of the committee are (i) to prepare annual management plans and budget, (ii) to instruct and supervise activities which are implemented by the service sections, (iii) to manage complaints and grievance from the farmers, (iv) to arrange and appoint volunteers employed in service sections (v) to manage accounting and general affair, (vi) to coordinate with other agencies and associations, and so on. The committee members take part of portion of these works. The regular meeting is held monthly for implementing these activities.

3) Service Sections

Under the instruction and supervision of the executive committee, the routing service works are implemented by the following four sections; (i) O&M, (ii) agriculture, (iii) marketing and credit, and (iv) women's group. These sections employ several volunteers, and these main activities are as follows:

(a) O&M Section

- Preparation of irrigation schedule,
- Operation and maintenance of irrigation facilities,
- Estimation of irrigation service charge,
- Management of communal works such as canal clearing and maintenance of farm roads,
- Security service for irrigation facilities, etc.

(b) Agricultural Section

- Transmission and notification of information for extension implemented by VEO and officers in the DALDO's offices,
- Information services for new farming practices and varieties,
- Arrangement of farmers' meeting on agricultural extension,
- Providing machinery services,
- Promotion, arrangements and leading for group farming such as cooperative control of pests and diseases, transplanting and harvesting, etc.

(c) Marketing and Credit Section

- Implementation of cooperative purchasing and shipping,
- Storing arrangements of farm inputs and products,
- Agricultural credit services,

- Exploitation of new marketing channel, etc.

(d) Women's Group

- Promotion for women's agri-business and cottage industry,
- Promotion for homestead development,
- Improvement of social welfare and health care,
- Educating activities on home economy and management, etc.

4) Audit Section

Although the registered farmers' cooperatives should have the auditing of the authorized organizations like COASCO, it is proposed that a WUG has an auditing system in addition to the above official auditing. Namely, an auditing section or committee, which consists of several volunteers (beneficiaries), is established apart from the executive committee. This section always check the WUG' accounting including collection of ISC, and reports those results at the general meeting.

Each sub-group has also furrow committee and 4 service sections which consist of O&M section, agricultural section, marketing and credit section, and women's group.

(3) Irrigation Service Charge

Irrigation Service Charge

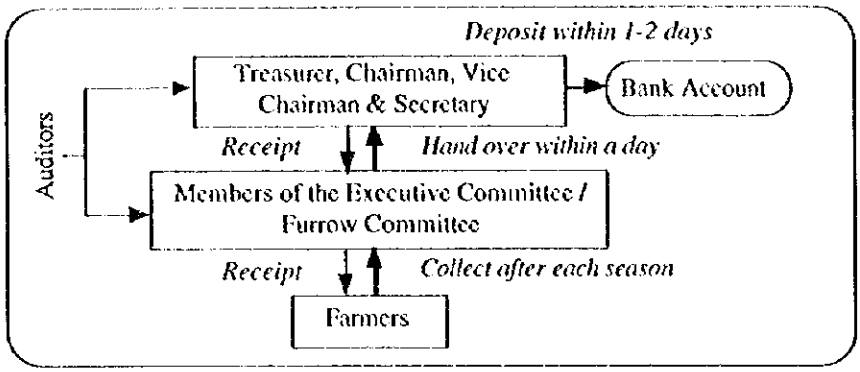
All O&M costs of irrigation facilities are covered by the irrigation service charges (ISC) collected from the farmers. The amount of ISC is estimated by each WUG, and includes the following items. In order to minimize the labour cost, it is proposed that maintenance works should be carried by the farmers' communal work which is widely adopted among the existing WUGs.

(a) Operation cost
(b) Maintenance cost
(c) Replacement cost of facilities and equipment
(d) Collecting cost (transportation cost of collectors and treasurer)

For the payment of ISC, there are two methods; "payment in kind" and "cash payment." Cash payment is proposed to the Mgongola WUG in view point of easy collection and management. At the public meeting held on July 1997, almost all farmers have agreed on its cash payment.

The proposed collecting procedure of ISC is as follows. All members of the executive committee and furrow committee collect ISC directly from the farmers, and collected amount are deposited immediately in WUG's bank account. For the collecting of ISC, the members make group consisting of 2-3 members, and they do not collect it alone. The treasurer manages all these transactions, and auditors should check their collection. The collectors (members) should issue receipt to the farmers, and treasurer collects those copies.

Proposed Collecting System of Irrigation Service Charge



To achieve a good progress on collecting of ISC, it is recommended to adopt the following punishment rule and incentive to the articles and by-laws.

1) To the farmers who are not able to pay on time, WUG fines them some percentage of total ISC per month during the non-payment period.

2) When farmers pay full amount and on time, some percentage of its full amount is reimbursed to him as an incentive.

The executive committee is responsible for management and operation of ISC. For the payment of O&M, there are two types. One is the recurrent costs such as operation and management costs, and the other is for the costs of emergency and specific O&M works. The former is paid by the treasurer after approval of the chairman, vice chairman and the general secretary, as a routine of the WUG's works. For the latter, a committee meeting is held to asses its necessity and released its fund to such works.

Annual Membership Fees

With the exception of O&M costs for irrigation facilities, costs necessary for WUG's supporting activities such as marketing and credit services are covered by annual membership fees collected from the farmers. These costs include personnel cost for leaders of WUG, transportation cost, and expenses for stationery such as pencil and notebook. It is recommended that the WUG' leaders are volunteers work with no wage or salary, though this matter should be decided by the farmers at the WUG's general meeting. The leaders of existing WUGs are also volunteers. Thus, the costs for management of WUG excluding the O&M of facilities are only transportation and stationery mentioned above, and it will be no need to collect a lot of membership fees from the farmers. The annual membership fees are collected by the same system with the irrigation service charge.

(4) By-laws of WUG

A standard article and by-laws of WUG have been prepared by the Department of Cooperative. But this is for the general cooperatives, and articles necessary to WUG which is responsible for the O&M of the project are not included at all. Although this standard articles and by-laws are adopted basically to WUG, it is necessary to enact several new articles. These are listed below.

(a) Farmers who use irrigation water from the project should be member of WUG.
(b) WUG has the right to collect ISC from the beneficiaries who received irriga-

tion services from WUG, and the beneficiaries have the duty to pay its ISC to WUG.

(c) WUG inflicts a punishment on the beneficiaries who use irrigation water and facilities illegally and are not able to pay ISC.

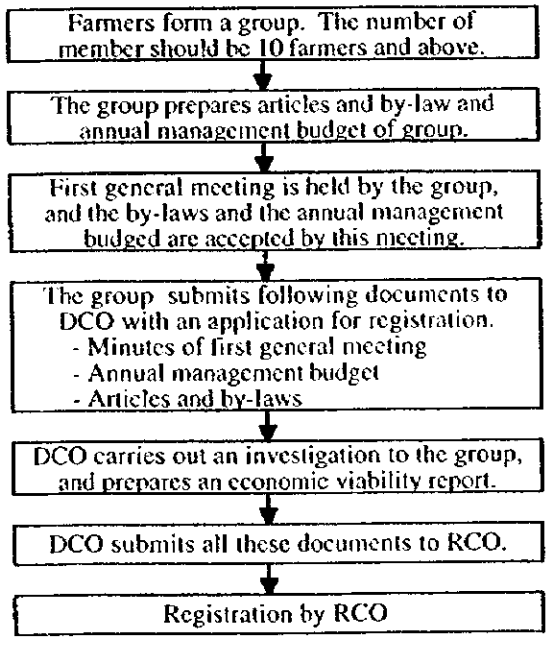
(d) The beneficiaries have the duty to participate in the communal works on O&M which are planned by WUG.

(e) The tenant beneficiaries have a right to join WUG with the election to the executive members, and are in duty bound to pay ISC and membership fees, instead of the owner beneficiaries.

The by-law must be authorized legally by the Government agencies. In case of the Lower Moshi Project located in the Kilimanjaro Region, the Moshi District Council has authorized their by-laws, under approval of the Minister responsible for Local Government. In 1996, CHAWAMPU which is WUG of the Lower Moshi Project sued the farmers for steal of water, then 7 farmers were sentenced to 4 months penal servitude, under the by-laws.

(5) Registration and Water Right of WUG

As authorized farmers' organization, WUG should be registered at government agencies. There are two ways for this registration. One is registration at the Ministry of Home Affairs and the other is MAC. In Tanzania, the organizations are classified into two types; "Association" and "Cooperative." The former Ministry handles the registration of "Association", and the latter is for "Cooperative." It is proposed that WUGs established in the Scheme are registered at MAC which is responsible for supporting services to such organizations. The present process of registration is shown below.



WUG should also take water right after registration. The Regional Water Engineer has handled the registration of the water right. At present, RALDO has the water right on behalf of the Mkind Cooperative. For the registration of water right, there is no competition with others at present, because no water right has been registered to the Mkula river. The DALDO's office provides necessary guidance and supporting services to WUG for taking water right.

(6) Irrigation Meeting

The production activities of crops are closely linked with various agricultural support activities including extension services, machinery services, supply of farm inputs, credit services, etc., which are implemented by the Government and private sectors, and all these should be coordinated with the farming. In this context, it is proposed to hold an irrigation meeting under the presidency of WUG. The meeting is held before each cropping season, and consists of the following members:

(a) All farmers (beneficiaries),
(b) Members of the executive committee of WUG,
(c) Officers of DALDO' office (DCO, DEO and DIVEO),
(d) Officers attached to the scheme (VEOs and Irrigation Technician),
(e) Members of village government (Village Chairman and Village Executive Officer), and
(f) Banks, NGO and private sectors such as owner of farm machinery and dealer of farm inputs.

VEO and Irrigation Technician who will be attached to the Scheme should make necessary support to hold this meeting by WUG. In this meeting, the following items are discussed among the attendance. Based on the result of these discussions, WUG requests to the related agencies for the necessary support services.

1) Recommended crops to be cultivated in the season,
2) Cropping schedule including land preparation, seeding, harvesting, etc.,
3) Irrigation schedule, and
4) Required quantity of farm inputs such fertilizers and agricultural credits, and those supplying periods, etc.

All farmers confirm the irrigation schedule through this meeting, and WUG commence to manage irrigation facilities and agricultural supporting services after the meeting.

(7) Rural Credit Facilities

At the initial stage of the Project, the farmers need a considerable amount of loan for purchasing farm inputs. However, almost no agricultural credit is found in the project area at present. To overcome such situation, the following three credit systems are proposed to the schemes.

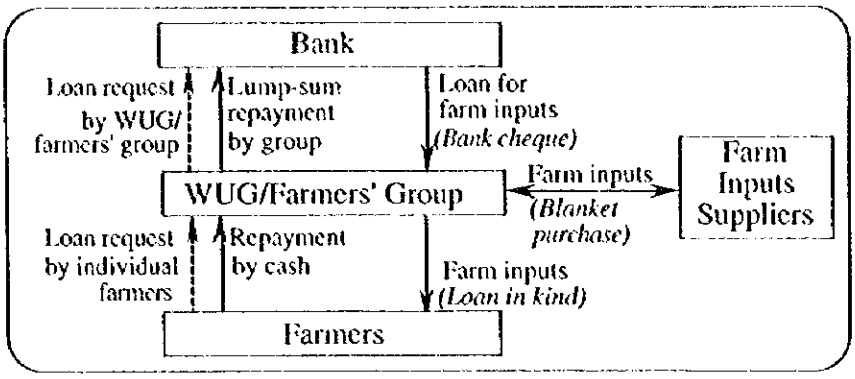
1) Group Loan System Administered by the Water Users' Group

Layout of the Group Loan System and Procedures

The purpose of the credit system proposal explained below is to provide loans to the farmers who will need them in order to purchase farm inputs required at the initial stage of the Project. The proposed system is based on a group loan system, which will be managed by WUG; this system not only covers agricultural credit but also encompasses marketing and technical guidance. This credit system is directly related to the marketing system proposed in the next section.

The figure below shows the outline of the proposed credit system:

Outline of the Group Loan System



The loan procedures to be followed under the system are as follows:

i) The loan is limited only to the purchase of farm inputs, and its ceiling amount is set depending on the type of crops.

ii) To receive a loan, the farmers have to form a group and select a representative. The members of such group are jointly and severally responsible for repayment of the loan for defaulters.

iii) Farm input requirements are estimated by the group together with the required loan amount. At this time, the extension officer gives technical guidance such as recommended fertilizers and agro-chemical to be used.

iv) The bank provided provides a loan for the group on a lump sum basis or dividing it into two portions. Then the group purchases farm inputs in one lot.

v) The bank provides the loan amount only to the suppliers of farm inputs, and the group receives farm inputs in kind from the suppliers. In this way, the group and its representative do not need to deal with cash money, except for the bank check to be issued to the suppliers.

vi) The representative collects the loan payment amount for each farmer, and repays it to the bank in a lump sum. The bank does not collect the loan payment amount from individual farmers.

Requisites for the Group Loan Operation

i) One prerequisite for the functioning of the credit system is that the WUG and the farmers themselves must thoroughly understand the credit operations involved in the system. They must also be able to carry out the procedures for obtaining the loan and have managerial and accounting knowledge for administering and monitoring the received loan.

ii) By-laws concerning the operation of the loan groups must be formulated with the agreement of all members and they must be formalized by the DALDO. The by-laws must specify the rights and duties of all members and the penalties in case of default.

iii) The bank must lecture the WUG about the specific banking proce-

dures to be followed for obtaining and repaying the loans. The training of the WUG on administration of the loan could be done through the VEO who must have been previously trained either by the bank providing the loans or by a hired specialist assigned for that purpose.

iv) The bank should grant a loan to the WUG with an interest rate lower than the normal market rate; this is because the WUG will take care of the administrative operations of the loan i.e., distribution, follow-up, and collection of the funds, lowering the operational costs for the bank.

2) Revolving Loan System

WUG collects a considerable amount of share from the members, and lends its money to the farmers at an interest rate lower than the market rate. The repayment amounts from the farmers are deposited in the WUG's account, and WUG finances the farmers again. Surplus from the revolving loan goes to payment to the investor.

The Ndung irrigation project in the Kilimanjaro region has such revolving loan system. The cooperative of the Ndung project consists of 147 members, and has collected the share amounting to TSh.147 millions (Tsh.10,000/member). Based on these funds, the commercial committee organized in the cooperative is providing loan services to the farmers. It may be possible to introduce such loan system to WUGs to be established in each scheme. The merit of the revolving loan system is a lower interest rate than the market rate.

3) Mutual Aid Credit Associations

Although the above system is to be applied for duly organized groups registered with the MAC, it is important and necessary that the farmers must have a simple credit organization like the one denominated "rotating-funds credit association." This type of credit organizations which are more modest in purpose than the system above explained, aims to provide the associates with funds to cover needs not necessarily for production purposes but also for emergencies or consumption purposes. The implementation of these associations will help to "educate" the farmers on using mutual aid mechanisms.

The rotating-funds credit association could be formed by 20 members from which an association head is selected and who is in charge of the administration of the system.

The members of a rotating-funds credit association, by means of monthly fixed deposits decided by all members, make up a communal fund from which each in turn withdraws certain amounts at regular intervals. The assignment of these sums can be made through a "lottery" system or decided by mutual agreement among the members. The deposits and withdrawals continue until each member has received the agreed standard sum of money. The duration of the associations may be unlimited or pre-determined, further, the association can be open or closed, in the sense that it admits or does not admit the entrance of new members or the departure of existing ones.

Penalties for defaulting must be established in the rules governing the association. These rules must be clearly defined and enforced. The peers' pressure plays an important role for the enforcement of the rules.

At present, the CRDB has stopped implementing a credit system with similar char-

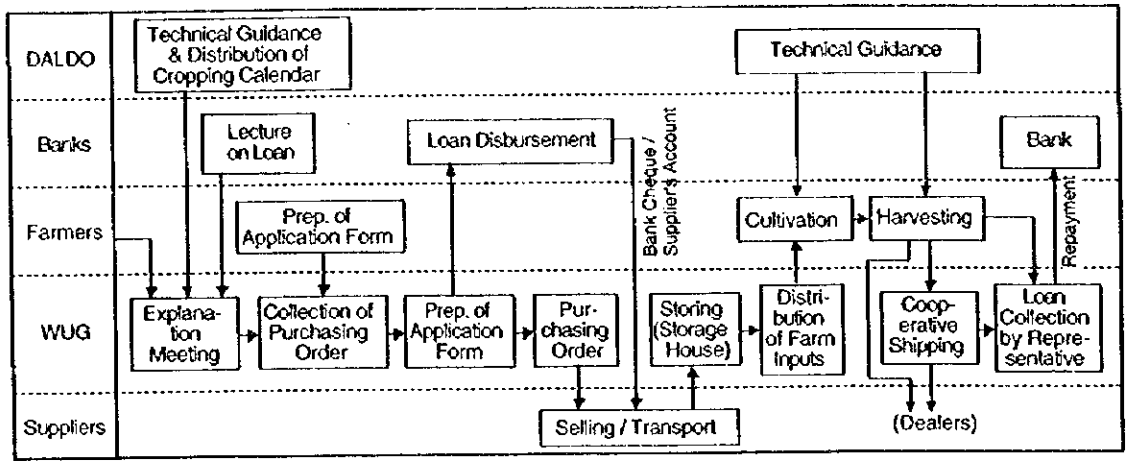
acteristics as the group loan system mentioned above. However, the CRDB would be interested in supporting the above proposed system if the farmers involved in the system are those who are producing in irrigated lands. If no group loan service from CRDB is available, it is proposed to introduce the revolving loan system managed by WUG. In this case, it will be needed to employ a permanent staff for handling revolving loan.

By implementing these credit systems explained above, the farmers would have the benefit of accessing credit in an organized way.

(8) Marketing System for Agricultural Commodities

The figure below shows the layout of the proposed marketing system.

Cooperative Purchasing and Group Loan



The system requires an efficient coordination among the DALDO office, the bank granting loans to the WUG and the farm inputs' suppliers. The flow of activities for the proposed marketing cum credit system is as follows:

(a) The DALDO office will provide technical guidance on the inputs to be purchased and how to use them in a proper way. Also must distribute the cropping calendar adequate for the farming area. Previous of the reception of the farm inputs from the suppliers, the DALDO office through the VEO will provide technical guidance on cultivation and harvesting.

(b) The bank granting the loan, together with the support of the DALDO will held an explanation meeting with the WUG where the system will be described and explained. The WUG will also receive a lecture on loan procedures by the bank's staff.

(c) After deciding to adopt the system, the WUG members will determine the loan amount to be requested to the bank based on their inputs' requirements. The WUG then prepares the loan application and delivers it to the bank. At the same time, the WUG will contact the inputs' suppliers and present their purchase list. The bank will make the disbursement directly to the inputs' supplier.

(d) The supplier will prepare the inputs' order for a timely deliver. After the bank makes the loan's disbursement, the supplier will transport the inputs to the storage facilities specified by the WUG.

(e) After receiving the inputs, the WUG should distribute immediately them to the farmers.

(f) The WUG collects the money for repayment to the bank from its members after harvesting. The WUG will be in charge of delivering the repayment to the bank.

For the selling of products, it is recommended to introduce a cooperative shipping system. After harvesting, the products will be collected at the storage facilities of the WUG waiting to be either delivered to the traders or to be picked up by them. The products' selling prices will be negotiated between the WUG and the traders. The WUG takes the money for repayment to the bank from total selling amount, then the members take the balance.

(9) Facilities of WUG

The facilities necessary for the activities of WUG are an office building (100 m2), a storage house for fertilizers (60 m2), motorcycles (3-5 nos. for each scheme), and tools (shovels, hoes, etc.) for maintenance of the canals.

The WUG shares a floor space of the office with VEO, Irrigation Technician and the village government. All necessary administrative works including typing, printing, communication, etc. should be supported by the offices of DALDO or Division Extension Officer (DIVEO).

3.5.2 Women's Participation to Development

The project will contribute to energize those activities related with crop production, marketing of farm inputs and products, post-harvest, transportation, community services, etc. In parallel with such economic and social development in the rural area, women will have the chance to join in these activities. On the other hand, it is expected that the economic and social development is activated and accelerated by the women's participation. The following points will be proposed for the women's participation in the development process.

1) Appointment of women's leaders in the executive committee of WUG in order to encourage greater participation of women in public affairs,
2) Establishment of women's group and encouragement of value-added processing of crops by these women's groups in order to improve their employment opportunities, and
3) Encouragement of livestock farming including portly, sheep, goats, etc. by the women's groups.

The WUGs should play an important role in promoting these activities, and the DALDO's office should provide necessary guidance to them. The establishment of women's group is proposed in WUG as mentioned in Sub-section 3.5.1 (2). A representative of the women's group joins the executive committee as its member, and participates in all WUG's management. The VEO conducts supporting services to activate them in cooperation with the village government.

3.5.3 Training Program for WUG

WUG to be established in the scheme should be strengthened through forced training program. In addition, officers and front line staff involved to the scheme should also be trained and enough skilled on O&M activities, through provision of intensive

training program, because they still have not enough experience and knowledge on the O&M of irrigation system.

For those training, a wide scale program will be introduced. Namely, the training program is implemented not only to the farmers and the staff below district level, but also to the senior officers involved in O&M and the people in the village including, Village Chairmen, Village Executive Officers, elder people, informal rural leaders in villages, because O&M by WUG needs a lot of cooperation and supporting services from them.

The DALDO's office of Kilombero district is responsible for the conducting of training program. The training program is divided into four (4) courses depending on training contents and trainee's educational background; i.e., Course-A, -B, -C, and -D. The details are shown in Table 3.5.1, and summarized as follows:

Proposed Training Courses and Trainees

Training Courses	Period (day)	Trainees
Course-A	2	- District Commissioner, District Executive Director, District Administrative Officer. - Senior officials of the offices of RALDO and DALDO and the Zonal Irrigation Office. - Senior officials of the offices involved in WUA's activities (District Water Engineer, District Community Development Officer, District Cooperative Officer, etc.).
Course-B	5	- Officials involved in O&M (Zonal Irrigation Office, RALDO and DALDO's offices, Division Extension Officer, DCO). - Village extension officer and irrigation technician to be attached to the project.
Course-C	10	- Farmer's level training to leaders of WUA, gate keepers and key farmers.
Course-D	2	- Village chairman, village executive office, chairman of ward council, ward executive office, elder people, informal rural leaders in the village, leaders of women's groups, etc.

The Course-A is for senior officers involved in WUG's activities; the Course-B is for officers of the Zonal Irrigation Office, RALDO's and DALDO's offices, and DCO's office; and the Course-C is for farmer's level training including leaders of WUG, gate operators, etc. The courses-D is conducted only to the people in the villages related to the projects. The training contents consist of O&M and WUG's management including agricultural supporting services, but some other contents such as new agricultural extension system and promotion of the women in development are also included in this training program, because the officers and the people involved in strengthening of WUG should have those basic knowledge. The lecture is made visually by the use of overhead projector, etc., and the training should be implemented intensively during the implementation period of the project.

In addition to the above training program, the following training are proposed:

1) Special Training to VEO and Irrigation Technician: Before the implementation of the project, VEO and Irrigation Technician to be attached to the project dispatch to KATC (Kilimanjaro Agricultural Training Center) for level-up of their basic technical knowledge.

2) Follow-up Training to WUG: The DALDO's office implement occasionally follow-up training to WUG according to the necessity for improvement of their management. The DALDO's office always monitor all WUG's activities through VEO and Irrigation Technician, and prepare necessary training program for them.

3.5.4 Reinforcement Plan for Agricultural Extension Services

(1) Training Programme for Reinforcement of Agricultural Activities

Through and after the project implementation, the agricultural extension services should be promoted for the improvement of the present agricultural productivity in the scheme. Subjects to be reinforced are listed up considering the current situation, and further the following order of priority is given, viewing the points of farmer's technical and financial capability as well as emergency degree;

First priority

(a) Dissemination of proposed farming practices

Farmers are aware of shortage of knowledge concerning proper utilization of fertilizer and agro-chemicals. It is necessary to disseminate proper utilization of fertilizer and agro-chemicals. Further, proper practices of land preparation, sowing/planting, etc. should be also transferred, in order to improve the current situation.

(b) Promotion of proper water management

It is, of course, important to effectively utilize limited amount of water resources. All the beneficiaries should be aware of critical stage which water is necessary for plant growth, and further proper amount of irrigation should be manifested, considering characteristics of crops and diseases/insects.

Second priority

(a) Improvement of soil fertility

Most of the soils are relatively fertile and sufficiently large moisture holding capacity to be suitable for crop cultivation and irrigation practices. With small exception, the soils developed in the steep slope have a shallow effective depth, course texture, and then, high erodebility.

(b) Improvement of storage facility

It is recommended that farm inputs and /or farm products be dealt with by farmer's group not individual farmers, in order to effectively negotiate with dealers. Namely, farm inputs should be purchased at a low price, while farm products be sold at a high price.

In order to control the buying or selling price, it is necessary to consider the establishment of storage facilities. It seems that the existing facilities have no functions due to poor conditions of the building, therefore it is recommended that they be rehabilitated or improved.

Third priority

(a) Adoption of improved tools

Normally, farmers have used big knife which is called "Panga" for multi-purpose, e.g. weeding, digging hole, tree cutting, etc. Considering the work efficiency, it is important to adopt proper tools for specified work.

(b) Popularization of draught cattle

As mentioned in Section 7.2.2 of Approach for Improvement of Current Agricultural Situation in Main Report, the utilization of draught animals could be quite important and useful, in order to mitigate the work load of land preparation which is undertaken by hand, and further promote the implementation of organic agriculture. Therefore, it is recommended that this approach be promoted under the implementation of long span training programme, considering the past defaults.

Subjects in the group of the first priority should be carried out to expect the rapid appearance of benefit from the project. Currently, farmers concerned have been facing to some constraints which decrease the agricultural productivity and further deteriorate the quality of farm products. Accordingly, subjects in the second priority are also expected for the improvement of the current situation, however a great deal of inputs and time might be required. Regarding the subjects in the third priority, it is necessary to arrange some additional input in future, from the financial and technical points of view.

It is proposed to concentrate the implementation of the subjects in the first priority in order to improve the current situation. Additionally, it would be expected to include the second priority to grade up the improved situation. While, subjects which are ranked in the third priority are recommended to be achieved under long-range approach, therefore they are excluded from the building-up programme for the agricultural extension services.

Training programme be provided into the target group such as farmers concerned and frontline extension staffs (DIVEO and VEOs), in order to build up their skills and knowledge on relevant farming practices as shown in Tables 3.5.2 to 3.5.4. Outline of the training programme is described as follows;

1) Approach for training and education to farmers concerned

(a) Field training in demonstration plots and farmers' fields

Based on the period of each farming practice of crops as shown in Table 3.5.2, field training programme for farmers will be conducted in demonstration plots to be managed through the project implementation, and further, in farmers' fields after the project implementation. This training plan will be managed by VEO of Mkula village under overall support of District Agriculture and Live-stock Development Officer's office (DALDO's office) , as shown in Table 3.5.3.

In principle, farmers should promote their capability on farming practices in collaboration with each other, based on the close communication and long term institutional building. Therefore, farmer's group is required to be organized each tertiary block. Each farmer's group will be provided field training which is shown in Table 3.5.4.

Each farmer's group should be self-governing and group member will select a leader. This leader should be a aggressive farmer who is interested in advanced farming practices and improvement of their living standard, further he has to take care of other members.

(b) Field tour to advanced areas

It is important to inspect some areas in which farming technologies are advanced, in order to enlighten and educate farmers. For instance, Lower Moshi Irrigation Project, Ndungu Irrigation Project, etc. in Kilimanjaro

Region is preferable inspection place for advanced paddy cultivation practices.

(c) Special training in KATC

Kilimanjaro Agricultural Training Centre (KATC) in Kilimanjaro Region which is technically and financially assisted by the Japanese Government has broad function for training of farmers and extension frontline staffs. As training course of KATC, key farmer's course is recommended, aiming at improving the skills and knowledge for advanced farming practices of paddy cultivation. The course covers major cultivation techniques and other related topics like water management, O&M of farm machinery, and further responsibility of key farmers.

2) Approach for training and education to DIVEOs and VEOs (see Table 3.5.5)

(a) Workshop

Extension frontline staffs of DIVEO and VEOs are required to be trained through periodical workshop. Through workshop, purpose and procedure of the project implementation will be enlightened, and further proper method on dissemination of advanced farming technology and monitoring/review of the training programme should be lectured to them.

Through and after the project implementation, frontline staffs will discuss the results of monitoring and review concerning the procedure of the training programme. As a result, training programme and guideline of proposed farming practices should be properly modified.

(b) Field training through and after the project implementation

Through the implementation of the demonstration plots, frontline extension staffs will be enlightened proper farming practices and theory of crop cultivation. Furthermore, monitoring and evaluation, yield analysis, water management, etc. are also guided to the frontline extension staffs. In principle, VEO has responsibility of management of demonstration plots and DIVEO assists that management. In order to effectively show farmers the results of the demonstration plots, the plots will be required to be settled at more than two places in the scheme. Guideline for proposed farming practices could be prepared in order to carry out effective field training for farmers, based on the findings and results which will be obtained through the implementation of demonstration plots.

After the project implementation, VEO will be required to coordinate the field training for farmers. Through the field training, the actual trial and dissemination concerning proposed farming practices, yield analysis, water management, etc. will be conducted by VEO.

(c) Special training in KATC

As mentioned above, KATC has broad function for training of farmers and extension frontline staffs. As training course for extension frontline staffs, rice cultivation and water management courses are recommendable, aiming at enhancement and improvement of skills and knowledge on those topics. Rice cultivation course aims at enhancement and improvement of paddy cultivation under irrigated and rainfed lowland conditions and other related subjects for extension activities. While water management course

covers advanced techniques on water management and other related subjects.

It is proposed that the implementation of the reinforcement programme mentioned above be managed and monitored by the Agricultural Coordinating Committee which will be established as a new organization for the Project. Organization and terms of reference of this committee are elaborated in Section 4.2.

(2) Supporting Services by Relevant Institutes

Research centres and other institutes concerned such as MATI, LITI, SUA, TOSCA, Special Programme of FAO, etc. are identified to support the extension services from technical point of views under NAEP II. That is, those institutes have carried out various training programmes, seminars and workshops, in order to support the extension activities of NAEP II. Depending on the future situation, the following supporting services to the Project will be expected to be carried out by those relevant institutes, in order to lead a successful implementation of the Project;

(a) Technical support from the on-going project concerning on-farm seed production.
(b) Education and training for farmers and extension staffs, concerning theory and methodology on specified topics through the regular programme.
(c) Implementation of farming system research approach.
(d) Identification of insects and diseases.

In order to widely disseminate the information concerning improvement of living standard in rural area, communication activity has been offered by the Zonal Communication Centre (ZCC) which was decentralized from the former Farmers Education and Publicity Unit. Under the NAEP II, ZCC has function to conduct various support services of extension services by means of mass-media, audio visual aids, etc. as follows;

(a) Poster, leaflets, booklets: These tools are useful to support the extension services by VEOs.
(b) Audio visual aids: These tools are useful to supplement the effect of study tour, residential courses, etc. Moreover, it is indispensable to support the lecture and practices in MTS and BMW as auxiliary material.
(c) Mobile extension service: It seems that there is the most useful tools for the dissemination toward a mass of villagers. Additionally, this tool also has a function as recreational facility.

Accordingly, it is expected that information of extension services be disseminated to the Project area by means of the function of ZCC.

3.6 Environmental Conservation / Protection Plan

3.6.1 Environmental Impacts Assessment

In Mkula scheme Area, it is identified that the environmentally susceptible elements have been, more or less, affected even under the present conditions with the negative impacts due to "high annual increment of both human and livestock population", "high energy consumption chiefly of the forest resources", "rural poverty and low educational conditions", "unconsolidated rural health and sanitation service facilities", etc.

The negative impacts to be brought by the proposed project implementation could be classified into "direct impacts" and "indirect impacts".

1) Direct Environmental Impacts

The following two environmental impacts have been pointed out as direct impacts of the proposed development.

(a) Increment of water-bone epidemic disease risks;

It is foreseeable that the hydrological regime in the scheme areas would be changed to a large extent, i.e. appearance of wide impounding area (in case of paddy growing season) through irrigation practices, and accordingly, diversification to a new ecological conditions. With such change of ecological conditions, the negative impacts would arise as an influence of the water-bone epidemic diseases, such as Malaria, Bilharzia Schistosomiasis, etc. due to population increase of vectors. Thus, in the implementation of the proposed project, particular attention shall be paid to this concern.

(b) Agro-chemical impacts and water contamination;

Utilization of chemical fertilizers and agro-chemicals is essentially needed for maintaining the agricultural production at a high level. Thus, in using those inputs, special attention should be paid to the fact that the toxic chemical elements from those inputs will surely be accumulated into the soils and excessive one contaminate water quality to a certain extent. Accordingly, those chemical elements bring a risk to human health as well as the natural eco-system especially for the aquatic species in the area.

2) Indirect environmental impacts

The indirect impacts which would be brought by the project implementation are the following two aspects:

(a) Deforestation and/or degradation of vegetation

When the development target is successfully achieved and accomplished activation of the agricultural production, the present living conditions could be up-graded, and consequently, energy consumption per household will largely be increased to a high level. This means that deforestation and/or degradation of vegetation will be accelerated due to increment of the fuel wood demand because of no alternative fuel sources in the rural area.

(b) Misgivings of social conflict

Although it shall be studied more precisely due to delicate issues in interest amongst the rural inhabitants, a social conflict on water rights, land ownership and tenure system, right of irrigable land occupancy, etc. is one of the misgivings in this scheme areas since the land and water resources in each scheme area have been mostly used to a maximum extent up to present.

3.6.2 Action Plan for Mitigation and/or Elimination of Negative Impacts

In order to eliminate or mitigate the environmental negative impacts in a satisfactory and successful way, the following measures are recommended as the basic approach to an environmental protection-cum-conservation means in implementation of the proposed project.

(1) Measures for Mitigation of Direct Negative Impacts

(a) Influence of water-bone diseases

The following practices are generally accepted as the most practical approach to eliminate and/or mitigate an influence of water-bone diseases in Mkula Scheme Area.

- Periodic cleaning of the irrigation and drainage canals and drying up these canals during the agricultural off-season so that it can be got out the habitat available for the vectors and intermediate hosts of diseases as well as cut off the life-cycle of the causative agents of diseases, effectively.

- Consolidation of the sanitation facilities in the village area. This is also essential for cutting off the life-cycle of the causative agents of diseases, effectively and successfully. As far as consolidation of the sanitation facilities is concerned, it shall be based on a national and/or regional health service program, and all the design conditions which might be applied to the proposed sanitation facilities should comply with that program.

- Utilization of the agro-chemicals for directory controlling the vectors and intermediate hosts habitat, immediately after drained out the irrigation water. This practice is, however, limited to only a small extent where such vector or host habitat are concentrated, i.e. empounding in small depression with in the paddy field, dead water in canals, etc.

(b) Agro-chemical impacts and water contamination

As for the water contamination problems due to utilization of chemical fertilizers and agro-chemicals, it is essential to prepare a standard guideline and advice farmers how to use agro-chemicals, safely and satisfactorily.

In order to eliminate and/or improve the accumulation hazard of toxic chemical elements in the drainage canal system, introduction of an "organic farming practices" is crucial. It is also essentially needed to organize the irrigation beneficiaries into water users' co-operatives, and then, establish the plant protection cum sanitation control functions within the co-operatives. Leading such communal work is the essential bases not only for encouragement of the beneficially participatory approach to the project, but in fact, promotion of a sustainable development of the agricultural development.

(2) Measures for Mitigation of Indirect Impacts

(a) Deforestation and degradation of vegetation

To properly maintain the present forest and vegetation against the negative impacts caused by fuel wood collection, it is necessary to make precise-cum-fair demarcation and allocation as well as limitation of the development area, etc. on the open forest, and set up by-law for collection of fuel wood. Afforestation program is the most essential cum practical way for conservation of the vegetation, therefore, it must be incorporated into the implementation schedule of this project.

(b) Social conflict in land and water utilization

To eliminate the social conflict in land and water utilization, it is essentially needed to enforce the village act, and more over, empowerment of the leadership of the village community societies.

3.6.3 Monitoring Plan

The proposed monitoring plan will work to verify the effectiveness of mitigation measures mentioned above, therefore, it should be carried out over the entire life of the project.

The major items of the environmental monitoring shall consist of the following:

- Execution of monitoring including compilation and analysis of the data accumulated and preparation of appropriate periodical reports and liaison with the other agencies concerned,
- Evaluation of the monitoring data and identification of unexpected environmental effects,
- Formulation of countermeasures to mitigate the unexpected negative effects,
- Cooperation with the Project Office or other agencies concerned with implementation any countermeasures or remedial measures required,

Originally, execution of the monitoring should be carried out on the 4 items which were the subjects of EIA. This plan proposes for Direct Negative Impacts which have the baseline data.

(1) Influence of water-bone diseases

(a) Disease vectors

Mosquitoes and the snail vector for Bilharzia have to be monitored periodically in order to establish effective vector control measures. New benchmark for this monitoring might be needed in the scheme area where the hydrological regime would be changed with this project.

(b) Hygienic condition

The control water–borne diseases in irrigation scheme can be successful if adequate and acceptable sanitation facilities for excreta disposal are provided and used. Monitoring of this condition in all scheme is very important. This will be done by taking inventory of sanitary facilities every year and check whether there is an increase in the availability such facilities. If no increase has been observed, proper measures should be taken by the village government together with the village health workers to further educate the villages on the importance of the issue and enforcing by laws where necessary.

(c) Community behavior

In all of the villages visited during the study, it was observed that most of the villagers have the habit of washing and bathing in canals and rivers. This habit contaminates the water used for domestic purpose and therefore spreads water borne diseases. This should be monitored by village health workers. If the situation will persist, the village authority should take action by introducing by-laws controlling such activities.

(d) Prevalence of endemic diseases

Monitoring the occurrence frequency of endemic diseases will indicate the effectiveness of control measures of diseases undertaken and be able to revise, if necessary, the adopted strategies; activities and resources allocations according to results of the monitoring.

(e) Water supply

It was noted during the field survey that most of the visited villages in the Project Area use contaminated or untreated water from traditional irrigation canals and rivers which leads to diarrhea diseases. Therefore, monitoring water quality should be undertaken. The samples should be taken at least 3 points for each scheme and twice per year.

(2) Agro-chemical impacts and water contamination

Spraying agro-chemicals from the air result not only in the treatment of the target fields but also of the surrounding area, as the mist of the chemicals will be carried down wind. Much of the poison end up in the soil and also in open water bodies. Irrigation canals and water courses in which fish live are also affected. Some of the chemical will reach the target organism e.g. crop pests.

However, not only the fish that will be affected by the contaminated water but also people that are drinking or use that water. Therefore, monitoring programme will be essential to find out whether the water, the soil, the fish and plants from the sprayed fields contain residues of active ingredients of the particular biocides applied. It will be necessary to determine the amount accumulated in these four items and therefore, control their accumulation to levels of toxic to users and the environment.

(a) Monitoring items

Water
When toxic biocides end up in the water, it becomes contaminated. They kill aquatic species that would be beneficial to people and also accumulate to toxic levels which are harmful to human health. Monitoring the accumulated concentrations will help control of the negative impact of the applied.

Soil
Much of active ingredients of biocides applied for crops enter the soil. Some of this poison can be absorbed and fixed by the soil particles temporarily and later get into the food chain where it may accumulate to toxic levels. Monitoring of the accumulation is required to avoid their danger to humans, animals and plant life as well as soil fertility.

Fish
Pesticides toxic to fish end up in the water, they kill fish that eat undesirable insects. The surviving surveying fish may have accumulated toxic levels of active ingredients of the chemicals applied which in turn when people consume the fish continue to accumulate in the human body and may reach toxic levels which are harmful.

Vegetables
Long persisting chemicals applied to vegetables active ingredients may accumulate in the plant tissues to high levels, resulting into harmful health effects to those who consume the vegetables.

(b) Methodologies

The methodology for each item is shown below:

Monitoring Items	Ingredients to be monitored	Method to be used
Water	Organochlorineseg HCH, DDT Dieldrin and heptacclor	Gas-liquid chromatography
	Orgonophosphous (e.g. malathion) carbamates dithiocarbanates synthetic pyrethoroids	
Soil	NH-N, Copper (Cu), Sodium (Na), Calsium (Ca)	Kjeldahl method Sodium diethy ldithiocarbametes method, Atomic absorption spectroscopy
Fish	Organochlorineseg HCH, DDT Dieldrin and heptacclor	Chromatographic techniques e.g. Gas-liquid chromatography
	Orgonophosphous (e.g. malathion) carbamates dithiocarbanates synthetic pyrethoroids	Thermic ditectors Flame photometric ditectors Spectrophotometric method
Vegetable	NH-N Organochlorines e.g. HCH, DDT Dieldrin and heptacclor	Kjeldahl method
	Orgonophosphous (e.g. malathion) carbamates dithiocarbanates synthetic pyrethoroids	Kjeldahl method
Soil over-richness	SA	Kjeldahl method
	CAN	Kjeldahl method followed by
	NPK	either a flame or atomic absorption method
	UREA	Kjeldahl method
	(NH4-N)	Kjeldahl method
	NH4NO3	Steam distillation method

CHAPTER IV IMPLEMENTATION PLAN

4.1 Construction Plan and Cost Estimate

4.1.1 Basic Consideration for Project Construction

The project construction plan is formulated on the basis of the following considerations:

1) Construction works of major facilities such as Mkula headworks, the main canal, the secondary canals, and the tertiary canals with their related structures should be carried out by a qualified civil work contractor. Preparation of paddy ridges and field ditches diverging from the tertiary canals would be constructed by farmers themselves.

2) Mechanized construction methods will be principally introduced for earthworks and major concrete works. From the beneficiaries participatory approach, local farmers should be employed as much as possible for manpower works such as small earthworks, chipping and concrete lining.

3) Consulting engineers should assist the Project office in the preparation of detailed design and tender documents, and the tendering and supervision of the construction works.

4) As the beneficiaries are not familiar with water management for the wet paddy cultivation and have to be reorganized for operation and maintenance of project facilities and the water management, a water management expert and an institutional expert should be assigned from latter half of the construction works for one to two years and also prior to the direct guidance in the project, some of farmers who are willing to study the water management should be despatched to an advanced project like KADEP during the construction period.

4.1.2 Construction Schedule

The construction schedule of Mkula scheme is shown in Figure 4.1.1. It includes the preparatory works such as survey and design and tendering, and the construction works. The most of major construction works are scheduled to be completed in one dry season.

4.1.3 Construction Plan

(1) Workable days

Construction work progress is much affected by rainfall. Workable day for each month is estimated based on the daily rainfall data of Kilombero rainfall station on the assumption that the construction works are suspended in accordance with the following conditions.

Daily rainfall depth	Time to be suspended (days)
5 - 10	0.5
10 - 30	1
30 - 50	1.5
more than 50	2

The workable day is estimated at 290 days/year and if Sunday is deducted, it is 250 days / year. The workable day during the dry season for 6 months from June to November is estimated at 168 days and if Sunday is deducted, it becomes 144 days.

(2) Construction plan and method

(a) Mkula headworks

During the mid dry season from August to November when river water is less than 0.2 m^3/sec, rehabilitation works of the headworks such as concrete membrane in the weir upstream apron, removal of the existing intake and then construction of a new intake structure will be carried out immediate after diversion and coffering works. During the construction works, irrigation water supply is stopped.

(b) Canals and related structures

Canal embankment materials will be transported from Pit.2 or Pit.0. Construction works for canals and the related structures will be carried out in accordance with the following sequence and method.

1) Stripping	by small bulldozers
2) Canal embankment	materials loaded by a loader, transported by dump trucks, spread by a small bulldozer, compacted by a roller and shaped by manpower
3) Canal excavation	by a small backhoe
4) Construction of structures	
5) Lining, if any	concrete blocks with cement mortar joints, installation and filled cement mortar by manpower
6) Finishing of earthworks	by manpower

4.1.4 Cost estimate

(1) Condition of cost estimate

1) The exchange rate applied in the estimate is Tsh. 620 = US$ 1.00 = Yen 120.

2) The construction works will be executed on the contract basis.

3) Unit costs are estimated referring to the relevant price information for the construction such as labour cost, material price and equipment hiring cost collected from Regional Engineers Office in Morogoro, National Construction Council and the general contractor.

4) No compensation is considered for land acquisition for project facilities.

5) Cost for the preparatory works is assumed to be 5 % of direct construction cost. The preparatory works include temporary access, construction office and staff quarters, etc.

6) O & M facility and equipment cost is estimated for operating the project after completion of the construction works. The facility and equipment taken up in this cost includes WUG office, office equipment, O&M tool and communica-

tion motor bike.

7) Administration cost during construction stage is estimated on the basis of field inspection needs of the executing government staff.

8) Engineering services cost to be required for the project implementation, including establishment and reinforcement of WUGs, training on water management and farming ,is estimated in accordance with the implementation schedule. The engineering services are assumed to be undertaken for all the four (4) schemes. Then the cost is allocated the each of the schemes.

9) Physical contingency is assumed to be 10 % of the direct construction costs.

10) Price contingency is assumed to be 3 % for the foreign and 17 % for local currency portions of all above cost items.

(2) Unit rates of major works

Labor cost, material cost, equipment and construction unit prices are listed in Table 4.1.1to 4.1.4 respectively.

(3) Estimate of direct construction cost

The direct construction cost is shown in Table 4.1.5 and summarized below.

Direct Construction Cost

Item	(Tsh. million)
Headworks	6.1
Irrigation system	285.8
Other works	28.4
Total	320.3

The direct construction cost includes general expenses and profit of contractors.

(4) Costs of O & M facility and equipment, Administration, and Engineering services

The O & M facility and equipment cost is estimated to 24.7 Tsh. million as given below.

O & M facility and equipment cost

	(Tsh. million)
Construction of WUG office	22.0
Purchase of Office equipment	1.1
Purchase of O & M Tools	0.1
Communication motor bike	1.5
Total	24.7

The administration cost is estimated to 5.0Tsh. million as given below.

Administration cost

	(Tsh. million)
Allowance of officers	3.1
Transportation	1.9
Total	5.0

The engineering services cost is estimated based on the project implementation schedule, on the assumption that the engineering services will be undertaken for all the four (4) schemes. Then, the engineering cost for Mkula scheme is allocated in accordance with the irrigation area in Mkula scheme to total area of all the four (4) schemes. The costs are summarized as follow.

Engineering services cost

Engineering services cost for all four schemes	(Tsh. million)	1,227.30
Total area of all four schemes	(ha)	1,379
Irrigation area of Mkula scheme	(ha)	149
Engineering services cost of Mkula scheme	(Tsh. million)	132.60

(5) Construction cost

The construction cost is summarized in the following table.

Construction Cost

(Tsh. million)

Item	Foreign portion	Local Portion	Total
Direct construction cost	182.7	137.6	320.3
Preparatory works cost	9.1	6.9	16.0
O&M facility and equipment cost	-	24.7	24.7
Administration cost	-	5.0	5.0
Engineering services cost	132.6	-	132.6
Sub-total	324.5	174.1	498.6
Physical contingency	18.2	13.8	32.0
Sub-total	342.7	188.0	530.7
Price contingency	19.4	69.3	88.7
Total	362.1	257.3	619.4

(6) Annual disbursement schedule

The construction cost will be disbursed in accordance with the implementation schedule. The disbursement schedule is as follow:

Disbursement Schedule

(Tsh. million)

1st Year	2nd Year	3rd Year
72.4	525.2	21.7

(7) O&M costs

The annual O & M cost after the construction works is estimated to 1.6Tsh. million at the rate of 0.5 % of the direct construction cost.

4.2. Implementation Schedule on Institutional Work

4.2.1 Executing Agencies related to the Project Implementation

The implementation of the Project is divided into three stages; (i) preparatory works such as explanation meeting, (ii) implementation of the Project including detailed design, construction and strengthening of WUG, and (iii) O&M by the farmers. These executing agencies would be as follows.

Agencies related to the Project Implementation

Development Stage	Major Activities	Implementing Agencies	Main Supporting Agencies
1) Preparatory Work	Public meeting	Zonal Irrigation Office	RAS, RPO, RALDO, DC, DALDO, RCO, DCOs, Village Government & Ward Councils
2) Project Implementation	D/D and construction - Establishment or re-organization of WUG - Land acquisition of right of way - Land re-allocation	Zonal Irrigation Office Village Government / Existing WUG	RAS, RPO, RALDO, DC, DALDO, RCO, DCOs, Ward Councils
3) O&M of Irrigation Facilities	- O&M of facilities - Farming	WUG (Farmers)	RALDO, DALDO, DCOs, Village Government

GOT has a restructuring plan of the Regional Government, and it is just on-going in the Morogoro Region. The study on the project executing agencies was therefore made on the basis of the organizational structure of the Regional Government as of August 1997.

4.2.2 Organization for the Project Implementation

The Commissioner of Agriculture and Livestock Development (CALD) in the Ministry of Agriculture and Cooperatives (MAC) would be the executing agency of the Project. CALD would coordinate all activities of the relevant Government agencies and regional administrative organizations in connection with the projects implementation. At the regional level, the Zonal Irrigation Office in Morogoro Region under the Assistant Commissioner for Irrigation, CALD would have direct responsibility for the project implementation. The organizational structure of this office is presented in Figure 4.2.1. The main tasks of the Zonal Irrigation Office would be listed as below.

1) Financial arrangements needed for the project implementation
2) Arrangement of staff necessary for project implementation
3) Public meeting with farmers
4) Collection of farmers' request and review of the rehabilitation plan
5) Necessary supporting services to general meeting of village government / existing WUG
6) Exchange of agreement with the village government / existing WUG for final plan
7) Detailed design and construction supervision of all implementation works

The Zonal Irrigation Office should implement not only engineering works but also the public meeting in accordance with the farmers' participatory approach. Namely, this office explains all of the plan and implementation schedule to the farmers at the public meeting before commencement of the Project, and takes their full understanding for the development plan and farmers' participation to the project implementation.

4.2.3 Organization and Schedule for Post-implementation of the Project

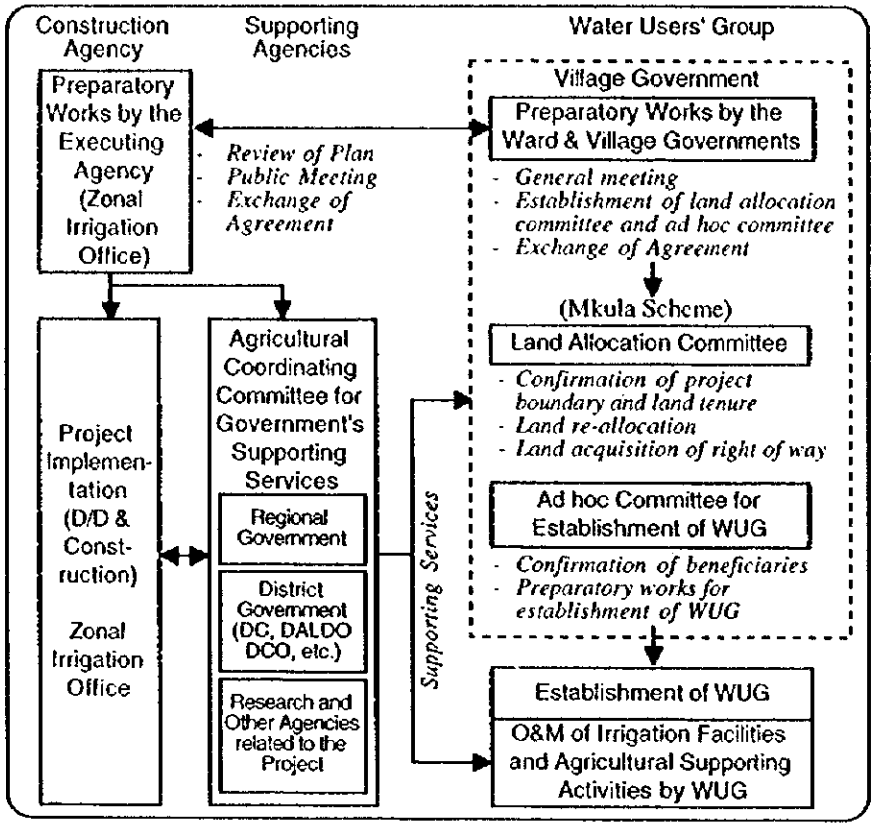
In order to achieve sustainable O&M of the facilities and successful irrigation farming, it is a prime requirement to strengthen WUG and agricultural extension services. Those proposed implementation schedule are described hereinafter.

(1) Implementation Schedule for Reinforcement Programme of WUG

All the irrigation facilities rehabilitated and expanded by the Project are managed

and maintained by the beneficiaries themselves. In order to arouse the farmers' sense of belonging and responsibility to the O&M of facilities, it is proposed to implement the Project by the farmers' participatory approach. The schematic flow of the organizational set-up and implementation schedule for WUG is presented below, and the details are shown in Figure 4.2.2.

Schematic Flow for Organizational Set-up
and Implementation Schedule of WUG



The organizational set-up and strengthening of WUG are implemented in parallel with the detailed design and construction of the facilities, and closely linked together.

At first, the public meeting is held at the project site, and the Zonal irrigation Office has to fully explain the rehabilitation plan to the farmers (beneficiaries) of Mkindo, Dihombo and Hembeti villages. At this meeting, farmers' participation such as labour supply for construction works and supply of local materials should be discussed with them. In addition, it should also be discussed between them for farmers' duties to the project implementation such as land acquisition of right of way and land re-allocation which are implemented by the farmers themselves.

After the public meeting, the general meeting for the project implementation should be held by the Mkula village government, which has attendance of all villagers. Then, the plan has to be acknowledged by the farmers with a full appreciation of its content. The Zonal Irrigation Office and the village governments have to exchange an agreement document for the plan after the general meeting. The farmers' duties should be mentioned fully in this agreement.

The Zonal Irrigation Office will commence the project works including field investigation, detailed design and construction, while the village governments will make necessary arrangements for supplying laborers and local materials. In parallel with these project implementation, a new WUG should be established and strengthened in accordance with

the proposed plan. The village government should take the initiative in implementing these activities, and organize a land allocation committee and an ad hoc committee for organizing WUG. These committees consist of leaders of the village governments, and have the following activities. The District Commissioner and the Ward Councilor provide necessary support to the land allocation committee and the ad hoc committee, especially for the land re-allocation and the land acquisition of the right of way.

Land Allocation Committee
a) Confirmation of project boundary and land tenure
b) Land re-allocation
c) Land acquisition of right of way

Ad hoc Committee of WUG
a) Confirmation of beneficiaries
b) Management of farmers' participation to construction works
c) Preparatory works for establishment of WUG (including preparation of draft by-laws and budget, receiving of candidate for leaders of WUG, arrangement of first general meeting, etc.)

The ad hoc committee arranges the establishment of WUG, and it should be established until three (3) months before the completion of construction works. The DALDO's office should commence immediately the training to WUG. After the construction, WUG carries out the operation and maintenance of the facilities. The existing WUG will be closed and all of members will join to new WUG.

The government's agencies provide necessary supporting services for establishment and strengthening of WUG. Those major services are listed below.

DC/Ward Councilor
- Supporting to land re-allocation and land acquisition

DALDO
- Supporting to the village government for general meeting.
- Supporting to the activities of the land allocation and ad hoc committees.
- Training programme for O&M of irrigation facilities and WUG's management including marketing, credits, etc.
- Technical supporting services to on-farm development.
- Overall engineering services for O&M of irrigation facilities

DCO
- Institutional improvement for WUGs.

Main agency of the above supporting services is the office of DALDO. The proposed organizational structure of this office is presented in Figure 4.2.3. The supporting services of the DALDO's offices are mainly implemented through the irrigation technicians and VEOs who are attached to each schemes.

The DALDO's offices have to periodically monitor and evaluate the activities of WUGs. The data and results of the evaluation will be feed back to improve O&M and agricultural production in the project areas. In addition, the DALDO's offices will make necessary support to settle problems of WUG observed through the monitoring, and implement follow-up training to WUG as the occasion demands.

(2) Implementation Schedule for Training Programme of the Extension Staffs and Farmers

Training programme for the extension staffs and farmers will be arranged by the office of DALDO. The implementation schedule is divided into two stages such as through and after the project implementation.

Major activities through and after the project implementation are summarized as follows;

(i) through the project implementation

- Preparation of the materials for training programme
- Implementation of workshop for the front-line extension staffs (DIVEOs and VEOs)
- Special training in KATC
- Implementation of demonstration plots for training of VEOs and aggressive farmers

(ii) after the project implementation

- Field training and field tour for farmers concerned
- Implementation of workshop for the front-line extension staffs

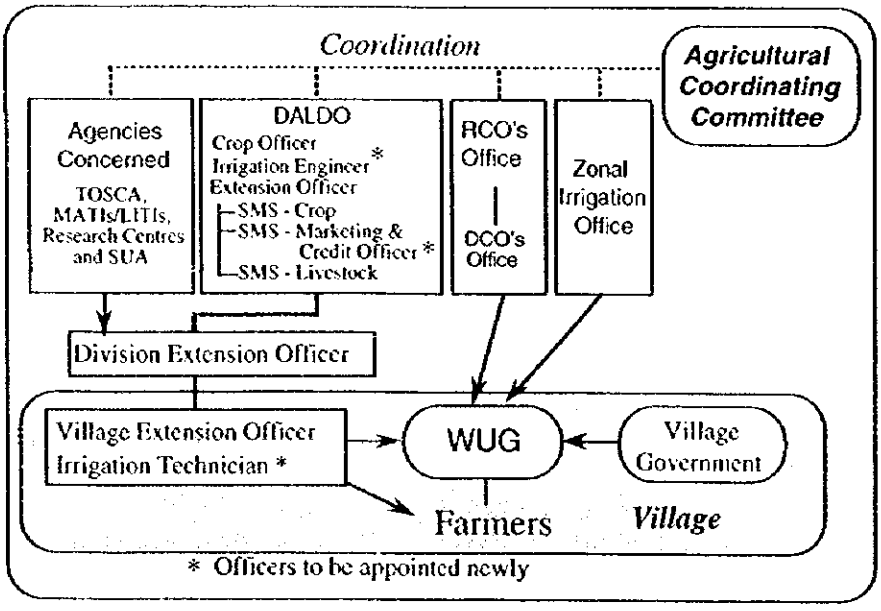
The schedule on the monthly-based training programme through and after the project implementation will be illustrated in Figure 4.2.4. The agricultural extension activities of DALDO's office are implemented under the powerful support from the agencies concerned which are TOSCA, MATIs/LITIs, Research Centres including Dakawa Research Station, KATRIN, etc. and SUA.

(3) Establishment of Agricultural Coordinating Committee

In order to effectively bring out the impacts of training programme and the government's supporting services, it is proposed to organize an Agricultural Coordinating Committee (ACC) in the Kilombero District Government, as shown in Figure 4.2.5. This committee, whose terms of reference are attached hereinafter, will coordinate all of the reinforcement and training programme.

This committee is chaired by RALDO. The activities of this committee will apply the participatory approach of the farmers concerned, in order to lead the sustainable implementation of agricultural development. The organizational structure and terms of reference for ACC are shown below.

Organizational Structure of Agricultural Coordinating Committee



(a) Members of the Agricultural Coordinating Committee

The Agricultural Coordinating Committee consists of the following members;

1.	RALDO	- Chairman
2.	REO	- Member
3.	Zonal Irrigation Office	- Member
4.	DALDO	- Member
5.	Farmers Organization(s)	- Member
6.	TOSCA	- Member
7.	MATIs/LITIs	- Member
8.	Research Centres	- Member
9.	SUA	- Member
10.	District Extension Officer	- Secretary

(b) Terms of reference for the Agricultural Coordinating Committee

The function of the Committee is summarized as follows;

1. To monitor and evaluate the progress of project implementation, activities of WUG and farmers, and study on necessary supporting services for further development.
2. To coordinate all of the agricultural supporting services
3. To monitor and review the agricultural supporting services, and provide necessary advice to the agencies concerned
4. To monitor and review the progress of agricultural training programme for VEOs and farmers
5. To hold periodical meeting of the Committee

4.2.4 Staff Required for Project Implementation

Prior to the implementation of the Project, the staffing of the Zonal Irrigation Office and the offices of RALDO and DALDO which are main supporting agencies of the Project should be strengthen. The proposed staffing to be deployed newly for the project implementation are as follows:

1) Agro-economist/Sociologist (Zonal Irrigation Office): Prior to the implementation of the Project, an agro-economist/sociologist is appointed in the Zonal Irrigation Office. The preparatory works including meeting with farmers, collecting of farmers' intention to the Project and guidance to the general meeting of the village government are carried out mainly by this officer.

2) Project Coordinator (RALDO's office): To make close coordination between the Zonal Irrigation Office and RALDO's Office, an officer attached to the Project is appointed as a representative of RALDO's Office.

3) Irrigation Engineer and Marketing and Credit Officer (DALDO's offices): In order to achieve sustainable O&M of WUGs and effective irrigation farming of the farmers, supporting services for O&M of irrigation facilities and marketing and credit are crucial factors, and the DALDO's offices should play an important role to implement these survives to WUG. At present, the DALDO's offices have however almost no specialist for these sectors. It is therefore proposed to appoint an Irrigation Engineer and a Marketing and Credit Officer in each DALDO's office, who graduated university or college and have a lot of experience on these sectors.

4) VEOs and Irrigation Technicians: At the filed level, it is also proposed to appoint a VEO in each village related to the scheme and an Irrigation Technician (IT) in each scheme. All necessary supporting services by the DALDO's office are implemented through these two officers.

The table below shows the number of staffs necessary for project implementation and agricultural supporting services. It is proposed that these officers will be deployed before the implementation of the Project.

Proposed Staffing for Project Implementation

Position	Present		Staff Required		Increment	
Morogoro Zonal Irrigation Office						
Economic & Social Survey Section						
Agro Economist/Sociologist	-		1		1	
Office of RALDO						
Project Coordinator	-		1		1	
Office of DALDO, Kilombero						
Irrigation Engineer	-		1		1	
Marketing and Credit Officer	-		1		1	
Village Extension Officer and Irrigation Technician						
(Project Site)	Villages	VEO IT	VEO	IT	VEO	IT
- Mkula	1	1 -	1	1	-	1

VEO: Village Extension Officer IT: Irrigation Technician

In addition, it is necessary to assign several specialist/experts, in order to train the above government's officers involved in the project implementation and the agricultural supporting services to WUG and farmers. Although these officers have a basic knowledge with some experience, it is needed to level-up more their knowledge for the successful and effective implementation of the Project. The experts required for this purpose and their terms of reference are listed below

1) O&M Expert

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

2) Institutional Expert

- Advice to establishment and strengthening of the government's supporting system
- Preparation of manual for WUG's management
- Preparation of training materials for WUG
- Training to officers involved in supporting services to WUG
- Providing necessary advice for improving supporting activities
- Monitoring and evaluation of agricultural supporting services for WUG
- Follow-up training to offices

3) Agronomist / Agricultural Extension Expert

- Technical advice for preparation of training programme coordinated by DALDO
- Technical advice for participation approach in the field training programme
- Implementation of workshop for senior staffs (DALDO, DEO, RALDO, REO, etc.)
- Technical advice to the field training for DIVEO and VEO coordinated by DALDO
- Technical advice to the field training for aggressive farmers managed by VEO
- Technical advice to the field training for general farmers managed by VEO
- Technical advice for monitoring and review of the training programme and extension services
- Technical advice for improvement of farming practices
- Technical advice for preparation of guideline for proposed farming practices

The assignment schedule of each expert is shown in Figures 4.2.2 and 4.2.4.

CHAPTER V EVALUATION OF THE SCHEME

5.1 Economic and Financial Evaluation of Each Scheme

5.1.1 Economic and Financial Evaluation Basis

An economic and financial evaluation was carried out for the 16 irrigation schemes . The evaluation has been carried out by identifying and valuing the costs and benefits that will arise in a "with" project situation and to compare them with the "without" project situation. Economic and financial Internal Rate of Return (IRR) will be calculated at the preliminary basis. To this evaluation, it is also taken into account the "capacity to pay annual O&M costs as well as the amortization cost for the development funds" of a typical farm household as well as the "contribution capacity of the project to the regional economy and the national food security program" from a macroeconomics viewpoint.

For the calculation of the net benefits coming from comparing the "with" and "without-project" situations, first, crop budgets, both financial and economic, for main crops have been calculated for the "with" and "without-project" situations (see Table 5.1.1, 5.1.2, 5.1.3, and 5.1.4); second, using the net return for each crop, the respective financial and economic net benefits have been calculated.

The evaluation has been made based on the following basic assumptions:

1) The economic useful life of the Project will be 50 years.
2) All prices are expressed in constant prices prevailing on August of 1997.
3) Import Parity Price for rice has been calculated and used for the economic analysis (see Table 5.1.5 for its calculation). The calculation was based on the projected world market prices of the World Bank in the long range for the period 1990-2005. Table 5.1.6 shows the financial and economic prices for inputs and crops used in the evaluation.
4) The exchange rate at Tsh.620 = US$1, prevailing on August 1996, was used.
5) Shadow price of labour works used for evaluation is 75% of the market price. This rate, as well as the one below was provided by the Planning Division of MAC.
6) Construction Cost Conversion Factor is 0.8.
7) Operation and Maintenance Cost has been considered to be 0.5% of the direct construction cost. At the moment of performing the economic evaluation, the O&M financial costs will be converted into economic costs by applying the construction conversion factor to those non-labour costs and the shadow price of labour for labour costs.

5.1.2 Economic Evaluation

(1) Economic Benefits

The irrigation benefits are primarily derived from the increased crop production (incremental benefit) attributable to a stable irrigation water supply. These benefits are estimated as the difference between the annual net crop production values under the "without" and "with" project conditions.

The calculation of the economic benefits is shown in Table 5.1.7.

The net benefits accrue to Tsh.84 million.

The procedure for calculation of the economic benefits are similar as the one used for financial benefits with two variations: 1) instead of farm-gate price for rice, its eco-

nomic import-parity price has been used; 2) at the moment of calculating the net return of main crops, the financial crop production costs have been transformed into economic production costs by multiplying the labour-related costs by the shadow price of labour.

(2) Economic Costs

Project costs broadly comprises direct construction costs, temporary works like mobilization costs, construction of lodgings for inside workers, compensation to land owners and crops, etc., administration costs, and engineering services costs. For the economic evaluation, the on-farm development costs have been fully incorporated. To obtain the economic development costs, the development costs have been multiplied by the construction conversion factor.

Table 5.1.8 shows the calculations for the economic costs. The total economic cost is Tsh.397 million, and the O&M cost is Tsh.0.96 million per year.

(3) Calculation of Economic IRR

Benefits increase 25% per year until reaching its full production target at the sixth year. Table 5.1.9 shows the calculation of the EIRR for Mkula scheme. The EIRR is 16.5%. According to information received from the Planning Division of MAC, a project could be considered acceptable from the economic point of view if its EIRR is above 12%. Then, the EIRR for Mkula is quite acceptable.

(4) Sensitivity Analysis

A sensitivity analysis was made to evaluate the soundness of the Project against possible future adverse changes in the following three conditions:

(a) Development costs increase by 17%;
(b) Reduction of benefits by 10%;
(c) Combined effect of (a) and (b)

Table 5.1.10 shows the procedures for application of the sensitivity analysis. The results of the calculation are as follows:

Sensitivity Analysis Result

(Unit : %)

	Condition 1	Condition 2	Condition 3
EIRR	14.5	15.1	13.2

The reduction of benefits would have a higher effect than the increase of costs on the Project; however, the combination of the two conditions has a greater effect than when consider each condition separately.

5.1.3 Financial Evaluation

(1) Financial Benefits

The procedure for calculation of the financial benefits are similar as the one used for economic benefits with two variations: 1) farm gate prices have been used for all crops; 2) at the moment of calculating the net return of main crops, the financial crop production

costs have been evaluated using market prices.

The net benefits accrue are Tsh.73 million. Table 5.1.11 shows the calculation of the net benefits.

(2) Financial Costs

Table 5.1.12 shows the calculation of the financial costs. The financial development costs are Tsh.497 million. The O&M cost is Tsh.1.6 million per year.

(3) Calculation of Financial IRR

Table 5.1.13 shows the calculation of the FIRR. The FIRR for Mkula scheme is 12.0%.

The FIRR for the scheme is above the 12% standard level required for the acceptance of the Project.

(4) Capacity to Pay

To evaluate the Project from the point of view of the farmers, an average farm budget analysis was made for each scheme with future projections under the "with-project" conditions. The calculations are shown in Table 5.1.14 and a summary of the results is given below. For purposes of the analysis, the hypothetical situation of the beneficiaries of the Project receiving a loan to cover the development costs of the Project has been considered; thus, for the capacity to pay analysis, the cost of amortization of the loan has been considered. The conditions of the loan are as follows: interest rate of 1% to be paid in 30 years; the amount used for the analysis represents the annual amount that the household have to pay to amortize the loan.

Capacity to Pay Analysis

(unit : 1,000 Tsh.)

	Mkula
a) Holding Size	0.4
b) Gross Income	436
c) Production Cost	125
d) Net Farm Income	311
e) Income Tax	7
f) O&M Cost	4
g) Amortization Cost	64
h) Net Profit	236
In case: if d-(c+f)	182
In case: if d-(c+f+g)	57

The results above indicate that the Project will bring about a great improvement to the farm economy; the net farm income is high enough to cover the production cost for the next cropping season, the O&M cost, and the amortization costs.

Figure 5.1.1 graphically shows the results of the analysis made above.

5.2 Other Development Impacts

5.2.1 Technical Aspects

(1) Effect on transfer of technology

Local government staffs and farmers participating to the project through the design and construction stages will have a big chance to obtain technical knowledges on design and construction in small irrigation and drainage facilities, which are very useful for the operation, maintenance and repair of irrigation and drainage facilities.

(2) Demonstration effect

Successfully progress of the project implementation including the operation and maintenance of facilities and water management will enhance the incentive to introduce the improved irrigation and drainage facilities, O&M methods, and water management practices in the similar smallholder irrigation schemes.

5.2.2 Socio-economic Aspects

(1) Improvement of living conditions

The implementation of the Project will help the farmers to rely on themselves for improving their production and living conditions after being provided with adequate agricultural infrastructure and conditions.

(2) Increase in employment opportunities

The Project will generate employment opportunities for unskilled workers during the construction period. Most of the manpower will be supplied from the farmers in and around the Project are. Moreover, workers will be able to gain experience and skillfulness in various working fields. The accumulation of experience and skills will be very useful for O&M work of the farmers. The Project will create a demand for farm labour arising from the increased farming activities due to intensive use of the land resulting from year-round irrigation. It must be mentioned that during the construction period, the income of some farmers could be decreased due to not being able to work in the fields where the construction works are being carried out. Adequate measure should be taken to mitigate this potential negative effect.

(3) Decreasing the out migration of young people to other areas

Young people after seeing the development and progress experimented by the areas benefited by the Project, could feel encouraged to stay in the region and dedicate themselves to agricultural activities. This will bring two positive effects: one is that the population could be stabilized by decreasing the out migration of young people to other areas; and the other is that by proving occupation to the young, the possibility of social problems created by idle unemployed people will decrease.

(4) Incentive for adopting improved irrigation to other area

With the completion of the Project, it could be expected that farmers in other agricultural areas as well as those in the Project area will become familiar with modern irrigation and drainage practices and the incentive for adopting improved irrigation and drainage

practices will be greatly enhanced.

(5) Contribution to national food security

The Project will increase the staple food production, i.e., rice, maize which will contribute to food security. The Project will make it possible for Mkula scheme to contribute with 1,080 ton of cereal and 123 ton of beans per year.

(6) Contribution to the regional economy

Once the project has fully accomplished its production target, it is expected that, at 1996 prices, the gross production value from the Mkula Scheme will be Tsh.149 million per year.

(7) Empowerment of women

Women will be benefited due to the increased production activities making it possible for them to participate and share the Project's benefits. Due to the increased level of income and improvement of production conditions, the farmers would be able to have the money and time to be involved in activities related to education, culture, leisure, etc. which will raise their living conditions quality.

5.2.3 Institutional Aspects

(1) Model project for institutional development of irrigation projects in Morogoro region

Under the strategic framework of NIDP, GOT has envisaged to the development of sixteen (16) smallholder irrigation systems in Morogoro region. For the successful and sustainable development of these projects, one of the prime requirements is the strengthening of institutional aspects including WUG and agricultural supporting services. The development plan formulated in the Project covers not only engineering aspect but also institutional aspect, and includes various ideas to attain sustainable O&M by the beneficiar-ies. Therefore, the implementation of this Project would give a good effect as a model of institutional development to the irrigation projects in the region. In addition, the govern-ment officials involved in the implementation of this Project will have a lot of knowledge and experience on institutional development, which are prerequisite matter for successful implementation of those irrigation projects.

(2) Improvement of agricultural supporting activities in the rural area

The Project proposes formation of new WUG. The WUG will be provided with an opportunity to conduct fruitful economic activities. Furthermore, with the achievement of a successful administration of the irrigation facilities, it will be possible to expand their activities to many other fields besides water administration. The Project proposes involve those groups in a credit and marketing system which will benefit all members.

(3) Strengthening rural organization

Improvement of irrigation/drainage system will facilitate the formation of other farmers' groups in the Study Area. Thus, implementation of the present project is highly beneficial in terms of strengthening rural organization.

5.2.4 Environmental Aspects

(1) Minimizing of negative impacts and mitigation of social conflicts

The environmental impact assessment pointed out that the Project would bring such misgivings such as "influence of water-borne diseases", "water contamination by use of chemical fertilizers and agro-chemicals", "degradation of vegetation due to increment of fuel wood consumption" and "social conflicts on utilization of the land and water resources." However, these effects could be mitigated through the application of an adequate environmental protection plan as the one previously mentioned in Chapter VII. Moreover, the negative impacts could be minimized without too much difficulty since all of the proposed schemes are smallsized.

The negative impacts mentioned above will be monitored periodically to confirm the effectiveness of the mitigation measures. This will allow to identify potential dangers and adopt early mitigation measures.

During the construction period, diverse construction detritus will reach the rivers and traffic on the roads near or in the construction area could be interrupted. This will be temporary disturbances that will pass away after finishing the construction works.

(2) Reduction of conservation costs

The Project, through a rational use of water and land resources will make it possible to promote the conservation of those resources and, at the same time, will reduce the costs of protecting them.

CHAPTER VI. RECOMMENDATION TO PROJECT IMPLEMENTATION

6.1 Technical Aspects

(1) Early implementation of the Project

Through the investigation and studies of Mkula scheme, it has been concluded that the implementation of irrigation development is technically sound and economically feasible. The development will contribute to a stabilisation and an increase in the agricultural production under full irrigation condition, ensuring an increase in farmer's income and living standard, and creating employment opportunities. It has been also recognised through the interview survey and public meetings that (1) the farmers in Mkula scheme are looking forward to the implementation of the project and that desire to positively participate in the implementation of the project and (2) they basically have a capacity to make operation and maintenance of irrigation facilities and proper water management by themselves, although the proper technical supports through training and guidance are required at the initial stage of the project operation. It is also expected that the realisation of the project will surely have a considerable demonsration effect on the smallholder irrigation schemes scattering over the country.

It is recommended, therefore, to implement the irrigation development as early as possible.

(2) Afforestation development

Afforestation development is a key factor to maintain the rural communities especially to ensure a steady supply of fuel woods near the communities, since the hauling distance to obtain fuel woods gradually increases in recent years as the population increases with a rather high rate. It is, therefore, recommended that the area around Mkula village except proposed irrggation area and the area along the road B127 should be utilized for plantation of useful trees.

6.2 Institutional Aspects

In order to achieve successful and effective implementation of the Project, it is recommended that the executing agencies concerned should undertake the following activities.

1) Staffs to be deployed newly for the project implementation are estimated to be 10 officers including irrigation engineers, irrigation technicians, VEOs, etc. The executing agencies concerned should arrange these staffs necessary for successful implementation of the Project.

2) At present, GOT has a plan for restructuring of the regional government. According to this plan, the Morogoro regional government will be simplified in its organization and staffing, and the district governments will be strengthened. In the Project, the district governments such as DALDO and DCO have direct responsibility for the supporting services to WUG to be established in the schemes, and the strengthening of these district governments under the restructuring plan will bring a good result to attain sustainable project. It is therefore recommended to accelerate further this restructuring plan of the Morogoro region.

3) In accordance with the government's policy that the development fruits should be distributed to the farmers equally and as well as possible, the development lands in the Mkula scheme will be re-allocated to the farmers. The village gov-

ernment should take the initiative in implementing its re-allocation. It will be possible, because its re-allocation is implemented to the farmers living within the Mkula village, and the result of the public meeting held by the Study Team in July 1997 shows that over 90% of the farmers in the village have agreed to its re-allocation. However, the executing agencies and the district government should provide necessary support to the village government and the farmers for its implantation, even though they have agreed with it so far.