

## 1.2.5 Environmental Management Plan

### 1) Soil and Water Conservation Plan

Farmers of this area are comparatively practicing soil conservation activities. However, in case that horticulture is practiced instead of coffee growing, soil conservation activities should be strengthened. Therefore, encouragement of farmers for the soil and water conservation shall be included in the extension service and farmers' training by DAO. MOA has the capability of these activities as they have the Soil and Water Conservation Manual published by Soil and Water Conservation Branch and a soil conservation officer is assigned in each district office.

The extension service and farmers' training include the field trip of model farm and the technical support for the following items:

- Plantation of trees along the river for feed, firewood and soil conservation.
- Plantation of grass as terrace banks.
- Sanitary management of livestock and production of manure.
- Thoroughness of crop rotation for horticulture.

Farmers' training should be held at least for group leaders including women groups. Some farms of participants can be used as practical training places so that farmers understand clearly how to conserve soil and water in their farm.

It is considered to choose several species of trees and grass for plantation to avoid the risk of diseases and insect damage. It may be better that MOA will support some active farmers groups for the production of seedlings and group members will visit the farm of each member with seedlings in turn to advice each other how to improve the farm and work together.

### 2) Public Health Plan

The extension service and farmers' training by MOA shall include the encouragement of following items:

- Risk and appropriate use of agrochemical including the system of MRL in EU. HCDA has the extension manual.
- Promotion of improved cooking stove for women's groups. It will save 30 - 50 percent of firewood, contribute to keep boiled water for drinking and for heating at night. Home Economic Branch of Extension Service Division in MOA has the knowhow as they worked for the promotion project of GTZ. The project of ENZARO JIKO (promotion of improved cooking stove) by JICA was also a great success and it must be effective to invite some women group leaders from Enzaro, where the community has become very active, to Rupingazi or to hold a study tour to Enzaro in order to exchange information among farmers.

Sanitary education for children at primary school is required not to drink the river water without boiling and to wash their hand before eating and after using the latrine. DAO shall request the primary school to warn the children frequently.

Water quality analysis of the sources of drinking water is required periodically by the Ministry of Health and the result shall be informed to the inhabitants so that they can learn which water source is more safe.

### 3) Watershed Management Plan

The Rupingazi water catchment area lies mostly within Mt. Kenya Forest Reserve. Therefore, the management of Mt. Kenya Forest Reserve is important for the stable water supply for drinking and irrigation in the Project Area. This area is managed by Forestry Department and the management shall be strengthened against illegal logging.

## 1.2.6 Institutional Development Plan for Farmers Organizations

### 1) Water Users Association Plan

#### Introduction

An institutional development plan for WUA will aim at achieving the following objectives;

- A better organized, cohesive and self reliant irrigation community
- Enhanced awareness of individual members rights and obligations
- Improved decision making capability by the management committee on implementation, operation and maintenance issues
- Increased capability to effectively deal with external agencies

In order to achieve the above four objectives, it is planned to undertake a range of training activities targeted at both WUA members and the management committee. These training activities are summarized below while detailed training modules, showing content and approach, are presented in Annex J.

#### a) Education and Training

Using PRA approaches, WUA members will be educated on implications and responsibilities associated with a group-based smallholder irrigation scheme. In particular the following issues will be covered;

- Expected roles, conduct and performance of management committee members
- Suitability for election as management committee member
- Irrigation by-laws, water allocation and distribution rules as well as disciplinary measures and procedures in executing penalties to non-compliant farmers
- Irrigation design and its relation to operation and maintenance issues
- Procedures for raising funds for irrigation implementation
- Financial implications for operation and maintenance

## b) Financial and General Management

The management committee of WUA will participate in training sessions aimed at improving their financial and management skills. The contents of this training is summarized below while full details are given in Annex J.

### Financial Management Training for WUA Committee

- Determination of irrigation water charges and collection procedures
- Financial records, book-keeping procedures, banking and accounting reports
- Planning for operation and maintenance including provision for maintenance fund
- Budget preparation and budget control

### General Management Training for WUA Committee

- Roles, conduct and performance of management committee members
- Elementary principles of management
- Community organization
- Conduct of meetings (committee and general meetings)
- Management of external relations (supporting agencies : GOK, NGOs, private sector)

## c) Linkages with Other Institutions

To adequately fulfil its members expectations, the WUA will be encouraged to form and maintain close linkages with other organizations and agencies. Such linkages are likely to be shown below;

### WUA Linkages with Other Institutions

Institution	Linkage Purpose/Advantage
Ministry of Agriculture	<ul style="list-style-type: none"><li>- Advisory services on design, implementation, operation and maintenance of irrigation system</li><li>- Coordination of other support services to the project community</li><li>- Organization and management support</li></ul>
Ministry of Land Reclamation, Regional and Water Development	<ul style="list-style-type: none"><li>- Security of irrigation water rights</li></ul>
Cooperative Society	<ul style="list-style-type: none"><li>- Use of cooperative building for WUA meetings</li><li>- Possible input credit facilities for members</li></ul>
Local NGOs	<ul style="list-style-type: none"><li>- Availability of loans on affordable terms</li><li>- Organization and management support</li></ul>
Private Sector	<ul style="list-style-type: none"><li>- Construction of irrigation infrastructure</li><li>- Farm in-puts &amp; market outlets for members</li></ul>

## 2) Cooperative Development Plan

### a) Education and Training

The education and training Cooperative Society members will be effected indirectly through the WUA. This is so because the cooperative shares the same membership with the Water Users' Association. Hence, members whose social and community awareness is enhanced through WUA training, will in turn contribute towards strengthening of the cooperative society.

In addition, a formal workshop will be conducted with the aim of bringing together management committees of the cooperative and WUA in order to explore areas of cooperation for the benefit of their members.

### b) Financial and General Management Training

#### Financial Management Training

Cooperative society has an established financial management system already put in place by the Ministry of Cooperative Development. However, on the basis of problems indicated by the members (ref. to Problem Tree), the society's performance could be improved if the management committee was exposed to a short training session on;

- Operational cost management
- Improved budget control procedures

#### General Management Training

Poor management of coffee cooperatives is a national problem at the moment, and Kibugu Cooperative is not an exception. The situation is likely get worse as the coffee sub-sector becomes fully liberalized.

With a view to strengthening the managerial capacity of the cooperative society, it is proposed that the Committee participates in a training workshop covering the following topics:

- Roles, conduct and performance of management committee members
- Elementary principles of management
- Containment of coffee factory processing costs
- Management geared to improved green coffee quality
- Options for improved cherry payment to members
- Conduct of meetings (committee and general meetings)
- Management of external relations (supporting agencies : GOK, consultants, private sector)

### c) Linkages with Other Institutions

The Coffee Cooperative Society will be encouraged to develop linkages with a number of institutions summarized as follows;

### Co-operative Linkages with Other Institutions

Institution	Linkage Purpose/Advantage
Ministry of Agriculture	- Advisory services coffee husbandry - Co-ordination of other support services to the project community
Ministry of Land Reclamation, Regional and Water Development	- Security of water rights for coffee processing
Irrigation Water Users' Association (WUA)	- Purchase of farm inputs by WUA members
Production/Marketing Groups	- Purchase of farm inputs by group members
Private Sector	- Bulk supply of farm in-puts - Training in improved coffee handling and processing

### 3) Marketing Group Development Plan

#### a) Education and Training

Promoting production/marketing groups are aimed at addressing major problems currently facing smallholder horticultural production (ref. to Problem Tree). The groups are expected to establish a mechanism for co-ordinating production and marketing opportunities. More specifically, each group will identify its own marketing outlets and then schedule the members production to match market requirements. The alternative of organizing marketing for the entire project community was considered but was found unattractive because of its excessive management requirements. The relatively smaller neighborhood marketing group consists of members who know each other well and is comparatively easier to co-ordinate and manage. As part of promoting the formation of marketing groups, prospective members will be given general education and training on;

- Advantages of group marketing as opposed to individual marketing
- Criteria for membership recruitment and procedures member mobilization and organization
- Group by-laws and registration requirements and procedures

The "Baricho Marketing Group" in Kirinyaga District could be used to demonstrate advantages and mode of operation of such a group;

#### b) Financial and General Management Training

For the groups to function effectively, they will need to acquire financial and general management capabilities as outlined below. More details on proposed training modules are given in Annex J.

#### Financial Management Training

- Members transaction records; delivery and receipt procedures
- Mode of payment by exporters to group and by group to individual members
- Banking procedures; cash deposit and withdrawal procedures; operating a cheque account; bank reconciliation

- Books of accounts and accounts reports
- Budget preparation and budget control

#### General Management Training

- Management principles
- Role, conduct and performance of management committee members
- Sourcing and processing of marketing information
- Accessing production technology; production planning in relation to market opportunities
- Production/purchase contract and implied legal issues
- Communication skills; sharpening negotiation and bargaining capabilities

#### c) Linkages with Other Institutions

Each production/marketing group, however, will need to forge links with several organizations summarized as follows;

#### Production /Marketing Group Linkages with Other Institutions

Institution	Linkage Purpose/Advantage
Ministry of Agriculture/HCDA	<ul style="list-style-type: none"> <li>- Sourcing marketing information</li> <li>- Accessing production technology</li> <li>- Organization and management support</li> <li>- Co-ordination of other support services to the group</li> </ul>
Horticultural Export Companies	<ul style="list-style-type: none"> <li>- Purchase contract for horticultural produce</li> <li>- Market outlet to horticultural produce</li> <li>- Farm-input credit</li> <li>- Advice on how to produce contract crop</li> </ul>
Produce Brokers	<ul style="list-style-type: none"> <li>- Market outlet for farm produce</li> <li>- Indication (though distorted) of market information</li> </ul>
Local NGOs	<ul style="list-style-type: none"> <li>- Organization and management support</li> <li>- Input credit facilities</li> </ul>
Irrigation Water Users' Association (WUA)	<ul style="list-style-type: none"> <li>- Reliable supply of irrigation water</li> </ul>
Local Farm input Stockists	<ul style="list-style-type: none"> <li>- Availability of farm inputs</li> <li>- Possibility of short-term input credit</li> </ul>
Banks	<ul style="list-style-type: none"> <li>- Banking facilities for members contributions</li> <li>- Clearance of cheques issued by exporter</li> <li>- Processing of cheques issued by group to individual member</li> </ul>

#### 4) Women's Group Development Plan

The four women groups within the Project Areas offer an entry point for getting women's perspective in irrigation and irrigated horticultural production. In this regard, it is planned to conduct a training programme targeted to these women groups with the aim of enhancing their capacity to effectively contribute to the irrigation design and obtain maximum benefits from created opportunities. The proposed training is outlined below while further details are given in Annex J.

a) Education and Training

A general education and training session will be conducted and will cover the following topics;

- Identification of women concerns and prioritized needs
- Review of proposed irrigation project plan in relation to women concerns and needs
- Review of the engineering design where women contributions will be sought and incorporated
- Implications of increased irrigated horticultural production not only in terms of increased workload for women but also in terms of new opportunities for women-specific benefits

b) Financial and General Management

Financial Management Training

One of the problems associated with women groups is their weak financial management capability. In order to remedy this constraint, women groups will be given an elementary course in financial management which will include the following:

- Procedures for keeping members financial records (contributions and disbursements)
- Banking procedures; types of bank accounts; cash deposit and withdrawal procedures
- Maintenance of simple accounting records
- Identifying income generating activities and associated expense and revenues streams
- Identifying agencies that can provide loans to women groups
- Procedures for applying and negotiating for loans
- Annual report of group activities including statement on expenditure and revenue as well as benefits to individual members

General Management Training

Presently women groups adopt short-term horizons and engage in a fairly narrow range of low turn-over activities. It therefore proposed to broaden the scope and depth of women development perceptions by giving them a training course in general management in the following areas;

- Group organization; management principles; leadership
- Strengths, weaknesses, opportunities and threats to the women group
- Review of current activities and exploration of irrigation-induced opportunities
- Forward-planning procedures
- Monitoring performance
- Accessing support agencies in government, ngos and private sector
- Negotiation/bargaining skills

c) Linkages with Outside Support Organizations

Since women account for the bulk of farm labour, they are likely to be the actual producers of most horticultural produce at Rupingazi Ngerwe Project Area. For this reason, women groups could act as independent production/marketing groups and form similar institutional linkages. Hence the linkages are likely to be as shown below;

### Women's Group Linkages With other Institutions

Institution	Linkage Purpose/Advantage
Ministry of Agriculture/HCDA	<ul style="list-style-type: none"> <li>- Sourcing women-specific production technology and market information</li> <li>- Coordination of other support services to the group</li> </ul>
Horticultural Export Companies	<ul style="list-style-type: none"> <li>- Purchase contract for horticultural produce</li> <li>- Market out-let to horticultural produce</li> <li>- Farm-input credit</li> <li>- Advice on how to produce contract crop</li> </ul>
Produce Brokers	<ul style="list-style-type: none"> <li>- Market outlet for farm produce</li> <li>- Indication (though distorted) of market information</li> </ul>
Irrigation Water Users' Association (WUA)	<ul style="list-style-type: none"> <li>- Reliable supply of irrigation water</li> </ul>
Local NGOs	<ul style="list-style-type: none"> <li>- Organization and management support</li> <li>- Input credit facilities</li> </ul>
Local Farm input Stockists	<ul style="list-style-type: none"> <li>- Availability of farm inputs</li> <li>- Possibility of short-term input credit</li> </ul>
Banks	<ul style="list-style-type: none"> <li>- Banking facilities for members contributions</li> <li>- Clearance of cheques issued by exporter</li> <li>- Processing of cheques issued by group to individual member</li> </ul>

#### **1.2.7 Institutional Supporting System Development Plan**

##### **1) Agricultural Extension Services**

Technology development, field trials, demonstration and extension in the model area should be carried out in close cooperation with the farmers, MOA staff, front line agricultural extension workers, and any involved NGOs staff.

The overall responsibility for developing the demonstration program, and supervising the layout and management of the trials at this site will be with the MOA staff in Kibugu, Nginda and Embu.

The development and responsibility for the training program for farmers, extension workers and NGOs staff will be under the overall supervision of the relevant MOA staff in Nairobi.

The implementation of the agricultural development plan and any modifications to the proposed cropping patterns will be decided jointly by farmers, extension staff, and any involved NGOs staff. An advisory role will be played by the district level Subject Matter Specialists in Embu. They will be asked to comment on the plan, as well as provide their technical input when specific technical problems arise in their field.

The farmers themselves have the primary responsibility for managing the Rupingazi irrigation scheme, and implementing this development plan. The extension workers and NGOs staff have the responsibility of acting as a liaison between the farm level and the district administration, as well as the Nairobi based project staff.



Training of all of the concerned players to assist them in their roles will be conducted under the project. Facilities for the trials and demonstrations will be provided by the project. The Government of Kenya will facilitate the involvement of their officials in the development and supply of the extension services to the model areas. Any involved NGOs staff will also be expected to participate on an ongoing basis.

## 2) Agricultural Credit Services

Supporting system development plan concerning to the agricultural credit can be formulated by reflecting the farmer's opinion obtained through the farm economic survey. The obstacles on credit facing by farmers in the Project Area are as follows;

- High interest
- Difficulty in application
- Necessity for collateral by banks
- Slow action of banks
- Rising an interest without prior notice to borrowers

Following countermeasures are proposed to overcome these hurdles:

- Decreasing interest
- Expansion of repayment period
- Educational training for farms to make them understood credit systems completely
- Improve credit system's availability even if without collateral
- Simplify application procedures
- Improve credit system's availability to group based credit, if farmer don't have title deed
- Promote farmland survey and publish the title deed
- Develop availability of credit to individual female and women groups who are main farm labour

## 3) Agricultural Input Supply

The supply of improved maize, cabbage and other vegetable seeds and banana planting material will be provided on a purchase basis. The private sector suppliers in the area, including the coffee cooperative, will be actively encouraged to develop new or existing outlets in the model areas, and to stock the required inputs for the agricultural development of Rupingazi.

## 4) Training to Strengthen Farmers' Organization

There are six institutions which presently provide some support services to the project community of Rupingazi Ngerwe Project Area. With the rehabilitation of the irrigation scheme, the need for strengthening farmers organizations will be critical. In this connection, it is proposed that staff of these institutions participate in specific training workshops where they can acquire appropriate operational skills geared to strengthening farmers' organizations.

In the first instance, it is planned that MOA as the irrigation project promoter convene a meeting within Embu where staff from these institutions will be;

- Briefed on the planned irrigation activities at Rupingazi Ngerwe Project Area
- Discuss and agree on a common approach to establishing or strengthening relevant farmers organizations.
- Identify specific training needs for staff of various institutions who are or will be involved in strengthening farmers' organizations

In the meantime, a likely training programme is given below;

#### Out-line of Training Programme for Enhancing Ability to Strengthen Farmers Organizations

Institution	Training Aimed at Enhancing ability to Strengthen Farmers Organizations	Farmers' Organization to be strengthened
Front-line Extension Worker (FEW)	<ul style="list-style-type: none"> <li>- Community organization and PRA approaches</li> <li>- Hands-on irrigation technology</li> </ul>	<ul style="list-style-type: none"> <li>- WUA</li> <li>- Production/Marketing Group</li> <li>- Women Group</li> </ul>
District Subject Mater Specialist	<ul style="list-style-type: none"> <li>- Community organization and PRA approaches</li> <li>- Irrigated horticultural production technology</li> <li>- Participatory extension needs assessment methods</li> <li>- Social marketing skills</li> <li>- Improved extension planning, packaging and delivery</li> </ul>	<ul style="list-style-type: none"> <li>- Production/Marketing Group</li> <li>- Women Group</li> </ul>
District Cooperative Office	<ul style="list-style-type: none"> <li>- Factory level cost management</li> <li>- Coffee processing for quality improvement</li> </ul>	<ul style="list-style-type: none"> <li>- Cooperative Society</li> </ul>
Local NGOs (Catholic Church & Anglican Church)	<ul style="list-style-type: none"> <li>- Community organization and PRA approaches</li> <li>- Financial management skills</li> <li>- Loan administration skills</li> </ul>	<ul style="list-style-type: none"> <li>- WUA</li> <li>- Women Group</li> <li>- Production/Marketing Group</li> </ul>
Ministry of Culture & Social Services District Office	<ul style="list-style-type: none"> <li>- Community needs assessment</li> <li>- Procedures for group formation, organization and follow-up</li> <li>- Work planning and scheduling</li> </ul>	<ul style="list-style-type: none"> <li>- Women Groups</li> <li>- Production/marketing Group</li> <li>- WUA</li> </ul>

### 1.2.8 Water Sources Development Plan

#### 1) Mode of Water Abstraction

As a method of water intake for the Project, direct abstraction from river through intake weir works is adopted to make project cost low. Therefore, run-off water of the Rupingazi river is intaked for the Project through existing Rupingazi intake.

#### 2) Methodology of Assessment of Water Availability

According to Water Act published by government, if a proposed scheme includes accommodation of storage facility in the project component, flood flow can be used for irrigation purpose, and if the scheme does not include storage facility, monthly dependable flow (Qd) for irrigation is defined by the following equation;

$$Q_d = Q_b - Q_m - Q_{cd}$$

where,

$Q_b$  : Base flow is a flow with 80 percent probability of exceedance in the driest month on the minimum monthly flow basis. The base flow at specific point is converted proportionally based on the acreage of catchment area from the base flow at RGS which is located in lower reach of related river or near location from the related project site.

$Q_m$  : River maintenance flow equivalent to 30 percent of the base flow

$Q_{cd}$  : Total committed water in the immediate down stream of proposed intake site

Thus, the dependable flow can be estimated through the probability analysis of minimum monthly flow by Iwai Method and total committed water in the immediate down-stream of a proposed intake site.

### 3) Assessment of Water Availability at the Intake Site

Since no gauging station exists at Rupingazi intake site, the discharge data at RGS-4DC3 of the Rupingazi river are analyzed to estimate dependable flow at the intake site. Based on the minimum monthly discharge record of 26 years from 1970 to 1996 as shown in Table G.2.1-2, Annex G.2, the 80 percent low flow of exceedance is estimated to be 0.40 cu.m/sec which occurs in March as shown in Table 1.2-2.

The base flow at Rupingazi intake site is estimated by multiplying the yield of base flow at RGS-4DC3 and the catchment area above Rupingazi intake. Thus obtained base flow at Rupingazi intake site is 0.264 cu.m/sec. Since there exists no water abstraction with permit in the immediate down-stream, the minimum dependable flow at the intake site is estimated at 0.185 cu.m/sec which is corresponding to 70 percent of base flow at the intake site. The estimated monthly dependable water ranges from 0.185 to 0.977 cu.m/sec as shown in Table 1.2-2.

### 4) Water Source Development Plan

The irrigation area of the Project is determined in consideration of the following concept;

- Full irrigation in the dry season as well as supplemental irrigation in the rainy season will be planned from the view point of marketability of irrigated crops.
- The irrigation area of the Project is allowed within the amount of available water source (0.185 cu.m/sec) and requested irrigation area (40 ha) by the WUA.

The dependable water source amount in the driest month at the intake site is 0.185 cu.m/sec, while the maximum unit water requirement in the driest month is estimated at 2.0 lit/sec/ha as shown below. Thus, the maximum water requirement for the irrigation area of 40 ha is 0.080 cu.m/sec.

Maximum unit water requirement in the driest month (q lit/sec/ha) is calculated as follow;

$$q = (ET_o * K_c - P_e) / IE * 10,000 / (h * 3,600) * 7/v = 2.0 \text{ l/sec/ha}$$

where,

Reference crop evapotranspiration ( $ET_o$ )

**Table 1.2-2 Dependable Water for Rupingazi Ngerwe Irrigation Scheme**

**1) Probability Analysis of River Flow at 4DC3 Regular Gauging Stations**

Station Code 4DC3  
 River Rupingazi  
 Drainage Area 197 sq.km  
 Location Latitude 00-08-00 S  
 Longitude 37-29-40 E  
 Period of Record 1970-1996

Exceeding Probability (%)	Probable Discharge of Monthly Minimum Flow (cu.m/sec)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
50	1.74	1.12	0.83	1.11	3.13	3.80	2.85	2.36	1.94	2.07	3.22	2.40	2.21
80	1.14	0.53	0.40	0.52	1.33	1.96	1.60	1.26	0.99	1.17	1.54	1.28	1.14
90	0.93	0.32	0.26	0.34	0.77	1.13	1.06	0.81	0.67	0.80	0.98	0.85	0.74

**2) Probable River Flow at Intake Site**

Water Source Rupingazi River  
 Drainage Area at Intake Site 130.0 sq.km  
 Code of Adopted Station for Estimation 4DC3 (Rupingazi River)  
 Drainage Area of Adopted Station 197.0 sq.km  
 Conversion Factor 0.660

Exceeding Probability (%)	Probable Discharge of Monthly Minimum Flow (cu.m/sec)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
50	1.148	0.739	0.548	0.732	2.065	2.508	1.881	1.557	1.280	1.366	2.125	1.584	1.461
80	0.752	0.350	0.264	0.343	0.878	1.293	1.056	0.831	0.653	0.772	1.016	0.845	0.754
90	0.614	0.211	0.172	0.224	0.508	0.746	0.699	0.535	0.442	0.528	0.647	0.561	0.491

**3) Dependable River Flow at Intake Site**

Base Flow(Qb): 0.264 cu.m/sec  
 River maintenance flow (30% of Qb=): 0.079 cu.m/sec  
 Committed water amount in upper basin of intake site: 0.376 cu.m/sec  
 Committed water amount in lower basin of intake site: 0.000 cu.m/sec

Exceeding Probability (%)	Dependable River Flow (cu.m/sec)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
80	0.673	0.271	0.185	0.264	0.798	1.214	0.977	0.752	0.574	0.693	0.937	0.765	0.675

	:	4.3	mm/day (refer to subsequent Clause of 1.2.9)
Crop factor (Kc)	:	0.9	(average)
Effective rainfall (Pe)	:	0.2	mm/day
Irrigation efficiency(IE)	:	0.50	(surface irrigation)
Operation hours per day (h)	:	12	hours
Irrigation days per week(v)	:	6	days

As the balanced water amount at the intake site after the abstraction of required water for the Project, is to be 0.105 cu.m/sec, Rupingazi river can supply the required water for the project. The existing intake facility is used as the water source facility of the Project.

### 1.2.9 Irrigation and Drainage Plan

#### 1) Irrigation Plan

The area to be irrigated is discussed in previous paragraph of 1.2.8, based on the available water amount at the project intake site and the requested area by the WUAs. The 200 farmers participate to the Project and each farmer is allocated the irrigation area of 0.2 ha, and the acreage of proposed irrigation area is 40 ha.

#### a) Irrigation Water Requirement

##### (1) Proposed Cropping Pattern

Introduced crops shall be examined considering the following factors;

- Natural condition (climate, soil, topographic conditions)
- Social condition (local demand, available labour, access to market)
- Technical condition (present crop grown, farmers experience to irrigation)
- Economical condition (profitability and marketability of crop)

Consequently, maize and grain maize as staple crops and coffee, bananas, cabbage, French beans, onion etc. as cash crop were selected. The proposed cropping pattern is shown in Table 1.2-1.

##### (2) Reference Crop Evaporation

Reference crop evapotranspiration (ET<sub>o</sub>) is estimated by Penman Method on monthly basis. For the calculation of ET<sub>o</sub> value, meteorological data at Embu station, which is nearest one from the Project is adopted.

The calculation of ET<sub>o</sub> was carried out by using computer program "CROPWAT" owned by IDB. The estimated ET<sub>o</sub> are ranging from 2.4 mm/day in July to 4.3 mm/day in February. The monthly ET<sub>o</sub> is tabulated in Table 1.2-3.

**Table 1.2-3 Reference Evapotranspiration (ET<sub>o</sub>) of Rupingazi Ngerwe Irrigation Scheme**

	Temperature		Humidity mean (%)	Wind Speed (km/day)	Sunshine hours (hrs/day)	Radiation Mj/m <sup>2</sup> /day (km)	ET <sub>o</sub> - Penman (mm)
	maximum (degree)	minimum (degree)					
Jan	24.4	12.1	66	76	8.5	76.0	4.0
Feb	26.0	13.1	64	89	9.0	89.3	4.3
Mar	26.3	14.0	65	87	8.1	87.4	4.3
Apr	24.8	15.4	78	70	6.6	69.5	3.6
May	23.7	14.9	74	57	6.2	57.1	3.2
Jun	22.2	13.3	73	64	4.3	63.6	2.7
Jul	20.8	12.6	75	77	2.4	77.1	2.4
Aug	21.7	12.1	75	72	3.8	71.5	2.8
Sep	24.7	12.7	65	65	5.4	64.5	3.4
Oct	25.8	13.9	65	66	7.1	65.6	3.8
Nov	23.6	13.6	75	86	6.9	85.7	3.6
Dec	23.8	12.8	70	74	8.4	73.9	3.8
Ave/Total	24.0	13.4	70	74	6.4	73.4	1,273

**Table 1.2-4 Crop Factors of Major Crops**

	Initial Stage	Crop Dev. Stage	Mid-season. Stage	Late season Stage
Coffee	1.05	1.05	1.05	1.05
Bananas	0.90	0.90	0.90	0.90
Napier	1.00	1.00	1.00	1.00
Potatos	0.45	0.75	1.15	0.85
Maize & Beans	0.40	0.80	1.15	0.70
French bean	0.35	0.70	1.10	0.90
Green Maize	0.40	0.80	1.15	0.70
Cabbage	0.45	0.75	1.05	0.90
Other crops	0.35	0.75	1.10	0.70

Source) Irrigation water management training manual no.3 FAO 1986

**Table 1.2-5 TRAM and Irrigation Interval of Rupingazi Ngerwe Irrigation Scheme**

Crop	Depth of Effe. Root Zone(m)	Half-storage Capa.* (mm/m)	TRAM (mm)	ET <sub>o</sub> (max) (mm/day)	Kc(max)	ET <sub>crop</sub> (mm/day)	Irrigation Interval (day)
Coffee	1.2	90	108	4.3	1.05	4.5	23.9
Bananas	1.2	90	108	4.3	0.90	3.9	27.9
Maize	0.8	90	72	4.3	1.15	4.9	14.6
Potatos	0.5	90	45	4.3	1.15	4.9	9.1
Beans	0.6	90	54	4.3	1.10	4.7	11.4
French bean	0.4	90	36	4.3	1.10	4.7	7.6
Cabbage	0.4	90	36	4.3	1.05	4.5	8.0
Other crops	0.6	90	54	4.3	1.10	4.7	11.4

\*) Soil Type: Clay loam

(3) Crop Evapotranspiration

The crop evapotranspiration (ET<sub>crop</sub>) will be determined as;

$$ET_{crop} = ETo \times Kc$$

ET<sub>crop</sub> : Crop evapotranspiration (mm/day)

ETo : Reference crop evaporation (mm/day)

Where; Kc : Crop factor (see Table 1.2-4)

(4) Irrigation Water Requirement

(a) Net Irrigation Requirement

The net irrigation requirement (NIR) is determined by deducting the corresponding effective rainfall estimated on monthly basis by following equation;

$$NIR = ET_{crop} - Pe$$

Where;

NIR : Net irrigation requirement (mm)

ET<sub>crop</sub> : Crop evapotranspiration (mm)

Pe : Effective rainfall (mm)

The USDA soil conservation method has been used to determine the effective rainfall. The monthly effective rainfall can be estimated the following formula developed by Kalder in 1987 .

$$Pem = 0.81 \times Pm^{0.975} \quad : \quad \text{for } Pm < 100 \text{ mm}$$

$$Pem = 18.54 + 0.52 \times Pm \quad : \quad \text{for } Pm > 100 \text{ mm}$$

Where: Pem : Monthly effective rainfall

Pm : Monthly rainfall with 80 percent probability of exceedance

The estimated effective rainfall is shown below;

Monthly and 5-days Effective Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
mm/month	1	7	62	245	92	14	13	20	16	67	142	31
mm/5day	0.2	1.2	10.3	40.8	15.3	2.3	2.2	3.3	2.7	11.2	23.7	5.2

The monthly rainfall data of Embu Meteorological station are used for the analysis of effective rainfall. The data are shown in Table L.2.1-1, Annex L.2.

(b) Gross Irrigation Requirement

Gross irrigation requirement(GIR) is determined by taking into consideration the irrigation efficiency(E) which is composed of field application efficiency, conveyance efficiency and operational efficiency. The GIR is estimated by the following equation. In this study, E values for surface and sprinkler irrigation are adopted 0.5 and 0.65 respectively.

$$GIR = NIR/E$$

Where;

- NIR : Net irrigation requirement
- E : Overall irrigation efficiency
- E :  $E_a \times E_c \times E_o$
- $E_a$  : Field application efficiency  
(surface irrigation: 0.55- 0.75, sprinkler irrigation 0.6-0.85)
- $E_c$  : Conveyance efficiency (0.8-0.9)
- $E_o$  : Operational efficiency (0.95)

(c) Irrigation Water Requirement

Irrigation water requirement (IWR) for the determination of system capacity is determined by taking into consideration the time of irrigation hours per day and working day per week. The following equation is used for the estimation of IWR;

$$IWR = GWR \times A \times 10,000 / (h \times 3,600) \times 7/v$$

where,

- IWR : Irrigation water requirement ( l/sec)
- GWR : Gross water requirement ( mm/day)
- A : Irrigation area (ha)
- H : Operation hours per day (hrs)
- V : Working days per week (days)

In the Project Area, 12 hours operation per day and six working days per week are generally adopted by farmers. Thus, the same values will be adopted for the estimation of IWR.

Two irrigation system, surface and sprinkler irrigation systems, are proposed as a adoptable irrigation system. The maximum irrigation water requirements in case of surface and sprinkler irrigation system are 63.6 lit/sec and 48.9 lit/sec, respectively and these annual variations are illustrated in Figure 1.2-2 and Figure 1.2-3. The detail are shown in Table L.2.1-2, Annex L.2.

b) Time Interval of Irrigation Application

The time interval of irrigation application is determined in the following procedures;

- (1) Determination of depth of root zone
- (2) Determination of half-storage capacity of soil
- (3) Calculation of total ready available moisture (TRAM)
- (4) Determination of time interval of irrigation application



Irrigation Water Requirement of Rupingazi Irrigation Scheme (Surface Irrigation)  
 Irrigation Area = 40 ha, Cropping Intensity = 185%, Maximum Water Requirement = 63.6 l/sec

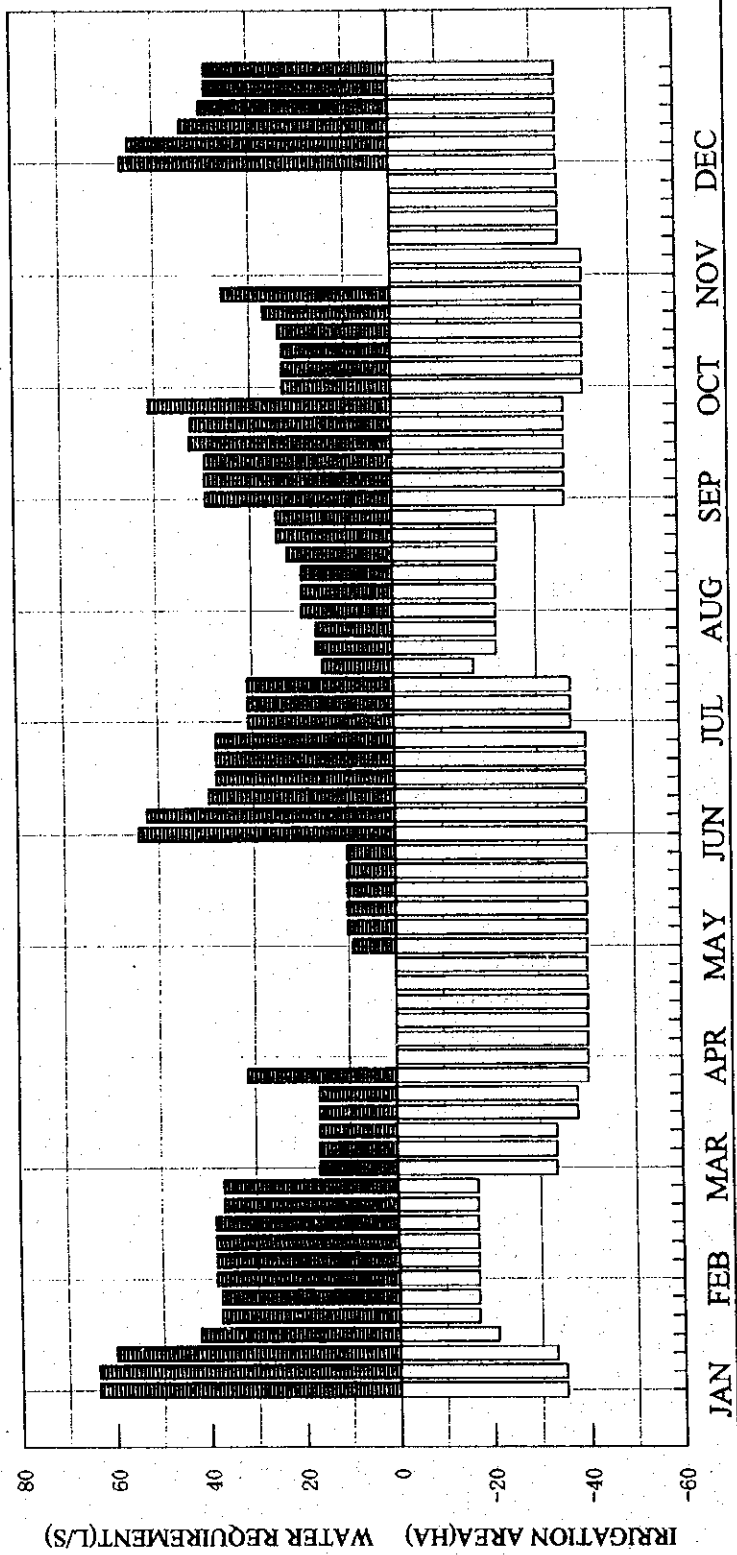


Figure 1.2-2 Irrigation Water Requirement of Rupingazi Ngerwe Irrigation Scheme (Surface Irrigation)

Irrigation Water Requirement of Rupingazi Irrigation Scheme (Sprinkler Irrigation)  
 Irrigation Area = 40 ha, Cropping Intensity = 185%, Maximum Water Requirement = 48.9 l/sec

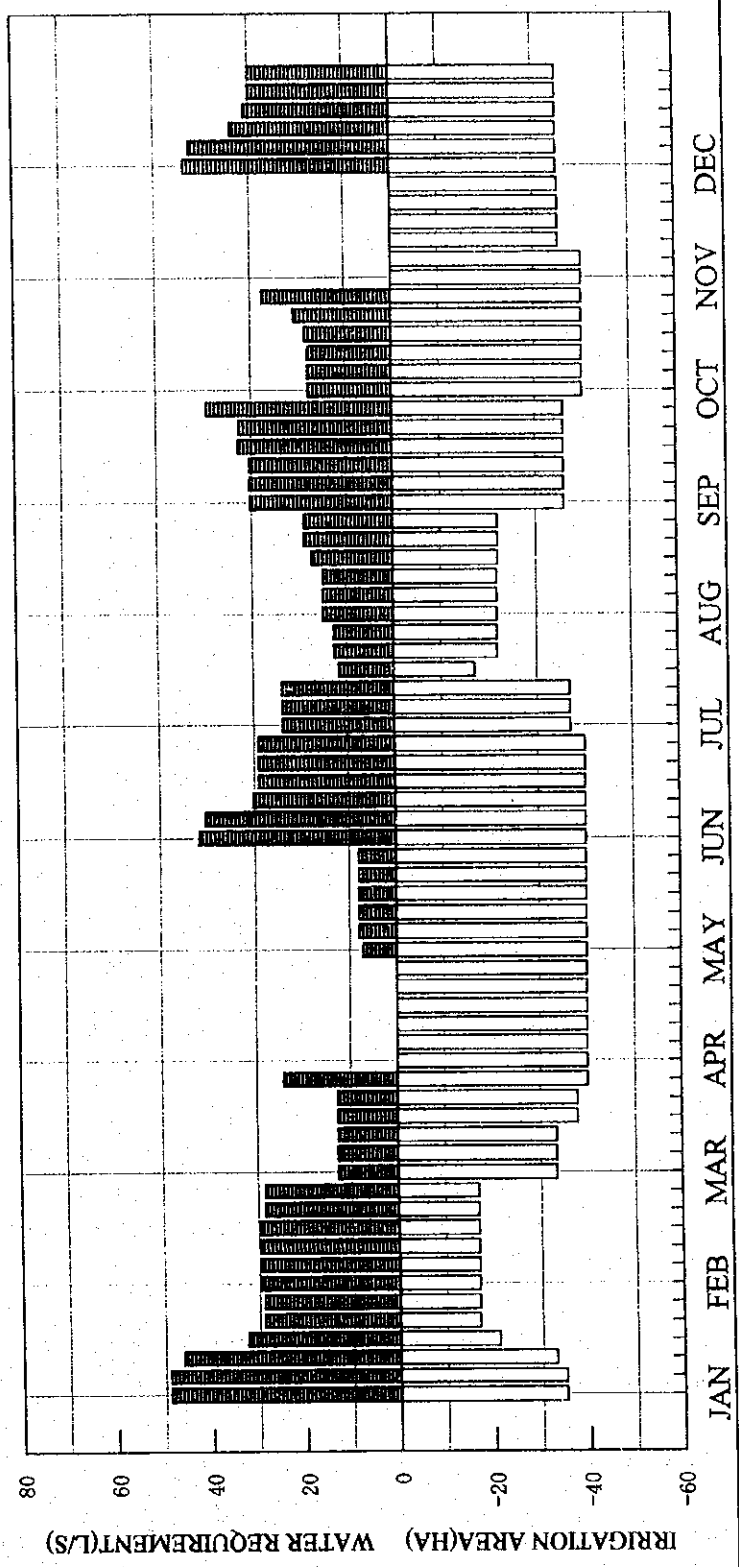


Figure 1.2-3 Irrigation Water Requirement of Rupingazi Ngerwe Irrigation Scheme (Sprinkler Irrigation)

### Depth of Effective Root Zone

The depth of effective root zone is determined on the basis of field survey and collected data on the root zone and is shown below;

Coffee	:	120 cm
Bananas	:	120 cm
Maize	:	80 cm
Potatoes	:	50 cm
Beans	:	60 cm
French beans	:	40 cm
Cabbage	:	40 cm

### Half-Storage Capacity of Soil (Ready Available Moisture)

Half- Storage capacity is defined as the quantity of water which is acceptable to the crop without loss of yield and is classified by soil type as bellow. The predominant soil type in the Project Area is clay loam.

Soil Type	Half-Storage Capacity (mm/m)
Clay	70 - 100
Clay loam	80 - 100
Loam	70 - 100
Sandy loam	40 - 80
Sand	30 - 50

### Total Ready Available Moisture (TRAM) and Interval of Irrigation Application

Total Ready Available Moisture (TRAM) is obtained from the following equation;

$$\text{TRAM} = (\text{depth of effective root zone}) \times (\text{half-storage capacity})$$

The time of interval of irrigation application is obtained by dividing the TRAM values by maximum crop evaporation as shown in Table 1.2-5. The estimated irrigation intervals for various crops ranged from seven to 28 days.

From the view point of water management, the irrigation on same day in a week is desirable, therefore, seven days of irrigation interval is planned for the Project Area.

#### c) Water Management Plan

The plot to be irrigated is spread over the Project Area of 161 ha. Therefore, the area to be irrigated is allocated according to the present command area of existing canal.

As the proposed irrigation area of 40 ha is irrigated in six days, the irrigation area per day is 6.7 ha. Considering of topographic condition of the Project Area, open canal system and pipeline system with partially open canal section are proposed. Since the proposed irrigation area extends in few distance from the intake facility, there is not adequate place for the facilitation of night storage. Thus, night storage is not introduced in the irrigation system. The water management plans are as follows;

(1) Open canal system

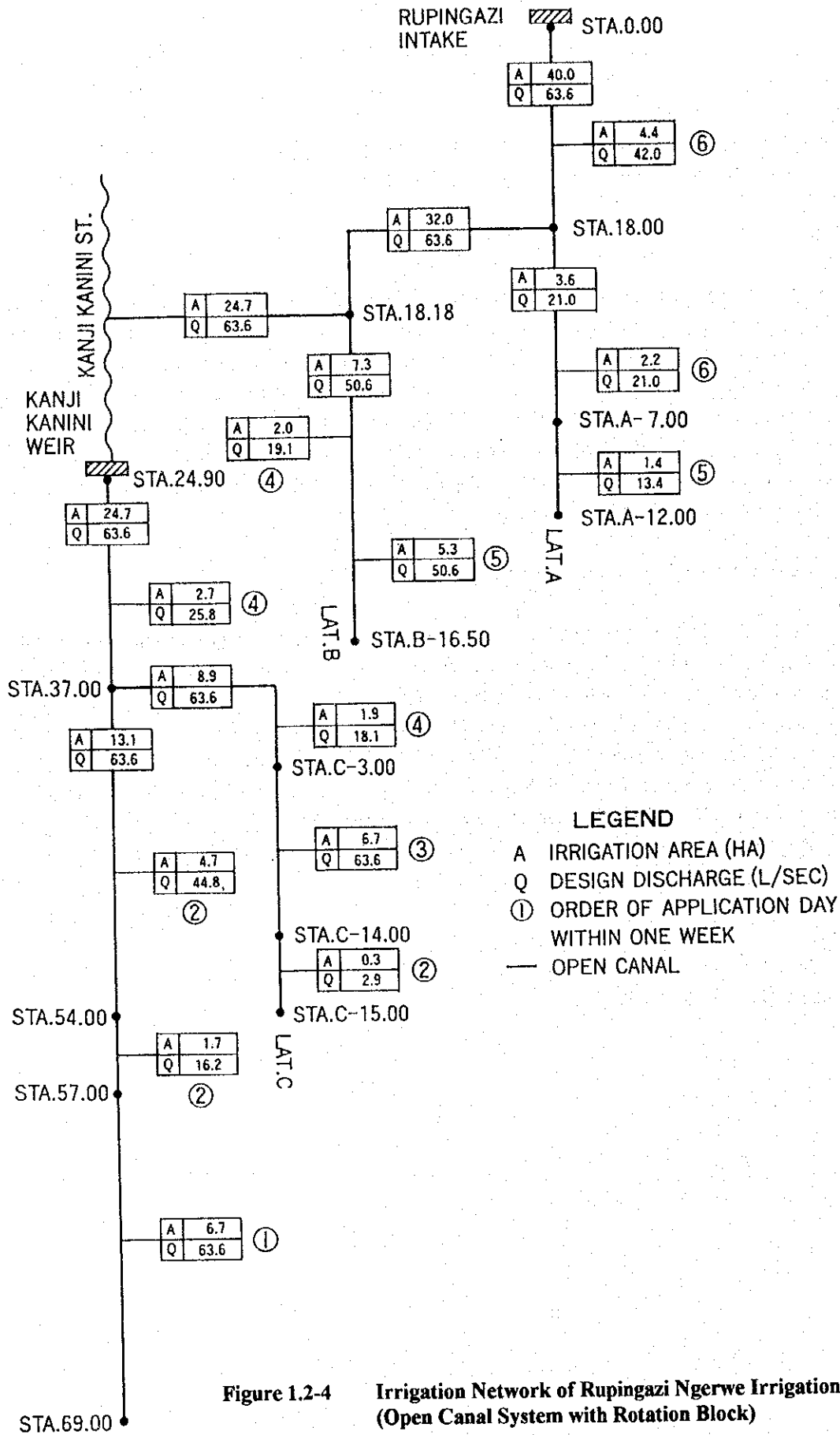
The earth canals are planned to accommodate in the open canal system. As the design discharge of planned canal is only 63.6 lit/sec, the discharge can be flown by earth canal with a minimum section with 0.3 m wide and the cross section of all canal in the scheme will be designed by minimum section. Thus, irrigation water distribution by single rotation block is proposed. The daily water supply is centered to some single place with irrigation area of 6.7 ha in the Project Area. The area to be irrigated moves from the downstream area to the upstream area with seven days interval, and one water guard will be required to control the canal system. Furrow irrigation is adopted as a water application method at on-farm level. The irrigation network is illustrated in Figure 1.2-4.

(2) Pipeline system with partially open canal section

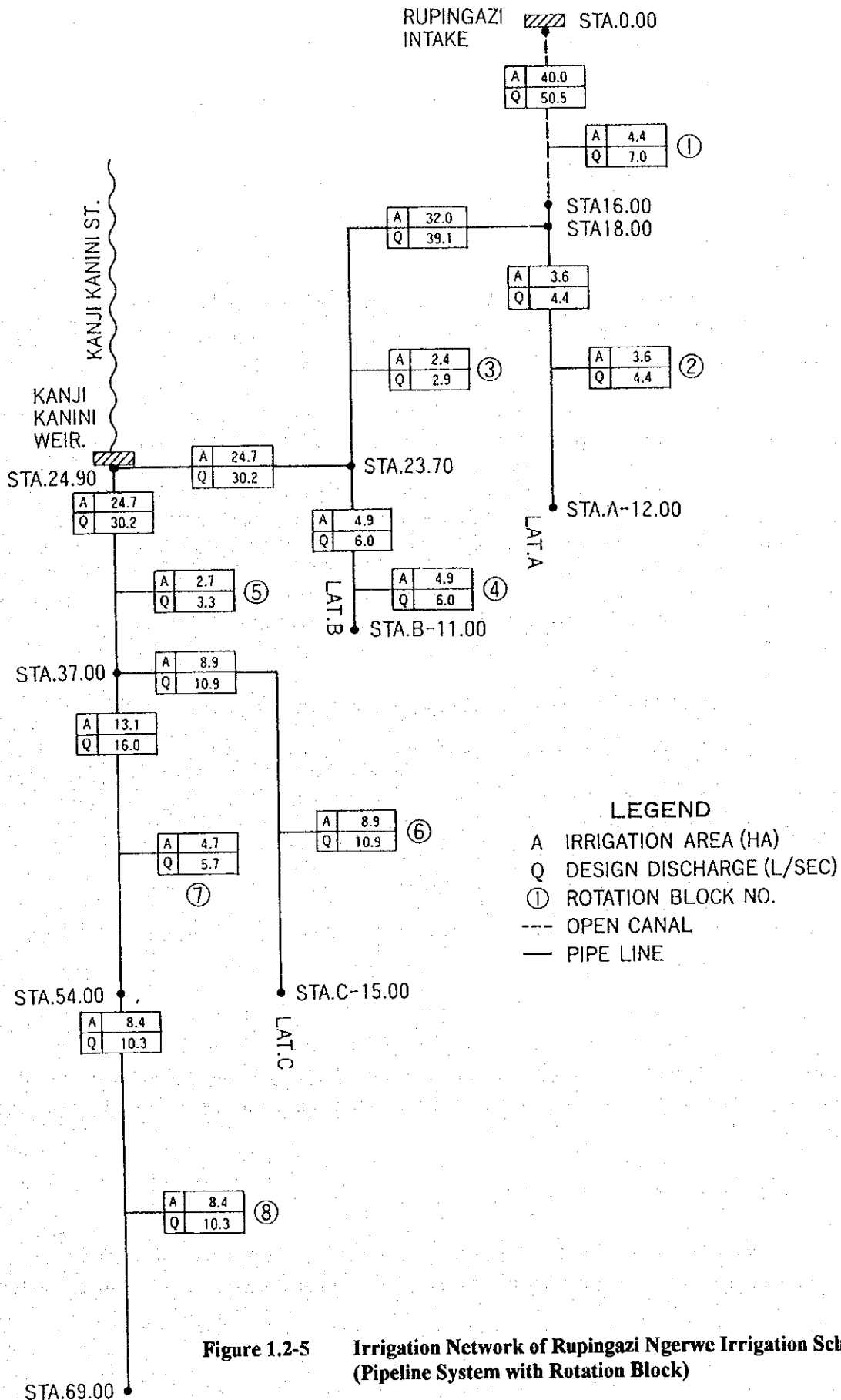
As the Project Area is sloppy, the natural slope is applicable to introduce pipeline system with sprinkler except the higher land of the Project Area. It is needed to minimize the size of proposed pipeline to make project cost low. Thus, eight rotation blocks are proposed. The daily water supply is separately executed at eight places in the Project Area at the same time with seven days interval. Therefore, eight water guard will be required to control the water distribution. As an open canal system is partially applied to the higher land, the maximum design discharge slightly increase to 50.5 lit/sec from 48.9 lit/sec, which is water requirement in case of pipeline system adopted over the Project Area. Sprinkler irrigation is adopted as a water application method at on-farm level. The irrigation network is illustrated in Figure 1.2-5.

2) Drainage Plan

Since the Project Area is located in sloping area, there is no severe drainage problem. Thus, no drainage plan is proposed for the Project.



**Figure 1.2-4 Irrigation Network of Rupingazi Ngerwe Irrigation Scheme (Open Canal System with Rotation Block)**



**Figure 1.2-5 Irrigation Network of Rupingazi Ngerwe Irrigation Scheme (Pipeline System with Rotation Block)**

### 1.3 Physical Plan and Cost Estimate

#### 1.3.1 Agriculture and Rural Infrastructure Plan

##### 1) Agriculture Infrastructure Plan

##### a) Irrigation and Drainage Facilities

As to irrigation facilities, present irrigation system shall be rehabilitated to a functional delivery system. Alternative study is made to meet the most effective irrigation system for Rupingazi Ngerwe Irrigation Scheme based on the present problems, farmers needs and natural conditions.

Alternative-1 : The system is an open canal system as it exist. Canal sections where the canals pass steep mountain slope are planned to improve with pipe conduit. Particularly the upper reach of the canal needs to eliminate siltation problem caused by soil erosion from steep mountain. All other structures will remained as it exist to minimize rehabilitation cost, and furrow irrigation method is applied for on-farm irrigation.

Alternative-2 : Pipeline system is introduced to apply sprinkler irrigation method, however the upstream section from the intake (Sta. 0+0) to Sta. 16+00 remains as an open canal system, the same as Alternative-1 due to topographic conditions. Possible sprinkler irrigation system shall be with PVC pipeline and low pressure sprinkler.

#### Alternative Study for Improvement of Rupingazi Ngerwe Irrigation System

Alternatives	Conditions		Objectives/Needs for Improvement			Direct Cost ('000 Ksh)
	Irrigation water supply system	On-farm irrigation method	To be operational system	To solve water shortage at lower reaches	To introduce sprinkler	
A-1	Open canal system	Furrow irrigation	Attained	Attained	Not attained	2,691
A-2	Pipeline system	Sprinkler irrigation	Attained	Attained	Attained	7,486

As a result of alternative study, Alternative-1 is recommended for the improvement of Rupingazi Ngerwe Irrigation System because of low improvement cost. However, final decision shall be made through workshop meetings to be held with association members before commencement of detailed design (Refer to Annex M and P).

##### b) Village/Farm Roads

Village/farm roads shall be rehabilitated with a spot improvement method which requires road grading and regraveling. A total length of the village/farm roads improvement shall be 1.20 km. (Refer to Annex P).

## 2) Rural Infrastructure Plan

### a) Domestic Water Supply

Domestic water supply is not included in the improvement plan as it is presently supplied by NWC&PC.

### b) Access Roads

For access roads, improvement and rehabilitation of E632 minor road is proposed for steep and earth surface sections where the road becomes impassable in the rainy seasons. Improvement of steep road section will be by tarmac surface pavement and rehabilitation of earth road be by spot regravelling. A total length of the access roads improvement shall be 1.0 km for tarmac pavement improvement and 5.3 km for spot regravelling (Refer to Annex P).

### c) Post-Harvest and Agro-Industry Plan

The grading and packing shed must be funded and constructed by farmers marketing groups in order to create motivation of self-help, strengthen reliable relationship among members, ownership and also lower the construction costs by using local materials and labour force of members.

## 1.3.2 Cost Estimate and Disbursement Schedule

### 1) Conditions of Cost Estimate

Unit costs are determined based on similar work items used in the recent and on-going projects in Kenya, and material costs are taken from the Annual Tender 1997/98 conducted by district offices. Base price year of the project cost is August 1998 and exchange rate is 1.0 US\$ = 60.0 Ksh.

Construction costs of the facilities are estimated on a contract basis with labour intensive method for all projects. For self-help projects, costs for casual labours for the works such as pipe laying, earth canal trimming, structure excavation and backfilling and so on are not included in this estimate since they are planned to be provided by Rupingazi Ngerwe Irrigation Association in order to lower the construction costs. On the other hand, community development and support services costs are estimated as it is implemented by the related government agencies, mainly MOA, through NGOs which are hired on a contract basis.

Associated costs necessary for project implementation are determined as seven percent of the construction cost for pre-engineering works, seven percent for administration activities and ten percent for consulting services. These percentages are based on the past experiences in similar irrigation project. Pre-engineering cost means the cost for field investigation and survey for roads improvement. Administration cost, which is necessary for administrative works undertaken by governmental implementing agencies, contains salaries and wages of office staff, miscellaneous cost for administration, fuel and light expenses, etc. during implementation period. Consulting services to be undertaken by consultants and NGOs are necessary for the detailed design, preparation of the tender documents, supervision of the construction works,



and community development & support services. Such consultants or NGOs shall be selected either through national or local tenders. Further ten percent of the construction cost is assumed as a physical contingency.

## 2) Project Costs and Disbursement Schedule

### a) Project Costs

Project costs consist of major two categories, i.e. construction cost and community development & support services cost. Summary of project costs is as shown below, and detailed cost and cost sharing by sector and by agency are shown in Annex Q.

#### Summary of Project Cost

		(Ksh)
<hr/>		
1. Construction Cost		
1) Irrigation & Drainage Improvement	3,714,000	
2) Marketing Improvement	0	
3) Access Roads Improvement	3,694,000	
4) Village/Farm Roads Improvement	684,000	
5) Domestic Water Supply Improvement	0	
Sub-total	8,092,000	
<hr/>		
2. Community Development & Support Services		
1) Agricultural Support Services	10,640,000	
2) Community Development	7,078,000	
3) Water Management Services	2,600,000	
4) Marketing Support Services	376,000	
5) Public Health Services	150,000	
Sub-total	20,844,000	
<hr/>		
3. Associated Cost		
1) Pre-engineering Cost	306,000	
2) Administration Cost	2,026,000	
3) Consulting Services	2,894,000	
Sub-total	5,226,000	
<hr/>		
4. Physical Contingency	809,000	
<hr/>		
Total	34,971,000	
<hr/>		

### b) Disbursement Schedule

Disbursement schedule of the project cost by sector and by agency is prepared based on the planned implementation period of seven years, as presented in Annex Q. Procurement of funds will be the most critical factor particularly for self-help projects.

### 3) Operation and Maintenance Costs

Annual operation and maintenance costs are composed of salaries and wages of O&M staff, administration and general expenditures, depreciation and repair costs, maintenance cost of the facilities. It is assumed that annual operation and maintenance costs are estimated at two percent of the initial construction cost unless obtained specifically from each project or facility. Summary of annual operation and maintenance costs are as presented below and details by sector and by agency are shown in Annex R.

### Annual Operation and Maintenance Cost

	(Ksh/year)
1) Irrigation & Drainage Facilities	74,000
2) Marketing Facilities	0
3) Access Roads	208,000
4) Village/Farm Roads	57,000
5) Domestic Water Supply Facilities	0
<b>Total</b>	<b>339,000</b>

## 1.4 Project Implementation, Operation and Maintenance Plan

### 1.4.1 Plan for Support Services During Project Implementation

#### 1) Support Services for Capability Build-up

At various stages of the project cycle, a number of agencies will provide support services aimed at capability build-up of farmers and farmers' organizations as illustrated in Figure 1.4-1. A summary of expected support services to be provided by these agencies is given as shown below;

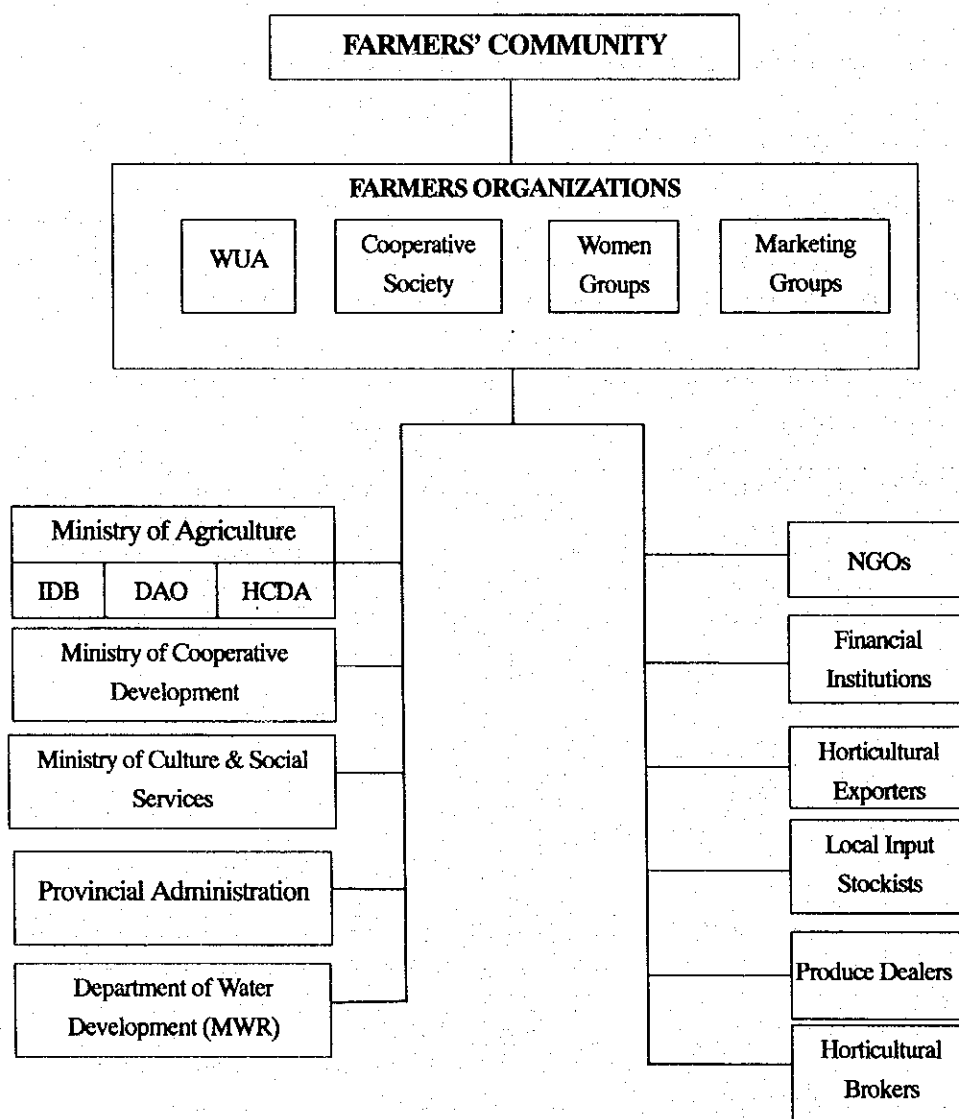
#### Agencies Providing Capability-build-up Services During Project Implementation

Project Stage	Agency	Type of Capability-Build-up Service
1. Project Planning	a) MOA/IDB	- Social preparation of project community - Facilitation of WUA planning sessions (activities, subactivities)
	b) MOA/DAO	- Acting as resource persons during social preparation sessions
	c) Local NGOs	- Acting as resource persons during social preparation sessions
2. Project Design	a) MOA/IDB	- Facilitating WUA design review sessions (availing design model, explaining design criteria and expected mode of operation of design elements) - Actively seeking women input into the design
	b) MWR	- Awarding and securing water rights for WUA
	c) Local NGOs	- Acting as resource persons
3. Project Funding	a) MOA/IDB	- Advising on project costing and alternative sources of project funding - Explaining funding conditions and procedures for various funding agencies
	b) Local NGOs	- Training WUA members on group formation for security fund contributions, banking operations, loan funds & loan servicing procedures
	c) MOCSS	- Assisting farmers on harambee organization
	d) Provincial Administration	- Facilitating harambee organization by issuing license
4. Project Construction	a) MOA/IDB	- Advising WUA on criteria for tender assessment and contractor selection, required supervision and quality control aspects of construction activities
	b) Local NGOs	- Training WUA committee on contractor payment procedures
5. Project (O&M)	a) MOA/IDB	- Facilitating and acting as resource persons during O&M sessions
	b) MOA/DAO	- Acting as resource persons during O&M sessions

2) Agencies Providing Support Services After Project Implementation

After completing installation of the irrigation infrastructure, the farmers will need to be provided with a range of post-construction support services to enable them make the best use of the harnessed irrigation water. Such services and agencies that can provide them are discussed below.

**Figure 1.4-1 Institution Arrangements for Providing Support Services to Farmers Organizations during Project Implementation**



#### a) Training and Research Services

KARI's Regional Research Station is already involved in on-farm research activities within the Project Area. Once irrigation horticultural production begins, it is planned that the research station will shift its research focus to irrigated horticulture particularly on the following felt needs (ref. to Problem Tree).

- Crop pests and diseases
- Low crop yields
- Lack of new crop introductions
- Disease and pest management

The planned research activities will be on-farm as well as participatory and will offer a training opportunity to both project farmers and extension staff at the divisional and locational levels. In addition, the research station will be expected to invite project farmers and associated extension staff to an annual on-station field day for training in new horticultural production techniques such as use of drip irrigation, recommended sprinkler handling methods, crop management as well safe handling of farm chemicals.

#### b) Extension Services

The DAO office, through its division field station, is responsible for providing extension services to the Project Area. With the on-set of a re-structured extension strategy (currently under preparation), the division centre will play the more important role of planning training programmes and overseeing performance of front-line extension workers (FEWs).

In order to provide adequate extension support to the project's irrigation community, the division extension office is expected to do the following;

- Plan, execute and monitor an extension programme that will participatory and pay special attention to production/market groups as well as women groups
- Appoint a front-line extension worker whose coverage will be limited to the irrigation project only
- Facilitate and coordinate all-round farmers training (field days, demonstration, agricultural shows, farmers training centre, visits to other irrigation schemes)
- Facilitate erection of a field office within the Project Area to be cost-shared with the farming community
- Make arrangements for the project FEW as well as divisional level back-stopping staff to be trained in participatory approaches, improved extension packaging and delivery methods as well as irrigated horticultural production
- Facilitate a one day annual review of irrigation project performance by the farmers and other stake holders.

#### c) Community Development and Organization Services

The irrigation project is planned to address one out of many problems facing the project community. Using the irrigation project to illustrate what collective action can achieve, the project community will be encouraged to address other outstanding problems (ref. to Problem Tree).

In this regard, it is proposed to provide support services from two sources;

- From a community organizer, deployed by an NGOs or consulting firm on short-term contracts, who will support and animate the local community in taking necessary courses of action
- From staff of the district social services office (Ministry of Culture and Social Services) who will be encouraged to provide assistance from time to time on community development issues

d) Basic Skills' Development, Industrial and Entrepreneurial Training

Within the project community (particularly at Kibugu trading centre) there are a number of artisans that include black-smiths, plumbers and masons. The Project Coordinator will make arrangements aimed at enlisting artisans within the project into the on-going World Bank/USAID training programme. Under this programme, vouchers are given to approved artisans for training in relevant technical and business skills in approved institutions (polytechnics and private firms).

Of particular interest to the project will be the training in plumbing, metal works as well as masonry since these are the skills that will be needed during the operation and maintenance phase.

e) Agricultural Credit Services

Here, agricultural credit for the small-scale irrigation is mainly described. Kenyan government policies on the small-scale irrigation project are as follows:

- Application of the project from farmer's side
- Establishment of irrigation group/WUA
- Full cost recovery by beneficiaries
- Operation and maintenance by irrigation group organized by farmers
- Irrigation facilities with easy O&M

Credit service for the small-scale irrigation project is given by Development Bank of Kenya (DBK) as of August 1998. SISDO also works in the field of technical assistance for farmers. Though Cooperative Bank of Kenya (CBK) has dealt with credit for small-scale irrigation project before, it has shifted to DBK at present. The current credit conditions are not changed such as 15 percent of security funds, four years repayment period, three to six month's grace period, but interest rate was improved to 16 percent.

The principle that project cost is burdened by farmers might be justifiable from the viewpoint of stimulating farmer's self-reliance. However, conditions of farm economy are quite different in each area. It is generally said that farmers who will be given credit are smallholders facing shortage of funds. This can be said for Ruringiri Ngerwe Area, too. Therefore, it must be regarded that credit for small-scale irrigation is one of poverty alleviation and must not impose farmers excessive credit conditions. In other words, credit with long- term repayment period (more than four years), low interest should be considered.

f) Fostering of Farmers' Capability

Provision of post-construction support services is aimed at enhancing the capability of individual farmers in managing her/his farm resources. Apart from financial incentives, the farmers capability should be recognized as a national asset and encouraged.

In this connection, it is planned that MOA will every year select the best three irrigated horticultural farmers within the project for award of prizes. The annual performance review session would be an ideal time and venue for such awards which would be handed over by a distinguished guest e.g. district commissioner or director of agriculture. During this particular day, the three winning farmers should be lionized as the heroes of the hour and this should serve to foster pursuit of excellence among the project community.

g) Marketing, Post-Harvest and Other Institutional Support

The seminars for smallholders arranged by and held at Jomo Kenyatta University of Agriculture and Technology (JKUAT) and other institutions managed by the government can help very much to motivate farming and for decision making for farmers and beside DAO officers and HCDA expert can be important information sources

**Institutional Support on Marketing**

Problems/Constraints	Interventions	Agency Concerned	Outputs
<b>Seminar hold at JKUAT and other institutions managed by the government</b>			
Inadequate agricultural extension services	Lecturing and practice on horticultural produce	MOA staff on horticulture with lectures/technicians	Better husbandry and reducing losses caused by diseases
Lack of market information	Lecturing on market trend in key wholesale markets	Marketing officer of Marketing Information Branch of MOA	Understanding methods of price enumeration on the newspaper and analysis of data.
Lack of marketing groups	Lecturing on farmers' marketing groups through PCM workshop	MOA staff on farmers' organization	Strengthening farmers' bargaining skills
Exploitation of middlemen	Introduction of farming contract	Marketing officer of HCDA	Improved transaction mode
Lack of knowledge of market demands for export produce	Lecturing on grading technique and measures for MRLs Lecturing on foreign market trend	Marketing officer of HCDA Technical staff of FPEAK or exporter	Reducing post-harvest losses caused by reject and understanding EU market demands in MRLs
Low quality of produce (in seed quality)	Lecturing on selection and procurement of certified seeds / seedlings	KARI	Assurance of high rate of germination and selection of marketable varieties
Lack of knowledge what are marketable produce/varieties or buyers' demands	Field trip pursuing marketing route	MOA staff expert on farmers' organization	More accessing to upper stream of marketing, understanding produce of other farmers and proposing sites are Nairobi markets, exporters' grading & packing facilities, Nairobi Horticultural Centre for auction, coffee auction
<b>Local institutional support</b>			
Lack of market information	Provision of data collected (weekly base data can be referred)	Marketing officer of DAO-Embu Marketing expert of HCDA-Embu	Better crop planning and outflows to the market and traders
Exploitation of middlemen	Witness of the contract with exporters	Marketing expert of HCDA-Embu	Immediate arbitration action

## 1.4.2 Facility Construction and Equipment Supply

### 1) Implementing and Supervising Agencies of the Project

The lead implementing agency shall be the MOA and supporting agencies be national line agencies, local governments, NGOs, JKUAT and financial agencies. An Executive Steering Committee (ESC) shall be established headed by National Project Coordinator (NPC) to be Permanent Secretary of MOA, with membership of representative of related national line agencies and NGOs. A Technical Working Committee (TWC) shall also be established under ESC for smooth implementation of the Project. Both ESC and TWC shall be located in Nairobi. Under TWC, District Project Management Office (DPMO) shall be established at Embu for actual project implementation at the field level. Proposed organization chart is presented in Figure 1.4-2.

### 2) Implementation Framework

Prior to the construction works, implementation of social preparation and institutional strengthening as a part of community development shall be rendered by suitable agencies such as consultants and NGOs which are hired on a contract basis by ESC. In the course of implementation of social preparation, community initiative shall be fully followed.

On the other hand, facility construction shall be on contract basis with labour intensive method wherever it is feasible. Irrigation & drainage improvement will be undertaken by small local contractors under supervision of DPMO. Access roads improvement will be carried out by equipment-based big contractors and village/farm roads will be by labour-based small contractors. Both access roads and village/farm roads improvement works will be supervised by consultants under direction of District Road Engineer. These contractors are selected through local tendering.

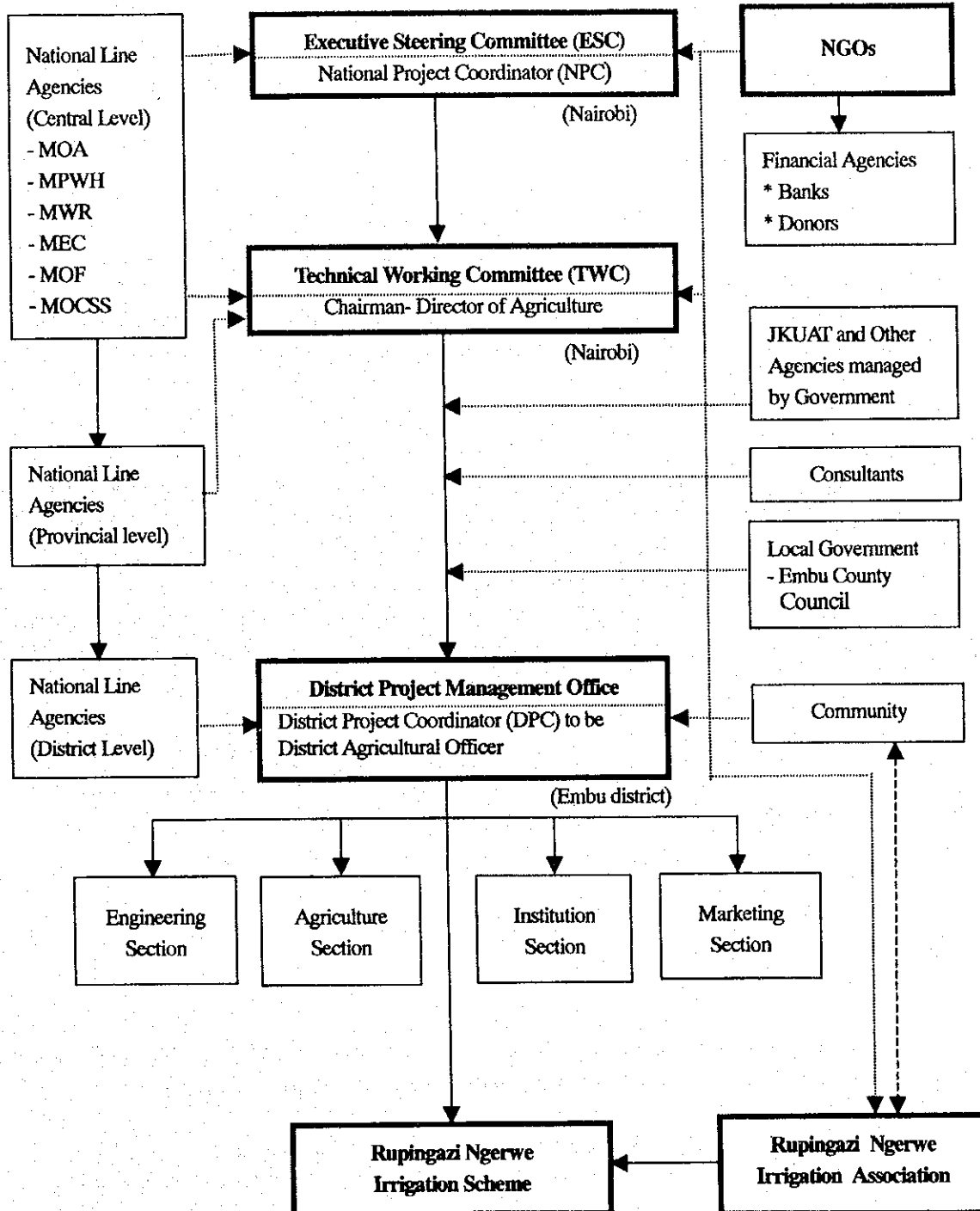
During and after the construction, community development together with support services for operation and maintenance of facilities shall be carried out by selected outside agencies with tight support of related government agencies. Well coordination among Rupingazi Ngerwe Irrigation Association, NGOs and government agencies must be provided by DPMO.

### 3) Implementation Process for Facility Construction

Proposed facilities under the Project are classified into two categories in terms of financial resources condition, i.e. one is self-help projects such as irrigation facilities, and the other is governmental public projects like access roads and village/farm roads.

Funds for self-help projects are planned to be on a cost recovery basis (in case of loan or self-contribution) or cost sharing basis (in case of partial grant or government support) or combination of those. On the other hand, governmental public projects are to be financed by the government which has to procure necessary funds from various sources such as government own budget, donor countries assistance in a form of loan/grant, international development bank loan, etc. Implementation process and period are relatively different between self-help and governmental public projects and they depend on project funds availability. Therefore, project implementation procedure is formulated by such project category.

**Figure 1.4-2 Proposed Organization Chart for Project Implementation for Rupingazi Ngerwe Irrigation Scheme**



← Control/Supervision  
 ← Tight Support/Monitoring  
 ← Cooperation



#### a) Self-help Projects

There are three major implementing bodies to be involved in the self-help projects, i.e. WUA, NGOs and ESC. Rupingazi Ngerwe Irrigation Association (WUA) is beneficiary group who has to bear the project cost. DPMO shall be responsible for all physical works, engineering works, construction supervision and consultation of the projects. ESC shall act on overall promotion, supervision and monitoring the projects. Detailed implementation process and flowchart for self-help projects are presented in Annex R.

#### b) Governmental Public Projects

Two government agencies are considered to be the actual implementing body, i.e. MPWH for classified access roads and Embu County Council for village/farm road improvement. Consultants shall be hired to undertake all physical works from the road identification survey up to construction supervision. Detailed implementation process and flowchart for governmental public projects are presented in Annex R.

#### 4) Implementation Schedule

Since project funds are not immediately available by both the government and self-help groups as well as procedure of fund procurement is different depending on project type, implementation schedule shall be formulated under certain conditions. Important factors for realization and successful implementation of the Project are social preparation for community development, fund procurement for self-help projects and follow-up support services for sustainability. Although each Project is very small-scale, the effort for these works would take longer time span and implementation must proceed step by step on community initiative basis.

It is assumed that the total implementation period for each Project will be seven years which consist of one and half years for social preparation, one and half years for construction and four years for follow-up support services. Proposed implementation schedule is presented in Figure 1.4-3.

### 1.4.3 Operation and Maintenance Plan of the Project

#### 1) Operation and Maintenance Organization

Executing agencies/bodies for the operation and maintenance (O&M) of facilities built under the Project are classified into two categories, i.e. public and private sectors (Refer to Annex R).

- |                  |                             |   |
|------------------|-----------------------------|---|
| - Public Sector  | : (1) Access roads          | : District Works Office, Embu, (MPWH)     |
| - Private Sector | : (1) Irrigation facilities | : Rupingazi Ngerwe Irrigation Association |
|                  | (2) Village/farm roads      | : Village community including Association |

Figure 1.4-3 Implementation Schedule for the Improvement of Rupingazi Ngerwe Irrigation Scheme

Work Item	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
<b>A. Social Preparation and Institutional Strengthening</b>							
1. Procurement of Funds (for support services)	=====						
2. Consultation at Village Level	=====						
3. Consultation at District Agricultural Office and Other Local Agency Level	=====						
4. Formation of Executive Steering Committee (ESC), Technical Working Committee (TWC), and District Project Management Office (DPMO)	=====						
5. Strengthening of Institutions							
a) IDB Field Office	=====						
b) Other Local Agencies	=====						
6. Selection and Contracting of NGOs	=====						
7. Social Preparation for Community Development	=====						
<b>B. Facility Construction and Equipment Supply</b>							
1. Apply Water Permit and Preparation Work	=====						
2. Survey, Detailed Design and Costing		=====					
3. Procurement of Funds (for construction works)		=====					
4. Consulting Services by NGOs and Consultants		=====					
5. Construction Works							
<b>C. Community Development, Support Services and O&amp;M</b>							
1. Community Development							
2. Agricultural Support Services							
3. Water Management Training Services							
4. Marketing Support Services							
5. Operation and Maintenance of Project Facilities							

## 2) Operation and Maintenance Plan of the Project

### a) Agricultural Development

#### Demonstrations

Demonstrations are used for technology which has been tested and proved to be suitable for the Rupingazi area, such as hybrid maize seed at KARI in Embu, but it has not yet been widely adopted. They are intended to be convincing proof that the technology is worth adopting. Demonstrations will be carried out by project staff in conjunction with the farmers themselves. An appropriate site will be chosen dependent on the nature of the particular demonstration, and the farmers interest. Different locations will be used for individual demonstrations and will shift from season to season. To encourage participation, the inputs will be provided by the project, but the farmers will be responsible for all of the husbandry. After the demonstration has been visited, perhaps during a field day and fully assessed, all of the production will remain the property of the participating farmer.

#### Trials

Trials are used for technology that is believed to be an improvement on the existing methods, but has not been tested under the particular conditions of the Project Area. Trials will also be conducted on farmers fields, primarily to test new technology under farm conditions, for example out of season snow pea production. Successful trials will also have a demonstration effect. These trials will be laid out by project staff, with the assistance of the land owner. The inputs will be provided by the project, and the farmers will be responsible for all of the husbandry. In the case of a crop failure, the project will reimburse the farmer for the lost production using the current crop compensation rates for wildlife damage in Embu district.

#### Livestock

Access to improved lines of poultry and urea feeding blocks will be facilitated by the project. The farmer will be responsible for the costs involved.

#### Improved inputs

After testing and demonstrating improved inputs such as new cabbage and maize varieties, urea feeding blocks, pesticides etc, the project will encourage the private sector stockists in the vicinity to stock the products. If necessary the project will facilitate the access to these improved inputs. The farmers will be responsible for the direct costs involved.

### b) Agricultural Infrastructures

#### - Irrigation Facilities

O&M of irrigation facilities shall be executed by existing Rupingazi Ngerwe Irrigation Association. During the O&M stage, technical support shall be extended by the Irrigation Unit of District Agricultural Office, Embu (MOA).

Major O&M activities are water distribution management, cleaning and repair of canals, repair of structures and so on. Water guards shall be hired for water distribution management. Adequate membership fees shall be collected by the association committee from beneficiary members for water management and maintenance activities.

- Village/Farm Roads

Since village/farm roads belong to County Council, its improvement is planned to be undertaken by Embu County Council. However, maintenance of these roads can be conducted by village community as presently carried out due to lack of road maintenance fund in the local government. Arrangement and scheduling of maintenance activities shall be made by village community.

Major O&M activities are routine maintenance which includes repair and cleaning of roads and side ditches, spot gravelling and repair of road structures. Technical and equipment support shall be extended by County Council or District Works Office (MPWH) when required for the maintenance activities.

c) Rural Infrastructures

- Access Roads

E632 Minor Road as an access road to the Project Area is also functioned as an important farm-to-market road connecting between Embu town and Kibugu area. Maintenance of access roads shall be undertaken by District Works Office, MPWH since classified roads belong to MPWH.

Routine maintenance as a major activities includes repair and cleaning of roads and side ditches, spot gravelling and repair of road structures. Such maintenance activities shall be carried out under labour-based method (LBM) which has a direct impact on the living environment of low income communities.

d) Post-Harvest and Agro-Industry

The grading and packing shed and charcoal store shall be operated by farmers marketing groups.

## **1.5 Project Evaluation and Cost Recovery**

### **1.5.1 Economic Evaluation**

#### **1) Method of Economic Evaluation**

The methods used for the economic evaluation are the same as other cases of four Project Area. Economic internal rate of return (EIRR) is adopted as the index judging economic viability of the small-scale irrigation project in Rupingazi Ngerwe Area. Even if EIRR is low in the result, irrigation project in the Area should be implemented as one of the policy for poverty alleviation program on the consideration that beneficial farmers are small holders living on low incomes. The standard EIRR of agriculture project in Kenya is eight percent.

Incremental agricultural benefit and economic project cost are discounted by using discount rates during 30 years of project life to get EIRR which is the discount rate at which total of present values of cost and benefit become equal. Annual operation and maintenance cost is included in the project cost.

Local currency (LC) in the financial project cost is converted to economic project cost by adopting standard conversion factor (SCF). On the occasion, tax, subsidy, the cost of land acquisition and compensation, contingency for price escalation are not included in the economic project cost. The cost for road improvement and preparing topographical maps are included in the project cost.

## 2) Price of Commodities

Farmgate prices in Rupingazi Ngerwe Area are based on the data obtained through the farm economic survey conducted by Study Team in June 1998. And the prices of agricultural inputs are collected in the farm economic survey and interview to stockist in Embu town. These prices are financial prices and utilized in financial analysis.

Economic price adopted in the economic evaluation of the project is estimated based on the forecasted price by the World Bank, which is released regularly. Economic prices of maize and coffee cultivated in the Project Area were estimated based on these data by World Bank. Meanwhile, financial price is regarded as economic price about the crop consumed mainly in domestic market. The price of fertilizer is based on the World Bank's long-term prediction. Financial price and economic price in Rupingazi Ngerwe area are shown in the Table 1.5-5.

## 3) Project Benefits

Project benefit is generated mainly from the increase in agricultural production. The difference between without Project and with Project cases is presented in terms of money. Basis of benefit estimation is on present land use and proposed land use. Information on the present land use was collected in the farm economic survey by Study Team, and proposed land use for Rupingazi Ngerwe Area was prepared taking into consideration the present agriculture, conditions of land, soil and climate, demand for crops, farmer's experience etc. The increase of irrigation area and crop yield with construction of the irrigation facilities will generate benefits. Though some area will remain dependent on the rainfed farming even after the project implementation, it can be expected that crop yield will be increased by the improvement of agricultural extension services and farmers' training. As the result, incremental agricultural benefit under these assumption in Rupingazi Ngerwe Aea is estimated at 2,506 thousand Ksh (refer to Table 1.5-6).

The project also includes road improvement which is composed of access road, farm road and village road. Of which, farm and village roads are improved by government, but maintained by farmers. Effects on road improvement are evaluated from national economic point of views. Benefit of road improvement could be calculated based on cost saving of fuel consumption with speed up of vehicles and shortening of transportation hours. As the result, road improvement benefit in Rupingazi Ngerwe Area is estimated at 6,321 Ksh (refer to Table 1.5-7).

#### 4) Economic Project Cost

The economic project cost for Rupingazi Ngerwe Area, which was estimated based on the principles mentioned in the paragraph of 1), is accounted at 32,663 thousand Ksh. As construction materials and labour necessary for the construction of irrigation facilities can be procured in Kenya, there is not foreign currency portion but local currency. The annual operation and maintenance is estimated at 317 thousand Ksh/year (refer to Table 1.5-8).

#### 5) Economic Internal Rates of Return

EIRR of the small-scale irrigation project in Rupingazi Ngerwe Area is calculated at 6.3 percent. Though this EIRR is under eight percent of the standard EIRR for irrigation project in Kenya, the project should be implemented considering that the project is for smallholders who are in low living standard, and implementation of irrigation project is ranked priority in the farm economic survey (refer to Table 1.5-9). Though mapping cost is not included in the project cost because JICA Study Team made it by its own payment, if including it, EIRR is 6.1 percent.

#### 6) Sensitivity Analysis

Sensitivity Analysis was made to verify the effect on EIRR with several assumed parameters mentioned below;

	<u>EIRR(%)</u>
i) 10 percent increase in project cost	5.16
ii) 10 percent decrease of project benefits	4.86
iii) three years delay of benefit generation	3.96
iv) combination of i) and ii)	3.86
v) combination of ii) and iii)	2.94

### 1.5.2 Financial Analysis of Typical Farmers

This is analysis of effect on change in farm household income with the small scale irrigation project in Rupingazi Ngerwe Area. The analysis compares the difference in income in without Project and with Project cases for standard farm household. The analysis is verified involving living expenses and off-farm income which were collected through the farm economic survey Study Team and price escalation for four years is taken into account.

The result of verification is shown in Table 1.5-10. In the case of without Project, farm household income is totaled at 98,237 Ksh including animal and off-farm incomes, and disposable income will be 38,543 Ksh. While, in the case of with Project, income will be 108,166 Ksh and disposable income is 48,472 Ksh, indicating that farm economy can be expected to improve with the irrigation project.

### **1.5.3 Cost Recovery Analysis of the Project**

Cost recovery analysis is to judge whether beneficial farmers can bear the burden of project cost with increased income. On the occasion, since farm road and village road are improved by government, farmer will bear the burden of operation and maintenance cost of these roads. And the cost of preparing topographical maps is planned to be burdened by the farmers. As mentioned above, farmers will get disposable income of 48,472 Ksh with project implementation. It is verified that farmers can repay the project cost within the disposable income.

The study on cost recovery was made by changing interest rates and repayment period in addition to the current credit condition to calculate monthly repayment. If monthly repayment is within the disposable income, it is judged that beneficial farmers have ability to cost recovery. The result is that farmers will have ability for cost recovery as the monthly repayment per farm household is estimated at 632 Ksh even under the current credit conditions. However, further generous credit conditions for smallholders in Ruringazi Negerwe Area will be 12 percent of interest, six years repayment in the case-2. Some alternative plans for possible credit conditions involving the case studies of excluding and including mapping cost are shown in Table 1.5-11. As the result, effect on involving mapping cost of farmer's share is considered small.

### **1.5.4 Study on the Proper Water Charge**

In operating the irrigation services, water charge collection is necessary to use the irrigation facilities with sustainability and to maintain irrigation benefits as well. Water charge is spent for i) the management of WUA, ii) salary for water guards, iii) repairing cost and so on. Proper water charge is calculated at 2,959 Ksh/ha/year, that is, 247 Ksh/ha/month.

### **1.5.5 Social and Environmental Effects by the Project**

There are tangible and intangible benefits generated by the Project. Some intangible benefits often have important meanings. The effects are as follows;

- The implementation of irrigation project become a model case of small-scale irrigation project not only in Embu district but also in other similar areas. As smallholders account for 98 percent in Kenya, it will considerably affect other areas.
- The strengthening of agricultural extension services and execution of educational training for farmers will provide good examples for future supporting service plans.
- The operation and maintenance of irrigation facilities by farmer's group will become a sample for other areas to adopt.
- The farm household income will increase temporarily by participating in construction of irrigation facilities.
- Farmers will foster their harmony in rural community through maintaining irrigation facilities as a common property of the rural society.
- Various activities in the hard and soft-aspects by many agencies will give ideas for promoting supports to the small scale irrigation project in the future.

**Table 1.5-1 Standard Conversion Factor**

	(unit:1,000 K.Pound)							
	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	Average
(1)Imports	2,545,630	2,645,913	2,945,863	5,056,419	5,753,988	7,758,420	8,424,310	5,018,649
(2)Exports	1,244,010	1,629,467	1,742,268	3,678,247	4,282,132	4,866,950	5,910,000	3,336,153
(3)Import Duties	347,968	334,680	255,939	459,150	739,639	929,910	1,058,780	589,438
(4)Export Duties	729	70	740	222	130	0	0	270
(5)Subsidy on Exports	0	0	0	0	0	0	0	0
(6)=(1)+(2)	3,789,640	4,275,380	4,688,131	8,734,666	10,036,120	12,625,370	14,334,310	8,354,802
(7)=(1)+(2)+(3)-(4)+(5)	4,136,879	4,609,990	4,943,330	9,193,594	10,775,829	13,555,280	15,393,090	8,943,970
(8)SCF=(6)/(7)	0.916	0.927	0.948	0.950	0.931	0.931	0.931	0.934

Source:Economic Survey 1997  
Statistical Abstract 1995

**Table 1.5-2 Price Structure of Fertilizer**

	Urea	TSP	Muriate of Potash
1. Projected 2010 World market price(\$/ton in 1990 price)	131.8	106.7	90.3
2. Projected 2010 World market price(\$/ton in 1998 price)	145.3	117.6	99.5
3. Freight and insurance(US\$/ton)	40	40	40
4. CIF Monbasa(US\$/ton)	185.3	157.6	139.5
5. Unloading and port handling(US\$/ton)	9	9	9
6. Value Kenya border			
- in US\$	194.3	166.6	148.5
- in Ksh(61.19Ksh/US\$)	11,889	10,194	9,086
7. Domestic handling, transport, margin(Ksh/ton)	831	831	831
8. Wholesale price(Ksh/ton)	12,720	11,025	9,917
9. Transport to/from farm(Ksh/ton)	103	103	103
10. Farmgate price(Ksh/ton)	12,617	10,922	9,814
11. Farmgate price in nutrient(Ksh/kg)	27.4	24.3	16.4

Source:Commodity markets and the developing countries, February 1998, World Bank

**Table 1.5-3 Price Structure of Maize**

1. Projected 2010 world market price(\$/ton in 1990 price)	94.9
2. Projected 2010 world market price(\$/ton in 1998 price)	104.6
3. Quality adjustment(%)	90
4. World market equivalent(US\$/ton)	94
5. Freight and insurance(US\$/ton)	40
6. CIF Monbasa(US\$/ton)	134
7. Unloading and port handling(US\$/ton)	9
8. Value Kenya border	
- in US\$	143
- in Ksh(61.19Ksh/US\$)	8,750
9. Domestic handling, transport, margin(Ksh/ton)	831
10. Processing ratio(%)	100
11. Wholesale price(Ksh/ton)	9,581
12. Transport to/from farm(Ksh/ton)	103
13. Farmgate price(Ksh/ton)	9,478

Source:Commodity markets and the developing countries February 1998,  
World Bank



**Table 1.5-4 Price Structure of Coffee and Tea**

	Coffee	Tea
1. Projected 2010 World market price(\$/ton in 1990 price)	1,812	1,405
2. Projected 2010 World market price(\$/ton in 1998 price)	1,997	1,549
3. Adjustment for quality(%)	95	90
4. Weighted average export price FOB price(US\$/ton)	1,897	1,471
5. Port charges/handling(US\$/ton)	9	9
6. Value at Kenya border(per ton)		
- in US\$	1,888	1,462
- in Ksh(81.19Ksh/US\$)	115,526	89,457
7. Domestic handling, transport, margin(Ksh/ton)	766	766
8. Ex-coffee factory price(Ksh/ton)	114,760	88,691
9. Yielding recovery(%)	15	20
10. Input price at coffee factory(Ksh/ton)	17,214	17,738
11. Transport to/from farm(Ksh/ton)	20	20
12. Farmgate price(Ksh/ton)	17,194	17,718

Source. Commodity markets and the developing countries, February 1998, World Bank

Table 1.5-5 Farmgate Price at Rupingazi Ngerwe

	Unit	Unit Price(Ksh)	
		Financial	Economic
<b>1. Crops</b>			
Maize	kg	11.5	9.5
Maize Green	kg	10.0	10.0
Sorghum	kg	15.0	15.0
Millet	kg	20.0	20.0
Beans	kg	31.6	31.6
French Beans	kg	29.6	32.6
Irish Potatoes	kg	11.7	11.7
Sweet Potatoes	kg	5.0	5.0
Bulb Onions	kg	24.7	24.7
Tomatoes	kg	24.0	23.0
Cabbage	kg	10.7	10.7
Kale	kg	3.0	3.0
Carrots	kg	16.6	21.4
Okra	kg	23.0	25.1
Banana	Bunch	150.0	150.0
Coffee	kg	25.0	17.2
Tea	kg	16.8	17.7
Milk	kg	23.8	23.8
Macadamia nut	kg	29.0	29.0
<b>2. Seed</b>			
Maize	kg	90	84
Cabbage	kg	1,200	1,121
Bulb onion	kg	4,700	4,390
Tomatoes	kg	6,400	5,978
Carrot	kg	2,400	2,242
Kale	kg	1,200	1,121
<b>3. Fertilizer</b>			
Nitrogen	kg	24.6	27.4
Phosphate	kg	17.0	24.3
Potassium	kg	23.8	16.4
<b>4. Agricultural Chemicals</b>			
Dimethoate	lit.	600	560
Sancozeb	kg	460	430
Milraz	kg	1,450	1,354
Karate	lit.	1,395	1,303
<b>5. Labour</b>			
Labour	MD	70	35
Animal Labour	MAD	1,000	500
<b>6. Nursery</b>			
Banana	plant	50	50
Coffee	plant	50	50
Papaya	plant	40	40
Mango	plant	60	60
Avocado	plant	50	50
Tea	plant	50	50
Passion fruit	plant	50	50
Macadamia nut	plant	60	60
Cashew nut	plant	50	50

Source: Farm Economic Survey (JICA) 1998 and interview survey to stockists

Table 1.5-6 Estimation of the Agricultural Benefits

	Maize		Cabbage/ French		Sweet Napier		Other		Perennial Crops		Total	
	Green	Maize/ Beans	Beans	Potato	Kale	Beans	Potato	Grass	Millet	Veget.		Coffee
<b>(A) Rainfed Areas</b>												
I. Without Project												
Unit price(Ksh/kg)	0	9.5/31.5	31.6	11.7	10.7	32.6	5.0	20.0	25.1	17.2	7.5	17.7
Yield(kg/ha)	0	1,750	600	7,500	10,000	3,000	6,500	12,000	850	4,000	4,500	10,000
Gross Income(Ksh/ha)	0	26,105	19,960	87,750	107,000	97,800	32,500	0	17,000	100,400	77,400	63,750
Cost of Production(Ksh/ha)	0	13,053	6,342	60,328	6,763	41,274	9,105	4,001	11,100	12,343	5,994	7,997
Net Return(Ksh/ha)	0	13,052	12,618	27,422	100,237	56,526	23,395	12,999	89,300	65,057	57,756	169,003
Planted Area(ha)	0.00	95.95	53.98	5.11	8.10	0.81	1.00	0.30	0.30	2.74	57.30	0.58
Total Net Return(1,000 Ksh)	0	1,252	681	140	812	34	23	0	4	245	3,728	33
II. With Project												
Unit price(Ksh/kg)	0	9.5	31.6	11.7	10.7	0	0.0	0.0	20.0	25.1	17.2	7.5
Yield(kg/ha)	0	2,000	650	8,000	11,000	0	0	12,000	850	4,500	4,500	10,000
Gross Income(Ksh/ha)	0	31,640	20,540	93,600	117,700	0	0	17,000	112,950	77,400	63,750	177,000
Cost of Production(Ksh/ha)	0	13,683	6,635	63,499	7,122	0	0	4,293	12,141	12,527	8,667	9,234
Net Return(Ksh/ha)	0.00	17,957	13,905	30,101	110,578	0	0	12,707	100,809	64,873	57,083	167,766
Planted Area(ha)	0.00	75.79	53.91	5.16	8.87	0.00	0.00	0.32	1.61	2.26	47.13	0.58
Total Net Return(1,000 Ksh)	0	1,362	750	155	738	0	0	20	228	3,057	33	715
III. Incremental Benefit(1,000 Ksh)	0	110	69	15	-74	-34	-23	0	17	-17	-670	-0
<b>(B) Irrigated Areas</b>												
I. Without Project												
Unit price(Ksh/kg)	10	0	31.6	0	10.7	0	0.0	0.0	20.0	25.1	0	0
Yield(kg/ha)	3,000	0	700	0	14,500	0	0	0	900	5,000	0	0
Gross Income(Ksh/ha)	30,000	0	22,120	0	155,150	0	0	0	18,000	125,500	0	0
Cost of Production(Ksh/ha)	7,740	0	7,558	0	7,739	0	0	0	4,056	12,109	0	0
Net Return(Ksh/ha)	22,260	0	14,562	0	147,411	0	0	0	13,944	113,391	0	0
Planted Area(ha)	4.56	0.00	0.30	0.00	2.43	0.00	0.00	0.00	1.22	1.03	0.00	0.00
Total Net Return(1,000 Ksh)	102	0	4	0	358	0	0	0	17	117	0	0
II. With Project												
Unit price(Ksh/kg)	10	9.5	31.6	0	10.7	32.6	5.0	0.0	25.1	17.2	7.5	0
Yield(kg/ha)	4,000	2,250/800	750	0	16,000	4,000	8,500	15,000	0	6,000	5,000	10,000
Gross Income(Ksh/ha)	40,000	40,335	23,700	0	171,200	130,400	42,500	0	150,600	86,000	75,000	0
Cost of Production(Ksh/ha)	9,312	16,597	8,760	0	11,282	44,802	12,557	0	19,385	15,512	8,687	0
Net Return(Ksh/ha)	30,688	23,738	14,940	0	159,918	85,598	29,943	0	131,215	70,488	66,313	0
Planted Area(ha)	4.84	32.02	2.20	0.00	4.00	10.80	5.80	0.16	0.00	0.97	10.01	3.20
Total Net Return(1,000 Ksh)	149	760	33	0	640	924	168	0	127	706	212	0
III. Incremental Benefit(1,000 Ksh)	47	760	28	0	281	924	168	0	-17	10	706	212
<b>(C) Incremental Benefit(1,000 Ksh)</b>												
	47	870	97	15	207	890	144	0	-0	-6	35	212
												-5
												2,506

**Table 1.5-7 Estimation of Benefits on the Farm and Village Roads Improvement**

① Fuel Consumption( 2 ton truck)

15km/hour	0.180 lit./km
20	0.160
30	0.135
40	0.116
50	0.105

② Speed(Km/hr)

	<u>without Project</u>	<u>with Project</u>
Rupingazi Ngerwe	20	40
Ngomano/Nyangati	40	50
Nkunjumo	30	40
Ruungu/Karocho	15	40

Note. Figures in parenthesis are fuel consumption(lit./km)

③ Road Length to be Improved(km)

	<u>without Project</u>	<u>with Project</u>
Rupingazi Ngerwe	7.5	7.5
Ngomano/Nyangati	3.2	3.2
Nkunjumo	2.5	2.5
Ruungu/Karocho	40.5	40.5

④ Fuel Consumption per Unit(lit.)

	<u>without Project</u>	<u>with Project</u>
Rupingazi Ngerwe	2.4	1.7
Ngomano/Nyangati	0.7	0.7
Nkunjumo	0.7	0.6
Ruungu/Karocho	14.6	9.4

⑤ Amount of Fuel Consumption(Ksh)

	<u>without Project</u>	<u>with Project</u>	<u>Diffrence</u>
	23,167	16,796	6,371
	21,932	19,852	2,080
	9,417	8,092	1,325
	<b>373,357</b>	<b>240,608</b>	<b>132,749</b>

**Table 1.5-8 Project Cost and O&M Cost**  
Project Cost(Rupingazi Ngerwe)

	Financial Cost(Ksh)		Of Which,		Economic Cost(Ksh)	
	Total Cost	Private Sector	Govt/Public Sect.	Of Which,	Total Cost	Private Sector
<b>1. Construction cost</b>						
1) Irrigation & drainage improvement	3,713,856	3,713,856	0	0	3,468,742	3,468,742
2) Marketing improvement	0	0	0	0	0	0
3) Access roads improvement	3,694,300	0	3,694,300	3,694,300	3,450,476	0
4) Village/farm roads improvement	684,000	0	684,000	684,000	638,856	0
5) Rural water supply improvement	0	0	0	0	0	0
Sub-Total	8,092,156	3,713,856	4,378,300	4,378,300	7,558,074	3,468,742
<b>2. Community Development &amp; Supporting Services</b>						
1) Agricultural support services	10,640,000	0	10,640,000	10,640,000	9,937,760	0
2) Community development	7,078,500	0	7,078,500	7,078,500	6,611,319	0
3) Water management services	2,600,000	0	2,600,000	2,600,000	2,428,400	0
4) Marketing support services	376,000	0	376,000	376,000	351,184	0
5) Public health services	150,000	0	150,000	150,000	140,100	0
Sub-Total	20,844,500	0	20,844,500	20,844,500	19,468,763	0
<b>3. Associated Cost</b>						
1) Pre-engineering cost	306,481	0	306,481	306,481	286,253	0
2) Administration cost	2,025,563	0	2,025,563	2,025,563	1,891,876	0
3) Consulting services	2,893,663	371,385	2,522,278	2,522,278	2,702,681	346,874
Sub-Total	5,225,707	371,385	4,854,322	4,854,322	4,880,810	346,874
<b>4. Physical Contingency</b>						
Total	34,971,577	4,456,625	30,514,952	30,514,952	32,663,453	4,162,488

**Operation and Maintenance Cost(Rupingazi Ngerwe)**

	Financial Cost	(unit:Ksh/year)	Economic Cost
<b>Annual Operation and Maintenance Cost</b>			
1) Irrigation & drainage facilities	74,000	69,116	69,116
2) Marketing facilities	0	0	0
3) Access roads	208,000	194,272	194,272
4) Village/farm roads	57,000	53,238	53,238
5) Rural water supply facilities	0	0	0
<b>Total</b>	<b>339,000</b>	<b>316,626</b>	<b>316,626</b>

Table 1.5-9 Calculation of EIRR  
-Rupingazi Ngerwe-

(Unit:1,000 Ksh)

Year	Capital Cost	O & M Cost	Total	Benefit	Return	Present Value by Discount Rate					
						Interest= 0.16		Interest= 0.12		Interest= 0.10	
						Cost	Benefit	Cost	Benefit	Cost	Benefit
1	2,778	317	3,093	1,256	-1,837	3,093	1,256	3,093	1,256	3,093	1,256
2	8,427	317	8,744	1,507	-7,237	8,498	1,120	8,971	1,201	7,228	1,245
3	9,636	317	9,953	2,010	-7,943	6,376	1,288	7,084	1,431	7,478	1,510
4	4,050	317	4,367	2,261	-2,106	2,412	1,249	2,775	1,437	2,983	1,544
5	2,711	317	3,028	2,512	-516	1,442	1,196	1,718	1,425	1,880	1,560
6	2,711	317	3,028	2,512	-516	1,243	1,031	1,534	1,273	1,709	1,418
7	2,352	317	2,669	2,512	-157	944	889	1,207	1,138	1,369	1,289
8	0	317	317	2,512	2,195	97	766	128	1,015	148	1,172
9	0	317	317	2,512	2,195	83	661	114	906	134	1,065
10	0	317	317	2,512	2,195	72	569	102	809	122	968
11	0	317	317	2,512	2,195	62	491	91	722	111	880
12	0	317	317	2,512	2,195	53	423	81	645	101	800
13	0	317	317	2,512	2,195	46	365	73	576	92	728
14	0	317	317	2,512	2,195	40	314	65	514	83	661
15	0	317	317	2,512	2,195	34	271	58	459	76	601
16	0	317	317	2,512	2,195	29	234	52	410	69	547
17	0	317	317	2,512	2,195	25	201	46	366	63	497
18	0	317	317	2,512	2,195	22	174	41	327	57	452
19	0	317	317	2,512	2,195	19	150	37	292	52	411
20	0	317	317	2,512	2,195	16	129	33	260	47	373
21	0	317	317	2,512	2,195	14	111	29	233	43	339
22	0	317	317	2,512	2,195	12	96	26	208	39	309
23	0	317	317	2,512	2,195	10	83	23	185	35	281
24	0	317	317	2,512	2,195	9	71	21	165	32	255
25	0	317	317	2,512	2,195	8	61	19	148	29	232
26	0	317	317	2,512	2,195	7	53	17	132	27	211
27	0	317	317	2,512	2,195	6	46	15	118	24	192
28	0	317	317	2,512	2,195	5	39	13	105	22	174
29	0	317	317	2,512	2,195	4	34	12	94	20	158
30	0	317	317	2,512	2,195	4	29	11	84	18	144
<b>Total</b>	<b>32,663</b>	<b>9,510</b>	<b>42,173</b>	<b>72,346</b>	<b>30,173</b>	<b>22,687</b>	<b>13,400</b>	<b>25,490</b>	<b>17,930</b>	<b>27,184</b>	<b>21,274</b>
						EIRR= 6.26 %					

B/C Ratio= 16 % 0.59  
 B/C Ratio= 12 % 0.70  
 B/C Ratio= 10 % 0.78

**Table 1.5-10 Financial analysis for Standard Farm**

Farm size: 1.33 ha

**Without Project**

Crops	Planted Area(ha)	Yield (kg/ha)	Production (kg)	Unit Price (Ksh/kg)	Gross Income(Ksh)	Cost of		
						Production (Ksh)	Net Return (Ksh)	
Maize/Beans	0.84	1,750	1,473	11.5	16,934	10,897	14,000	
Beans/Maize	0.84	300	252	31.6	7,963			
Beans	0.47	600	284	31.6	8,970	4,134	4,837	
French Beans	0.01	3,000	30	29.6	888	491	397	
Other vegetables	0.22	4,000	880	23.0	20,240	4,057	16,183	
Coffee	0.47	4,500	2,115	25.0	52,875	5,801	47,074	
Banana	0.01	8,500	85	7.5	638	86	552	
<b>Total</b>	<b>2.02</b>						<b>83,043</b>	
1. Crop Income(Ksh/year)								<b>83,043</b>
2. Animal Income(Ksh/year)								<b>7,415</b>
3. Off-Farm Income(Ksh/year)								<b>7,779</b>
4. Living Expense(Ksh/year)-family size 7.6 persons/family								<b>59,694</b>
5. Disposable Income(Ksh/year)								<b>38,543</b>

**With Project**

**I. Rainfed Area**

Crops	Planted Area(ha)	Yield (kg/ha)	Production (kg)	Unit Price (Ksh/kg)	Gross Income(Ksh)	Cost of	
						Production (Ksh)	Net Return (Ksh)
Maize/Beans	0.69	2,000	1,380	11.5	15,870	11,989	12,822
Beans/Maize	0.69	400	278	31.6	8,722		
Beans	0.50	650	325	31.6	10,270	4,597	5,673
Other vegetables	0.19	4,500	855	23.0	19,665	3,743	15,922
Coffee	0.44	4,500	1,980	25.0	49,500	8,718	40,784
Banana	0.01	8,500	85	7.5	638	94	544
<b>Sub-Total</b>	<b>1.83</b>						<b>75,545</b>

**II. Irrigated Area**

Crops	Planted Area(ha)	Yield (kg/ha)	Production (kg)	Unit Price (Ksh/kg)	Gross Income(Ksh)	Cost of		
						Production (Ksh)	Net Return (Ksh)	
Maize/Beans	0.16	2,250	360	11.5	4,140	3,547	3,827	
Beans/Maize	0.16	600	96	31.6	3,034			
Maize green	0.02	4,000	80	10.0	800	245	35	
Beans	0.01	750	8	31.6	253	111	142	
French Beans	0.05	4,000	200	29.6	5,920	2,646	3,274	
Other vegetables	0.03	6,000	180	23.0	4,140	915	3,225	
Sweet Potato	0.03	8,500	255	5.0	1,275	499	776	
Coffee	0.05	5,000	250	25.0	6,250	1,174	5,076	
Banana	0.02	10,000	200	7.5	1,500	228	1,272	
<b>Sub-Total</b>	<b>0.37</b>						<b>17,427</b>	
1. Total Crop Income(Ksh/year)								<b>92,972</b>
2. Animal Income(Ksh/year)								<b>7,415</b>
3. Off-Farm Income(Ksh/year)								<b>7,779</b>
4. Living Expense(Ksh/year)-family size 7.6 persons/family								<b>59,694</b>
5. Disposable Income(Ksh/year)								<b>48,472</b>

**Table 1.5-11 Cost Recovery Analysis**

	Excluding Map Preparation	Including Map Pre.
Case-1 Present condition		
1) Number of beneficiaries	200 farm households	
2) Total project cost to be paid by the beneficiaries of which, irrigation facilities	34,971,577 Ksh 4,456,625 Ksh	4,976,563
3) Loan per farm household	22,283 Ksh	24,883
4) Repayment Period(years)	4 48 (months)	
5) Annual interest rate(%)	16 per year	
6) Monthly interest ratre(%)	1.33 (16/12)	
7) Monthly repayment(Ksh)	632 Ksh/month	705

Alternative Plans for Loan Repayment

Case-2		
1) Loan per farm household(Ksh)	22,283	24,883
2) Repayment Period(years)	6 72 (months)	
3) Annual interest rate(%)	12 per year	
4) Monthly interest ratre(%)	1.00 (12/12)	
5) Monthly repayment(Ksh)	436 Ksh/month	486

Case-3		
1) Loan per farm household(Ksh)	22,283	24,883
2) Repayment Period(years)	8 96 (months)	
3) Annual interest rate(%)	10 per year	
4) Monthly interest ratre(%)	0.83 (10/12)	
5) Monthly repayment(Ksh)	338 Ksh/month	378

Case-4		
1) Loan per farm household(Ksh)	22,283	24,883
2) Repayment Period(years)	10 120 (months)	
3) Annual interest rate(%)	5 per year	
4) Monthly interest ratre(%)	0.42 (5/12)	
5) Monthly repayment(Ksh)	236 Ksh/month	264

Case-5		
1) Loan per farm household(Ksh)	22,283	24,883
2) Repayment Period(years)	4 48 (months)	
3) Annual interest rate(%)	30 per year	
4) Monthly interest ratre(%)	2.50 (30/12)	
5) Monthly repayment(Ksh)	802 Ksh/month	896

Repayment under the Current Situation(Rupingazi Ngerwe)

Case-6		
1) Loan per farm household	22,283 Ksh	24,883
2) Repayment Period(years)	4 48 (months)	
3) Annual interest rate(%)	16 (% per year)	
4) Monthly interest ratre(%)	1.33 (16/12)	
5) Monthly repayment(Ksh)	632 (Ksh/month)	705
6) Monthly repayment and disposable income(Ksh)		

	Repayment	Disposable Income
1st year	632	83 (farm economic survey 1998)
2nd year	632	2,020
3rd year	632	2,830
4th year	632	4,039



Table 1.5-12 Estimation of Water Charge

(Unit:Ksh)

Year	Initial Cost	O & M Cost	Replac- ement Cost	Total	Present Value by Discount Rate														
					Int.= 0.16			Int.= 0.15			Int.= 0.20								
					Initial Cost	O&M Cost	Replac- ement	Total	Initial Cost	O&M Cost	Replac- ement	Total	Initial Cost	O&M Cost	Replac- ement				
1	0	74,000	0	74,000	0	74,000	0	74,000	0	74,000	0	74,000	0	74,000	0	74,000	0	74,000	0
2	2,228,312	74,000	0	2,302,312	1,655,999	54,994	0	1,710,993	1,684,924	55,955	0	1,740,879	1,547,439	51,389	0	1,600,000	1,547,439	51,389	0
3	2,228,313	74,000	0	2,302,313	1,427,586	47,409	0	1,474,994	1,465,152	46,658	0	1,513,806	1,288,533	42,824	0	1,350,000	1,288,533	42,824	0
4	0	74,000	0	74,000	0	40,870	0	40,870	0	42,310	0	42,310	0	35,687	0	35,000	35,687	35,687	0
5	0	74,000	0	74,000	0	35,232	0	35,232	0	36,791	0	36,791	0	29,739	0	29,000	29,739	29,739	0
6	0	74,000	0	74,000	0	30,373	0	30,373	0	31,992	0	31,992	0	24,782	0	24,000	24,782	24,782	0
7	0	74,000	0	74,000	0	26,183	0	26,183	0	27,819	0	27,819	0	20,652	0	20,000	20,652	20,652	0
8	0	74,000	0	74,000	0	22,572	0	22,572	0	24,181	0	24,181	0	17,210	0	17,000	17,210	17,210	0
9	0	74,000	0	74,000	0	19,459	0	19,459	0	21,035	0	21,035	0	14,342	0	14,000	14,342	14,342	0
10	0	74,000	0	74,000	0	16,775	0	16,775	0	18,292	0	18,292	0	11,951	0	12,000	11,951	11,951	0
11	0	74,000	0	74,000	0	14,461	0	14,461	0	15,906	0	15,906	0	9,960	0	10,000	9,960	9,960	0
12	0	74,000	0	74,000	0	12,466	0	12,466	0	13,831	0	13,831	0	8,300	0	8,000	8,300	8,300	0
13	0	74,000	0	74,000	0	10,747	0	10,747	0	12,027	0	12,027	0	6,916	0	7,000	6,916	6,916	0
14	0	74,000	0	74,000	0	9,264	0	9,264	0	10,458	0	10,458	0	5,764	0	6,000	5,764	5,764	0
15	0	74,000	0	74,000	0	7,987	0	7,987	0	9,094	0	9,094	0	4,803	0	5,000	4,803	4,803	0
16	0	74,000	0	74,000	0	6,885	0	6,885	0	7,908	0	7,908	0	4,003	0	4,000	4,003	4,003	0
17	0	74,000	0	74,000	0	5,935	0	5,935	0	6,877	0	6,877	0	3,335	0	3,500	3,335	3,335	0
18	0	74,000	0	74,000	0	5,117	0	5,117	0	5,960	0	5,960	0	2,780	0	3,000	2,780	2,780	0
19	0	74,000	0	74,000	0	4,411	0	4,411	0	5,200	0	5,200	0	2,316	0	2,500	2,316	2,316	0
20	0	74,000	0	74,000	0	3,803	0	3,803	0	4,521	0	4,521	0	1,830	0	2,000	1,830	1,830	0
21	0	74,000	0	74,000	0	3,278	0	3,278	0	3,932	0	3,932	0	1,609	0	1,800	1,609	1,609	0
22	0	74,000	0	74,000	0	2,826	0	2,826	0	3,419	0	3,419	0	1,340	0	1,500	1,340	1,340	0
23	0	74,000	0	74,000	0	2,436	0	2,436	0	2,973	0	2,973	0	1,117	0	1,200	1,117	1,117	0
24	0	74,000	0	74,000	0	2,100	0	2,100	0	2,585	0	2,585	0	931	0	1,000	931	931	0
25	0	74,000	0	74,000	0	1,810	0	1,810	0	2,248	0	2,248	0	776	0	800	776	776	0
26	0	74,000	0	74,000	0	1,561	0	1,561	0	1,955	0	1,955	0	646	0	700	646	646	0
27	0	74,000	0	74,000	0	1,345	0	1,345	0	1,700	0	1,700	0	538	0	600	538	538	0
28	0	74,000	0	74,000	0	1,160	0	1,160	0	1,478	0	1,478	0	449	0	500	449	449	0
29	0	74,000	0	74,000	0	1,000	0	1,000	0	1,285	0	1,285	0	374	0	400	374	374	0
30	0	74,000	0	74,000	0	862	0	862	0	1,118	0	1,118	0	312	0	350	312	312	0
Total	4,458,625	2,220,000	0	6,678,625	3,083,585	461,320	0	3,550,904	3,150,076	495,535	0	3,645,611	2,836,972	380,775	0	2,800,000	2,836,972	380,775	0

Annual 148,554 74,000 0 222,554 102,786 15,577 0 118,363 105,003 16,518 0 121,520 94,566 12,692 0

Water Charge

	Interest 0.16	Interest 0.15	Interest 0.20
a. Annual Water Intake	420,700 Ksh/year		
b. Cost	Present Value	Present Value	Present Value
b.1 Cost per year at financial price	102,786	105,003	94,566
b.2 Annual O&M cost at financial price	15,577	16,518	12,692
b.3 Replacement cost at financial price	0	0	0
Total	118,363	121,520	107,258
c. Water Charge			
c.1 per cubic meter	0.28 Ksh	0.29 Ksh	0.25 Ksh
c.2 per ha/year	2,959 Ksh	3,038 Ksh	2,681 Ksh
c.3 ha/month	247 Ksh	253 Ksh	223 Ksh

## 1.6 Project Monitoring and Evaluation

### 1) Necessity and Objectives of Monitoring and Evaluation

Irrigation improvement for Rupingazi Ngerwe Irrigation Scheme is planned to be implemented as a self-help project. Moreover, since community-based smallholder farmers in the rural areas are suffering from weak economic and technical foundation, follow-up support may be necessary to make the Project sustainable. Therefore, for certain period after commencement of the Project operation, actual benefits and impacts by the Project shall be properly obtained and evaluated through monitoring and evaluation works. Under such consideration, objectives of monitoring and evaluation of the Project are;

- To obtain and judge how many goals and targets initially formulated under the Project are attained,
- To judge whether follow-up support is required or not from viewpoint of project sustainability under self-help management, and
- To learn lessons, both positive and negative, from the Project in order to apply to other Project Areas.

### 2) Monitoring Works

Monitoring works shall be conducted on the following items;

- a) Irrigation system operation
  - Water distribution operation including irrigation water rotation
  - Condition of irrigation facilities such as intake, canals, division boxes, etc.
  - Condition of farmers participation and maintenance costs in O&M
  - Condition of water flow through the canals
- b) Access and village/farm roads maintenance
  - Road maintenance activities and conditions within the Project Area
  - Road accessibility of village/farm roads in the Project Area
  - Participation of community people in maintenance activities
  - Condition of support services to be extended by Embu County Council for O&M of village/farm roads
  - Condition of access roads maintained by MPWH
- c) Agricultural aspect
  - Condition of area irrigated, crops planted and crop yield
  - Condition of farm inputs such as seeds, fertilizer, pesticide, etc
  - Activities of extension workers from MOA
- d) Institutional aspect
  - Management and activities of Rupingazi Ngerwe Irrigation Association (irrigation group, women group, marketing group, cooperative society)
  - Management and activities of village community in relation to the maintenance of village/farm roads
  - Management and activities of cooperatives and women's group
  - Collection of O&M fee for irrigation facilities

- No. of days being held an education training, assembly meeting and its agenda.
- e) Marketing aspect
  - Changes in marketing condition
- f) Farm economy aspect
  - Changes in farm income and expenditure
  - Changes in farm gate price by crops
  - Crop budget including material cost, labour cost, etc.
  - Condition of water fee collection and repayment of loan to funding agencies/banks

### 3) Evaluation Works

Based on the data obtained from monitoring works, analysis and evaluation of the Project shall be conducted in consideration of goals and targets expected from the Project. Problems and constraints, if any, shall be analyzed and discussed with beneficiary groups/communities through workshop meetings. Countermeasures shall also be prepared as a follow-up support if necessary. Moreover, evaluation shall focus on the method how to apply to other Project Areas.

### 4) Implementation of Monitoring and Evaluation

It is essential to take community participation approach for implementation of monitoring and evaluation works. Workshop meetings will be held with association members, community members, women's groups, etc. during data collection, analysis and evaluation.

Monitoring and evaluation for the irrigation system operation and village/farm roads maintenance are carried out by NGOs under supervision of ESC for two years after completion of construction works. These will be the most important aspects since physical condition of facilities and its system functions of facilities are always the base of promotion of improved horticultural production.

Monitoring and evaluation of other aspects by NGOs as well can be conducted in the course of implementation of the community development and support services which are scheduled to implement up to four years after the construction.

## 1.7 Recommendations

### Agriculture

- a) The current dominant farming type in the Rupingazi Ngerwe Irrigation Scheme, which was classified as a Type-B in Model Area selection, is commercial-based coffee farming, and beneficial farmers have such strong willingness that preset farming type should be shifted to commercial-based coffee farming in combination with horticultural crops in the Area. Therefore, plan of agricultural farming in the Area should be formulated in the direction mentioned above.
- b) The trials and demonstrations will be conducted by the GOK staff in Agricultural Extension and Irrigation Development Department. The recipients will be the smallholders. The trials and demonstrations will be conducted on farmer's fields. The actual timing will be determined by the nature of the trial, and preparations will have to be made in advance of the planting season. The frequency will be as shown below. The method will be collaboration between individual farmers and the project.

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Demonstrations	2	2	1	1	1	7
Trials	2	2	2	1	1	8

- c) The training programs on crop cultivation will be conducted by GOK staff and hired professionals from private sectors. They will be given to interested farmers, and will be held in the field near to the irrigation scheme, in churches, meeting halls etc. for the periods of approximately every six months for the first two to two and a half years. These training programs will be linked to the trials and demonstration farms.

The programs will include topics such as selection of new varieties (e.g. maize hybrids) and how their production differs from traditional varieties, water management and irrigation techniques, animal nutrition including the use of urea supplement blocks, etc.

d) Others

- Introduction of adapted improved maize lines,
- Supply of virus free/improved planting materials,
- Implementation of trials off urea supplement blocks,
- Test of impact of deep plowing on plant growth

### Institutional Supporting Services

- a) The District Irrigation Unit at Embu should liaise with IDB, Nairobi in drawing a training programme specific to Rupingazi Ngerwe Irrigation Scheme for social preparation of the community and capability-building of relevant agencies such as department of social services and local private sectors.

- b) Project Coordinator (DPMO) should draw a training timetable for social preparation and capability building of relevant agencies.

### Irrigation and Drainage

- a) Considering the current situation whereby the proposed irrigation areas of 40 ha are spread over total farmland of 161 ha along the existing open canal with a length of 10.7 km, with irrigation water diverted directly from main and/or lateral canal directly through temporary gap, it is recommended to introduce a water management plan with a single rotation block with six irrigation groups. The WUA shall decide the area and location of proposed farmland to determine design capacity of the irrigation canal before the commencement of detailed design study.
- b) In order to realize effective water management, a water management manual shall be prepared by employing consultants. As part of the content of the manual, the following items as well as general techniques of water management shall be included, and training for members of the WUA, especially for members in the downstream area who have no experience on irrigation, shall be provided before actual irrigation begins.
- Adaptive organization for water management (general water management method for total system, organization of irrigation group)
  - Water operation rule (method of water distribution, observance of standard cropping pattern, formulation of penalty)
  - Water distribution method within the irrigation group (irrigation turn, irrigable area)
  - Irrigation method (furrow length, water application time per unit area)
  - Irrigation schedule
- c) It is recommended to obtain a water permit.

### Marketing

- a) Discussion and formulation of farmer's marketing groups,
- b) Contract farming with exporters as a marketing alternative,
- c) Practical utilization of social and natural resources for marketing advantages, i.e. i) huge inflow of horticultural produce into Embu wholesale market from other districts, ii) introduction of coffee cherry advance payment system (CAPS), iii) group buying system of farm inputs by coffee societies, iv) competition among macadamia nuts companies, v) use of organic fertilizer, vi) potential of production of export crops and farming contract, vii) facilities such as sheds and warehouses at coffee factory,
- d) Participation to related seminars for smallholders held at Jomo Kenyatta University of Agriculture and Technology (JKUAT) and other institutions managed by the government,

## Agricultural and Social Infrastructure

- a) Basic plan for the irrigation improvement shall be finalized based on feasibility study results through workshop meetings to be held with participation of association members before commencement of the detailed design.

## Project Implementation

- a) The main implementing agency of the Project is MOA, however, close cooperation and adjustment of work demarcation should be made among related government agencies such as MPWH, MWR, MEC, etc., since the Project involves many project components being related to each other.
- b) For the construction work of the self-help projects, detailed work allocation and responsibilities as indicated below, among Contractors, WUA and NGOs, which are directly related to the construction cost, shall be clearly presented to WUA in the detailed design stage;
  - Contents of works to be contributed by WUA in the form of labour,
  - Responsibility of procurement and management of materials, equipment and skilled labours, and
  - Responsibility of work quality and schedule.
- c) In the course of project implementation, farmers/farmers representatives should make reference to the on-going activities of classified Type-A smallholder irrigation schemes such as Ciambarage Irrigation Scheme in Tharaka Nithi and Muguna Water Project in Meru district for their horticultural development.
- d) For the planning of irrigated horticultural development for each Model Area, Study Team prepared the topographic map with scale of 1:5,000 in scale applying aerial photography and ground survey methods. Its cost is about 669 thousand Ksh per site (average size is 276 ha). These topographical maps were deemed to be essential and useful not only for carrying out physical planning of irrigation and drainage facilities in the Area, but also encouraging of farmers' participation in the project with their awareness of common ownership for community resources.

In the project evaluation, the required costs for preparation of the topographical maps mentioned above were not counted because the Study Team covered the burden of costs. However, when other projects are planned, such topographical maps with scale of 1:5,000 should be prepared and these required costs should be assumed by the beneficiary groups themselves.

## Environment

- a) Promotion of horticultural crops should be limited to the gentl sloping farmland. On the other hand, improvement of coffee-growing techniques and the management of coffee societies, and the possibility of fruits-tree growing, etc. should be examined on the steep slopes of the Area.
- b) From the viewpoint of the rural environment, MOA should support horticulture as well as livestock raising, production of feed and manure synthetically. Extension officers of the MOA should improve the know-how in agriculture and livestock-raising. Further, it is important to approach the plan in combination with other projects executed or being executed by other donors.

## Project Economy and Farm Budget

- a) It is recommended for the preparation of the detailed project plans of the proposed small-scale irrigation schemes that MOA should undertake a careful appraisal to examine project plans to be proposed by the communities concerned, placing emphasis on the appropriateness of the technology designed for irrigation systems and the accuracy of the cost estimate to be based on lowest-cost approaches.

In almost all the small-scale irrigation projects, many farmers are confronted with difficulty in loan repayment. This holds true even for the farmers of Ciambaraga Irrigation Schemes in Tharaka Nithi district, one of the more well-managed projects among the 463 reviewed. Accurate cost estimates are important, since the cost is a crucial element in determining the financial and economic viability of the project and also for planning its funding.

- b) It is recommended that prior to the implementation of the projects, a farm budget analysis of the representative farms should be conducted, through detailed farm surveys, with the primary objective of providing the basis for an assessment of the investment plans and debt repayment capacities of the farmers.

The farm budget analysis also provides a basis for setting repayment terms and conditions for credit that will be enough to encourage the farmers to participate in the project and make sure that the farmers will have sufficient cash to repay the loan. The ability of the farmers to pay is an instrument for promoting sustainability.

- c) It is recommended that intensive backing should be given to the farmers participating in the project until they have attained the full production target, since it may take several years to reach this target. To this end, the district governments should establish the District Project Management Office (DPMO), responsible for providing support services to the farmers, as proposed in this study.

The proposed DPMO shall formulate support services programs in close coordination with HCDA, FPEAK, DAO and NGOs as agricultural development could be realized only with the full cooperation of the agricultural services agencies, as well as the cooperation of the private entities concerned.

## Monitoring of the Project

- a) Monitoring of the progress of the project and implementation should be carried out by external agencies under the supervision of the Executive Steering Committee (ECS), to cope with the following purposes;
- To obtain and judge how many goals and targets initially formulated under the Project are attained,
  - To judge whether or not follow-up support is required from the viewpoint of project sustainability under self-help management, and
  - To learn lessons, both positive and negative, from the Project in order to apply to other Project Areas.
- b) Monitoring work shall be conducted on the following items;
- Irrigation system operation
  - Access and village/farm roads maintenance
  - Agricultural aspect

- Institutional aspect
- Marketing aspect
- Farm economy aspect
- Control of soil erosion and watershed management

Table 1.7-1 indicated the required training items for implementation of smallholder irrigation schemes in Rupingazi Ngerwe Irrigation Scheme.



**Table 1.7-1 Required Training Items for Rupingazi Ngerwe Irrigation Scheme**

	Training Items	Farmers/ Farmers' Group	Implementing Staff	
1. Agriculture/Irrigation	- Land use in combination with coffee plantation		●	
	- Irrigated and rainfed crop farming for both horticulture and food crops	●		
	- Establishment of cooperative society to purchasing agricultural inputs	●		
	- Application of farm input	●		
	- Water saving farming	●		
	- Water management in open canal system with long length	●		
	- O&M works for irrigation facilities in a slopping area	●		
	- Management of trial and demonstration farms	●	●	
	- Monitoring of the project		●	
	- Development of farm and water management manuals		●	
	- Maximum residue levels (MRLs) and crop assurance for export crops	●	●	
	2. Marketing	- Establishment/strengthening of marketing group	●	●
		- Marketing techniques for both horticulture and food crops to brokers/exporters	●	
- Promotion of contract farming		●	●	
- Collection/compilation of market information		●	●	
- Rehabilitation of access roads			●	
3. Rural Society/Infrastructure	- Capability-building for farmers/farmers' group and implementing staff	●	●	
	- Promotion of women's participation to the project	●		
	- O&M for water source facilities for rural water supply	●		
	- Construction and O&M of village and farm roads	●	●	
4. Support Services	- WUAs' roles and performance	●		
	- Financial management for cooperative societies	●	●	
	- Processing techniques for coffee produce	●		
	- Access to agricultural credit	●	●	
5. Environment	- Soil erosion control at sloping farms	●	●	
	- Watershed Management and water conservation	●	●	
	- Promotion of improved cooking stove	●		