3.3.5 PROPOSED IRRIGATION AND DRAINAGE PLANS

(1) The Nadzipulu river basin

The Lower Nadzipulu Irrigation Project with irrigation area of 250 ha of lands was identified through investigation and studies for delineation of the irrigation and drainage development. The project features and alternative studies on the project formulation are described below. The general layout and location of the project is shown in **Figure.3.3.3.**

(i) The project area

The Lower Nadzipulu Irrigation project lies in the left bank of the lower reaches of the Nadzipulu river, the sole water source for the project. The area slopes down to the northeast with an approximate land gradient of 1/250. The Nadzipulu river bounds the area in the southeast, a range of high elevated lands and small streams in the west, and the lakeshore in the northeast. The project area is isolated and there is no jeepable road connecting the area with the trunk road, M-17.

Since there are the high elevated lands on the right bank of the Nadzipulu river, floods frequently flow over the river course into the flood plain on the left bank, where the project area is selected. The Nadzipulu river, a huge sediment load carrier, has changed its river course at 4 km upstream of the project area due to sedimentation and floods.

The main points to be considered for planning and design of the irrigation and drainage system for the project are:

- to select a stable intake site,
- to keep a certain area for passing floods on the left bank of the Nadzipulu,
- to protect the project area from flood intrusion by the construction of flood protection dike which will be used as the canal inspection road.

(ii) *Alternative study*

The area for the irrigation development is identified as of 250 ha out of the suitable lands of 300 ha from the view point of soil and land capability as mentioned hereinbefore. Since topography, soil, and land capability for irrigation farming restrict the irrigation area, no alternative plan for the irrigation system

was prepared, except these intake site and construction method of the headworks.The alternative intake sites were selected and their main features of the alternative are shown below:

	Alternative-1	Alternative-2
- Location	2.5 km upstream of the project area	1.5 km upstream of Alt-1 site
- Design flood Discharge	266.1 m3/sec.	266.1 m3/sec.
- Intake discharge	0.36 m3/sec.	0.36 m3/sec.
- Structures		
-Weir height	1.0 m above river bed (2.0 m in total)	1.0 m above river bed (3.0 m in total)
-Weir length	56.4 m	56.4 m
-Scouring sluice	1.2 m wide X 2 Nos.	1.2 m wide X 2 Nos.
-Intake gate	0.7 m wide	0.7 m wide
-flood dike	(construct as connecting road)	(construct as inspection road)
-Irrigation canal length	-	1.5 km longer than Alt.-1
-Construction method	dry condition by using river meandering	river diversion channel required

The alternative-1 was formulated based on the views of easy and safety construction and securing the construction works from the floods through out the year by using present river course as diversion channel. As for the alternative-2, river diversion method was applied and the channel is designed with a probable flood of 5-year return period. The both alternatives satisfy the technical requirement for construction of the intake. The differences among the alternatives are length of the main irrigation canal, the total height of weir, and accuracy and safety of the construction of the facilities. The direct construction cost for the alternative-1 is 76.6 million Japanese Yen against 80 .0 million Japanese Yen for the alternative-2. Since the accuracy for safety in the construction of the alternative-1 is superior to that of the alternative-2, the alternative-1 site was selected as the proposed irrigation system.

(iii) Project features

The project features of the proposed Lower Nadzipulu Irrigation Project is shown below. The irrigation diagram and drainage diagram are shown in **Figure. 3.3.7** and **3.3.8**, respectively.

- Irrigation area	250 ha
- Project facilities	
- Head works	1 site
- Main irrigation canals	7.0 km
- Branch canal	0.6 km
- Tertiary canals	18.4 km
- Drainage canals	5.2 km
- Inspection roads	7.9 km
- Road/flood protection dikes	4.5 km
- Connecting road	2.0 km
- Rice mill and related facilities	2 sites

The proposed head works is shown in **Figure.3.3.9** and the longitudinal sections of main and branch canals for the project are shown in **Figure.3.3.12** to **3.3.15**.

(2) The Namikokwe river basin

In the Namikokwe river basin, the following 3 areas were identified for the irrigation and drainage development:

- The Upper Namikokwe Irrigation Project : 570 ha
- The Mtandamula Rehabilitation Project : 230 ha
- The Lower Namikokwe Irrigation project : 160 ha

For formulating the optimum irrigation and drainage development plan in the Namikokwe river basin, the integrated irrigation projects with coupling two (2) or all projects mentioned above are elaborated since selection of an intake site for every project will be restricted at the same site; just downstream of the confluence of the Namikokwe with the Nadzipokwe river, and the irrigation areas of the above 3 project are closed. The following 3 integrated irrigation projects are were considered for optimizing the development plan in the basin.

- The Namikokwe Integrated Irrigation Project - 1(Upper Namikokwe+Mtandamula): 800 ha
- The Namikokwe Integrated Irrigation Project - 2(Upper Namikokwe+Lower Namikokwe): 730 ha
- The Namikokwe Integrated Irrigation Project - 3(Upper Namikokwe+Mtandamula+Lower Namikokwe):960 ha

The general layout and location of the identified projects are illustrated in **Figure.3.3.4** and a schematic alignment of the 3 integrated projects are shown in **Figure.3.3.5**.

(i) The Upper Namikokwe Irrigation Project

The Upper Namikokwe Irrigation Project is located in the left bank of the Namikokwe river, water source of the project. The project area lying in the flood plain of the Namikokwe extends from 3 km east of the Mua railway station to the north-east with the land gradient ranging between 1/170 and 1/250. The area is broadly bounded by the Namikokwe river in the south and a hilly area in the west. The existing Mtandamula irrigation scheme adjoins to the area in the east. A village road connects the villages developed in the western hilly area with the trunk road; M-17.

The Namikokwe river is fed by the Nadzipokwe river; one of the major tributaries of the Namikokwe, at about 1.5 km upstream of the area. Flood water in the wet season overspills the river course at about 2 km downstream of the conjunction with the Nadzipokwe river and inundates overt the flood plain where the project area is delineated. No irrigation activity exist in the project area. The main points to be considered for formulating the irrigation and drainage system are:

- to select a stable intake site,
- to keep a certain area for passing floods on the left bank of the Namikokwe,
- to protect the project area from flood intrusion by the construction of flood protection dikes aligned in parallel with the river course of the Namikokwe,
- to use the said flood protection dike as the canal inspection road,
- to keep a certain area for passing drainage water of the western hilly area,
- to align the main irrigation canal to provide irrigation water to not only the Upper Namikokwe project but also the Mtandamula Rehabilitation project and the Lower Namikokwe Irrigation project

The main point for the alternative study is location of the intake site from the view point of technical difficulty and safety in construction of the intake structure. Two alternatives were prepared; alternative-1 and -2. In alternative-1, an intake structure will be constructed on the dry land by using the river course meandering. The construction works will not be affected by floods in the wet season. The intake structure in alternative-2 will be constructed with temporary diversion of the river water based on the estimated flood of the 5-year return period. The following are the main features of the alternative intake sites.

	Alternative-1	Alternative-2
- Location	0.6 km downstream of the conjunction of the Namikokwe with Nadzipokwe	0.7 km downstream of Alt-1
- Design flood Discharge	205.4 m^3/sec.	205.4 m^3/sec.
- Intake Capacity	0.81 m^3/sec.	0.81 m^3/sec.
- Structures		
-Weir height	1.4 m above river bed (2.4 m in total)	1.4 m above river bed (3.4 m in total)
-Weir length	46.4 m	46.4 m
-Scouring sluice	1.2 m wide X 2 Nos.	1.2 m wide X 2 Nos.
-Intake gate	0.9 m wide X 2 Nos.	0.9 m wide X 2 Nos.
-flood dike	300 m long on the left bank	1.0 km on the left bank
-Irrigation canal length	0.55 km longer than Alt-2	
-Construction method	dry condition by using river meandering	river diversion channel be required

The differences among the alternatives are the length of main irrigation canal and flood protection dike and weir height caused by the foundation condition in terms of depth to the hard layer. In addition, an accuracy of safety construction of the facilities is the important point to be considered. The direct construction cost for alternative-1 is 76.9 million Japanese Yen and 86.2 million Japanese Yen for alternative-2. Since the accuracy for safety construction and an economy in the alternative-1 are superior to those in the alternative-2, the alternative-1 site is employed as the proposed intake site for the project.

The following are the main features of The Upper Namikokwe Irrigation project.

- Irrigation area	570 ha
- Project facilities	
- Head works	1 site
- Main irrigation canal	6.7 km
- Branch canals	3.8 km
- Tertiary canals	43.1km
- Drainage canals	12.2 km
- Inspection roads	10.1 km
- Road/flood protection dikes	7.0 km
- Connecting road	1.2 km
- Rice mill and related facilities	3 sites

(ii) The Mtandamula Rehabilitation Project

The Mtandamula Rehabilitation Project is proposed to rehabilitate the deteriorated irrigation facilities in the existing Mtandamula Self-help scheme. The scheme is located 9 km east of the national road M-17. It extends to the northeast and slopes down to Lake Malawi with an approximate gradient of 1/250. The area is broadly bounded by the artificial dike in the southwest, the elevated land in the north, and

the natural flood way in the south. Since water source depends flood water of the Namikokwe, no irrigation activity has been carried out in the dry seasons. The scheme which developed on the floodplain of the Namikokwe river was constructed in 1987 by the Government of Malawi with the financial assistance of EEC and handed over to the scheme committee comprising 472 farmers. The irrigation area of about 230 ha of paddy fields has been managed by the farmers through scheme committee. The jeepable road connects the Mtembanji village with M-17.

The existing irrigation facilities of the Mtandamula irrigation scheme consist of flood protection dikes, a simple intake structure, a main feeder canal with related structures, and field canals. No farm road is provided in the scheme. The technical constraints on the scheme are;

- unstable irrigation water source,
- deterioration of the irrigation facilities, especially at the intake gate on the dike, main feeder canal, and related structures,
- poor quality on the land levelling of the paddy fields, and
- poor transportation system.

In order to solve the above technical constraints especially for unstable water supply, the location of the intake structure proposed for the Upper Namikokwe Irrigation Project is only the optimum site for the construction of the intake facilities for the Mtandamula scheme.The intake structure is to be constructed with new aligned canals. The length of the main canal is more than 6 km. As for the economic efficiency, the development of the project with that of the Upper Namikokwe Irrigation Project will be rather high. The main features of the project, in case of development as the single project without any coupling, are summarised below.

- Irrigation area	230 ha
- Project facilities	
- Head works (newly constructed)	1 site
- Main irrigation canal (new)	6.7 km
- Branch canals	4.5 km
- Tertiary canals	12.6 km
- Inspection roads (new)	6.0 km
- Road/flood protection dikes	6.9 km
(rehabilitation	1.0 km)
- Connecting road (new)	2.4 km
- Rice mill and related facilities(new)	2 sites

(iii) The Lower Namikokwe Irrigation Project

The area of the Lower Namikokwe Irrigation Project is adjacent to the Mtandamula Rehabilitation Project area in the south as illustrated in **Figure 3.3.4.** The area which extends over the relatively high elevated lands has been scarcely affected by flooding of the Namikokwe river. The area slopes down to the northeast with an approximate gradient of 1/250. A jeepable road connects the Mtembanji village with the trunk road M-17.

The main technical constraints in developing the project area are;

- No stable water source and intake site exist near the project site,
- Land suitability for paddy cultivation is low, and
- Residential areas lie in the project area
- Small labour force is available; the most of the inhabitant of the area are presently cultivate the Existing Mtandamula self-help scheme and the no surplus labour force for new irrigation farming activities exist.

Since no stable water source is available near the area, an intake structure at the same site provided in the Upper Namikokwe Irrigation Project where is only the optimal site for the construction of the intake structure in terms of stability of the river course. Thus the main canal conveying water to the project area will be more than 6 km in length. Therefore, the main point to be considered for the alternative study on the project is to develop the project in couple with the Upper Namikokwe Irrigation Project. The followings are the main features of the Project, in case of single development of the project without any coupling.

- Irrigation area	160 ha
- Project facilities	
- Head works	1 site
- Main irrigation canal	6.7 km
- Branch canals	4.7 km
- Tertiary canals	11.1 km
- Drainage canals	5.6 km
- Inspection roads	5.1 km
- Road/flood protection dikes	4.2 km
- Connecting road	1.8 km
- Rice mill and related facilities	2 sites

(iv) Integrated development projects

As for the development of 3 irrigation projects in the Namikokwe river basin, an integrated development project was elaborated for increasing the economic and technical efficiencies. The integrated project was formulated by coupling the areas of 2 or 3 irrigation projects identified and make up the following deficit of each irrigation project.

- construction of an intake structure which is rather costly for the single project identified,
- long head race for conveying water to the areas in the Lower Namikokwe Irrigation Project and the Mtandamula Rehabilitation Project, and
- unstable water availability in the Mtandamula Rehabilitation project

An alternative study on the integrated development Project was carried out by coupling of 2 and/or 3 individual identified irrigation projects as follows:

Integrated Project -1: The Upper Namikokwe Irrigation Project
The Mtandamula Rehabilitation Project

Integrated Project -2: The Upper Namikokwe Irrigation Project
The Lower Namikokwe Irrigation Project

Integrated Project -3: The Upper Namikokwe Irrigation Project
The Mtandamula Rehabilitation Project
The Lower Namikokwe Irrigation Project

The main features of each Integrated Irrigation Project are summarized below.

	Integrated-1	Integrated-2	Integrated-3
- Irrigation area	800 ha	730 ha	960 ha
- Project facilities			
- Head works	1 site	1 site	1 site
- Main irrigation canal	6.7 km	6.7 km	6.7 km
- Branch canals	8.3 km	7.4 km	11.9 km
- Tertiary canals	55.7 km	54.2 km	66.8 km
- Drainage canals	12.2 km	17.8 km	17.8 km
- Inspection roads	12.8 km	12.9 km	15.6 km
- Road/flood protection dikes	7.0 km	7.0 km	7.0 km
- Connecting road	2.4 km	1.8 km	2.4 km
- Rice mill and related facilities	5 sites	5 sites	6 sites

(v) Selection of the Optimum Development plan in the Namikokwe river basin

On the basis of the results of field investigations and surveys, studies, design of the irrigation system and facilities, construction cost estimate, and economic evaluation, the optimum irrigation development plan was selected from among the 3 individual irrigation projects and the 3 integrated projects. The main emphasis was placed on the following points in selecting the optimum plan:

a) technical viability,
b) economic viability,
c) maximum use of natural resources, and
d) availability of labor .

The table in the next page shows the results of the evaluation of the 6 development plans:

Development plan	Irrigation area (ha)	FIRR (%)	Available labor force
The Upper Namikokwe Irrigation Project	570	11.6	A
The Mtandamula Rehabilitation Project	230	1.7	A
The Lower Namikokwe Irrigation Project	160	2.1	C
Integrated Irrigation Project - 1	800	11.9	A
Integrated Irrigation Project - 2	730	10.2	B
Integrated Irrigation Project - 3	960	10.2	B

where, A : enough labor , B : partly short, C : short

In accordance with the above table, the Upper Namikokwe Irrigation Project and the 3 integrated irrigation projects are superior to the others in terms of economic viability. Since most of the farmers in the Lower Namikokwe Irrigation Project area are beneficiaries of the existing Mtandamula self-help scheme, a small labor force will be available for new irrigation development under the Lower Namikokwe Irrigation Project. The Integrated projects - 2 and - 3, which comprise the Lower Namikokwe Project, will have the same problem. The Integrated irrigation project - 1 is superior to the others in all the evaluation items; economic viability, maximum use of natural resources, and available labor. The Integrated irrigation project - 1, therefore, is to be employed as the proposed project in the Namikokwe river basin.

The proposed headworks for the project is shown in **Figure 3.3.10** and the longitudinal profiles of the irrigation canals are illustrated in **Figure 3.3.16** to **3.3.23.**

(3) The Livulezi river basin

The Lower Livulezi Irrigation Project was identified in the Livulezi river basin through investigation and studies for delineation of the irrigation and drainage development. The area of the Lower Livulezi Irrigation Project is located in the right bank of the lower reaches of the Livulezi river. The area which extends over the flood plain of the Livulezi river slope down to the north with an approximate land gradient of 1/350. The area is broadly bounded by the Livulezi river to the west and hilly ranges to the east. The flood protection dike will be constructed in the south edge. There is no village exist in the project area.

The Livulezi river has changed its river course for the recent 20 years mainly due to floods. The sedimentation and consequent river meandering are the most serious problems to be solved for the formulation of the irrigation development. The river crossing structures on M-18 at the 1.5 km upstream of the project area are frequently silted in the wet seasons and annual desilting works are required. In the 1992/93 floods, the main crossing structures on M-18 were buried by the sediments due to the poor design of the structure. In early 1993, the Ministry of Works changed the main river course to make flood water flow across the other culvert. Consequently, the Livulezi river detours the upper part of the project area and flows into the original course 2 km downstream of the proposed intake site.

The main constraints for planning and design of the irrigation and drainage system of the project are unstable river course, heavy siltation, and floods. In order to solve the said constraints, the following measures are employed.

(i) to construct sabo dikes with a flood way for keeping an stable intake site,
(ii) to keep a certain area for passing floods on the left bank of the Livulezi river,
(iii) to protect the project area from flood intrusion by the construction of flood protection dikes aligned in parallel with the river course of the Livulezi,
(iv) to use the said flood protection dike as the canal inspection road

The project works consist of the replacement of the main crossing structure on M-18 and dredging works in the upperstream portion of M-18 for restoring the main course of the Livulezi river. The main point of the alternative study is to compare the above plan with the plan which maintain the present river course without any replacement and dredging. The project features of each alternative are shown below.

	Alternative-1	Alternative-2
- Irrigation area	520 ha	380 ha
- Project facilities		
- Head works	1 site	1 site
- Main irrigation canal	11.1 km	7.8 km
- Branch canals	1.0 km	-
- Tertiary canals	38.3 km	21.8km
- Drainage canals	13.7 km	11.2 km
- Inspection roads	8.5 km	2.5 km
- Road/flood protection dikes	6.1 km	4.2 km
- Connecting road	2.5 km	3.6 km
- Rice mill and related facilities	3 sites	2 sites
- Additional Works		
- Rehabilitation of Culverts on M-18	Required	Not required
- River dredging	1.0 km	-

The main points in selection of the optimal development plan among the above 2 alternatives are;

a) Economic viability
b) Maximum use of water and land resources, and
c) Technical soundness

As for the evaluation of the economic viability, the internal rate of Return (FIRR) , as discussed hereinafter, was employed. The FIRR value was calculated at 7.6 % for the Alternative-1 and 6.9 % for the alternative-2. Alternative-1 is superior to the alternative-2 in terms of economic viability and the point of maximum use of the water and land resources. As regards the technical soundness, the present river course in the alternative-2 is not stable at the crossing point of M-18. Considering the above, the alternative-1 was selected for the proposed irrigation and drainage plan in the Nadzipulu river basin. The general layout is shown in **Figure 3.3.6**. The proposed design of the head works is shown in **Figure 3.3.11** and the longitudinal profiles of irrigation canals are illustrated in **Figure 3.3.24** to **3.3.30**.

3.4 RURAL ROAD NETWORK DEVELOPMENT

The road network in and around the project areas is still poor with respect to both road density and quality. The project areas are broadly bounded by national road M-17 (Salima - Balaka) to the west and M-18, branched off from M-17 to Monkey Bay, to the south, as shown in **Figure 2.9.1**. The jeepable roads or the all weather roads which connect the project areas with the national roads or major villages are about 60 km in length and the density of jeepable roads is less than 0.3 km/ km^2. The 3 major rivers flowing down from southwest to northeast divide the area into several blocks. Since

there are no structures , especially for the river crossing, except national roads, the traffic in the wet season between the blocks as well as villages has been frequently impeded by river floods.

Such poor road conditions have hindered the economical activities and the public welfare of the inhabitants in and around the project areas. It is urgently required to improve the present road conditions and their network in and around the project areas.

The road network plan was formulated based on the following basic concepts.

(i) to increase the density of jeepable roads and all season roads
(ii) to maintain a smooth access between the project areas and the national roads M-17 and M-18,
(iii) to ensure traffic between the blocks intersected by the rivers even in the wet season, and
(iv) to connect the major villages with all weathered roads.

Based on the basic concept, the road network was planned and its preliminary layout is made as shown in **Figure 3.5.1**. The proposed plan consists of the five routes. The salient features of the plans are shown below;

Route-A
- Route : M-18 (left bank of the Nadzipulu river) - Njoka village- the intake site for the Lower Nadzipulu Irrigation Project - Chatala
- Proposed works
  - Rehabilitation of existing jeepable roads ; 6.5 km
  - Establishment of new jeepable roads ; 2.5 km
  - Construction of a crossing structure on the Nadzipulu river (by using the intake structure for the project),
  - Small road structures ; L.S.

Route-B
- Route : M-17 (Mtakataka) - Chatala - Chitula
- Proposed works
  - Rehabilitation of existing jeepable roads ; 13.0 km
  - Establishment of new jeepable roads ; 2.5 km
  - Small road structures ; L.S.

Route-C
- Route : M-17 (Mua station) - Mwasinja
- Proposed works
  - Rehabilitation of existing jeepable road ; 12.0 km
  - Rehabilitation of a railway crossing structure at Mua station
  - Small road structures ; L.S.

Route-D

- Route : Chatala - Mwasinja - Mtembanji (Mtandamula scheme)
- Proposed work
  - Rehabilitation of existing jeepable road ; 9.0 km
  - Small road structures ; L.S.

Route-E

- Route : Mtembanji village - Intake site for the Lower Livulezi Irrigation Project
- Proposed work
  - Establishment of new jeepable road ; 10.0 km
  - Construction of a crossing structure on the Namikokwe river
  - Construction of a crossing structure on the Livulezi river (by using the intake structure for the Lower Livulezi Irrigation Project),
  - Small road structures ; L.S.

3.5 VILLAGE WATER SUPPLY

As explained in the previous chapter, the present drinking water supply is very poor in terms of water quality and quantity. Such situations cause the basic backgrounds that the serious diseases hit the farmers in the project areas. Moreover, the work of fetching drinking water is a traditional women's' role and becomes a heavy work load to them. Such work takes about 2 hours/day/household. Especially female headed households with small labour force is difficult to cultivate a proper scale of the farm land due to water fetching work.

The construction of boreholes is a prerequisite to improve such situations. It was planned that one borehole per each village should be installed in the project. The boreholes with manual pump system will be introduced. 29 borehole systems are required in the study area.

3.6 REINFORCEMENT PLAN OF SUPPORTING ACTIVITIES FOR IRRIGATION AND AGRICULTURAL DEVELOPMENT

3.6.1 BASIC CONCEPT

In order to ensure the expected irrigation/agricultural benefits and maintain the high project sustainability of the proposed irrigation projects over their useful life, irrigation and agricultural supporting activities are required. The following issues are crucial for sustaining the projects:

(a) Government support system in Salima ADD:

(i) lack of site offices and office equipment,
(ii) lack of vehicles for O/M of the project facilities,
(ii) lack of a communication system between the head office, branch offices and site offices, and
(iv) shortage of irrigation engineers, project management staff, extension workers, and operators of the irrigation facilities.

(b) Technical aspects of the governmental staff in Salima ADD

(i) not much experience of irrigation farming, irrigation water management, and O & M works for the irrigation facilities,
(ii) lack of technique and know-how for management of the irrigation projects, and
(iii) lack of institutional support for agricultural research works.

(c) Farmers' experience of the O & M works of the irrigation projects

(i) lack of experience of water management of irrigation on-farm facilities,
(ii) lack of experience of and technique for the O & M works of irrigation on-farm facilities, and
(iii) lack of experience of and technique for irrigation farming of paddy and upland crops.

For strengthening the agricultural support activities of the proposed irrigation projects in consideration of the above crucial points, the following concepts are to be included in the supporting plans for irrigation / agricultural development.

(a) to strengthen the facilities concerning the development support and the projects,
(b) to train the government staff key farmers on the management and O & M works of the irrigation projects and core farmers on irrigated farming,
(c) to provide equipment and machinery for the present research works, and
(d) to prepare the long-term supporting plan for staff training, research works, and extension of the irrigation farming techniques.

In order to realize the above concepts, a supporting plan, comprising (i) a short / medium-term component and (ii) a long-term component, was formulated which

depended on the urgency for realization, required time for preparation, and a target for realization. The following are the main features of both of the components of the supporting plan:

(1) Short / medium-term component

(i) Improvement of facilities concerning the supporting activities
- to rehabilitate and improve the field office (EPA office) of Salima ADD
- to construct site offices for the proposed irrigation projects,
- to provide vehicles for the O & M works of the proposed irrigation projects, and
- to provide office equipment for the field office and site offices.

(ii) Training of the government staff and key farmers
- to train government staff in irrigation practices, water management, irrigation farming, and post harvest works through training courses abroad,
- to inspect irrigation projects which are successfully managed in neighbouring countries,
- to train the key farmers on irrigation farming and O & M of on-farm facilities.

(iii) Support of the present research activities
- to provide equipment and tools for research and testing,
- to provide seed and fertilizer, and
- to prepare the primary research fields required.

(2) Long-term component

(i) Establishment of a development center with the objectives of training the government staff and farmers, extension of the advanced irrigation farming techniques, and agricultural research works.
- to construct the facilities of the development center,
- to construct an experimental farm, and
- to provide the required equipment and machinery.

(ii) Consecutive training of the government staff and farmers.

3.6.2 THE SHORT/MEDIUM TERM PLAN OF STRENGTHENING AGRICULTURAL SUPPORTING ACTIVITIES

The short/medium term plan was basically formulated with the principal aim of improvement of the existing agricultural supporting activities as follows:

(1) Improvement of facilities

(i) Improvement of facilities of the existing Mtakataka EPA office
- enlargement of a office space : 100 m^2
-.provision of a drinking water supply system
-.provision of a electric supply system
-.provision of office equipment

(ii) New construction of a site office at Mtembanji village near the projects
-.office space : 60 m2
-.provision of a drinking water supply system
-.provision of office equipment
-.provision of electric supply system

(iii) Improvement of O/M work facilities of the proposed irrigation projects
-.provision of pick-up : 3 nos.
-.provision of jeep : 1 nos.
-.provision of bike : 10 nos.

(2) Training of the government staff and key farmers

The trained government staff is a prerequisite for the successful operation of the irrigation projects. At present few trained staff area available in Salima ADD. Thus, reinforcement of capability of the present staff in Salima Add who will be engaged in the project is necessary though training.

Two kinds of the training programs are proposed. One is a training program that is available in the foreign countries such as Japan. The other is a training program in which is available neighbouring countries such as Kenya and Tanzania. The items of the training are irrigation practices, water management, irrigation farming and post harvest works. The total number of staff is 5 for the program in the foreign countries and 15 in neighbouring countries. These training will be carried out in the first year of the construction period of the project facilities.

The training for key farmers' will be carried out for the second year of the construction period of the project facilities. Such training will be carried out in both the field and Senga Bay headquarters of Salima ADD.

(3) Support of the research activities

It is proposed that a farm plot with one ha is made in the area near the proposed intake site of the Upper Namikokwe Irrigation Project in order to conduct the primary research work. The research work will cover the followings: (i) fertilizer test, (ii) selection of upland crops for the dry season crop and (iii) variety test of vegetables in the dry season.

The farm plot is planned to be irrigated by pumps. Farm inputs such as fertilizer, chemicals and seed will be provided.

Operation of the farm plot will be conducted by staff of the Adaptive Research Branch in Salima ADD and the Lifu experimental station. The analysis of the test will be carried out in the laboratory of the Lifu station. Reinforcement of the existing equipment and facilities of analysis in the Lifu station will be conducted.

3.6.3 THE LONG-TERM PLAN OF STRENGTHENING AGRICULTURAL SUPPORTING ACTIVITIES

After the implementation of the short/medium term plan of strengthening agricultural supporting activities, further reinforcement of the government staff, especially irrigation engineers and farmers in the project areas, may be necessary by means of ramrod discipline. Also adaptive research works and their dissemination to the farmers are necessary. For this purpose, the Bwanje Development Center (BDC) will be established. The center will be the core for training, extension of irrigation farming techniques, and agricultural research for future irrigation/agricultural development in the whole of Malawi and the Study area. The plan was formulated as shown below:

(1) Research work

The research work to be started in the BDC will cover the following aspects.

(i) Crops and farming practices
-.optimum cropping patterns
-.suitable farming techniques

-.variety selection
-.production of foundation and/or registered seeds through pure-line selection
-.fertilization experiment, i.e. four (4) fertilizer elements, application amounts, selection of fertilizers, etc.
-.selection of upland crops for second crop season
-.plant protection

(ii) Irrigation and drainage techniques
-.establishment of O&M system including methods and scheduling
-.supervising actual O&M work
-.periodical inspection of project works
-.maintenance of O&M equipment
-.studies on water users association and water charge

(iii) Past-harvest and marketing
-.establishment of post-harvest techniques of paddy
-.studies on marketing flow of rice
-.O&M of rice mills to be installed under the Project

(2) Staff training and farm guidance

Staff training and farm guidance will be provided first to the personnel concerned the proposed irrigation projects and second to personnel in the whole of Malawi.

(i) Training for government staff

The training of high-technical level will be executed throughout crop seasons in such fields as crop science, irrigation engineering and post-harvest and marketing. The government staff engaged in the irrigation projects will be trained in the daily O&M activities of the Project. They are 2 agronomists, 2 irrigation experts and 1 marketing expert. The candidates should have a basic knowledge, at least, at technical collage level and actual working experiences of several years in the existing irrigation schemes. The following operators and mechanics will be recruited and trained for operation of O&M equipments and rice mill for the BDC. They are 2 operators for O&M equipment, 2 mechanics for O&M equipment and 11 operators for rice mill. Their intensive training will be given by factories, who will supply O&M equipment and rice mills under the Project.

(ii) Training for members of scheme committees

Farmers (project beneficiaries) will organize a scheme committee for each of five projects. The scheme committees thus organized will represent the farmers. The BDC will make a guidance to the scheme committees at onset of irrigation water supply. The most important issues are (i) operation rules of the project works and (ii) farmers' participation to O&M of the Project including collection of water charge. In the following years, meetings will be periodically held in order to monitor performance of irrigation activities and identify constrains to be arising from the Project.

(iii) Training for farmers

Over 4,000 smallholders will be involved to the Project. The farmers will be grouped to 250 tertiary blocks . The farming guidance will be given to 250 leading farmers, who will be selected among each of tertiary blocks. At the BDC, leading farmers will be trained irrigation farming techniques and canal maintenance work. Those leading farmers will transfer such knowledge given at the BDC to followers at the fields under supervision of the BDC staff. After training for the farmers in the project areas, the BDC will function to provide farmers' training in the whole country.

(3) Facilities and equipment

The following facilities and equipment will be required for the BDC in order to ensure the research and training activities mentioned above.

(i) Office block: Offices, Training rooms (20 persons), Laboratory
(ii) Guest houses
(iii) Staff quarters
(iv) Workshop cum spareparts storage
(v) Storage for farm inputs and products
(vi) Drying yard
(vii) Water supply facilities
(viii) Tools and equipment for workshop
(ix) Laboratory equipment (soil laboratory and plant physiology)
(x) Experimental farm plots
(xi) Farm machinery for experimental farm

The general layout of BDC is illustrated in **Figure 3.6.1**.

3.7 OPERATION AND MAINTENANCE PLAN

3.7.1 IRRIGATION DEVELOPMENT COMPONENT

The operation and maintenance (O/M) works of the irrigation projects will comprises administrative affairs, planning and design of maintenance works, operation of water distribution, rehabilitation of the irrigation facilities, and agronomic activities for irrigation farming. The O/M works for the irrigation projects shall be done basically by the beneficiaries; farmers, in the project areas with the assistances of the Government.

Since the farmers in the proposed irrigation project areas are not familiar with the irrigation farming as well as the management of the large scale irrigation scheme, the certain period for training the farmers in execution of O/M works is to be required. For the smooth and successful initiation of the irrigation projects, the stepwise O/M plan is proposed The concepts of the proposed O/M plan are:

Step-1 :
- At the initial stage of 5 years after the completion of the project implementation, the Government of Malawi, through the Department of Irrigation (DOI), the Ministry of Agriculture, shall directly manage the O/M works. The farmers participate to their labour forces to the O/M works, as required.
- DOI shall train the farmers in management of O/M works and assist them in establishing the farmers' association which will be the main body for future O/M organization.
- The required expenses for execution of the O/M works cost the Government.

Step-2 :
- All the O/M works will be handed over to the farmers' association newly organized for execution of the O/M works.
- DOI shall assist the farmers' association in planning, design, arrangement of procurement, and other soft works.
- The required expenses for O/M works, except for the DOI's assistant components, cost the farmers' association.

3.7.2 INFRASTRUCTURAL DEVELOPMENT COMPONENT

(1) Rice mill

The O/M works for the agricultural development facilities, such as the rice mill equipment, drying yards, and storage houses will be carried out by the beneficiary farmers. In the initial stage, the farmers will handle the management and O/M works of the facilities through the existing village organization and/or the temporary organization established by the farmers only for the agricultural development facilities. In the full stage of the Project, the management and O/M works will be handed over to the farmers' association which will be established for the O/M works of all of the Project.

(2) Social infrastructure

In conformity with the present official duties for the O/M works of the rural roads, the O/M works for the rural road networks will be carried out by MOW.

As for the O/M works for the village water supply system, the beneficiaries have to execute the works. After completion of the construction and installation of the boreholes and manual pumping equipment, the water supply system will be handed over to the administrative unit at the village level. The O/M works will be executed by the village administrative unit and the villagers will help with labor and costs.

4. IMPLEMENTATION PLAN

4.1 PRINCIPLE APPROACH TO PROJECT IMPLEMENTATION

The projects hereby formulated include the irrigation and drainage development plan, agricultural development plan, and consolidation of the related infrastructure facilities as well as reinforcement of the supporting functions as described below.

(i) Irrigation and drainage development plan
- The Namikokwe Integrated Irrigation Development Project,
- The Lower Livulezi Irrigation Development Project, and
- The Lower Nadzipulu Irrigation Development Project.

(ii) Agricultural development plan
- Consolidation of the post harvest facilities: rice mill and related structures.

(iii) Social infrastructure development plan
- Improvement of the rural road networks
- Consolidation of village water supply system

(iv) Supporting activities plan
- Short / medium-term plan
- Long-term plan

As for the implementation of the development components, 3 packages were formulated to realize the development goals. The packages include the irrigation project as a core, agricultural development plan, and social infrastructure development components. It is proposed that these development components will be implemented on a package-by-package basis in accordance with the priority order for implementation of the irrigation project discussed hereinafter. The implementation of the long-term plan of the supporting activities component is set as the 4 th package.

(a) First Package

(i) The Namikokwe Integrated Irrigation Development Project
- Construction of the irrigation and drainage system

(ii) Agricultural development plan
- Construction of the rice mills and related facilities (5 sites),

(iii) Construction and installation of the village water supply system

(iv) Improvement of the rural road networks: route C and part of D

(v) Supporting activities
- Short / medium-term plan

(b) Second Package

(i) The Lower Livulezi Irrigation Development Project
- Construction of the irrigation and drainage system

(ii) Agricultural development plan
- Construction of the rice mills and related facilities (3 sites),

(iii) Improvement of the rural road networks: Route A, B and part of D

(c) Third Package

(i) The Lower Namikokwe Irrigation Project
- Construction of the irrigation and drainage system

(ii) Agricultural development plan
- Construction of the rice mills and related facilities (2 sites),

(iii) Improvement of the rural road networks: Route E

(d) Fourth Package

(i) Supporting activities component
- Long-term plan

4.2 IMPLEMENTATION SCHEDULE

(1) Irrigation and agricultural development component

The project works for irrigation and agricultural development are to be implemented within 3 years, including 1 year for the project preparatory works such as selection of consultants, detailed design, tendering, mobilization for implementation, and land compensation. All construction works and procurement works for the irrigation system, rural road improvement, and rice mill facilities will be carried out for 2 years on a contract basis. The implementation schedules of the 3 irrigation development projects and the rice mill facilities are shown in **Figure. 4.2.1.**

(2) Social infrastructure development and the short / medium-term plan of the supporting activities

Implementation of the social infrastructure development plan and short / medium-term plan of the supporting activities will be in the same way as that for the irrigation and agricultural development components. The construction and procurement works for these components will be carried out within 2 years, comprising 1 year for the preparatory works and 1 year for the construction / procurement works.

Training of the government staff and inspection of the irrigation projects in neighbouring countries will be performed during the period of construction.

(3) Long-term plan of the supporting activities

Establishment of the Bwanje development center will include the construction of buildings, irrigation facilities, and an experimental farm, and the procurement of the required equipment and machinery. The construction and procurement works will be carried out in the same way as those for the irrigation and agricultural development components. The government Malawi will carry out the preparatory works for the establishment of the center as well as for the training of the government staff and farmers during the period of construction of the irrigation and agricultural development components. The actual implementation of the long-term plan of the supporting activities will begin depending on the progress of the short / medium-term plan and implementation of the irrigation / agricultural development components.

(4) Implementation of all of the development components

The implementation schedule for each package and the flow chart of the implementation of whole the development components are shown in **Figure 4.2.1** and **Figure 4.2.2**, respectively.

5. COST ESTIMATE

5.1 CONDITIONS FOR THE COST ESTIMATE

The construction cost was estimated on the basis of the following conditions:

(i). The unit prices were estimated based on the market prices in the middle of 1993 in Malawi in conformity with the Japanese standard on unit price estimation. The unit prices were checked by using current construction costs from data and information collected in the Ministry of Works, Ministry of Agriculture, and the foreign and local contractors,

(ii) The exchange rate used is : Kwacha 1.0 = J.Yen 24.0

(iii) The main construction works will be carried out by a contract basis through the competitive bidding,

(iv). The unit price of the works were divided into the foreign currency portion and the local currency portion. The foreign currency portion of the materials and equipment to be imported was estimated on the basis of CIF Lilongwe. The transportation costs of those equipment and materials to the site were estimated individually. The route for transportation is:

Yokohama, Japan - Dar es Salaam, Tanzania - Lilongwe - Salima - Project sites

The classification of the local currency portion and the foreign currency portion was carried out by the following basis:

(Local Currency Portion)
- Labour force,
- Wooden materials,
- Concrete aggregates,
- Cement,
- Reinforcement bars,
- Land acquisition cost, and
- Others which can be purchased in Malawi.

(Foreign Currency Portion)
- Depreciation of construction equipment and machinery,

- Metal works,
- Contractors' general expenses and profit of the contractors, and
- Expenses and fee of engineering services by foreign consultants.

(5). The physical contingency of the cost estimate was assumed to be 10 % of the total construction cost. The price contingencies of 10 % per annum for the local currency portion and 3 % for the foreign currency portion were applied.

5.2 COST ESTIMATE FOR IRRIGATION AND DRAINAGE PROJECTS

5.2.1 CONSTRUCTION COST

The project cost comprises the construction cost, the procurement cost of equipment and machinery, land compensation cost, engineering services cost, administration cost, and contingencies. The total cost of proposed irrigation and drainage projects e is summarized below.

The Lower Nadzipulu Irrigation Project

	Description	Local Currency	Foreign Currency	Total
		(1,000 MK)	(1,000 J.Yen)	(1,000 J.Yen)
I.	Direct Construction Cost			
	1. Preparatory Works	623	19,141	34,093
	2. Head Works	1,609	37,970	76,586
	3. Main Canals	2,246	44,701	98,605
	4. Branch Canal	160	2,567	6,407
	5. Inspection Roads	741	43,650	61,434
	6. Flood Dike/Road	845	46,653	66,933
	7. Connecting Road	873	46,584	67,536
	8. Tertiary Development	1,545	71,714	108,794
	9. Drainage Canals	106	3,649	6,193
	10.Rice Mill	356	18,566	27,110
	(Sub-total)	(9,104)	(335,195)	(553,691)
II.	Engineering Services	1,190	106,400	134,960
III.	Administration Cost	1,627	0	39,048
VI.	Land Compensation	375	0	9,000
	(Total; I-V)	12,296	441,595	736,699
V.	Contingencies			
	1. Physical	1,230	44,160	73,670
	2. Price	2,966	31,378	102,563
	(Grand Total; I - VI)	16,492	517,132	912,932

The Namikokwe Integrated Irrigation Project

	Description	Local Currency	Foreign Currency	Total
		(1,000 MK)	(1,000 J.Yen)	(1,000 J.Yen)
I.	Direct Construction Cost			
	1. Preparatory Works	1,120	33,036	59,916
	2. Head Works	1,607	38,311	76,879
	3. Main Canals	2,644	65,401	128,857
	4. Branch Canal	2,614	40,191	102,927
	5. Inspection Roads	1,198	70,603	99,355
	6. Flood Dike/Road	1,075	61,927	87,727
	7. Connecting Road	248	13,310	19,262
	8. Tertiary Development	4,606	216,938	327,482
	9. Drainage Canals	441	13,689	24,273
	10.Rice Mill	891	46,416	67,800
	(Sub-total)	(16,444)	(599,822)	(994,478)
II.	Engineering Services	1,398	125,600	159,128
III.	Administration Cost	1,834	0	44,016
VI.	Land Compensation	855	0	20,520
	(Total; I-V)	20,530	725,422	1,218,142
V.	Contingencies			
	1. Physical	2,053	72,542	121,812
	2. Price	4,941	52,026	170,599
	(Grand Total; I - VI)	27,523	849,990	1,510,553

The Lower Livulezi Irrigation Project

	Description	Local Currency	Foreign Currency	Total
		(1,000 MK)	(1,000 J.Yen)	(1,000 J.Yen)
I.	Direct Construction Cost			
	1. Preparatory Works	1,203	35,146	64,018
	2. Culvert on M-18	971	14,206	37,510
	3. River Dredging	46	3,995	5,099
	4. Head Works	3,802	135,333	226,581
	5. Main Canals	3,822	73,412	165,140
	6. Branch Canal	393	5,879	15,311
	7. Inspection Roads	795	38,066	57,146
	8. Flood Dike/Road	1,478	84,022	119,494
	9. Connecting Road	273	14,208	20,760
	10.Tertiary Development	3,217	149,269	226,477
	11.Drainage Canals	846	33,812	54,116
	12.Rice Mill	534	27,850	40,666
	(Sub-total)	(17,380)	(615,198)	(1,032,318)
II.	Engineering Services	1,351	119,600	152,024
III.	Administration Cost	1,834	0	44,016
VI.	Land Compensation	780	0	18,720
	(Total; I-V)	21,345	734,798	1,247,078
V.	Contingencies			
	1. Physical	2,135	73,480	124,708
	2. Price	5,067	52,070	173,681
	(Grand Total; I - VI)	28,547	860,348	1,545,467

The detailed breakdown of the direct construction cost of respective project are shown in **Table 5.2.1** to **5.2.3**.

5.2.2 ANNUAL DISBURSEMENT SCHEDULE

The annual disbursement of the construction cost was worked out in accordance with the implementation schedule discussed in Chapter 4. The disbursement schedule for the respective irrigation projects is summarized below and the details are shown in **Table 5.2.4.**

Year	Local Currency	Foreign Currency	Total
	(1,000 MK)	(1,000 J.Yen)	(1,000 J.Ycn)
The Lower Nadzipulu Irrigation Project			
1994	1,541	62,828	99,807
1995	8,740	221,865	431,633
1996	6,211	232,439	381,492
Total	16,492	517,132	912,932
The Namikokwe Integrated Irrigation Project			
1994	2,507	84,524	144,687
1995	14,854	384,741	741,239
1996	10,162	380,726	624,602
Total	27,523	849,990	1,510,553
The Lower Livulezi Irrigation Project			
1994	2,363	77,744	134,451
1995	16,708	428,592	829,577
1996	9,476	354,012	581,438
Total	28,547	860,348	1,545,467

5.2.3 OPERATION AND MAINTENANCE COST

The operation and maintenance cost comprises the administration cost, equipment cost, and operation and maintenance cost for irrigation system. The annual operation and maintenance cost in the full operation stage for the respective irrigation projects is summarized below and the details are shown in **Table 5.2.5.**

(unit : 1,000MK)

Project	Administration Cost	O/M Equipment	Maintenance of Facilities	Total
The Lower Nadzipulu	300	168	72	540
The Namikokwe Integrated	307	183	134	640
The Lower Livulezi	310	204	126	624

5.2.4 REPLACEMENT COST

The metal works of the irrigation facilities and rice mill equipment will be replaced periodically. The economic life and the replacement cost are shown in Table 5.2.6.

5.3 COST ESTIMATE FOR IMPROVEMENT OF RURAL ROAD NETWORKS AND WATER SUPPLY

The construction costs for the improvement of the rural road networks and water supply to the villages scattered in and around the irrigation project areas were estimated on the direct cost basis. The costs are summarized below.

Route of Road	Local Currency	Foreign Currency	Total
	(1,000 MK)	(1,000 J.Yen)	(1,000 J.Yen)
(Rural road networks)			
Route A	1,375	56,315	89,324
Route B	2,235	91,512	145,152
Route C	2,321	95,032	159,735
Route D	1,547	63,354	100,490
Route E	1,719	79,393	111,656
(Rural water supply; boreholes and equipment)			
29 villages	1,330	0	31,900

5.4 COST ESTIMATE FOR THE SUPPORTING ACTIVITIES

The costs of the supporting activities for irrigation/agricultural development are shown in the next page.

Items	Local Currency	Foreign Currency	Total Currency
	(1,000 MK)	(1,000 J.Yen)	(1,000 J.Yen)
(a) Short / medium-term plan			
- Improvement of supporting facilities	630	34,600	49,700
- improvement of field and site offices	630	14,700	29,800
- procurement of vehicles for O/M works	0	12,700	12,700
- procurement of office equipment	0	7,200	7,200
- Training of government staff and key farmers	0	35,000	35,000
- training under overseas training courses	0	22,600	22,600
- inspection of irrigation projects in neighbouring countries/training of key farmers	0	12,400	12,400
- Support of present research activities			
- procurement of tools and equipment	0	6,100	6,100
(b) Long-term plan			
- Establishment of the development center	6,200	167,700	316,100
- construction of facilities	6,200	125,900	274,300
- procurement of equipment and machinery	0	41,800	41,800

The details of the construction costs of the facilities for the Bwanje Development Center are shown in **Table 5.4.1.**

6. ORGANIZATION AND MANAGEMENT

6.1 ORGANIZATION IN THE CONSTRUCTION STAGE

The Department of Irrigation (DOI), the Ministry of Agriculture, shall be primarily responsible for implementation of both the Namikokwe Integrated Irrigation project and the supporting development components. As for the actual execution of the construction works, the Construction Office under DOI will be established. The office headed by a full-time project manager shall be principally based at the project site. The Construction Office comprising the technical division and the administrative division shall have the responsibility on the actual construction works on all the development components. The main functions of the construction office are;

(i) a financial arrangement needed for construction works,
(ii) plan, design and construction supervision of construction activities on all the development components by using consultants and contractor(s),
(iii) survey, plan, and the required works for compensation of land and private properties for construction of all the development components, and
(iv) an initial arrangement of farmers candidates to whom the farm land will be allocated.

To implement the supporting development components, the close coordination among the relevant agencies and DOI is essential and crucial. The Construction Committee in conjunction with the relevant ministries and agencies will be organized for the construction of the rural road improvement and village water supply component. The committee will be consulted on technical, administrative, and political matters for construction of such supporting components.

The proposed organization for the construction stage is shown in **Figure 6.1.1.**

6.2 ORGANIZATION FOR OPERATION AND MAINTENANCE STAGE

DOI shall be responsible for the operation and maintenance of the irrigation and agricultural development components in the initial stage. To execute the O/M works of such development components, the Project Committee headed by the representative of DOI will be organized. The Committee in conjunction with the local administration

unit and farmers' representatives shall be responsible for all the O/M works. The main functions of the Project Committee are;

(i) preparation of O/M programme,
(ii) a financial arrangement needed for O/M works,
(iii) coordination of DOI, relevant agencies, and farmers,,
(iv) preparation of hand-over programme of O/M works of the development components to the farmers and other beneficiaries, and
(v) an assistance in organizing the farmers' association and other organizations which will execute the O/M works in future.

Under the Committee, an O/M office will be established by re-organizing the construction office. The O/M Office will execute all the actual O/M works in conformity with the policies and guideline on the O/M works formulated by the Project Committee. The O/M Office comprises 2 divisions; technical and administrative divisions. The technical divisions will be responsible for all the engineering matters and the administration division will have the responsibility on accounting, financing, administrative affairs, and procurement works for the O/M works. The proposed O/M organization chart for the O/M Office is shown in **Figure 6.1.2**.

After the certain period, the O/M works will be handed over to the farmers' organization and/or the other organizations established by the beneficiaries. DOI will act as the consultancy organization on technical and administrative matters concerning to the O/M works. The period of handing over is expected as 5 years after the commencement of the O/M works. The detailed programme will be prepared by the Project Committee depending on the progress of the establishment of the farmers' organization and/or other organizations.

The O/M works of the rice mill facilities under the agricultural development plan will be carried out by the beneficiary farmers through the existing village organization and/or the temporary farmers' organization in the initial stage. After establishing the farmers' association for the irrigation facilities of the irrigation development plan, the O/M works will be handed over to the farmers' association.

The O/M works for the rural road networks and village water supply system will be carried out by the Ministry of Works and the village administration units, respectively.

As for the Bwanje Development Center in the long-term plan of the supporting activities, DOI shall be responsible for all the O/M works. DOI shall prepare operation plan, training programme, and budgetary arrangement required for the O/M works of the center. The Management Office directly controlled by DOI will be established at the site of the Center. The Office shall execute the actual O/M works in conformity with the O/M programme prepared by DOI. The Office comprises 4 divisions; irrigation, agronomy, mechanical and administration division as shown in **Figure. 6.1.3.**

7. PROJECT EVALUATION

7.1 OBJECTIVES

In order to clarify the viability of 3 irrigation and drainage projects in the 3 river basins, which were optimized and selected in Chapter 3, an evaluation of those projects was made from the viewpoints of economic feasibility, financial aspects, social affects, and environmental aspects. The following are the projects that were evaluated:

Project	Irrigation area (ha)	
	Rainy season	Dry season
Nadzipulu River Basin		
- Lower Nadzipulu irrigation project	250	224
Namikokwe River Basin		
- Namikokwe Integrated irrigation project	800	123
Livulezi River Basin		
- Lower Livulezi irrigation project	520	239

7.2 ECONOMIC EVALUATION

7.2.1 BASIC ASSUMPTION

Since no data and information concerning export subsidy, shadow exchange rates, import/export tax, etc. are available, the conversion factors for the adjustment of financial and economic prices cannot be calculated according to the standard methodology of economic evaluation. Instead of the economic internal rate of return (EIRR), a financial internal rate of return (FIRR) was used for the economic evaluation. The evaluation was based on the following basic assumptions:

(i) The construction period of each scheme would be 3 years, including 1 year for the detailed design and preparatory works.

(ii) The economic useful life of the Project would be 30 years, including the construction period of 2 years.

(iii) All prices are expressed in constant 1993 prices.

(iv) No conversion factors were applied to adjust financial cost to economic cost due to the lack of data and information.

(v) The exchange rate of US$1.00 = MK 4.33 = ¥ 104 as of 1993 was applied.

7.2.2 PRICE SETTING

The financial prices of farm products and inputs applied in the evaluation are summarized below.

Inputs	Unit	Financial Price
1. Farm Products		
Rice at mill gate (including value of bran)	(MK/ton)	4,000
Paddy at farm gate	(MK/ton)	1,500
Maize at farm gate	(MK/ton)	430
2. Farm Inputs		
Paddy seed	(MK/kg)	1.50
Maize seed	(MK/kg)	3.31
Urea	(MK/kg)	1.22
TSP	(MK/kg)	1.32

As seen in the table, the current paddy prices set under the government price policy are slightly higher than those on the international market, while the price of milled rice is remarkably higher. The prices of chemical fertilizer under SACA are favourable for farmers, but they are subject to change under the scheduled reformation of SACA.

7.2.3 PROJECT BENEFIT

The project benefit is defined as the difference in primary profit from crops between the future with-project and without-project conditions. On the basis of production cost and gross income, the primary profit from crops per ha was estimated for both the with-and-without project conditions. In this Study the primary profit from crops under the without-project condition was considered as the profit at present. The primary profits from crops under both the without-project and with-project conditions are shown in **Table 7.2.1.** Irrigation benefit is to be generated in the 3 rd year after the project implementation. The irrigation benefit in the full development stage in the 3 proposed irrigation and drainage projects was estimated as shown in **Table 7.2.2.**

7.2.4 PROJECT COST

(1) Capital Cost

The details of the project cost are presented in Chapter 5. The project cost consists of (i) direct construction cost, (ii) engineering services cost, (iii) administration expenses, (iv) land acquisition expenses, (v) physical contingency, and (vi) price

contingency. Excluding price contingency from the project cost, the capital cost was obtained for the purpose of the calculation of FIRR. The total capital cost and annual disbursement of it for each project are summarized below.

Projects	L/C (Million MK)	F/C (Million Yen)	Total (Million Yen)
Lower Nadzipulu Irrigation Project			
- 1st year	1.41	61.16	96.06
- 2nd year	7.34	210.23	386.37
- 3rd year	4.78	214.36	328.94
- Total capital cost	13.53	485.75	810.37
Namikokwe Integrated Irrigation Project			
- 1st year	2.30	82.28	137.43
- 2nd year	12.47	364.56	663.91
- 3rd year	7.81	351.13	538.62
- Total capital cost	22.58	797.97	1,339.96
Lower Livulezi Irrigation Project			
- 1st year	2.17	75.68	127.66
- 2nd year	14.03	406.11	724.81
- 3rd year	7.28	326.49	501.31
- Total capital cost	23.48	808.28	1,371.78

(2) Annual O&M Cost and Replacement Cost

The annual O/M cost and replacement cost was estimated at 0.5 % of the capital cost and administration expenses. The O/M equipment and gates were assumed to be replaced in 20 years after commencement of the project. The annual O/M cost and replacement cost are summarized below.

Project	Annual OM Cost (1000 MK)	Replacement Cost (1000 MK)
Lower Nadzipulu Irrigation Project	539	914
Namikokwe Integrated Irrigation Project	640	2,161
Lower Livulezi Irrigation Project	624	1,443

7.2.5 INTERNAL RATE OF RETURN (FIRR)

The FIRR was calculated on the basis of the financial cost and benefit flow as shown in **Table 7.2.3.** The value of FIRR for each irrigation project is listed below.

Project	FIRR Value (%)
Lower Nadzipulu Irrigation Project	5.5
Namikokwe Integrated Irrigation Project	11.9
Lower Livulezi Irrigation Project	7.6

7.3 FINANCIAL ANALYSIS

The farm budget was analyzed to assess whether the Project would cause sufficient incentive among the farmers in the project areas and bring about a sufficient income increase in the farmers' economy. The farm budget analysis was carried out on the typical farmers in the Mtandamula irrigation scheme and the rainfed area. The results are shown in **Table 7.3.1** and are summarized below.

Description	unit	Mtandamula irrigation scheme		Rainfed area	
		With project condition	Without project condition	With project condition	Without project condition
Farm size	person	4.0	4.0	4.3	4.3
Cultivated land					
irrigated paddy	ha	0.4		0.36	
irrigated maize	ha	0.03		0.03	
irrigated vegetables	ha	0.03		0.03	
rainfed paddy	ha		0.4		0.36
rainfed maize	ha	1.0	1.0	0.83	0.83
Total farm income	MK	4,053	2,240	3,679	395
Livestock income	MK	41	41	126	126
Off-farm income	MK	0	0	0	184
Total income	MK	4,094	2,281	3,805	705
Total expenditure	MK	2,493	1,979	2,680	756
Balance/capacity to pay	MK	1,601	302	1,125	-51

As shown in the above table, the capacity to pay of the farmers in the Mtandamula irrigation scheme and rainfed area is MK 1,601 and MK 1,125, respectively. The farmers in both Mtandamula scheme and rainfed area will be able to afford to pay for the O/M cost after the government hands over the management of the project to the farmers' association. The farm economy, after sharing the O/M cost of the with-project condition under the 3 proposed irrigation projects, is shown in the following table:

	O/M Cost		Surplus	
	share / ha	share/ household	before sharing	after sharing
Lower Nadzipulu Irri. Project				
- rainfed area	1,176	470	1,125	655
Namikokwe Integrated Irri. Project				
- rainfed area	480	192	1,125	933
- Mtandamula	480	192	1,601	1,409
Lower Livulezi Irri. Project				
- rainfed area	713	285	1,125	840

The table shows that the farmers in the project areas will have a financial surplus after sharing the O/M cost of the with-project condition.

7.4 SOCIAL IMPACT

In addition to the direct benefits counted in the project evaluation, various secondary and intangible benefits and/or favourable socio-economic impacts are expected under the project.

(1) Increase in employment opportunity

The opportunity for self-employment in and around the project area will be increased through the Project and this will activate monetary movement in the regional economy. Irrigation will improve the crop productivity. The increased crop production will generate other agro-industries and commercial activities. The employees will gain more work experience and technical skilfulness not only in the irrigation sector but also in the industrial and commercial sectors.

(2) Demonstration effects

The Project will play a leading role in the irrigation sector in the Central Region. With the completion of the Project, the farmers in the potential areas for further irrigation development will become more familiar with irrigated rice farming. In addition, qualified seed will be available for farmers who will cultivate rainfed paddy around the project area.

(3) Improvement of local transportation

The local transportation system will be much improved by the construction of the flood-free O&M roads along the irrigation canals and on the flood protection dikes. The road extension will not only enhance the economic activities, but will also contribute to inter-regional accessibility and communication.

(4) Improvement of farm products

The quality of rice grains will be much improved by the sufficient water supply, which minimizes crop damage and assures uniform maturing of the rice. Such improved quality would increase the marketability of the products.

(5) Increased feed sources to animals

Plant residues including rice straw and bran will be used as feed sources for local animals. It is estimated that the paddy field after harvesting can provide a stocking rate of 0.3 livestock unit s (LU) per ha (1 LU is equivalent to 300 kg of liveweight of animals).

(6) Improvement of the nutritional status of the rural population

The Project will contribute to the improvement of the nutritional status of the rural population by supplying more cereals and vegetables.

(7) Improvement of the present water supply condition

The Project should produce easy water fetching conditions by providing a deep well with pump equipment in every village in the Study area. The irrigation canals to be constructed for distributing water to the paddy fields are also water sources for the everyday use of the inhabitants.

(8) Improvement of womens' works

Installation of a deep well in every village under the Project will cause a reduction in improvement of womens' heavy work load of fetching drinking water, which has been the womens' traditional role in the Study area.

7.5 INFLUENCE ON THE ENVIRONMENT OF THE PROJECT IMPLEMENTATION

The environmental analysis of the proposed irrigation and drainage projects was carried out from the viewpoints of: (i) effects on the ecological environment and (ii) water pollution in the rivers and Lake Malawi.

As for the ecology, no deforestation will be included in the irrigation development and the area where the specific animals and birds inhabit will not be touched under the Project. It is judged, therefore, that few effects on the ecological environment will occur under the Project.

It is supposed that fertilizers to be applied under the agricultural development plan may affect river water quality in the downstream portion of the project areas. Since there

are few residential area in the downstream portion of the project areas, no effect on the everyday services of the farmers will occur. It seems that the usage of fertilizers under the Project will not cause water pollution in Lake Malawi, because of a difference in the scales of water-inflow and the lake water.

Bilharzia is recognized as a significant health problem in the smallholder irrigation schemes in Malawi. Two types of Bilharzia have been identified in Malawi: *Schistosoma haematobium* (SH) and *Schistosoma mansoni* (SM), which infest the bladder and stomach, respectively. A person suffering from this disease has worms in his/her body. These germs lay eggs which end up entering bladder or the intestines, and these germs go out when person pass urine or faeces. The eggs hatch to small germs and enter into small snails in the water. After a few days these germs come out of the snails and stay in water and enter in body of a person by making a hole on the skin when he/she bathes, crosses or drinks. This disease results in: (i) Destruction organs: bladder, liver, kidney, and sometimes stomach, (ii) Loss of blood and energy, and (iii) Ill-effect to immune system

The Bilharzia monitoring survey is carried out annually in the existing irrigation schemes by the Public Health Officer in Salima ADD. The records for 1993 showed that the proportional extent of persons with Bilharzia ranged from 12.7% to 40.9% in the existing irrigation schemes in Salima ADD as presented in the following table. The risk of contracting Bilharzia, therefore, is much higher in relation to irrigation development.

Irrigation Scheme	Tested	SH Positive	%	Tested	SM Positive	%
Lifuwu	109	18	16.5	89	12	13.5
Mpamantha	121	39	32.2	110	14	12.7
Bua	110	45	40.9	79	11	13.9
Kasitu	109	21	19.3	95	32	33.7
Mtandamula	1,042	328	31.5			

Although there is few test results outside the irrigation schemes, the occurrence of SH/SM positive might be less than 10%. The risk of Bilharzia, therefore, is much higher in relation with irrigation development. Under the direction of PHO of Salima ADD, the on-going Bilharzia Control Programme is required to be extended to the project area with the following objectives.

(i) Education to rural population
(ii) Execution of more frequent periodical test

(iii) Drug procurement and distribution to patients
(iv) Promotion of sanitation and water supply
(v) Control of intermediate snail host

7.6 EVALUATION RESULTS

In accordance with the economic evaluation, the Namikokwe Integrated Irrigation Project has the highest economic efficiency. The Namikokwe Project, which has the largest irrigation area of the 3 proposed irrigation projects, is superior to the others in terms of the maximum use of natural resources and improvement of farm economy. In addition, the noteworthy social effects under this project can be expected as well as those under the other 2 projects.

The results of the economic evaluation and priority order for the implementation of the 3 proposed irrigation projects is shown below:

			FIRR value (%)
1 st. priority	:	The Namikokwe Integrated Irrigation Project	11.9
2 nd. priority	:	The Lower Livulezi Irrigation Project	7.6
3 rd. priority	:	The Lower Nadzipulu Irrigation Project	5.5

On the basis of the priority order for the implementation of the irrigation projects, the priority for the implementation of the proposed development packages is set out as shown in the next page:

1 st. priority : Package 1
- The Namikokwe Integrated Irrigation Project including construction of post harvest facilities
- Consolidation of the village water supply system (100%)
- Improvement of the rural road networks (C route and a part of D route)
- Supporting activities for irrigation / agricultural development (Short medium-term plan)

2 nd. priority : Package 2
- The Lower Livulezi Irrigation Project including construction of post harvest facilities
- Improvement of the rural road networks (A,B routes and a part of D route)

3 rd. priority : Package 3

- The Lower Nadzipulu Irrigation Project including construction of post harvest facilities
- Improvement of the rural road networks (E route)

ANNEX II
FEASIBILITY STUDY FOR FIVE SELECTED PROJECTS

Tables

TABLE 2.1.1 *DEMOGRAPHIC DATA OF THE VILLAGES AROUND THE PROJECT AREAS*

Name of project	NO.	Village	Number of households	Population	Average family size
Lower Nadzipulu project	1	Chingwandali	81	334	4.12
	2	Njoka	23	92	4.00
	3	Chiude	48	240	5.00
	4	Kasakala	83	245	2.95
	5	Dungeya	55	142	2.58
	6	Mayola	43	267	6.21
	7	Kadzakalowa	45	227	5.04
	8	Chimseu	30	119	3.97
	9	Mgawi	61	301	4.93
	10	Chikomba	61	269	4.41
		Sub-total	*530*	2236	4.22
Lower Namikokwe and Mtandamula project	1	Bwanamakowa	45	177	3.93
	2	Chatewa	102	426	4.18
	3	Dziko	150	661	4.41
	4	Garuanenenji	118	496	4.20
	5	Mbangali	67	315	4.70
	6	Mkondolile	100	359	3.59
	7	Mthembanji	136	619	4.55
	8	Mwasinja	136	632	4.65
		Sub-total	854	3685	4.31
Upper Namikokwe project	1	Maiwaza	146	510	3.49
	2	Mlongoti	156	564	3.62
	3	Nkhoswe	48	199	4.15
	4	Michembo	43	171	3.98
	5	Mdulambale	85	336	3.95
	6	Ndongwe	54	198	3.67
	7	Mchanja	168	685	4.08
	8	Fole	118	452	3.83
	9	Madziasatsi	130	397	3.05
		Sub-total	948	3512	3.70
Lowe Livulezi project	1	Chatha	23	84	3.65
	2	Chikoleza	90	323	3.59
	3	Leza	88	321	3.65
	4	Ndindi	332	1639	4.94
	5	Chagunda 1	82	418	5.10
	6	Kadiwa	31	154	4.97
	7	Josafati	66	282	4.27
	8	Dzindebvu	27	109	4.04
	9	Sitolo 2	65	269	4.14
	10	Msuka	34	148	4.35
	11	Chagunda 2	63	219	3.48
	12	Nkhalira	172	546	3.17
	13	Sitole 1	146	782	5.36
	14	Chagunda 3	67	354	5.28
	15	Kabulika 2	166	763	4.60
		Sub-total	1,452	6,411	4.42
		Total	3,784	15,844	4.19

Data source: office files in development officer in Bwaje Valley Regional Development Project

Table 2.2.1 Soil Profile Characteristics of the Project Area (1/4)

Sample No.	Horizon No.	Horizon Symbol	Depth (cm)	Texture	Color (wet)		Color (dry)		Mottling	Soil pH (1:2.5)	EC (1:5) (us/cm)	Land Use	G.water (cm)
1	M1-1	Ap	0 - 18	sicl	brownish black	7.5YR2/2	brown	7.5YR4/3		6.2	120	paddy	108
2	M1-2	C1	18 - 52	sil	dark reddish brown	5YR3/2	dark reddish brown	5YR3/3	+	6.7	140		
3	M1-3	C2	52 - 72	s	brown	7.5YR4/3	dull brown	7.5YR5/4	+	7.0	140		
4	M1-4	C3	72 - 135+	cl	black	5YR1.7/1	brownish black	5YR2/1	+	7.3	170		
5	M2-1	A1	0 - 23	sil	brownish black	7.5YR3/2	brown	7.5YR4/3	++	6.2	100	reed	160
6	M2-2	C1	23 - 47	l	dark reddish brown	5YR3/2	brown	7.5YR4/3	+	6.7	140		
7	M2-3	C2	47 - 75	cl	dark reddish brown	5YR3/2	brown	7.5YR4/3	+	6.8	140		
8	M2-4	C3	75 - 102	sil	dark reddish brown	5YR3/3	dull reddish brown	5YR4/4	++	6.9	140		
9	M2-5	C4	102 - 149	sic	brownish black	5YR2/2	dark reddish brown	5YR3/2	++	6.9	150		
10	M2-6	C5	149 - 200+	c	brownish black	5YR2/1	brownish black	5YR2/2	++	6.9	160		
11	M3-1	Ap	0 - 32	sil	brownish black	7.5YR3/1	brown	7.5YR4/3		6.6	140	maize	
12	M3-2	C1	32 - 60	ls	dark reddish brown	5YR3/2	dull reddish brown	5YR4/4		6.8	130		
13	M3-3	C2	60 - 145	sil	brown	7.5YR4/3	brown	7.5YR4/4	++	6.8	140		
14	M3-4	C3	145 - 200+	sc	brownish black	5YR3/1	dark reddish brown	5YR3/2	+	7.2	180		
15	M4-1	A1	0 - 25	sic	brownish black	7.5YR3/1	brownish black	10YR3/1	+	6.8	140	reed, palm	
16	M4-2	C1	25 - 90+	sic	brownish black	7.5YR3/2	brownish black	7.5YR3/2		8.2	260	Acacia	
17	M5-1	Ap	0 - 22	sicl	dark reddish brown	5YR3/2	brown	7.5YR4/3	+	5.6	110	paddy	
18	M5-2	B1	22 - 43	sic	brownish black	5YR3/1	dark reddish brown	5YR3/2	+++	5.8	110		
19	M5-3	C1	43 - 110	c	brownish black	5YR3/1	dark reddish brown	5YR3/2	+	6.6	160		
20	M5-4	C2	110 - 155+	c	grayish brown	7.5YR4/2	brown	7.5YR4/3	+	8.1	220		
21	M6-1	Ap	0 - 20	sic	brownish black	5YR2/1	dark reddish brown	5YR3/2	+++	6.0	110	paddy	148
22	M6-2	C1	20 - 100	sc	brownish black	5YR2/1	brownish black	5YR2/1	++	6.8	200		
23	M6-3	C1g	100 - 150+	sc	grayish brown	7.5YR4/2	dark reddish brown	5YR3/3	++	7.8	350		
24	M7-1	Ap	0 - 22	sicl	brownish black	5YR3/1	dull reddish brown	5YR4/3	++	5.8	120	paddy	150
25	M7-2	C1	22 - 48	sicl	brownish black	5YR2/1	grayish brown	5YR4/2	++	6.0	120		
26	M7-3	C2	48 - 66	sil	dark reddish brown	5YR3/2	dull reddish brown	5YR4/3	++	6.0	120		
27	M7-4	C3	66 - 92	sicl	brownish black	5YR2/1	dark reddish brown	5YR3/2	+	6.0	110		
28	M7-5	C4	92 - 124	sic	dark reddish brown	5YR3/2	dull reddish brown	5YR4/3	++	6.4	140		
29	M7-6	C5	124 - 130	s	brownish black	5YR2/2	grayish brown	5YR4/2		6.6	140		
29a	M7-7	C6	130 - 150+	c	brownish black	5YR2/1	brownish black	5YR3/1		6.6	140		

Table 2.2.1 Soil Profile Characteristics of the Project Area (2/4)

Sample No.	Horizon No.	Horizon Symbol	Depth (cm)	Texture	Color (wet)		Color (dry)		Mottling	Soil pH (1:2.5)	EC (1:5) (us/cm)	Land Use	G.water (cm)
30	M8-1	Ap	0 - 23	cl	brownish black	7.5YR3/1	grayish brown	7.5YR4/2		5.7	180	paddy	49
31	M8-2	C1	23 - 55	sic	grayish brown	7.5YR4/2	dull brown	7.5YR5/3	++	6.6	140		
-	M8-3	C2	55 - 100+	scl/sl	dark reddish brown	5YR3/2	dull reddish brown	5YR4/3					
32	M9-1	Ap	0 - 23	sicl	brownish black	7.5YR3/2	grayish brown	7.5YR4/2	+++	5.7	110	paddy	58
33	M9-2	C1	23 - 45	sil	grayish brown	5YR5/2	dull brown	7.5YR6/3	++	6.4	120		
34	M9-3	C2	45 - 60+	sicl	brownish black	5YR2/1	brownish black	5YR3/1		6.5	150		
35	M10-1	Ap	0 - 21	ls	brown	7.5YR4/3	dull brown	7.5YR5/3		6.8	150	maize/	
-	M10-2	C1	21 - 110+	s	brown	7.5YR4/3	dull brown	7.5YR5/3	++			banana	
36	M11-1	Ap	0 - 12	sic	brownish gary	5YR4/1	grayish brown	5YR5/2	++	5.0	160		
37	M11-2	C1	12 - 30	cl	brownish black	7.5YR3/1	grayish brown	7.5YR4/2	++	5.6	100		
38	M11-3	C2	30 - 60+	cl	brownish black	7.5YR3/1	grayish brown	7.5YR4/2	+++	6.5	150		
39	P1-1	A11	0 -18	sil	brownish black	7.5YR3/1	brownish black	7.5YR3/2		6.1	100	maize/	180
40	P1-2	A12	18 - 31	sil	brownish black	7.5YR3/2	brown	7.5YR4/3	++	6.0	100	beans/	
41	P1-3	C1	31 - 81	c	black	7.5YR2/1	brownish black	7.5YR3/2	+	6.4	140	banana	
42	P1-4	C2	81 - 110	c	black	7.5YR2/1	black	7.5YR2/1	+	6.8	180		
43	P1-5	C3	110 - 150	sic	brownish black	7.5YR3/1	brownish black	7.5YR3/2	+++	6.7	180		
44	P1-6	C4	150 - 200+	sc	brown	7.5YR4/3	brown	7.5YR4/4	+++	6.9	200		
45	P2-1	A1	0 - 27	scl	black	7.5YR2/1	brownish black	7.5YR3/2		7.0	180	reeds in	
46	P2-2	C1	27 - 130	c	black	7.5YR2/1	brownish black	7.5YR3/1	++	7.3	210	dambo	
47	P2-3	C2	130 - 160	sil	grayish brown	7.5YR4/2	brown	7.5YR4/3	++	7.4	220		
48	P2-4	C3	160 - 200+	s	grayish brown	7.5YR5/2	dull brown	7.5YR5/3	++	7.5	200		
49	P3-1	A1	0 - 30	sil	brown	7.5YR4/3	dull brown	7.5YR5/4		7.2	150		
50	P3-2	C1	30 - 68	sl	brown	7.5YR4/3	dull brown	7.5YR5/4	++	7.3	180		
51	P3-3	C2	68 - 98	si	brownish black	7.5YR3/2	brown	7.5YR4/3	++	7.4	160		
52	P3-4	C3	98 - 105	cl	brownish black	5YR3/1	grayish brown	5YR4/2	++	6.6	100		
53	P3-5	C4	105 - 115	s	dull reddish brown	5YR5/4	dull reddish brown	5YR5/4	++	7.6	210		
54	P3-6	C5	115 - 200+	s	dull reddish brown	5YR4/4	dull reddish brown	5YR5/4	++	7.5	170		

Table 2.2.1 Soil Profile Characteristics of the Project Area (3/4)

Sample No.	Horizon No.	Horizon Symbol	Depth (cm)	Texture	Color (wet)		Color (dry)		Mottling	Soil pH (1:2.5)	EC (1:5) (us/cm)	Land Use	G.water (cm)
55	P4-1	A1	0 - 46	s	brownish black	7.5YR3/2	brown	7.5YR4/3		6.6	150	maize/ beans/ banana	
56	P4-2	C1	46 - 51	s	brown	7.5YR4/3	dull brown	7.5YR5/4	++	6.7	140		
57	P4-3	C2	51 - 69	sc	brownish black	5YR2/1	grayish black	5YR4/2	+++	6.0	130		
58	P4-4	C3	69 - 88	s	brown	7.5YR4/3	dull brown	7.5YR5/4	++	6.6	140		
59	P4-5	C4	88 - 149	c	brownish black	5YR2/1	dark reddish brown	5YR3/2	+	6.5	150		
60	P4-6	C5	149 - 200+	sic	dark reddish brown	5YR3/2	dark reddish brown	5YR3/3		6.5	140		
61	P5-1	A1	0 - 15	sil	brownish black	7.5YR3/1	brown	7.5YR4/3		7.5	180		
62	P5-2	C1	15 - 40	s	brownish black	7.5YR3/1	brown	7.5YR4/3		7.8	160		
63	P5-3	C2	40 - 60	sic	brownish black	7.5YR3/1	brown	7.5YR4/3	+++	7.8	180		
64	P5-4	C3	60 - 82	si	brownish black	7.5YR3/2	brown	7.5YR4/3		8.0	180		
65	P5-5	C4	82 - 140	c	black	7.5YR2/1	brownish black	7.5YR3/1		8.0	180		
66	P5-6	C5	140 - 200	si	brownish gray	7.5YR4/1	grayish brown	7.5YR4/2		8.1	220		
66a	P5-7	C6	200 - 220+	c	black	7.5YR2/1	black	7.5YR2/1		8.0	220		
67	P6-1	A1	0 - 16	sil	brownish black	7.5YR3/2	brown	7.5YR4/3		7.3	160		
68	P6-2	C1	16 - 49	c	brownish black	7.5YR3/2	brownish black	7.5YR3/2		7.5	170		
69	P6-3	C2	49 - 78	s	grayish brown	7.5YR4/2	dull brown	7.5YR5/4	+++	7.8	180		
70	P6-4	C3	78 - 98	si	grayish brown	7.5YR4/2	brown	7.5YR4/3	+++	8.0	180		
71	P6-5	C41	98 - 144	c	black	7.5YR2/1	brownish black	7.5YR2/2	+	8.3	240		
72	P6-6	C42	144 200+	sc	grayish brown	7.5YR4/2	brown	7.5YR4/3	+++	8.5	260		
73	P7-1	Ap	0 -25	si/s	brownish black	7.5YR3/2	brown	7.5YR4/3		8.3	200	maize	
74	P7-2	C1	25 - 69	s/si	brownish black	7.5YR3/2	dull brown	7.5YR5/4		8.3	170		
75	P7-3	C2	69 - 85	cl	brown	7.5YR4/3	dull brown	7.5YR5/4	+++	7.6	140		
76	P7-4	C3	85 - 155	si/s	brownish black	7.5YR3/2	brown	7.5YR4/3	++	8.2	170		
77	P7-5	C4	155 - 200+	cl	brownish black	7.5YR3/1	brown	7.5YR4/3	+	8.0	190		
78	P8-1	Ap	0 - 37	sil	dark reddish brown	5YR3/2	grayish brown	5YR4/3		8.0	170	maize	
79	P8-2	C1	37 - 51	sl	dark reddish brown	5YR3/3	brown	7.5YR4/3	++	8.0	150		
80	P8-3	C2	51 - 88	sic	brownish black	7.5YR3/2	brown	7.5YR4/3	++	8.0	150		
81	P8-4	C3	88 - 180	c	brownish black	7.5YR3/1	brownish black	7.5YR3/1		7.9	170		
82	P8-5	C4	180 - 200+	sic	brownish black	7.5YR3/1	grayish brown	7.5YR4/2	++	8.2	170		

Table 2.2.1 Soil Profile Characteristics of the Project Area (4/4)

Sample No.	Horizon No.	Horizon Symbol	Depth (cm)	Texture	Color (wet)		Color (dry)		Mottling	Soil pH (1:2.5)	EC (1:5) (us/cm)	Land Use	G.water (cm)
83	P9-1	A1	0 - 26	sic	brownish black	7.5YR3/1	grayish brown	7.5YR4/2	+	8.4	220	grasses in dambo	180
84	P9-2	C1	26 - 69	ls	brownish black	7.5YR3/2	grayish brown	7.5YR4/2	+	8.8	220		
85	P9-3	C2	69 - 121	sic	brown	7.5YR4/3	dull yellowish brown	10YR4/3	++	9.2	240		
86	P9-4	C3	121 - 150	c	brownish black	7.5YR3/1	brownish black	7.5YR3/1	+	9.2	250		
87	P9-5	C4	150 - 200+	sc/s	brownish black	10YR3/2	dark brown	10YR3/3		9.0	250		
88	N1-1	Ap	0 - 32	sil	brownish black	7.5YR3/1	brownish black	7.5YR2/2		8.2	150	maize/ beans	126
89	N1-2	C1	32 - 64	s	brown	7.5YR4/3	dull brown	7.5YR5/3	+	8.3	160		
90	N1-3	C2	64 - 110	sil	dark reddish brown	5YR3/3	brown	7.5YR4/3	++	8.2	150		
91	N1-4	C3	110 - 130+	ls	grayish brown	7.5YR4/2	dull brown	7.5YR5/3	+	8.2	150		
92	N2-1	Ap	0 - 23	sic	dark brown	7.5YR3/3	brown	7.5YR4/3	++	7.8	100	paddy	42
93	N2-2	C1	23 - 42	sl	brownish black	7.5YR3/2	dull brown	7.5YR5/3	++	8.0	120		
94	N2-3	C2	42 - 50+	c	black	7.5YR2/1	brownish black	7.5YR3/2		7.8	140		
95	N3-1	Ap	0 - 30	l	grayish brown	7.5YR4/2	dull brown	7.5YR5/3		8.0	130	paddy	15

Table 2.2.2 Criteria for Land Suitability Classification (Modification of LREP System)

IRRIGATED RICE

Factor		S1	S2	S3	N1	N2
1. Texture	a	Medium to Fine	Medium to Fine	Coarse	Coarse (Rapid permeability)	Coarse (Very rapid permeability)
2. Depth	d	>50 cm	>30 cm	>30 cm	<30 cm	<30 cm
3. Alkalinity/Salinity	n	<15% ESP < ECe 4mmho/cm	<15% ESP < ECe 4mmho/cm	<15% ESP < ECe 4mmho/cm	>15% ESP > ECe 4mmho/cm	>15% ESP > ECe 4mmho/cm
4. Compactness	c	none	none	none	very compact subsoil	very compact subsoil
5. Slope	t	<2%	<2%	<2%	2 - 8%	>8%
6. Micro-relief	r	very smooth	smooth	irregular	irregular	irregular
7. Flooding hazard	f	none	none - exceptional	exceptional-frequent regular, prolonged wet season flooding and waerlogging	frequent remain flooded or severely waterlogged throughout wet season	swamp near lakeshore
8. Moisture availability (Drainage)	m	poor to imperfect	poor to imperfect	imperfect to well	well to excessive	excessive

IRRIGATED UPLAND CROPS

Factor		S1	S2	S3	N1	N2
1. Texture	a	Medium to Fine	Medium to Fine	Coarse	Coarse (Rapid permeability)	Coarse (Very rapid permeability)
2. Depth	d	> 150 cm	150 - 100 cm	100 - 30 cm	< 30 cm	< 30 cm
3. Alkalinity/Salinity	n	<15% ESP < ECe 4mmho/cm	<15% ESP < ECe 4mmho/cm	<15% ESP < ECe 4mmho/cm	>15% ESP > ECe 4mmho/cm	>15% ESP > ECe 4mmho/cm
4. Compactness	c	none	surface compactness	surface compactness	very compact subsoil	
5. Slope	t	<2%	2 - 4%	4 - 8%	8 - 16%	16%<
6. Flooding hazard	f	none	none - exceptional	exceptional-frequent Regular, prolonged wet season flooding and waerlogging	frequent remain flooded or severely waterlogged throughout wet season	swamp near lakeshore
7. Oxigen availability (Drainage)	w	mod. well to well	mod. well to well	very poor to well	imperfect	imperfect

Remarks :

S1 : Highly suitable
S2 : Moderately suitable
S3 : Marginally suitable
N1 : Currently not suitable
N2 : Permanently not suitable

Fine Texture : SC, SiC, CL Heavy, SiCL Heavy
Medium Texture : SCL, CL, SiCL, L, SiL, Si, S, SL Heayy
Coarse Texture : S, LS, SL Light

Table 2.3.1 CLIMATIC CONDITIONS IN THE PROJECT AREAS AT MONKEY BAY STATION

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Average	Periods
Rainfall *1) (mm)	49.0	210.3	264.8	239.0	155.7	45.1	3.1	2.3	0.7	0.5	2.6	3.3	976.4	1952-78
Temperature (℃)														1979-87
Max.	32.6	30.1	29.7	29.5	30.3	29.7	28.5	26.4	26.3	28.1	31.0	32.3	29.5	
Min.	23.6	22.7	22.2	21.8	21.9	20.6	18.3	16.0	16.0	17.4	19.6	22.4	20.2	
Average	28.1	26.4	26.0	25.7	26.1	25.2	23.4	21.2	21.2	22.8	25.3	27.4	24.9	
Wind Speed (m/sec)	2.8	2.4	1.9	1.8	2.0	2.2	2.2	2.4	2.5	2.5	2.6	3.0	2.4	1979-87
Relative Humidity (%)	79.0	74.0	79.0	80.0	75.0	70.0	64.0	61.0	58.0	55.0	53.0	53.0	66.8	1979-87
Sunshime Hours (hours/day)	9.0	6.9	6.6	6.8	8.1	8.6	9.4	8.9	8.8	9.6	9.8	9.8	8.5	1979-87
Evaporation *2) (mm)	225.0	187.0	165.0	138.0	167.0	168.0	160.0	145.0	152.0	173.0	194.0	240.0	176.2	1953-78

Data Source : National early warning system for food security (Techical paper No.2) Potential evapotranspiration studies in Malawi, October,1989. Meteorological Department, Ministry of ransport and Comminications.

: *1) Meteorological Department

: *2) National Water Resources Master Plan Annex 3 March,1986

Note : Above rainfall data were observed at Mua Mission.

Table 2.4.1 ESTIMATION OF PROBABLE ANNUAL RAINFALL IN 1/5 DROUGHT YEAR

	Year	Recorded annual rainfall in each years Xi	(Xi-Xo)	(Xi-Xo)^2
1	1977/78	1,520	543.97	295,900.43
2	1956/57	1,402	425.86	181,354.45
3	1975/76	1,379	402.75	162,205.39
4	1962/63	1,291	314.36	98,820.52
5	1955/56	1,186	209.20	43,763.51
6	1954/55	1,141	164.75	27,141.68
7	1973/74	1,132	155.61	24,213.63
8	1968/69	1,046	69.25	4,795.19
9	1976/77	1,024	47.91	2,295.11
10	1959/60	999	22.26	495.39
11	1960/61	991	14.38	206.71
12	1971/72	937	-39.72	1,577.89
13	1957/58	937	-39.72	1,577.89
14	1964/65	925	-51.91	2,694.93
15	1958/59	899	-77.56	6,015.97
16	1972/73	881	-95.09	9,042.62
17	1966/67	880	-96.87	9,384.32
18	1974/75	860	-116.17	13,496.09
19	1970/71	842	-134.21	18,013.05
20	1963/64	840	-136.75	18,701.30
21	1961/62	794	-182.97	33,479.01
22	1969/70	750	-226.92	51,493.91
23	1965/66	729	-247.49	61,252.63
24	1953/54	699	-277.72	77,129.89
25	1967/68	685	-291.69	85,084.63
26	1952/53	621	-355.44	126,339.51
			Total	1,356,475.64

Data source : Meteorological Department

n= 26.00
Xo= 976.47
1/a= 323.02

X= Xo+(1/a)*z

T	z	X
1/5	0.5951	784.24
1/10	0.9062	683.75
1/30	1.2971	557.48
1/50	1.4522	507.38

Note: T: Return period
z: Normal variable
X: Probable annual rainfall in T year return period (mm)
n: Number of data
Xo: Average annual rainfall (mm)

Table 2.4.2 DAILY RAINFALL DATA IN 1/5 DROUGHT YEAR AT MUA MISSION STATION

(Unit:mm)

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	0.0	9.1	0.0	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	14.7	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	28.2	30.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	23.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	35.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	48.3	68.1	77.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	0.0	4.8	6.8	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	57.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	84.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	32.5	25.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	33.5	19.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	18.3	0.0	27.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	18.3	210.6	71.6	3.3	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.8	21.1	7.2	0.3	0.0	4.7	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	34.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	28.2	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	10.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	43.7		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	45.0	0.0	2.8		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31		0.0	0.0		0.0		0.0		0.0	0.0		0.0
Sub-total	45.0	38.9	112.3	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	4.5	3.5	10.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	63.2	297.7	252.0	89.7	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0

Data source : Meteorological Department

Note : above data was recorded at Mua Mission in 1969/70.

Table 2.4.3 PROBABLE MAXIMUM DAILY RAINFALL WITH 1/5 RETURN PERIOD AT MUA MISSION STATION

	Year	Date	Recorded maximum daily rainfall in each year Xi	(Xi-Xo)	(Xi-Xo)^2
1	1956/57	10-Jan	105.92	25.28	638.85
2	1958/59	4-Mar	103.89	23.25	540.35
3	1977/78	28-Jan	103.89	23.25	540.35
4	1962/63	9-Nov	103.38	22.74	516.90
5	1972/73	18-Dec	100.58	19.94	397.42
6	1973/74	4-Feb	98.55	17.91	320.60
7	1976/77	24-Jan	95.76	15.12	228.47
8	1971/72	17-Dec	91.44	10.80	116.54
9	1952/53	24-Jan	88.90	8.26	68.15
10	1955/56	5-Apr	88.90	8.26	68.15
11	1969/70	15-Dec	84.07	3.43	11.73
12	1968/69	26-Jan	80.77	0.13	0.02
13	1954/55	11-Dec	78.99	-1.65	2.74
14	1965/66	12-Feb	76.71	-3.93	15.48
15	1953/54	21-Dec	76.20	-4.44	19.75
16	1963/64	15-Feb	73.66	-6.98	48.78
17	1974/75	8-Dec	72.14	-8.50	72.33
18	1957/58	5-Jan	71.37	-9.27	86.02
19	1964/65	19-Feb	70.61	-10.03	100.69
20	1975/76	12-Feb	69.60	-11.04	121.98
21	1959/60	28-Dec	66.04	-14.60	213.29
22	1961/62	12-Feb	66.04	-14.60	213.29
23	1970/71	26-Nov	65.53	-15.11	228.45
24	1967/68	19-Feb	59.94	-20.70	428.68
25	1960/61	13-Feb	59.18	-21.46	460.73
26	1966/67	27-Feb	44.70	-35.94	1,292.02
				Total	6,751.78

Data source : Meteorological Department

n= 26.00
Xo= 80.64
1/a= 22.79

X= Xo+(1/a)*z

T	z	X
1/5	0.5951	94.21
1/10	0.9062	101.30
1/30	1.2971	110.21
1/50	1.4522	113.74

Note: T:Return period
z:Normal variable
X:Probable maximum daily rainfall(mm)
n:Number of data
Xo:Average maximum daily rainfall (mm)

Table 2.4.4 DAILY DISCHARGE OF THE NAKAINGWA IN 1969/70

Station No.: 3.F.2

Place : Songwe Area : 63.40 km2 Unit: m3/sec

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1	0.131	0.061	0.843	1.600	0.843	0.327	0.217	0.141	0.125	0.081	0.059	0.032
2	0.067	0.071	0.644	4.290	0.810	0.319	0.217	0.141	0.125	0.081	0.058	0.031
3	0.056	0.081	5.680	7.040	0.731	0.311	0.212	0.152	0.118	0.088	0.049	0.042
4	0.054	0.112	2.960	2.790	0.686	0.301	0.212	0.149	0.115	0.084	0.051	0.046
5	0.053	0.203	1.750	2.550	0.658	0.301	0.207	0.145	0.112	0.084	0.051	0.036
6	0.046	0.121	1.280	3.040	0.604	0.295	0.207	0.141	0.110	0.075	0.054	0.033
7	0.053	0.099	1.190	3.410	0.553	0.280	0.207	0.138	0.107	0.073	0.058	0.032
8	0.044	0.086	0.948	2.750	0.604	0.273	0.203	0.134	0.107	0.071	0.058	0.031
9	0.041	0.069	0.701	3.460	0.540	0.258	0.203	0.134	0.107	0.071	0.058	0.029
10	0.038	0.063	0.604	3.000	0.949	0.303	0.198	0.134	0.104	0.075	0.056	0.029
Mean	0.058	0.081	0.995	2.825	0.648	0.290	0.208	0.141	0.113	0.078	0.055	0.034
Max.	0.131	0.203	5.680	7.040	0.949	0.327	0.217	0.152	0.125	0.088	0.059	0.046
11	0.036	0.056	0.553	2.790	1.080	0.287	0.193	0.141	0.104	0.073	0.056	0.028
12	0.035	0.327	0.505	3.810	0.731	1.100	0.189	0.141	0.101	0.079	0.056	0.027
13	0.044	0.056	0.461	2.710	0.672	0.390	0.189	0.138	0.101	0.077	0.056	0.027
14	0.051	0.254	0.419	2.090	0.604	0.371	0.189	0.138	0.101	0.077	0.042	0.026
15	0.048	0.217	0.380	1.890	0.578	0.336	0.189	0.134	0.099	0.075	0.041	0.026
16	0.046	2.290	0.362	1.690	0.540	0.319	0.185	0.134	0.099	0.075	0.041	0.026
17	0.038	2.510	0.344	1.580	0.517	0.319	0.185	0.134	0.096	0.073	0.040	0.024
18	0.036	0.672	0.591	1.450	0.494	0.336	0.185	0.134	0.093	0.071	0.040	0.035
19	0.034	0.419	0.505	1.300	0.471	0.327	0.180	0.134	0.091	0.069	0.038	0.025
20	0.030	0.701	0.461	1.230	0.450	0.311	0.180	0.134	0.091	0.077	0.038	0.026
Mean	0.040	0.338	0.430	1.743	0.541	0.326	0.186	0.136	0.098	0.075	0.045	0.027
Max.	0.051	2.510	0.591	3.810	1.080	1.100	0.193	0.141	0.104	0.079	0.056	0.035
21	0.042	0.277	0.895	1.130	0.429	0.296	0.176	0.134	0.077	0.075	0.037	0.025
22	0.079	0.232	0.686	1.060	0.419	0.283	0.176	0.134	0.086	0.071	0.029	0.026
23	0.058	0.238	0.604	1.010	0.409	0.271	0.172	0.134	0.086	0.069	0.029	0.027
24	0.045	0.930	0.658	1.010	0.390	0.259	0.172	0.134	0.084	0.071	0.029	0.027
25	0.040	1.060	0.617	0.912	0.429	0.265	0.168	0.131	0.084	0.073	0.029	0.025
26	0.039	0.949	0.591	0.877	0.390	0.254	0.164	0.131	0.091	0.071	0.029	0.025
27	0.034	0.471	0.540	0.826	0.380	0.243	0.160	0.128	0.086	0.069	0.029	0.027
28	0.032	0.319	0.630	0.877	0.362	0.238	0.152	0.128	0.084	0.069	0.029	0.027
29	0.031	1.190	1.420		0.353	0.232	0.141	0.128	0.084	0.067	0.029	0.025
30	0.029	0.777	5.010		0.344	0.222	0.141	0.128	0.084	0.067	0.029	0.026
31		0.716	2.050		0.336		0.141		0.086	0.059		0.026
Mean	0.043	0.545	0.738	0.919	0.376	0.248	0.160	0.131	0.085	0.069	0.030	0.026
Max.	0.079	1.190	5.010	1.130	0.429	0.296	0.176	0.134	0.091	0.075	0.037	0.027

Data source : Department of water

Note: Horizontal line on data shows that data were omitted from calculations for 10-days average discharge .

Table 2.4.5 DAILY DISCHARGE OF THE NADZIPULE IN 1969/70

Area : 224 km2 Station No.: 3.F.3

Place : Chikaola Unit: m3/sec

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1	0.190	3.460	8.120	14.100	4.800	2.210	1.700	0.893	0.658	0.463	0.335	0.199
2	0.185	1.770	7.980	25.500	4.320	2.130	1.650	0.879	0.647	0.454	0.328	0.219
3	0.181	1.130	7.340	17.000	3.420	2.050	1.630	1.030	0.613	0.446	0.321	0.342
4	0.258	1.590	7.270	15.900	3.870	2.020	1.590	0.968	0.602	0.491	0.314	0.335
5	0.246	1.540	7.140	12.600	3.660	2.000	1.540	0.953	0.581	0.481	0.308	0.328
6	0.225	1.520	7.070	11.700	3.540	1.970	1.560	0.938	0.570	0.454	0.301	0.321
7	0.219	1.500	4.560	11.500	3.380	1.940	1.590	0.908	0.549	0.437	0.295	0.230
8	0.209	1.330	4.050	11.400	3.710	1.920	1.560	1.000	0.539	0.420	0.288	0.225
9	0.204	1.320	4.090	11.300	3.420	1.840	1.540	0.984	0.570	0.500	0.282	0.219
10	0.199	1.300	4.090	11.200	3.310	2.130	1.500	0.953	0.591	0.481	0.276	0.214
Mean	0.212	1.404	5.701	12.463	3.539	1.984	1.586	0.951	0.592	0.463	0.305	0.263
Max.	0.258	3.460	8.120	25.500	4.800	2.210	1.700	1.030	0.658	0.500	0.335	0.342
11	0.195	1.280	4.050	11.100	7.620	2.050	1.480	0.938	0.581	0.463	0.276	0.172
12	0.190	1.260	4.000	11.000	4.140	4.600	1.460	0.984	0.570	0.454	0.258	0.163
13	0.549	1.240	3.960	10.900	3.750	2.940	1.390	0.968	0.560	0.454	0.258	0.132
14	0.529	1.220	3.920	4.600	3.500	2.240	1.480	0.953	0.549	0.446	0.252	0.136
15	0.510	1.200	20.900	11.100	3.350	2.190	1.440	1.000	0.539	0.437	0.246	0.132
16	0.185	1.180	10.700	4.510	3.190	2.130	1.410	1.060	0.519	0.412	0.252	0.122
17	0.181	1.150	10.400	4.510	3.080	2.050	1.370	1.030	0.570	0.870	0.241	0.172
18	0.176	2.120	8.960	4.460	2.980	8.570	1.350	1.000	0.539	0.364	0.241	0.168
19	0.172	25.800	7.140	4.370	2.940	6.490	1.330	0.968	0.529	0.357	0.246	0.163
20	0.163	3.960	5.600	4.320	2.800	4.090	1.320	0.923	0.519	0.380	0.241	0.159
Mean	0.285	1.331	6.004	6.096	3.199	2.786	1.403	0.982	0.548	0.464	0.251	0.152
Max.	0.549	25.800	20.900	11.100	7.620	8.570	1.480	1.060	0.581	0.870	0.276	0.172
21	0.159	2.940	5.480	4.270	2.610	2.770	1.300	0.865	0.510	0.403	0.235	0.155
22	0.155	2.910	5.380	4.410	2.580	2.300	1.280	0.782	0.500	0.395	0.230	0.151
23	0.151	2.800	5.320	4.510	2.510	2.190	1.260	0.718	0.491	0.387	0.225	0.143
24	0.181	2.740	5.270	4.410	2.740	2.050	1.240	0.756	0.500	0.380	0.219	0.136
25	0.176	2.300	5.110	4.370	2.800	1.970	1.220	0.718	0.529	0.372	0.214	0.129
26	0.172	2.270	5.060	4.510	2.700	1.920	1.200	0.707	0.519	0.364	0.209	0.122
27	0.163	1.240	21.300	4.460	2.640	1.890	1.170	0.694	0.491	0.357	0.204	0.350
28	0.147	1.220	12.600	4.800	2.540	1.840	1.100	0.718	0.481	0.350	0.214	0.342
29	0.136	1.200	6.550		2.450	1.820	1.000	0.694	0.491	0.342	0.209	0.335
30	0.132	1.180	6.120		2.330	1.770	0.968	0.682	0.481	0.335	0.204	0.314
31		8.270	18.300		2.270		0.908		0.472	0.328		0.308
Mean	0.157	1.984	6.321	4.405	2.514	1.931	1.150	0.733	0.497	0.365	0.216	0.226
Max.	0.181	8.270	21.300	4.800	2.800	2.770	1.300	0.865	0.529	0.403	0.235	0.350

Data source : Department of water

Note: Horizontal line on data shows that data were omitted from calculations for 10-days average discharge .

Table 2.4.6 DAILY DISCHARGE OF THE NADZIPOKWE IN 1969/70

Place : Mua Area : 30.1 km2 Station No.: 3.E.1

Unit: m3/sec

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1	0.352	0.085	0.493	2.690	0.656	0.365	0.266	0.137	0.104	0.078	0.040	0.022
2	0.137	0.107	0.449	2.430	0.656	0.352	0.266	0.137	0.104	0.076	0.040	0.028
3	0.076	0.093	0.605	2.030	0.605	0.339	0.266	0.145	0.101	0.076	0.040	0.043
4	0.067	0.098	1.270	3.310	0.572	0.326	0.255	0.137	0.093	0.076	0.040	0.043
5	0.061	0.098	1.890	2.370	0.556	0.326	0.244	0.137	0.093	0.076	0.040	0.039
6	0.057	0.085	1.130	1.620	0.540	0.326	0.244	0.137	0.093	0.073	0.040	0.032
7	0.057	0.080	0.879	1.510	0.540	0.314	0.244	0.137	0.093	0.073	0.040	0.023
8	0.057	0.076	0.783	1.570	0.524	0.302	0.233	0.137	0.093	0.069	0.040	0.020
9	0.048	0.069	0.656	4.880	0.509	0.314	0.233	0.137	0.093	0.065	0.040	0.019
10	0.040	0.065	0.639	1.860	0.493	0.352	0.222	0.137	0.090	0.063	0.039	0.019
Mean	0.095	0.081	0.704	2.010	0.542	0.325	0.247	0.138	0.096	0.073	0.040	0.029
Max.	0.352	0.107	1.890	4.880	0.656	0.365	0.266	0.145	0.104	0.078	0.040	0.043
11	0.035	0.065	0.621	4.620	0.840	0.352	0.222	0.145	0.090	0.065	0.038	0.020
12	0.034	0.622	0.588	2.030	0.556	0.691	0.222	0.145	0.093	0.069	0.038	0.022
13	0.042	0.212	0.572	1.700	0.556	0.379	0.233	0.145	0.090	0.065	0.038	0.020
14	0.050	0.392	0.783	1.490	0.524	0.352	0.233	0.145	0.088	0.067	0.038	0.016
15	0.050	0.192	0.639	1.320	0.493	0.379	0.222	0.137	0.085	0.065	0.036	0.014
16	0.043	6.960	0.588	1.200	0.478	0.339	0.212	0.137	0.085	0.059	0.036	0.013
17	0.042	4.040	0.493	1.090	0.449	0.352	0.202	0.129	0.085	0.059	0.036	0.013
18	0.038	1.020	0.879	0.960	0.434	1.320	0.202	0.154	0.085	0.057	0.036	0.013
19	0.032	0.691	0.879	0.940	0.434	0.727	0.202	0.113	0.085	0.057	0.034	0.014
20	0.032	0.524	0.840	0.940	0.434	0.392	0.192	0.107	0.085	0.057	0.032	0.015
Mean	0.040	0.465	0.641	1.205	0.475	0.405	0.214	0.136	0.087	0.062	0.036	0.016
Max.	0.050	6.960	0.879	4.620	0.840	1.320	0.233	0.154	0.093	0.069	0.038	0.022
21	0.061	0.463	0.691	0.840	0.406	0.365	0.182	0.107	0.083	0.057	0.032	0.014
22	0.129	0.379	0.588	0.840	0.406	0.339	0.182	0.107	0.080	0.059	0.032	0.014
23	0.107	0.919	1.070	0.840	0.406	0.326	0.172	0.107	0.080	0.055	0.029	0.014
24	0.053	24.400	24.200	0.783	0.420	0.302	0.163	0.107	0.080	0.053	0.025	0.014
25	0.050	48.400	2.000	0.745	0.420	0.302	0.163	0.107	0.080	0.053	0.023	0.015
26	0.040	0.656	1.290	0.673	0.406	0.302	0.163	0.107	0.080	0.050	0.023	0.014
27	0.038	0.605	3.030	0.656	0.392	0.302	0.154	0.107	0.080	0.048	0.023	0.013
28	0.035	0.493	0.899	0.691	0.392	0.290	0.137	0.107	0.080	0.045	0.022	0.013
29	0.035	1.270	2.370		0.392	0.290	0.137	0.107	0.080	0.043	0.022	0.013
30	0.053	0.493	3.280		0.379	0.278	0.137	0.107	0.078	0.042	0.022	0.014
31		0.524	3.390		0.365		0.137		0.078	0.042		0.014
Mean	0.060	0.645	1.691	0.731	0.394	0.299	0.157	0.107	0.080	0.050	0.025	0.014
Max.	0.129	48.400	24.200	0.840	0.420	0.365	0.182	0.107	0.083	0.059	0.032	0.015

Data source : Department of water

Note: Horizontal line on data shows that data were omitted from calculations for 10-days average discharge .

Table 2.4.7 DAILY DISCHARGE OF THE NAMIKOKWE IN 1969/70

Place : Mua Livulezi Area : 129.00 km2

Unit: m3/sec

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1	0.093	0.059	3.511	8.127	2.486	1.246	0.694	0.453	0.340	0.244	0.147	0.071
2	0.093	0.184	3.143	10.590	2.294	1.246	0.694	0.453	0.340	0.235	0.147	0.071
3	0.354	0.340	13.450	13.025	2.463	1.206	0.694	0.453	0.326	0.235	0.136	0.119
4	0.244	0.515	6.909	11.184	2.180	1.167	0.680	0.430	0.326	0.235	0.136	0.119
5	0.207	0.651	5.578	9.061	2.067	1.147	0.665	0.408	0.326	0.227	0.125	0.119
6	0.173	0.255	3.738	7.362	1.965	1.147	0.665	0.408	0.326	0.227	0.125	0.113
7	0.156	0.651	3.511	6.513	1.812	1.113	0.637	0.396	0.311	0.227	0.113	0.096
8	0.133	0.314	2.265	5.946	2.042	0.937	0.623	0.396	0.311	0.204	0.113	0.082
9	0.116	0.244	2.588	6.343	1.914	1.065	0.623	0.396	0.311	0.204	0.108	0.074
10	0.093	0.153	2.265	5.890	1.787	1.065	0.623	0.396	0.311	0.204	0.108	0.074
Mean	0.166	0.258	3.325	7.479	2.008	1.106	0.660	0.419	0.323	0.224	0.126	0.094
Max.	0.354	0.651	13.450	13.025	2.486	1.246	0.694	0.453	0.340	0.244	0.147	0.119
11	0.088	0.125	2.095	6.343	2.486	1.031	0.600	0.408	0.297	0.204	0.105	0.091
12	0.076	0.651	1.838	5.408	2.265	0.997	0.600	0.408	0.297	0.227	0.105	0.091
13	0.076	0.328	1.659	4.899	2.095	1.407	0.578	0.396	0.297	0.227	0.096	0.082
14	0.076	0.951	1.710	4.729	1.965	1.206	0.578	0.396	0.297	0.215	0.096	0.071
15	0.133	0.487	1.849	4.304	1.838	1.147	0.566	0.396	0.283	0.210	0.096	0.062
16	0.093	0.810	2.016	3.908	1.787	1.186	0.566	0.382	0.283	0.204	0.091	0.059
17	0.093	8.778	3.143	3.596	1.710	1.147	0.566	0.382	0.283	0.198	0.091	0.059
18	0.088	3.596	2.418	3.200	1.518	1.863	0.566	0.382	0.277	0.198	0.091	0.059
19	0.079	2.124	2.588	3.738	1.583	1.608	0.566	0.382	0.277	0.198	0.096	0.059
20	0.076	1.608	2.945	3.738	1.557	1.427	0.566	0.382	0.269	0.187	0.096	0.059
Mean	0.088	0.886	2.022	4.014	1.757	1.194	0.575	0.391	0.286	0.207	0.096	0.069
Max.	0.133	8.778	3.143	6.343	2.486	1.863	0.600	0.408	0.297	0.227	0.105	0.091
21	0.277	3.143	5.295	3.256	1.515	1.322	0.544	0.368	0.269	0.187	0.096	0.057
22	0.232	1.889	3.171	2.917	1.472	1.226	0.544	0.368	0.261	0.198	0.113	0.057
23	0.207	3.511	3.738	2.656	1.450	1.147	0.521	0.368	0.252	0.198	0.105	0.057
24	0.184	4.474	6.909	2.384	1.450	1.096	0.521	0.368	0.252	0.193	0.096	0.054
25	0.173	3.313	5.294	2.180	1.407	1.065	0.510	0.354	0.261	0.193	0.082	0.054
26	0.150	2.418	4.219	1.991	1.365	1.065	0.510	0.354	0.261	0.187	0.082	0.054
27	0.125	2.016	5.464	2.452	1.342	1.031	0.510	0.354	0.261	0.187	0.082	0.054
28	0.102	1.659	4.474	2.237	1.303	0.997	0.510	0.354	0.261	0.176	0.079	0.051
29	0.059	2.764	13.648		1.263	0.980	0.487	0.340	0.252	0.170	0.079	0.051
30	0.059	2.169	11.921		1.246	0.951	0.487	0.340	0.252	0.159	0.074	0.045
31		2.945	6.909		1.303		0.464		0.244	0.159		0.042
Mean	0.157	2.480	5.053	2.317	1.348	1.042	0.510	0.357	0.257	0.182	0.089	0.052
Max.	0.277	4.474	13.648	3.256	1.515	1.322	0.544	0.368	0.269	0.198	0.113	0.057

Data source : Department of water

Note : Horizontal line on data shows that data were omitted from calculations for 10-days average discharge .

Table 2.4.8 DAILY DISCHARGE OF THE LIVULEZI IN 1969/70

Area : 452 km2 Station No.: 3.E.3
Place : Kwekwelele Unit: m3/sec

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1	0.372	0.142	0.923	~~21.800~~	~~23.800~~	3.310	1.350	1.070	0.662	0.680	0.425	0.155
2	0.239	0.719	0.963	11.700	~~21.200~~	2.920	1.320	1.000	0.628	0.623	0.425	0.155
3	0.184	1.820	0.612	~~16.400~~	17.000	2.950	1.260	0.962	0.611	0.566	0.522	0.260
4	0.174	~~2.490~~	1.270	6.460	12.700	1.980	1.320	0.905	0.628	0.510	0.510	0.215
5	0.164	1.440	2.270	6.510	17.000	1.530	1.300	0.905	0.611	0.453	0.495	0.195
6	0.121	~~2.440~~	2.040	6.460	11.300	1.780	1.280	0.893	0.594	0.453	0.453	0.185
7	0.111	1.660	1.980	6.120	5.810	3.740	1.300	0.905	0.580	0.453	0.435	0.158
8	0.104	1.550	~~6.000~~	6.740	9.490	~~4.730~~	1.300	0.893	0.580	0.425	0.430	0.158
9	0.090	1.300	1.550	13.800	11.300	~~4.160~~	1.280	0.863	0.566	0.425	0.385	0.165
10	0.090	1.080	~~2.860~~	11.700	5.520	3.310	1.230	0.848	0.580	0.425	0.385	0.158
Mean	0.165	1.214	1.451	8.686	11.265	2.690	1.294	0.924	0.604	0.501	0.447	0.180
Max.	0.372	2.490	6.000	21.800	23.800	4.730	1.350	1.070	0.662	0.680	0.522	0.260
11	0.090	~~0.776~~	2.010	9.520	2.010	~~2.550~~	1.230	0.832	0.552	0.425	0.350	0.150
12	0.085	~~0.765~~	1.440	11.300	~~12.300~~	2.270	1.210	0.832	0.523	0.396	0.325	0.158
13	0.085	0.583	1.730	12.200	5.950	3.060	1.230	0.905	0.495	0.396	0.270	0.165
14	0.107	0.396	2.860	~~13.300~~	7.500	~~2.610~~	1.210	0.893	0.467	0.396	0.250	0.150
15	0.146	0.283	0.697	11.100	~~11.000~~	2.070	1.190	0.863	0.495	0.396	0.190	0.140
16	0.142	0.170	~~3.960~~	9.460	9.060	1.730	1.210	0.893	0.480	0.368	0.195	0.135
17	0.142	0.127	0.283	~~12.600~~	3.400	2.270	1.230	0.893	0.523	0.368	0.190	0.130
18	0.138	0.113	0.227	10.500	2.270	1.670	1.210	0.863	0.505	0.368	0.185	0.165
19	0.132	0.227	~~3.030~~	8.670	5.240	1.640	1.210	0.832	0.540	0.368	0.185	0.150
20	0.129	0.396	1.500	11.300	2.970	2.320	1.210	0.603	0.540	0.340	0.185	0.185
Mean	0.120	0.287	1.343	10.506	4.800	2.129	1.214	0.841	0.512	0.382	0.233	0.153
Max.	0.146	0.776	3.960	13.300	12.300	3.060	1.230	0.905	0.552	0.425	0.350	0.185
21	0.116	0.493	3.340	18.300	~~5.240~~	~~2.320~~	1.190	0.803	0.523	0.340	0.180	0.185
22	0.112	0.326	~~12.700~~	20.400	3.540	~~1.850~~	1.160	0.803	0.495	0.340	0.180	0.220
23	0.101	1.080	10.300	16.300	2.970	1.780	1.190	0.803	0.480	0.340	0.180	0.195
24	0.090	~~1.870~~	7.080	~~107.000~~	4.110	1.700	1.190	0.764	0.430	0.312	0.185	0.185
25	0.090	~~1.440~~	0.453	~~69.700~~	~~4.810~~	1.700	1.160	0.764	0.425	0.312	0.165	0.430
26	0.090	0.963	~~11.900~~	12.500	3.820	1.670	1.160	0.748	0.373	0.312	0.158	0.340
27	0.085	0.566	5.320	16.300	4.810	1.560	1.140	0.732	0.351	0.312	0.158	0.275
28	0.101	0.368	7.820	18.700	1.700	1.500	1.190	0.732	0.330	0.283	0.158	0.260
29	0.116	1.440	6.230		4.390	1.440	1.160	0.705	0.283	0.283	0.180	0.200
30	0.114	0.864	2.550		4.110	1.420	1.120	0.679	0.315	0.283	0.165	0.185
31		0.680	5.660		3.260		1.090		0.310	0.283		0.877
Mean	0.102	0.753	5.417	17.083	3.634	1.596	1.159	0.753	0.392	0.309	0.171	0.305
Max.	0.116	1.870	12.700	107.000	5.240	2.320	1.190	0.803	0.523	0.340	0.185	0.877

Data source : Department of water

Note : Daily discharge data are not available in followig months ; December, January, February, March, April and August in 1/5 drought year year estimated. Instead of those data we used daily data in 1965/66 year which it is second nearrest for 1/5 drought year and runoff pattern alomost same as drought year catimated.

: Horizontal line on data shows that data were omitted from calculations for 10-days average discharge .

Table 2.4.9 10-DAYS DISCHARGE OF THE RELEVANT RIVERS IN 1969/70

1.Nadzipule river(for the Lower Nadzipule project)

(Unit:m3/sec)

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1st 10-day	0.270	1.485	6.696	15.288	4.187	2.274	1.794	1.092	0.705	0.541	0.360	0.297
2nd 10-day	0.325	1.669	6.433	7.839	3.740	3.112	1.589	1.119	0.645	0.538	0.296	0.179
3rd 10-day	0.200	2.530	7.059	5.324	2.890	2.179	1.310	0.864	0.582	0.434	0.246	0.252

Note: above data is combined the discharge of Nadzipule and Nakaingwa river in 1969/70.

2.Namikokwe river(for the upper Namikokwe,the existing Mtandamula and Lower Namikokwe project)

(Unit:m3/sec)

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1st 10-day	0.261	0.339	4.029	9.489	2.550	1.431	0.907	0.557	0.419	0.297	0.166	0.123
2nd 10-day	0.128	1.351	2.663	5.219	2.232	1.599	0.789	0.527	0.373	0.269	0.132	0.085
3rd 10-day	0.217	3.125	6.744	3.048	1.742	1.341	0.667	0.464	0.337	0.232	0.114	0.066

Note: above data is combined the discharge of Namikokwe and Nadzipokwe river in 1969/70.

3.Livulezi river(for Lower Livulezi project)

(Unit:m3/sec)

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1st 10-day	0.165	1.214	1.451	8.686	11.265	2.690	1.294	0.924	0.604	0.501	0.447	0.180
2nd 10-day	0.120	0.287	1.343	10.506	4.800	2.129	1.214	0.841	0.512	0.382	0.233	0.153
3rd 10-day	0.102	0.753	5.417	17.083	3.634	1.596	1.159	0.753	0.392	0.309	0.171	0.305

Table 2.6.1 RECORDED MAXIMUM FLOOD DISCHARGE AT THE GAUGING STAION

Recorded maximum discharge in each year on Nakaingwa river

Year	Date	Discharge (m3/s.)
1958/59	Mar.5	3.00
1959/60	Mar.15	5.96
1960/61	Mar.4	5.54
1961/62	Feb.20	33.20
1962/63	Mar.17	23.60
1963/64		*
1964/65	Feb.20	85.30
1965/66	Feb.1	5.17
1966/67	Feb.2	7.89
1967/68	Jan.27	7.98
1968/69	Jan.23	9.41
1969/70	Feb.3	7.04
1970/71	Feb.19	99.70
1971/72	Mar.25	4.52
1972/73	Jan.29	2.31
1973/74	Mar.28	3.33
1974/75	Mar.8	24.30
1975/76	Mar.5	21.80
1976/77	Mar.3	10.20
1977/78	Mar.21	92.00
1978/79	Feb.26	109.00
1979/80		*
1980/81	Dec.30	38.90
1981/82	Feb.6	7.85
1982/83	Feb.15	12.07
1983/84	Feb.25	3.11
1984/85	Mar.26	8.96

Note:Station closed since in 1985.

Recorded maximum discharge in each year on Nadzipule river

Year	Date	Discharge (m3/s.)
1958/59	Feb.22	25.00
1959/60	Jan.5	32.40
1960/61	Mar.4	64.60
1961/62	Dec.17	21.00
1962/63	Mar.17	51.50
1963/64	Feb.9	31.40
1964/65	Feb.20	40.20
1965/66	Feb.19	21.80
1966/67	Mar.20	81.60
1967/68	Jan.28	91.70
1968/69	Jan.30	42.40
1969/70	Dec.19	25.80
1970/71	Dec.7	21.50
1971/72	Jan.16	59.30
1972/73	Dec.6	34.30
1973/74	Feb.2	69.80
1974/75	Mar.10	17.80
1975/76		*
1976/77		*
1977/78	Mar.11	87.80
1978/79	Feb.27	33.90
1979/80	Apr.16	35.60
1980/81	Mar.4	52.90
1981/82	Jan.8	41.24
1982/83	Mar.11	21.53
1983/84	Feb.21	29.46
1984/85	Dec.27	29.78
1985/86	Jan.13	32.87
1986/87	Mar.10	30.21
1987/88	Feb.9	26.28
1988/89	Feb.4	39.87
1989/90	Jan.2	28.47
1990/91	Jan.11	16.28

Recored maximum discharge in each year on Nadzipokwe river

Year	Date	Discharge (m3/s.)
1958/59	Feb.22	5.55
1959/60	Mar.14	4.16
1960/61	Mar.4	33.90
1961/62	Feb.19	6.96
1962/63	Feb.9	8.64
1963/64	Feb.15	5.46
1964/65	Feb.21	8.08
1965/66	Feb.3	3.39
1966/67	Feb.2	5.97
1967/68	Mar.12	17.50
1968/69	Jan.29	29.00
1969/70	Dec.25	48.40
1970/71	Dec.28	26.00
1971/72	Apr.15	1.84
1972/73	Apr.9	6.86
1973/74	Jan.31	9.33
1974/75	Mar.1	22.40
1975/76	Jan.11	14.90
1976/77	Mar.2	7.07
1977/78		*
1978/79		*
1979/80	Dec.24	7.00
1980/81	Mar.4	51.80
1981/82	Feb.6	80.50
1982/83	Feb.12	8.66
1983/84	Dec.24	16.68
1984/85	Jan.31	12.64
1985/86	Dec.14	13.18
1986/87	Jan.18	12.52
1987/88	Jan.24	14.58
1988/89	Jan.8	47.39
1989/90		
1990/91	Jan.18	7.08

Recorded maximum discharge in each year on Namikokwe river (Mua Livulezi)

Year	Date	Discharge (m3/s.)
1969/70	Jan.29	13.65
1980/81	Dec.28	41.00
1981/82	Feb.7	130.16
1982/83	Feb.14	65.70
1983/84	Dec.24	*
1984/85	Feb.8	15.84
1985/86	Dec.24	117.13
1986/87	Feb.14	31.40
1987/88	Jan.25	79.02
1988/89	Jan.30	89.01
1989/90	Dec.30	44.04
1990/91	Dec.9	22.08

Note: Daily discharge data is not available before in 1980,except in 1969/70.

Recorded maximum discharge in each year on Livulezi river

Year	Date	Discharge (m3/s.)
1958/59	Dec.12	37.30
1959/60	Mar.14	17.80
1960/61	Mar.10	59.80
1961/62	Feb.20	133.00
1962/63	Feb.10	113.00
1963/64	Jan.4	68.00
1964/65	Feb.23	147.00
1965/66	Feb.24	107.00
1966/67	Jan.2	72.20
1967/68	Jan.23	33.50
1968/69	Mar.6	32.40
1969/70	Jan.28	145.00
1970/71	Jan.28	111.00
1971/72	Feb.28	61.00
1972/73	Dec.25	30.10
1973/74	Mar.20	58.40
1974/75	Mar.1	79.00
1975/76		*
1976/77	Jan.24	47.00
1977/78		*
1978/79	Dec.21	54.10
1979/80	Dec.13	74.00
1980/81	Dec.25	76.00
1981/82	Jan.26	105.00
1982/83	Feb.12	101.16
1983/84	Feb.9	118.00
1984/85	Dec.19	176.66
1985/86	Jan.26	371.98
1986/87	Mar.25	37.37
1987/88	Feb.9	34.18
1988/89	Jan.29	26.64
1989/90	Jan.2	28.23
1990/91		*

Remarks : * is data gap.

Table 2.6.2 PEAK FLOOD ESTIMATION BY PIKE'S FORMULA AND COEFFICIENTS

Name of River	Drainage area (km2)	Return period T year	C	Peak Flood Discharge Q(T)(m3/sec)	Remarks
Nakaingwa	63.4	5	11.02	87.7	
		10	13.23	105.3	
		25	16.89	134.5	
		30	-	-	
		50	21.11	168.1	
Nadzipule	224.0	5	11.02	164.9	
		10	13.23	198.0	
		25	16.89	252.8	
		30	-	-	
		50	21.11	315.9	
	287.4	5	11.02	186.8	In case of cathment area
		10	13.23	224.3	combined to Nakaingwa
		25	16.89	286.3	and Nadzipule rivers.
		30	-	-	
		50	21.11	357.9	
Nadzipokwe	30.1	5	11.02	60.5	
		10	13.23	72.6	
		25	16.89	92.7	
		30	-	-	
		50	21.11	115.8	
Namikokwe	129.0	5	11.02	125.2	
		10	13.23	150.3	
		25	16.89	191.8	
		30	-	-	
		50	21.11	239.8	
	159.1	5	11.02	139.0	In case of cathment area
		10	13.23	166.9	combined to Nadzipokwe
		25	16.89	213.0	and Namikokwe rivers.
		30	-	-	
		50	21.11	266.3	
Livulezi	452.0	5	11.02	234.3	
		10	13.23	281.3	
		25	16.89	359.1	
		30	-	-	
		50	21.11	448.8	

Source : Flood frequencies in Malawi ,a basis for Design by E.Z.Laisi
Water Resources Branch,Ministry of Works & Supplies

Pike's equation and Coefficients

$Q=C \times A^{n}$ $n=0.5$

The value of C for each of three catchment types for various flood frequencies is shown by Pike.

Table 2.6.3 PEAK FLOOD ESTIMATION BY DRAYTON ET AL EQUATIONS

Name of River	Drainage area (km2)	Return period T year	No. of junction counted	STMFRQ	MAF	Peak Flood Discharge Q(T) (m3/sec)	Remarks
Nakaingwa	63.4	5	165	2.60	39.96	56.4	
		10				74.4	
		25				100.9	
		30				106.5	
		50				123.4	
Nadzipule	224.0	5	463	2.07	73.63	103.9	
		10				137.2	
		25				185.8	
		30				196.3	
		50				227.4	
	287.4	5	628	2.19	86.15	121.6	In case of cathment area
		10				160.5	combined to Nakaingwa
		25				217.5	and Nadzipule rivers.
		30				229.7	
		50				266.1	
Nadzipokwe	30.1	5	53	1.76	23.04	32.5	
		10				42.9	
		25				58.2	
		30				61.4	
		50				71.2	
Namikokwe	129.0	5	365	2.83	60.86	85.9	
		10				113.4	
		25				153.6	
		30				162.3	
		50				188.0	
	159.1	5	418	2.63	66.50	93.9	In case of cathment area
		10				123.9	combined to Nadzipokwe
		25				167.9	and Namikokwe rivers.
		30				177.3	
		50				205.4	
Livulezi	452.0	5	1266	2.80	120.85	170.6	
		10				225.1	
		25				305.0	
		30				322.3	
		50				373.2	

Source : A regional analysis of river floods and low flows in Malawi,by R.S. Drayton,C.H.R. Kidd, A.N. Mandeville and J.B. Miller
Water Resources Branch, Department of Lands,Valuation and Water Office of the President and Cabinet

$MAF = 2.89 \times Area^{0.55} \times STMFRQ^{0.36}$

$Q(T)/MAF = -1.92 + 2.58x(T-0.5)^{0.17}$

MAF : the arithmetic mean of the annual floods.
STMFRQ : stream frequency variable is in junctions/km2

Table 2.6.4 PEAK FLOOD ESTIMATION BY LAISI'S FLOOD EQUATION

Name of River	Drainage area (km2)	Return period T year	Peak Flood Discharge (m3/sec)	Remarks
Nakaingwa	63.4	5	63.9	
		10	97.0	
		25	150.9	
		30	163.2	
		50	200.9	
Nadzipule	224.0	5	99.4	
		10	150.9	
		25	234.7	
		30	253.9	
		50	312.6	
	287.4	5	108.4	In case of cathment area
		10	164.7	combined to Nakaingwa
		25	256.1	and Nadzipule rivers.
		30	277.0	
		50	341.1	
Nadzipokwe	30.1	5	49.2	
		10	74.8	
		25	116.3	
		30	125.8	
		50	154.8	
Namikokwe	129.0	5	81.9	
		10	124.4	
		25	193.5	
		30	209.3	
		50	257.7	
	159.1	5	88.1	In case of cathment area
		10	133.9	combined to Nadzipokwe
		25	208.2	and Namikokwe rivers.
		30	225.2	
		50	277.3	
Livulezi	452.0	5	127.0	
		10	192.9	
		25	300.1	
		30	324.6	
		50	399.6	

Source : Flood frequencies in Malawi ,a basis for Design by E.Z.Laisi
Water Resources Branch,Ministry of Works & Supplies

Regional flood equation

Q(m3/sec)=((T/2.774) x10^(-6))^0.256-25) x Area^0.35

Table 2.6.5 PEAK DISCHARGE CALUCULATED USING AVAILABLE *FLOOD FORMULA FOR MALAWI*

(Unit: m3/sec)

Name of River	Drainage area(km2)	Return Period	Pike's formula	Drayton's equation	Laisi's equation	Remarks
Nakaingwa	63.4	5	87.7	56.4	63.9	
		10	105.3	74.4	97.0	
		25	134.5	100.9	150.9	
		30	-	106.5	163.2	
		50	168.1	123.4	200.9	
Nadzipule	224.0	5	164.9	103.9	99.4	
		10	198.0	137.2	150.9	
		25	252.8	185.8	234.7	
		30	-	196.3	253.9	
		50	315.9	227.4	312.6	
	287.4	5	186.8	121.6	108.4	
		10	224.3	160.5	164.7	In case of catchment
		25	286.3	217.5	256.1	area combined to
		30	-	229.7	277.0	Nakaingwa and
		50	357.9	266.1	341.1	Nadzipule rivers.
Nadzipokwe	30.1	5	60.5	32.5	49.2	
		10	72.6	42.9	74.8	
		25	92.7	58.2	116.3	
		30	-	61.4	125.8	
		50	115.8	71.2	154.8	
Namikokwe	129.0	5	125.2	85.9	81.9	
		10	150.3	113.4	124.4	
		25	191.8	153.6	193.5	
		30	-	162.3	209.3	
		50	239.8	188.0	257.7	
	159.1	5	139.0	93.9	88.1	
		10	166.9	123.9	133.9	In case of catchment
		25	213.0	167.9	208.2	area combined to
		30	-	177.3	225.2	Nadzipokwe and
		50	266.3	205.4	277.3	Namikokwe rivers.
Livulezi	452.0	5	234.3	170.6	127.0	
		10	281.3	225.1	192.9	
		25	359.1	305.0	300.1	
		30	-	322.3	324.6	
		50	448.8	373.2	399.6	

Table 2.7.1 RESULTS ON WATER QUALITY ANALYSIS

River : Nadzipule

Labo No. 109 Sample ID. : NADZIPU
Date of test 18-Jun-93
Date of sampling 21-May-93
Sampling Place: Salima-Balaka Road,Dedza

	mg/l	me/l		
Carbonate	0.00	0.00	pH	7.07
Bicarbonate	83.00	1.36	EC	105
Chloride	6.00	0.17	Cpmputed EC	141
sulphate	0.00	0.00	TDS	60
Nitrate	0.00	0.00	Computed TDS	75
Fluoride	0.00	0.00	Ionic Balance%	3.87
		1.530		
Sodium	11.00	0.48	Silica	1.0
Potassium	1.00	0.03	Suspended Solids	78
Calcium	9.60	0.48	Turbidity(NTU)	17
Magnesium	4.90	0.40		
Iron	0.81	0.03	Hardness(CaCO3)	45
Manganese	0.00	0.00	Alkalinity(CACO3)	68
		1.420		
			Analyst	AMB
			Missing Data	(-9)

River : Namikokwe

Labo No. 111 Sample ID. : NAMINKH
Date of test 18-Jun-93
Date of sampling 21-May-93
Sampling Place: Salima-Balaka Road,Dedza

	mg/l	me/l		
Carbonate	0.00	0.00	pH	6.52
Bicarbonate	95.00	1.56	EC	160
Chloride	5.00	0.14	Cpmputed EC	168
sulphate	0.40	0.01	TDS	94
Nitrate	0.00	0.00	Computed TDS	92
Fluoride	0.00	0.00	Ionic Balance%	-2.32
		1.710		
Sodium	25.00	1.09	Silica	1.0
Potassium	2.90	0.07	Suspended Solids	42
Calcium	9.60	0.48	Turbidity(NTU)	25
Magnesium	1.50	0.12		
Iron	0.65	0.02	Hardness(CaCO3)	31
Manganese	0.00	0.00	Alkalinity(CACO3)	77
		1.790		
			Analyst	AMB
			Missing Data	(-9)

River : Livulezi

Labo No. 108 Sample ID. : LIVULEZ
Date of test 18-Jun-93
Date of sampling 21-May-93
Sampling Place: Salima-Balaka Road,Dedza

	mg/l	me/l		
Carbonate	4.00	0.13	pH	6.94
Bicarbonate	115.00	1.88	EC	225
Chloride	5.00	0.14	Cpmputed EC	232
sulphate	4.50	0.09	TDS	66
Nitrate	4.90	0.08	Computed TDS	121
Fluoride	0.00	0.00	Ionic Balance%	0.03
		2.320		
Sodium	18.00	0.78	Silica	1.0
Potassium	1.70	0.04	Suspended Solids	108
Calcium	18.40	0.92	Turbidity(NTU)	55
Magnesium	6.80	0.56		
Iron	0.73	0.03	Hardness(CaCO3)	75
Manganese	0.00	0.00	Alkalinity(CACO3)	100
		2.330		
			Analyst	AMB
			Missing Data	(-9)

Data source : Laboratory of water department

Table 2.8.1 (1/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Bua Irrigation Scheme
2. Location : 21 km north of Nkhotakota
3. General Features
   (1). Management status : Government support
   (2). Donor : Taiwan (Chainese Agricultural Mission (CAM))
   (3). Project history : 1975 - 1977 ; construction of system,
   1978/79 ; construction of temporary weir with sand and soil (river course was changed)
   (4). Technical assistance : Investigation, study, design, construction supervision, and operation of the scheme by CAM
4. Technical Features
   (1). Water source : The Bua river (gravity water)
   (2). Annual rainfall : 950 mm
   (3). Irrigation area : 200 ha (Original plan: 300 ha),
   - 200 ha ; rainy season,
   - 60 ha ; dry season
   (4). Facilities :
   - Flood protection dike ; L= 5,419 m
   - Main canal ; L= 5,710 m, B=1.0 m, H=1.1 m, (concrete lining, L= 3,440 m)
   - Branch canal ; L= 8,741 m earth canal, B=1.0m, H=1.1 m
   - Field channel ; L= 9,940 m earth canal,
   - Field drain ; L= 30,068 m
   - Collector drain ; L= 14,000 m
   - Other drains ; L= 3,102 m
   - Flood way ; L= 1,682 m ,W=60 m, H=1.5 m
   - Connecting road ; L= 11,097 m, gravel paved,W=7 m
   - Scheme road ; L= 17,470 m, earth road, W= 4 m

   Irrigation canal density : 122 m/ha
   Drainage canal density : 244 m/ha
   Farm road density : 143 m/ha
   (5). Irrigation method :
   - 24 hour- operation with rotation system,
   - field channel with single purpose as irrigation or drain canal,
   - water inlet and outlet provided on each plot
   (6). Construction method : CAM direct management, mainly by manpower (labours and prisoner)
5. Agricultural Features
   (1). Main crop : Rice (IET-4094), Vegetables in 4 ha
   (2). Total house hold : 318, avarage size of a household 0.4 ha
   (3). Avarage yield : 3,959 kg/ha in paddy (1986/87 - 1992/93)
   5 ton/ha in demonstration farm by applying 400 kg/ha of DAP
6. Operation and Maintenance
   (1). Major maintenance work
   :
   - desilting of intake structure, canals
   - construction of temporary diversion weir (end of May)

   (2). Maintenance :
   - 25 person/ day (prisoner)
   - US$ 10,000/ year for desilting of intake structure and construction of temporary weir

   (3). Organization : Scheme committee
7. Observation
   (1). The scheme is well operated at field level.
   (2). Although sedimentation at intake site and canals has been the main technical constraint, no settling basin is provided.
   (3). No structure for clearing intake front; scoring sluice or flush gate, is provided.
   (4). Branch canals which were designed as unlined canal have been partly lined with concrete or replaced by concrete U-flume. It is to protect canal collapse or to reduce seepage loss of water from canal.
   (5). Badgetary arrangement for operation and maintenance cost is the present main constraint. The scheme is not yet handed over to the Government.
   (6). The scheme is worth to be technically analised for preparing proposed plan and design of the Bwanje Valley Smallholder Irrigation Development Project (the Project) on river treatment, canal design, irrigation system in the certain scale of the scheme, and agronomic points of view.

Table 2.8.1 (2/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Mpamantha Irrigation Scheme
2. Location : 15 km SSE of Nkhotakota
3. General Features
   (1). Management status : Government support
   (2). Donor : UK and Taiwan (Chainese Agricultural Mission)
   - UK on dam construction
   - Taiwan on irrigation facilities
   (3). Project history : 1970 - 1971 ; construction of system
   1990; enhightening dam and new intake
   (4). Technical assistance : Operation by Chainese Agricultural Mission till 1973
4. Technical Features
   (1). Water source : Lake Mdila and the Mbambra river (regulated water)
   (2). Annual rainfall : 1,500 mm
   (3). Irrigation area : 60 ha (potential area 200 ha)
   - 50 % of area owned by private estate
   - 25 % of area cultivated by Malawi Young Pioneer settler farmer
   (4). Facilities : - Reservoir dam, ; L= 671 m, Crest W= 3.05 m, Maxi.H= 2.75 m, side slope 1: 3, Capacity=764,000 m3
   - Gabion intake for taking water from the Mbambara river to Lake Mdila
   - Main canal, earth canal, W= 2.0 m, L=910 m
   - Branch canal ; L= 700 m earth canal,
   - Field channel ; L= 3,000 m earth canal,
   - Field drain ; L= 3,760 m earth canal,
   - Collector drain ; L= 800 m earth canal,
   - Main drain ; L= 590 m earthcanal,
   - Connecting road ; L= 1,410 m,
   - Scheme road ; L= 3,620 m, earth road
   Irrigation canal density : 77 m/ha
   Drainage canal density : 86 m/ha
   Farm road density : 84 m/ha
   (5). Irrigation methd : - 24 hour irrigation with rotation system,
   - field channel with single purpose as irrigation canal or drain,
   - plot by plot irrigation with each water inlet and outlet
   (6). Construction : - CAM direct management (irrigation system)
5. Agricultural Features
   (1). Main crop : Rice (IET), double cropping
   (2). Avarage size per house hold
   : 0.6ha
   (3). Avarage yield : 5,925 kg/ha in paddy (1986/87 - 1992/93)
6. Operation and Maintenance
   (1). Major maintenance work
   : cleaning and reshaping of canals and rehabilitation of structures
   (2). Maintenance cost : K 19,300 at the 1993 price (K322/ha = US$ 75/ ha)
   (3). Organization : Private estate (30 ha) and farmers' committee
7. Observation
   (1). Since the scheme has plenty of rainfall rather than the Project areas and stable water source (Lake Mdila), double cropping is carried out.
   (2). The land leveling was well performed. It causes high yield.
   (3). Main feeder canal has been collapsed. The rehabilitation works on the canal will be required. New intake constructed on the embankment portion of enhightened dam is unstable.
   (4). Private estate locates at upperstream portion of the main feeder canal which is co-used by the scheme. Situation is quite different from that on the Project.

Table 2.8.1 (3/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Lifuwu Irrigation Scheme
2. Location : 12 km north of Senga Bay (SLADD Headoffice)
3. General Features
   (1). Management status : Government support
   (2). Donor : Germany (40 ha), EEC (14 ha)
   (3). Project history : 1974 ; construction of system
   1978 ; reconstruction of pumping station due to rising lake water surface,
   1980 ; construction of laboratory, new office, seed storage,
   1986 ; renewal of pump
   (4). Technical assistance : German technical assistance
4. Technical Features
   (1). Water source : Lake Malawi
   (2). Irrigation area : 54 ha
   - 44 ha ; seed multiplication, initiated in 1975
   - 10 ha ; research
   (3). Facilities : - Pumping station ; Capacity= 2,900 lit. /min. H= 23 m
   - Penstock ; Dia. 300 mm, asbestos cement pipe
   - Main canal (pipeline) ; L= 1,200 m asbestos cement pipe of dia. 300 - 250 mm
   - Lateral (pipeline) ; Dia.200 mm pipe, valve-controlled outlet for each plot with wooden stilling basin
   - Sub surface water drains to main drain
   (4). Irrigation method : - pipeline netwark,
   - 9-12 hour operation,
   - plot by plot irrigation system with valve-controlled inlet,
   (5). Construction method : German direct management (40 ha),
5. Agricultural Features
   (1). Main crop : Rice (IET, Blue Bowet,IRRI)
   (2). Annual seed production : 180 tons
6. Operation and Maintenance
   (1). Major maintenance work : - everydy services on pump
7. Observation
   (1). The scheme is well-operated as the sole seeds supply center in Salima ADD and as the research station.
   (2). Since no field drain is provided, operation of pump is restricted in daytime and drainage of heavy rainfall water has been technical constraints.
   (3). Maintenance of pump; replacement of pump and parts, electricity charge, and rehabilitation of pipeline system has pressed the O & M expenses.
   (4). Water source, intake method, system itself, and irrigation method differ from those of the Project.

Table 2.8.1 (4/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Kasitu Irrigation Scheme
2. Location : 90 km north of Nkhotakota
3. General Features
   (1). Management status : Self-help
   (2). Donor : EEC
   (3). Project history : 1986 ; 1st stage, land reclamation
   1989 ; 2nd stage, construction of flood protection dike and intake structure
   (4). Technical assistance : No technical assistance by donor country
4. Technical Features
   (1). Water source : The Kasitu river (gravity water)
   (2). Annual rainfall : 1,100 - 1,200 mm
   (3). Irrigation area : 60 ha
   (4). Facilities : - Flood protection dike
   - Main canal ; L= 500 m, earth canal
   (5). Irrigation method : - field channels with dual purposes; irrigation canal and drain,
   - plot-to-plot irrigation,
   - 24 hour irrigation with non-scheduled rotation system,
   (6). Construction method : DOI direct management with financial assistance of donor on major construction materials, mainly by manpower,
5. Agricultural Features
   (1). Main crop : Rice (Faya)
   (2). Total house hold : 123, avarage size of a household 0.4 ha
   (3). Avarage yield : 3,021 kg/ha in paddy (1986/87 - 1992/93)
6. Operation and Maintenance
   (1). Major maintenance work
   : canal maintenance
   (2). Organization : Farmers' committee
   (3). Labour input : 700 man-day (123 person x 6 days) per year by farmers
   (4). Dues : K.0.5/ household /year , to the committee
7. Observation
   (1). Since there is a dambo at the upper stream of the Tasitu river, irrigation water is rather stable and the few flood and sedimentation effect exists on the scheme.
   (2). Irrigation facilities are deteriorated. Rehabilitation works on them are required.
   (3). Since land leveling is poor in quality, a plot is divided into small sub-plot by low levees.
   (4). No farm road networks exists. It is hard to access the scheme.
   (5). Scale of the scheme is too small to be refered for planning and design of the facilities in the Project.

Table 2.8.1 (5/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Likowa Irrigation Scheme
2. Location : 22 km south of Nkhotakota
3. General Features
   (1). Management status : Self-help
   (2). Donor : EEC
   (3). Project history : construction, 1992 - present
   (4). Technical assistance : No technical assistance by donor country
4. Technical Features
   (1). Water source : The Likowa river (gravity water)
   (2). Irrigation area : 45 ha (potential 80 ha)
   (4). Facilities : - Free intake
   - Main canal , earth canal with a capacity of 140 lit/sec
   (5). Irrigation method : - field channels with dual purposes; irrigation canal and drain,
   - plot-to-plot irrigation,
   - 24 hour irrigation with non-scheduled rotation system,
   (6). Construction method : DOI direct management with financial assistance of donor on major construction materials, mainly by manpower,
5. Agricultural Features
   (1). Main crop : Rice (Faya) ; summer
   Beans, maize; winter
   (2). Total house hold : 90, avarage size of a household 0.5 ha
   (3). Avarage yield : 2,400 kg/ha in paddy , only one crop harvested since initiation
6. Operation and Maintenance
   (1). Major maintenance work
   : canal maintenance
   (2). Organization : Scheme committee
7. Observation
   (1). Irrigation facilities are still under construction.
   (2). Since land leveling is poor in quality, a plot is divided into small sub-plot by low levees.
   (3). No farm road network exists. It is hard to access the scheme.
   (4). Scale of the scheme is too small to be refered for planning and design of the facilities in the Project.

Table 2.8.1 (6/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Lifuliza Irrigation Scheme
2. Location : 35 km south of Nkhotakota
3. General Features
   (1). Management status : Self-help
   (2). Donor : EEC
   (3). Project history : 1989 - 1990 ; construction of dike and intale weir
   (4). Technical assistance : No technical assistance by donor country
4. Technical Features
   (1). Water source : The Dzumbu river (gravity water)
   (2). Irrigation area : 50 ha (potential 90 ha)
   (4). Facilities : - Flood protection dike,
   - Intake weir of gabion mattress
   - Main canal, earth canal
   (5). Irrigation method : - field channels with dual purposes; irrigation canal and drain,
   - plot-to-plot irrigation,
   - 24 hour irrigation with non-scheduled rotation system,
   (6). Construction method : DOI direct management with financial assistance of donor on major construction materials, mainly by manpower,
5. Agricultural Features
   (1). Main crop : Rice (Faya) in summer season
   (2). Total house hold : 136, avarage size of a household 0.36ha
   (3). Avarage yield : No data available
6. Operation and Maintenance
   (1). Major maintenance work : canal maintenance
   (2). Organization : scheme committee
7. Observation
   (1). Irrigation facilities are still under construction.
   (2). Since land leveling is poor in quality, a plot is divided into small sub-plot by low levees.
   (3). No farm road network exists. It is hard to access the scheme.
   (3). Scale of the scheme is too small to be refered for planning and design of the facilities in the Project.

Table 2.8.1 (7/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Ngolowindo Irrigation Scheme
2. Location : 6 km east of Salima
3. General Features
   (1). Management status : Self-help
   (2). Donor : EEC
   (3). Project history : 1985 - 1988 ; construction of system
   - 1985 ; 6 ha in gross
   - 1988 ; 9 ha in gross
   (4). Technical assistance : British irrigation agronomist
4. Technical Features
   (1). Water source : Ground water (by electric pump)
   (2). Irrigation area : 14.2 ha
   - 14 ha allocated to farmers
   - 0.1 ha for women's club
   - 0.1 ha for demonstration farm
   (4). Facilities : - Submerged pump and pumping station
   - Capacity; 20 lit./ sec. (actual, 16 lit./sec.), Head= 70 m
   - Pipe line (pumping station to Storage tank),L= 300 m
   - Concrete storage tank, circle shape of 10 m dia.
   - Feeder canal with brick lining (covered by mortal)
   - Main canal, earth canal
   (5). Irrigation method : - No diversion structure on feeder canal, portable P.V.C. pipe using for intake syphon (from feeder canal)
   - furrow irrigation,
   - day-time operation with scheduled rotation system, night-time storage
   (6). Construction method : DOI direct management with financial assistance of donor on purchasing of pump, major construction materials, mainly by manpower,
5. Agricultural Features
   (1). Main crop : - Vegetable: cabbage, tomato, onion, etc. in rainy season,
   - Early-matured hybrid maize (90-day) in dry season
   (2). Total household : 140
   (3). Avarage size per house hold : 0.1ha
   (4). Farm input : seeds, chemicals, fertilizer
   (5). Gross income : K 1,500/ year/ avarage household
6. Operation and Maintenance
   (1). Major maintenance work : Pumping station, canal system
   (2). Maintenance cost : K75/year/household (1992/93)
   - K65 for electricity for pump
   - K10 for others
   - K75 is 5 % of annual gross income
   (3). Organization : Scheme committee
7. Observation
   (1). The scheme is operated under well-organized scheme committee.
   (2). Structures are partly damaged. The rehabilitation works will be required.
   (3). Scheduled rotation irrigation could be employed because of scheme scale.
   (4). Replacement of pump and parts and daily maintenance of pump has pressed to O & M expenses.
   (5). Marketing of the products, especially for vegetables, has been the main constraint. No certain route for marketing exist.
   (6). The scheme is not refered to plan and design of the Project. Target crops, water source, and scale of scheme is quite different form the Project.

Table 2.8.1 (8/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Mtandamula Irrigation Scheme
2. Location : 12 km east of Mtakataka (M-5)
3. General Features
   (1). Management status : Self-help
   (2). Donor : EEC
   (3). Project history : 1987 ; construction of system
   (4). Technical assistance : No technical assistance
4. Technical Features
   (1). Water source : The Namikokwe river (Flood water only)
   (2). Annual rainfall : 890 mm
   (3). Irrigation area : 230 ha
   (4). Facilities : - Flood protection dike; L= 1,000 m, Max.H= 1.7 m,
   - Intake gate structure on the food protection dike,
   - Main feeder canal: L=3.0 km, earth canal
   - Field channel; 21 nos, earth canal with asbestos cement pies of Dia.150 mm, 1.2 m long, as inlet (for every 0.3 to 0.6 ha)
   Total L= 12 km
   Irrigation canal density : 65 m/ha
   (5). Irrigation method : - field channels with dual purposes; irrigation canal and drain,
   - plot-to-plot irrigation,
   - 24 hour irrigation with non-scheduled rotation system,
   (6). Construction method : DOI direct management with financial assistance of donor on major construction materials, mainly by manpower,
5. Agricultural Features
   (1). Main crop : Rice (winter season)
   (2). Total household : 472
   (3). Avarage size per house hold : 0.4 ha
   (4). Avarage yield : 2,992 kg/ha in paddy (1986/87 - 1992/93)
6. Operation and Maintenance
   (1). Major maintenance work : - cleaning of sedimentation at intake and main feeder canal,
   - reshaping and rehabilitation of canal embankment
   (2). Organization : Scheme committee
7. Observation
   (1). The scheme is operated under well-organized scheme committee.
   (2). Since the structures are deteriorated, rehabilitation works are urgently required.
   (3). Poor water distribution structures on field channel causes unfair water utilization; upstream plot (near main feeder canal) would be fed by plenty water and the downstream plot had no water.
   (4). Sedimentation at inkake and main feeder canal has forced the farmers to frequent maintenance of facilities.
   (5). The irrigation water is available only in the rainy season; flood water of the Namikokwe. Unstability of water source has been the major constraint.
   (6). Poor quality of land leveling causes rather low crop yield.
   (7). The scheme should be refered to plan and design of the Project.

Table 2.8.1 (9/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Mwalawoyera Irrigation Scheme
2. Location : 6 km south of Bwanje RDP office (Bwanje Valley)
3. General Features
   (1). Management status : Self-help
   (2). Donor : EEC
   (3). Project history : 1990 - 1992 ; construction of system
   (4). Technical assistance : No technical assistance
4. Technical Features
   (1). Water source : The Bwanje river
   (2). Irrigation area : 120 ha
   (4). Facilities : - Intake weir of gabion mattress
   - Main canal, earth canal with a capacity of 0.36 m3/sec.
5. Agricultural Features
   (1). Main crop : Rice (Faya); rainy season (120 ha)
   Maize, tomato, vegetable: dry season (6 ha)
   (2). Total household : 198
   (3). Avarage size per house hold
   : 0.6 ha
   (4). Average yield : 2.3 ton/ha in paddy
   (5). Irrigation method : - field channels with dual purposes; irrigation canal and drain,
   - plot-to-plot irrigation,
   - 24 hour irrigation with non-scheduled rotation system,
   (6). Construction method : DOI direct management with financial assistance of donor on major construction materials, mainly by manpower,
6. Operation and Maintenance
   (1). Major maintenance work
   : - everydy services on pump
7. Observation
   (1). The operation of scheme is just initiated .
   (2). Poor quality of land leveling will cause low crop yield.
   (3). The scheme will not be refered to plan and design of the Project.

Table 2.8.1 (10/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Mnema Irrigation Scheme
2. Location : 10 km north-east of Nkhotakota
3. General Features
   (1). Management status : Self-help
   (2). Donor : Germany
   (3). Project history : 1973 ; construction of simple gabion weir,
   1973/74 ; the weir washed out by floods,
   1974 ; construction of new weir (for 108 ha) and flood protection dike,
   1975 ; construction of irrigation system,
   1976 ; weir covered by sediment 0.9 m in depth,
   1981 ; The scheme was abandoned.
   (4). Technical assistance : German technical assistance
4. Technical Features
   (1). Water source : The Limpimbi river
   (2). Irrigation area : 200 ha (original plan)
   no irrigation activity at present (rainfed rice, 80 - 100 ha)
   (3`). Facilities : - Flood protection dike ; H=4 m above original river bed L= 2.2 km
   - Intake structure (1974) ; a conduit of 10 m long under protection dike, single mannual gate provided
   - Main canal ; unlined canal (completely collapsed at present)
5. Agricultural Features
   (1). Main crop : Rice (Faya)
   (2). Total household : 575 at the time of initiation of the project
   (3). Avarage size per household
   : 0.4 ha at the time of initiation of the project
   (4). Avarage yield : 3 - 4.0 ton/ha in the initial year,
   0.5 ton/ha in 1991/92, 1.5 ton/ha in 1992/93 (rainfed rice)
6. Operation and Maintenance
   (1). Major maintenance work
   : - desilting of intake and canals
   (2). Mintenance : - removal of sand sediment of 870 m3 over 238 long canal (1974/75)
   - 14 labours/ day were required for clearing sand in canals.
7. Observation
   (1). Although the siltation at intake and in canals has been the major constraint for the scheme, no structure for protecting the scheme from the sedimentation is provided; a settling basin in the canal, a scoring sluice on the intake weir.
   (2). Unstability of stream course of the Limpimbi river is the main reason for consequent abandonment of the scheme.
   (3). Frequent flood damages on the scheme show the check points on planning and designing of the Project;
   - location, shape, dimention, and construction materials of flood protection dike,
   - location of intake structure,
   - necessity of measures for preventing from the siltation at the intake and canals,
   (4). The plan and design of the scheme should be discussed in planning and designing of the Project.

Table 2.8.1 (11/11) INSPECTION OF EXISTING IRRIGATION SCHEME IN SALIMA ADD

1. Name of Scheme : Thiwi Irrigation Scheme
2. Location : 17 km west of Nkhotakota
3. General Features
   (1). Management status : Government support
   (2). Donor : U.K.
   (3). Project history : 1969 - 1972 ; construction of irrigation system
   1971 ; construction of a dam
   1992 ; construction of flood protection dike
   1974/75 ; main canal washed out by floods,
   1975/76 ; construction of pipeline as main canal,
   A part of the pipeline was flushed away by flood, then the irrigation area was reduced.
   1979 ; Since floods overtopped the dike and the scheme was burried by sand, 0.5 m in depth, the scheme was abandoned.
   (4). Technical assistance : British technical assistance
4. Technical Features
   (1). Water source : The Kaombe river, Chilingari reservoir (regulated water)
   (2). Irrigation area : 250 ha (original plan), 60 ha since 1976,
   no irrigation activity at present
   (3). Facilities : - Storage dam ; L= 152.5m, Crest W= 4.3 m
   Max.H= 6.1 m Side slope=1:3,
   Capacity= 12,300,000 m3
   - Main canal (1975/76) ; Concrete pipe, L= 3,250 m
   - Branch canal ; B= 0.6 m, L= 1,646 m
   - Field channel ; B= 0.3 m, L= 6,765 m
   - Field drain ; B= 0.3 m, L= 6,765 m
   - Other drains ; L= 5,900 m
   - Flood protection dike
   - Access road ; B= 5.0 m, L= 2,445 m
   B= 3.0 m, L= 2,095 m
   irrigation canal density : 58 m/ha
   drainage canal density : 63 m/ha
   road density : 22 m/ha
   (5). Construction method : heavy equipment and manpower
5. Agricultural Features
   (1). Main crop : Rice
6. Operation and Maintenance: No data available
7. Observation
   (1). The flood damages were main reason for consequent abandonment of the scheme.
   (2). The scheme is completely deteriorated.

TABLE 2.9.1 LIST OF EXISTING INFRASTRUCTURES

(unit:number)

Name of Project	Name of village	Number of household	Name of EPA	Number of boreholes		Number of wells		Post office	Health centre	School	ADMARC's market branch	Local market	Maize mill	Rice mill	Chemical shop	Kiosuku
				functioned	no-functioned	functioned	no-functioned									
(1) Lower Nadzipule project	Chikomba	61	Mtakataka	0	1	0	0	0	0	0	0	0	0	0	0	0
	Mgawi	62	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Njoka	23	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chiude	48	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kasakala	84	Mtakataka	0	1	0	0	0	0	0	0	0	0	0	0	1
	Kadzakalowa	46	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dungeya	55	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mayola	44	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chinseu	30	Mtakataka	0	0	0	0	0	0	0	0	1	0	0	0	1
	Chingwandali	81	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
sub-total	10	534		0	2	0	0		0	0	0	1	0	0	0	2
(2) Mtandamula and Lower Namikokwe project	Nkondoline	100	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mbangali	67	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Garuanenenji	118	Mtakataka	1	0	0	0	0	0	0	0	0	0	0	0	0
	Dziko	150	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chatewa	102	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	1
	Bwanamakowa	45	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mtembanji	136	Mtakataka	1	0	0	0	0	0	1	1	1	0	0	0	4
	Mwasinja	136	Mtakataka	1	0	0	0	0	0	0	0	0	1	0	0	1
sub-total	8	854		3	0	0	0	0	0	1	1	1	1	0	0	6
(3)Upper Namikokwe project	Maiwaza	146	Mtakataka	1	0	0	0	0	0	0	0	0	0	0	0	1
	Mlongoti	156	Mtakataka	1	0	1	1	0	0	0	0	0	0	0	0	2
	Khoswe	48	Mtakataka	0	1	0	0	0	0	0	0	0	0	0	0	0
	Michembo	43	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	M'chanja	168	Mtakataka	0	0	0	0	0	0	1	0	1	1	0	0	2
	Mdulambale	85	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ndongwe	56	Mtakataka	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fole	117	Mtakataka	1	0	0	0	0	0	0	0	0	0	0	0	1
	Madziasatsi	128	Mtakataka	1	0	0	0	0	0	0	0	0	0	0	0	1
sub-total	9	947		4	1	1	1	0	0	1	0	1	1	0	0	7
(4) Lower Livulezi project	Josofati	67	Golomoti	1	0	0	0	1	0	1	1	1	0	0	0	1
	Sitolo 2	77	Golomoti	1	0	1	0	0	0	0	0	0	0	0	0	0
	Msuka	26	Golomoti	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chagunda 3	64	Golomoti	0	0	1	0	0	0	0	0	0	0	0	0	0
	Mkalira	175	Golomoti	1	0	0	0	0	0	1	1	0	0	0	0	1
	Chagunda 1	81	Golomoti	0	1	0	0	0	0	0	0	1	0	0	0	1
	Kadiwa	31	Golomoti	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ndindi	335	Golomoti	2	0	1	0	0	1	1	0	1	0	0	0	1
	Dzindebvu	27	Golomoti	0	0	0	0	0	0	0	0	0	0	0	0	0
	Leza	88	Golomoti	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chikoleza	91	Golomoti	0	0	0	0	0	0	0	0	1	0	0	0	1
	Chatha	23	Golomoti	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sitole 1	173	Golomoti	1	0	0	0	0	0	1	0	1	0	0	0	1
	Chagunda 2	58	Golomoti	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kabulika 2	147	Golomoti	1	0	0	0	0	0	0	0	0	1	0	0	1
sub-total	15	1463		6	1	3	0	1	1	4	2	5	1	0	0	7
Total	42	3798		13	4	4	1	1	1	6	3	8	3	0	0	22
density/1000 household				3.42	1.05	1.05	0.26	0.26	0.26	1.58	0.79	2.11	0.79	0.00	0.00	5.79

Table 2.9.2 CONDITIONS OF EXISTING MAIZE MILLS IN AND AROUND THE PROJECT AREAS

	Item	Unit	Maize mill(1)	Maize mill(2)	Maize mill(3)	Maize mill(4)
1.	TA		Kachindamoto	Kachindamoto	Kachindamoto	Kachindamoto
2.	name of village		Mkhalira	Mwasinja	Mchanja	Kabulika II
3.	name of owner		Mr. Chiyanzu	Mr. Ziligone	Mr. Paulo	Mr. A.Kabulika
4.	year of purchase		1993	1989		
5.	purchased cost	Kwacha	57000			
6.	name of manufacture		Lister	Lister	Lister	Ruston
7.	country made in		England	England	England	India
8.	milling capacity	Kg/hrs	1100	360	540	360
9.	engine	HP	45	27	31	23.5
10.	RPM	no/min	2000	2000	2000	1800
11.	consumption of fuel	Lit/hr				
12.	operation month		throughout year	throughout year	throughout year	throughout year
13.	condition of machine		good	good	good	good
14.	name of dealer for sparepart supply		Brown/Clapton company			
15.	milling charge	Kwacha/20Kg	1.5	1.5	2	2

Table 2.10.1 PRESENT LAND USE CONDITIONS OF THE PROJECT AREAS

Unit: ha

Land Use Category	Upper Namikokwe	Mtandamula Scheme	Lower Namikokwe	Livulezi	Nadzipulu	Total
1. Agricultural Land	300	230	110	190	80	910
1.1 Irrigated Rice	0	230	0	0	0	230
1.2 Raifed Rice	150	0	0	190	0	340
1.3 Upland Crops	150	0	110	0	80	340
2. Natural Vegetation and Miscellaneous Land	350	0	180	560	190	1280
Total Area	650	230	290	750	270	2,190
Net Irrigable Area	570	230	160	520	250	1,730

TABEL 2.12.1 AGRICULTURAL CONDITIONS OF THE PROJECT AREAS

Item	Lower Nadzipulu		Lower Namikokwe & Mtandamula		Upper Namikokwe		Lower Livulezi		Whole Project Area		
		(%)		(%)		(%)		(%)		(%)	per head
Sample size	23		36		40		61		160		
Family size (person)											
Male	2.22	49%	1.97	48%	1.75	43%	2.52	52%	2.16	49%	
Female	2.3	51%	2.11	52%	2.28	57%	2.34	48%	2.27	51%	
Total	4.52	100%	4.08	100%	4.03	100%	4.86	100%	4.43	100%	
Labour force/family (person)											
Male	1.35	49%	1	46%	0.9	44%	1.23	46%	1.11	45%	
Female	1.43	51%	1.17	54%	1.15	56%	1.53	54%	1.34	55%	
Total	2.78	100%	2.17	100%	2.05	100%	2.76	100%	2.45	100%	
Farm size/farmer (ha)	1.07	100%	1.61	100%	0.95	100%	1.31	100%	1.25		
Total cultivated land (ha)											
Maize	22.3	82%	20.1	40%	20.3	46%	50.4	64%	113	58%	0.71
Rice	1.6	6%	31	59%	10.9	25%	16.7	21%	60.2	31%	0.38
Cotton	0	0%	0	0%	9	20%	8.2	10%	10.6	5%	0.07
Beans/pulses	2.6	10%	1	1%	3.4	8%	0.6	1%	7.6	4%	0.05
Millet/sorghum	0	0%	0	0%	0.2	0.50%	1	1%	1.5	1%	0.01
Groundnuts	0.4	1%	0	0%	0	0%	0.9	1%	1.3	1%	0.01
Seweet potatos	0	0%	0.1	0%	0.2	0.50%	0		1.2	1%	0.01
Cassava	0.2	1%	0	0%	0	0%	0.4	1%	0.6	1%	0.00
Tabacco	0	0%	0	0%	0	0%	0.2	1%	0.2	1%	0.00
sub-total	27.1	100%	52.2	100%	44	100%	78.4	100%	196.2	100%	1.23
Total number of livestock											
Cattle	45	2*	78	2.2	21	0.5	70	1.1	214	1.3*	1.34
Goats	134	5.8	87	2.4	33	0.8	49	0.8	303	1.9	1.89
Sheep	15	0.7	0	0	0	0	0	0	15	0.1	0.09
Pigs	4	0.2	2	0.1	2	0.1	0	0	8	0.1	0.05
Chicken	173	7.5	128	3.6	107	2.7	328	5.4	736	4.6	4.60

*:head/farmer

Data source: the farmer's interview survey conducted by JICA team in 1993

TABLE 2.12.2 FARM BUDGET OF THE TYPICALFARMERS IN THE PROJECT AREA(1991/92)

Item	Average	Maximum*	Minimum*	Sample size
1. Family size	4.30	9.00	1.00	28
2. Cultivated land (ha)				
Lowland	0.36	1.00	0.00	28
Upland	0.83	1.80	0.10	28
Total	1.19			28
3. Sale of products (MK)				
Crops	395	2385	0	28
Livestock	126	1428	0	28
Total	521			28
4. Non-farm income (MK)	184	1332	0	28
5. Total income (MK)	705			28
6. Production cost (MK)	40	182	0	28
7. Non-farm cost (MK)	27	250	0	28
8. Living expenditure (MK)	689	1433	228	28
9. Total outgo (MK)	756			28
10. Balance	-51			28

Data source: the farmer's economic survey conducted by the JICA study team on July, 1993
* : a maximum or a minimum value for each item is the value among the samples

TABLE 2.12.3 FARM BUDGET OF THREE FARMERS IN MTANDAMULA SCHEME

Item	NO.1	NO.2	NO.3
Type of farmers	MHH,draft animals*	MHH**	FHH***,draft animals
Family size	9	4	4
Cultivated land (ha)			
Lowland	4	0	0
Upland	1	1	1
Total	5	1	1
Production (kg)			
Rice	11,920	2,000	1,680
Maize	1,350	1,080	720
Sale of products (MK)			
Rice	11,790	1,925	1,635
Maize	0	315	0
Livestock and poultry	2,149	41	700
Total	13,939	2,281	2,335
Non-farm income (MK)	0	0	0
Total income (MK)	13,939	2,281	2,335
Production cost MK)			
Farming materials	300	67	28
Wage for laborers	5,002	179	42
Farming tools	23	49	21
Total	5,325	294	91
Living expenditure			
Food	1,664	773	1,131
Drinks and cigarette	845	278	9
Sundry goods	231	136	58
Housing	0	0	95
Fuel	173	80	9
Household utensils	4	0	10
Clothing	27	221	90
Footwear	0	87	59
Medical care	216	92	17
School fee	20	0	0
Taxes	27	0	0
Donation	35	17	12
Total	3,241	1,685	1,490
Total outgo (MK)	8,566	1,979	1,581
Balance (MK)	5,373	302	754

*: male headed farmer having draft animals

**: male headed farmer having no draft animals

**: female headed farmer having draft animals

Data source: the farm work survey (keeping a diary) conducted by JICA team in 19

Table 2.12.4 (1/4) THE RESULTS OF HEARING FOR GROUP VILLAGE HEADMEN AND VILLAGE HEADMEN

Item	Lower Nadzipulu project		Lower Namikokwe/Mtandamula		Upper Namikokwe project		Lower Livulezi project	
	Chikomba	Kasakala	Nkondolire	Dziko	Mlongoti	M'chanja	Ndindi	Kabulika 2
1.Organizational structure	Group village h	Group village h	Village headma	Village headma	Village headma	Group village head.	Group village head.	Group village head.
Villages ruled over	8	8	1	1	1	6	7	7
Staff(messenger"Nyakwawa")	2	1	2	2	1	2	2	2
Election and appointment	Hereditary and lifelong after ellection by traditional village comi				Hereditary and lifelong after ellection by traditional village committee			
	"Kabungwe" when village headman changes				"Kabungwe" when village headman changes			
Taxes	3.5 MK per male over 18 years old ,except students. Duty free this year.							
Budget	no	no	no	no	no		no	
Salary	Bonus from CD once a year						Bonus from CD once a year	
2. Present administrative and social constraints								
No drinking water	lack	lack	lack	lack	lack	lack	water short. of bore	lack
No school					lack	lack		
No hospital	lack	lack	lack	lack	lack(11 km)	lack(11 km)		lack
No market					lack	lack		
No good road and bridge	lack	lack			lack	lack		
No maize mill				lack		lack	lack(0 / 7 villages)	lack(1 / 7 villages)
No foodstuff		lack						
No post office			thief at harvest				lack	
Damage of flood and hippo							Serious	
3. Data on village community keeeping by village headman								
1) List for collection of taxes	exist	exist	exist	exist	exist	exist	exist	exist
2) Resident cards of entire villagers	no	no	no	no	no	no	no	no
3) Notice of death and birth	Informed from villager to village headman , and from village he				Informed from villager to village headman , and from village headman			
	to group village headman.				to group village headman.			

Table 2.12.4 (2/4) THE RESULTS OF HEARING FOR GROUP VILLAGE HEADMEN AND VILLAGE HEADMEN

Item	Lower Nadzipulu project		Lower Namikokwe/Mtandamula		Upper Namikokwe project		Lower Livulezi project	
	Chikomba	Kasakala	Nkondolire	Dziko	Mlongoti	M'chanja	Ndindi	Kabulika 2
4) Allocation of lands	The right of cultivated land is inherited. If villager go away from land is inherited by relatives. If cultivation is impossible by short labor, annual mutual trust is made within farmers. Farm rent is free, and farmer ex thanks in kind(maize and rice)		The right of cultivated land is inherited by relatives. If cultivation is impossible by shortage of labor, annual mutual trust is made within farmers. Land Allocation Committee allocates the vacant land. Mutual trusts are reported to Land Allo. Committee.		The right of cultivated land is inherited. If villager go away from village, Farm rent is free, and farmer expresses thanks in kind(maize and rice) Expansion of land is needed agreement with village headman			
4. Organization and function of family								
1) % of matrilineal families	85%	85%	85%	85%	90%	90%	90%	90%
2) Decision-maker in matrilineal family								
a) Property management and inherit	Wife		both		Wife		Wife	
b) Inheritance of land	If wife divorces , the right of cu land is inherited to wife and chil		Land is shared by husband and wife, because the scheme is public land.		If wife dies , the right of cultivated land is inherited to wife and children			
b) Management of cash of farming i	Husband	Husband	Husband	Husband	Both		Both	
c) Actual boss of fundamental decis	Uncles	Uncles	Uncles	Uncles				
d) Share of property in divorce	50 % : 50 %		50 % : 50 %		100 % to wife		Both	
5. Marketing of products								
1) Rice								
a) ADMARC	80%	80%	90%	90%				
b) Private traders	5%	5%	10%	10%				
c) Exchange with maize	15%	15%	0%	0%				
2) Maize								
a) ADMARC	95%	95%	90%	90%				
b) Private traders	5%	5%	10%	10%				

Table 2.12.4 (3/4) THE RESULTS OF HEARING FOR GROUP VILLAGE HEADMEN AND VILLAGE HEADMEN

	Lower Nadzipulu project		Lower Namikokwe/Mtandamula		Upper Namikokwe project		Lower Livulezi project	
Item	*Chikomba*	*Kasakala*	*Nkondolire*	*Dziko*	*Mlongoti*	*M'chanja*	*Ndindi*	*Kabulika 2*
6. Contribution to maintain the social conditions in village								
1) General matters								
a) Road cleaning and repairing	to e) : 7days-2 persons per fami		to e) : 7days-2 persons per fami		1 day	1 day	1 day	1 day
b) School block making (brick)						7 days	1 day	1 day
c) Bus shelter block making (brick)					7 days	1 day	1 day	1 day
d) Cleaning yard of grave					1 day	1 day	1 day	1 day
e) Cleaning yard of borehole								
f) Cutting down the tree for coffin					1 day			
g) Diging shallow well					2 days			
Total					12 days	10 days	4 days	4 days
Penalty	a chickine per day		a chickine per family		a chickine per day,except illness		a chickine per day,except illness	
2) Labor service to irrigation scheme								
Cleaning protection dyke			2 days per year					
Cleaning main canal			2 days per year					
Cleaning 2ndary canal			1 day per month(from Dec. to Mar.)					
Repairing box culvert			1 day per year					
total			10 man-day per year					
7. Illness attacked villagers and medical facilities								
1) The order of importance								
malaria	4	4			1	1	4	1
blood diarrhoea	2	2	3	3	2	2	5	2
bilharzia			4	4	5	5	6	
whooping cough					3	3		6
tuberculosis	3	3						
cholera	1	1	1	1	4	4	4	
headache	5	5			6	6	1	3

Table 2.12.4 (4/4) THE RESULTS OF HEARING FOR GROUP VILLAGE HEADMEN AND VILLAGE HEADMEN

Item	Lower Nadzipulu project		Lower Namikokwe/Mtandamula		Upper Namikokwe project		Lower Livulezi project	
	Chikomba	Kasakala	Nkondolire	Dziko	Mlongoti	M'chanja	Ndindi	Kabulika 2
body pain							3	4
eyeache	6	6						
stomachache							2	
measles			2	2				
pneumonia								5
9. Irrigation system management after implementation of the project								
1) Operation of the system at initial stage								
a) by Salima ADD	yes	yes	yes	yes	yes	yes	yes	yes
b) by Farmer'sassociation								
2) Operation of the system in and after full stage								
a) by Salima ADD								
b) by Farmer'sassociation	yes	yes	yes	yes	yes	yes	yes	yes
3) Contribution of labor for canal rel	yes	yes	yes	yes	yes	yes	yes	yes
4) Collection of water charge (in kinyes, 20% of yielves, 20 % of yiel			yes	yes	yes	yes	yes	yes
10. Construction of irrigation system (farmer's participation to construction)								
1) Contribution of labor force			yes	yes				
2) Contribution of brick			yes	yes				

Data source: the interview survey for 8 group village headmen and village headmen conducted by JICA team in 1993

TABLE 2.12.5 FARM WORKING HOURS FOR RICE CULTIVATION

(1) NO.1 Farmer cultivating a arear of 3.7ha for rice, male headed household, having draft animals

Farm work	Period of farm work		Working hours of each family member												
	First day	Last day	Day*	42M**	39F***	20M	17F	15M	12F	10M	8M	42M	Emp****.	Sum*****	Hours / ha
Ploughing	Sep.	Oct.	30 (0)	8	0	24	4	5	0	0	0	21	456	518	140
Breaking clods	28-Dec.	16-Jan.	13 (4)	33	37	39	23	37	23	9	9	26	63	299	81
Seed bed making & sowing	15-Dec.	16-Jan.	12 (4)	83	75	79	19	12	12	0	0	40	80	400	108
Puddling & transplanting	19-Jan.	25-Mar.	52 (22	332	324	182	158	110	72	42	14	54	1992	3280	886
Weeding	16-Feb.	23-Apr.	42 (6)	257	262	218	173	154	115	56	33	113	898	2279	616
Birds control	23-Apr.	17-Jun.	56 (0)	9	15	0	5	0	0	0	0	0	2201	2230	603
Harvesting & drying	1-Jun.	25.6	21 (1)	47	100	43	74	11	10	10	0	71	369	735	199
Threshing ,winnowing & st	2-Jun.	17-Jul.	36 (1)	203	298	260	221	62	47	34	36	130	241	1532	414
Total				932	1071	805	677	391	279	151	92	455	6300	11273	3047
Ratio (%)				8.3	9.5	7.1	6.0	3.5	2.5	1.3	0.8	4.0	55.9	100.0	

(2) NO.2 Farmer cultivating an area of 0.4 ha for rice, male headed household, having no draft animals

Farm work	Period of farm work		Working hours of each family member					
	First day	Last day	Day*	38M**	28F	Emp		Hours / ha
Ploughing	Sep.	Oct.	25 (0)	150	150	0	300	750
Breaking clods	25.12	28.12	2 (1)	6	5	0	11	28
Seed bed making & sowing	28.12	7.1	5 (1)	16	13	0	29	73
Puddling & transplanting	27.1	25.3	45(14)	203	272	69	544	1360
Weeding	18.1	21.4	38 (4)	225	113	12	350	875
Birds control	23.4	23.6	59 (0)	137	272	0	409	1023
Harvesting & drying	7.6	3.7	19 (0)	187	149	5	341	853
Threshing ,winnowing & st	30.6	22.7	20 (0)	202	183	0	385	963
Total				1126	1157	86	2369	5923
Ratio (%)				47.7	49.0	3.3	100.0	

Data sourc the farm work survey carried out by JICA team in 199

Remarks:

- *: number of working day, ( ) number of rain
- **: 42M : male 42 years old
- ***: 39F: female 39 years old
- ****: Emp: casual labourers employed
- *****: Sum: the total working hours

(3) NO.3 Farmer cultivating an area of 0.4 ha for rice, female headed household, having draft animals

Farm work	Period of farm work		Working hours of each family member							
	First day	Last day	Day*	59F	14M	20M	18F	Emp.	Sum	Hours / ha
Ploughing	Sep.	Oct.	3 (0)	0	24	24	0	0	48	120
Breaking clods	27.12	13.1	11 (3)	40	28	20	24	0	112	280
Seed bed making & sowing	21.12	13.1	11 (3)	37	25	18	22	0	102	255
Puddling & transplanting	26.1	17.2	3 (11)	113	54	39	27	155	388	970
Weeding	8.1	21.4	5 (9)	332	203	157	167	113	972	2430
Birds control	22.4	22.6	61	163	631	0	0	0	794	1985
Harvesting & drying	27.5	22.6	23 (1)	186	0	111	63	0	360	900
Threshing ,winnowing & st	23.6	9.7	14 (0)	119	13	24	0	0	156	390
Total				990	978	393	303	268	2932	7330
Ratio (%)				33.8	33.4	13.4	10.3	9.1	100.0	

TABLE 2.12.6 CONDITIONS OF DRINKING WATER IN THE PROJECT AREAS

Name of project	Source of water	Number of farmers used	Perception of respondent(%)		Quantity of water (buckets*/head/day		Fetching water	
			quality good	quantity enough	present	expected	total time	distance(Km/one way)
Lower Nadzipulu	well	3	0	0	1	1.3	4	0.3
irrigation project	borehole	16	94	44	1.1	1.8	4.8	0.7
	lake & river	4	25	100	1.1	1.8	3.5	1.6
Lower Namikokwe	well	4	25	0	1.3	1.6	2.3	0.5
irrigation project &	borehole	22	96	64	2.8	3.7	6.1	1
Mtandamula scheme	lake & river	9	0	100	0.8	1.1	3.2	1
Upper Namikokwe	well	6	83	17	0.7	1.7	2.5	1
irrigation project	borehole	18	72	11	1.2	1.8	4.1	0.7
	lake	7	0	43	0.8	1.7	3.9	1.3
	river	9	0	11	1	1.9	3.2	1.4
lower Livulezi	well	23	65	39	1	1.3	4.4	0.5
project	borehole	23	96	91	1	1.2	4.6	0.3
	lake & river	14	7	93	0.8	1.7	3.7	2.2
Average					1.2	1.8	3.9	1

Data source: the farmer's interview survey performed by JICA team in 1993

*: The volume of one bucket is about 20 litters.

TABLE 2.12.7 CONDITION OF MAIZE MILLS IN THE PROJECT AREAS

Name of project	there is mill in or nearby village	Distance from home to mill (one way,km)	Number of milling times per month	Amount of maize milled per one time	Milling charge (MK / 20 kg)
Lower Nadzipulu	yes	1.3	1.9	44.5	1.6
project	no	4.3	2.4	38.5	1.6
Lower Namikokwe and	yes	3.3	2.3	41.3	1.1
Mtandamula scheme	no	5.1	2.1	33.9	1.5
Upper Namikokwe	yes	1.6	2.2	37.1	1.3
project	no	8.3	2.3	38.8	2.2
Lower Livulezi	yes	2.8	2.1	28.4	2.2
project	no	4.9	1.9	30.6	2.1

Data source: the farmer's interview survey conducted by JICA team in 1993

TABLE 2.13.1 FARM WORKING HOURS FOR MAIZE CULTIVATION

(1) NO.1 Farmer; fame headed household having draft animals,cultivate an area of 1.0 ha with maize

Farm work	Period of farm work			Working hours of each family member (hrs)									
	First day	Last day	Days*	42M**	39F***	20M	17F	15M	12F	10M	8M	42M	Casual labour	total
Cleaning	15-Sep.	19-Sep.	4 (0)	32	32	32	32	32	32	32	32	32	0	288
Ridging	15-Oct.	22-Oct.	7 (0)	56	56	56	56	56	56	56	56	56	0	504
Ridging & sowing	18.1	1.4	8 (1)	54	43	39	39	39	39	39	26	12	0	330
Fertilizer application	18.4	18.4	1 (0)	5	5	5	10	10	9	9	0	0	0	53
Weeding	6.1	13.2	15 (4)	89	93	84	81	57	56	46	24	55	5	590
Harvesting	27.4	22.5	5 (1)	41	41	25	15	7	0	0	0	26	0	155
Total				277	270	241	233	201	192	182	138	181	5	1920
Proportional extent (%)				14.4	14.1	12.6	12.1	10.5	10.0	9.5	7.2	9.4	0.3	100.0

(2) NO.2 Farmer; male headed household having no draft animals, cultivate an area of 1.0 ha with maize

Farm work	Period of farm work			Working hours of each family member (hrs)			
	First day	Last day	Days	38M	28F	Casual labour	total
Cleaning	15-Sep.	20-Sep.	5 (0)	40	40	0	80
Ridging	15-Oct.	29-Sep.	14 (0)	112	112	0	224
Ridging & sowing	17.12	21.12	4 (2)	35	23	0	58
Fertilizer application				0	0	0	0
Weeding	29.12	24.1	19 (5)	112	66	12	190
Harvesting	17.5	26.5	9 (0)	53	40	0	93
Total				352	281	12	645
Proportional extent(%)				54.6	43.6	1.9	100.0

(3) NO.3 Farmer; female headed household having draft animals, cultivate an area of 1 ha with maize

Farm work	Period of farm work			Working hours of each family member (hrs)					
	First day	Last day	Days	59F	14M	20M	18F	Casual labour	total
Cleaning	10-Sep.	24-Sep.	14 (0)	112	112	112	0	0	336
Ridging	5-Oct.	26-Oct.	21 (0)	168	168	168	0	0	504
Ridging & sowing	16.12	24.12	6 (3)	29	26	0	10	0	65
Fertilizer application				0	0	0	0	0	0
Weeding	4.1	29.1	22 (6)	138	115	84	38	23	398
Harvesting	5.5	26.5	19 (0)	132	9	105	16	0	262
Total				579	430	469	64	23	1565
Proportional extent (%)				37.0	27.5	30.0	4.1	1.5	100.0

Data source: the farm work survey conducted by JICA team in 1992/93

Remarks: *: farm working period, ( ) means the number of rainy day

**: 42 M means male 42 years old

***: 39 F means female 39 years old

TABLE 2.13.2 STANDARD WORKING HOURS FOR RICE AND MAIZE CULTIVATION

(1) Rice (0.4 ha)

Farm work	Period of farm work for 0.4 ha			Working hours of each family member (hrs) for 0.4 ha				
	First day	Last day	Days*	38M**	28F***	casual labour	total	Hours / ha
Ploughing	Sep.	Oct.	25 (0)	150	150	0	300	750
Breaking clods	25-Dec.	10-Jan.	8 (3)	47	40	0	87	217
Seed bed making & sowing	28-Dec.	7.1	3 (1)	15	13	0	28	70
Puddling & transplanting	27-Jan.	10-Feb.	5 (2)	31	30	0	61	152
Weeding	18.1	21.4	12 (3)	70	65	0	135	338
Birds control	23.4	23.6	59					
Harvesting & drying	10-Jun.	25-Jun.	8 (0)	45	35	0	80	200
Threshing ,winnowing & storage	20-Jun.	5-Jul.	15 (0)	90	70	0	160	400
total				448	403	0	851	2,127

(2) Maize (1.0 ha)

Farm work	Period of farm work for 1 ha			Working hours of each family member (hrs) for 1 ha				
	First day	Last day	Days	38M	28F	casual labour	total	Hours/ha
Cleaning	Sep.	Oct.	5 (0)	40	40	0	80	80
Ridging	15-Oct.	29-Sep.	14 (0)	112	112	0	224	224
Ridging & sowing	17.12	21.12	4 (2)	35	23	0	58	58
Weeding	29.12	24.1	19 (5)	112	66	12	190	190
Harvesting	17.5	26.5	9 (0)	53	40	0	93	93
total				352	281	12	645	645

Data source: Farm work diaries of 3 farmers,1992/93

Remarks *: working day, ( ) is the number of rainy day

**:38 M means male 38 years old

***: 28F means female 28 years old