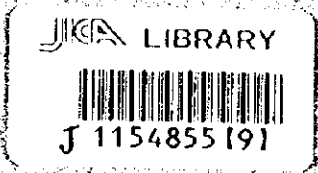


MINISTRY OF AGRICULTURE
AND COOPERATIVES
THE UNITED REPUBLIC OF
TANZANIA

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
MWEGA SMALLHOLDER IRRIGATION SCHEME
IN
MOROGORO REGION
IN
THE UNITED REPUBLIC OF TANZANIA



OCTOBER 1999

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.

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**JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.**



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PREFACE

In response to a request from the Government of the United Republic of Tanzania, the Government of Japan decided to conduct a basic design study on the Project for Mwegu Smallholder Irrigation Scheme in Morogoro Region and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team from March 15 to May 4, 1999.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tanzania in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the teams.

October, 1999



Kimio FUJITA

President
Japan International Cooperation Agency

October, 1999

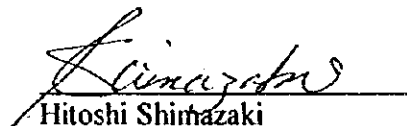
Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Mweha Smallholder Irrigation Scheme in Morogoro Region in the United Republic of Tanzania.

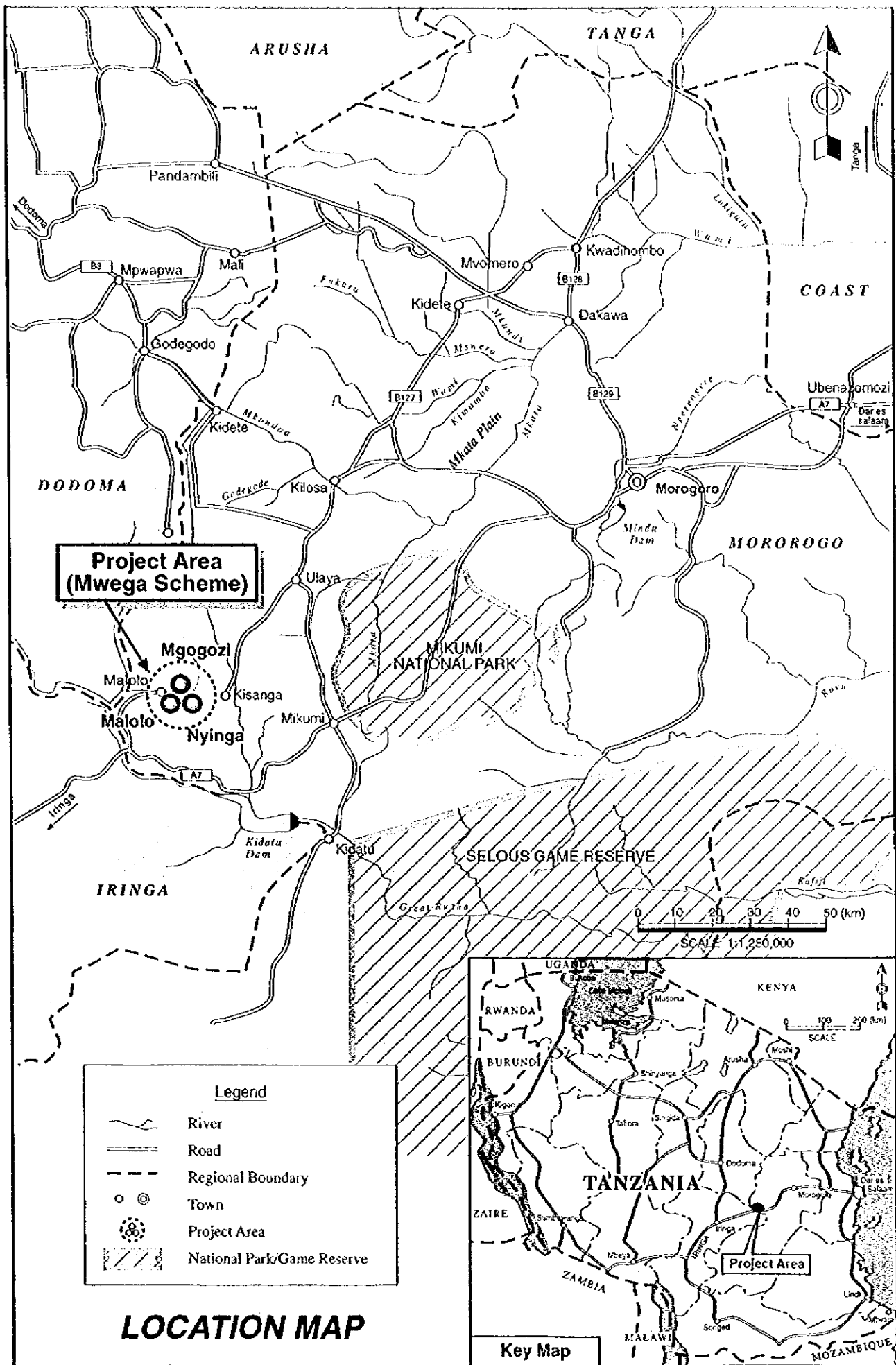
This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from March 10, 1999 to November 22, 1999. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tanzania and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Hitoshi Shimazaki
Project manager,
Basic design study team on the
Project for Mweha Smallholder
Irrigation Scheme in Morogoro
Region in the United Republic of
Tanzania
Nippon Koei Co., Ltd.



**Project Area
(Mweza Scheme)**

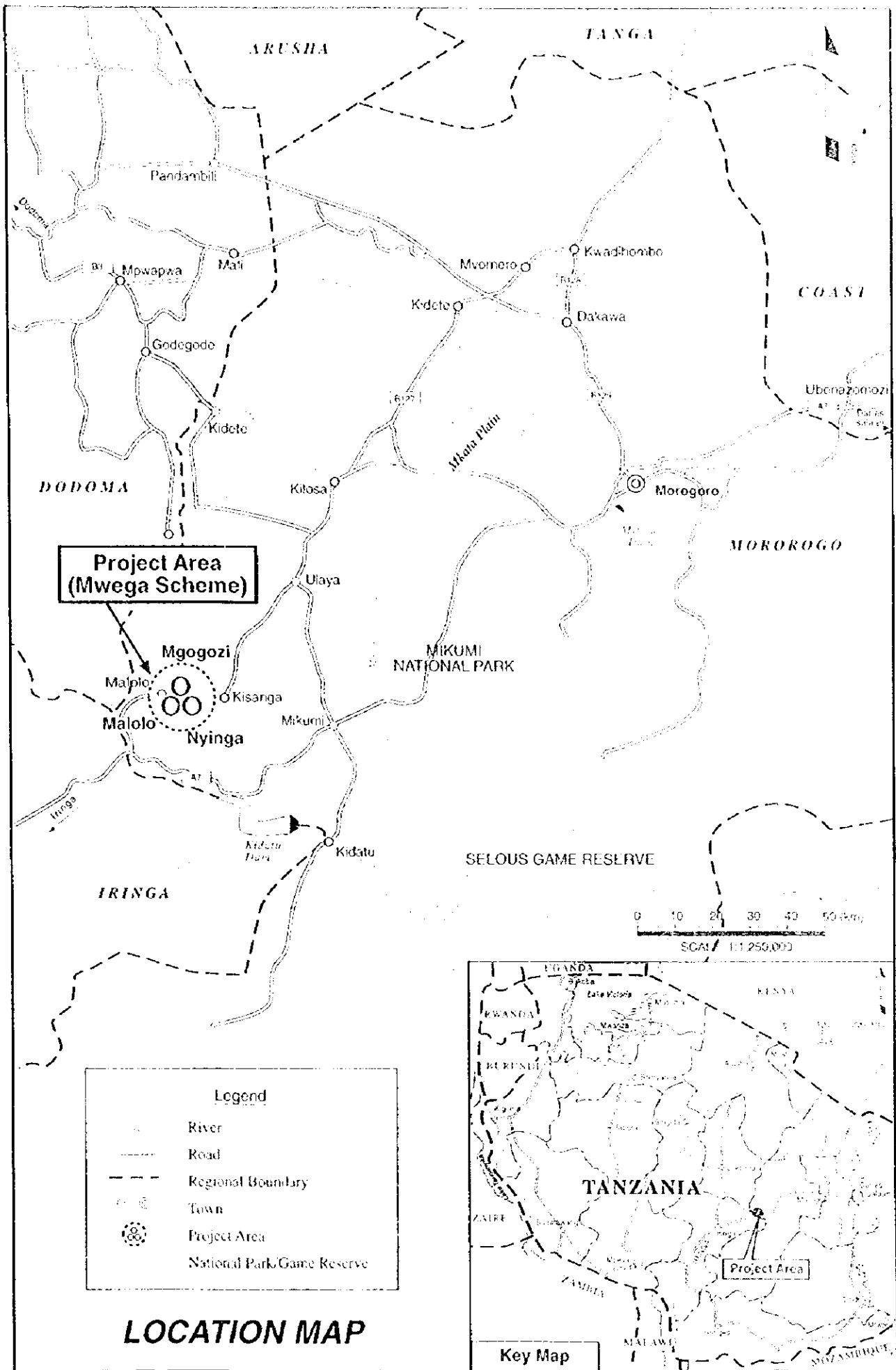
Legend

- River
- Road
- Regional Boundary
- Town
- Project Area
- National Park/Game Reserve

LOCATION MAP



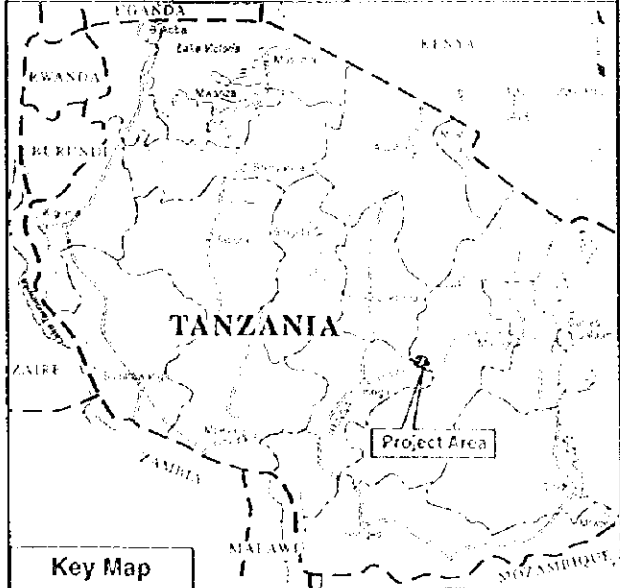
Key Map



**Project Area
(Mwege Scheme)**

Legend	
	River
	Road
	Regional Boundary
	Town
	Project Area
	National Park/Game Reserve

LOCATION MAP



Key Map



PERSPECTIVE

ABBREVIATIONS

ACC	Agricultural Coordinating Committee
CIDA	Canadian International Development Agency
COASCO	Cooperative Audit and Supervision Corporation
DALDO	District Agriculture and Livestock Development Officer
DED	District Executive Director (previously called to as District Development Director: DDD)
DEO	District Extension Officer
DIO	District Irrigation Office
DIVEO	Division Extension Officer
DSI	Development Studies Institute
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GNP	Gross National Product
GOJ	Government of Japan
GOT	Government of the United Republic of Tanzania
GTZ	German Development Agency
IBRD	International Bank for Reconstruction and Development
ID	Irrigation Department of the Ministry of Agriculture and Cooperatives
IDA	International Development Association
IFAD	International Fund for Agricultural Development
JICA	Japan International Cooperation Agency
MOF	Ministry of Finance
MOW	Ministry of Works
NASCO	National Shipping Agency Co., Ltd.
NGO	Non-Governmental Organization
NIDP	National Irrigation Development Plan
RALDO	Regional Agriculture and Livestock Development Officer
RAS	Regional Administrative secretary
RDD	Regional Development Director
REO	Regional extension Officer
RIO	Regional Irrigation Officer
RPFB	Rolling Plan and Forward Budget for Tanzania (1994/95 – 1886/97)
RPO	Regional Planning Officer
SEP	Sokoine Extension Programme
SUA	Sokoine University of Agriculture
TIP	Traditional Irrigation Improvement Project
TOSCA	Tanzania Official Seed Certification Agency
TRA	Tanzanic Revenue Authority
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Scientific and Cultural Organization
VAT	Value Added Tax
VEO	Village Extension Officer
WID	Women in Development
WUG	Water User's Group
WUSG	Water User's Sub-Group
ZIO	Zonal Irrigation Officer

MEASUREMENT UNITS

Length

mm	=	Millimeter
cm	=	Centimeter(cm=10mm)
m	=	Meter(m=100cm)
km	=	Kilometer(km=1,000m)

Area

ha	=	Hectare(10,000 m ²)
m ²	=	Square meter(1.0m x 1.0m)
km ²	=	Square kilometer

Volume

cm ³	=	Cubic-centimeter
l	=	Liter(1dm ³)
l/min	=	Liter per minute
m ³	=	Cubic meter
m ³ /h	=	Cubic meter per hour
m ³ /s	=	Cubic meter per second
m ³ /d	=	Cubic meter per day

Currency

Tsh.	=	Tanzanian shilling
US\$	=	United State dollar

Weight

g	=	Gram
kg	=	Kilogram(1,000g)
t	=	Ton(1,000kg)

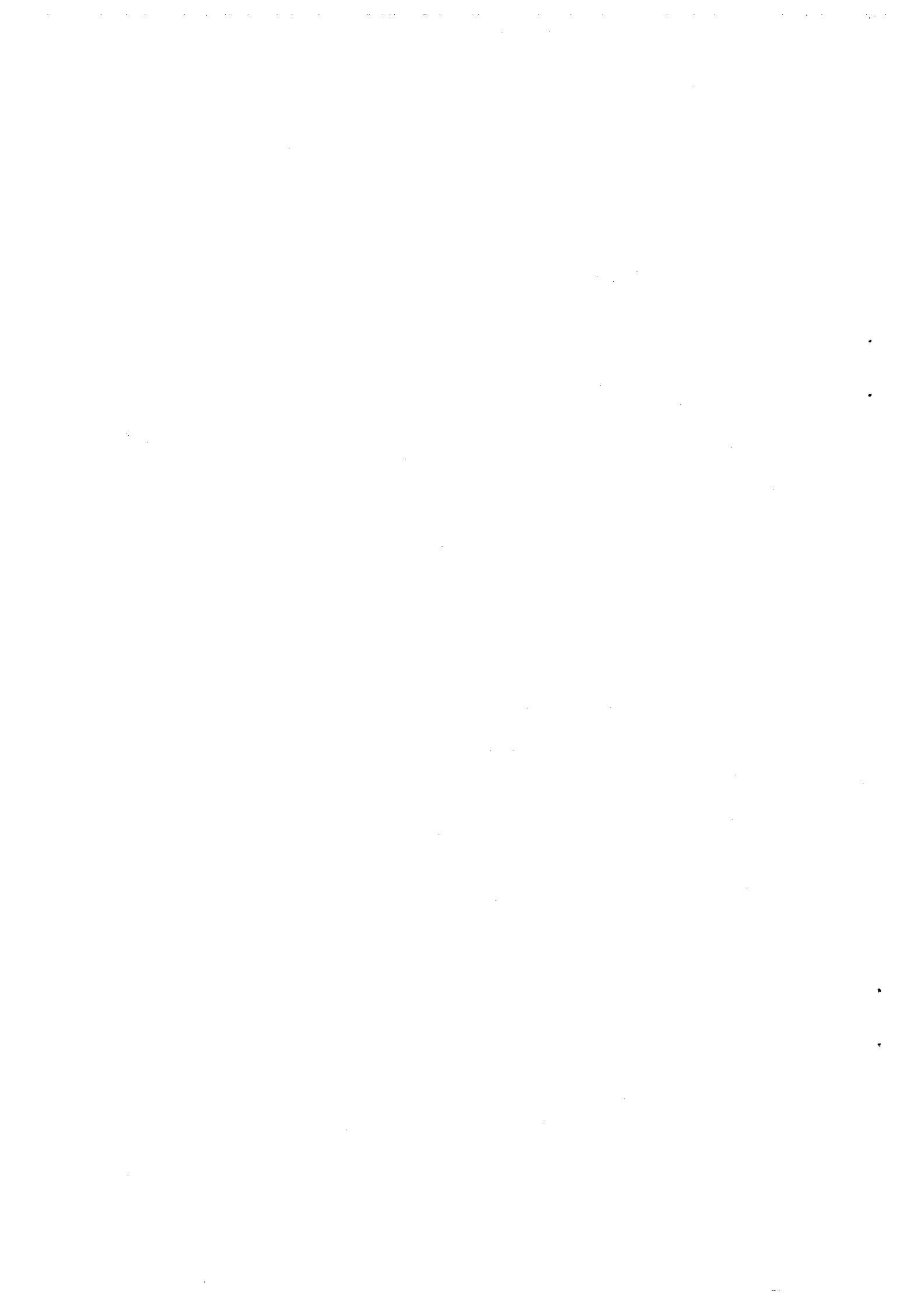
Time

s	=	Second
min	=	Minute(60s)
h	=	Hour(60min.)
d	=	Day

Others

%	=	Percent
°	=	Degree
'	=	Minute
''	=	Second
°C	=	Degree celsius
no.	=	Number

SUMMARY



SUMMARY

Background of the Project

1. Tanzania has an area of 945,200 km² consisting of 943,200 km² in the Mainland and 2,000 km² in Zanzibar and Pemba. The total population was estimated at about 28.8 million as of the end of 1994, of which approximately 23 million or almost 80 % live in the rural area. In the last decade, the population has increased at a high rate of 2.8 % a year. Agriculture is the mainstay of the Tanzania economy. It absorbs almost 84 % of the employed population and generates almost 50 % of the Gross Domestic Products (GDP) and 75 % of the foreign exchange earnings. However, it is mainly traditional and rainfed, and operated by smallholder farmers, so that agricultural production is low and unstable. In 1994, the national food production shortage came to about 435,000 tons of cereal equivalent due to severe drought weather.
2. As a result of this serious food shortage, the Rolling Plan and Forward Budget (1994/95-1996/97) of the Government of Tanzania (GOT) focused on the development of agriculture sector with particular emphasis on activation of smallholder farmers as well as agricultural investigators in the private sector, increased production of the export-oriented economic crops, development of agricultural infrastructure especially for improvement of accessibility to the market, and elimination of primary constraints through structural improvement of the existing traditional irrigation systems. To successfully accomplish this agricultural development, the Ministry of Agriculture and Cooperatives (MAC) has launched the National Irrigation Development Plan (NIDP) since October 1994.
3. In NIDP, GOT took up 156 small scale irrigation schemes all over the country and acknowledged that those selected in the Morogoro region would ensure increase of food production through improvement of the existing irrigation systems, and consequently contribute to the national food security and rural poverty alleviation as well as significant impacts to the other irrigation areas. GOT thus requested the Government of Japan (GOJ) on May 24, 1993, to extend technical assistance for execution of the Master Plan Study on the Central Wami River Basin, and then, Feasibility Study on the selected 16 priority smallholder irrigation schemes. In reply to this request, GOJ, through JICA, extended the technical assistance for those studies in 1996 and 1997.
4. With the results of the studies, GOT further requested GOJ to provide a grand aid for implementation of four priority schemes of Mgeta, Mgongola, Mkula, and Mwega. Out of them, the Mwega scheme was selected for the basic design study because of a priority order in development, topography, land use plan, soil conditions, and financial situations of beneficial farmers. GOT finally agreed with this selection.
5. GOJ, through JICA, dispatched the Basic Design Study Team to Tanzania from March 15, 1999 to May 4, 1999. In field work, the Study Team has found that the course and sections of the Mwega river were largely changed due to a big magnitude flood brought by the *El Niño* phenomena occurred from the end of 1997 to March

SUMMARY

1998 and canal layout should be totally re-planned accordingly. The Study Team discussed the results of field work including public meetings with farmers' representatives, with MAC and examined the requested items by GOT. As a result, it was confirmed that there were no any changes in the requested items, however the quantities of respective items would have to be re-examined due to the re-planning of canal layout.

6. The basic design study was made for irrigation and drainage facilities, river improvement work and road improvement work through analyzing the results of field work. The results of the study as well as field work were compiled in the draft basic design report.
7. JICA dispatched a mission to explain the draft basic design report to GOT during the period from July 26, 1999 to August 5, 1999. The report was principally agreed by GOT, so that the minutes of discussion was signed by both parties on July 31, 1999.

Basic Concepts for Basic Design

8. The basic concepts for the basic design are as follows:

- (1) **Irrigation and Drainage Plan**

The beneficial farmers have a strong desire to realize stable water abstraction and timely water distribution. They should operate and maintain the Project facilities by themselves. Therefore, the following basic concepts are applied for the irrigation and drainage plan:

- (a) Application of gravity irrigation system as it is less costly and easy to operate and maintain.
- (b) Preparation of more safe canal layout plan putting care on the changed course and eroded sections of the Mwega river.
- (c) Maximum use of the existing canals considering the cost savings and easy acceptance by beneficial farmers.
- (d) Introduction of simple and firm structures related to canals.
- (e) Attendance of beneficial farmers to excavation of lateral canals under "farmers participatory approach".

- (2) **River Improvement Plan**

The river improvement plan will be worked out according to the following three basic concepts, considering that the Project is principally an irrigation development project:

- (a) Enlargement of river cross section only in reaches of insufficient conveyance capacity.

SUMMARY

- (b) Provision of river side protection work in reaches being exposed to danger of erosion and scouring, where a proposed irrigation canal is obliged to be closely located by the Mwega river.
 - (c) Application of simple riverside protection work in consideration of capability of farmers.
- (3) Road Improvement Plan
- The road improvement will be applied only for rehabilitation of the existing roads. The basic concepts for road improvement plan are as follows:
- (a) Access road from Highway A7 to Malolo
Rehabilitation shall be executed only for 7 existing crossing structures since the road condition itself is presently well-maintained.
 - (b) Malolo-Chabi Road
Improvement works shall include the embankment of about a 1.2 km portion located at low-lying plain and new construction of Mwega bridge and submerged bridge.

Contents of the Project

9. The proposed contents of the Project are as follows:
- (1) Project irrigation area : 580 ha
 - (2) Crops for plan : Paddy, maize, onion, and tomato
 - (3) Mwega headworks : Overflow type fixed weir, weir width 24.8m, weir height 7.7m
 - (4) Irrigation canal works
 - (a) Left main irrigation canal : Design discharge 0.52 m³/s~0.10 m³/s, total length 12.2 km, Trapezoidal cross section concrete block lining
 - (b) Right main irrigation canal : Design discharge 0.37 m³/s ~ 0.14 m³/s, total length 9.0 km, Trapezoidal cross section concrete block lining
 - (c) Connection canals : Design discharge 0.049 m³/s~0.056 m³/s, total length 0.64 km, Trapezoidal cross section unlined canal
 - (d) Lateral canals : Excavation by farmers, design discharge 0.03 m³/s ~0.08 m³/s, total length 5.3 km, Trapezoidal cross section unlined canal
 - (5) Road improvement works
 - (a) Bridge : T-type bridge of 24 m in total length

SUMMARY

- (b) Road : 1.2 km in length of Malolo-Chabi road with 6.0 m in total width
 - (c) Drainage canal : 0.5 km in length with canal bottom width 4.0 m
 - (d) Others : Repairs of 7 existing crossing structures, construction of Mwega bridge and submerged bridge
- (6) River improvement works
- (a) Kikalo river
 - 1) Improvement extension : 0.3 km
 - 2) Cross section : Trapezoidal cross section, bottom width 2.5 m, side slope 1.5:1
 - (b) Mwega river
 - 1) Improvement extension : 1.0 km
 - 2) Cross section : Trapezoidal cross section, bottom width 10.0 m, side slope 1.5:1
 - 3) Others : River side protection works of 11 places
10. The implementation of the Project would require about 24.5 months.
11. The Ministry of Agriculture and Cooperatives (MAC) is the executing agency, and the Irrigation Services of Crop Development Division is directly responsible for implementation of the Project. Under control of Irrigation Services, the Zonal Irrigation Office will have construction supervision of the Project facilities.
12. In accordance with the policy of GOT, operation and maintenance of the Project shall be executed by the beneficial farmers under technical support of Kilosa Office of District Agriculture and Livestock Officer (KDALDO). In the Project area, there are 7 existing Water Users' Groups (WUGs), but they are institutionally weak and do not have enough capability to properly operate and maintain the Project facilities. Accordingly, in connection with the establishment of new irrigation canal network, these existing WUGs will be incorporated into the Mwega WUG as Water Users' Sub-Groups, to keep the sustainability of the Project.
13. The Mwega WUG will be equipped with 4 service functions such as General Meeting, Executive Committee, Services Sections and Auditing Section, aiming at its effective operation. Major activities of these service functions are as follows:
- (1) General Meeting
- The General Meeting is a deliberative organ in the Mwega WUG, and will be held at least once a year. It will perform the following activities:

SUMMARY

- (a) Election of the executive committee members and the auditor.
- (b) Approval of the auditing results.
- (c) Approval of the annual management plan and budget.
- (d) Determination of the irrigation service charge amount.
- (e) Revision and enactment of articles and by-laws.
- (f) Specific items requested by the members and committees, etc.

(2) Executive Committee

The Committee is composed of a Chairman, a Vice Chairman, General Secretary, a Treasurer, an Auditor, and several members who are representatives of the service sections. The Committee which will be operated through a regular meeting, shall be (i) to prepare the annual management plans, (ii) to instruct and supervise activities implemented by the service sections, (iii) to manage complaints and grievance from the farmers, (iv) to arrange and appoint volunteers to work in service sections, (v) to manage accounting and general affairs, and (vi) to coordinate with other agencies and associations.

(3) Service Sections

Under the instruction and supervision for the Executive Committee, the routine service works are implemented by 4 sections, namely (i) O&M, (ii) Agriculture, (iii) Marketing and Credit, and (iv) Women's Group.

(4) Auditing Section

The Mwega WUG have an auditing system in addition to the authorized official auditing organization. Namely, the Auditing Section or Committee, which consists of several volunteers (beneficiaries), is established apart from the Executive Committee. This Section always checks the Mwega WUG's accounting including collection of irrigation service charge, and reports those results at the General Meeting.

- 14. The Project facilities shall be designed to be more simple, however the existing WUGs do not have enough experience operating and maintaining headworks, settling basin, and concrete block lining canals. Such major facilities will therefore be jointly operated and maintained by both WUG and the Kilosa office of District Agriculture and Livestock Development Officer (KDALDO) for at least one year after completion of the Project, aiming at smooth transfer of operation and maintenance function to the Mwega WUG. In joint activities, KDALDO shall provide necessary know-how to the Mwega WUG through on-the-job-training.
- 15. The Mwega WUG will collect both the irrigation service charge covering all O&M costs of the Project facilities from the beneficial farmers and the annual membership fee to cover the Mwega WUG's supporting activities such as marketing and credit services. The required amount for them is estimated at Tsh. 14,600 for the average

SUMMARY

holding size farmer (0.79ha), which is only 1.8% of the net reserve of Tsh.832,000 under the "with project condition". From these figures, it is clear that the total of irrigation service charge and annual membership fee can be paid by the beneficial farmers and would not create any heavy financial burden.

16. In the Project, it is planned that strengthening of the Mwege WUG and agricultural extension services will be executed by ZIO in Morogoro Region, KDALDO and KDCO. Thus, the government officers shall be involved in the Project implementation and the agricultural extension services to the Mwege WUG and farmers.

Conclusion and Recommendations

17. The implementation of the Project is suitable and viable for Japan's Grant Aid as the Project will largely contribute to the achievement of key policies stipulated in the Rolling Plan and Forward Budget for Tanzania and also the National Irrigation Development Plan.
18. Judging from the circumstances around the Project, it is expected that the Project will be implemented smoothly and effectively as long as the government agencies concerned commit to realizing the following:
- (1) Obtain the water right satisfying the water demand by the proposed cropping pattern, prior to commencement of the Project implementation.
 - (2) Execute the land acquisition necessary for rehabilitation of the Project facilities.
 - (3) Execute the budget and staff arrangement for smooth implementation of the Project by MAC.
 - (4) Provide the technical support and timely supervision for beneficial farmers on excavation of lateral canals under the "farmers participatory approach" concept.
 - (5) Establish a technical supporting system to the farmers' organization for effective and sustainable operation and maintenance of the Project by strengthening the local governments concerned.

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CHAPTER 1
BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

Tanzania has an area of 945,200 km² consisting of 943,200 km² in the Mainland and 2,000 km² in Zanzibar and Pemba. The total population was estimated at about 28.8 million as of the end of 1994, of which approximately 23 million or almost 80 % live in the rural area. In the last decade, the population has increased at a high rate of 2.8 % a year.

The World Bank reported that about 59 % of rural households were poor according to a relative poverty line of Tsh. 46,173 per capita per annum in 1991, which were higher than 39 % of households outside Dar es Salaam and 5 % in Dar es Salaam. Even though these were the survey results obtained in 1991, the conclusion that poverty was one of crucial problems to be tackled by the Government of Tanzania (GOT) is still unchanged even now.

Tanzania is a predominantly agricultural country. It absorbs almost 84 % of the employed population and generates almost 50 % of the Gross Domestic Products (GDP) and 75 % of the foreign exchange earnings. However, it is mainly traditional and rainfed, so that agricultural production is low and unstable. In 1994, food production decreased about 30 % because of a drought in the short rainy season and a 2 months delay in start of the long rainy season. Thus, the national food production shortage became about 435,000 tons of cereal equivalent.

Taking this such serious food shortage into consideration, in the Third Rolling Plan and Forward Budget (1994/95 - 1996/97), GOT put a focus on the development of agriculture sector with particular emphasis on activation of smallholder farmers as well as agricultural investigators in the private sector, production increase of the export-oriented economic crops, development of agricultural infrastructure especially for improvement of accessibility to the market, and elimination of primary constraints through structural improvement of the existing traditional irrigation systems. To successfully accomplish this agricultural development, the Ministry of Agriculture and Cooperatives (MAC), has launched the National Irrigation Development Plan (NIDP) since October 1994.

In preparation of NIDP, GOT acknowledged that the irrigation schemes selected in the Morogoro region would ensure increase of food production through improvement of the existing irrigation systems, and consequently contribute to the national food security and rural poverty alleviation as well as significant impacts to the other irrigation areas. GOT thus requested the Government of Japan (GOJ) on May 24, 1993, to extend technical assistance for execution of the Master Plan Study on the Central Wami River Basin, and then, Feasibility Study on the selected 16 priority smallholder irrigation projects. In reply to this request, GOJ, through JICA, provided the technical assistance for these studies in 1996 and 1997.

With the results of studies, GOT requested GOJ to provide a grand aid for 4 priority schemes of Mgeta, Mgongola, Mkula, and Mwega, which were selected and

recommended in these studies. These 4 priority schemes were examined from viewpoints of priority order in development, topography, land use plan, soil condition, financial situations of beneficial farmers, and finally the Mwege scheme was taken up for the basic design study, which was agreed by GOT.

GOJ, through JICA, dispatched the Basic Design Study Team to Tanzania from March 15, 1999 to May 4, 1999. In field work, the Study Team has found that the course and sections of the Mwege river were largely changed due to a big magnitude flood brought by the *El Niño* phenomena occurred from November 1997 to March 1998 and canal layout should be totally re-planned accordingly. The Study Team had discussions the results of field work including public meetings with farmers' representatives, with MAC and examined the requested items by GOT. As a result, there were no any changes in the requested items which are mentioned below, however, the quantities of respective items will be re-examined since the river course and sections were largely changed due to large magnitude flood brought by the *El Niño* phenomena:

- (1) Construction of main and lateral canals, access road and related structures.
- (2) Construction of headworks, drains and related structures and river improvement.

CHAPTER 2
CONTENTS OF THE PROJECT

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2.1 Objectives of the Project

In the National Socioeconomic Development Plan, the Government of Tanzania (GOT) has given the highest priority to the agriculture sector focusing on “the satisfaction of subsistence requirement in a large part of the country”, and “generation of local surpluses of staple food products”, aiming to facilitate food security both at villages and at regional or national levels. Following this political target, the Ministry of Agriculture and Cooperatives (MAC) has prepared the National Irrigation Development Plan stressing consolidation of agricultural land especially with rehabilitation and/or improvement of the existing smallholder irrigation system on the basis of the concept of the farmers participatory approach to the development.

The Project for Mwega Smallholder Irrigation Scheme in the Morogoro Region (the Project) is one of 156 priority schemes selected in the National Irrigation Development Plan. The objective of the Project is to improve farmers' economy and living condition through stability and increase in production of staple foods and cash crops by rehabilitating existing irrigation facilities for the stable water abstraction and timely water distribution which farmers concerned strongly desire.

Also, the Project is highly expected to be a model pioneer project for the development of the remaining 155 traditional smallholder irrigation schemes.

Operation and maintenance of the existing irrigation facility in the Project area has been executed by the farmers themselves for 40 to 50 years. However, large magnitude floods due to the *El Niño* phenomena from the end of 1997 to March 1998 brought about severe damages to the existing irrigation facilities, and so agriculture production remarkably decreased. The farmers in the Project area are therefore further desiring the early implementation of the Project.

2.2 Basic Concept of the Project

The Project will provide stable irrigation water supply with the construction of new headworks and irrigation water conveyance systems unifying existing irrigation areas such as Mwega, Nyinga, and Mgogozi areas instead of existing intakes and conveyance systems which have been damaged by floods every year. In addition, the Project contains river improvement works for improving an area against habitual inundation and road improvement works such as an access road from the highway A7 to Malolo village and an existing road connecting Chabi and Mgogozi villages with Malolo village. These project components are fundamentally the same as those requested by GOT. But big floods caused by the *El Niño* phenomena from the end of 1997 to March 1998, largely changed the course and section of the Mwega river, which brought about the need to modify the proposed canal route and change of river improvement reaches planned in the Feasibility Study. Also, in line with the request

from beneficiaries, washing-basins utilizing water from the proposed main canals and a submerged bridge are incorporated in the Project works. Lateral canals which were originally planned to be constructed by beneficiaries themselves in the beginning of the Feasibility Study, will be constructed by a contractor for the embankment works and by beneficiaries for the excavation works.

In order to maintain the Project facilities in good condition, it is necessary to strengthen the Mwega Water Users' Group (WUG), which will be responsible for operation and maintenance of them. Thus, GOT will provide the Mwega WUG with necessary training in line with the construction schedule.

2.2.1 Project Area

The Project area is presently cultivated by employing seasonal labor at peak farming time. In connection with the expansion of the Project area from 477 ha to 580 ha, a study was made to whether such expansion should be allowed or not from a viewpoint of available seasonal labors based on the results of a farmers' interview survey.

According to the interview survey, farmers are adjusting seasonal employment in the Project area by means of mutual assistance and planting period. These laborers are employed from inside and outside villages at land preparation time of paddy, transplanting and harvesting time of maize and onion when labor shortage occurs. Thirty-three out of 46 households interviewed, replied that agricultural activities could be executed only by their families members, while the remaining use seasonal employment as required. It is confirmed that such seasonal employment can easily be made from other villages in the Project area and adjacent villages in Iringa Region. In fact, the survey showed there were no labor shortages or disputes on labor employment among farmers in the Project area.

Based on the results of the interview survey, seasonal employment is estimated at 5 labors per ha on an average and cultivated area is about 50 ha out of 276 ha of surveyed area (corresponding to 13 out of 46 households), say about 18 % of the surveyed area. With this rate, the seasonal employment is estimated at 420 laborers for 477 ha of the present cultivation area. In case of 580 ha, the required seasonal employment is calculated at 540 laborers, which is only about 24 % larger than those for 477 ha. It is likely that such labor increase could be arranged from the adjacent villages judging from their population.

2.2.2 Plan for Irrigation and Drainage Facilities

(1) Location of Headworks and Canal Layout

The river course around the proposed headworks site has not been severely changed even by the big flood caused by *El Niño*, although scouring has been observed in the riverbed. Rock formation exists around 2 meters below the riverbed. The Project area can be irrigated by gravity. Thus, it is judged that the site selected at the

Feasibility Study stage is relatively stable and suitable.

In the Feasibility Study, a main irrigation canal was planned to run from the headworks along the left side of the Mwega river and divert water to secondary canals across the Mwega river to the right side area. Because of the big flood caused by *El Niño*, the river section has largely enlarged. In and around the proposed crossing points of the secondary canals planned at the Feasibility Study stage, the river widened from 8 m -10 m to 60 m – 100 m and deepened to 4 m - 6 m. It has not been long since the big flood hit the river. Thus the river banks are sheer formed by scouring and still unstable. The river banks are affected by repeated scouring and collapse especially along the concave side. It is, therefore, not suitable for a small canal to cross the river. It is possible to supply irrigation water to the right bank area by provision of a canal directly diverting from the headworks to the right bank side. In this case, it is safer since the canal does not cross the large Mwega river, although the canal crosses small streams on the way. Considering these situations, it is proposed to provide a main irrigation canal along the right bank of the river instead of the secondary canals.

Eventually, main canals are to be provided along both bank sides from the headworks (hereinafter respective main canals running along the right and left bank sides will be referred to as “the right main canal” and “the left main canal”). Then the main canals divert water to lateral canals or connection canals. Three connection canals are planned. They are of chute type, which runs steep slope from the left main canal to the existing Canal B.

(2) Lateral Canals

In case that a lateral canal is not available in the reaches other than the connection canals which are provided, a new lateral canal is to be provided so as to connect the existing canal system with the proposed main canal. The lateral canal is of earthen type, the same as the existing ones.

The Project requests that the beneficiaries positively participate in the construction of the irrigation canal systems on the basis of the “Beneficiaries’ Participatory Approach for the Development”. In line with this concept, it was planned that the beneficiaries should construct the lateral canals by themselves. However, the farmers do not have enough technique and experience in the construction of embankment canals, although they constructed excavation canals, and thus it is difficult for them to maintain a satisfactory quality and construction schedule. Therefore the embankment work of lateral canals is included in the works constructed on a contract basis and the canal excavation is carried out by beneficiaries under the technical assistance from the Zonal Irrigation Office, Morogoro.

2.2.3 Basic Concept for River Improvement Works

The Project is principally an irrigation development project. From this point, the

river improvement works are limited to the following two works. One is an enlargement work of the river cross section in the reaches with insufficient conveyance capacity, which leads to habitual inundation and expects to damage proposed irrigation canals. The second is a riverside protection work in the reaches, which are exposed to the danger of erosion and scouring and where a proposed main irrigation canal is obliged to be closely located by the river.

The reaches corresponding to the former case are about 1 km upstream from the existing intake A as shown in Figure-2.2.1. In these reaches, the river course is changed to the left side and is closely located to the proposed route of the left main canal. In order to restore the function of the original river course, the riverbed is lowered to meet those of the downstream and upstream by removing sediments deposited in the original river course. Also, the Kikalo river, which is one of tributaries of the Mweга river is deepened in the reaches of about 300 m upstream from the confluence point with the Mweга river.

2.2.4 Basic Concept for Road Improvement Works

(1) Improvement of Access Road from Highway A7 to Malolo

The access road between the highway A7 and Malolo village, about 21 km in length, is the only road connecting from the outside to the Project area. This road crosses small streams. The scale of the streams is comparatively large and the obstacle causes traffic disruption at seven places where repairing or protection work is required.

(2) Improvement of Malolo-Chabi Road

The Malolo-Chabi road is the most important road connecting Mgogozі village and Chabi village to Malolo village and further connecting to the national highway A7 through the access road. The road crosses the low-lying plain situated along the Mweга river for a distance of 1.2 km, where the road height is lower than surrounding areas. Thus the road suffers from inundation in the rainy season, which often interferes with traffic. In order to improve such situations, the road is improved with earth embankment and provision of a side drain along the road upstream side.

Moreover, the bridge where the Malolo-Chabi road crosses the Mweга river is becoming obsolete, and is at a point which vehicles cannot pass. In addition, the river course was drastically changed at the time of the flood caused by *El Niño* and residents are crossing on foot at a point downstream (about 100 m from an old bridge to the downstream) where the old river and the new river are joined. The old river course rapidly becomes small upstream from the old bridge point, and is a few meters in width and 1 m in depth or less at a few hundreds meters upstream. In such situations, little water flows. On the other hand, a new river course is remarkable in the sand sedimentation, and is shallow of 0.4 m to 0.8 m at depth with a width of 15 m at the bottom at the expected point of a river-crossing structure. As the probability

of a flood happening of the scale like the flood in 1997/98 is very low, the supply of sand from the upstream will decrease in the future, and the possibility of causing the riverbed to decrease is high. Thus, the possibility of the present river course returning to the old river course is scarce since there will be a possibility in the new river that the river section will grow bigger due to the riverbed decreasing in the future and the scale is small in the old river. Therefore, a bridge is to be set up at about 100 m downstream point from the old bridge where the old river joins the new river.

(3) Construction of Submerged Bridge

In the original development plan, the aqueduct to be provided on the proposed secondary canal was planned to serve as a pedestrian bridge by covering the flume with a wooden cover in accordance with the request of farmers. However, the secondary canal and the aqueduct crossing over the Mwega river is cancelled from the project plan following the review of the canal layout. Instead of the aqueduct, a submerged bridge is constructed within a short distance at a point which connects Nyinga, Malolo, and Mgogozu villages.

2.2.5 Basic Concept for Procurement Works

In this Project, no equipment is scheduled to be supplied to GOT will be scheduled. On the contrary, the gates will need to be procured for the Mwega headworks. Some manufacturers in Tanzania can make gates. They, however, do not have sufficient experience and it is very difficult to expect the rubber equipped to the gates to seal against leakage. In addition, gates procured from other eligible countries in Africa are not reliable against leakage and maintenance service. Consequently the gates for the Mwega headworks will be procured from Japan.

2.2.6 Basic Concept for Operation and Maintenance Plan

Operation and maintenance of the Project facilities and water management are important tasks for WUG. Thus, it is essential to formulate a well-planned Mwega WUG for sustainability of the Project. In this formulation plan, the basic concepts to be applied are (i) incorporation of existing WUGs and (ii) no combination of existing WUGs in principle.

In view of operation and maintenance by the Mwega WUG, the Project facilities shall be designed to be more simple, however the existing WUGs do not have enough experience operating and maintaining headworks, settling basin, and concrete block lining canals. Accordingly, such major facilities will be jointly operated and maintained by both WUG and the Kilosa office of District Agriculture and Livestock Development Officer (KDALDO) for at least one year after completion of the Project, aiming at smooth transfer of operation and maintenance function to the Mwega WUG. In joint activities, KDALDO shall provide necessary know-how to the Mwega WUG through on-the-job-training.

As for minor Project facilities, the Mwege WUG will conduct operation and maintenance immediately after completion of the Project. It is deemed that the Mwege WUG has the capability of operation and maintenance of the facilities subject to less technical problems and financial burden.

2.2.7 Basic Concept for Water Management Plan

Taking into consideration that the Project is comparatively blessed with water resources as compared with the command area, and that farmers do not have enough experience in systematic water management, a more simple water management plan will be worked out so as to be understandable and acceptable to them. In addition, water management shall be jointly executed by the Mwege WUG and KDALDO for at least one year after completion of the Project, to assure the Mwege WUG's knowledge on water management activities.

2.2.8 Basic Concept for Marketing System Improvement Plan

As for marketing of agricultural products, there is no public intervention in the marketing process. The prices of agricultural commodities are thus being set freely through negotiation between traders and farmers from time to time. Figure-2.2.2 schematically shows the marketing flow for maize, rice, and vegetables.

In the Project area, the trader visits each farmer, and then the prices are set between the trader and farmer through a negotiation process. The prices set are rather advantageous for the trader because the farmer has no means of carrying agricultural products to markets. Procurement of chemical fertilizers and agro-chemicals is individually made, although use of them is remarkably low due to high prices and unstable delivery time.

As mentioned above, marketing is not systematically arranged in spite of the existing WUGs. In view of this present situation, the improvement of a marketing system will be planned under the basic concept that arrangement of agricultural products and inputs necessary for agricultural activities be one of the services to be conducted by the new WUG. This plan will be realized step by step.

In the Project, the access road from the A7 national road (Morogogo - Iringa) to the Project site will be improved through provision of stable road protection work for 6 crossing places with wadis. In addition, improvement will also be made for 1.1 km of the village road from Malolo to Chabi. These improvements would create the infrastructure necessary for smooth transportation of agricultural inputs and outputs.

2.2.9 Features of the Project Plan

Based on these basic concepts, the outline of the Project is formulated as follows. Proposed project facilities are shown in Figure-2.2.3.

- (1) Project irrigation area : 580 ha
- (2) Crops for plan : Paddy, maize, onion, and tomato
- (3) Mwega headworks : One place
 - (a) Type : Overflow type fixed weir
 - (b) Width of weir : 24.8 m
 - (c) Weir height : 7.7 m from the foundation rock to the overflow weir crest and 4.7m from the surface of downstream apron.
 - (d) Gate : Scouring sluice gate : 2 nos., intake gate: 2 nos., and settling basin : 2nos.
 - (e) Related facilities : 2 Intakes, 2 settling basins, and one operation bridge
- (4) Irrigation canal works : One place
 - (a) Left main irrigation canal (One no.)
 - 1) Design discharge : $0.52 \text{ m}^3/\text{s} \sim 0.10 \text{ m}^3/\text{s}$
 - 2) Design total length : 12.2 km
 - 3) Canal type : Trapezoidal cross section concrete block lining
A part of concrete flume
 - 4) Related facilities : Turnout, drop, superpassage, culvert, and aqueduct, etc.
 - (b) Right main irrigation canal (One no.)
 - 1) Design discharge : $0.37 \text{ m}^3/\text{s} \sim 0.14 \text{ m}^3/\text{s}$
 - 2) Design total length : 9.0 km
 - 3) Canal type : Trapezoidal cross section concrete block lining
A part of concrete flume
 - 4) Related facilities : Turnout, drop, superpassage, culvert, and aqueduct, etc.
 - (c) Connection canals (3 nos.)
 - 1) Design discharge : $0.049 \text{ m}^3/\text{s} \sim 0.056 \text{ m}^3/\text{s}$
 - 2) Design total length : 0.64 km
 - 3) Canal type : Concrete flume
 - 4) Related facilities : Energy dissipater at three places
 - (d) Lateral canal : excavation by farmers.
 - 1) Design discharge : $0.03 \text{ m}^3/\text{s} \sim 0.08 \text{ m}^3/\text{s}$
 - 2) Design total length : 2.0km in left bank 3.3km in right bank and 5.3km in total
 - 3) Canal type : Unlined canal with trapezoidal cross section
 - 4) Related facilities : Drop
- (5) Road improvement works
 - (a) Bridge : T-type bridge of 24 m in total length
 - 1) Road : 1.2 km in length of Malolo-Chabi road with 6.0 m in total width

- 2) Drainage canal : 0.5 km in length with canal bottom width 4.0 m
- (b) Others : Access road (from national highway A-7 to the project area), repairing of 7 places and Mwega river submerged bridge at one place.

(6) River improvement works

(a) Kikalo river

- 1) Improvement extension : 0.3 km
- 2) Cross section : Trapezoidal cross section, bottom width of 2.5 m and side slope of 1.5:1

(b) Mwega river

- 1) Improvement extension : 1.0 km
- 2) Cross section : Trapezoidal cross section bottom width of 10.0 m and side slope of 1.5:1
- 3) Others : River side protection works of 11 places

2.3 Basic Design

2.3.1 Design Concept

(1) Design Concept for Natural Conditions

(a) Headworks site and river crossing structure site on Malolo-Chabi road

The existence of rock was confirmed from the present riverbed at the depth of 2m to 4m (604m to 606m above sea level) at the proposed site of the headworks according to the geological investigation as shown in Figure-2.3.1. Therefore, a direct foundation method is adopted so that the headwork structure directly contacts the rock. As for the river crossing structure site on Malolo-Chabi road, there is a loose sandy soil layer having an N-value of 6 to 12 in the range from the ground surface to about 11 m in depth where the foundation layer exists as shown in Figure-2.3.2. Therefore, the pile foundation is adopted to support the river crossing-road structure.

(b) Canal route

The proposed canal is provided so as to be apart from the river in principle. However, it is obliged to run near the river due to the topographic condition. In that case, river bank protection by gabion is given to the river, and the canal is constructed by flume. When excess water flows in the Mwega river through the drainage works by which the main irrigation canal crosses, river side protection by gabion is provided as well for protecting the riverside from scouring.

(2) Basic Concept for Social Conditions

GOT gives priority to the irrigation development of the small-scale landholders, and is taking the policy by which the operation and maintenance management of facilities is entrusted to the farmers who are the beneficiaries. Therefore, the project irrigation

facilities should be simple in design and easy to maintain, repair, and operate so that the beneficiaries can easily manage them.

(3) Use of Local Contractors and Materials

The facilities will be designed using the construction materials available in Tanzania and employment of local contractors, and utilization of local construction materials will be expedited within a technically allowable extent.

(4) Design Concept for Grade of Facilities and Equipment

The main irrigation canals will be provided with lining for effective use of water resources, ease of maintenance and ensuring proper water distribution. The canal lining will be also helpful in reducing burden on the farmers' organization concerning operation and maintenance activities. In line with the basic concept of "participatory approach to the development", the lateral canal will be unlined canals, which the farmers can construct by themselves (except the embankment portion).

As the irrigation facilities along the canals except the headworks are small in size and simple structures which require less maintenance and operation works, no inspection roads shall be furnished. For the Mwega headworks, an inspection road shall be constructed.

At every turnouts, stop logs will be adopted instead of steel gates. For the Mwega headworks, manually operated steel gates will be installed, and spindles will be made of stainless steel (SUS) for long term utilization.

(5) Design Concept for Implementation Schedule

A water running test for the Mwega headworks and the canals is essential, so that its period should be added to the construction schedule. Required construction equipment and materials will be set taking into account the balance of their supply to the site during the whole construction period. In addition, the period of the preparatory and demobilization works will be determined in light of the procedure regarding the construction works, mobilization and demobilization of the temporary works and procurement of construction equipment and materials. Consequently, the construction schedule will require 18 months as shown in the table below:

Construction Schedule

Works	2000						2001						2002											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1. Preparatory Works																								
2. Temporary Works																								
3. Headworks																								
4. Canal System																								
5. Road Improvement																								
6. River Improvement																								
7. Water Running Test																								
8. Demobilization of Temporary Works																								
9. Demobilization Works																								

2.3.2 Basic Design

(1) Irrigation and Drainage Facilities

(a) Headworks

1) Basic design conditions

a) Design flood

Probability flood ($99\text{m}^3/\text{s}$) for 50 years based on the Feasibility Study (page C20 of Volume II of "The Study on the Smallholder Irrigation Projects in Central Wami River Basin, Morogoro" January 1998) is adopted for the design flood discharge. The flood discharge by *El Niño* is presumed by hydraulic calculation, and the flowing ability of the weir is confirmed. In this case, the freeboard is not considered.

b) Design intake discharge

The design intake discharge is assumed to be $0.89\text{m}^3/\text{s}$ in total consisting of right bank side of $0.37\text{m}^3/\text{s}$ and left bank side of $0.52\text{m}^3/\text{s}$ as shown in Figure-2.3.3.

c) Design of stilling basin

Particle size trapped by the settling basin is assumed to be 0.3mm.

d) Earthquake

A concrete structure is designed in consideration of an earthquake. An earthquake coefficient of $kh=0.12$ is assumed.

2) Basic plan

a) Headworks site

The site was selected about 500 m upstream from the irrigation benefited area under the conditions that the benefited area can be irrigated by gravity and that the river water course is stable.

b) Composition of headworks

As the river is narrow, and the water course is steady, the diversion of water to both sides is adopted. A scouring sluice is provided at each of end of the fixed overflow weir, and an inlet is built perpendicular to the scouring sluice on each side. An operation bridge (pedestrian bridge) is installed over the weir for the gate operation and the maintenance management. Each scouring sluice is equipped with a steel-made sluice gate. Both intake structures consist of the inlet, a leading canal, a settling basin, and a sand-flushing culvert. The inlet is furnished with a screen and a steel-made sluice gate. The settling basin, which is provided following the leading canal is furnished with a side spillway, a sand flushing gate to drain sand deposited in the settling basin to the river through the sand-flushing culvert, and an overflow weir for the flow measurement of diverted water from the river.

c) Type of weir

Fixed overflow type weir which is the easiest to operate and maintain, is adopted since there is little influence on the flood control on the upstream reaches of the proposed weir site.

d) Design intake water level and overflow weir crest level

The design intake water level is set at 611.50m in consideration of elevation (610.50m) of the irrigation service area and the distance to the area. The fixed weir crest level is set at 611.60m.

e) Foundation of weir body

Direct foundation method is adopted. Earth covering the rock is removed in the proposed weir site, and then foundation concrete is placed on the exposed rock surface. Concrete for the headworks structure is placed on the foundation concrete.

f) Weir width

The overflow weir length is determined to be 20m in consideration of the width of the river (about 20m) at the current state.

g) Sill elevation of weir downstream apron and apron length

The sill elevation was determined to be 606.90m in consideration of the present riverbed elevation of around 607.50m in the weir downstream and the design flood water level (610.00m) after hydraulic jump. The downstream apron is a settling basin type III of USBR from the velocity and Froude number of the flow entering into the apron, and the apron length is decided at 7.5m.

h) Flood water level and bank height

Flood water level just downstream of the weir is estimated at 610.00 m at design flood time. The discharge and the water level during the time of flood caused by *El Niño* are estimated at about 150m³/s and 611.10 m, respectively at the weir site. On the other hand, the necessary crest levels of the banks of the settling basin and the main canal at the beginning point are 611.70m and 611.20m, respectively. They are higher than the elevation added freeboard of 0.60m to the design flood water level of 610.00m or higher than the flood water level at the *El Niño* time. Thus, the bank elevation is set at 611.70 m in the downstream of the overflow weir section and 611.20 m in the site after the beginning point of the main canals. Bank elevation at the upstream of the weir was decided at 614.20 m adding a freeboard of 0.80m to the design flood water level of 613.40 m in the weir upstream, confirming the flood of 150m³/s at *El Niño* can pass the weir.

i) Examination of the creep length

Since the weir body sticks to the foundation rock, the safety of infiltration under the weir body is secured. However, both side banks in the weir should secure a necessary creep length, since the side banks are composed of the

sandy soil. According to the calculation by both Bligh method and Lane method, the creep length is required to be 16.8 m on the right bank side and 11.1 m insufficient on the left bank side. Thus sheet-piles was to be provided in perpendicular to the direction of the current line.

j) Flow velocity of intake

The applied flow velocity at intake is 1.0m/s or less.

k) Sill elevation of intake

The applied sill elevations for intake are 610.70m in the left main canal and 610.80m in the right main canal.

l) Sill elevation of the scouring sluice

The bed of the scouring sluice is laid lower by 1m or more than that of the intake.

3) Outline of facilities

The outline of the headworks facilities is as follows:

a) Weir body

- Weir crest : 611.60m
- Weir height : 4.7m from the downstream apron sill elevation and 5.7m from foundation surface
- Weir length : 24.8m in total length and 20 m in the overflow section
- Scouring sluice gate : Each of one gate, two gates in total, and HxB=2.1x1.5m for both banks
- Downstream energy dissipater : USBR III type, 7.5m in length
- River bed protection works : Gabion works in the downstream of 15m length

b) Intake

Design intake water level : 611.50m

	<u>Right bank intake</u>	<u>Left bank intake</u>
Intake gate	: 0.8x0.8m	1.0x1.0m
Leading canal	: Concrete flume canal 0.8mB x 1.0mH	Concrete flume canal 1.0mB x 1.0mH
Settling basin	: 2.4mx(1.3-1.5m) x 9.0m	3.0m x (1.3-1.5m) x 10.0m
	1 gate for each settling basin for sand flushing purpose	

(b) Irrigation and drainage works

1) Basic design condition

a) Effective use for existing irrigation facilities

Farmers themselves have been engaged in the irrigated agriculture for many years, and constructed and managed small-scale irrigation facilities. Therefore, the Project is based on the concept in which these existing irrigation facilities are effectively used.

b) Irrigation canal design discharge

The proposed cropping pattern basically has not changed from the feasibility study stage. The unit design irrigation water requirements were, therefore, decided at 2.16 l/s/ha for paddy and 1.06 l/s/ha for upland crops based on the results of Feasibility Study. The discharge is assumed to be constant in the commanding section of each water users group in the design of the main canals, though canal design discharge is the sum of the product of the irrigation area and the kind of crop as a rule. The design discharge of the main canals, the laterals, and the connection canals is shown in Figure-2.3.3. The maximum intake discharge is 0.89 m³/s. in total.

c) Design discharge of drainage structures crossing the main irrigation canal

The design discharge is set at a 20-year flood discharge based on the results of the Feasibility Study.

2) Basic plan

a) Basic layout

If a lot of turnouts are provided in the main irrigation canal, water management becomes complex and it often leads to shortage of irrigation water in the downstream part. The installation of turnouts is, therefore, limited to one place or a few places in each WUGs. Irrigation water is supplied directly from the main irrigation canal to the existing canal systems in principle. If a canal, which connects the main canal with the existing canal system, is not available, a new canal is provided. Of those newly provided, a canal set up in the steep gradient section is designed as a chute, which is called a connection canal, and another canal is called a lateral.

The rainfall is little with 360 mm on average annually. Drainage canals are, therefore, not provided in principle based on the results of the Feasibility Study. However, the drainage canal planned along the Malolo-Chabi road, which is described clearly in the request from GOT, is needed to protect the road from floods and to improve the drain of a low plain in the Malolo area (Refer to the road improvement works). Thus the drainage canal is newly provided with the improvement of the Malolo-Chabi road.

b) Canal works

The main irrigation canals are basically of lining canal type with concrete

blocks. The concrete block has been adopted in many projects including the Lower Moshi Irrigation Project and the Ndung Irrigation Project, which were financially and technically assisted by GOJ and its durability has been actually proven through such projects. Moreover, the block has the characteristic that damage does not spread easily to surroundings and the feature of easy restoration when it is damaged. Therefore, the concrete block is applied to the canal lining in this Project.

However, the connection canal is to be concrete flume, say a chute since it runs perpendicular to the contour line. The laterals are of earthen canal type.

— Basic longitudinal plan of irrigation canals

An excavation canal is more economical than an embankment canal. The topographic gradient ranges from 1/150 to 1/250 in the route of the main irrigation canals. Thus, it not only enables the main canals to secure enough flow velocity, but also requires the canals to make their gradient gentler than the topographic gradient by providing drop structures. Therefore, the main irrigation canals are so designed as to become the excavation canal by providing check cum drop structure just downstream of the turnout, although becoming an embankment canal from the upstream reaches of the turnout point since the design water level should be kept higher than the irrigation service area at the turnout point. The connection canals run on a steep slope perpendicular to the contour line as previously mentioned and are designed as a chute in a short distance of 200 m to 300 m.

— Hydraulic design

The cross-sectional scale of the irrigation canals is determined by use of the Manning Formula. The roughness coefficient is assumed to be 0.015 for concrete surface and 0.030 for earth surface. The permissible velocity is two-third for a concrete-made canal except chute and 0.6 m/s for an earth canal.

— Outline of canal

Primary features of the canals are shown in the following table.

Hydraulic Properties of Canal

Canal name	Design discharge (m ³ /s)	Length of canal (km)	Canal bottom width (m)	Canal length (m)
Right main canal	0.52~0.10	12.2	0.6~0.3	0.8~0.5
Left main canal	0.37~0.14	9.0	0.5~0.3	0.7~0.5
Connection canal 1	0.05	0.2	0.4	0.35
Connection canal 2	0.06	0.2	0.4	0.35
Connection canal 3	0.06	0.3	0.4	0.35
Laterals				
RLC-2	0.03	0.2	0.3	0.4
RLC-3	0.03	0.1	0.3	0.4
RLC-5	0.08	1.5	0.3	0.5
RLC-7	0.07	0.23	0.3	0.4
LLC-2	0.06	0.66	0.3	0.4
LLC-3	0.07	1.13	0.3	0.4
LLC-4	0.07	0.53	0.3	0.4
LLC-5	0.04	0.93	0.3	0.4

Note: R and L of the laterals show the right and the left banks, and L of the second character shows lateral canal. The lateral canals' number applies correspondingly to the turnout number.

c) Canal-related structures

Necessary and indispensable facilities like turnout, drop, culvert, chute, and drainage culvert, etc. are installed on main irrigation canals and washing basins are installed in the convenient points for the beneficiaries along the canals.

- A structure to drain flood from the mountain side safely crossing the main irrigation canal

There are largely three methods for draining flood water coming from the mountainous side across the irrigation canals. The first is a method that flood water crosses over the irrigation canal. The second is that flood water crosses under the irrigation canal. The third is that flood water crosses the irrigation canal by a level crossing.

The first method is attained by a structure crossing over the irrigation canal, a siphon provided on the irrigation canal, and by covering the irrigation canal. In this Project, the siphon structure is not adopted, since the irrigation canal is small in the scale and it is difficult to keep good maintenance in such a small canal. In the second method, a drain culvert crossing under the irrigation canal is used in general or an aqueduct is provided on the irrigation canal.

In this Project, as the irrigation canal becomes a canal formed mainly by excavation, the method in which excess water crosses over the irrigation canal or the level-crossing is adopted. Concretely, the irrigation canal is designed of concrete flume type in the drain-crossing section (hereinafter called as "superpassage") and the flume is covered with concrete slab or not covered. A superpassage located at the place where the main irrigation canal runs at the foot of a hill is provided with a concrete-made cover. Also, as for a wadi

flowing through Malolo settlement and crossing the left main canal, a big flood is expected from the large catchment area, so the flume is covered with concrete slabs. A superpassage, which is located at the place where the main canal runs in the Mwega plain apart from the foot of the hill is not covered with concrete slabs. In this type of the superpassage, crest level of the flume is set 10 cm lower than the crest of the lining of the upstream and downstream canals so that superpassage works as a canal spillway as well.

When the ground surface or the riverbed across the irrigation canal is lower than the canal bed elevation, a cross drain, which crosses under the irrigation canal is to be provided. However, an aqueduct is provided in each of the two places where the flood discharge is larger than 4 m³/s. The two points are situated on the right main canal, including the crossing point of the Kikalo river.

The cross drain consists of a concrete pipe portion under the irrigation canal and the protection works by the gabion works in the inlet and outlet portions. The aqueduct consists of concrete-made abutments and a concrete flume, which is a superstructure.

— Point where the right main canal crosses the Kikalo river

As mentioned in the following section, the Kikalo river, which is buried with sand sediment at present is improved by excavation together with the Mwega river and an aqueduct is provided at the point where the right main canal crosses the improved Kikalo river. However, there would be a possibility that the improved section of the Kikalo river will be buried again in the future, and thus the Kikalo river will flood again. Considering such a situation, the right main canal is provided with a concrete flume covered with concrete slabs in the section covered with sand sediment at present in order to protect against the intrusion of sand sediment caused by flooding.

Cross drainage works (superpassage, cross drain, and aqueduct) including the crossing point of the Kikalo river are listed in the following table. The location of the catchment area is shown in Figure-2.3.4.

Number of Cross Drainage Works

Number of Drainage area	Drainage area km ²	Peak flood discharge m ³ /s	Cross Drainage Works
Left main irrigation canal			
1-3	0.6	1.1	Superpassage 1
1-4	0.2	0.5	Superpassage 2 and 3
1-5	2.0	3.0	Superpassage 4
1-6	0.5	1.0	Cross drain 1
1-7	0.5	1.0	Superpassage 5 and 6
1-8	1.8	2.7	Superpassage 7
1-9	1.1	1.8	Superpassage 8 and cross drain 2
1-10	0.3	0.6	Superpassage 9
1-11	0.9	1.6	Superpassage 10
1-12	1.0	1.7	Superpassage 11
1-13	1.0	1.7	Superpassage 12, 13, 14, and 15
2	56.5	44.6	Superpassage 16, 17, 18, 19, and 20
3-1	3.7	4.9	Superpassage 21, 22, and 23
3-2	3.9	5.1	Superpassage 24, 25, and 26
3-3	1.8	2.7	Cross drain 3 and superpassage 27
3-4	5.5	6.8	Superpassage 28, cross drain 4, and superpassage 29
3-5	2.3	3.3	Superpassage 30
Right main irrigation canal			
4-0	14.9	15.2	Superpassage 1, cross drain 1, and aqueduct 1
4-1	0.6	1.1	Superpassage 2 and 3
4-2	0.4	0.8	Superpassage 4
4-3	0.5	1.0	Superpassage 5
4-4	2.7	3.8	Superpassage 6
4-5	0.9	1.6	Cross drain 2 and superpassage 7
4-6	0.4	0.8	Superpassage 8
4-7	0.5	1.0	Cross drain 3
Kikalo river		4.7	Aqueduct 2
5-1	0.3	0.6	Superpassage 9 and cross drain 4
5-2	0.9	1.6	Superpassage 10 and 11
5-3	3.0	4.2	Superpassage 12 and 13

Note: The drainage areas were measured in the topographic map on a scale of 1:50,000 and the peak flood discharge was calculated by the Rational formula. The peak flood discharge of the Kikalo river is derived from the Feasibility Study Report.

— Turnout and check

As previously stated, the installation of turnouts is limited to one place or a few places in each water users' group. The turnouts are provided at the diversion points from the main canal to the connection canal or the lateral canal.

Diversion points are seven in both right and left main canals or 14 in total. A turnout consists of a stop-log gate and a portion of connection to the downstream canal. In the connection portion, there is a drop in which diversion discharge can be estimated by measuring the water depth. Turnout will be constructed at the connection with lower canal, which is able to measure water discharge by measuring water depth. It is also possible to measure water discharge by measuring overflow depth when water flows over the stop-log gate. Width of stop-log is 30cm or 40cm.

A check is provided on the main canal just downstream of the turnout. Adjustment of water depth is made by stop-logs. Stop-log width is limited to 50cm at maximum so as to be easily operated. When the designed discharge is more than 180 l/s, the check is furnished with double sluices of stop-log. In the place where the water level of the main canal should be dropped immediately after the diversion, the check is designed also to serve as a drop.

The canal is widened by about double so as to slow down water velocity more than 180 l/s in front of the turnout and check mainly at the large design discharge section more than 180 l/s to easily divert water and operate the stop-log.

— Drop

Drop structures are provided to keep water velocity within the permissible velocity on the main canals and laterals. The drop is of a vertical type and has a stop-log guide at the mouth of the drop, the same as the check structure. The maximum drop is 1 m at each drop.

— Culvert

A culvert is provided at the point where the irrigation canal crosses the existing road. The culvert is a concrete flume type with pre-cast concrete covers, the same as the superpassage. Covering depth of earth on the culvert cover is 0.6 m at minimum.

— Cross-over flume (A structure to convey irrigation water crossing over the main canal)

Cross-over flume structures are provided at the major places where the proposed main canal crosses existing canals, so that the existing canals can convey irrigation water crossing over the main canal. The cross-over flume consists of abutments built on both banks of the main canal and a superstructure of concrete flume. The flume is set at 0.3 m in width and 0.4 m in height assuming that the discharge is 50 l/s at maximum.

— Washing basin

Washing basins are provided at the point where the main canals pass Nyinga, Malolo, and Mgogozzi villages. The washing basin is provided outside of the main canal to avoid pollution of canal water. It consists three sections upstream, middle, and downstream, so as to be convenient for washing, rinsing, and

finishing.

— Energy dissipater

An energy dissipater is provided at the end point of each of the connection canals, which is a connection point with an existing canal. The energy dissipater has a structure of double frame consisting of an inner frame and an outer frame. The inner frame dissipates the water energy and the outer frame settles water turbulence.

— Concrete frame protection

A slope, with a height of more than 3 m, is protected by concrete frame works in principle. The concrete frame is 1.7m x 1.7m, and filled with stones. The concrete size of the frame is 0.3m x 0.3m.

— Measuring facility

A broad-crested weir is provided at the end of settling basin and turnouts, for measuring the intake discharge and the distribution discharge, respectively.

— Number of Canal-related Structures

The number of the proposed canal-related structures is shown in the following table.

Number of Canal-related Structure

Name	Total	Right main canal	Left main canal	Connection canal	Lateral canals
Superpassage	43	13	30		
Cross drain	7	4	3		
Aqueduct	2	2			
Turnout	14	7	7		
Check structure	13	6	7		
Drop	59	23	30		6
Culvert works	4	3	1		
Cross-over flume	14	6	8		
Washing basin	10	2	8		
Energy dissipater	3			3	

(2) River Improvement Works

(a) Basic design condition

1) Enlargement of river cross section

The river section is decided on the basis of the discharge of a 10-year flood. The objective reaches are about 0.9 km from intake A to 0.9 km upstream on the Mwega river at which the river habitually floods and about 0.3 km in the Kikalo river from the confluence of the Mwega river. The 10-year flood discharges are 56m³/s in the Mwega river at Malolo village and 3.1m³/s in the Kikalo river in accordance with the Feasibility Study Report "The Study on the Smallholder

Irrigation Projects in Central Wami River Basin, Morogoro” Volume II. Design discharge is therefore set at $56\text{m}^3/\text{s}$ in the Mwega river and $3.1\text{m}^3/\text{s}$ in the Kikalo river.

2) River bank protection

River bank protection works are provided in the river bank, which is located in the concave riverside and from which the main canal route is located within 15 m, or the river bank protection works are provided in case that the river bank is located within 50 m from the drain structure crossing the main canal.

(b) Basic plan

1) River improvement

The route of the Mwega river changed in the reaches from the existing intake A to 0.9 km upstream due to the flood caused by *El Niño* from the end of 1997 to March 1998. At present, the river runs near the route of the proposed left main canal. It is estimated that the change of the river route originated in the damming-up by the weir of the intake A. In order to recover the original river course, the original river course is excavated at a depth of 2.0 m to 2.5 m and the side slope of 1.5 : 1 so as to meet to the bed level of the upstream and downstream portions of the river. The river bottom width is determined at 10 m in consideration of 10-year flood of $56\text{m}^3/\text{s}$. The Kikalo river is excavated in the bottom width of 2.5 m, the depth of 2 m, and the side slope of 1.5 : 1.

2) River bank protection

The river banks to be protected, located in the concave side, from which the canal is located within 15 m are three locations in the right main canal and two locations in the left main canal as listed below:

	<u>Section to be protected</u>	<u>Length of protection</u>
a) Along the Right Main Canal	670m - 840m	170m
	1400m - 1520m	120m
	1610m - 1730m	120m
b) Along the Left Main Canal	432m - 502m	70m
	1007m - 1077m	70m

And the locations of river bank protection related to the cross drain structures of the main irrigation canals are those related to the superpassage No.3, 4, 5, and 7 in the right main canal and superpassage No.1 and 2 in the left main canal. The length of river bank protection is set at three times the length of superpassage. The river bank protection is totally made of gabions and height of protection is set at 2.0 m considering the flood water depth.

(3) Road Improvement Works

(a) Improvement of access road from National highway A7 to Malolo village

The access road from the national highway A7 and Malolo village is suffering with some damages, mainly enlargement of the small streams especially in the width due to erosion caused by the flood originated by *El Niño*. The seven places are to be improved in total namely at the 0.1km point, 0.5 km point, 0.85 km point, 1.5 km point, 6.1 km point, 7.1 km point, and 13.5 km point (gully erosion prevention work) . Six places are improved with the provision of a causeway structure simply composed of concrete slab and gabion protection in upstream and downstream. The remaining one place, which suffers from gully erosion at the edge of the road side is filled with permeable materials such as sand and gravel in the gully.

(b) Malolo-Chabi road improvement and Mwega river crossing structures

1) Malolo-Chabi road improvement

Malolo-Chabi road is the most important road connecting Mgogozi village and Chabi village with Malolo village and the highway A7 through the access road. This road is improved for 1.1 km. The point of improvement is the raising of the road by earth fill. The road width is expected to be 6 m and cross-sectional slope of the road surface is 4 %. The drainage canal provided along Malolo-CHABI road has a bottom width of 4 m and is protected with gabion against erosion in the road side bank.

2) Malolo-Chabi bridge

A bridge is proposed for the place where Malolo-Chabi road crosses the Mwega river. The bridge type is a two spans' reinforced concrete-made T-beam bridge. The primary features of the bridge are shown below:

Bridge length	: 24.7m in total length, 12.0m in one span
Bridge width	: 4.6m in total width
Abutment	: Reinforced concrete, 5m in height, 4.6m in width
Pier	: reinforced concrete, 5m in height, 4.6m in width
Foundation	: Pile foundation, pile length 10.0m

3) Submerged bridge

A submerged bridge is provided at about 300 m upstream from the confluence of the Mwega river and the Kikalo river to connect Mgogozi village, Malolo village, and Nyinga village. The submerged bridge has five lanes of concrete pipe conduits (diameter 1.0m) in consideration of average discharge $4\text{m}^3/\text{sin}$ the rainy season. The inlet and outlet of the pipe conduit are protected by concrete and the road surface is paved with concrete slab against erosion. The upstream and downstream of the bridge are protected by gabion mattress.

2.4 Basic Concept for Project Implementation

2.4.1 Organization

MAC will be the executing agency of the Project. At present, GOT promotes the re-structuring of government agencies based on the strengthening policy of district offices, which directly have contact with inhabitants. Based on the re-structuring plan of MAC as shown in Figure-2.4.1, it is partly being re-structured, but still unfixed. Recently, Irrigation Services were subordinated to the Crop Development Division of MAC. The old organization chart of MAC is given in Figure-2.4.2.

The office organization of Zonal Irrigation Officer (ZIO) in Morogoro Region, which will be directly responsible for construction supervision of the Project facilities under control of In-Charge for Irrigation Services, is shown in Figure-2.4.3. As can be seen in this figure, ZIO has 3 Sections (Project Preparation and Design Section, Operation of Projects Support Services Section and Administration/Account Section) and 5 Subsections (Design Subsection, Soil Survey Subsection, Topographic Survey Subsection, Environmental Subsection and Social Survey Subsection) under the Zonal Irrigation Officer.

2.4.2 Budget

The budgets of MAC for the past 3 years are tabulated below.

Budgets for MAC

(Unit : Tsh.million)

Budget Item	1994/95	1995/96	1996/97
Recurrent	7,667.0	11,860.4	14,598.3
Development	7,603.8	6,819.3	3,456.2
Local	716.0	1,216.9	1,051.2
Foreign	6,887.9	5,602.4	2,405.0
Total	15,270.8	18,679.7	18,054.5

(Source: Rolling Plan and Forward Budget, 1996/97-1998/99)

The budget of MAC has increased by about 20% over these 3 years. The recurrent budget has increased by about 2 times, while the development budget has largely decreased due to less foreign aid. The budgets of Irrigation Services of MAC for the past 3 years are also given below:

Budgets for Irrigation Services

(Unit : Tsh.million)

Budget Item	1994/95	1995/96	1996/97
Recurrent	169.6	165.3	230.1
Development	1,864.5	1,661.3	567.6
Local	145.7	231.3	162.6
Foreign	1,718.8	1,430.0	405.0
Total	2,034.1	1,826.6	797.7

(Source: Rolling Plan and Forward Budget, 1996/97-1998/99)

The budget of the Irrigation Services has decreased by about 60% in the past 3 years. The recurrent budget has increased by about 40%, but the development budget has decreased by about 70 %, which is caused by reduction of foreign aid.

As for implementation of the Project, it is essential for MAC to make budget arrangement for operation and maintenance of ZIO during construction period and taxes to be imposed on procured materials and Japanese experts.

2.4.3 Staffing

(1) Staffing

(a) Irrigation Services of MAC

The Irrigation Services of MAC which is a direct agency for construction supervision, consists of 26 staffs in total as of April 1999, of which breakdown are one Assistant Commissioner, one Principal Irrigation Engineer, 7 Senior Engineers, 15 Engineers and 2 Assistant Engineers. These staffs are mostly irrigation engineers. Agricultural Economist, Soil Scientist, Sociologist and Environmentalist also belong to the Irrigation Services.

(b) Zonal Irrigation Office in Morogoro Regional

At present, ZIO has 22 staffs (2 staffs are not yet nominated). These are 5 Civil/Irrigation Engineers, one Land Surveyor, one Agriculture Engineer, one Soil Scientist, one Environmentalist, one Sociologist and 12 Administration staffs. Figure-2.4.4 indicates the organization of ZIO in Morogoro Region.

(2) Technical Level

The Irrigation Services of MAC has experience in undertaking construction works, although such direct management system was ceased last year due to the strengthening and promoting policy of the private sector. From such experience, it is judged that the staff of ZIO has enough knowledge to supervise the construction works.

CHAPTER 3
IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

(1) Implementation Method

The Project will be implemented in consideration of the application of Japan's Grant Aid System.

- (a) MAC will be the executing agency for the Project implementation.
- (b) When the Exchange of Note (E/N) between GOJ and GOT regarding the detailed design and preparation of the tender documents is signed, MAC will take care of overall procedures necessary for the implementation of the Project.
- (c) A Japanese Consultant firm, recommended by JICA and entrusted by MAC will sign the contract with MAC, and will prepare detailed design and tender documents.
- (d) When E/N between GOJ and GOT regarding the procedure of the construction works is signed, a Japanese Consultant firm, recommended by JICA and entrusted by MAC will sign the contract with MAC, and will start the tendering.
- (e) A Japanese Contractor after signing the contract for construction works, will undertake the construction works, and the consultant will execute construction supervision.
- (f) Upon completion of the construction works, the responsibility of operation and maintenance function will be transferred to the Mweza Water Users' Groups.
- (g) A joint inspection of MAC, the Consultant and the Contractor will inspect all facilities constructed under the contract, one (1) year after completion of the construction works.

(2) Formation of Construction

In Tanzania, several Japanese contractors have been engaged in the construction works of projects under the Japan's Grand Aid Program. These contractors have employed the local contractors as subcontractors, mostly for the purpose of manpower supply and construction equipment.

In this Project, the construction works are planned to be performed in formation that the Japanese contractor will arrange construction equipment and materials by himself, and use the manpower supplied by the subcontractors.

(3) Necessity of Japanese Experts for the Contractor

The construction works will consist of the following;

- (a) Construction of the Mwega headworks,**
- (b) Construction of canals and related structures**
- (c) Road Improvement**
- (d) River Improvement**

Taking into account the quantities of the construction materials and the construction schedule, these works are divided into two work groups. One group will include (a), (c) and (d), and the other group (b). One Japanese expert will be assigned for each work group. In addition, at the beginning of the construction works, two Japanese experts will be assigned for quality control (concrete and soil mechanics). Thus, the following Japanese experts will be assigned;

- (a) Manager**
- (b) Expert (headworks, road improvement and river improvement)**
- (c) Expert (canal system)**
- (d) Expert for quality control (soil mechanics)**
- (e) Expert for quality control (concrete)**

3.1.2 Implementation Conditions

(1) Procedures of Tax Exemption

Tax exemption will be applied for the construction works under the Japan's Grand Aid Program. In Tanzania, Value Added Tax (VAT) of 20 % is imposed by law. MAC, the executing agency, will coordinate the exemption of VAT to the Ministry of Finance (MOF). After receiving the application from MAC, MOF will issue the approval letter to MAC. With this letter, the Contractor will take necessary activities. Different procedures will be applied for import and domestic materials as follows:

- (a) Procedure of tax exemption for import materials (including custom clearance)**
 - 1) An applicant will fill in an application form of tax exemption called VAT 220A(4copies).**
 - 2) The application form will be examined and approved by MAC.**
 - 3) The application form will be sent to the Tanzania Revenue Authority (TRA).**
 - 4) The examined form will be returned to MOF for further check.**
 - 5) The form will be sent to TRA for final approval.**
 - 6) An agency for custom clearance on behalf of the applicant will fill in the documents of custom clearance issued by TRA.**

- 7) The form of tax exemption and the documents of custom clearance will be examined by TRA.
- 8) These will be sent to the company called National Shipping Agency Co., Ltd. (NASACO) dealing with custom clearance.
- 9) After examination by NASACO, these will be sent to the port office.
- 10) The port tariff will be paid, and then the applicant can receive the imported materials without tax.

(b) Procedure of tax exemption for domestic materials

- 1) An applicant will fill in an application form called VAT 220 (4 copies).
- 2) The application form will be examined and approved by MAC, executing agency.
- 3) The application form will be sent to the regional revenue office, for its examination and approval.
- 4) Based upon the approval of the application form, the applicant can receive the materials without tax.

(2) Construction in Existing Cultivated Land

The construction works will be executed in the existing cultivated lands. Regarding suspension of farming during the construction work, it was confirmed through public meetings that the beneficial farmers would cooperate with the contractor so as not to interfere with the construction works. The Contractor, however, should explain to the farmers about construction schedule and sites under attendance of office staff of ZIO, prior to commencement of the construction works.

(3) Environment Impacts during Construction

The possible environment impacts during the construction will be (i) noises due to the construction, (ii) dust mainly from the vehicles, (iii) vibration due to operations of heavy machines, and (iv) traffic accidents. At every construction site, it is likely that no damage to buildings will occur due to noise and vibration. However, considering the inhabitants, night works should be strictly prohibited in principle. In order to avoid dust mainly from the vehicles, spreading of water on the construction road will be carried out properly. In addition, prevention of accidents caused by construction equipment should be encouraged by (i) limiting driving speed, (ii) regular safety assembly, and (iii) deployment of traffic control officer.

3.1.3 Scope of Works

(1) Scope of Works to be executed by Japanese Side

- (a) Detailed design and preparation of tender documents.
- (b) Undertaking of the construction of irrigation and drainage facilities, river improvement, and road improvement as described in Clause 2.3.

(2) Undertaking by Government of Tanzania

- (a) Land provision and arrangement required for implementation of the Project.
- (b) Construction by beneficial farmers under participatory approach plan (excavation work for lateral canals).
- (c) Provision of technical support by DALDO to Mwega WUGs.
- (d) Budget arrangement and payment for import tax, internal taxes, and other levies.

3.1.4 Construction Supervision

(1) Preparation of Detailed Design and Tender Documents

Immediately after signing the Exchange of Note between GOJ and GOT for the detailed design stage, the contract for the consulting services will be concluded between MAC and the Japanese consultant, and then detailed design and tender documents will be prepared in collaboration with MAC. The Consultant should discuss the design and implementation schedule of the works with MAC during the site investigation. During the detailed design stage, the following works will be made;

- (a) Additional investigation / survey
 - 1) Investigation of erosion condition along the Mwega river.
 - 2) Determination of the construction sites of the gabion works
 - 3) Check of positions of the canal related structures.
- (b) Preparation of detailed design
 - 1) Detailed design based on the additional investigation/survey results.
 - 2) Review of the Project cost through the detailed design.
- (c) Preparation of the tender documents
 - 1) Preparation of the tender drawings.
 - 2) Preparation of the tender documents for the construction works.

(2) Tendering and Construction Supervision

Immediately after the Exchange of Note between GOJ and GOT for the construction stage is signed, the contract for the consulting services will be concluded between MAC and the Japanese Consultant, and the tendering works will be started in collaboration with MAC.

The tender for selection of a successful contractor for the construction works will be conducted after approval from MAC for the tendering documents. The first step is the pre-qualification tender, and its notice will be published in the major daily newspapers on construction and economy in Japan on behalf of MAC.

The pre-qualification documents will be distributed by the Consultant to the applicants, and the tender documents will be distributed by the consultant to the pre-qualified applicants. The quoted tenders will be received by the Consultant and opened in the presence of the representatives of MAC. After the opening, the tender evaluation will be made by the Consultant in collaboration with the representatives of MAC, and the draft contract will be prepared by the Consultant based on the tender evaluation result.

Once the contract for construction supervision is concluded for the construction works, the Consultant will review and clarify the construction method and time schedule submitted from the Contractor. The Consultant's resident engineer will be assigned to supervise the construction works with the commencement of the construction, and will regularly report the work progress to both JICA Tanzania office and MAC. The resident engineer will also coordinate the activities by the government agencies concerned with the Project, including the contractor, for smooth implementation of the Project. The scope of construction supervision is summarized as follows:

(a) Evaluation and approval of construction drawings

Evaluation and approval of construction drawings, application for commencement of the works, sample of materials, specifications of the equipment, etc. submitted by the contractor.

(b) Progress and quality control

Checking and guidance on the construction plan and time schedule, progress and quality control of the construction works and necessary inspection of the construction methods.

(c) Approval for the payment to the contractor

- 1) Checking and evaluation of the performance of the works necessary for issuing payment certificates and completion certificate to the contractor.
- 2) Attendance at the handing-over of the completed facilities to MAC after confirming the completion of the works and fulfillment of the contract.

3.1.5 Procurement Plan

Major construction materials for the construction works are cement, aggregates, crushed stones, pre-cast concrete products, forms, reinforcement bars, PVC pipes, etc. These materials are available in Tanzania. On the contrary, sheet piles type II (headworks) and weep holes including T-shaped connection pipes (canal system) are not purchasable, and thus these materials will be imported from Japan.

Since there are several lease companies of construction equipment in Dar Es Salaam and it is possible to lease construction equipment from the regional offices of the Ministry of Works (MOW), the required construction equipment will be leased for this

Project.

3.1.6 Implementation Schedule

(1) Implementation Schedule

As stated in Clause 2.3, the Project will be implemented in the following stages;

(a) Detailed design stage : 4.0 months in total including overlapped 0.5 month

- 1) Detailed design : 2.5 months
- 2) Preparation of tender documents : 2.0 months

(b) Construction stage : 20.5 months

- 1) Tendering works : 2.5 months
- 2) Construction works : 18.0 months

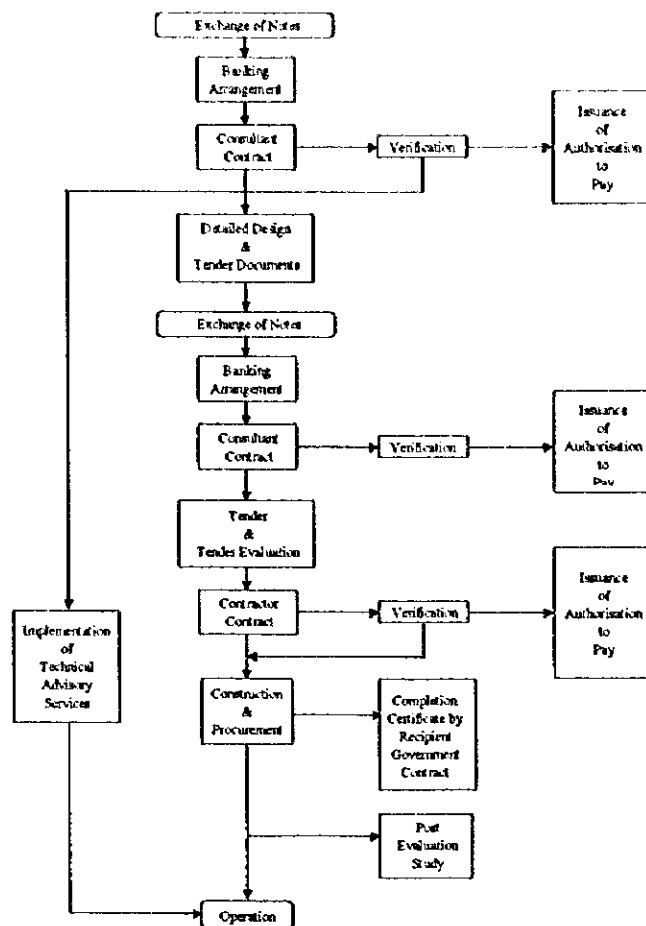
The construction schedule is shown below:

Implementation Schedule

Stage	Contents	2000	2001	2002
Detail Design Stage	Detailed Design	■		
	Preparation of Tender Documents	■		
Construction Stage	Tendering		■	
	Construction		■	■

(2) Implementation Procedure under Japan's Grant Aid System

The project shall be implemented as shown below, taking into consideration the procedures of the Japan's Grant Aid system.



Implementation Procedure under Japan's Grant Aid System

3.1.7 Obligations of Recipient Country

- (a) To obtain water right to satisfy the design intake discharge prior to commencement of construction of the Project facilities.
- (b) To execute land acquisition necessary for construction of the Project facilities, prior to commencement of construction of the Project facilities.
- (c) To execute budget and staff arrangement for smooth implementation of the Project by MAC.
- (d) To make budget and staff arrangement for ZIO which shall be responsible for construction supervision of the Project facilities.
- (e) To provide a technical support to the farmers on excavation of lateral canals under "participatory approach" concept
- (f) To establish and strengthen the Mwega WUG as a core of existing WUGs.
- (g) To provide a technical support to farmers organization on operation and maintenance activities through local governments.

3.2 Operation, Maintenance and Water Management Plan

3.2.1 Government Policy on Operation and Maintenance for Smallholder Irrigation Projects

According to the National Irrigation Development Plan, October 1994, the beneficial farmers shall be responsible for operation and maintenance of the irrigation and drainage facilities. In this Project, it is also confirmed that the Project facilities to be constructed will be operated and maintained by the beneficial farmers under technical support of government agencies concerned.

3.2.2 Operation Plan

(1) Kilosa Office of District Agriculture and Livestock Development Officer (KDALDO)

KDALDO will be responsible for technical support to the Mwega WUG, which will execute the operation and maintenance of the Project facilities. KDALDO presently consists of 4 Sections of Irrigation Development, Extension Services, Livestock Development and Crop Development. Out of them, the Irrigation Development Section is directly related to the Mwega WUG on operation and maintenance activities.

If the re-structuring plan is realized, these 4 Sections would be narrowed down to the 3 Sections of Cooperative Development, Crop Development and Livestock Development as shown in Figure-3.2.1. In this plan, the Crop Development Section will provide the technical support for WUG in the Project.

As of April 1999, KDALDO has a staff of 112 consisting of one Officer, 29 Experts, 12 Ward Extension Officers, and 70 Village Extension Officers.

At present, the Project area is provided with one Irrigation Technician and one Village Extension Officer for technical support to farmers. The Irrigation Technician has made The Irrigation Technician and Village Extension Officer prepare and send a monthly report to KDALDO. Based on this report, KDALDO takes actions if necessary.

In order to execute operation and maintenance works by farmers, it is necessary that KDALDO give farmers more supporting activities such as initial training, field training, and follow-up training as shown in Table-3.2.1.

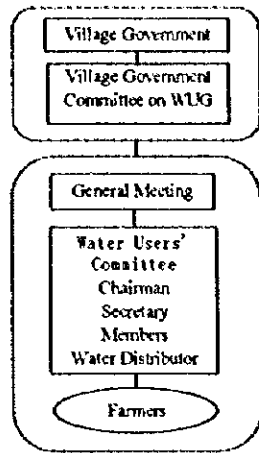
Also, KDALDO shall assign one Irrigation Engineer and one Marketing/Credit Expert to the Project, in addition to the existing Irrigation Technician and Village Extension Officer, to realize effective operation and maintenance activities by farmers. In the future, the Irrigation Technician and Village Extension Officer will be transferred to the Mwega WUG.

(2) Water Users' Group (WUG)

(a) Existing WUGs

There are 7 WUGs in the Project area: Nyinga, Mwengere—Chuma, Mgogoji—

Mwega, Canal--A, Canal--B, Canal--C and Canal--D Water Users' Groups as shown in Figure-3.2.2. The organization structures of these WUGs are mostly similar as shown below:



Structure of Existing WUG

The establishment years of respective WUGs are 1960 for Nyinga, 1963 for Mwengere--Chuma, 1965 for Canal A, 1976 for Canal B, C and D, and 1985 for Mgogoji--Mwega. A WUG generally consists of a Chairman, a Secretary, and several Water Distributors. The number of farmer ranges from 30 to 300, depending on their command areas. The major duties of WUGs are water distribution and maintenance of canals. Rotational irrigation is applied along the canal, and irrigation time is determined at a general meeting. Maintenance of the canal is carried out by farmers' communal work. Almost

all farmers take part in the communal work. WUG imposes a fine upon absentees, which ranges from Tsh.500 to Tsh.2,500 depending on WUGs.

(b) Need of Strengthening of WUGs

All the Project facilities will be operated and maintained by beneficial farmers in line with the government policy. Accordingly, beneficial farmers are requested to formulate a WUG to cope with this policy on the implementation of the Project. There are 7 WUGs in the Project area, but they are weak and do not have enough capability to fulfill the proper operation and maintenance of the Project facilities. In connection with the integration of the canal system under the Project, it is essential to establish a firm WUG by unifying the existing WUGs, to keep the Project sustainability.

(c) Strengthening Plan of the Mwega WUG

The Mwega WUG would consist of 4 functions: general meeting, executive committee, service sections, and auditing, as shown in Figure-3.2.3. The existing WUGs will be incorporated into the Mwega WUG as Water Users' Sub-Groups (WUSGs). The proposed 15 WUSGs shown in Figure-3.2.4, have the same functions as the Mwega WUG. These functions are detailed as follows:

1) General Meeting

The General Meeting is a deliberative organ in the Mwega WUG, and will be held at least once a year. It will perform the following activities:

- Election of the executive committee members and the auditor.
- Approval of the auditing results.

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

2) Executive Committee

The Committee is composed of a Chairman, a Vice Chairman, General Secretary, a Treasurer, an Auditor, and several members who are representatives of the service sections. All of these posts should be opened to both genders. A regular meeting will be held monthly.

The main tasks of the Committee are (i) to prepare the annual management plans, (ii) to instruct and supervise activities implemented by the service sections, (iii) to manage complaints and grievance from the farmers, (iv) to arrange and appoint volunteers to work in service sections, (v) to manage accounting and general affairs, and (vi) to coordinate with other agencies and associations.

3) Service Sections

Under the instruction and supervision for the Executive Committee, the routine service works are implemented by 4 sections, namely (i) O&M, (ii) Agriculture, (iii) Marketing and Credit, and (iv) Women's Group. The main activities of these sections are as follows:

Main Activities of Service Sections

O & M Section	Preparation of annual irrigation schedule.
	Management of communal works such as canal clearing and canal repairs.
	Estimate of irrigation service charge
	Security service for irrigation facilities.
Agriculture Section	Transmission and notification of information for extension implemented by Village Extension Officer and officers in KDALDO.
	Information services for new farming practices and varieties.
	Arrangement of farmers' meetings on agricultural extension.
	Promotion, arrangement and guidance for group farming such as communal control of pests and diseases, transplanting and harvesting.
Marketing and Credit Section	Implementation of cooperative purchasing and shipping.
	Arrangement of storage facilities for farm inputs and products.
	Agricultural credit services.
	Exploitation of new marketing channels.
Women's Group Section	Promotion for women's agri-business and cottage industry
	Promotion of homestead development
	Improvement of social welfare and health care.
	Educating activities on home economy and management.

4) Auditing Section

Although the registered farmers' cooperatives should be subject to auditing by authorized organizations like Cooperative Audit and Supervision Corporation (COASCO), it is proposed that the Mwega WUG have an auditing system in

addition to the above official auditing. Namely, the Auditing Section or Committee, which consists of several volunteers (beneficiaries), is established apart from the Executive Committee. This Section always checks the Mwega WUG's accounting including collection of irrigation service charge, and reports those results at the General Meeting.

5) Strengthening Plan of WUGs

Attachment-3 gives the detailed strengthening plan of WUGs.

3.2.3 Maintenance Plan

(1) Need of Maintenance Work

Maintenance work aims to keep proper functions of the Mwega headworks, settling basins, canals and related structures, to make stable water abstraction and delivery irrigation water to fields on time, and is thus indispensable for the increase of agriculture production as planned and also to ensure the Project sustainability.

(2) Demarcation of Maintenance Work

Operation and Maintenance work is demarcated as follows:

- Mwega WUG : O & M of common facilities (headworks, right main canal, left main canal, related structures, access road, Malolo-Chabi road, stabilization of Mwega river)
- WUSGs : O & M of lateral canals (lateral canals, related structures)

(3) Major Items of Operation and Maintenance Work

Major Items of Operation and Maintenance Works

Mwega headworks	Conditions of floating debris in front of intake and scouring sluice gates
	Conditions of intake and scouring sluice gates
	Conditions of stilling basin and concrete slabs downstream from scouring sluices
	Sinking condition of gabions
	Conditions of operation deck and handrail
Main canals and related structures	Check on occurrence of cracks on concrete block lining and base concrete
	Inspection of joints of concrete block lining
	Sediments condition on canal
	Erosion and grass growing conditions on canal embankment
	Sediments condition on settling basin
	Inspection of gate on settling basin
	Inspection of gauging staff at settling basin
	Inspection of stilling basin of drop
	Sediments condition of turnout
	Conditions of stop logs on turnout
	Conditions of handrail for road bridge
	Riverbed condition around abutments and pier of road bridge
	Floating debris condition upstream of submerged bridge
	Lateral canals and related structures
Existence of cracks and animal holes on canals	
Erosion on downstream canal of drop	

For these items, regular inspections will be conducted, to ensure stable water abstraction and distribution. In particular, attention shall be paid to the crack condition of the canal prior to the commencement of irrigation, to minimize canal conveyance loss.

3.2.4 Water Management Plan

(1) Intake Discharge

In view of seasonal irrigation demand and comparatively abundant water resources, the intake discharges for the Left and Right Main Canals are divided into the following 3 seasonal variations:

Design Intake Discharge

Description	Jan. -- Mar.	Apr. -- Mid. Oct.	Mid. Oct. -- Mid. Nov.	Mid. Nov. -- Dec.
Left Main Canal				
Intake Discharge (l/s)	520	290	0	290
Right Main Canal				
Intake Discharge (l/s)	370	210	0	210

To make gate operation easier, the corresponding water levels will be painted on the staff gauge of the measuring device installed at the end of the settling basin (for example, black paint for 520 l/s, and red paint for 290 l/s). Thus, gate opening will be adjusted using these marked water levels.

(2) Operation of Left and Right Main Canals

Canal discharge in the Left and Right Main Canals follows the intake discharge mentioned above. Canal water in the Main Canals flows continuously.

(3) Water Distribution Method at Turnout

Canal water is distributed in proportion to the commanded area by one lateral canal. To simplify the stoplog control, canal water to be distributed is only for 2 cases, 100% and 55% of distribution discharge, estimated in proportion to the commanded area by one lateral canal, and corresponding water levels are painted on side wall of turnout structure for easy operation.

(4) Water Supply Method along Lateral Canal

Water supply along the lateral canal is conducted using rotational irrigation method since paddy and upland crop fields exist in the same command area. The rotational irrigation method will be easily accepted by the beneficial farmers, because (i) the existing WUGs serve as WUSGs in the new WUG, (ii) one WUSG governs one lateral canal branched off from the main canal in principle, and (iii) the rotational irrigation is presently applied by the existing WUGs, although at a primitive level.

3.2.5 Operation, Maintenance and Water Management Manual

(1) Need of Manual

As the Project facilities consist of headworks, settling basins, concrete block lining and numerous related structures, and operation and maintenance for them are conducted by the Mwega WUG, it is essential to prepare an O&M manual for Mwega WUG to properly carry out operation and maintenance work.

(2) Contents of Manual

The O&M manual will be composed of operation, maintenance and water management. The manual should be so prepared in simple terms to be easily understood by the Mwega WUG, and contain the operation rule of intake and scouring sluice gates, frequency and time of sluice gates of settling basins, repairing method of concrete block lining, control of stoplogs at turnout, rotational irrigation method along lateral canals and so on. The manual shall be updated from time to time by an Irrigation Technician under the technical support of KDALDO, based on results of actual activities.

3.2.6 Possibility of Payment of Irrigation Service Charge and Annual Membership Fee

The Mwega WUG will collect the irrigation service charge covering all O&M costs of the Project facilities from the beneficial farmers. In addition, the Mwega WUG will collect from the farmers the annual membership fee to cover the Mwega WUG's supporting activities such as marketing and credit services. The required amounts for the irrigation service charge and annual membership fee are estimated and examined whether those are payable or not from the farm economy under the "with project" condition.

(1) Present Collection Condition of Irrigation Service Charge

At present, the Canal A WUG is collecting an irrigation service charge of Tsh.1,000 per year from the beneficial farmers, but other existing WUGs are not collecting any irrigation service charge. The irrigation service charge collected by the Canal A WUG is used for maintaining the water right, which was granted last year. The collection rate of the irrigation service charge is less than 20%. Such a low collection rate is mainly due to (i) low farm income, and (ii) shortage of irrigation water. Although the farmers recognized the need of irrigation service charge for operation and maintenance of the Project facilities according to the farmers interview survey, the large magnitude of floods from the end of 1997 to March 1998 put spurs to the lower collection rate of irrigation service charge. The existing irrigation facilities were severely damaged, so a stable water supply could not be made and agriculture production remarkably decreased, which resulted in less farmers' income.

(2) Estimate of Irrigation Service Charge

The irrigation service charge covers the salary of watchman for headworks, maintenance cost of water right, replacement cost of gate, screen, and material costs of facilities. The salary of the Irrigation Technician and Village Extension Officer will also be included in the service charge in the future, to mitigate government financial burden. Laborers for maintenance work will be voluntarily supplied by the farmers. The irrigation service charge is thus estimated at Tsh.17,000/ha, the breakdown of which is tabulated below:

Breakdown of Irrigation Services Charge

Item	Amount (Tsh.)
(1) Salaries of Irrigation Technician, VEO and watchman	108,000
(2) Maintenance cost of water right (Water Office rule)	978,000
(3) Replacement of gates, screens and so on	3,658,000
(4) Material cost	4,212,000
(5) Miscellaneous (10% of the above)	896,000
Total	9,852,000
Per ha	17,000

(3) Estimate of Annual Membership Fee

Annual membership fee covers the operation cost for the general meeting and executive committee including supporting services. Chairman and members shall be voluntary services. The annual membership fee is thus estimated at Tsh.1,200 as shown below:

Breakdown of Annual Membership Fee

Item	Amount (Tsh.)
(1) General Meeting	30,000
(2) Executive Committee	60,000
(3) Furrow Committee	600,000
(4) Transportation cost, etc.	120,000
(5) Miscellaneous (10% of the above)	81,000
Total	891,000
Per household	1,200

(4) Capacity to Pay

The feasibility study indicates that the average land holding size in the Project area is 0.79ha, and net reserve is estimated at Tsh.832,000 as shown below:

Estimate of Net Reserve

Item	Amount (Tsh.)
(1) Gross Income	1,178,000
(2) Production Cost	334,000
(3) Income Tax	12,000
(4) Net Reserve (= (1)-(2)-(3))	832,000

While, the irrigation service charge and annual membership fee for an average holding size farmer come to Tsh.14,600 in total, which is equivalent to only 1.8 % of the net

reserve. From these figures, it is clear that the total of irrigation service charge and annual membership fee can be paid by the beneficial farmers and would not create any heavy financial burden.

Also, the farmers interview survey relates that the amount payable by farmers is Tsh.17,000/ha on an average. From this survey result, it is deemed that Tsh.14,600 of the above amount could be accepted by farmers.

3.2.7 Possibility of Subsidization to O&M Cost by Traded Crops Levy

The Malolo village government in the Project area collects the traded crops levy from traders at the rate of Tsh.200/bag for agricultural products. After implementation of the Project, the anticipated incremental crop production of paddy, maize, and onion are 780 tons, 858 tons and 1,570 tons, respectively. Due to this incremental crop production, the traded crops levy would be increased by Tsh.6,283,000 consisting of Tsh. 1,950,000 for paddy, Tsh.1,716,000 for maize and Tsh.2,617,000 for onion. As a result, the increased traded crop levy would be estimated at Tsh.471,000 for the Malolo village government using the present allocation rate of 7.5%. This amount could be used for a part of the O&M cost mentioned above. Concurrently, the Kilosa District Council could obtain Tsh.5,812,000 of revenue increase due to this incremental crop production. Therefore, it is expected that the Kilosa District shall strengthen technical support to the Project using this increased revenue.

3.3 Improvement Plan of Marketing System

As stated above, the marketing system will be improved in combination with the strengthening plan of the Mwega WUG, using the following stepwise development method:

Improvement Plan of Marketing System

Improvement Plan	1st Step		2nd Step		3rd Step	
	2000	2001	2002	2003	2004	2005
Construction	█					
Water Users' Group (WUG)						
- Preparatory work	█					
- Operation			█			
Agricultural Inputs/Outputs						
- Action by aggressive Groups	█					
- Action by WUSGs						
- Action by WUG					█	

Note: WUSGs: Water Users' Sub-Groups, WUG: Water Users' Group

(1) First Step (about 2 years)

The farmers will cease individual negotiation with traders, and make aggressive groups for more favorable negotiation with the traders. This is regarded as the first step in the introduction of marketing services to the Mwega WUG in the future. The first step could be easily conducted by farmers themselves under the technical guidance of KDALDO, prior to the implementation of the Project.

(2) Second Step (about 2 years)

The interested groups will become cores for the improvement of the marketing system for WUSG. At the second step, a marketing system will be controlled by respective WUSGs.

(3) Third Step

Selling of agricultural production and purchasing of agricultural inputs which will have been executed by respective WUSGs, will be conducted by the Mwega WUG. In negotiation with traders, constant purchasing of many agricultural inputs and a well-planned selling schedule will lead to more advantageous situations to farmers. In order to attain this step, however, the Mwega WUG envisages some problems to be settled, such as financial constraint and establishment of confidence among farmers, and should therefore be provided with enough technical support from KDALDO and other government agencies.

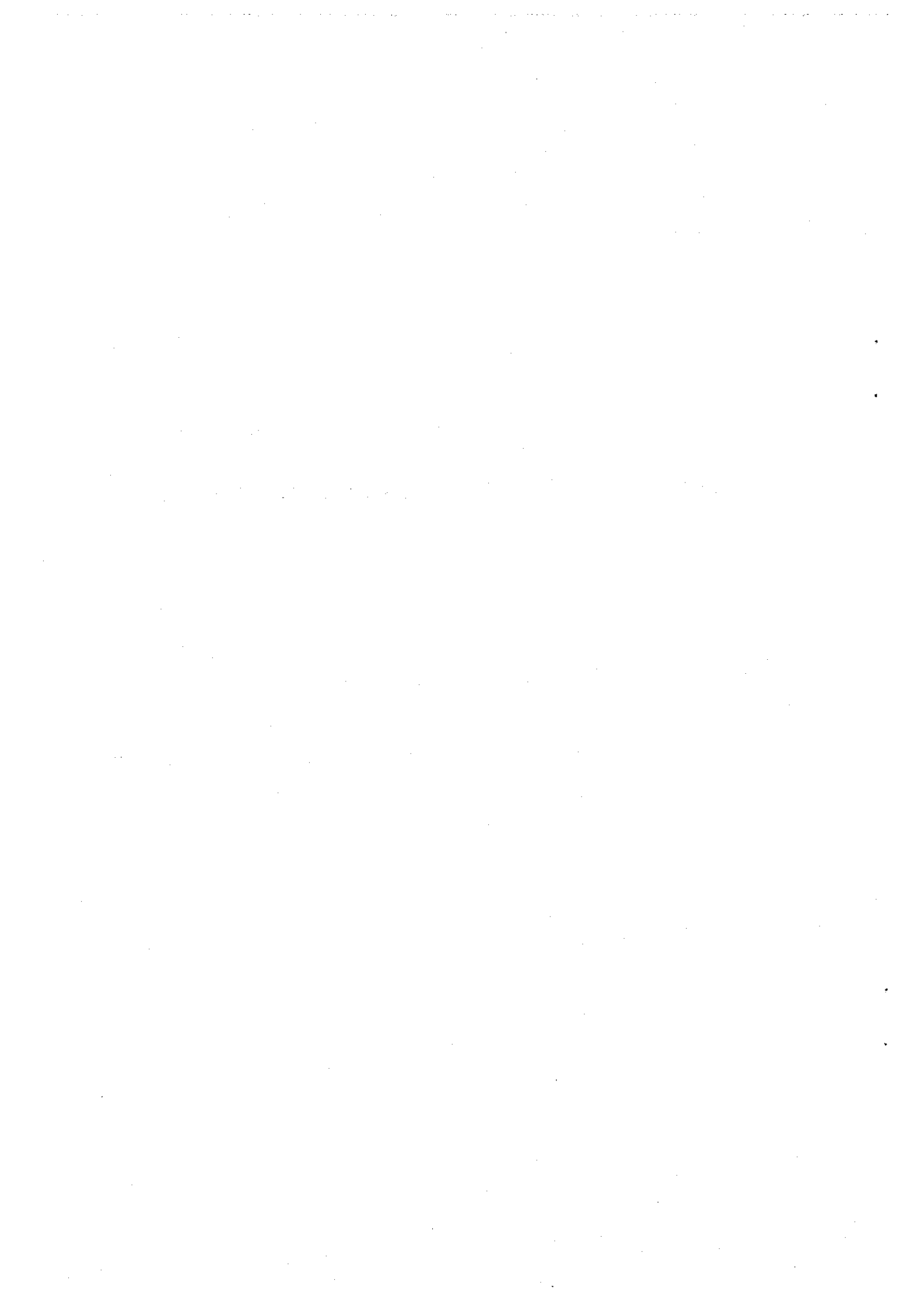
3.4 Need of Technical Assistance

It is essential to organize a well-planned WUG and to strengthen the agricultural extension services to support it, to keep the targeted agricultural production through proper operation and maintenance of the Project facilities.

In the Project area, there are 7 existing WUGs, but they are institutionally weak and have insufficient building capacity. Thus, a key point to a successful Project is to strengthen WUGs and to provide them with sustainable operation and maintenance and competent agriculture extension services in the light of integration.

In the Project, it is planned that strengthening of the Mwega WUG and agricultural extension services will be executed by ZIO in Morogoro Region, KDALDO and KDCO as shown in Table-3.2.1. The government officers are therefore required to be involved in the Project implementation and the agricultural extension services to the Mwega WUG and farmers. For the more successful and effective implementation of the Project, it might be necessary to upgrade knowledge of these government officers as well as beneficial farmers.

CHAPTER 4
PROJECT EVALUATION AND RECOMMENDATIONS



CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effect

The implementation of the Project under the Japan's Grant Aid is judged viable for the following reasons:

- (1) The Project will contribute to improvement of farmers' economy and living condition through stability and increase in production of staple foods and cash crops by means of rehabilitation of existing irrigation facilities for the stable water abstraction and timely water distribution.
- (2) The Project is one of 156 priority traditional smallholder irrigation schemes selected in the National Irrigation Development Plan. The Project is therefore highly expected to be a model pioneer project for the development of the remaining 155 schemes.
- (3) The Project would present local government staffs and farmers participating in construction stage a big chance for obtaining technical knowledge on construction of small irrigation and drainage facilities. The acquired knowledge would be very useful for the operation, maintenance and repair of them.
- (4) The Project would substantially contribute to the mass transportation of agricultural products and inputs and thus to drastically activate the local economy in Chabi and Mgogozi villages as well as Malolo village by improvement of the access road from National Road A7 to the Malolo village and the Malolo-Chabi road with provision of a new bridge across the Mwega river.
- (5) The Project will generate employment opportunities for unskilled workers during construction period, and also create a demand for farm labour arising from the increased farming activities due to intensive use of the land resulting from year-round irrigation.
- (6) The Project would be conducive to activation of regional economy since bearing the gross production of Tsh.929 million in 1996 price at full accomplishment of its production target, equivalent to about 1.5% of Morogoro regional GDP in 1994.
- (7) The Project would create a opportunity of women's involvement in activities related to education, culture, leisure, etc. due to the increased level of income and improvement of production conditions.

4.2. Recommendation

Through the field investigations in Tanzania and studies in Japan, it is concluded that the implementation of the Project is suitable and viable for Japan's Grant Aid. The

Project would contribute to not only increase of farmers' income and living standards through stabilization and increase of agricultural production, but also activation of regional economy, which are main targets of agriculture sector in the Rolling Plan and Forward Budget.

MAC has a plan to transfer the operation and maintenance function to the beneficial farmers in accordance with the government policy. In order to execute successfully such transfer and to keep the Project sustainability, it is necessary to provide the technical support for them through strengthening of staffs and budget of ZIO and DALDO.

Judging from the circumstances around the Project, it is expected that the Project will be implemented smoothly and effectively with due consideration and realization of the following commitments by GOT:

- (1) Obtain the water right satisfying the water demand by the proposed cropping pattern, prior to commencement of the Project implementation.
- (2) Execute the land acquisition necessary for rehabilitation of the Project facilities.
- (3) Provide the technical support and timely supervision for beneficial farmers on excavation of lateral canals under the "farmers participatory approach" concept.