

2.2.3 Land Use and Agricultural Development Plan

The development potential and land use at a site is determined by a number of factors including; the soils, the topography, the climatic conditions, the present land use and the relative prices of inputs and products. During the PDM, the land users worked in conjunction with the study team to help identify the particular physical, social and economic possibilities and constraints at their location. This section has the horticulturists recommendations for Nyangati. The conditions from farm to farm vary quite considerably at Nyangati. An appropriate land use plan is very site specific, and contingent on the individual particular farm conditions and the current market prices. The suggestions that follow will need modification in the future. Project staff should work with the Ngomano/Nyangati farmers to develop a suitably modified cropping pattern and a drainage improvement program to meet those conditions.

The major problems to be addressed at this site are likely to be competition for water with upstream users, both within and outside the scheme; avoiding the seasonal marketing gluts for crops like tomato and French bean; and the general soil fertility status, particularly any plough pan which can impede drainage and lead to waterlogging.

1) Land Use Plan

The land resources in the Ngomano/Nyangati area are mixed. The red soils on the top of the ridges are variable in quality, with patches of lower fertility and some areas of waterlogging. The black cotton clay soils in the valley bottoms are difficult to manage, their current use for rice paddies combined with rough grazing is probably their best use. Improvements in land use and management on the valley soils and improved fertility and organic matter management, plus localized drainage on the red ridges soils are needed. The current ploughing is shallow and done mainly by oxen. Mechanical deep ploughing with a chisel or a mole plough is needed occasionally to fracture the plough pan. Deep ploughing combined with improved drainage, will allow reclamation of the areas currently waterlogged. The use of this land is currently seasonal. Minor land leveling could also improve the efficiency of the current system of furrow irrigation

Intensification of production with a market orientation is likely to be successful here, given that the community is used to both marketing product and using improved inputs, plus the location has good access to the major markets of Kutus and Nairobi. Inputs are comparatively easily available, given the proximity of the Mwea Irrigation scheme, which is currently producing large quantities of horticultural crops using the tail water from the rice irrigation. Yield improvements are likely to come from improved intensive management. Given the existing market orientation of Nyangati farmers, rapid adaptation of new techniques is expected, plus investment capital is likely to be available. The area has the chance to develop a comparative advantage in the production of French beans and tomato, but close attention has to be paid both to the timing of the production, and increasing yields of the higher grade products. Specialization in particular crops, such as musk melons, onions and varietal pulses, such as Rose Coco and warimu beans is also likely to be a profitable strategy for some of the Nyangati area farmers.

2) Crop Selection and Cropping Pattern

The recommendation for Ngomano/Nyangati is to produce for sale a mixture of both export and domestic vegetables, such as maize, bananas, French beans, specialty beans, tomatoes, onions, and melons.

Suitable fruit trees for this area include guava, mango, banana and pawpaw. The topography of the area is generally flat or gentle slopes of less than five percent, so erosion is not a major problem. The bananas can be planted in compact groups near the homestead where they can be intensively managed.

The main crops at the moment are maize, beans and tomato. They are all projected to increase their total area, through an expansion in the area under irrigation. The areas currently under coffee (a marginal crop for the area), sorghum/millet, green maize, and kale are projected to remain the same. Although kale (a traditional woman's crop) hasn't been increased there is a small increase in the area under sweet potato projected. Also given the particular nature of the community in Nyangati, French beans has been regarded as a crop from which the returns are controlled to some degree by the women.

The only crop which has been projected to decrease in area from the current pattern is rice. This is for a number of reasons: firstly it has a high water demand, secondly it tends to be grown in the areas upstream of the project, and thirdly the yields are low. These factors combine to suggest, that for the scheme as a whole rice is not the best use of their limited water, while for the individual farmer his/her opportunity cost of using the irrigation water for rice rather than other crops is likely to be high. This is particularly true given the proximity of the major rice producing area of Mwea, where the yields are higher, and rice is available for purchase.

The increase in the area under maize is primarily by the addition of irrigated improved maize, grown in conjunction with inter-cropped beans. The climatic conditions of the area with its high temperature and good solar radiation are conducive to achieving high maize yields, assuming the fertility issues are dealt with and that the irrigation water is applied appropriately on a suitable schedule. A portion of this main maize crop can also be sold early in May as green maize. The area under beans as a sole crop has been increased through an expansion of the irrigated rather than the rainfed area. Using irrigation on the seven new ha projected, the scheme can produce speciality pulses such as Mwitmania, Rose Coco, and Wairimu beans and Dolichos lablab. The climate in the area with its generally low humidity is suitable for pulse production, and prices for these special beans during droughts and in the off-season rise quite steeply.

A small number of farmers in the area are already going in for specialized banana production, and a new irrigated area of 3.4 ha has been planned for cooking bananas. There is a steady demand for good cooking bananas in Nairobi and the drier areas in the rift valley.

The big changes in the area under particular crops are in the irrigated cash crops. This is in line with the choice of specialization for market production as the target activity of this scheme. French beans and tomato are both being grown currently in the vicinity, and their area under irrigation is projected to increase by 250 percent and 60 percent respectively. Key to successful growth of both these crops in timing the quality and the quantity of the production to meet the market demand. It is hoped that with the substantial area under production of French bean, more lucrative contracts can be forged with the exporters, and that producers will develop the skills to avoid the glut periods and produce consistently high quality.

The adjacent tarmac road means that rains will not hinder the pickup of the crop. Tomatoes given adequate fertility and management can produce large yields. Good tomato nursery management and starting the plants early in the field makes the difference between the timing of the peak yield pre-glut or during the glut. The target should be to making the second and third picking by the end of July

Proposed Cropping Areas at Ngomano/Nyangati with Project

Land Use (%)	Land Area (ha)	Cropping Intensity (%)	Crop	Area (ha)
1. Irrigated	48			
- Food Crops		79	Maize/beans	37.7
		6	Sweet Potato	2.9
		16	Beans	7.7
		1.8	Kale	1
103%			Sub-total	49.3
- Cash Crops		45	French beans	21.6
		17.5	Maize (green)	8.4
		17.3	Tomato	8.2
		7.9	Cabbage	3.8
		5	Onion	2.4
		4.8	Other Vegetables	2.3
		0.8	Melon	0.4
98%			Sub-total	47.1
- Perennials		7	Banana	3.4
7%			Sub-Total	3.4
		208%	Irrigated Total	99.8
2. Rainfed	332.6			
- Food Crops		64	Maize/beans	213
		21	Beans	69
		1.5	Kale	5
		0.2	Sweet Potato	0.8
87%			Sub-total	288
- Cash Crops		16.8	French Beans	56
		11.4	Tomato	38
		2.6	Sorghum/Millet	8.7
		0.9	Other Vegetables	3
		0.8	Melon	2.7
		0.7	Onion	2.3
		0.2	Cabbage	0.8
34%			Sub-total	111.5
- Perennials		3.5	Coffee	11.8
		1.9	Banana	6.5
5%			Sub-Total	18.3
		126%	Rainfed Total	418
Total	380.6			517.8

Source: JICA Study Team. Overall cropping intensity = 517.8 ha / 380.6 ha x 100 = 136%

Table 2.2-1 indicates the proposed cropping pattern of Ngomano/Nyangati Water Furrow Project.

3) Proposed Farming Systems

The key to profit is professional farmers. A series of activities should be planned to build on the existing skills in the area. Dissemination of the existing information available about improved seeds, plant protection chemicals, fertilizer rates and application methods, and phasing of production to avoid glut periods, through technical leaflets, seminars and farmer training via field days and farm visits is suggested. Demonstrations of new techniques should be easy to establish, manage and oversee given the easy access from Nairobi. Training in handling, packing and quality control, especially of export crops would be particularly useful, this training could perhaps be conducted in conjunction with the OECF center at Sagana. The surrounding areas are already producing large amounts of vegetables for both the domestic and the export markets, such as tomatoes and French beans, so a variety of farming systems are already available for review and evaluation.

The goal should be testing and demonstrating the best technology available for each crop. Nyangati has the opportunity to be the market leader and a center of innovation for horticultural production. The early innovators are likely to be the farmers who will make a profit. A continuing interaction between project staff, government agencies, such as extension, research, and the farmers will be of mutual benefit. A whole range of trials and demonstrations can be planned. For example, trials of counter season tomato production using the available irrigation water, starting in August and February and taking advantage of the dry season sunshine and the low humidity reducing fungal diseases should be tried. The whole emphasis has to be on producing high yields, high quality out of the main season. Mole or chisel ploughing demonstrations in those areas with a plough pan is likely to increase crop performance markedly, particularly for shallow rooted crops like French beans, which are particularly sensitive to impeded drainage.

Projected Crop Production at Ngomano/Nyangati with Project

Crop	Area Rainfed (ha)	Area Irrigated (ha)	Unit Yields (ton/ha)	Total Production (ton)
Maize in mixture	213	38	1.65/2	427
Beans in mixture	213	38	0.3/0.5	90
Maize (green)	0	8.4	4.5	38
Beans	69	7.7	0.65/0.85	51
French beans	56	21.6	4.5/6	383
Tomato	38	8.2	11/14	535
Kale	5	0.9	7/10	47
Sweet Potato	0.8	2.9	7/8.5	30
Sorghum/Millet	8.7	0	1	9
Melon	2.7	0.4	8.5/10	26
Onion	2.3	2.4	7/8.5	36
Cabbage	0.8	3.8	9/12	53
Other Veggies	3	2.3	4.5/5.5	26
Banana	6.5	3.4	9.5/12.5	104
Coffee	11.8	0	3	35

Source: JICA Study Team estimates

The irrigation pattern which follows has been used to calculate the water requirement and the output of the scheme after installation of the irrigation facilities. It must be stressed that this is only an average over the whole area. It represents all of the different types of farms and farmers that are combined on the scheme. It includes small farms and large farms; farms that will focus mainly on maize and bean production, and those that will become vegetable specialists, growing mainly cabbage, tomato and French bean. Not everyone will grow all of these crops, the actual cropping mix on a farm will vary with the existing crops and the individual farmers interest, as well as the availability of labour and capital to the head of household. Furthermore, in Kenya the average farmer does not make much more than a subsistence living. The maximum profits and returns come to those who can intensify their production, who can match their production to the peak market demands, and those who can innovate and adopt new technologies successfully.

The design cropping pattern at full development is shown below. The peak water demand period is during June. This is the beginning of the dry season, and a number of crops are beginning extended past their usual harvest date by growing them using irrigation. This is to increase the harvest price. There is another smaller water demand peak at the beginning of the second dry season in December. Shifting crops and planting dates will change these periods of peak water use.

An important proviso to these provisional recommendations, especially in Nyangati where the transmission distances are quite long, the soils are variable and furrow irrigation is the method currently being used, is that the study area soils or water have not been tested for salinity/alkalinity, percolation rates, (a determinant of transmission losses in surface systems), or soil moisture storage capacity.

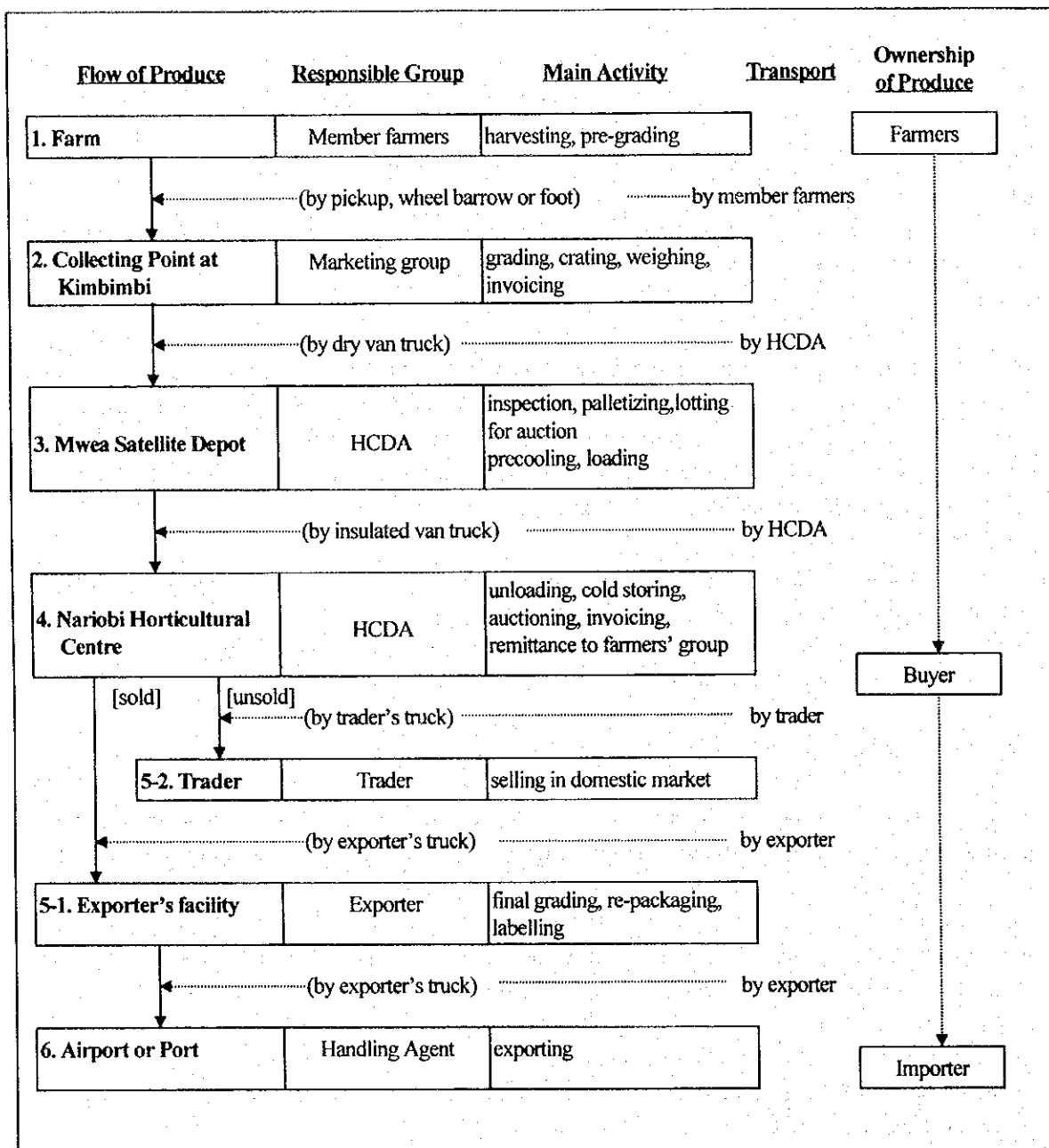
4) Animal Husbandry Plan

The large flat fields in this area are frequently ox ploughed. It is important that the oxen are in good condition at the end of the dry season to allow for timely ploughing. The availability of rough grazing on the vertisol areas and the production of residues from the irrigated hybrid maize will help alleviate any shortages of fodder for the areas livestock. The provision of urea blocks to increase the utilization of the roughage should be explored. Vaccines and other medicines are available in the local area. The existing cattle, sheep and goats are kept either in stalls or tethered for grazing on the vertisols. Given the intensive crop production in the area, free range grazing is not usually possible. Also the organic matter produced by this system is a necessary and useful input to the upland soils to improve their structure and fertility status. Improved breeds of free range chicken, such as Fayoumi could be introduced to the area, through the provision of cocks for purchase.

5) Post-Harvest and Rural Industry Plan

The Project Area is close to Mwea Satellite Depot for precooling and auction at distance of 4km. The Satellite Depot will provide various services of horticultural marketing. The flow of produce can be summarized as below:

Produce Flow Diagram on Horticultural Produce Handling Facilities Project



For export of chilli, avocado, okra and Asian vegetables, the construction of grading and packing shed with charcoal temporary store is recommended. Quality assurance has become an important aspect in export trade. The shed is quite simple using timbers for frame, vinyl chloride plastic films for side cover, grading tables and safety tapped water. The washing of hands when handling produce are requisite. Before and after grading, it is better to store the produce in charcoal covered by nets. The latent heat of water in charcoal will be remove the respiration heat of green beans and direct sunshine can be avoided. It is estimated that about 5-10 degree centigrade can be lowered than ambient temperature according to the test by Karen Appropriate Technology Center. Also for local consumed produce, member farmers can store before group loading or awaiting traders. These facilities can be constructed or funded by farmers themselves using local materials, and it will motivate ownership of facilities among members for sustainable operation.

2.2.4 Marketing Plan of Agricultural Products

1) Strategies on Marketing Development

The main strategies for this Project Areas are, i) expansion of marketing alternatives for export produce by auction consignment with HCDA, ii) horticultural production planning to meet market demands at Kutus wholesale market or Wanguru market with price information collection and transporting arrangement and iii) participation in smallholders seminar holding at JKUAT and other institutions managed by the government including marketing sector. The necessary interventions as government services or activities to be done by farmers' marketing groups are categorized by the problems indicated on PCM workshop and identified in field survey as follows:

Interventions and Outputs Categorized by Problem

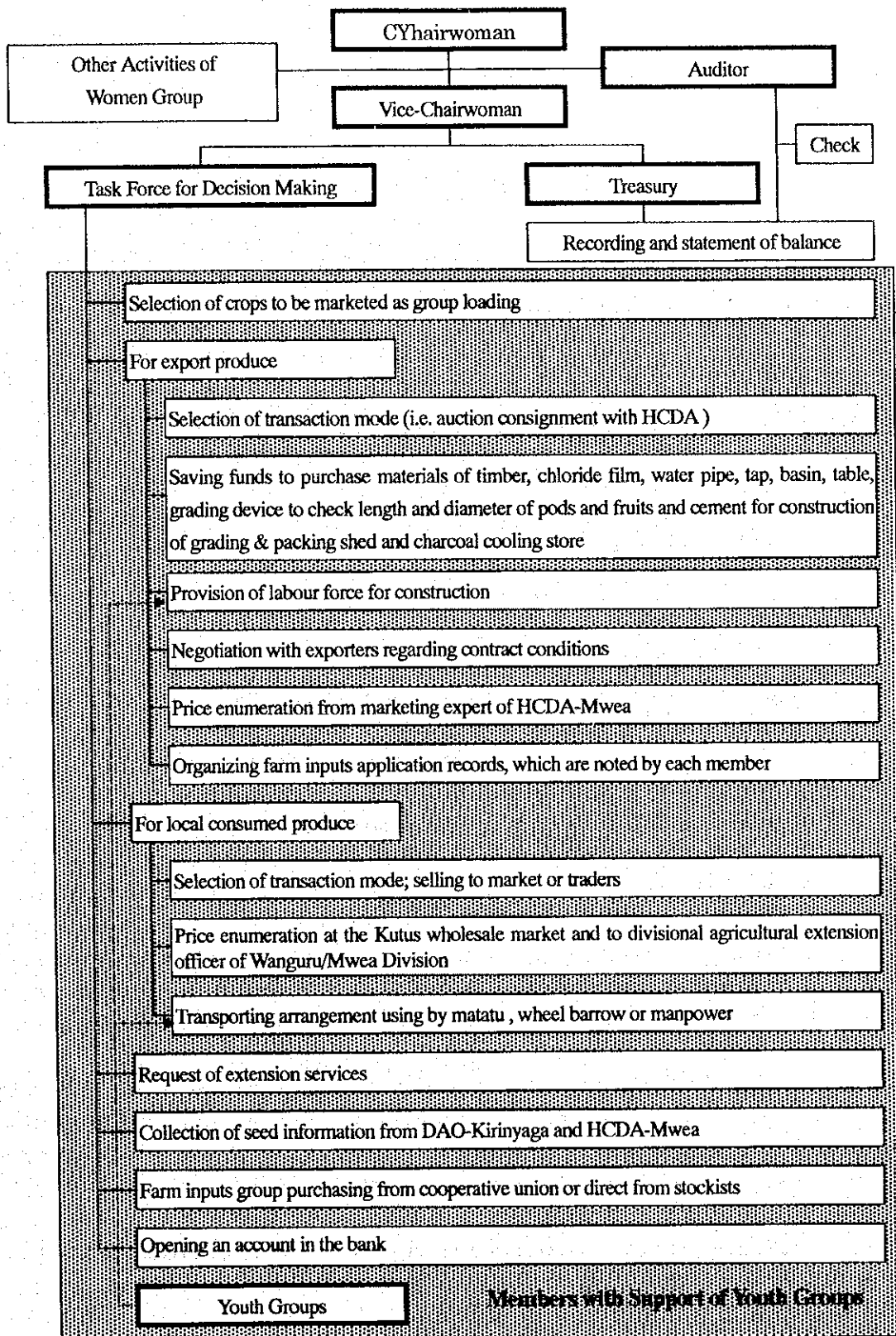
Problems/Constraints	Interventions/Activities	Agency/Operation Body Concerned	Outputs
Indicated problems on PCM workshop			
<ul style="list-style-type: none"> - Middlemen in lower prices of our produce & exploitation of farm produce by exporters - Poor marketing arrangements 	<ul style="list-style-type: none"> - Seminar on auction consignment at JKUAT and other institutions managed by the government 	<ul style="list-style-type: none"> - Marketing expert of HCDA-HQ 	<ul style="list-style-type: none"> - Introduction of auction consignment with HCDA - Organizing small scale marketing groups
	<ul style="list-style-type: none"> - Provision of market price information from Nairobi Horticultural Centre (auction results) for export produce 	<ul style="list-style-type: none"> - Marketing expert of HCDA-Mwea 	<ul style="list-style-type: none"> - Attaining auction market information - Better crop planning
	<ul style="list-style-type: none"> - Provision of market price information at Wanguru market and collection at Kutus wholesale market for local consumed produce 	<ul style="list-style-type: none"> - Mwea divisional extension officer at Wanguru - Member farmers for Kutus 	<ul style="list-style-type: none"> - Better crop planning - Reducing post-harvest losses - Increasing bargaining power
	<ul style="list-style-type: none"> - Group loading and transport arrangement for local consumed produce 	<ul style="list-style-type: none"> - Marketing groups 	<ul style="list-style-type: none"> - Creating options of market alternatives to Kutus, Wanguru or traders

Problems/Constraints	Interventions/Activities	Agency/Operation Body Concerned	Outputs
	<ul style="list-style-type: none"> - Seminar on varieties and certified seeds procurement at JKUAT and other institutions managed by the government - Collection of certified seed information 	<ul style="list-style-type: none"> - KARI - Farm inputs/ marketing officer of DAO-Kirinyaga - Marketing expert of HCDA-Mwea or Karatina 	<ul style="list-style-type: none"> - Better yields and plant protection - Assurance of germination rate
<ul style="list-style-type: none"> - Long distance to selling Points - Poor access roads 	Comparing with other Project Areas, this Project Area is not far from the markets.		
<ul style="list-style-type: none"> - Poor storage for products - Lack of electricity 	<ul style="list-style-type: none"> - Participation to auction utilizing the facility of precooling 	<ul style="list-style-type: none"> - Mwea Satellite Depot of HCDA 	<ul style="list-style-type: none"> - Extending shelf life and better prices for export produce
Identified problems by Study Team			
Lack of knowledge on requirements on export produce	<ul style="list-style-type: none"> - Seminar on maximum residue levels (MRLs), crop assurance and grading using Export Crop Bulletin at JKUAT and other institutions managed by the government - Seminar on trend in foreign markets 	<ul style="list-style-type: none"> - Marketing expert of HCDA - Representative of exporters or FPEAK staff 	<ul style="list-style-type: none"> - Attaining information for export of chili, okra, etc., crop assurance and grading - Increasing materials for decision-making in selection of crop
Lack of marketing organization	<ul style="list-style-type: none"> - Seminar on marketing organization through PCM workshop at JKUAT and other institutions managed by the government 	<ul style="list-style-type: none"> - MOA staff on farmers' organization 	<ul style="list-style-type: none"> - Organizing small scale marketing groups with support of women groups and youth groups
High losses by bad weather conditions	<ul style="list-style-type: none"> - Weather forecasting 	<ul style="list-style-type: none"> - Kenya broadcasting (KBC) - DAO-Kirinyaga 	<ul style="list-style-type: none"> - Crop planning to select fluctuated produce such as green maize, beans, green gram, carrot, kale, fresh peas when expecting drought
Lack of knowledge on consumers' or buyers' demands	<ul style="list-style-type: none"> - Field trip pursuing marketing route; Nairobi markets, exporters' grading & packing facilities, Nairobi Horticultural Centre 	<ul style="list-style-type: none"> - MOA staff 	<ul style="list-style-type: none"> - Better understanding of consumers' or buyers' demands and how to handle produce

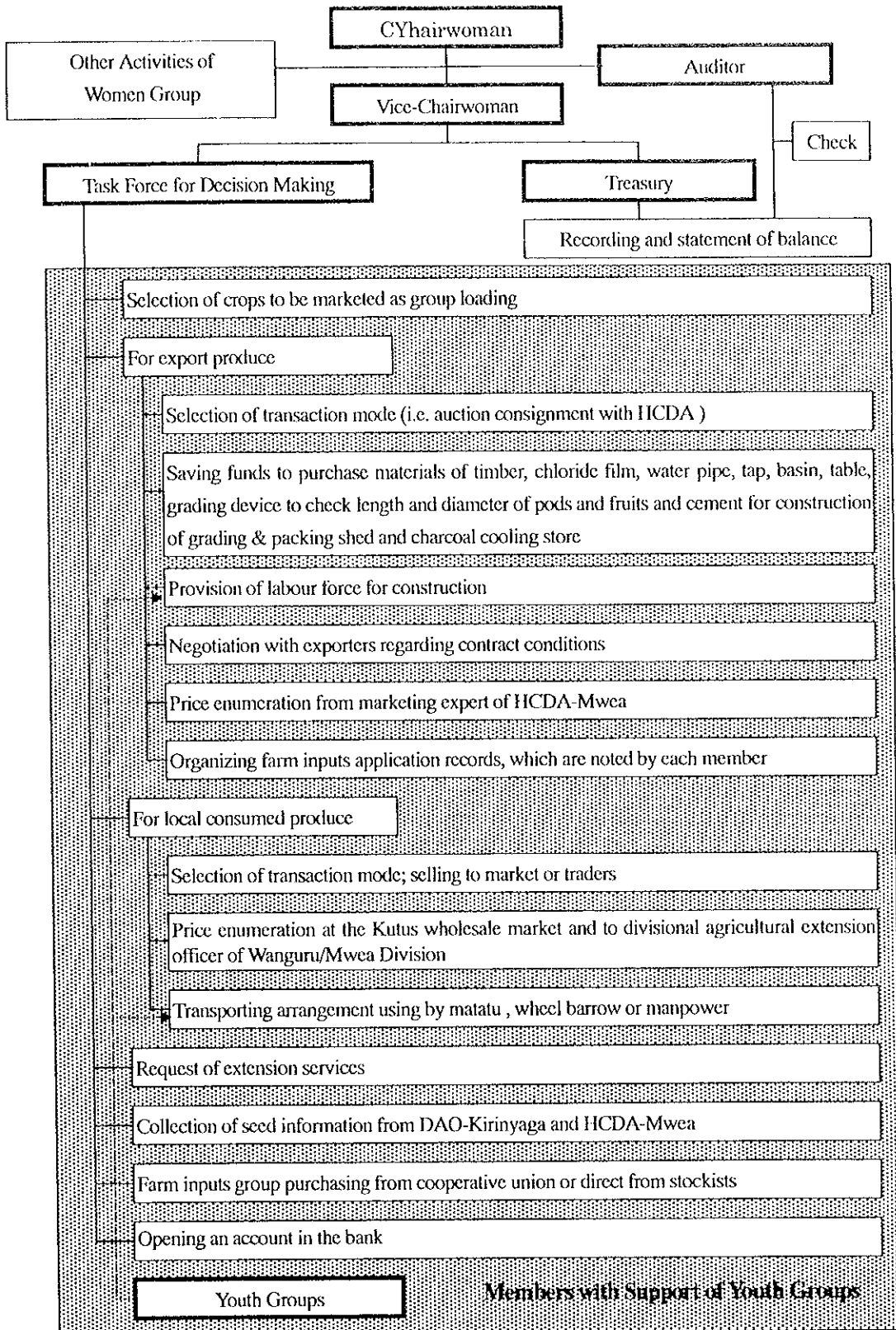
2) Structure of Functional Marketing Group

Farmers understand the importance and benefits of establishment of marketing groups, which was confirmed on PCM workshop. Women groups and youth groups are relatively active in the Project Area. The recommended formation of the groups are shown in the next page, but it is necessary to discuss among all members before the formation.

Recommended Organization Chart and the Functions



Recommended Organization Chart and the Functions



3) Strategic Marketable Horticultural Crops

Utilizing the resources of market demands, locating advance, agro-climatic aspect and current production, the following crops are recommended to be selected through discussion among members of marketing groups:

Strategic Horticultural Crops in the Project Area

Category	Strategic Crop
Home consumed produce	dry maize (Pioneer Hybrid H3253, Cargill Hybrid), beans (Rose coco, Dolichos, Wairimu when expecting drought)
Local consumed produce	ripe banana (Apple, Giant Cavendish), green maize, cabbage (Washington Naval), green gram (when expecting drought), sweet potato, spinach, papaya, tomato (Cal J), cowpea, soya (in future), mask melon
Export produce	French bean (Monel, Caudia, Gloria, Morgan, Espada), avocado (Fuerte, Hass), mango (Tommy Atkins, Van Dyke, Keitt, Kent, Apple, and in future Matthias, Kensington, Azacus, Zill, Nimrod, Irwin Sabine after observation), okra (Pusa Sawani, Clemson Spineless, Green Emerald, Dwarf Long Pod Green, White Velvet), chilli (Anaheim M, Anaheim Select, Fresno, Jalapeno, Long Red Cayenne, Jwala), baby corn, curry leave, ravaya, and other Asian vegetables

2.2.5 Environmental Management Plan

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

- Risk and appropriate use of agrochemical including the system of MRLs
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 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's group leaders from Enzaro, where the community has become has very active, to Nyangati 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 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. Nyangati Primary School has set up a water tank to wash hands near the latrine. This kind of good idea should be introduced into home life.

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.

2.2.6 Institutional Development Plan for Farmers Organizations

1) Water Users Association Plan

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 four objectives mentioned above, 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 fulfil its members expectations of reliable and adequate water supply on a sustained basis, the WUA will need to maintain linkages with other organizations.

Hence as part of project implementation, WUA will be encouraged to form and maintain linkages with other organizations as shown below;

WUA Linkages with Other Institutions

Institution	Linkage Purpose/Advantage
Ministry of Agriculture	- Advisory services on design, implementation, operation and maintenance of irrigation system - Coordination of other support services to the project community - Organization and management support
Ministry of Land Reclamation, Regional and Water Development	- Security of irrigation water rights
Nyangati Cooperative Society	- Use of cooperative building for WUA meetings - Possible input credit facilities for members
Local Church NGOs	- Availability of loans on affordable terms - Organization and management support
Private Sector	- onstruction of irrigation infrastructure - Source of farm in-puts for members

2) Cooperative Development Plan

a) Education and Training

The education and training of Nyangati Cooperative Society will be effected indirectly through the WUA. This is so because the cooperative shares some 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

Nyangati Cooperative society has an established financial management system already put in place by the Ministry of Cooperative Development. However, the society's performance could be improved if the management committee were exposed to a short training session on:

- Operational cost management
- Factory processing for improved quality outcomes
- Improved budget control procedures
- Optimization of farm-input stocking levels

General Management Training

Poor management of coffee cooperatives is a national problem at the moment, and Nyangati is not an exception. 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

Nyangati Coffee Cooperative Society will be encouraged to develop linkages with a number of institutions summarized as shown below;

Cooperative Linkages with Other Institutions

Institution	Linkage Purpose/Advantage
Ministry of Agriculture	- Advisory services coffee husbandry - Coordination 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

Production/Marketing groups will be promoted with the aim of addressing a major problem 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 (30-50 members) 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" which is in the same district as the Project Area could be used to demonstrate advantages and mode of operation of such a group.

b) Financial and General Management Training

As part of project implementation, it is expected that formation of production groups will be promoted. For such groups to function effectively, they will need training in financial and general management as outlined below (see Annex J for details).

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 including deposit, withdrawal and cheque operation
- 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 as summarized as shown below;

Production /Marketing Group Linkages with Other Institutions

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

4) Women's Group Development Plan

The five women's 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 design of the irrigation system
- Identifying how women can optimize benefits from the rehabilitated irrigation system.

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 and identifying necessary adaptations

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 general management training course covering the following areas:

- Group organization; management principles; leadership
- Strengths, weaknesses, opportunities and threats to the women group
- Review of current activities and exploration of other opportunities when irrigation becomes available e.g production/marketing of horticultural produce
- 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's account for the bulk of farm labour, they are likely be the actual producers of most horticultural produce. 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
MOA/HCDCA	<ul style="list-style-type: none"> - Sourcing women-specific production technology and market information - Coordination of other support services to the group
Horticultural Export Companies	<ul style="list-style-type: none"> - Purchase contract for horticultural produce - Market out-let to horticultural produce - Farm-input credit - Advice on how to produce contract crop
Produce Brokers	<ul style="list-style-type: none"> - Market outlet for farm produce - Indication (though distorted) of market information
WUA	<ul style="list-style-type: none"> - Reliable supply of irrigation water
Local NGOs	<ul style="list-style-type: none"> - Organization and management support - Input credit facilities
Local Farm input Stockists	<ul style="list-style-type: none"> - Availability of farm inputs - Possibility of short-term input credit
Banks	<ul style="list-style-type: none"> - Banking facilities for members contributions - Clearance of cheques issued by exporter - Processing of cheques issued by group to individual member

2.2.7 Institutional Supporting System Development Plan

1) Agricultural Extension Services

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

The overall responsibility for developing the demonstration program, and supervising the layout and management of the trials at each site will be with the MOA staff at Kerugoya.

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. Close cooperation with HCDCA, which is already conducting a range of training programs in the area, is encouraged.

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 at Kerugoya. 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 Nyangati farmers themselves have the primary responsibility for managing the irrigation scheme, and implementing the agreed upon 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, such as chisel ploughing, 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

The supporting services development plan for agricultural credit service in Ngomano/Nyangati Areas different from that of the Rupingazi Ngerwe Area, in which 70 percent of farms hold their title deed. Ministry of Land and Settlement is required to survey individual farmlands to specify farm size and land category and publish title deed immediately in the consideration that only 42.5 percent of farmers in this area possess title deed. These would contribute to promote use of agricultural credit by smallholders. In parallel with these actions, educational training on how to apply, meaning of collateral, interest and the principal, repayment period, credit to individual and group are necessary to enlighten smallholders.

Though this Area has the highest possibility for developing commercial horticultural farming, it also has weak points that there are no marketing group and cooperative society. Therefore, irrigated horticulture should be realized not only through the construction of irrigation facilities but also improvement of credit services for farmer's groups, which has less risks than credit for individual.

Banks are required to improve their services by easing of credit conditions, simplifying application procedures and promotion of group based credit services taking into consideration current harsh farmer's condition in farm economy.

3) Agricultural Input Supply

The supply of improved vegetable seeds and banana planting material will be provided on a purchase basis. The private sector suppliers in the nearby towns will be actively encouraged to develop new or existing outlets in the model areas, and to stock the particular inputs required for the agricultural development of Nyangati.

4) Training to Strengthen Farmers' Organization

Realization of the proposed rehabilitation project will require strengthened farmers organizations. In this connection, it will be necessary for the staff of institutions providing support to the project community to acquire necessary skills needed for strengthening farmers' organizations.

In the first instance, it is planned that MOA/DAO Kirinyaga, as the project promoter, convene a meeting where staff from relevant institutions will be;

- Briefed on the planned irrigation activities at Ngomano/Nyangati
- 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 aimed at providing skills for strengthening farmers' organizations 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"> - Community organization and PRA approaches - Hands-on irrigation technology 	<ul style="list-style-type: none"> - WUA - Production/Marketing Group. - Women Group
District Subject Matter Specialist	<ul style="list-style-type: none"> - Community organization and PRA approaches - Irrigated horticultural production technology - Participatory extension needs assessment methods - Social marketing skills - Improved extension planning, packaging and delivery 	<ul style="list-style-type: none"> - Production/Marketing Group - Women's Group
District Cooperative Office	<ul style="list-style-type: none"> - Factory level cost management - Coffee processing for quality improvement 	<ul style="list-style-type: none"> - Cooperative society
Catholic Church	<ul style="list-style-type: none"> - Community organization and PRA approaches - Financial management skills - Loan administration skills 	<ul style="list-style-type: none"> - WUA - Women Group - Production/Marketing Group
Anglican Church	<ul style="list-style-type: none"> - Community organization and PRA approaches - Financial management skills - Loan administration skills 	<ul style="list-style-type: none"> - WUA - Women Group - Production/Marketing Group
Ministry of Culture & Social Services, District Office	<ul style="list-style-type: none"> - Community needs assessment - Procedures for group formation, organization and follow-up - Work planning and scheduling 	<ul style="list-style-type: none"> - Women Group - Production/marketing Groups - WUA

2.2.8 Water Sources Development Plan

1) Available Water Sources

The available water sources for the Area is river water. There are two ways to use river water, one is stored water in a reservoir and other is run-off water. As the smallholder irrigation scheme is planned to implement by poor farmer themselves, it is required to make project cost low as much as possible. Therefore, the plan of storage construction as excluded from the project component. Thus, available water resources is only run-off water in the related river.

2) Methodology of Assessment of Water Availability

According to Water Act published by the 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 (Q_d) for irrigation is defined by the following equation;

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

where,

Q_d : Dependable flow

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 and total committed water in the immediate down-stream of a proposed intake site. The probability flow is analyzed by Iwai Method.

3) Assessment of Water Availability at Project Site

Since no gauging station exists at Nyangati intake site, the dependable flow at the intake site is estimated based on the discharge data at RGS-4DA10 of the Thiba river. The minimum monthly discharge record has a record length of 26 years from 1970 to 1996 as shown in Table G.2.2-2, Annex G-2. The estimated monthly probability flow is shown in Table 2.2-2 and the estimated minimum monthly flow with 80 percent probability of exceedance is 1.99 cu.m/sec which will occur in March.

The scheme receives transferred water from the Thiba river to the Gakuo river through a transfer canal constructed in 1950's. The transferred water is estimated to be 0.30 cu.m/sec for January to April and 0.50 cu.m/sec for the other months.

The base flow at Nyangati intake site consists of a base flow which come out from the inherent catchment area and above transferred water. The former is estimated by multiplying the yield of base flow at RGS-4DA10 and the catchment area above Nyangati intake. Thus obtained base flow at Nyangati intake site is 0.441 cu.m/sec.

Since there exists any water permit in the immediately down-stream, the minimum dependable flow is estimated at 0.309 cu.m/sec which is corresponding to 70 percent of base flow at the intake site. The estimated monthly dependable water ranges from 0.309 to 0.945 cu.m/sec as shown in Table 2.2-2.

Table 2.2-2 Dependable Water for Ngomano/Nyangati water Furrow Project

1) Probability Analysis of River Flow at 4DA10 Regular Gauging Stations

Station Code	4DA10	
River	Thiba	
Drainage Area	353 sq.km	
Location	Latitude	00-02-85 S
	Longitude	37-19-00 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	4.51	3.51	3.11	3.45	10.26	11.11	8.14	6.57	5.38	5.02	6.24	6.20	6.13
80	3.08	2.34	1.99	2.28	5.73	8.15	6.91	5.09	4.03	3.89	4.08	4.52	4.34
90	2.44	1.91	1.55	1.89	4.21	6.64	6.37	4.42	3.59	3.50	3.60	3.92	3.67

2) Probable River Flow at Intake Site

Water Source	Murubara River
Drainage Area at Intake Site	25.0 sq.km
Code of Adopted Station for Estimation	4DA10 (Thiba River)
Drainage Area of Adopted Station	353.0 sq.km
Conversion Factor	0.071

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	0.619	0.549	0.520	0.544	1.227	1.287	1.076	0.965	0.881	0.856	0.942	0.939	0.867
80	0.518	0.466	0.441	0.461	0.906	1.077	0.989	0.860	0.785	0.775	0.789	0.820	0.741
90	0.473	0.435	0.410	0.434	0.798	0.970	0.951	0.813	0.754	0.748	0.755	0.778	0.693

Water is being transferred from the Thiba river to the Gakuo river since 1950s. The estimated amount of water to be transferred is to be 0.3 to 0.5 cu.m/sec. Then, the amount of transferred water is added to the analyzed figures with probability by 0.3 cu.m/sec in dry season from January to April and 0.5 cu.m/sec for the other months.

3) Dependable River Flow at Intake Site

Base Flow(Qb):	0.441 cu.m/sec
River maintenance flow (30% of Qb=):	0.132 cu.m/sec
Committed water amount in upper basin of intake site:	0.002 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	0.386	0.333	0.309	0.329	0.774	0.945	0.857	0.728	0.653	0.643	0.657	0.688	0.608

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 (0.309 cu.m/sec) and requested irrigation area (48 ha) by the WUA.

The dependable water source amount in the driest month at the intake site is 0.309 cu.m/sec, while the maximum unit water requirement in the driest month is estimated at 2.3 lit/sec/ha as shown below. Thus, the maximum water requirement for the irrigation area of 48 ha is 0.110 cu.m/sec.

Maximum unit water requirement in the driest month is calculated as follow;

$$q = (ET_o * K_c - P_e) / IE * 10,000 / (h * 3,600) * 7 / v = 2.3 \text{ lit/sec/ha}$$

where;

Reference crop evapotranspiration (ET _o)	:	4.8 mm/day (refer to subsequent Clause of 2.2.9)
Crop factor (K _c)	:	0.9 (average)
Effective rainfall (P _e)	:	0.0 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 positive value (0.199 cu.m/sec), the proposed irrigation area of 48 ha could be irrigated. Thus, it is proposed that the required water for the Project is taken by the intake weir to be rehabilitated by this Project.

2.2.9 Irrigation and Drainage Plan

1) Irrigation Plan

The area to be irrigated is discussed in previous paragraph of 2.2.8, based on the available water amount at the project intake site and the requested area by the WUAs. The 120 farmers participate to the Project and each farmer is allocated the irrigation area of 0.4 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 condition)
- 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 beans as staple crops, and bananas, tomato, cabbage, French beans, onion etc. as cash crops were selected. The proposed cropping pattern is shown in Table 2.2-1.

(2) Reference Crop Evapotranspiration

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

The calculation of ET_o was carried out by using computer program "CROPWAT" owned by IDB. The estimated ET_o ranged from 2.8 mm/day in July to 4.8 mm/day in February. The monthly ET_o is tabulated in Table 2.2-3.

(3) Crop Evapotranspiration

The crop evapotranspiration (ET_{crop}) will be determined as follows;

$$ET_{crop} = ET_o \times K_c$$

Where;

- ET_{crop} : Crop evapotranspiration (mm/day)
- ET_o : Reference crop evapotranspiration (mm/day)
- K_c : Crop factor (see Table 2.2-4)

Table 2.2-3 Reference Evapotranspiration (ET_o) of Ngomano/Nyangati Water Furrow Project

	Temperature		Humidity mean (%)	Wind Speed (km/day)	Sunshine hours (hrs/day)	Radiation Mj/m ² /day (km)	ET _o - Penman (mm)
	maximum (degree)	minimum (degree)					
Jan	28.4	13.7	59	101	9.2	23.0	4.6
Feb	29.7	14.7	58	94	9.1	23.6	4.8
Mar	30.0	16.3	60	91	7.9	21.9	4.6
Apr	27.9	17.4	68	66	6.9	19.7	3.9
May	26.8	16.9	69	49	7.0	18.7	3.6
Jun	25.5	15.8	65	20	5.4	15.8	2.9
Jul	24.3	15.3	66	59	4.0	14.1	2.8
Aug	24.9	15.1	65	68	4.0	14.8	3.1
Sep	27.5	15.5	58	82	6.1	18.8	3.9
Oct	28.8	16.3	60	73	7.5	21.0	4.2
Nov	26.9	16.1	69	73	7.0	19.7	3.9
Dec	26.9	14.7	66	81	8.5	21.6	4.1
Ave/Total	27.3	15.7	64	71	6.9	19.4	1,409

Table 2.2-4 Crop Factors of Major Crops

	Initial Stage	Crop Dev. Stage	Mid-season. Stage	Late season Stage
Bananas	0.90	0.90	0.90	0.90
Tomato	0.45	0.75	1.05	0.90
Poteto	0.45	0.75	1.15	0.85
Maize & Beans	0.40	0.80	1.15	0.70
Beans	0.35	0.75	1.10	0.70
French beans	0.35	0.70	1.10	0.90
Onion	0.50	0.75	1.05	0.85
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 2.2-5 TRAM and Irrigation Interval of Ngomano/Nyangati water Furrow Project

Crop	Depth of Effc. Root Zone(m)	Half-storage Capa.* (mm/m)	TRAM (mm)	ET _o (max) (mm/day)	Kc(max)	ET _{crop} (mm/day)	Irrigation Interval (day)
Bananas	0.7	90	63	4.8	0.90	4.3	14.6
Tomato	0.5	90	45	4.8	1.05	5.0	8.9
Poteto	0.5	90	45	4.8	1.15	5.5	8.2
Maize & Beans	0.7	90	63	4.8	1.15	5.5	11.4
Beans	0.6	90	54	4.8	1.10	5.3	10.2
French beans	0.4	90	36	4.8	1.10	5.3	6.8
Onion	0.5	90	45	4.8	1.05	5.0	8.9
Cabbage	0.4	90	36	4.8	1.05	5.0	7.1

*) Soil Type: Clay loam to Loam

(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;

$$\text{NIR} = \text{ET}_{\text{crop}} - P_e$$

Where;

- NIR : Net irrigation requirement (mm/day)
- ET_{crop} : Crop evapotranspiration (mm/day)
- P_e : Effective rainfall (mm/day)

The monthly effective rainfall can be estimated the following formula developed by Kalder in 1987.

$$\begin{aligned} P_{em} &= 0.81 \times P_m^{0.975} && : \text{ for } P_m < 100 \text{ mm} \\ P_{em} &= 18.54 + 0.52 \times P_m && : \text{ for } P_m > 100 \text{ mm} \end{aligned}$$

- Where : P_{em} : Monthly effective rainfall
- P_m : Monthly rainfall with 80 percent probability of exceedance

The estimated effective rainfall is shown in below table;

Monthly and 5-days Effective Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
mm/month	0	1	19	182	55	4	3	3	2	69	101	27
mm/5day	0.0	0.2	3.2	30.3	9.2	0.7	0.5	0.5	0.3	11.5	16.8	4.5

The monthly rainfall data observed at Tabere Cotton Research station are used for the analysis of effective rainfall. The data are shown in Table L.2.2-1, 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. Considering topographic condition, surface irrigation is proposed for the Project. The E values for surface irrigation is assumed to be 0.5. The GIR is estimated by the following equation;

$$\text{GIR} = \text{NIR}/\text{E}$$

Where;

GIR : Gross irrigation requirement (mm/day)

NIR : Net irrigation requirement (mm/day)

E : Overall irrigation efficiency

$$E = E_a \times E_c \times E_o$$

E_a : Field application efficiency (surface irrigation: 0.55- 0.75)

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 number of irrigation hours per day and working day per week. The following equation is used;

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

where,

IWR : Irrigation water requirement (lit/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 day per week are generally adopted by farmers. Thus, the same condition will be adopted for the estimation of IWR.

Based on the above procedure, the water requirement of five-days basis is estimated at 69.3 lit/sec of the maximum irrigation water requirement. The variations of water requirement are illustrated in Figure 2.2-2. The details 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 effective 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

Depth of Effective Root Zone

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

Irrigation Water Requirement of Ngomano/Nyangati Water Furrow Project(Surface Irrigation)
 Irrigation Area = 48 ha, Cropping Intensity = 208%, Maximum Water Requirement = 69.3 l/sec

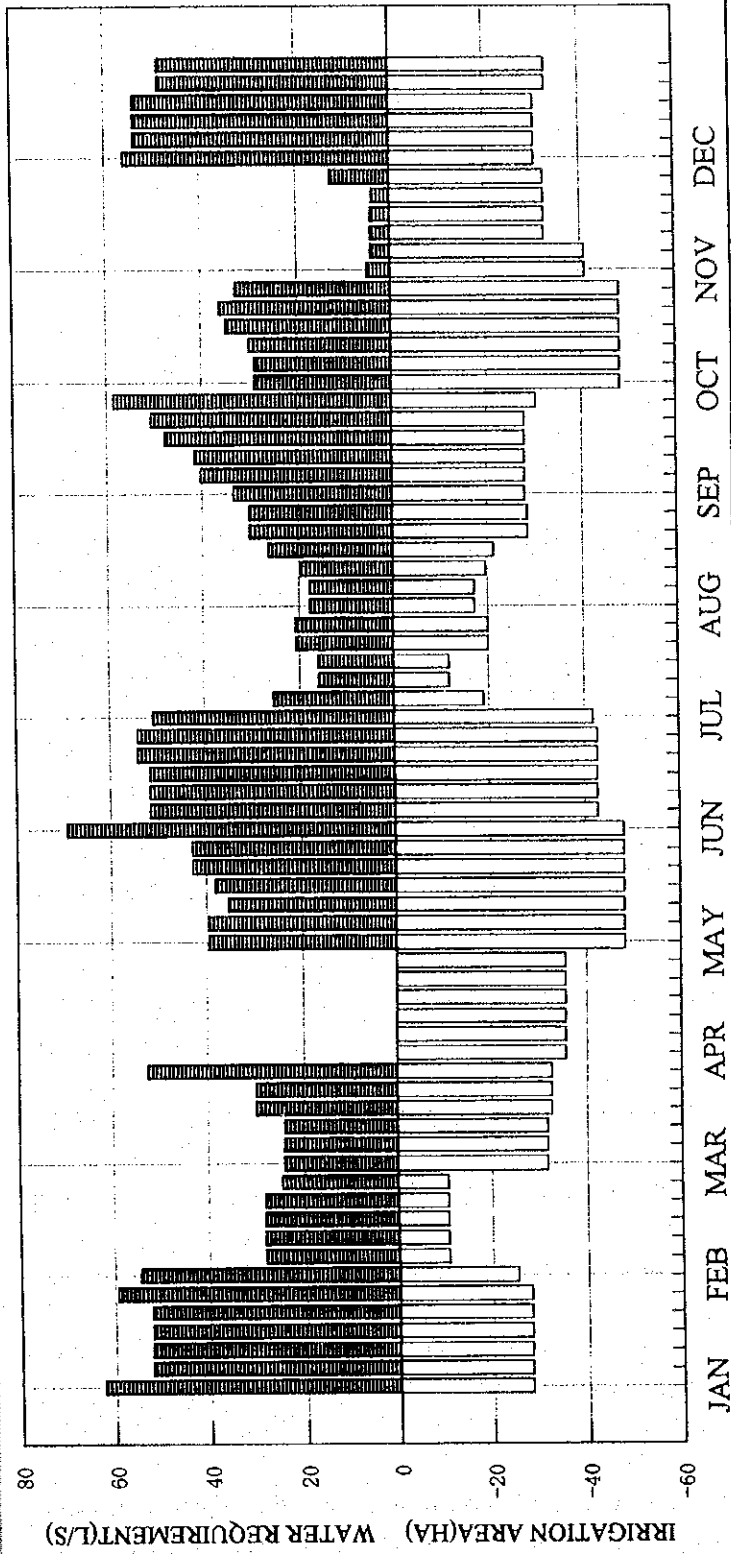


Figure 2.2-2 Irrigation Water Requirement of Ngomano/Nyangati water Furrow Project (Surface Irrigation)

the root zone. According to the result of soil survey in this Study, a hard plough pan were observed at 40-70 cm. Therefore, the maximum depth of effective root zone is premised less than 70 cm. Thus, the depths of effective root zone are as follows:

Bananas	:	70 cm
Maize	:	70 cm
Tomato	:	50 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;

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

The predominant soil type in the Project Area is clay loam to loam.

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 2.2-5. The estimated irrigation intervals for various crops ranged from seven to 15 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 380 ha. Therefore, the area to be irrigated is allocated according to the estimated present command area along the existing canal.

As the proposed irrigation area of 48 ha is irrigated in six days, the irrigation area per day is 8.0 ha. As described above, irrigation operation time per day is 12 hours, then a night storage can be introduced to the system theoretically. However there is not adequate place for the facilitation of night storage because the proposed irrigation area extends in few distance from the intake facility. Thus, night storage is not introduced in the irrigation system. Considering of topographic condition of the Project Area, open canal system with a furrow irrigation is proposed.

According to the number of rotation block to be adopted, two water management plans are proposed as shown below;

(1) Open canal system with single rotation block

The earth canals are planned to accommodate in the open canal system. As the design discharge of planned canal is only 69.3 lit/sec, the discharge can be flown by earth canal with a minimum wide of 0.3 m. Therefore, if the cross section of canal up to the tail-end is designed by the minimum section, single rotation block is adaptable. The daily water supply is centered to some single place of eight hectare in the Project Area and the daily irrigation area is shifted from the downstream area to the upstream area with seven days interval. One water guard will be required to control the canal system. The irrigation network is illustrated in Figure 2.2-3.

(2) Open canal system with plural rotation blocks

The Project Area is divided in seven rotation blocks taking into consideration of present canal alignment and the geographical features under the same situation of canal design as above system. The daily water supply is separately executed at seven places at the same time with seven days interval. Therefore seven water guards will be required to control the water distribution. The irrigation network is illustrated in Figure 2.2-4.

2) Drainage Plan

Since the Project Area is located in a relatively plain area, part of the Area suffer from poor drainage. Thus the drainage plan is established according to the following drainage criteria:

a) Design Rainfall

As a design rainfall for drainage, maximum one-day rainfall with a 5-year return period is adopted. Based on the maximum one-day rainfall record from 1979 to 1986 at Mwea Meteorological Station, design one-day rainfall is estimated at 100 mm/day.

b) Drainage Modulus

The design daily rainfall in the upland field should be removed within one day. Thus, the drainage modulus is calculated using the following equation;

$$q = (R_{24} \times 10^3 \times A \times 104) / (T \times 60 \times 60)$$

Where; q : Drainage modulus (lit/sec/ha)
R₂₄ : Design daily rainfall (100 mm/day)
A : Drainage area (ha)
T : Drainage period (24 hours)

Thus, the unit drainage water requirement is estimated at 11.6 lit. sec/ha.

c) Design Drainage Discharge

Two collecting drains are planned for the Project Area as shown in the attached Drawings. The drain dimensions are shown below;

Dimension of Proposed Drains

	Catchment Area (ha)	Design Discharge (lit/sec)	Length (m)
Drain A	13	150	700
Drain B	19	220	750

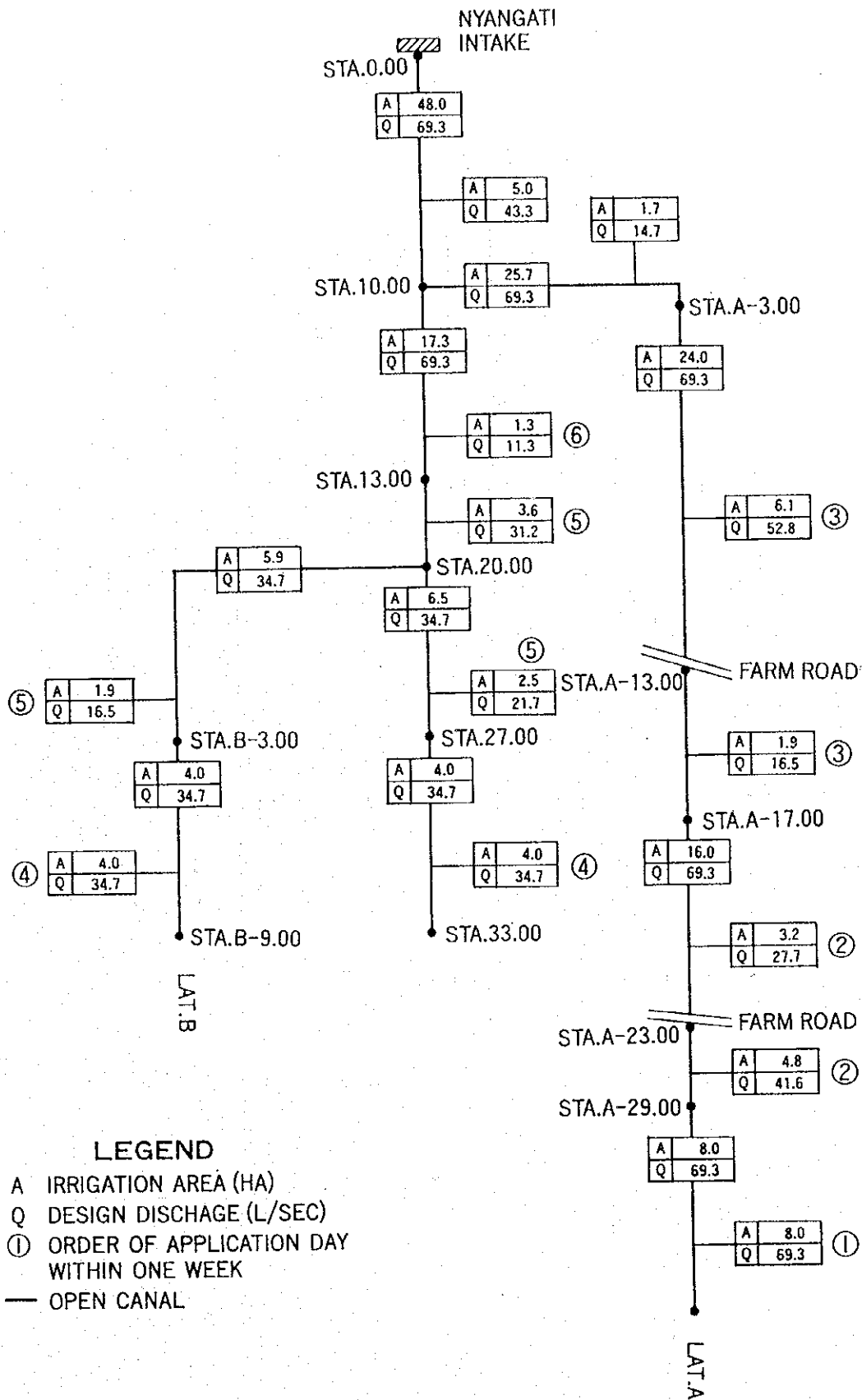


Figure 2.2-3 Irrigation Network of Ngomano/Nyangati water Furrow Project (Open Canal System with single Rotation Block)

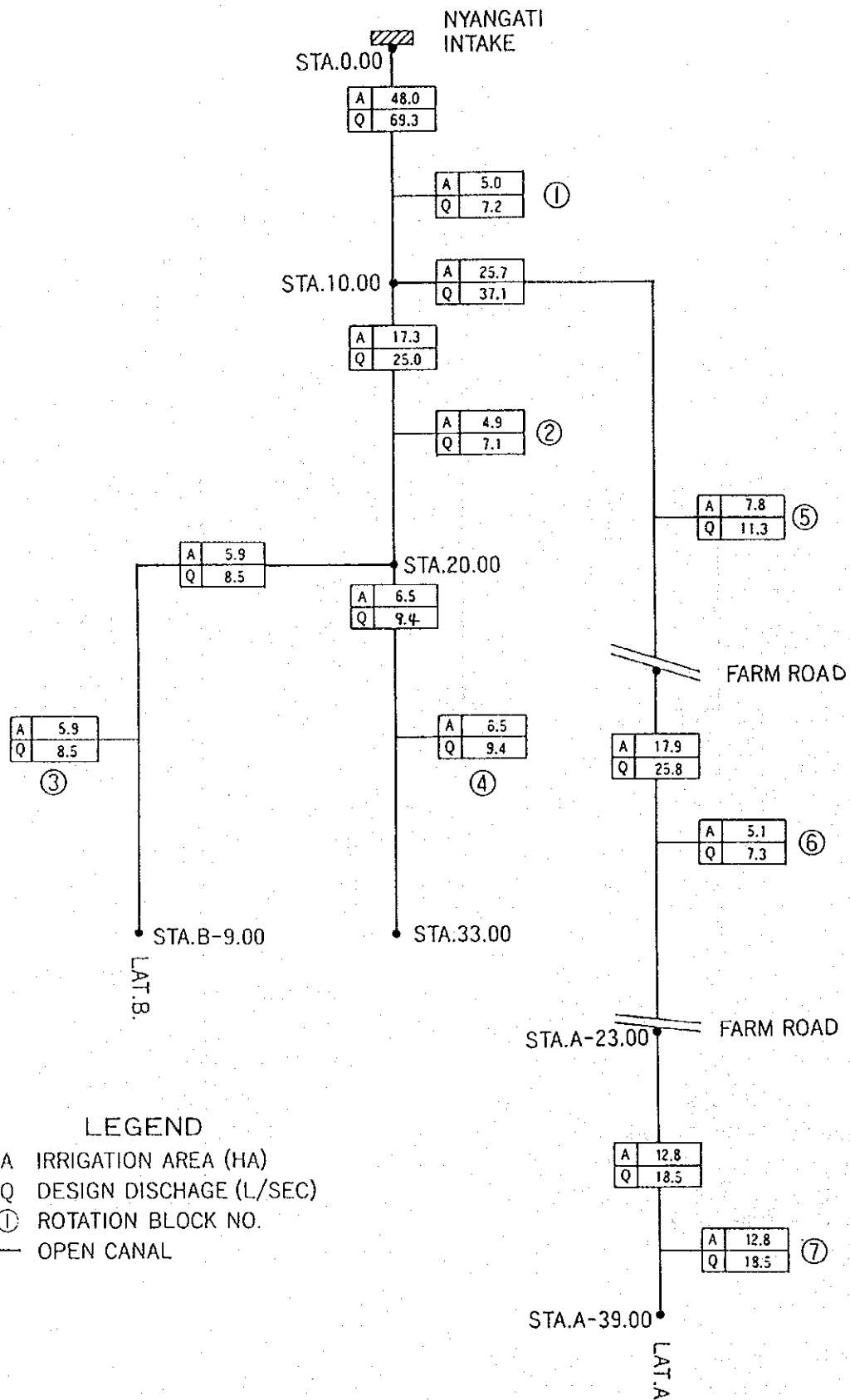


Figure 2.2-4 Irrigation Network of Ngomano/Nyangati water Furrow Project (Open Canal System with Plural Rotation Blocks)

2.3 Physical Plan and Cost Estimate

2.3.1 Agriculture and Rural Infrastructure Plan

1) Agriculture Infrastructure Plan

a) Irrigation and Drainage Facilities

As to irrigation facilities, present irrigation system shall be improved from the view point of reliable intake for irrigation water, effective water conveyance and efficient water distribution. Intake weir, presently temporary wooden structure which is washed away a few times every year by floods, shall be replaced by a permanent structure. Location of a permanent diversion weir is planned to be at the same site of the existing temporary weir and it will be built as a concrete structure across Murubara river on the earth foundation. The weir shall be a drop type structure provided with stop log to maintain intake water levels and to release flood river water. Riverbed protection and an intake box are also planned. However, it is noted that foundation investigation will be required in the detailed design stage.

For improvement of water conveyance system, alternative study is made from the view point of irrigation rotation system and canal lining type. Division structures are also planned at the canal division points to improve water distribution.

Alternative-1 : Whole irrigation area is divided into seven rotation blocks, then daily irrigation at weekly rotation basis from Monday to Saturday is scheduled for 1/6 areas of each rotation block. Canal at upper reaches can be an earth canal, however canal at lower reaches where water flow is very small shall be concrete flume canal to minimize conveyance losses.

Alternative-2 : Whole irrigation area shall be one rotation block, then it is divided into six application blocks for daily irrigation at weekly basis from Monday to Saturday. As water flow at lower reaches is increased, canal type can be all earth canal with minimum cross section.

Alternative Study for Improvement of Ngomano/Nyangati Irrigation System

Alternatives	Conditions		Objectives/Needs	Direct Cost
	Irrigation Rotation System	Canal Type	To solve water shortage at lower reaches	(,000 Ksh)
A-1	Whole area is divided into seven rotation blocks. Daily irrigation is made for 1/6 areas of each rotation block.	Earth canal for upper reaches, and concrete flume for lower reaches	Attained	4,692
A-2	Whole area as one rotation block is divided into six application block for daily irrigation.	All earth canal with minimum cross section	Attained	2,292

As a result of Alternative study, Alternative-2 is recommended for the improvement of Ngomano/Nyangati Irrigation System. Irrigation rotation system recommended in Alternative-2 is a key factor to solve water shortage at lower reaches. However, final decision shall be made by Ngomano/Nyangati Water Furrow Association members before commencement of detailed design. (Refer to Annex M and P).

As to drainage improvement, construction of drainage canals are proposed at the lower part of the Project Area. It is noted that land acquisition is necessary for new drainage canals.

b) Village/Farm Roads

Village/farm roads shall be rehabilitated with a spot improvement method which requires road grading and regravelling. A total length of the village/farm road improvement shall be 3.2 km (Refer to Annex P).

2) Rural Infrastructure Plan

a) Domestic Water Supply

Domestic water supply is not included in the improvement plans as domestic water is presently obtained from natural springs and shallow wells.

b) Access Roads

Access roads are also not included in the improvement plans.

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 relationship among members, ownership and also lower the construction costs by using local materials and labour force of members.

2.3.2 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 earth canal trimming, structure excavation and backfilling and so on are not included in this estimate, since they are planned to be provided by Ngomano/Nyangati Water Furrow 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, respectively. These percentages were based on the past experiences in similar irrigation project. Pre-engineering cost means the cost for geological investigation for intake weir and survey for road 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. Costs for land acquisition for new drainage canals are also estimated. 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)

1. Construction Cost	
1) Irrigation & Drainage Improvement	3,564,000
2) Marketing Improvement	0
3) Access Roads Improvement	0
4) Village/Farm Roads Improvement	1,824,000
5) Domestic Water Supply Improvement	0
Sub-total	5,388,000
2. Community Development & Support Services	
1) Agricultural Support Services	12,950,000
2) Community Development	7,078,000
3) Water Management Services	1,810,000
4) Marketing Support Services	374,000
5) Public Health Services	150,000
Sub-total	22,364,000
3. Associated Cost	
1) Pre-engineering Cost	228,000
2) Administration Cost	1,942,000
3) Consulting Services	2,775,000
Sub-total	4,945,000
4. Land Acquisition	175,000
5. Physical Contingency	539,000
Total	33,411,000

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	71,000
2) Marketing Facilities	0
3) Access Roads	0
4) Village/Farm Roads	157,000
5) Domestic Water Supply Facilities	0
Total	228,000

2.4 Project Implementation, Operation and Maintenance Plan

2.4.1 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 by Figure 2.4-1. The range of support services to be provided by various agencies are summarized in the following table;

Agencies Providing Capability Build-up Support 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

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

a) Training and Research Services

With expansion of irrigated horticultural production, it is planned that KARI regional station at Embu will be requested to establish a research presence in Ngomano/Nyangati Project Area that will focus on solving the following problems;

- Soil and seed born diseases as well other crop pests and diseases
- Low crop yields
- Limited crop diversity

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 frontline 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 be participatory and which will 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
- Facilitate and coordinate all-round farmers training (field days, demonstration, agricultural shows, farmers training center, 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 confront 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 Kimbimbi 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 construction, operation and maintenance phases.

e) Credit Assistance

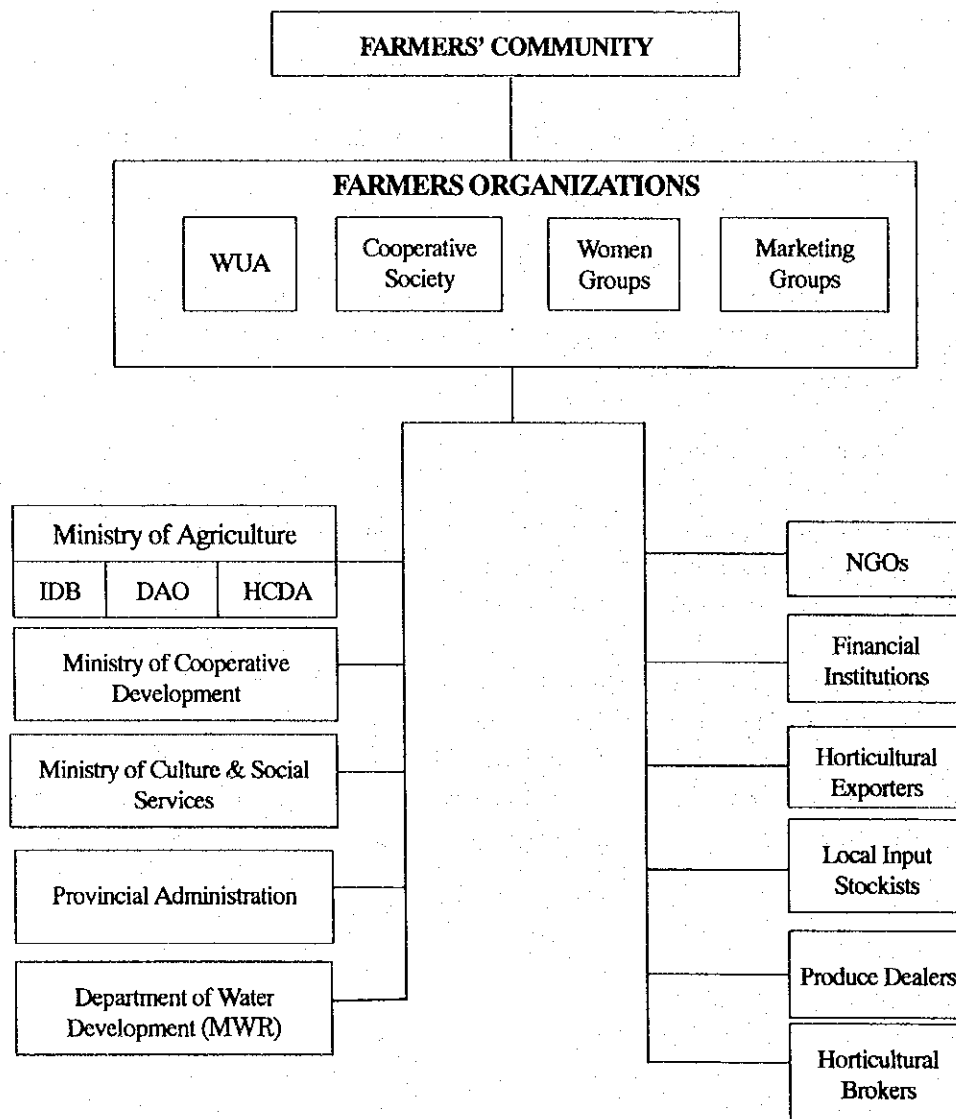
Ngomano/Nyangati Area is in better condition as to location, land condition and marketing than the other three Project Areas, and has higher potentiality for irrigated horticultural farming. As this Area has been partly irrigated by the existing irrigation facilities, diversified agriculture has managed though there has been many problems and constraints to be overcome. The existing irrigation group is eager to promote irrigated agriculture under the leadership of committee members. However, about 60 percent of the farms don't possess the title deed. Banks as financial agencies will judge that lending money to them is risky. Therefore, Ministry of Land and Settlement should survey farmlands immediately and publish the certificate. Banks should set up credit system by which marketing and irrigation groups of the smallholders can apply credit even if they don't possess the title deed.

f) Fostering of Farmers' Capability

Provision of 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 to be cultivated and fostered.

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 eg 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.

Figure 2.4-1 Institution Arrangements for Providing Support Services to Farmers Organizations during Project Implementation



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

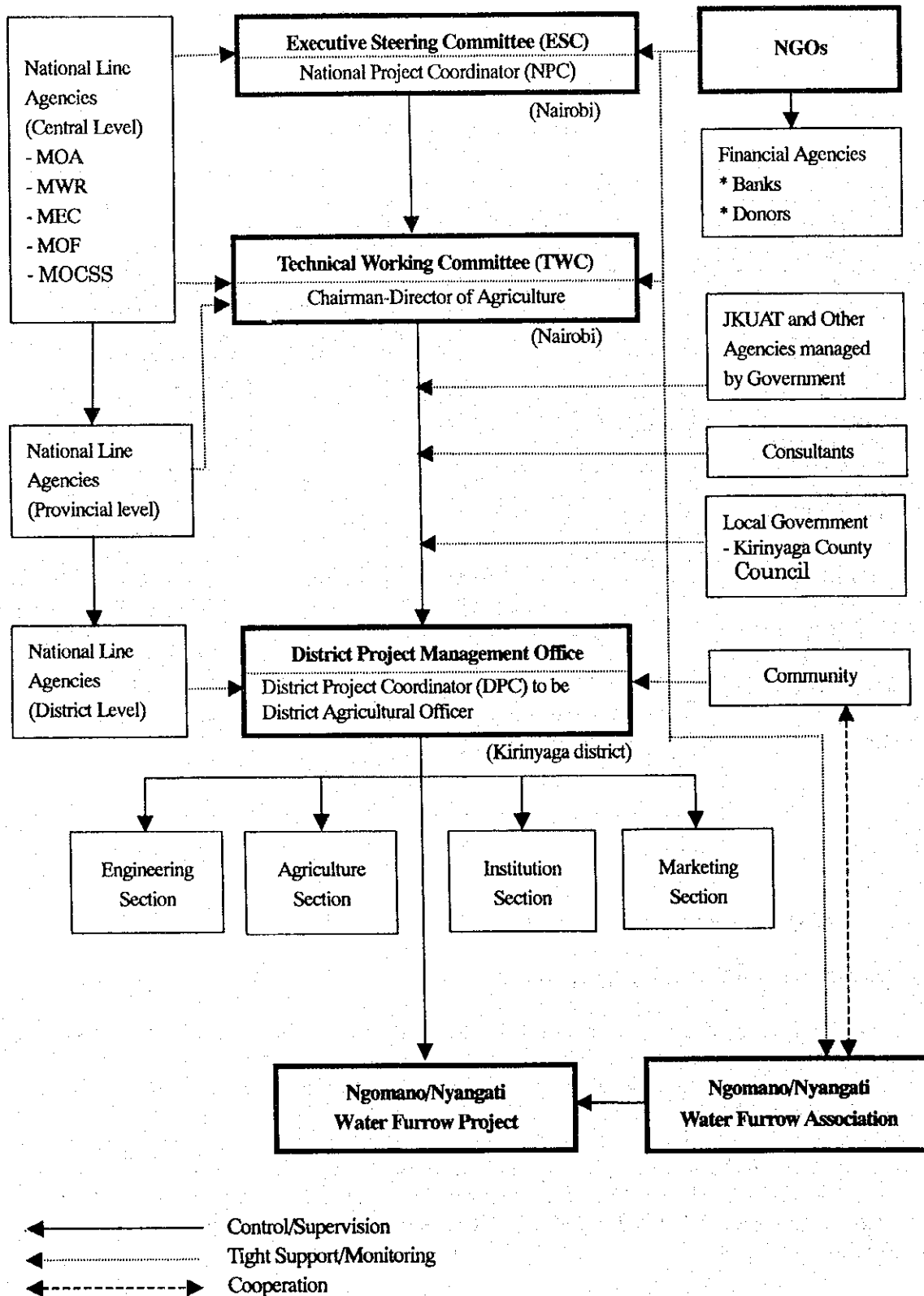
Problems/Constraints	Interventions	Agency Concerned	Outputs
Seminar hold at JKUAT and other institutions managed by the government			
Inadequate agricultural extension services	Lecturing and practice on horticultural produce	MOA staff on horticulture with lectures/technicians	Better husbandry and reducing 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	PCM workshop	MOA staff on farmers' organization	Strengthening farmers' bargaining skills
Exploitation of middlemen	Introduction of auction consignment	Marketing officer of HCDA	Improved transaction mode
Lack of knowledge of market demands for export produce	Lecturing on grading technique and measures for MRLs	Technical staff of FPEAK or exporter	Reducing post-harvest losses caused by reject and understanding EU market demands in MRLs
Low quality of produce	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 on farmers' organization	More accessing to upper stream of marketing and proposing sites are Nairobi markets, exporters' grading & packing facilities, Nairobi Horticultural Centre for auction
Local institutional support			
Lack of market information	Provision of data collected (weekly base data can be referred)	Divisional agricultural extension officer of Mwea Div.-Wanguru Marketing expert of HCDA-Mwea	Better crop planning and outflows to the market and traders
Exploitation of middlemen	Auction consignment with HCDA	Marketing expert of HCDA-Mwea	Fare trade in pricing and attaining price information

2.4.2 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 other institutions managed by the government 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, and District Project Management Office (DPMO) shall be established at Kerugoya for actual project implementation at the field level. Proposed organization chart is presented in Figure 2.4-2.

Figure 2.4-2 Proposed Organization Chart for Project Implementation for Ngomano Nyangati Water Furrow Project



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 laour intensive method wherever it is feasible. Irrigation & drainage improvement will be undertaken by small local contractors under supervision of DPMO. Village/farm road improvement will be carried out by laour-based small contractors and supervised by consultants under direction of District Roads 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 Ngomano/Nyangati Water Furrow 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 and drainage facilities, and the other is governmental public projects like 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.

a) Self-help Projects

There are three major implementing bodies to be involved in the self-help projects, i.e. WUA, NGOs and ESC. Ngomano/Nyangati Water Furrow Association (WUA) is a 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

Implementing body for access road improvement shall be Embu County Council. 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 2.4-3.

2.4.3 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 as private sectors (Refer to Annex R).

- Private Sector: (1) Irrigation & drainage facilities : Ngomano/Nyangati Water Furrow Association
- (2) Village/farm roads : Village community including Association

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 Project Area, but has not yet been widely adopted, for example speciality bean varieties. 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. A 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, inputs such as seed will be provided by the project, but the farmers will be responsible for all of the husbandry. After the demonstration has been visited and assessed, perhaps during a field day or a training session, all of the yield will remain the property of the participating farmer.

Figure 2.4-3 Implementation Schedule for the Improvement of Ngomano/Nyangati Water Furrow Project

Work Item	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
A. Social Preparation and Institutional Strengthening							
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. Facility Construction and Equipment Supply							
1. Apply Water Permit & Preparation Work	=====						
2. Survey, Detailed Design and Costing		=====					
3. Procurement of Funds (for construction works)		=====					
4. Consulting Services by NGOs and Consultants		=====				=====	Monitoring
5. Construction Works			=====				
C. Community Development, Support Services and O&M							
1. Community Development							
2. Agricultural Support Services							
3. Water Management Training Services							
4. Marketing Support Services							
5. Operation and Maintenance of Project Facilities							

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, for example some types of Asian vegetables in Nyangati. Trials will also be conducted on farmers fields, primarily to test new technology under farm conditions. 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 the district.

Livestock

Access to improved lines of poultry will be facilitated by the project. The farmer will be responsible for the costs involved. If there is a demand for it, trials and demonstrations of fodder species can be conducted.

Improved inputs

After testing and demonstrating improved inputs such as new melon varieties, urea feeding blocks, speciality 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 the improved inputs. The farmers will be responsible for all the direct costs involved.

b) Agricultural Infrastructures

- Irrigation & Drainage Facilities

O&M of irrigation and drainage facilities shall be executed by existing Ngomano/ Nyangati Water Furrow Association. During the O&M stage, technical support shall be extended by the Irrigation Unit of District Agricultural Office, Kirinyaga (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 Kirinyaga 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

There is no improvement activities under the Project. O&M of B6 National Trunk Road as an access of the Project Area are to be carried out by District Works Office, MPWH as presently conducted.

d) Post-Harvest and Agro-Industry

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

2.5 Project Evaluation and Cost Recovery

2.5.1 Economic Evaluation

1) Method of Economic Evaluation

Economic internal rate of return (EIRR) as an index to judge economic viability for small scale irrigation project is used similar to the other three Project Areas. In the consideration of lower income level of farm household in the Area in comparison with that of national and Kirinyaga district averages, even if EIRR is under eight percent, that is the standard of the Kenyan agriculture project, irrigation project in this Area should be implemented. This idea should also be applied to the other areas as well. It should be considered that the major contributors to Kenyan agriculture are the smallholders which account to 98 percent of the total farm households and they are living on lower income.

The project life is designed at 30 years. Benefits and cost during the 30 years are discounted with several discount rates to get EIRR. EIRR can be presented as the rate at which total of present values of cost and benefit will become equal. The project cost includes annual operation and maintenance cost, and replacement cost, if necessary. Local currency portion is converted to economic project cost by applying standard conversion factor (SCF). Tax, subsidy, the cost for land acquisition and compensation, contingency for price escalation are not included in the economic project cost. The cost for the road improvement and drawing of topographical map are included in the project cost.

2) Commodity Prices

Agricultural commodities are divided into two, that is, tradable one like maize and fertilizers and non tradable ones. The World Bank releases the long-term forecast about the price of tradable commodities regularly and economic price for project evaluation are based on them. The economic price of other crops consumed in domestic market is estimated based on farmgate price gained in the farm economic survey undertaken by Study Team. Economic prices of vegetables for export are based on the price gained at HCDA. Fertilizer prices are estimated on the long-term forecast by the World Bank.

3) Project Benefits

The major project benefits in Ngomano/Nyangati Area are generated from an increase of agricultural production. The base of the agricultural production increase is the present land use and proposed land use, which are prepared based on the result of the farm economic survey. The land use plan was proposed taking into consideration the present agriculture, condition of land, soil and climate, demand for crops, farmer's experience and so on. Benefits are generated with the expansion of irrigation areas and increase in crop yield, which is attained by the completion of irrigation facilities. The incremental benefit is the difference between without Project and with Project cases. Though some areas will remain dependent on the rainfed farming even after the implementation of the project, it can be expected that the increase in crop yield by the improvement of crop management through the strengthening agricultural extension services and training for farmers. Incremental agricultural benefits in Ngomano/Nyangati Area is estimated at 5,157 thousand Ksh (refer to Table 2.5-6).

Other than agricultural benefits, improvement of access, farm and village roads also generate benefit. Effects of road improvement are generally estimated such that fuel consumption will be reduced by speed up of vehicles and shortening of transportation hours. As the result, road improvement benefit in Ngomano/Nyangati Area is estimated at 2,080 Ksh (refer to Table 2.5-7).

4) Economic Project Cost

Project cost, in other words, financial project cost for Ngomano/Nyangati Area is estimated at about 33,560 thousand Ksh. The project cost consists of only local currency as construction materials and laour can be procured in Kenya. Economic project cost estimated based on the principle mentioned in above paragraph of 1) is estimated at about 31,182 thousand Ksh and annual operation and maintenance cost is estimated at about 213 thousand Ksh as well (refer to Table 2.5-8).

5) Economic Internal Rate of Return

EIRR of the small scale irrigation project in Ngomano/Nyangati Area is calculated at 22.1 percent, which is higher than eight percent of EIRR which is the standard of judging economic viability on irrigation projects in Kenya. Therefore, the implementation of the small scale irrigation project in Ngomano/Nyangati Area is judged economically feasible. It including mapping cost, which is not included in the project cost because JICA Study Team made it, EIRR is 21.5 percent.

6) Sensitivity Analysis

Sensitivity analysis was done to verify the effects on EIRR in accordance with some assumed parameters:

	EIRR(%)
i) 10 percent increase in project cost	19.27
ii) 10 percent decrease of benefit	18.83
iii) 3 years delay of benefit generation	12.95
iv) Combination of i) and ii)	16.49
v) Combination of ii) and iii)	11.56

2.5.2 Financial Analysis of Typical Farmers

Financial analysis was undertaken to verify the influence on the farm economy with the implementation of small scale irrigation project. Farm household income of standard farm in case of without Project and with Project was compared. Financial prices are used for the analysis and household expenditure and off-farm income are taken into account with a price escalation for four years. The data on the farm household income, expenditure and off-farm income at the present is based on the result of the farm economic survey conducted by Study Team.

The result is shown in Table 2.5-10. Farm household income is 78 thousand Ksh including animal and off-farm incomes, and the disposable income is 45 thousand Ksh in the case of without Project. While, total farm household income is estimated at 179 thousand Ksh, and the disposable income is 146 thousand Ksh in the case of with Project, indicating farm household economy will improve with the small scale irrigation project.

2.5.3 Cost Recovery Analysis of the Project

Farm household income is expected to improve by the implementation of the irrigation project, however it must be verified that project cost can be burdened by farmers in accordance with the full cost recovery policy. On the occasion, O & M cost for farm and village roads and cost for drawing topographical maps are subject to be a debt on beneficial farmers.

The standard farm household in Ngomano/Nyangati Area will get disposable income of 146 thousand Ksh with the implementation of the Project. It will be verified if farmers can bear the burden of the project cost within this disposable income. Some alternative plans for cost recovery will be suggested to decide payable repayment. If this is within the disposable income mentioned, farmers are judged to have the ability for cost recovery.

The result is that project cost to be paid by individual farm household in Ngomano/Nyangati Area is estimated at 40 thousand Ksh, and farmers must repay 1,075 Ksh per month under the current credit conditions for small scale irrigation project. Therefore, beneficial farmers have the ability for cost recovery within their disposable income. However, if credit condition is improved to repayment period of six years, 12 percent of interest, that is, case 2, the monthly repayment will be 742 Ksh, and the burden on farmers would be much lightened. Table 2.5-11 shows the monthly repayment in both cases of excluding and including mapping cost to farmer's burden.

2.5.4 Study on the Proper Water Charge

After the completion of irrigation project, the members of WUA must pay water charge to operate and maintain irrigation facilities to gain irrigation benefits with sustainability. Water charge is spent to manage WUA involving salary for water guards and repairing cost of irrigation facilities etc. The proper water charge in Ngomano/Nyangati Area is estimated at 2,508 Ksh/ha/year, that is, 209 Ksh /ha/month.

2.5.5 Social and Environmental Effects by the Project

There are tangible benefits such as agricultural benefit and intangible benefits. Some intangible benefits often have important meanings that effect on the other small-scale irrigation in the future.

- The implementation of small scale irrigation project in Ngomano/Nynagati Area will become a model case of irrigation project not only in Kirinyaga district but also in other similar areas in and around foothills of Mt. Kenya .
- This area can be characterized as the commercial horticultural area. The various supporting services on crop management, marketing and water management will give the good example for other areas to adopt.
- The way of operation and maintenance of irrigation facilities by farmer's groups will also give a good sample to the other area.
- The farm household income increases temporally by participating in construction of irrigation facilities.
- Farmer's recognition will be fostered by maintaining irrigation facilities as a common property of the rural society. Therefore, harmony among people will also be fostered.
- Activities by many organization concerned with the implementation of the project in hard and soft-aspects will show the direction for necessary activities and supports to be given to the small scale irrigation project in the future.

2.6 Project Monitoring and Evaluation

1) Necessity and Objectives of Monitoring and Evaluation

Irrigation improvement for Ngomano/Nyangati Water Furrow Project 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 Kirinyaga 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 Ngomano/Nyangati 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.

Table 2.5-1 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	10,775,629	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 2.5-2 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(81.19Ksh/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 2.5-3 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(81.19Ksh/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 2.5-4 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(61.19Ksh/US\$)	115,528	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 2.5-5 Farmgate Price at Ngomano/Nyangati

	Unit	Unit Price(Kash)	
		Financial	Economic
1. Crops			
Maize	kg	9.4	9.5
Maize Green	kg	10.5	10.5
Millet	kg	21.5	21.5
Sorgum	kg	15.3	15.3
Rice	kg	22.0	16.8
Beans	kg	28.9	28.9
French Beans	kg	20.0	29.8
Cowpeas	kg	15.0	15.0
Irish Potatoes	kg	18.3	18.3
Sweet Potatoes	kg	5.0	5.0
Bulb Onions	kg	15.0	15.0
Tomatoes	kg	26.0	24.0
Okra	kg	23.4	26.1
Kale	kg	3.0	3.0
Cabbage	kg	8.8	8.8
Carrots	kg	23.0	22.4
Watermelon	kg	15.0	15.0
Banana	Bunch	200.0	200.0
Coffee	kg	23.0	17.2
Milk	kg	25.6	25.6
Avocado	kg	10.0	10.0
Mangoes	kg	15.0	15.0
2. Seed			
Maize	kg	98	92
French Beans	kg	190	177
Bulb onion	kg	4,400	4,110
Tomatoes	kg	6,400	5,978
Cabbage	kg	2,000	1,868
Carrot	kg	1,700	1,588
Kale	kg	900	841
3. Fertilizer			
Nitrogen	kg	24.1	27.4
Phosphate	kg	17.3	24.3
Potassium	kg	23.3	16.4
4. Agricultural Chemicals			
Dimethoate	lit.	585	546
Antracol	kg	600	560
Sancozeb	kg	480	448
Milraz	kg	1,285	1,200
Karate	lit.	1,395	1,303
5. Labour			
Labour	MD	95	48
Animal Labour	MAD	910	455
6. Nursery			
Banana	plant	50	50
Papaya	plant	40	40
Mango	plant	60	60
Avocado	plant	50	50
Tea	plant	50	50

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

Table 2.5-6 Estimation of the Agricultural Benefits

(A) Rainfed Areas	Maize/ Maize		French Beans		Kale/ Cabbage		Sweet Sorghum/ Potato		Water Melon		Rice		Onion		Veget		Banana		Coffee		Total
	Beans	Green	Beans	Green	Beans	Green	Potato	Millet	Melon	Rice	Onion	Veget	Banana	Coffee	Beans	Green	Beans	Green	Beans	Green	
I. Without Project	9.5/28.9	0.0	28.9	29.8	3.0	5.0	21.5	15.0	0.0	0.0	15.0	26.1	10.0	17.2							
Unit price(Ksh/kg)																					
Yield(kg/ha)	0	500	3,500	5,000	6,000	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
Gross Income(Ksh/ha)	21,475	0	14,500	104,300	15,000	30,000	16,125	112,500	0	0	97,500	117,450	90,000	51,600							
Cost of Production(Ksh/ha)	15,337	0	11,397	19,735	8,545	11,118	5,239	28,434	0	0	35,881	14,140	7,799	10,421							
Net Return(Ksh/ha)	6,138	0	3,053	84,565	6,455	18,884	10,886	84,066	0	0	61,619	103,310	82,201	41,179							
Planted Area(ha)	212.67	0.00	69.28	56.25	32.74	0.64	8.90	2.54	0.00	2.23	3.18	6.36	11.70								
Total Net Return(1,000 Ksh)	1,305	0	212	4,757	211	12	97	213	0	0	137	329	523	482							
II. With Project	9.5/28.9	0.0	28.9	29.8	3.0	5.0	21.5	15.0	0.0	0.0	15.0	26.1	10.0	17.2							
Unit price(Ksh/kg)																					
Yield(kg/ha)	0	650	4,500	7,000	7,000	10,000	1,000	8,500	0	0	7,000	4,500	9,500	3,000							
Gross Income(Ksh/ha)	25,068	0	18,785	134,100	21,000	35,000	21,500	127,500	0	0	105,000	117,450	95,000	51,600							
Cost of Production(Ksh/ha)	18,112	0	11,792	19,941	9,143	13,081	5,844	31,146	0	0	38,877	14,284	8,477	11,305							
Net Return(Ksh/ha)	8,956	0	6,993	114,159	11,857	21,919	15,856	96,354	0	0	66,323	103,166	86,523	40,295							
Planted Area(ha)	213.14	0.00	68.89	56.33	44.15	0.76	8.75	2.66	0.00	2.28	3.05	6.47	11.80								
Total Net Return(1,000 Ksh)	1,909	0	482	6,431	523	17	139	256	0	0	151	315	560	475							
III. Incremental Benefit(1,000 Ksh)	604	0	270	1,674	312	5	42	43	0	0	14	14	37	-6							
(B) Irrigated Areas																					
I. Without Project	0.0	10.5	28.9	29.8	3.0	5.0	21.5	15.0	0.0	0.0	15.0	26.1	10.0	17.2							
Unit price(Ksh/kg)																					
Yield(kg/ha)	0	3,500	600	4,500	6,000	0	0	0	0	2,500	8,000	5,000	10,000	3,500							
Gross Income(Ksh/ha)	0	36,750	17,340	134,100	18,000	0	0	0	0	42,000	120,000	130,500	100,000	60,200							
Cost of Production(Ksh/ha)	0	9,018	11,498	20,042	8,855	0	0	0	0	10,811	38,987	14,917	7,236	13,013							
Net Return(Ksh/ha)	0	27,732	5,842	114,058	9,145	0	0	0	0	35,289	81,013	115,583	92,764	47,187							
Planted Area(ha)	0.00	8.70	0.90	8.70	5.25	0.00	0.00	0.00	0.00	4.80	0.30	3.18	6.36	11.70							
Total Net Return(1,000 Ksh)	0	241	5	992	48	0	0	0	0	169	24	388	590	552							
II. With Project	9.5/28.9	10.5	28.9	29.8	3.0	5.0	21.5	15.0	0.0	0.0	15.0	26.1	10.0	17.2							
Unit price(Ksh/kg)																					
Yield(kg/ha)	4,500	4,500	850	5,500	10,000	8,500	0	10,000	0	0	3,250	8,500	5,500	12,500	0						
Gross Income(Ksh/ha)	34,895	47,250	24,565	163,900	30,000	42,500	0	150,000	0	0	54,800	127,500	143,550	125,000	0						
Cost of Production(Ksh/ha)	18,989	10,406	13,297	29,088	11,146	17,478	0	34,342	0	0	42,238	15,639	11,879	0							
Net Return(Ksh/ha)	16,205	36,844	11,268	134,812	18,854	25,022	0	115,658	0	0	12,562	111,861	131,671	113,321	0						
Planted Area(ha)	37.70	8.40	7.70	21.60	12.96	2.90	0.00	0.38	0.00	2.40	2.32	3.40	0.00								
Total Net Return(1,000 Ksh)	611	309	87	2,912	244	73	0	44	0	205	297	385	0								
III. Incremental Benefit(1,000 Ksh)	611	68	82	1,920	196	73	0	44	0	169	180	71	205	385	0						
(C) Incremental Benefit(1,000 Ksh)	1,214	68	352	3,594	508	77	42	87	-169	194	-85	-168	-558								

Table 2.5-7 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>Difference</u>
	23,167	16,796	6,371
	21,932	19,852	2,080
	9,417	8,092	1,325
	<u>373,357</u>	<u>240,608</u>	<u>132,749</u>

Table 2.5-8 Project Cost and O&M Cost

Project Cost(Ngomano/Nyangati)

	Financial Cost(Ksh)		Of Which,		Economic Cost(Ksh)
	Total Cost	Private Sector	Govt/Public Sect.	Total Cost	
1. Construction cost					
1) Irrigation & drainage improvement	3,563,767	3,563,767	0	3,328,558	0
2) Marketing improvement	0	0	0	0	0
3) Access roads improvement	0	0	0	0	0
4) Village/farm roads improvement	1,824,000	0	1,824,000	1,703,616	0
5) Rural water supply improvement	0	0	0	0	0
Sub-Total	5,387,767	3,563,767	1,824,000	5,032,174	
2. Community Development & Supporting Services					
1) Agricultural support services	12,950,000	0	12,950,000	12,095,300	0
2) Community development	7,080,000	0	7,080,000	6,612,720	0
3) Water management services	1,810,000	0	1,810,000	1,690,540	0
4) Marketing support services	374,000	0	374,000	349,316	0
5) Public health services	150,000	0	150,000	140,100	0
Sub-Total	22,364,000	0	22,364,000	20,887,976	
3. Associated Cost					
1) Pre-engineering cost	227,680	100,000	127,680	212,653	0
2) Administration cost	1,942,622	0	1,942,622	1,814,409	0
3) Consulting services	2,775,176	356,376	2,418,800	2,592,014	0
Sub-Total	4,945,478	456,376	4,489,102	4,619,076	
4. Land Acquisition	175,000	175,000	0	0	
5. Physical Contingency	538,776	356,376	182,400	503,217	
Total	33,411,021	4,551,519	28,859,502	31,042,444	

Operation and Maintenance Cost(Ngomano/Nyangati)

	Financial Cost	(unit/Ksh/year) Economic Cost
Annual Operation and Maintenance Cost		
1) Irrigation & drainage facilities	71,000	66,314
2) Marketing facilities	0	0
3) Access roads	0	0
4) Village/farm roads	157,000	146,638
5) Rural water supply facilities	0	0
Total	228,000	212,952

Table 2.5-9 Calculation of EIRR
-Ngomono/Nyangati-

(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	2,763	213	2,976	1,032	-1,944	2,976	1,032	2,976	1,032	2,976	1,032
2	6,829	213	7,042	3,095	-3,947	5,234	2,300	5,614	2,468	5,820	2,558
3	8,071	213	8,284	3,095	-5,189	5,307	1,983	5,896	2,203	6,224	2,326
4	4,129	213	4,342	4,127	-214	2,398	2,279	2,759	2,623	2,965	2,819
5	3,197	213	3,410	5,159	1,749	1,624	2,456	1,935	2,927	2,118	3,203
6	3,197	213	3,410	5,159	1,749	1,400	2,117	1,728	2,614	1,925	2,912
7	2,856	213	3,069	5,159	2,090	1,066	1,825	1,388	2,334	1,575	2,647
8	0	213	213	5,159	4,946	65	1,574	66	2,084	99	2,407
9	0	213	213	5,159	4,946	56	1,357	77	1,860	90	2,188
10	0	213	213	5,159	4,946	48	1,169	69	1,661	82	1,989
11	0	213	213	5,159	4,946	42	1,008	61	1,483	75	1,808
12	0	213	213	5,159	4,946	36	869	55	1,324	68	1,644
13	0	213	213	5,159	4,946	31	749	49	1,182	62	1,494
14	0	213	213	5,159	4,946	27	646	44	1,056	56	1,359
15	0	213	213	5,159	4,946	23	557	39	943	51	1,235
16	0	213	213	5,159	4,946	20	480	35	842	46	1,123
17	0	213	213	5,159	4,946	17	414	31	751	42	1,021
18	0	213	213	5,159	4,946	15	357	28	671	38	928
19	0	213	213	5,159	4,946	13	308	25	599	35	844
20	0	213	213	5,159	4,946	11	265	22	535	32	767
21	0	213	213	5,159	4,946	9	229	20	478	29	697
22	0	213	213	5,159	4,946	8	197	18	426	26	634
23	0	213	213	5,159	4,946	7	170	16	381	24	576
24	0	213	213	5,159	4,946	6	146	14	340	22	524
25	0	213	213	5,159	4,946	5	126	13	303	20	476
26	0	213	213	5,159	4,946	4	109	11	271	18	433
27	0	213	213	5,159	4,946	4	94	10	242	16	394
28	0	213	213	5,159	4,946	3	81	9	216	15	358
29	0	213	213	5,159	4,946	3	70	8	193	13	325
30	0	213	213	5,159	4,946	2	60	7	172	12	296
Total	31,042	6,390	37,432	145,484	108,052	20,479	25,027	23,040	34,213	24,573	41,015
						EIRR= 22.06 %					

B/C Ratio= 16 % 1.22
B/C Ratio= 12 % 1.48
B/C Ratio= 10 % 1.67

Table 2.5-10 Financial analysis for Standard Farm

Farm size:1.50 ha

Without Project

	Planted Area(ha)	Yield (kg/ha)	Production (kg)	Unit Price (Ksh/kg)	Gross Income(Ksh)	Cost of Production (Ksh)	Net Return (Ksh)
Maize/Beans	1.00	1,500	1,500	9.4	14,100		
Beans/Maize	1.00	250	250	28.9	7,225	20,137	1,188
Beans	0.33	500	165	28.9	4,769	4,642	127
French Beans	0.26	3,500	910	20.0	18,200	6,913	11,287
Tomatoes	0.13	10,000	1,300	26.0	33,800	4,251	29,549
Other Vegetables	0.11	4,500	495	23.4	11,583	2,626	8,957
Banana	0.03	9,000	270	10.0	2,700	334	2,366
Coffee	0.06	3,000	180	23.0	4,140	1,016	3,124
Total	1.91						56,598
1. Crop Income(Ksh/year)							<u>56,598</u>
2. Animal Income(Ksh/year)							<u>3,768</u>
3. Off-Farm Income(Ksh/year)							<u>17,746</u>
4. Living Expense(Ksh/year)-family size 6.6 persons/family							<u>33,268</u>
5. Disposable Income(Ksh/year)							<u>44,844</u>

With Project

I. Rainfed Area

	Planted Area(ha)	Yield (kg/ha)	Production (kg)	Unit Price (Ksh/kg)	Gross Income(Ksh)	Cost of Production (Ksh)	Net Return (Ksh)
Maize and Beans	0.96	2,000	1,920	9.4	18,048		
Beans/Maize	0.96	550	528	28.9	15,259	20,508	12,799
French Beans	0.25	4,500	1,125	20.0	22,500	6,733	15,767
Tomatoes	0.17	11,000	1,870	26.0	48,620	6,066	42,554
Beans	0.31	650	202	28.9	5,838	4,513	1,325
Other Vegetables	0.12	4,500	540	23.4	12,636	2,880	9,756
Banana	0.03	9,500	285	10.0	2,850	359	2,491
Coffee	0.05	3,000	150	23.0	3,450	890	2,560
Sub-Total	1.89						87,252

II. Irrigated Area

	Planted Area(ha)	Yield (kg/ha)	Production (kg)	Unit Price (Ksh/kg)	Gross Income(Ksh)	Cost of Production (Ksh)	Net Return (Ksh)
Maize/Beans	0.31	2,000	620	9.4	5,828		
Beans/Maize	0.31	550	171	28.9	4,942	7,733	3,037
French Beans	0.18	6,000	1,080	20.0	21,600	7,585	23,839
Tomatoes	0.07	14,000	980	26.0	25,480	3,501	21,979
Beans	0.06	850	51	28.9	1,474	979	495
Other Vegetables	0.18	5,500	990	23.4	23,166	4,739	18,427
Banana	0.03	9,500	285	10.0	2,850	359	2,491
Sub-Total	0.83						70,268
1. Total Crop Income(Ksh/year)							<u>157,520</u>
2. Animal Income(Ksh/year)							<u>3,768</u>
3. Off-Farm Income(Ksh/year)							<u>17,746</u>
4. Living Expense(Ksh/year)-family size 6.6 persons/family							<u>33,268</u>
5. Disposable Income(Ksh/year)							<u>145,766</u>

Table 2.5-11 Cost Recovery Analysis

Case-1 Present condition	Excluding Map Preparation	Including Map Prep.
1) Number of beneficiaries	120 farm households	
2) Total project cost to be paid by the beneficiaries of which, irrigation facilities	33,411,021 Ksh 4,551,519 Ksh	4,950,445
3) Loan per farm household	37,929 Ksh	41,254
4) Repayment Period(years)	4 48 (months)	
5) Annual interest rate(%)	16 per year	
6) Monthly interest rate(%)	1.33 (16/12)	
7) Monthly repayment(Ksh)	<u>1,075 Ksh/month</u>	<u>1,169</u>

Alternative Plans for Loan Repayment

Case-2		
1) Loan per farm household(Ksh)	37,929	41,254
2) Repayment Period(years)	6 72 (months)	
3) Annual interest rate(%)	12 per year	
4) Monthly interest rate(%)	1.00 (12/12)	
5) Monthly repayment(Ksh)	<u>742 Ksh/month</u>	<u>807</u>

Case-3		
1) Loan per farm household(Ksh)	37,929	41,254
2) Repayment Period(years)	8 96 (months)	
3) Annual interest rate(%)	10 per year	
4) Monthly interest rate(%)	0.83 (10/12)	
5) Monthly repayment(Ksh)	<u>576 Ksh/month</u>	<u>626</u>

Case-4		
1) Loan per farm household(Ksh)	37,929	41,254
2) Repayment Period(years)	10 120 (months)	
3) Annual interest rate(%)	5 per year	
4) Monthly interest rate(%)	0.42 (5/12)	
5) Monthly repayment(Ksh)	<u>402 Ksh/month</u>	<u>438</u>

Case-5		
1) Loan per farm household(Ksh)	37,929	41,254
2) Repayment Period(years)	4 48 (months)	
3) Annual interest rate(%)	30 per year	
4) Monthly interest rate(%)	2.50 (30/12)	
5) Monthly repayment(Ksh)	<u>1,366 Ksh/month</u>	<u>1,485</u>

Repayment under the Current Situation(Ngomano/Nyangati)

Case-6	
1) Loan per farm household	37,929 Ksh
2) Repayment Period(years)	4 (48 months)
3) Annual interest rate(%)	16 (% per year)
4) Monthly interest rate(%)	1.33 (16/12)
5) Monthly repayment(Ksh)	1,075 (Ksh/month)
6) Monthly repayment and disposable income(Ksh)	

	Repayment	Disposable Income
1st year	1,075	875 (farm economic survey 1998)
2nd year	1,075	6,070
3rd year	1,075	8,500
4th year	1,075	12,147

Table 2.5-12 Estimation of Water Charge

(Unit: Keh)

Year	Initial Cost	O & M Cost	Replac- ement Cost	Total	Present Value by Discount Rate													
					Int= 0.18				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	Total		
1	0	71,000	0	71,000	0	71,000	0	71,000	0	71,000	0	71,000	0	71,000	0	71,000	0	71,000
2	2,413,260	71,000	0	2,484,260	1,793,445	52,765	0	1,846,210	1,824,771	53,666	0	1,878,437	1,875,875	49,306	0	1,925,181		
3	2,136,259	71,000	0	2,207,259	1,369,892	45,487	0	1,415,379	1,405,940	46,884	0	1,452,824	1,237,418	41,088	0	1,278,506		
4	0	71,000	0	71,000	0	39,213	0	39,213	0	40,594	0	40,594	0	34,240	0	34,240		
5	0	71,000	0	71,000	0	33,804	0	33,804	0	35,300	0	35,300	0	28,533	0	28,533		
6	0	71,000	0	71,000	0	29,141	0	29,141	0	30,895	0	30,895	0	23,778	0	23,778		
7	0	71,000	0	71,000	0	25,122	0	25,122	0	26,692	0	26,692	0	19,815	0	19,815		
8	0	71,000	0	71,000	0	21,657	0	21,657	0	23,210	0	23,210	0	16,512	0	16,512		
9	0	71,000	0	71,000	0	18,670	0	18,670	0	20,183	0	20,183	0	13,780	0	13,780		
10	0	71,000	0	71,000	0	16,095	0	16,095	0	17,550	0	17,550	0	11,467	0	11,467		
11	0	71,000	0	71,000	0	13,875	0	13,875	0	15,261	0	15,261	0	9,556	0	9,556		
12	0	71,000	0	71,000	0	11,961	0	11,961	0	13,270	0	13,270	0	7,963	0	7,963		
13	0	71,000	0	71,000	0	10,311	0	10,311	0	11,539	0	11,539	0	6,836	0	6,836		
14	0	71,000	0	71,000	0	8,889	0	8,889	0	10,034	0	10,034	0	5,530	0	5,530		
15	0	71,000	0	71,000	0	7,663	0	7,663	0	8,726	0	8,726	0	4,606	0	4,606		
16	0	71,000	0	71,000	0	6,606	0	6,606	0	7,567	0	7,567	0	3,840	0	3,840		
17	0	71,000	0	71,000	0	5,695	0	5,695	0	6,596	0	6,596	0	3,200	0	3,200		
18	0	71,000	0	71,000	0	4,909	0	4,909	0	5,737	0	5,737	0	2,667	0	2,667		
19	0	71,000	0	71,000	0	4,232	0	4,232	0	4,989	0	4,989	0	2,222	0	2,222		
20	0	71,000	0	71,000	0	3,648	0	3,648	0	4,338	0	4,338	0	1,852	0	1,852		
21	0	71,000	0	71,000	0	3,145	0	3,145	0	3,772	0	3,772	0	1,543	0	1,543		
22	0	71,000	0	71,000	0	2,711	0	2,711	0	3,280	0	3,280	0	1,288	0	1,288		
23	0	71,000	0	71,000	0	2,337	0	2,337	0	2,852	0	2,852	0	1,072	0	1,072		
24	0	71,000	0	71,000	0	2,015	0	2,015	0	2,480	0	2,480	0	893	0	893		
25	0	71,000	0	71,000	0	1,737	0	1,737	0	2,157	0	2,157	0	744	0	744		
26	0	71,000	0	71,000	0	1,497	0	1,497	0	1,875	0	1,875	0	620	0	620		
27	0	71,000	0	71,000	0	1,291	0	1,291	0	1,631	0	1,631	0	517	0	517		
28	0	71,000	0	71,000	0	1,113	0	1,113	0	1,418	0	1,418	0	431	0	431		
29	0	71,000	0	71,000	0	959	0	959	0	1,233	0	1,233	0	359	0	359		
30	0	71,000	0	71,000	0	827	0	827	0	1,072	0	1,072	0	299	0	299		
Total	4,551,518	2,130,000	0	6,681,518	3,163,337	446,374	0	3,611,712	3,230,711	475,446	0	3,706,157	2,913,293	366,338	0	3,278,631		

Annual 151,717 71,000 0 222,717 105,445 14,946 0 120,390 107,690 15,848 0 123,539 97,110 12,178 0 109,286

Water Charge

	Interest 0.18	Interest 0.15	Interest 0.20
a. Annual Water Intake	525,100 m ³ /year		
b. Cost			
b.1 Cost per year at financial price	105,445	107,690	97,110
b.2 Annual O&M cost at financial price	14,946	15,848	12,178
b.3 Replacement cost at financial price	0	0	0
Total	120,390	123,539	109,286
c. Water Charge			
c.1 per cubic meter	0.229271 Keh	0.235267 Keh	0.208127 Keh
c.2 per ha/year	2,506 Keh	2,574 Keh	2,277 Keh
c.3 ha/month	209 Keh	214 Keh	190 Keh