

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 Mgeta 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 water feeding to livestock as well as 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.

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 successfully.

4) Supporting Infrastructure for Irrigation-based Agricultural Development:

- Consolidation of trunk roads as well as access roads to the scheme areas, including bridges.
- Rehabilitation of the go-down and/or storage facilities for both marketing of crop production and properly storing the farm inputs.
- Rehabilitation or renewal of facilities to be used for community activities.
- If possible, provision of micro-hydropower generation system.
- Provision of domestic water supply system in connection to the irrigation facilities.
- Provision of water-shed protection measures

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.

Mwega scheme had been developed by the local farmers themselves since long time years ago, and hence, majority of arable land has already reclaimed intensively. Pro-

duction of dry onion is predominant in the dry season, and it has specialized as the principle product. In this area, however, the agricultural production per farm household is still at a subsistence level. A fragmentation of the land titles to a petty farming sizes through recent generation changes make farmers difficult to improve the farm economy and getting out a rural poverty. Therefore, it is crucial and essentially needed to increase crop production together with rationalization of the irrigation water utilization and protection of both crop and land against the seasonal flooding .

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 basic objectives for the subjected irrigation-based agricultural development in Mgeta 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 improvement of the existing traditional irrigation systems and expansion of an irrigable land as much as water resources are available.

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

For accelerating further increment and stabilization of the agricultural production, and hence, maintaining a sustainable development of farm economy in smallholder farming, a consolidation of the existing irrigation system is the basic subject in this scheme. To this concern, it can be expected that an increment of irrigable land could be expected approximately 210 ha at the lowest reaches of this scheme area when the existing intake weir and canal system are rehabilitated, successfully.

- 2) Improvement of agricultural productivity through introduction of improved farming technology.

As stated in the preceding Section 1.3 of Chapter I, almost all of the beneficiary farmers have experienced an intensive-cum-diversified crop production up to date. However, the present low crop production make those farmers difficult to improve the farm economy and getting out a rural poverty. Thus, to generate farm income of such smallholder farmers more than that at the present poverty line, it is crucial and essentially needed to promote further increment of crop production by means of improvement of farming practices, i.e. soil fertilization, crop protection against insects attacking and influence of diseases, etc.

To achieve the above goal, an extension of irrigation as well as irrigated farming technology to the farmers is indispensable, accordingly, through reinforcement of the respective institutions.

- 3) Community development especially reinforcement of the existing farmers' organization, i.e. the water users' groups (WUG).

Organization of farmers into the formal co-operatives society will much be effective not only for regularization of communal activities on O&M works of irrigation facilities as well as other agricultural infrastructure, mitigation of social conflicts, access to the group loan in the institutional 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 reinforcement of the existing farmers' organization, i.e. the "Water Users' Groups (WUG)" in the scheme area is one of the essential program for accomplishment of the above tasks of the beneficiary farmers. The organization of the co-operative societies will also bring various job opportunities for participation of those women, youth and/or gender groups in the scheme 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 extending 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-borne 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-borne epidemic diseases, such as Malaria, Schistosomiasis, Filariasis, 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. In case of the implementation of this Project, however, it is foreseeable that the said negative impacts might not so seriously extend to the surrounding area because of the proposed schemes is at small scale and isolated in valley area. However, special attention shall be paid to the fact that the toxic chemical elements will surely be accumulated to a certain extent within the scheme areas if the agro-chemicals is not utilized properly.

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 Mwega 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/conservate 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 Mwega Scheme

(Unit : ha)

Land Use Type	Present	Proposed	Remarks
Paddy field	210	240	upland crops in the dry season
Upland field	340	340	
Pasture land	35	0	will be developed to paddy land
Forest/Wood lands	35	35	
Swamp/River	65	65	un-arable land
Right of ways	55	60	canal, roads, drain, etc.
Total	740	740	

The existing swamp (65 ha in gross) shall remain as the natural retarding basin for regulating the seasonal flood. The forest/woodland (65 ha in gross) shall be also left without development. The present pasture land (35 ha), which is the village community land and being managed by the village Government at present, will be reclaimed as paddy field for allocation to the smaller holder farmers according to the wishes from majority of the farmers in the scheme area.

The other land, which had been cultivated since long time years ago, will be continued to use for crop production. The land classified into the soil units of Mwg-5 and Mwg-6 (285 ha in gross) will be cultivated with paddy in the rainy season as much as efficiently utilizing the seasonal flood and supplementary irrigation by the proposed canal system. In the dry season, this land will be used for production of beans, onion, etc. The land other than the above is used for upland crop production, *i.e.* maize, beans, etc. in the rainy season, and beans, onion in the dry season under fully irrigated conditions.

Based on the above land use plan, it is expected to hold a total 240 ha of paddy field and 340 ha of upland fields in net in the entire scheme area. The net increment of the farm land will be 30 ha of the paddy field through reclamation of the present pasture land. The land shared as the right of ways will be increased to 60 ha from the present occupancy of 55 ha.

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 Mwega scheme are summarized as follows;

- Cultivated area of onion and paddy should be expanded.
- Quality of seeds is not acceptable in general.
- Fertilizer is available, but expensive.
- Price of farm products is fluctuated season by season and low.
- Agro-chemicals is not available in time.

(2) Selection of Proposed 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.

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 maize as food crop as well as such cash crops as onion, 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 rehabilitation of irrigation system, supplemental irrigation in rainy season will be ensured, while irrigation efficiency in dry season will be improved fully, hereby the expansion of irrigated cultivation will be realized in the Project area. It is judged that farmer's consciousness against irrigation and advanced agricultural technology are relatively high if compared with farmers in other schemes. However, these area also have less possibility on expansion of the agricultural land. Accordingly, larger increment of unit yield of each crop is the essential subject in the agricultural development of this scheme.

While it is assumed that future situation without project is almost same as the present situation, considering the irrigation facilities will be hardly improved.

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

Cultivated Area and Cropping Intensity in Mwega Scheme

	Without Project Condition				With Project Condition			
	Project Area (ha)	Cultivated Area (ha)		Cropping Intensity (ha)	Project Area RS	Cultivated Area (ha)		Cropping Intensity (%)
		RS	DS			DS	(%)	
Paddy		210	0			240	0	
Maize/Pulse*1		266	114			340	136	
Pulse		0	70			0	0	
Onion		0	182			0	444	
Total	550	476	366	153	580	580	580	200

RS : Rainy season, DS : Dry season

*1 : Maize 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 and 3.3.5, respectively.

(1) Onion

(a) Land preparation

Land preparation is manually carried out by using hand hoe. Draught cattle are not in common, though cattle is kept by some farmers. While, no tractors for farming practices are available in the area and not hired from outside. Generally, man-power for land preparation which is most laborious activities relies

on seasonal labours.

Ridge formation for planting beds is not required due to high water permeability of sandy loam soil. That is, planting beds are just surrounded by small band in order to preserve irrigation water. The ordinary size of a planting bed is estimated at around 4 m long x 2 m wide and hereby around 400 planting beds are required for one acre of the main field.

(b) Nursery Preparation

Nursery area is surrounded by small band, in order to preserve irrigated water. Ridge is not necessary for seed bed. Seed amount is estimated at around 5 to 6 kg for one acre. Its required nursery size is around 600 m² for one ha of the main field. Common variety in the scheme is "Red Creole". Concerning seeds, some farmers generally multiply by themselves, while some farmers relied on the market seeds which are multiplied by seed farmers in Arusha of Kilimanjaro Region. Nursery period to be required is estimated around one and half month (40 to 45 days).

(c) Transplanting

Planting density is in the range between 10 cm x 10 cm and 10 cm x 20 cm. Transplanting to the main field is done when the seedlings attain pencil thickness.

(d) Application of fertilizer

Application of fertilizer is a common activity in the scheme. In the nursery, a little amount of Nitrogen is applied around 2 weeks after sowing. As for basal dressing, 30 kg of Nitrogen and 20 kg of P₂O₅ should be applied just before transplanting. As 1st top-dressing, 15 kg of Nitrogen is applied around 30 days after setting (transplanting), in order to promote visible bulbing. Consequently, 15 kg of Nitrogen as 2nd top-dressing is applied around 60 days after setting (transplanting), in order to promote thickening growth. Fertilizer is applied in the surface of field and incorporated with soil by using small hand hoe.

(e) Field Management (Plant protection, weeding, and water management)

Thrip is recognized as a dominant insect. Regarding insects, it is recommended to apply proper agro-chemicals as shown in Tables 3.3.4 and 3.3.5. Weeding is manually carried out once or twice during the whole planting time, by using small hand hoe or uprooting. Irrigation is supplied 2 to 3 times a week, depending on the soil condition.

(g) Harvesting

Harvesting is carried out when the neck of plant dries. After picking them up, onion bulbs are dried in the field for 1 or 2 days. Generally, farmers do not store harvested onions until the price will be raised up, but sell them to traders as early as they are available, while there are some cases which traders directly come to farmers' fields and purchase all the harvested onions.

(2) Paddy

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 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, sheath rot, etc. are mainly identified in the area, while stalk eyed sheath 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 pe-

riod, 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.

(3) Maize

Land preparation is generally carried out by applying manpower. 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.

(4) Pulse crops

(a) Land preparation

Land preparation is manually carried out by using hand hoe. Manner of land preparation is almost similar with maize 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 Mwega Scheme

Crops	Present	Without	(Unit: ton/ha)
			With
Paddy	2.0	2.0	5.0
Maize	1.5	1.5	3.0
Pulse	0.8	0.8	1.5
Onion	10.0	10.0	15.0

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 Mwega Scheme

Crops	Present / Without	With	(Unit: ton)
			Increment
Paddy	420	1,200	780
Maize / pulse *1	570	1,428	858
Pulse	56	-	-56
Onion	1,820	3,390	1,570

*1: Maize is applied as representative crop.

3.4 Irrigation and Drainage Development Plan

3.4.1 Development Concept

As stated in the 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, de-

sign, 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 Mwega scheme

- 1) Irrigation and drainage works including farm roads and flood protection dikes 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-borne diseases as much as possible.
- 4) Simple design shall be applied as much as possible for easy rehabilitation.
- 5) Small facilities made by locally available materials shall be constructed by beneficiaries as much as possible.

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 Mwega scheme is formulated. Major matters concretely put to the formulation of the development plan are as follows:

(1) Headworks

All the intake structures are of primitive free intake type, which are easily washed away during the rainy season or of a smallscale concrete fixed weir type, which causes sedimentation in the upstream river bed and flood. Thus instead of these intakes, an unified headworks is proposed to be constructed in the upstream of the scheme area. The most important points in the headworks 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

As for the irrigation system, it should be laid out to connect to the drainage system at the system end and/or on the way so that excess water in the irrigation canal system can be drained automatically to the drain system. In line with this, all the tertiary canals are proposed to connect to the secondary drains at the tertiary canal ends and also side spillways provided on the major irrigation canals connect to drains or directly rivers so that excess water flows into drainage canals and returns to the river. By applying this system, major irrigation canal system can convey water at a constant discharge level without frequent operation.

Canals should be primarily a trapezoidal cross sectional type, which is basically of earth-oriented. Major irrigation and drainage canals should be designed so as to maintain the flow velocity more than 0.6 m/sec for preventing the breeding of parasites causing water-borne 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. Turnouts and checks provided on irrigation canals will be equipped with stoplog guides only since steel gates are easily ruined and have actually deteriorated in the most of the schemes. Livestock water basin and washing steps should be provided at required and convenient points.

(3) Operation and maintenance concept

From the irrigation operation point of view, 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 an intake, checks, and off-takes. 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

From the point of beneficiaries participatory approach, small facilities such as field ditches diverted from turnouts provided on major canals are expected to be constructed by beneficiaries 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 Mwege scheme is being formulated.

3.4.2 Canal System Layout

The proposed canal system layout is shown in Figure 3.4.1. The Mwege river was carefully inspected in order to find a suitable site for diversion of the river water. The inspection indicates that the Mwege river is not so suitable for the site of the intake structure of Mwege scheme in whole reaches from Nyinga to Malolo areas such that one of reaches is shallow and has insufficient flood carrying capacity, and the other is deep with very fragile river banks. Throughout the inspection of the Mwege river, it is concluded that a point of about 500 m upstream of the existing upper Nyinga intake is suitable as a intake structure site. At the proposed intake site, the Mwege river runs nearly straight. The bottom width is about 7 m and the depth is 1.7 m from both banks, which increases in their elevation when getting apart from the river side. The river banks consist of sandy soils having a permeability rate of 10^{-4} cm/sec order. Outcrop of rock can be seen at the foot of the hill on the left bank about 15 m apart from the river edge. Boring investigation found rock formation at about 4 m below the river bed in the left side and 5.5 m in the right side.

A main canal is proposed to be provided for conveying irrigation water for all the irrigation area of 580 ha in net. It will run from the intake site along Mwege river on the left bank side. It will firstly feed to the existing Nyinga upper canal and run almost parallel to it. At about 1.2 km point from the intake, it will diverge Secondary canal -1, which conveys water to the left bank area of the Mwege river across it. Its irrigation area is 57 ha. Then the main canal will feed to the existing lower Nyinga canal and run in parallel to it. At about 4 km point from the intake, Secondary canal -2 will branch off from the main

canal for conveying water to the left bank side across the Mweha river. The Secondary canal -2 will serve 95 ha consisting of Mgogozu Mweha area of 48 ha and existing canal -D area of 47 ha. Further the main canal will run on the left side and join to the irrigation canal -A. The Irrigation canal -A will be completely improved as a part of the main canal. From the improved irrigation canal -A, branch canals so-called connecting canals will be provided at an interval of about 1.5 km to the existing irrigation canal -B. Total canal length is as follow:

Main canal	13.4 km
Secondary canal-1	1.6 km
Secondary canal-2	4.6 km
Connecting canals	0.8 km
<u>Total</u>	<u>20.5 km</u>

As for the mitigation of flood or flood protection, the Mweha river is proposed to be enlarged in its river cross section in the reaches about 1.9 km long from 400 m downstream to 1.5 km upstream of the current lower Nyinga intake where the carrying capacity is very small as explained in Chapter 1. Also all the existing intakes including the intake A and B weirs should be removed so that the river bed can be lowered.

A drainage canal will be provided along the upstream side of the existing Malolo-Chabi road to drainage flooding water to Mweha river. The Malolo-Chabi road is proposed to be improved in the section where the road crosses the Malolo basin and Mweha river.

3.4.3 Irrigation Water Requirement

(1) General

Irrigation water requirement is estimated by using daily rainfall data and climatological data in accordance with the proposed cropping pattern consisting of double cropping of paddy in two-third of the irrigation area and paddy and upland cropping pattern in the remaining one-third.

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

Climatological data are not available in Mweha scheme area except rainfall data. Meteorological stations located near Mweha area are four stations; Iringa, Dodoma, Mp-

wapwa, and Ironga. Mwega area lies on the altitude of around 600 m, while Ironga, Dodoma, and Mpwapwa are located more than 1,000 m above sea level. Ironga station is only nearly located almost similar altitude as Mwega area. The annual rainfall pattern is almost the same as Mwega area and the annual rainfall is 780 mm against 360 mm in Mwega area. Thus the climatological data of Ironga station is employed for estimating potential evapotranspiration in Mwega area. The following table shows the estimated potential evaporation.

Potential Evapotranspiration estimated by modified Penman Method

(Unit: mm/day)											
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
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

(3) Percolation loss

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

Results of Field Intake Rate Tests

Location	Basic W.Level Reducing Rate (mm/hr)	Evaporation Rate (mm/hr)	Percolation Rate	
			(mm/hr)	(mm/day)
<u>Ponding Test</u>				
before puddling				
Malolo 02-01 (middle point)	0.0	0.3	0.0	0.0
Malolo 02-02 (middle point)	0.5	0.3	0.2	5.0
<u>Cylinder Intake Rate Test</u>				
Malolo 02-02 (middle point)	2.0	0.3	1.7	41.0

The testing point of Malolo 02-01 is located in the paddy field of which groundwater table is nearly equal to the ground surface and no percolation was observed. The testing point of Malolo 02-01 is also a paddy field having a high groundwater table. From these results of percolation tests and the fact that many of the paddy fields are located in the low-lying lands just at the foot of hills or the swampy area in the central part of Malolo area where are formed with clayey soil and water is often stagnant with high groundwater table, the percolation rate especially after puddling is estimated to be negligibly small. With project condition, these physical situations are not so changed in such swampy area. However some of paddy planted areas are expected to have more percolation than observed. Considering such things into account as well as testing results, here in order to estimate the irrigation water requirements, percolation rate is assumed to be 15 mm/day before puddling and 5 mm/day after puddling.

(4) Puddling water requirement

Land preparation and puddling works are scheduled to be carried out in two-month period from the middle of December to the middle of February 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 at the 02-02 point, initial water soaking into soil is only about 15 mm. Such small amount is derived from very wet condition of clayey soil with high groundwater table. In the transplanting season, which is scheduled in mid-rainy season, the soil is expected to be wet the same as the test time with high groundwater table. Considering the results of ponding test and the seasonal soil moisture condition, thus 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 4.7 mm to 5.0 mm/day in December to February. Thus evaporation loss for the 10-day period is estimated about 50 mm. Under such conditions and assumptions, the puddling water requirement for 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 15 mm/day before puddling =	75 mm
5 mm/day after puddling =	25 mm
<u>Total</u>	<u>200 mm</u>

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

(4) Water requirement for land preparation prior to upland crop planting

No water application is considered for land preparation of upland crop cultivation, since the loam dominates in upland crop area is not so hard even under the dry condition and the clayey soil in the paddy cultivation area is also not so hard with moderate moisture content in upland crop planting season.

(5) 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	Nursery	1.1	1.1										
	Main field	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.2	1.0			
Upland Crops													
Maize (wet season)		0.5	0.5	0.7	0.8	0.9	1.0	1.1	1.1	1.0	0.9	0.8	0.6
Onion	Nursery	0.6	0.6	0.6	0.6								
	Main field	0.6	0.7	0.8	0.9	1.0	1.1	1.0	0.9	0.8			
Beans (dry season)		0.6	0.6	0.7	0.8	0.9	1.0	1.1	1.0	0.7	0.3		

One growing stage = 10 days

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

(6) Effective rainfall and net irrigation water requirement

In order to estimate effective rainfall to be utilized for crop growing, daily rainfall data for 11 years from 1978 to 1991 except a few years of Malolo rainfall gauge, of which code is 963606, located in Mwega area 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 45 mm supposing that the minimum water content nearly equals to the wilting point, which is generally about 90 mm/m in medium textured 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 210 mm/m considering that medium to coarse textured soil is dominant in the upland crop area. Root zone is 50 cm. Thus the upper limit in upland crop area is 105 mm. Available moisture contents is then 60 mm. Water extraction pattern is different in root zone. Generally, upper layer is bigger than lower one in water extraction by plant. Thus upper layer reaches to the wilting point faster than lower one. Considering the different water extraction pattern, it is assumed that irrigation water is applied at 70 % of total available moisture; 42 mm is extracted from the root zone.

The relation between rainfall and effective rainfall on 10 day basis are presented by the following equations obtained by least square method from the effective rainfall calculation results.

(a) Paddy

$$\begin{array}{ll} R < 5 \text{ mm} & ER = 0 \\ 5 < R < 120 \text{ mm} & ER = 0.9 R \\ R > 120 \text{ mm} & ER = 91 \text{ mm} \end{array}$$

(b) Upland crop

$$\begin{array}{l} ER = 0.9 R \\ ER : \text{effective rainfall (mm)} \\ R : \text{rainfall (mm)} \end{array}$$

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

(7) 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 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.

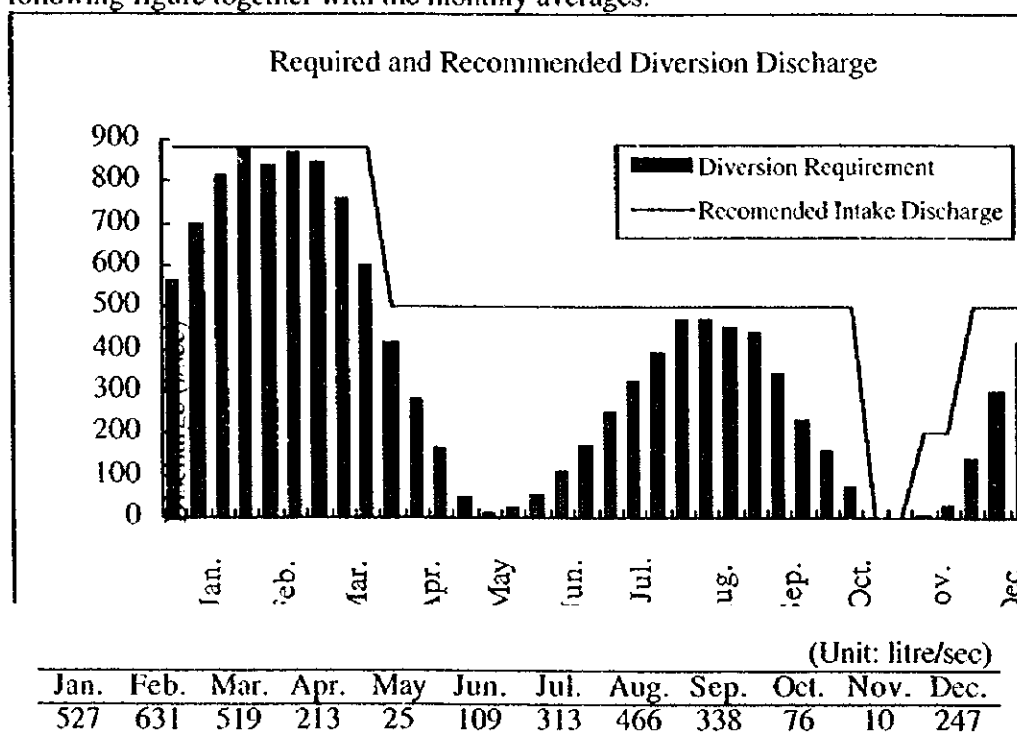
The conveyance efficiency (E_c) is assumed to be 0.85 under the conditions of continuous supply with no substantial change in flow with canal lining in most of reaches. Field canal efficiency (E_b) is assumed to be 0.85 in consideration that field canals are earthen-made and short in length. The field application efficiency (E_a), 0.7 is taken for upland crop irrigation and 0.8 for paddy irrigation.

The irrigation efficiency (E_i) is concluded as follows:

$$E_i = E_c E_b E_a = \begin{matrix} 0.51 & \text{for upland crops} \\ 0.58 & \text{for paddy} \end{matrix}$$

(8) 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 the following figure together with the monthly averages.



The project has two peak seasons in irrigation water requirement; 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 the peak growing season for upland crops.

Peak irrigation water requirements are estimated at 2.16 l/s/ha for paddy and 1.06 l/s/ha for upland crop at the project level. Peak diversion requirement is estimated at 880 litre/sec (1.52 litre/s/ha) at the headworks. No irrigation water requirement in late October to early November.

(9) Design canal discharge

Conveyance system consisting of a main canal, two secondary canals and four connecting canals with the existing irrigation canal B is to supply water on 24-hour basis. Thus, the design discharges of the conveyance system are a product of irrigation area and the peak irrigation water requirement. The peak irrigation water requirements are estimated at 1.52 l/s/ha at the head of the Main canal in accordance with the proposed cropping pattern and 1.74 l/s/ha at the secondary canals of which commanding area is planted with paddy and upland crops in the ratio of 6 : 4. After diversion of the connecting canal -2, the main canal commands only upland crop area in which the peak irrigation water requirement is only 1.06 l/s/ha. Design discharge is shown in Figure 3.4.2.

Field channels diverted from the conveyance system through turnouts command a few hectares to 15 ha except a few bigger channels. Design discharge of these small field channels should be 30 l/sec.

3.4.4 Drainage Requirement and Flood Discharge

Drainage in the project area is not so important as irrigation in Mweha Scheme except for water stagnant areas, since rainfall is as small as 360 mm/year.

However as the proposed main and secondary canals are aligned to cross several seasonal streams as shown in Figure 3.4.3, it is very important for the design of crossing structures to know the storm discharge of such seasonal streams as well as flood on the Mweha river for the design of the proposed headworks.

- Flood discharge of the Mweha river

The Mweha river habitually overflows its banks in upper and middle Nyinga and the upper Malolo. Consequently, these areas suffer from flooding especially during big floods. It is therefore very important to take flood mitigation or protection measures against the flooding from the Mweha river. The flood discharge was estimated at:

Nyinga (m ³ /sec)	Malolo (m ³ /sec)	
99	117	at 50 year return period
67	80	at 20 year return period
48	56	at 10 year return period
31	37	at 5 year return period
14	17	at 2 year return period

- Flood discharge from mountainous area

The peak flood discharge flowing from the mountainous area is estimated at 20 year probability by the following rational formula.

$$Q_p = f r A / 3.6$$

where, Q_p : peak flood discharge (m³/sec)
 f : runoff coefficient, 0.5 is adopted.
 r : rainfall intensity over a period equal to the time of concentration (mm/hr)
 A : catchment area (km²)

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

$$t = C A^{0.22} r_e^{-0.35}$$

$$r = (R_{24} / 24) (24 / t)^{2/3}$$

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 (km²)
 r_e : effective rainfall intensity during the time of concentration (mm/hr)
 R_{24} : daily rainfall (mm)

According to the Master Plan Report, probability daily rainfall estimated from Malolo rainfall station as follows:

Return Period	Probability Rainfall (mm/day)
5	51
10	58
20	64

Calculation results are as follows:

**Peak Flood Discharge of Small Streams across
Proposed Main and Secondary Canals**

Basin No.	Catchment Area (km ²)	Peak Flood Discharge at 20 year probability (m ³ /sec)
1-1	1.2	1.6
1-2	1.2	1.6
1-3	0.6	0.9
1-4	0.2	0.4
1-5	2.0	2.4
1-6	0.5	0.8
1-7	0.5	0.8
1-8	1.8	2.2
1-9	1.1	1.5
1-10	0.3	0.5
1-11	0.9	1.2
1-12	1.0	1.3
1-13	1.0	1.3
Total	12.3	
2	56.5	36.0
3-1	3.7	4.0
3-2	3.9	4.2
3-3	1.8	2.2
3-4	5.5	5.5
3-5	2.3	2.7
3-6	3.4	3.8
Total	20.6	
4-1	0.6	0.9
4-2	0.4	0.7
4-3	0.5	0.8
4-4	2.7	3.1
4-5	0.9	1.2
4-6	0.4	0.7
4-7	0.5	0.8
Total	6.0	
5-1	0.3	0.5
5-2	0.9	1.2
5-3	3.0	3.4
5-4	1.2	1.6
5-5	1.7	2.1
Total	7.1	

3.4.5 Engineering Design

The project works consist of the construction of the conveyance system including the unified Mwega headworks, the Main canal, the Secondary canal -1 and -2, and the connection canals and the improvement of the Malolo-Chabi road about 1km and the improvement of the Access road from the highway A-7.

(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:

Canal Type	Inside slope	Outside slope
Concrete lining canal	1 : 1	1 : 1.5
Earth canal		
$H \leq 0.5$ m	1 : 1	1 : 1
$0.5 \text{ m} < H < 1.5$ m	1 : 1.5	1 : 1.5
$1.5 \text{ m} \leq H$	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 allowable maximum velocity for protecting the canal wetted perimeter against soil erosion by water flowing is 0.9 m/sec in clayey soil. Thus, in case of an earthen irrigation canal, the design permissible canal velocity is set at 0.9 m/sec. 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 : $Fb = 0.07 \times h + hv + 0.15$

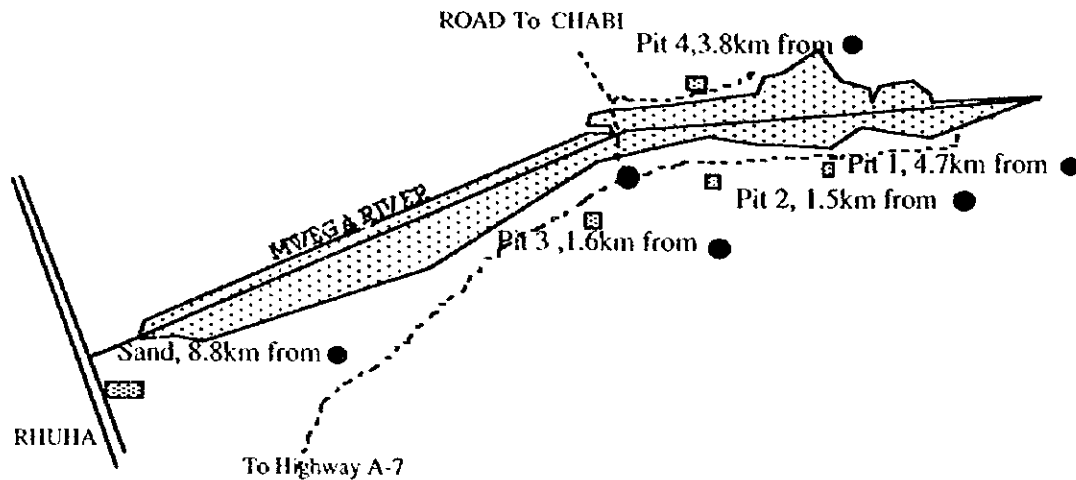
In addition to the freeboard, lining canals are given the height of 0.1 m in the canal bank above the top of the lining.

(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 Mwega 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.

Location of Sampling Points of Earth Materials



Suitability of Earth Materials

Location	Classification by Unified Soil Classification System and Evaluation			
		Class	Suitability for canal embankment	earth lining
Pit.1	Sample No. 1	SM or SC	suitable	marginally suitable
	Sample No. 2	SW or SP	marginally suitable	not suitable
Pit.2	Sample No. 1	CL	marginally suitable	marginally suitable
	Sample No. 2	SC	suitable	suitable
Pit.3	Sample No. 1	SC	suitable	suitable
	Sample No. 2	SC	suitable	suitable
	Sample No. 3	SC	suitable	suitable
Pit.4	Sample No. 1	SC	suitable	suitable
	Sample No. 2	GC	most suitable	most suitable
	Sample No. 3	SC	suitable	suitable

Earth materials of the borrow pits identified around the scheme area are mostly suitable for canal embankment and earth lining. The earth materials are easily obtained within 5 km range.

As for stone or outcrops of rock, which is a raw material of stone are identified around the Mwega scheme. The hardness of rock seems to be high, ranging the estimated abrasion ratio in 20 to 30 % and its required volume is enough to produce stones and coarse aggregates. Also, a commercial 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 is producing fine and coarse aggregates and various sized stones, and shipping them to Dar es Salaam and other areas. Coarse aggregate for concrete works will be obtained from this quarry.

(3) Design

(a) Mwega headworks

The Mwega headworks consists of an overflow weir, a sand flushing sluice equipped with a gate, an intake equipped with a gate, and a sand trap pond with gravitational sand flush device furnished with a gate. The overflow weir will directly contact with foundation rock located about 4 m below the current river bed in the left side and about 5.5 m below in the right side. The intake is designed so as to cope with a 50 year probability flood. The freeboard of the banks and walls is taken 90 cm above the flood water level. Figure 3.4.4 shows the general feature of the Mwega headworks.

(b) Irrigation canals

The main canal, secondary canals and connecting canal-1 are proposed to be lined with concrete.

Salient Features of Irrigation Canals

	L (km)	Q (m ³ /sec)	B (m)	H (m)	i (1/x)	V (m/sec)	Remark
<u>Main canal</u>							
Reaches-1	1.20	0.88	0.8	1.0	700	1.17	
Reaches-2	2.70	0.78	0.8	0.9	700	1.13	
Reaches-3	4.50	0.57	0.6	0.9	650	1.08	
Reaches-4	1.60	0.24	0.5	0.7	600	0.90	
Reaches-5	1.70	0.16	0.4	0.6	600	0.81	
Reaches-6	1.70	0.09	0.3	0.6	800	0.64	
<u>Secondary canal-1</u>							
Whole Reaches	1.60	0.10	0.3	0.6	600	0.72	
<u>Secondary canal-2</u>							
Reaches-1	0.80	0.17	0.4	0.6	600	0.82	
Reaches-2	0.30	0.17	0.6	0.5	85	1.65	Flume type
Reaches-3	0.10	0.17	0.4	0.6	600	0.82	
Reaches-4	0.50	0.12	0.4	0.6	1200	0.58	
Reaches-5	3.00	0.12	0.4	0.6	600	0.75	
<u>Connection canal-1</u>							
	0.18	0.15	0.6	0.5	40	2.00	Flume type
<u>Connection canal-2</u>							
	0.19	0.08	0.5	0.5	35	1.80	Flume type
<u>Connection canal-3</u>							
	0.24	0.03	0.4	0.4	30	1.50	Flume type
<u>Connection canal-4</u>							
	0.22	0.04	0.4	0.4	25	1.70	Flume type

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

(c) Irrigation canal-related structures

On the main and secondary canals, turnouts and checks or drops having a function of check are provided at 0.5 km to 1.0 km interval. Also culverts are often planned just after the drop structures for tractor crossing the major canals. At crossing points of these canals with natural streams coming from the hilly side, drain culverts are planned across these irrigation canals, or siphons are planned across the natural streams. At crossing points of the secondary canal -1 and -2 with Mwega river, aqueduct structures are provided. These aqueducts will be of concrete flume type supported by concrete-made piers and abutments. The foundation of the abutments and piers are rock is found a few meters below the ground surface. The aqueducts will be covered with wooden plates so as to function as a footpath as requested by farmers. Side channel spillway are provided at every points where the canal design discharge is drastically changed. Livestock water basins and washing steps are also planned to be provided at the convenient points.

Major structures to be provided on the irrigation canal system are listed as follows:

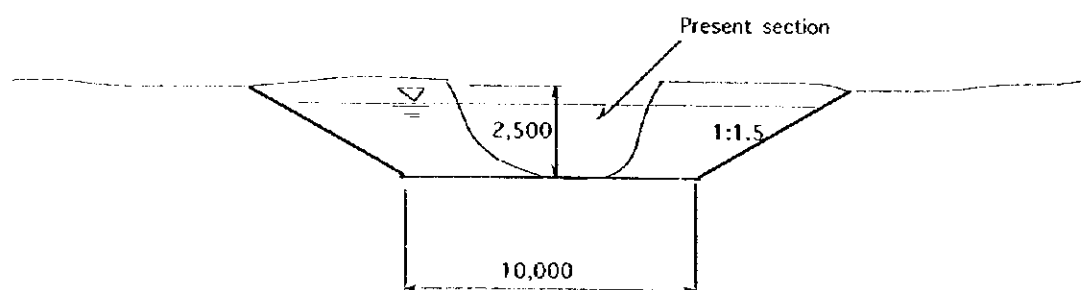
Number of Major Structures provided on Canals

Structure	Main canal	SC-1	SC-2	CC	Total
Turnout	33	6	9	-	48
Check	11	-	2	-	13
Drop	31	6	12	-	49
Culvert	21	1	4	-	26
Cross drain	10	4	4	-	18
Siphon	17	-	2	-	19
Aqueduct	-	1	2	-	3
Spillway	4	-	-	-	4

(d) River improvement

The Mwega river is proposed to be enlarged to 10 m wide and 2.5 m deep so as to convey flood flow of 10 year probability in the reaches about 1.9 km long from a 400 m downstream point to a 1.5 km upstream point from the current lower Nyinga intake. About 300 m reaches within the above reaches in and around the lower Nyinga intake are deepened by about 1 m by excavation of rock which exposes the river bed.

Typical Cross Section of River Enlargement

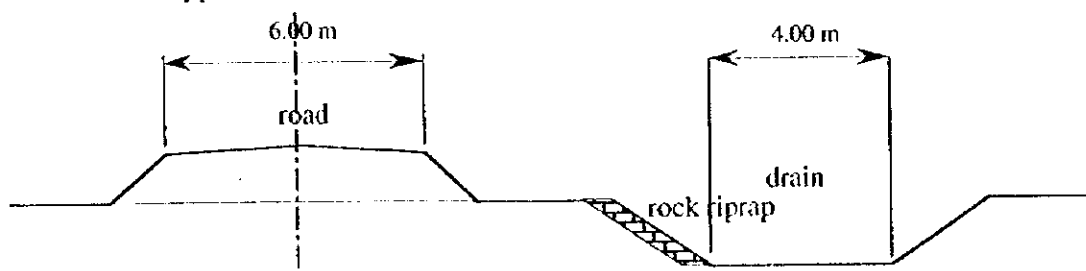


All the existing intakes on the Mwega river including the intake A and B weirs will be removed and the inlet portion will be completely closed.

(c) Improvement of Malolo-Chabi road and the side drain

The Malolo-Chabi road is proposed to be improved with earth embankment in the section of 1 km long where the road crosses the Mwegea river basin. The road is of earthen type having a width of 6 m and accompanied with a side drain as shown in the following figure. The drain functions to protect the road against flood as well as drainage of excess water from the adjacent field to the Mwegea river. The depth of the drain is around 1 m from the ground surface and the bottom width is 4 m. The road side slope of the drain is proposed to be protected by rock rip rap or gabion. The drain is 1 / 450 in the longitudinal slope and the flow velocity is 1.2 m/sec, when the flow discharge is 6.0 m³/sec.

Typical Cross Section of Malolo-Chabi Road and Side Drain



An existing ruined bridge provided across the Mwegea river on the road will be replaced with a new bridge. The new bridge will be of concrete-made T-shape beam type supported by abutments. The width is 4.0 m. The net span is 12.0 m. The abutments will be directly built on rock foundation, which is found about 1 to 3 m below the river bed level.

(f) Improvement of access road from highway A-7

The access road from the highway A7 will be improved at the crossing points of seasonal streams with submersible concrete slab. The number of the improvement points is five.

3.4.6 Operation and Maintenance

(I) 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 Diversion Discharge (m ³ /sec)
Puddling and transplanting stage	Jan. to mid March	0.88
After puddling and transplanting	Late March to Oct.	0.50
Maintenance period	November	Intake gate is closed.
Former stage of puddl. and transplanting	December	0.50

During each period of the above stages, river water is constantly diverted through the intake. Excess water in the Main canal is drained through spillways.

From the main and secondary canals to tertiary canals, water will be diverted continuously without rotation in principle, but in case that the tertiary block is small, rotational irrigation water diversion will be carried out among small tertiary blocks and water is diverted alternatively from the parent canal. 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 all the 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 the period of puddling and transplanting stage, in which the tertiary canals continuously distribute water to field ditches in principle.

- Paddy

Irrigation water supply method should be changed by the situation of water availability and the irrigation water demands. Rotational irrigation water supply should be applied during the puddling and transplanting period. 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. However, 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 periodically lubricate the spindles of all the steel gates provided on the Mwega headworks and to paint these gates' frame and leaves.
- To periodically remove floating debris from the front of the inlet of the Mwega headworks and the front of inlets of culvert, checks, and siphons.
- To weed 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 to 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 continuous 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. To-

gether 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

At present, there are 8 WUGs in Mweha scheme, and all existing irrigation systems have been operated separately by these WUGs. After the Project, all these irrigation areas are joined by a new intake weir. Considering the smooth and effective O&M of the facilities, it is proposed that a new WUG which covers all irrigation areas will be established in the scheme. Then, the existing WUGs will be re-organized into sub-groups under the new WUG. Although their knowledge and experience will be handed over to the new WUG, any their vested rights will be rejected from the O&M by new WUG.

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.

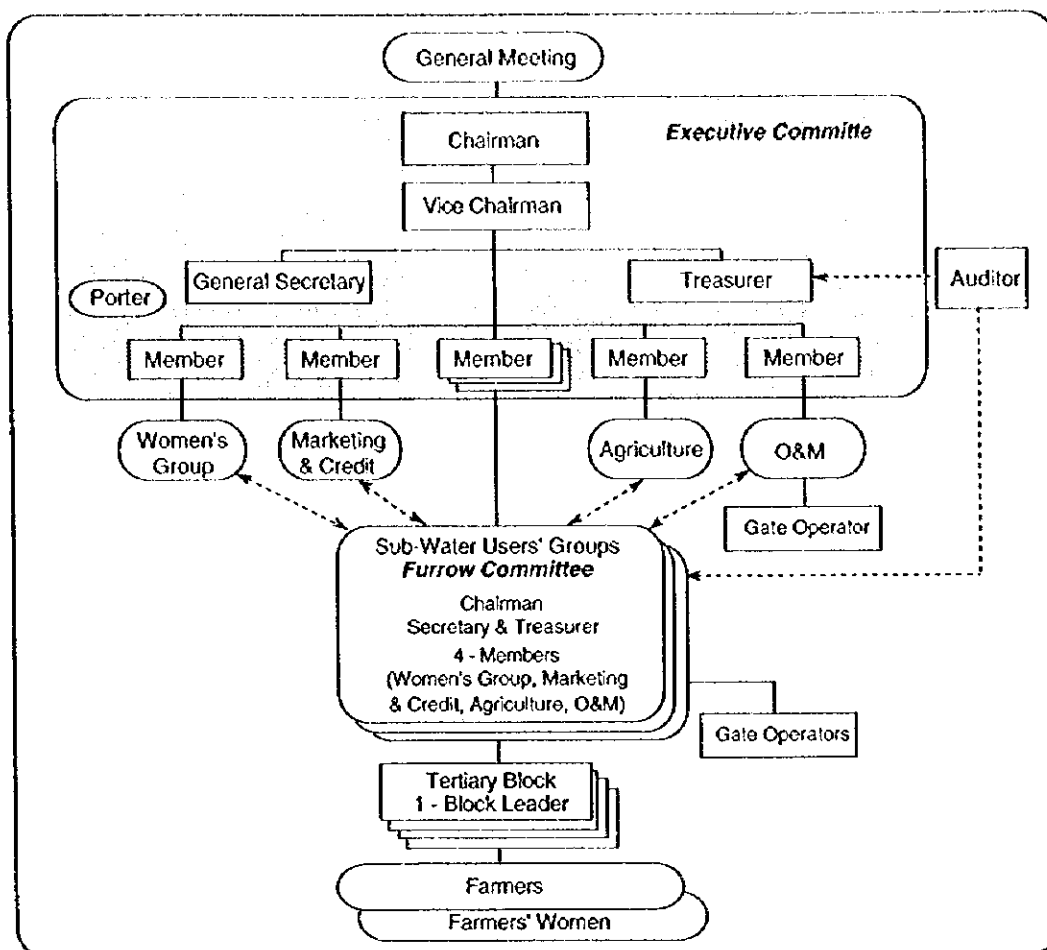
In the project areas, it is proposed to take (b), taking the following reasons into consideration. The activities of WUG and agricultural cooperative should be linked closely. The farmers will cultivate crops according to an irrigation schedule decided by WUG, then supporting services such as credits 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

In the Mweha scheme, all existing irrigation systems will be covered by one intake weir to be constructed newly by the project. It is therefore recommended that all existing WUGs organized in these systems should be integrated into one WUG, taking into consideration smooth operation and management of irrigation facilities.

The proposed organizational structure of integrated 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 VEOs and officers in the DALDO's office,
- 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 co-operative 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

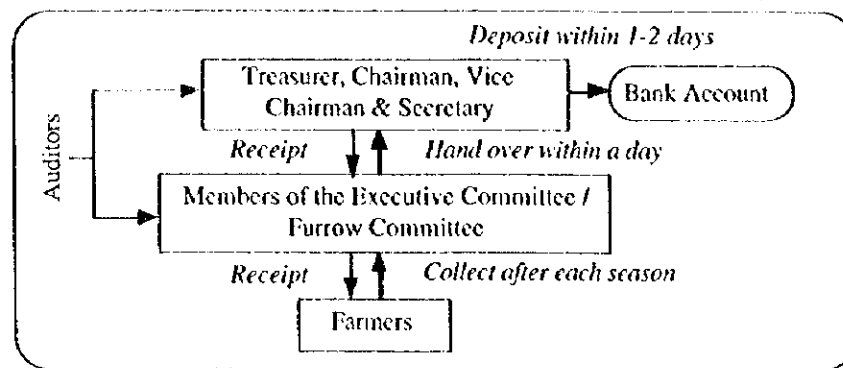
All O&M costs of irrigation facilities are covered by the irrigation service charges (ISC) collected from the farmers. The amount of ISC is estimated by each WUG, and includes the following items. In order to minimize the labour cost, it is proposed that maintenance works should be carried by the farmers' 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." At the public meeting held on July 1997, about 30% of farmers disagreed on its cash payment. However, payment in kind is laborious for handling of products collected from the farmers, and will have storage and quality losses. From the stand point of easy collection and management, cash payment is proposed to WUG

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 assess 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's 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 irrigation services from WUG, and the beneficiaries have the duty to pay its ISC to

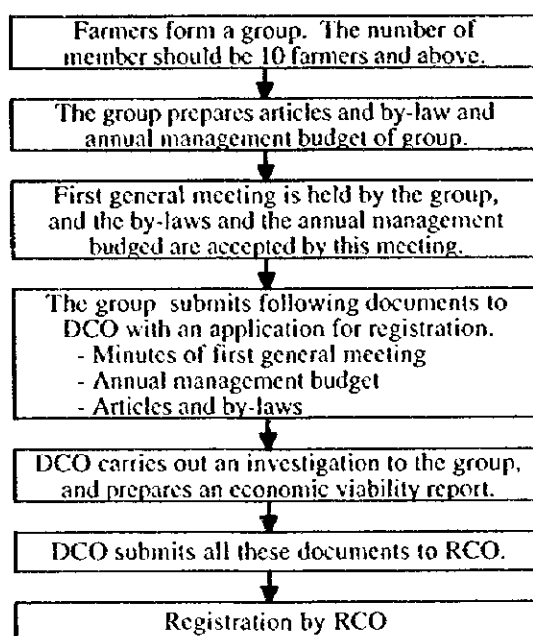
WUG.

- (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. For the registration of water right, there is no competition with others, and no water right is registered to the Mwega river at present. The Regional Water Engineer has handled the registration of the water right. The DALDO's office provides necessary guidance and supporting services to WUGs 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.

VEOs and Irrigation Technician 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.

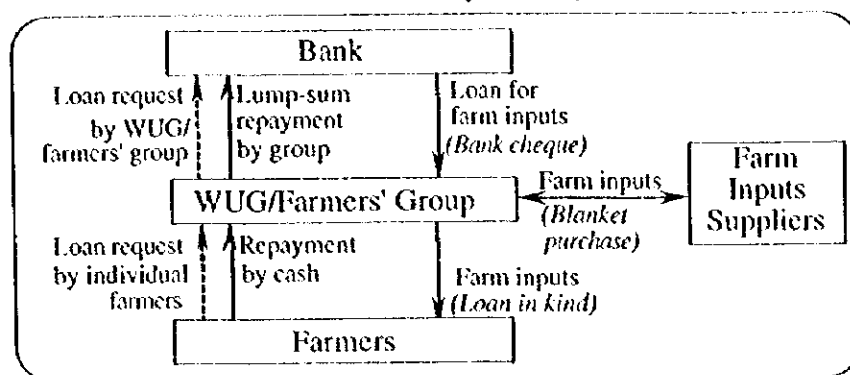
1) Group Loan System Administered by the Water Users' Group

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.

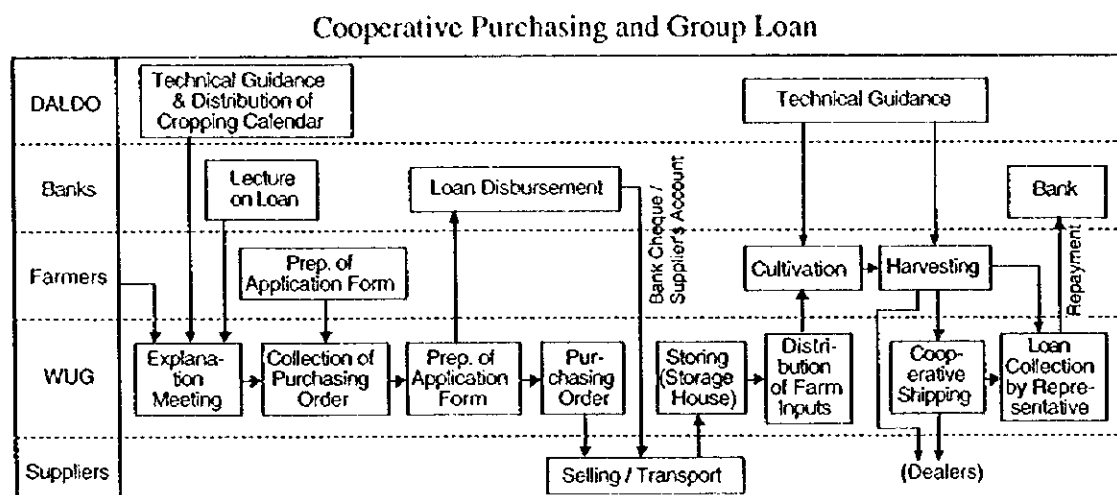
At present, the CRDB has stopped implementing a credit system with similar char-

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.



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.

- (c) After receiving the inputs, the WUG should distribute immediately them to the farmers.
- (d) 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 (200 m²), a storage house for fertilizers (330 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 poultry, sheep, goats, etc. by the women's groups.

The WUGs should play an important role in promoting these activities, and the DALDO's offices 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 in the scheme should be strengthened through forced training program. In addition, officers and front line staff related to the scheme should also be trained and enough skilled on O&M activities, through provision of intensive training program. They

still have not enough experience and knowledge on the O&M of irrigation systems.

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 offices are 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 and subgroup, gate operators, etc. The courses-D is conducted only to the people in the villages related to the scheme. 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 VEOs and Irrigation Technician: Before the implementation of the project, VEOs and Irrigation Technicians 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 implements occasionally follow-up training to WUGs according to the necessity for improvement of their management. The DALDO's office always monitor all WUG's activities through VEOs 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, coarse texture, and then, high erodebility.

(c) 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 pro-

moted 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 will be managed by VEO of Malolo village under overall support of District Agriculture and Livestock 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 Development 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 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 Mwega 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-borne 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-borne 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-borne diseases

The following practices are generally accepted as the most practical approach to eliminate and/or mitigate an influence of water-borne diseases in Mwega 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. emponding 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 BIA. This plan proposes for Direct Negative Impacts which have the baseline data.

(1) Influence of water-borne 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	Organochlorines e.g. HCH, DDT Dieldrin and heptachlor Organophosphorus (e.g. malathion) carbamates dithiocarbamates synthetic pyrethroids	Gas-liquid chromatography
Soil	NH ₄ -N, Copper (Cu), Sodium (Na), Calcium (Ca)	Kjeldahl method Sodium diethyl dithiocarbamate method, Atomic absorption spectroscopy
Fish	Organochlorines e.g. HCH, DDT Dieldrin and heptachlor Organophosphorus (e.g. malathion) carbamates dithiocarbamates synthetic pyrethroids	Chromatographic techniques e.g. Gas-liquid chromatography Thermal detectors Flame photometric detectors Spectrophotometric method
Vegetable	NH ₄ -N Organochlorines e.g. HCH, DDT Dieldrin and heptachlor Organophosphorus (e.g. malathion) carbamates dithiocarbamates synthetic pyrethroids	Kjeldahl method Kjeldahl method
Soil over-richness	SA CAN NPK UREA (NH ₄ -N) NH ₄ NO ₃	Kjeldahl method Kjeldahl method followed by either a flame or atomic absorption method Kjeldahl method Kjeldahl method Steam distillation method

CHAPTER IV. IMPLEMENTATION PLAN AND COST ESTIMATE

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 Mwega headworks, the main canal, the secondary canals, and the connection canals with their related structures should be carried out by a qualified civil work contractor. Other small facilities such as canals connecting existing canals to the main and secondary canals and field ditches 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 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 irrigated 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 a certain period 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 is shown in Figure 4.1.1. It includes the preparatory works, the construction works, and guidance works for establishing and managing water users association and for water management.

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 Malolo 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	1.0
30 - 50	1.5
more than 50	2.0

The workable day is estimated at 333 days/year and if Sunday is deducted, it is 285

days / year.

(2) Construction plan and method

(a) Mwega headworks

A temporary diversion channel and coffer dikes will be provided. The diversion channel will run the right side of the construction site so as to detour the proposed weir site. The channel length is 140 m and the bottom width will be 5 m. The coffer dikes will be provided at both upstream and downstream of the weir site. The crest elevation of the upstream and downstream coffer dikes will be 613.7 m and 613.0 m, respectively. Immediate after the coffering, the weir site will be completely excavated up to the foundation rock surface and then lean concrete will be placed up to El. 607.0 m. Then weir body and the walls of the weir will be constructed. Immediate after the completion of the left side wall of the weir with back-filling with earth, the construction of the intake structure is commenced. Also after completion of the weir, the downstream river protection works are executed. After all the works are completed in the weir portion including the installation of the intake gate and sand-scouring sluice gate, coffer dikes will be removed and the diversion channel will be buried with earth materials.

(b) Canals and related structures

Canal embankment materials will be transported from any pits identified around the project area. 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 bull-dozer, 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 mor-tar 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 = \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 communication 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 to 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 4.1.1 to 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	428.6
Irrigation system	1,261.30
Road and drainage	167.5
River improvement	185.2
Other works	178.1
Total	2,220.70

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 Tsh. 48.7 million as given below.

O & M facility and equipment cost	
	(Tsh. million)
Construction of WUG office	43.9
Purchase of Office equipment	2.2
Purchase of O & M Tools	0.1
Communication motor bike	2.5

The administration cost is estimated to Tsh. 11.2 million as given below.

Administration cost	
	(Tsh. million)
Allowance of officers	6.3
Transportation	4.9
Total	11.2

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 Mwega scheme is allocated in accordance with the irrigation area in Mwega 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)	1,227.3
Total area of all four schemes	(ha)	1,379
Irrigation area of Mwega scheme	(ha)	580
Engineering services cost of Mwega scheme	(Tsh. million)	516.2

(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	865.8	1,354.9	2,220.7
Preparatory works cost	43.3	67.7	111.0
O&M facility and equipment cost	0	48.7	48.7
Administration cost	0	11.2	11.2
Engineering services cost	516.2	0	516.2
Sub-total	1,425.2	1,482.5	2,907.7
Physical contingency	86.6	135.5	222.1
Sub-total	1,511.8	1,618.0	3,129.8
Price contingency	98.1	718.6	816.7
Total	1,609.9	2,336.6	3,946.5

(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	4th Year
281.8	2,349.8	1,303.3	11.6

(7) O&M costs

The annual O & M cost after the construction works is estimated to Tsh. 11.1 mil-

lion 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

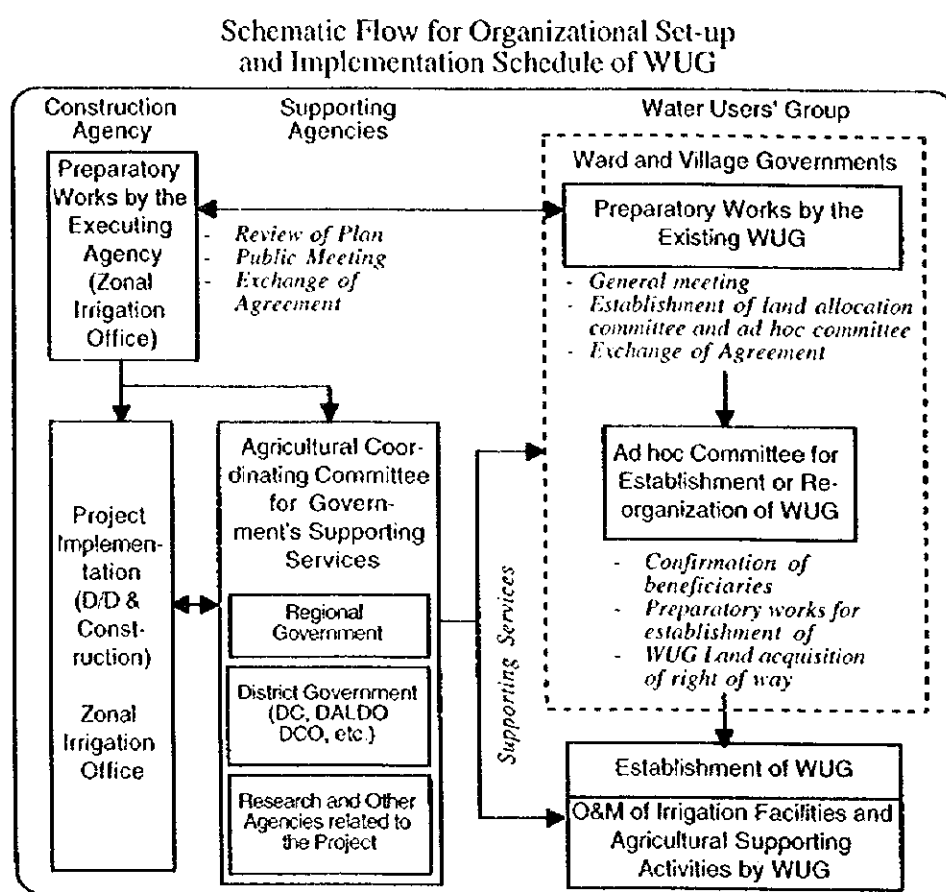
development plan and farmers' participation to the project implementation.

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.



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 Malolo and Mgogozi 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 which are implemented by the farmers themselves.

After the public meeting, the general meeting for the project implementation should be held by three village governments. All of the farmers and members of existing WUGs should attend this general meeting, and the Ward government should coordinate these two villages. Then, the plan has to be acknowledged by the farmers with a full appreciation of its contents. The Zonal Irrigation Office and two village governments have to exchange an agreement document for the plan after the general meeting. The Ward government countersigns to this document. 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 Ward and village governments will make necessary arrangements for supplying laborers and local materials. In parallel with these project implementation, WUG should be established and strengthened in accordance with the proposed plan. The village governments should take the initiative in implementing these activities, and organize an ad hoc committee for establishment of WUG. This committee consists of leaders of the Ward government, two village governments, and existing WUGs, and has the following activities. The District Commissioner provides necessary support to the ad hoc committee, especially for the land acquisition of the right of way.

Ad hoc Committee of WUG

- a) Confirmation of beneficiaries
- b) Land acquisition of right of way
- c) Management of farmers' participation to construction works
- d) 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 a new WUG, and it should be organized 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. Their by-laws are also cancelate.

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 WUG. 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

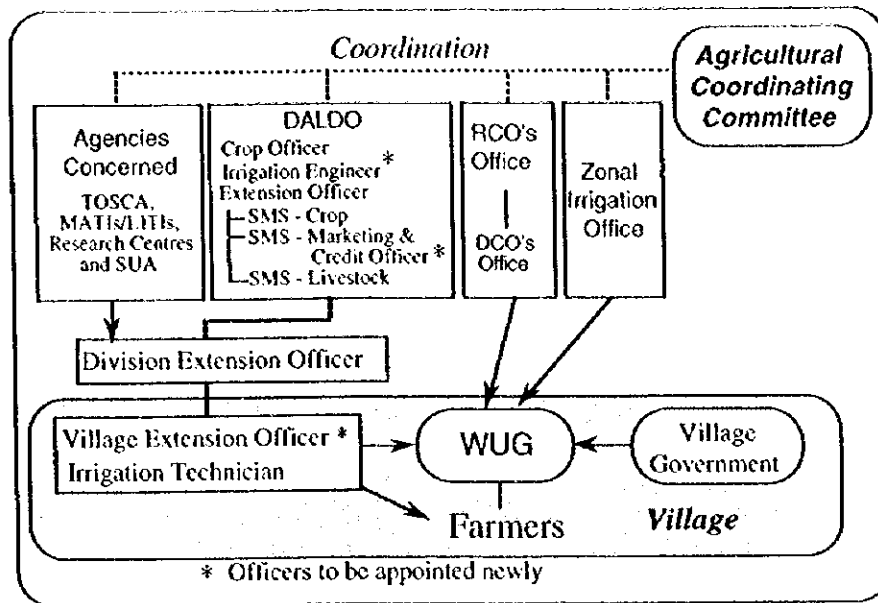
The schedule on the monthly-based training programme through and after the project implementation will be illustrated in Figure 4.2.4. The agricultural extension activities of DALDO's office are implemented under the powerful support from the agencies concerned which are TOSCA, MATIs/LITIs, Research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

mentation 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 services 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 field 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		
<u>Morogoro Zonal Irrigation Office</u>							
Economic & Social Survey Section							
Agro Economist/Sociologist	-		1			1	
<u>Office of RALDO</u>							
Project Coordinator	-		1			1	
<u>Office of DALDO, Kilosa</u>							
Irrigation Engineer	-		1			1	
Marketing and Credit Officer	-		1			1	
Village Extension Officer and Irrigation Technician							
(Project Site)	VEO	IT	VEO	IT	VEO	IT	
- Nyinga *1	-	-	- *2	-	- *2	-	
- Malolo	1	-	1	-	-	-	
- Mgogozo	-	1	1	1 *3	1	-	

*1 Sub-village of Malolo.
*2 Covered by Malolo staff.
*3 Covers whole system.

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

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.475 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 economic 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.475 million, and the O&M cost is Tsh.0.24 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 Mwega scheme. The EIRR is 16.8%. 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 Mwega 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	14.7	15.3	13.3

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.448 million. Table 5.1.11 shows the calculation of the net benefits.

(2) Financial Costs

The financial development costs are Tsh.2,784 million. The O&M cost is Tsh.11.10 million per year. Table 5.1.12 shows the calculation of the financial costs.

(3) Calculation of Financial IRR

The FIRR for Mwega scheme is 13.0%. Table 5.1.13 shows the calculation of the FIRR.

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.)

	Mwega	
	Maloto	Mgogozi
a) Holding Size	0.8	0.7
b) Gross Income	1,267	1,260
c) Production Cost	331	320
d) Net Farm Income	936	940
e) Income Tax	12	12
f) O&M Cost	6	6
g) Amortization Cost	222	121
h) Net Profit	696	801
In case: if d-(c+f)	581	596
In case: if d-(c+f+g)	377	493

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 Engineering 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 knowledge 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) Improvement of local transportation

Local transportation will be much improved by the improvement of the Malolo-Chabi road with the provision of a new bridge across the Mwega river and the improvement of the access road from the highway A7 to Malolo. They are expected to much contribute to the mass transportation of agricultural products and inputs and thus to drastically activate the local economy in Chabi and Mgogozozi villages as well as Malolo village.

(3) Improvement of water supply to cattle grazing

Shortage of water during the dry season is a serious problem for cattle grazing carried out by Masai and Mangati tribes. Upon the completion of the project, they are endowed with stable water supply of canal systems through places for watering cattle.

(4) 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 such as Lumuma, Mgogoji Kikalo, and Chabi 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 area. 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 providing 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 Mwega scheme to contribute with 2,460 ton of cereal, 99 ton of beans, and 6,660 ton of vegetables 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 Mwega Scheme will be Tsh.929 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 beneficiaries. 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 government 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 or strengthening those already in existence. 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 small-sized.

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 Mwega scheme, it has been concluded that the implementation of irrigation development is technically sound and economically feasible in the priority development schemes. 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 Mwega areas 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 as they are actually carrying out operation and maintenance works in each of existing irrigation systems, 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 demonstration effect on the other smallholder irrigation schemes. 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 due to lack of fuel wood near the communities.

Areas adjacent to the irrigation fields such as the fields along the main and secondary canals and along the Mwega river are suitable for producing trees, since such areas usually contains water infiltrating from the adjacent irrigation fields. It is, therefore, recommended to implement afforestation development around the irrigation area.

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.