PART - I BACKGROUND INFORMATION

CHAPTER I. INTRODUCTION

1.1 Authority

This is the Study Report on the Smallholder Irrigation Projects (the Project) in the Central Wami River Basin, Morogoro region, the United Republic of Tanzania. The study on the Project was performed for one year and five months from July 1996 to November 1997 in accordance with the Scope of Work (S/W) agreed upon between the Ministry of Agriculture and Cooperatives (MAC), the Government of Tanzania (GOT) and the Japan International Cooperation Agency (JICA) on March 19, 1996.

The Report is composed of three volumes: Volume I: Main Report, Volume II: Annexes, and Volume III: Drawings. The Main Report is practically the summary text on the formulated Project, while the Annexes present the results of both the master plan for irrigated agriculture development in the Central Wami River Basin and the feasibility study on the selected four priority irrigation schemes in the same Basin.

1.2 History of the Project

GOT has made utmost efforts to support smallholder farmers, and has been promoting extension of irrigated farming technologies since the late 1980s, as the most important subject in the agricultural sector development. In collaboration with UNDP/FAO, MAC formulated the "National Village Irrigation Development Program (NVIDP)" and set forth the basic strategy on irrigation development for the entire country. MAC later prepared and launched the "National Irrigation Development Program (NIDP)" in April 1994. In implementing NIDP, MAC first grouped the irrigation schemes into six irrigation zones, and reviewed all the existing small scale irrigation schemes as well as those proposed by the local authorities. As a result of this action, MAC prepared the implementation plan (I/P) on 156 priority schemes which were selected basically in due consideration of technical, economic, and social aspects as well as willingness of the beneficiaries concerned in each scheme. The major schemes included in I/P consist of rehabilitation of the irrigation-cum-drainage facilities and/or expansion of irrigable areas. In NIDP, MAC gives high development priority to the traditional smallholder irrigation schemes in the Morogoro Irrigation Zone. These schemes are generally recognized as the essential areas for production of the staple food crops especially rice and maize, and at present, are playing the role of granary for consumers in Dar es Salaam. Thus, GOT is expecting that the irrigation schemes selected in the Morogoro Irrigation Zone will ensure increase of food crop production through improvement of the existing irrigation system, and accordingly, contribute to the national food security as well as rural poverty alleviation.

Against the above background, GOT requested the Government of Japan (GOJ) on May 24, 1993, to extend technical assistance for execution of the Feasibility Study on the Project in the Central Wami River Basin of Morogoro Region. GOJ accepted this request, and JICA dispatched a Preparatory Study Team on March 19, 1996 for reviewing the proposed Project and set up S/W with GOT for extending technical assistance for the respective study and development planning for the proposed smallholder irrigation schemes.

1.3 Scope of Work under JICA Technical Assistance

The main objectives of JICA technical assistance set forth in S/W are as follows:

1) To conduct a field reconnaissance survey for preparing the master plan for irrigated agriculture development in the entire Central Wami River Basin, and then, to select priority-cum-model development schemes for feasibility study.

2) To conduct the feasibility study and prepare the implementation plan for each selected priority scheme.

3) To transfer technology to the counterpart personnel in the course of the above two works.

To the above end, GOT proposed 16 smallholder irrigation schemes as the essential areas to be subject to study and development planning. Thirteen of these schemes, have been more or less developed with the traditional irrigation furrow system, while the remaining three are new schemes for irrigation development. The total area of these subject schemes is primarily estimated at 8,000 ha, of which 5,395 ha had been developed as irrigable land under the existing 13 irrigation schemes.

In S/W, the above-mentioned works are scheduled to be performed in the following three phases:

(1) Phase-I (Master Planning)

- To perform the reconnaissance survey and prepare the master plan for the Project with reference to the development policy of GOT as well as development needs and wishes of the farmers in the Basin. The master plan will include the basic approach to the Project and fundamental framework on irrigated agriculture development covering 16 irrigation schemes proposed by MAC in the entire Central Wami River Basin.

- To select the priority development schemes according to the case study to be made in the said master plan. Feasibility study on the selected priority development schemes will be conducted in Phase-III.

(2) Phase-II (Aerial Photo-shooting and Ground Control Survey)

- To carry out aerial-photo shooting (scale of 1:10,000) and ground control survey necessary for preparation of the detailed topographic map (scale of 1:5,000) for the priority development area selected in the Phase-I study.

(3) Phase-III (Aerial Photo-mapping and Feasibility Study)

- To prepare the detailed topographic map on a scale of 1:5,000 with contour lines at 1.0 m intervals and interpolation at 0.5 m based on the aerial-photos and the ground control survey results obtained in the Phase-II.

- To perform the feasibility study and prepare the irrigated agriculture development plan for the priority development schemes.

1.4 Performance Progress of the Study Works

1.4.1 Phase-I (Master Plan Study)

The field investigation and study at the project site were carried out during three months from July 6 until October 3, 1996. The field investigation included such technical observations as river discharge and water quality (EC and pH), soils and land use, inventory and structural functions of the existing furrow irrigation systems, growing conditions of the dry season crops, etc. The field study was conducted to grasp socio-economic aspects including farmers' organizations and community or co-operative activities, agricultural production, activities of institutional support services, etc. The initial environmental examination (IEE) was carried out extensively in the entire Central Wami River Basin according to the IEE guideline of JICA.

In addition to the above, the farm economic survey, soil and water quality analyses were conducted on a sub-contract basis by the Sokoine University of Agricultural in Morogoro city. The development needs of the beneficiaries were confirmed by means of "Questionnaire to the Beneficiaries" in parallel with the field interview of farmers in each scheme.

In succession to the above field works, the master planning for the Project, including preparation of the basic concept, development framework, and preliminary design of each scheme was made in Tokyo. The master plan was prepared with particular emphasis on the following programs:

1) Intensification of land use and increase of agricultural production;
2) Rehabilitation and/or improvement of the existing irrigation systems;
3) Improvement of the access road and its related structures, i.e. bridges, culverts, etc.;
4) Community development and reinforcement of the farmers' organizations, especially the water users' association; and
5) Reinforcement of the agricultural and irrigation technology extension services.

The technical feasibility and socio-economic viability of each scheme were assessed on a preliminary basis.

The priority development schemes were selected according to the specific criteria prepared based on the results of the field investigation as well as the information obtained through field interview of leading farmers and the representatives of village societies. Each of 16 candidate schemes was evaluated from the technical, sociological, institution and organization, financial, economic and environmental viewpoints, covering 54 check items in total. As a result, 6 representative schemes, i.e. Mgeta, Mgongola, Mkula, Nyinga, Malolo, and Mgogozi-Mwega have been selected out of the respective 16 schemes.

1.4.2 Phase-II (Aerial Photo-shooting and Ground Control Survey)

The field works in Phase-II, i.e. aerial photo-shooting and ground control survey were commenced on January 6, 1997 and successfully finished by March 6, 1997 as scheduled. In succession to the field works, aerial triangulation was executed as the essential preparatory work for aerial photo-mapping in Tokyo.

1.4.3 Phase-III (Aerial Photo-mapping and Feasibility Study)

(1) Aerial Photo-mapping

Based on all the results of the Phase-II works, the detailed topographic maps of the respective 6 priority areas were prepared in Tokyo, and completed on May 6, 1997. The aerial photo-shooting and mapping areas are as summarized below:

Aerial Photo-shooting and Mapping Area by Scheme

Name of Scheme	Aerial Photo-shooting Area	Aerial Photo-mapping Area
	(Km^2)	(Km^2)
Mgeta Scheme	2.0	1.5
Mgongola Scheme	27.0	17.0
Mkula Scheme	12.0	9.0
Nyinga, Malolo and Mgogozi-Mwega Scheme	40.0	22.5

(2) Feasibility Study on Selected Priority Schemes

The field work of feasibility study on the respective 6 priority irrigation schemes was commenced on May 10, 1997 and finished on August 22, 1997.

The field investigation and study were first performed to grasp the rainy season conditions in the Project area, i.e. rainfall distribution and seasonal flooding, cropping work, socio-economic and cultural activities, etc. The field work also included collection of detailed data and relevant information required for compilation and finalization of the proposed development plan, design of each scheme, and satisfactory evaluation of the technical feasibility and economic viability of the Project. The technical observation and data collection included river discharge, soils and land use, detailed inventory of the existing traditional irrigation furrow system and its related structure, growing conditions of the rainy season crops, etc. Socio-economic aspects including farm economy of individual households, farmers' organizations and community or cooperative activities, agricultural production and marketing system, institutional support services, etc. were also investigated. The survey works were mostly done by means of questionnaire to the concerned village government and/or farmers' community societies, direct interview of farmers, and data collection from out-side sources. Particular attention was paid to the following points:

1) Present conditions of the irrigation-based agricultural production activities in the Central Wami River Basin, including structural function of the existing irrigation schemes, impacts of irrigation development, activities of agricultural extension services.

2) Institutional and organizational set-up of the water users' groups for operation and maintenance of the irrigation facilities

3) Background conditions of each scheme, i.e. the farm economy of irrigation beneficiaries as well as their technical experiences of both irrigation and agricultural production.

In parallel with the above works, technical discussions with and verbal inquiries to representatives of the village government, village community societies including the women's societies/groups in the respective scheme areas were held at the early stage of field investigation using such technical materials as the basic framework on irrigated agriculture development and primary layout of each scheme, which had been formulated during the master planning study in 1996. Besides, a "Public Meeting with Irrigation Beneficiaries" was held as an essential part of the program on "Farmers' Participatory Approach to the Project". These two programs have dual purposes: to first motivate the irrigation beneficiaries in irrigation-based agricultural development; and to confirm how the farmers wish to develop the existing irrigation schemes. Many farmers including a number of women participated in the above discussions and aggressively brought their comments on the proposed development plan and design of the schemes.

As for the engineering study, geo-technical investigation including core boring, standard penetration test, permeability test and laboratory test on samples from geological formations was carried out at the proposed intake-weir site and its alternative sites in Malolo-Nyinga-Mgogozi Mwega complex scheme. The works were conducted on a sub-contract basis by the Central Materials Laboratory (CML), Dar es Salaam. Soil mechanical investigation and laboratory tests on soil and aggregates were also performed on a sub-contract basis also by CML. Besides, the canal route survey was carried out according to the proposed layout of irrigation and drainage systems in each scheme. An intensive grid-leveling survey was also made in a typical part of the scheme areas so as to clarify the micro-relief conditions and determine whether leveling work is required or not for on-farm development. The works were conducted on a sub-contract basis by ARDHI Institutes, Morogoro.

In addition to the above, field investigation for environmental impacts assessment (EIA) was performed in collaboration with the local consultant ARDHI Institutes. Special attention was paid to four essential aspects: (a) influence of water-borne epidemic diseases due to expansion of irrigable area, (b) water contamination due to increase of agro-chemical utilization, (c) degradation of natural vegetation and/or reduction of forest resources due to certain increment of fuel-wood consumption because of upgrading of farm economy, and (d) social conflicts related to land allocation, irrigation water utilization, etc. These aspects had been clarified through the initial environmental examination (IEE) in the master planning study in Phase-I in 1996, and identified as the most critical concerns out of negative impacts which may occur during and/or after implementation of the Project.

Based upon all the data and relevant information obtained through the above field investigation and study, formulation of the Project, preliminary design of each scheme as well as preparation of the implementation plan were made in Tokyo. Technical feasibility and socio-economic viability of the Project were justified from the engineering, social, economic, financial, institutional and organizational, and environmental viewpoints. Prospective development impacts were assessed with particular attention to effective utilization of natural resources, upgrading of farm economy, contribution to regional economy and national food sufficiency program, and environmental conservation effects. Besides, the implementation plan, including farmers' participatory approach to be applicable to that was studied taking the above concern into account.

1.5 Acknowledgment

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CHAPTER II. GENERAL BACKGROUND OF THE PROJECT

2.1 Socio-economic Setting of Tanzania

2.1.1 Present Conditions of Socio-economy in Tanzania

Tanzania has an area of 945,200 km^2 consisting of 943,200 km^2 in the Mainland and approximately 2,000 km^2 in Zanzibar and Pemba. The land area of Mainland is 881,300 km^2, the remaining 61,500 km^2 consist of lakes, rivers, and reservoirs. Approximately half of the total land area is composed of forest and woodland, about 40% of savanna grassland, and only 8% is being cultivated.

The total population was estimated at about 28.8 million as of the end of 1994, of which approximately 23.0 million or almost 80% live in the rural area. In the last decade, the population increased at a rate of 2.8% a year, while the urban population, which was estimated at about 5.8 million, grew rapidly at a rate of 7% to 8% per annum. The country has a low population density of about 32.8 persons/km^2, although there is a great internal variation. In some parts of the north and west highlands, the population density is several hundred persons per km^2, while very low density is observed in the dry west and/or central savanna areas. A small percentage of the rural population is engaging in fisheries as the main means of livelihood, either in coastal sea or in rivers, lakes or reservoirs.

In the 1960s, the national economy performed favorably with a GDP growth of about 5% annually. During the years from 1973 to 1984, however, its performance slowed down and brought about severe macro-economic imbalances due mainly to a series of external shocks, i.e. quadrupling oil prices, drought, breakup of the East African Community, the Kagera War with Uganda, expansion in debt-servicing, etc. combined with poor economic management policies. Encouraging signs of economic recovery were observed during the period of implementation of the Economic Reform Program, and in fact, GDP annual growth reached 5.5% in the years 1986 to 1990 and 4.3% from 1991 to 1996.

Gross Domestic Product (at Constant 1985 Prices)

Economic Sectors	GDP (Tsh. million)					Average Growth Rate (%)	
	1986	1988	1990	1993	1996	1986-90	1991-96
Agriculture	51,634	59,380	66,084	81,965	94,339	5.8	6.1
Mining & Quarrying	333	317	428	1,182	1,542	5.6	25.1
Manufacturing	9,772	11,183	12,038	11,144	10,711	4.4	-1.8
Tourism & Commerce	14,195	15,988	17,105	20,417	23,100	18.8	23.5
Others	25,750	34,730	37,158	36,690	40,965	9.0	2.8
Total	101,684	121,598	132,813	151,398	170,657	5.5	4.3
GDP per Capita	4,638	5,245	5,329	5,592	5,607	2.9	3.6

Source : Economic Bulletin of the Bank of Tanzania (March 1997)

Concerning poverty, the World Bank set up a relative poverty line of Tsh. 46,173 per capita per annum in 1991 to measure the level of poverty. It was found that about 59% of rural households are poor compared to 39% of households outside Dar es Salaam and 5% in Dar es Salaam. Even though the results were obtained for the year 1991, the conclusion that poverty is one of the main and pressing problems to be tackled by the Government is still valid at present.

2.1.2 Present Conditions of the Agriculture Sector in Tanzania

Agriculture is the mainstay of the national economy. It absorbed almost 84% of the employed population and generates almost 50% of GDP and 75% of the foreign exchange earnings. More than 90% of farmers (or about 3.7 million farm households) are smallholder farmers who have less than 2 ha of land, and of them, some 3.5 million are cultivating 0.9 ha on an average. The majority of agricultural products, especially the staple food crops, i.e. maize and rice, are produced by the said smallholder farmers.

In the Mainland, approximately 5.9 million ha of agricultural land have been developed up to present. The agricultural land belonging to smallholder farmers is about 4.5 million ha (or about 76% of the total agricultural land), and out of which, about 4.13 million ha are being cultivated for annual crop production, while the rest is used for pasture, forest and/or other purposes. Irrigation has been provided so far for 160,000 ha, which correspond to only 3.8% of the total cultivated land. Cultivated area and production by major crop in 1994 are summarized as follows:

Cultivated Area and Production by Major Crop

Major Crops	Cultivated Area (10,000 ha)	Production (10,000)	Unit Yield (ha)	Major Crops	Cultivated Area (10,000 ha)	Production (10,000/t)	Unit Yield (t/ha)
Cereals	340	374	1.1	Root-crops	94	221	2.4
Maize	190	228	1.2	Beans	65	43	0.7
Sorghum	70	50	0.7	Industrial Crops:			
Paddy	45	64	1.4	Cotton	53	15	0.3
Millet	25	20	0.8	Coffee	30	7	0.2
Wheat	8	6	0.8	Sisal	6	3.5	0.6

Source Ministry of Agriculture and Cooperatives

Cereals are the most important crops in the country. Among cereals, maize is the most preferred food crop. Rice has recently become very important not only as a staple food but for the good returns it fetches in the urban markets. Production of the staple food crops in the past four years from 1991 to 1994 is as follows:

Production of Major Cereal Crops

Year	Maize	Wheat	Rice
1991	2331	84	624
1992	2226	65	392
1993	2282	59	641
1994	2159	59	614

Note: Unit: 1,000 tons, Data source: MDB

Food production generally balanced with the demand, although there were localized intermittent deficits in some areas caused by drought and inadequate distribution structure. Production of industrial and/or export crops was also good; however, export performance of the traditional crops was poor in this period due mainly to unfavorable prices in the international market in case of coffee, cotton and pyrethrum and inadequate processing facilities in case of cotton. In contrast, export of the non-traditional crops, i.e. groundnut, cowpeas, sunflower, soybean, etc. showed significant performance with export earnings increasing from US$ 25.6 million in 1990 to US$ 53.23 million in 1992.

Imported of agricultural products are mainly cereal crops for supplementing the domestic food production. Since 1992, imports of maize and rice have increased significantly. According to the Food Security Department, all of the 61,150 tons of maize imported in 1994 were donations, while the bulk of rice, 41,000 tons, and all of the 50,500 tons of wheat imported in 1994 were commercial imports by private traders.

The economic performance of the agriculture sector during the past three years of 1991 to 1993 was recognized as quite satisfactory, if compared with a population growth at 2.8% per annum on an average for the same period. Namely, the growth of agricultural GDP was 4.0% in 1991, and increased to 4.4% in 1992 and 7.3% in 1993. In 1994, however, the overall performance of agricultural production slowed down to a serious extent. Food production decreased about 30% decreased because of drought in the short rainy season (Vuli) and two-month delay of the long rainy season (Masika) in the Southern Highland regions where maize production accounts for almost 70% of the national output. Since then, the national food deficit became about 435,000 tons of cereal equivalent. The industrial/export crops, especially coffee and cotton, were also affected by drought problems.

2.1.3 Necessity and Importance of Structural Improvement in the Agriculture Sector

As stated above, the agriculture sector continues to play the most important role for maintaining the national economy, however, it has a delicate structure for production against the physical constraints since its structural improvement is still at the primary level. Accordingly, to sufficiently support the national food security program as well as satisfactorily maintain the foreign trade balance, further expansion and stabilization of the agricultural production are essential and the primary subject of the agricultural sector.

To successfully perform sustainable agricultural development, it is indispensable to consolidate the existing agricultural land through improvement of such physical constraints as shortage of irrigation water, poor drainage, salinity and/or alkalinity problems, infertile soils, etc. as well as reinforcement of the agricultural infrastructure especially for marketing of the agricultural commodities. It is also essential to motivate greater population of smallholder farmers through promotion of a participatory approach to the agricultural development, and then, to adjust the productive structure in agriculture from the extensive operational form of large scale national farms to the intensive operational form of smallholder farming. In the current implementation of the Socio-Economic Development Program (the Rolling Plan and Forward Budget: 1994/95 - 1996/97), GOT is making utmost efforts to develop the agriculture sector with particular emphasis on (i) activation of smallholder farming as well as agricultural investors in the private sector; (ii) production increase of the export-oriented economic crops; (iii) development of agricultural infrastructure especially for improvement of accessibility to

the market; and (iv) elimination of primary constraints through structural improvement of the existing traditional irrigation systems.

2.1.4 Current National Program on Agriculture Sector Development

To successfully accomplish agricultural development as mentioned above, GOT is implementing the following three national development programs:

(1) National Irrigation Development Program (NIDP)

Some 100,000 farm families are currently self-supported in agricultural production with the traditional irrigation system. Traditional irrigation schemes are in most cases required to be upgraded and/or rehabilitated to allow increased water use efficiency, due to fair wear and tear, increase in population pressure (necessity of wider irrigable land), degradation of vegetation in the catchment area that causes a reduction of water discharge especially in the dry season, occasional rapid flooding in the rainy season, and perhaps change in local climate resulting in drought even in the rainy season, etc. Despite the vast rainfed arable potential, irrigation, especially for the traditional smallholder areas, has a vital role to play in achieving the following primary objectives:

- To satisfy subsistence requirement in many parts of the country;
- To generate the local surpluses of main staples, particularly maize and rice, in order to facilitate food security at regional or national levels; and
- To ensure the production much needed for dietary supplement, i.e. vegetables, fruit, oil seeds, etc.

In NIDP, the strategy framework for implementing the policy on irrigation development has been established with particular attention to "rehabilitation or upgrading of the existing traditional irrigation schemes". To this end, GOT expected that the maximum impact will have to be brought by farmers themselves with their independence of mind in the participatory approach to irrigation development.

(2) National Special Program on Food Production in Supporting Food Security (SPFP)

SPFP has started since May 1995 under technical and financial assistance of FAO. This program is practically the pilot project for promotion of the food crop production increase, specifically maize in upland fields and rice in lowlying fields, and growing up the participatory smallholder farmers' groups[1]. The specific terms and essential subjects of the program are as follows:

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[1] The registered participatory farmers' group means the farmers' group who has been organized by farmers themselves based on the participatory program of SPFP, and has registered with the Ministry of Home Affairs taking through the legal procedure specified. Under assistance and supervision of the District Extension Officer, the farmers' group shall prepare and establish the by-law and/or necessary constitution. Opening of its bank account in authorized bank(s) is also subject to successful registration.

For Maize Production:

- Two to 3 years for primary operation at the first stage,
- Introduction of high yielding varieties, i.e. "Staha (composite)" and "TMV 1 (hybrid)"
- More adequate control of plant spacing
- Protection against pest and diseases
- Seed treatment
- Oxenization, including land preparation, weeding, transportation, etc.
- Farm ridge formation as one of the water harvesting means for utilizing rainwater efficiently.
- Increase of the present yield by 2 to 2.5 times (to 4 to 5 tons/ha).

For Rice Production:

- Construction of farm ridges as one of the water harvesting means for utilizing floodwater efficiently.
- Introduction of the improved varieties, Line 88 and TXD 85, which had been developed by the Chollima Agro-scientific Research Centre.
- Introduction of the transplanting method by the use of space marker (simple lining implement) as well as through improvement of the direct seeding method using drill seeder.
- Introduction of the rotary weeder for weeding
- Introducion of soil fertilization technology
- Extension of the seed production technology for upgrading the quality of farmers' own seeds
- Extension of the use of foot-pedal thresher
- Increase of the present yield by 3 times or more (to 4 to 5 tons/ha).

In the above context, it is also scheduling to provide a short term credit (6-month term and credit in kind, i.e. farming implement and inputs) for the registered participatory farmers' groups through the National Agricultural Inputs Trust Fund (NAITF) which has been established under financial assistance of FAO.

(3) Agricultural Extension and Financial Supporting Service Programs

MAC started the National Agricultural and Livestock Extension Rehabilitation Project (NALERP) since 1988/89 with financing from the World Bank (IDA), the African Development Bank (AFDB), and the Government of Tanzania. It was focused on enforcement of extension system, upgrading quality of extension officers, and provision of physical infrastructure and logistical support to the system. It has covered 16 regions of Mainland including Morogoro region. In parallel with the above program, the Southern Highlands Extension and Rural Financial Services Project, which covers the remaining 4 regions including Zanzibar, has been launched in 1993/94 under financial assistance of IFAD. NALERP was officially closed on September 30, 1996.

The National Agricultural Extension Program Phase-II (NAEP-II) has been successively implemented since October 8, 1996 as Phase-II of NALERP. The objectives of this programme are to continue to improve the delivery of extension services to smallholder farmers in order to improve crop productivity and cost effectiveness as well as farmers' living standards. Major extension services provided under NAEP II consist of

four components; (i) institutional strengthening, (ii) extension education and training, (iii) extension communication support, and (iv) pilot initiatives.

2.2 Environmental Protection and Conservation Issues

There are various efforts to address the environmental problem in Tanzania through policy, program and legislative framework. It includes the preparation of a National Conservation Strategy for Sustainable Development (NCSSD, 1993), the Draft National Environmental Policy (NEP, 1996) by the Environmental Sector, Division of Environment of the Vice-president Office; a National Environmental Action Plan (NEAP) in June 1994 by the Ministry of Tourism, Natural Resources and Environment; and the Overview Study Results of Existing Legislation Pertaining to Environment by the Division of Environment of the Ministry and National Environmental Management Council (NEMC, 1993).

The overall objectives NEAP are outlined below:

- To ensure sustainable and equitable use of resources for both present and future generations without degrading the environment.
- To prevent and control degradation of life support system.
- To conserve and enhance natural and man-made heritage, including bio-diversity of the unique ecosystems of Tanzania.
- To improve the condition and productivity of degraded areas for all nations.
- To raise awareness and understanding of the linkages between the environment and development and to promote participation in environmental action.
- To promote international cooperation on the environment agenda.

An agricultural policy was prepared in 1983 by MAC. In 1995, the policy was revised and clearly stated the specific objectives to promote integrated and sustainable use and management of natural resources in order to conserve the environment. Concerning irrigation development, the following objectives for wetland management were considered:

- To promote integrated and sustainable use and management of natural resources such as land, soil, water, and vegetation.
- To promote efficient utilization of irrigation water and proper drainage to avoid water logging which causes soil salinity as well as health problems to the community.
- To organize farmers' groups and associations which will be facilitated to undertake activities including distribution of cattle, inputs, management of grazing lands and dips.

In addition, as leading agencies (MTNRE, 1994), the organizations, which are addressed to conduct the National Environment Action Plan, are in the process of preparing an environment management system within the present parent bodies. The required actions of MAC as a Lead Agency are outlined below;

- Strengthening of soil and water conservation activities.
- Re-assessment of range management in the communal sector and re-appraisal of livestock marketing.
- Prevention of environmentally detrimental methods of tse-tse fly control by bush clearing and its related land degradation.
- Improvement of water management in irrigation schemes.

2.3 Socio-economic Setting of Morogoro Region

The total administrative area of Morogoro region is estimated to be 73,000 km^2. Morogoro had a population of 1.25 million in 1990, and it is growing at a rate of 2.8% annually. Around 85% of the population lives in rural areas. The population density is as low as 17 persons per km^2 on an average. However, within the district there are extensive forestry areas, sisal plantations, and national parks and wildlife reserves, therefore most of the people have to compete for available land. It is estimated that there are approximately 1.9 million rural households. On an average, each household has 5.1 members, which does not differ much from the national average. The proximity to Dar-es-Salaam has a positive economic impact on the Morogoro region; the regional economy enjoys a comparatively prosperous condition. However, the smallholder farmers are the core of economic activities in the regional agriculture sector.

The following Table provides information on production, cultivated area, and the unit yield for major food crops for the period of 1987/92.

Cultivated Area, Production, and Unit Yield of Major Crops in Morogoro Region

	Cultivated Area (1,000 ha)			Production (1,000 tons)			Unit Yield (ton/ha)		
	94/95	95/96	96/97	94/95	95/96	96/97	94/95	95/96	96/97
Maize	140	119	129	227	210	225	1.6	1.8	1.7
Paddy	92	86	81	181	167	166	2.0	1.9	2.0
Cassava	23	16	25	90	65	133	3.9	4.1	5.3
Sorghum	35	30	21	86	30	24	2.5	1.0	1.1
Potato	4	2	2	23	9	7	5.8	4.5	3.5
Legumes	28	17	8	25	14	7	0.9	0.8	0.9

Of major crops cultivated in the region, rice is an essential product not only as staple food but also as a cash source in farm economy. Morogoro is one of the main producers of rice in Tanzania. Paddy is being cultivated mainly in the rainy season under the following irrigated conditions: 1) rain-fed; 2) floodwater-fed, and 3) artificial irrigation. The first two irrigation types are extensively prevailing in the region. For the variety of rice, the "Supa-India" is the most common and popular among the rice producers and consumers.

The livestock production in the region is the traditional types of cattle, sheep, goat, pigs, etc. The table below gives information on livestock in the last 5 years:

Present Conditions of Livestock in Morogoro Region (Unit: 1,000 heads)

Main Livestock	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Cow	366	374	382	390	398	405
Sheep	53	53	53	53	53	53
Goat	169	176	184	192	200	209
Pig	10	11	11	12	12	13

The suppression of price controls on agricultural products as a part of the policy of free market adopted by the Government has given an incentive to commercialization of products by private enterprises and co-operatives. However, smallholder farmers do not have direct access to the markets and, therefore have to depend on intermediaries for the

commercialization of their products. On the other hand, subsidies for agricultural inputs like fertilizers or agro-chemicals have been suspended as part of the economic reform policy adopted by the Government. Prices of farm inputs vary freely according to the market demand and supply and prices and sometimes are too expensive for the smallholder farmers, forcing them to use inputs in lower amounts than recommended. Specially for paddy production, fertilizers or agro-chemicals have not been used in recent years.

PART - II MASTER PLAN STUDY ON THE SMALLHOLDER IRRIGATION PROJECTS IN CENTRAL WAMI RIVER BASIN

CHAPTER III. MASTER PLAN ON IRRIGATION-BASED AGRICULTURAL DEVELOPMENT IN CENTRAL WAMI RIVER BASIN

3.1 Present Conditions of the Central Wami River Basin Area

3.1.1 Location of the Study Area

The Central Wami River Basin (the Study Area) lies between 36° to 38° east longitudes and 6° to 8° south latitudes. More specifically, the Basin extends in the western part of Morogoro city, the capital of Morogoro region which is located about 200 km west of Dar es Salaam. The Study Area extends at the middle and upper reaches of the Wami river, including a small part of the Ruvu and Rufiji river basins. Its physiographical area is approximately 11,460 km^2. Administratively, the Study Area belongs to three districts of Morogoro region, i.e. Morogoro, Kilosa, and Kilombero.

3.1.2 Physical Nature of the Study Area

(1) Physiographical Zoning

The Study Area could be divided into four physiographical zones: "cool and wet climate mountainous sloped zone", "savanna climate alluvial plain zone", "savanna climate piedmont plain and fan zone", and "semi-arid climate valley and riverine terrace zone" taking into account the topographic condition, soils, river system, climate, and vegetation. Major characteristics of each zone are tabulated below.

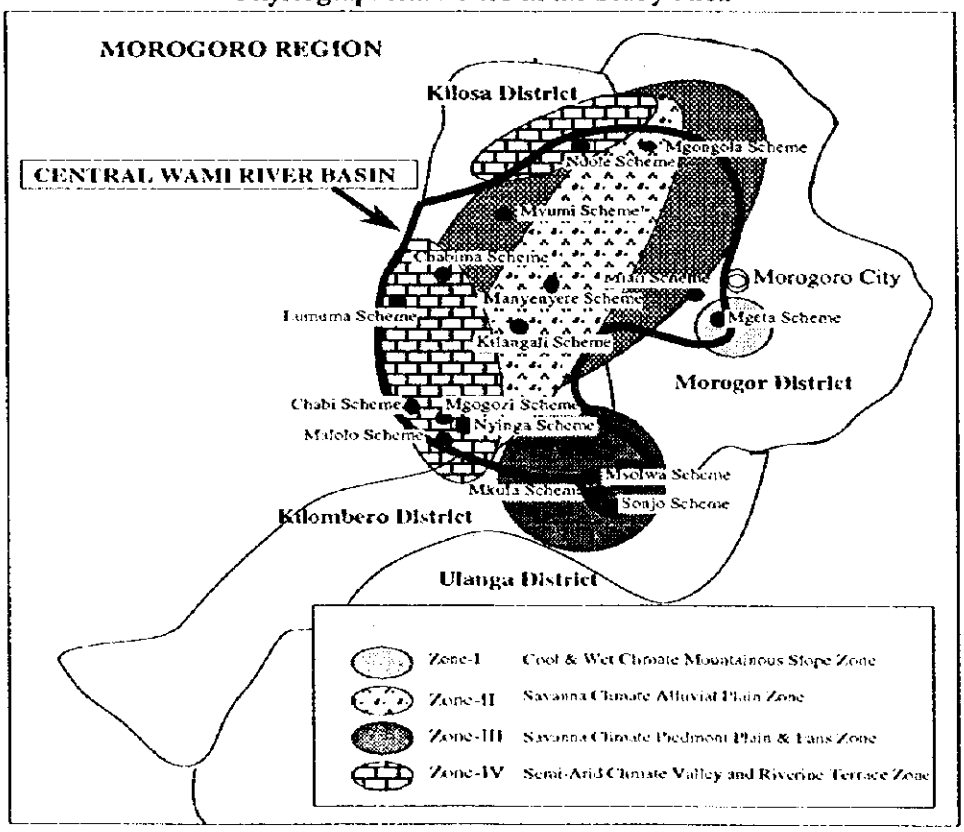
Specific Zones		Major Characteristics
Zone-I:	Cool and Wet Mountainous Zone (Uluguru Mountains)	- High altitude, extremely steep slopes, narrowly dissected by eroded gullies having serious environmental hazards, i.e. soil erosion, landslide, watershed degradation, etc. - Eutric Cambisols with undifferentiated soils on Pyroxene Granulite rocks having shallow effective soil layer and coarser textures. - High annual rainfall of more than 2,000 mm - Monsoon forest type vegetation in forest reserve, while maze and vegetables in the cultivated area
Zone-II	Savanna Climate Alluvial Plain Zone (Mkata Plain)	- Lowlying flat plain having a large swampy depression - Quaternary alluvium to be classified into Eutric and Gleyic Fluvisols associated with Luvic and Vertic Cambisols. These soils are clayey to sandy loam in texture and relatively fertile - Deep inundation of 40 to 100 cm during the rainy season - Grass savanna associated with swampy vegetation in the non-reclaimed area, while extensive cultivation of paddy in the reclaimed area.

(to be continued)

Specific Zones		Major Characteristics
Zone-III	Piedmont Plain and Fan Zone (Surrounding Mkata and Msolwa Plain)	- Gently undulating topography at the foot of mountains, and flat in lowlying flood plain downward - Eutric Cambisols originating from the Post Miocene deposits on the Precambrian rocks in piedmont plain, while Eutric Fluvisols (recent alluvium) in the fan formation - Bush/grass savanna vegetation in the non-reclaimed area. In cultivation area, maize is predominant in piedmont plain and fans, while paddy in the seasonal flood plain.
Zone-IV:	Valley/Riverine Terrace Zone	- Narrow peneplain (fans) and riverine terraces having nearly flat in swamp to gently sloped topography. - Eutric Fluvisols associated with Eutric and Chromic Cambisols originating from the quaternary alluvium having loamy to sandy in texture. - Baobab-cactus type vegetation associated with acacia-grass savanna vegetation in the uncultivated area, while maize, paddy, onion, etc. in the cultivated area.

The Figure below shows the distribution of the physiographical zones in the Study Area.

Physiographical Zones in the Study Area



(2) Meteorology

The Study Area lies between the Tropical Monsoon Climatic Zone in the east coast area and the Semi-arid Climatic Zone in the central to westernmost area in Tanzania, and is characterized as the Tropical Savanna Climate having two distinct seasons, i.e. the rainy season and dry season. The rainy season is divided into two sub-seasons: the short rainy season (locally called Vuli) from November to January, and the long rainy season from February to May (Masika). The general air-flow system is defined by the topography and it influences the rainfall pattern. The typical rainfall pattern and other climatic parameters in the Study Area are as shown in the following two tables:

Rainfall Data

Name of Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Bunduki	202	147	287	371	182	39	31	47	89	177	304	306	2,190
Kilangali Farm	134	89	147	151	46	5	5	8	14	24	77	131	828
Maskati	125	105	177	278	143	27	19	27	27	62	107	177	1,313
Mlali	112	41	197	202	83	5	1	4	16	44	90	104	902
Kisangata Sisal	112	89	151	192	89	14	11	2	19	24	52	98	777
Kilombero	173	126	249	336	136	25	19	9	16	43	108	178	1,425
Lumuma	121	83	149	234	125	19	10	5	17	51	79	117	1,045
Malolo	60	48	60	61	15	6	4	0	0	3	24	64	362

Climatic Parameters in the Study Area

Parameters	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(1) Mean Maximum Temperature (℃)	31.8	32.0	31.8	30.1	28.9	28.1	27.9	28.6	30.5	32.1	32.9	32.3
(2) Mean Minimum Temperature (℃)	21.0	21.1	21.2	20.8	19.2	16.4	15.5	15.9	17.3	19.4	20.7	21.0
(3) Mean Temperature (℃)	26.4	26.6	26.5	25.5	24.1	22.3	21.7	22.3	23.9	25.7	26.8	26.7
(4) Relative Humidity (%)	82.7	83.4	84.8	86.8	85.3	81.6	79.8	77.9	74.5	74.1	74.9	78.8
(5) Sunshine Duration (hr/day)	7.2	7.3	7.3	5.8	5.9	7.2	7.0	6.6	6.9	7.8	8.2	7.6
(6) Solar Radiation (l/day)	16.8	18.4	15.5	13.9	12.6	12.8	12.7	12.9	15.1	15.9	17.5	16.8
(8) Evaporation (mm/day)	5.8	6.7	5.6	3.9	3.1	3.1	3.4	4.1	5.6	6.3	6.7	6.3
(7) Wind Velocity (m/s)	1.9	1.7	1.4	1.0	0.9	1.1	1.3	1.5	1.8	2.1	2.1	2.1

(3) Hydrology

The Study Area is fed by the Wami river system and partly by the Ruvu river system in the south-easternmost part and by the Rufiji river system in the south-westernmost part. The Wami river and its tributaries originate in the Nguru and Rubeho mountains and flow down into the Mkata Plain. Major tributaries of the Wami river are the Mkata, Mkondoa, and Miyombo rivers. The Ruvu river and its tributaries such as Ngerengere and Mgeta rivers receive their water from the Uluguru mountains. Small tributaries like Mlali river suffer from sedimentation in fan formation. In the Rufiji river basin, the small tributaries such as Msolwa, Sanje, Mkula and Sonjo rivers originate from the Gologolo Mountains, and flow through the fans into a lowlying flood plain, the Msolwa Plain, and then extend to the Kilombero Plain. The Mwega river is also a tributary of the Rufiji river flowing through the Great Ruaha river.

Generally, these rivers have a shallow bottom at their lower reaches due to heavy siltation, and accordingly, their river courses are changed easily whenever a large seasonal flooding occurs. Heavy sediment load and unstability of these rivers are one of the serious physical constraints in irrigation development in the Study Area. In fact, the following troubles and/or damage have appeared up to present: Burying of the intake

structures by sediment, difficult intake of a irrigation water due to change of the river course, and crop damage by seasonal floods.

The run-off patterns of six major rivers in the Study Area, i.e. the Miyombo, Mkindo, Sonjo, Lumuma, Mwega, and Mohazima are summarized below:

Run-off Pattern of Major Six Rivers (unit : m^3/s)

River Name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Miyombo	5.1	4.4	6.8	10.1	8.4	5.6	3.5	2.7	1.8	1.8	2.9	5.3	4.88
Mkindo	3.0	4.4	9.0	11.1	8.2	3.9	2.5	2.0	1.7	2.8	3.8	3.7	4.66
Sonjo	0.8	0.8	1.9	3.6	2.3	1.2	0.6	0.4	0.3	0.2	0.5	0.6	1.10
Lumuma	1.8	1.9	2.0	4.7	2.0	1.3	0.9	1.1	0.9	2.1	4.3	3.5	2.20
Malolo	5.6	5.1	4.3	6.1	5.7	4.3	3.5	2.9	1.6	2.6	3.1	5.0	4.15
Mohazima	1.8	1.9	1.8	2.1	1.5	0.9	0.7	0.7	0.5	0.6	0.7	1.1	1.19

(4) Soils

The soils in the Study Area are classified into two great soil groups of "Fluvisols" and "Cambisols" according to the soil classification standard (Soil Map of the World) specified by FAO/UNESCO. These soils are further sub-classified into 6 sub-groups and 11 soil phases taking into account the soil texture, drainability, effective soil depth, etc. as shown in the following table.

Soils in the Study Area

Zone*	Soil Name	Texture	Drainability	Soil Depth	Topography	Legend
I	Eutric Cambisols	L - SCL	well	0.5-1.5m	mountain	CM-a
II	Luvic Cambisols	SL - L	moderately well	>1.5m	alluvial plain	CM-d
II	Vertic Cambisols	CL - SC	poor to imperfect.	>1.5m	alluvial plain	CM-e
II	Eutric Fluvisols	SL - LS	moderately well	1-1.5m	levee	FL-a
II	Gleyic Fluvisols	CL - SiCL	poor	>1.5m	alluvial plain	FL-f
II&III	Eutric Fluvisols	CL - SiCl	imperfectly	1.5m	alluvial plain	FL-a
III	Eutric Fluvisols	CL - SiC	imperfectly	1-1.5m	fan	FL-c
IV	Eutric Fluvisols	LS - SL	imperfect. to well	0.5-1.5m	valley bottom	FL-d
IV	Eutric Fluvisols	SL - CL	poor	0.5-1.5m	valley bottom	FL-e
IV	Eutric Cambisols	L - CL	mod. well to well	1-1.5m	terrace	CM-b
IV	Chromic Cambisols	SL - L	well	0.5-1.5m	terrace/foothill	CM-c

Remarks *: Zone I: Mountain range, Zone II: Alluvial plain,
Zone III: Piedmont/fan, Zone IV: Valley and riverine terrace

Most of the soils are relatively fertile and have sufficiently large moisture holding capacity suitable for crop cultivation and irrigation practices. With small exception, the soils developed on steep slope have a shallow effective depth, course texture, and therefore, high erodability.

(5) Vegetation and General Land Categories

The Study Area is approximately 11,460 km^2, corresponding to about 15.7% of the total area of Morogoro region (73,040 km^2). About 38% of the area is covered with forests of which some 3,630 km^2 are registered as forest reserves and the remainder is still open woodland; about 30% belongs to the savanna and partly bush; and 32% or approximately 370,510 ha is agricultural land inclusive of village yards, etc. Of the total

agricultural land, an estimated area of 60,000 ha is under cultivation by smallholder farmers, and the greater remainder belongs to large scale state farms, i.e. sugar and sisal plantations. Only 5,000 ha (8%) of smallholder farms are irrigated and the remaining farmland is cultivated under rain-fed and/or floodwater-fed conditions. The land distribution by topographic zone is as follows:

Land Distribution by Topographic Zone

(Unit: ha)

Topographic Zones		Physical Extent	Area Covered with Natural Vegetation	Agricultural Lands
I	Mountainous Ranges	255,550	253,550	2,000
II	Flood Plains	500,000	425,000	75,000
III	Piedmont Plains & Fans	377,000	94,250	282,750
IV	Valley & Riverine Terraces	13,450	2,690	10,760
	Total	1,146,000	775,490	370,510

3.1.3 Socio-Economic Setting in the Study Area

(1) Administrative Divisions and Demographic Data

Each village in the Study Area consists of a few to several tribes. Those inhabitants are organized into the traditional village community and conduct social as well as economic activities without any serious conflicts between them. The table below presents the demographic data by administrative division corresponding to the representative 16 irrigation schemes in the Study Area:

Administrative Division and Population (1996)

Scheme	District	Division	Ward	Village	Population	Household
1) Mgeta	Morogoro	Mgeta	Langali	4 villages	6,740	1,348
			Tchenzema	4 villages	7,020	1,404
			Kikeo	2 villages	13,130	2,626
			Bunduki	2 villages	2,460	492
2) Manyenyere	Kilosa	Masanze	Mabwerewere	Tindiga	4,500	750
				Malui	4,000	667
			Kilangali	Kivungu	2,940	490
3) Kilangali	Kilosa	Masanze	Kilangali	Kilangali	3,040	434
4) Mgongola	Morogoro	Mvomero	Hembeti	Mkindo	4,220	844
				Dihombo	1,850	370
				Hembeti	2,400	480
5) Mlali	Morogoro	Mlali	Mlali	Mlali	2,625	526
				Kipera	3,111	622
6) Mvumi	Kilosa	Magolo	Msowero	Mvumi	7,448	1,863
7) Msolwa	Kilombero	Kidatu	Sanje	Msolwa	2,996	500
8) Mkula	Kilombero	Mang'ula	Mkula	Mkula	2,940	490
9) Sonjo	Kilombero	Mang'ula	Mkula	Sonjo	1,774	253
10) Chabima	Kilosa	Masanze	Masanze	Chabima	700	140
11) Lumuma	Kilosa	Kidete	Lumuma	Msowero	1,080	154
				Idole	3,060	437
				Mkughulu	1,300	186

(to be continued)

Scheme	District	Division	Ward	Village	Population	Household
12) Ndole	Morogoro	Mvomero	Maskati	Ndole	1,043	260
13) Nyinga	Kilosa	Mikumi	Malolo	Malolo	200	50
14) Malolo	Kilosa	Mikumi	Malolo	Malolo	3,800	475
15) Mgogozi	Kilosa	Mikumi	Malolo	Mgogozi	1,265	211
16) Chabi	Kilosa	Mikumi	Malolo	Chabi	1,076	180

Of the 16 irrigation schemes, 5 (Mgeta, Manyenyere, Mgongola, Mlali and Lumuma) cover 2 or 3 wards each while the rest only one ward each.

(2) Rural Infrastructure

1) Roads

The existing access roads to the respective scheme areas in the Mountainous and Valley/Riverine Terrace Zones generally run along river meandering with ups and downs through the hills. Traficability of these roads is generally poor. The roads are as narrow as 3 m wide in most cases. Many of them have no river crossing structures. Therefore, they are hardly practicable for vehicles during the rainy season, especially for the road from Kilosa via Chabima to Lumuma. This road meanders acutely with ups and downs, and has no river crossing structures in the section after the Chabima scheme area.

In the Alluvial Plain Zone, the road system is composed of unconsolidated earth roads constructed with muddy alluvium and without pavement or embankment. During the mid rainy season from February to March, it is often submerged by floodwater at some sections where the land is depressed. These roads have to be improved with provision of drain culverts, road embankment, and pavement.

In the Piedmont Terrace and Fan Zone, access to the schemes is easy in most cases since the schemes are located quite close to the consolidated trunk roads. However, almost all access roads to the headworks and/or the cultivated fields are poor like in other areas.

2) Other Social Infrastructure

Each village has a primary school. In some cases, however, the facilities are dilapidated and not always functioning well due to lack of maintenance. Also, there is a lack of teaching materials at some schools. Most of the villages have a dispensary or have one relatively near them. These dispensaries usually are only for first-aid services. The staff usually consists of a medical assistant and/or registered nurse. For cases which require better equipment and staff, the patient must be taken to a urban center to be attended there.

As most of the villages do not have tap water, they have to be fetched from rivers or shallow wells. Sometimes the water source is not near the village and fetching water several times per day is too much time-consuming. Water-borne diseases i.e. diarrhea, colitis, are common. Lack of electricity severely limits economic activities, especially those related to storage and processing of agricultural products.

(3) Socio-economic Activities

All the villagers have, more or less cultivated land within the village area, and earn their incomes from crop production. However, since most of their land is not satisfactorily consolidated yet, the agricultural production is still at the subsistence level. Nevertheless, agriculture provides employment to more than 95% of the economically active population in the villages. The activities are carried out in their own fields, third-party fields, and private and parastatal estates. The commerce and service sector do not provide employment in a significant way. Seasonal employment becomes an important source of income especially for young villagers who do not own lands and have to supplement the income received from working at their families' fields by hiring themselves to third parties.

3.1.4 Present Agricultural Setting in the Study Area

(1) Land Use

The present agricultural land use in the respective 16 scheme areas is as summarized below:

Agricultural Land Use in the Study Area

Schemes by Zone	Net Agricultural Land (ha)			Cultivated Area (ha)			Cropping Intensity (%)
	Irrigated Area	Rainfed Area	Toal	Wet Season	Dry Season	Total	
Zone I							
Mgeta	1,600	3,110	4,710	4,710	1,600	6,310	134
Zone II							
Manyenyere	290	1,250	1,540	1,540	0	1,540	100
Kilangali	65	495	560	560	0	560	100
Mgongola	40	2,710	2,750	2,750	40	2,790	101
Zone III							
Mlali	2	838	840	840	130	970	115
Mvumi	8	1,620	1,628	1,628	0	1,628	100
Msolwa	0	900	900	900	400	1,300	144
Mkula	0	630	630	630	280	910	144
Sonjo	0	350	350	350	150	500	143
Zone IV							
Chabima	0	240	240	240	20	260	108
Lumuma	380	280	660	660	280	940	142
Ndole	8	110	118	118	8	126	107
Nyinga	90	60	150	150	40	190	127
Malolo	400	210	610	610	160	770	126
Mgogozi	220	0	220	220	35	255	116
Chabi	270	10	280	280	200	480	171
Total	3,373	12,813	16,186	16,186	3,343	19,529	121

Note: *1 : As for cultivated area in the dry season, some cultivated area under rainfed in which soil moisture is maintained by high groundwater and cultivated area of sugarcane which has long growth period are respectively included.
*2 : Mwega sub-scheme in Mgogozi scheme is included.
*3 : Kikalo sub-scheme

Irrigation activities in the Study Area are limited to 20 % of the total agricultural land due to bad conditions of irrigation facilities and damage by frequent occurrence of seasonal flooding in the rainy season. Irrigation efficiency has also gone down due to heavy sedimentation at the intake weir and major canals, resulting in some difficulty in water distribution and water management.

1) Zone-I: Cool & Wet Mountainous Zone

The agricultural land in the Mgeta scheme area is wholly reclaimed on steep mountainous slopes. In the rainy season, maize, beans, peas, etc. are cultivated mainly under the rainfed condition, while in the dry season, vegetables and beans are the essential crops for marketing. Since there is a certain rain distribution even during the dry season, beans are grown mostly under rainfed conditions. Such vegetables as cabbage, lettuce, cauliflower, leek, etc. are grown under fully irrigated conditions.

2) Zone-II: Savanna Climate Alluvial Plain Zone

Some part of the cultivated area in the respective schemes is categorized as irrigable land. The irrigable land is, however, not always irrigated sufficiently due to poor functioning or low working efficiency of the irrigation facilities. Accordingly, most of the agricultural land in this zone is cultivated under rainfed conditions, except about 40 ha of paddy field in the Mkindo Irrigation Scheme which was developed as the pilot project in the upper reaches of the Mgongola scheme. Paddy is the main crop in the lowlying area where seasonal flooding occurs in the rainy season. Maize, sorghum, cotton, and such oil seeds as sunflower, sesame, etc. are major crops grown in rather elevated area.

3) Zone-III: Savanna Climate Piedmont Plain & Fan Zone

Paddy is the main crop in the lowlying fan formation, while maize, beans and other upland crops are grown in the piedmont plain and upper reaches of the fan formation. In an exceptional case in the Mvumi irrigation scheme area, double cropping of maize and beans is being practiced by farmers in the areas where soils are sufficiently moistened by capillary water from shallow groundwater even in the dry season. Other than those crops, sugarcane is extensively cultivated under rainfed conditions in and around the piedmont plains and fans in the Mkula, Msolwa, and Sonjo scheme areas.

In the Mlali scheme, the existing irrigation facilities are not functioning well due to degradation of the intake weir and main irrigation canal caused by heavy siltation. Therefore, majority crops are grown mostly under rainfed conditions. In the dry season, tomatoes are cultivated in a small extent using the natural soil moisture maintained by shallow groundwater.

4) Zone-IV: Semi-arid Climate Valley/Riverine Terrace Zone

In the schemes in this zone except the Chabima and Ndole schemes, the riverine terraces are intensively utilized for agricultural production throughout the year under fully irrigated conditions. The major products are maize and paddy in the rainy season, and onion and beans in the dry season. In the case of Chabima and Ndole, agricultural land is used only in the rainy season for subsistence production of maize, beans, etc. Recently, farmers in these schemes have developed traditional irrigation furrows, but those are still at a marginal level.

(2) Land Ownership and Tenure System

The agricultural land tenure system is generally based on the traditional inheritance, land allocation by village council, land purchasing, land borrowing or renting. The most common tenure regime in the Study Area is the one based on customary tenure, where land rights are transferred according to an ancestral land tenure and/or the traditional inheritance accepted by the village council.

In most villages in zone-IV, there are no more arable lands to allocate to villagers. Therefore, the cultivated land has been fragmented into small parcels due to recent population increase and traditional inheritance through generation changes. Shrinkage of land holding size per farm household has, therefore, become a serious problem in this area. The landholding size per farm household in each scheme is estimated to be 1 to 1.5 ha on an average as shown in the table below:

Landholding Size by Scheme

	Population	Family Size (person)	No. of Households (no.)	Holding Size per Household		
				Irrigated (ha)	Rainfed (ha)	Total (ha)
Zone-1						
Mgeta	29,350	5	5,870	0.27	0.53	0.80
Zone-2						
Manyenyere	11,440	6	1,907	0.15	0.66	0.81
Kilangali	3,040	7	434	0.15	1.14	1.29
Mgongola	8,470	5	1,694	0.36	1.26	1.62
Zone-3						
Mlali	5,740	5	1,148	-	0.73	0.73
Mvumi	7,450	4	1,863	-	0.87	0.87
Msolwa	3,000	6	500	-	1.80	1.80
Mkula	2,940	6	490	-	1.29	1.29
Sonjo	1,770	7	253	-	1.38	1.38
Zone-4						
Chabima	700	5	140	-	1.71	1.71
Lumuma	5,440	7	777	0.49	0.36	0.85
Ndole	1,040	4	260	0.03	0.42	0.45
Nyinga	200	4	50	1.27	-	1.27
Matolo	3,800	8	475	0.79	0.49	1.28
Mgogozi	1,265	6	211	0.84	0.70	1.54
Chabi	1,080	6	180	1.50	0.06	1.56

Remark) Nyinga scheme includes Mgogozi-Mwega sub-scheme, while Mgogozi scheme means Mgogozi-Kikalo sub-scheme.

(3) Agricultural Production

1) Present Cropping Pattern and Farming Practices

In the Study Area, maize, paddy, beans, sorghum, etc. are the dominant food crops, while vegetables, i.e. onion, tomatoes, cabbage, cotton, sunflower, sugarcane, etc. are the essential crops for cash earnings. Major crops in the respective 16 schemes and cropping seasons are summarized in the following table:

	Irrigation Schemes	Rainy Season	Dry Season
Zone-I	1. Mgeta scheme	Maize, Beans	Cabbage, Beans
Zone-II	2. Manyenyere scheme	Paddy, Maize, Cotton, Sunflower	-
	3. Kilangali scheme	Paddy, Maize, Sorghum, Sunflower	-
	4. Mgongola	Paddy, Maize, Cotton	Paddy
Zone-III	5. Mlali scheme	Paddy, Maize, Sorghum	Tomato
	6. Mvumi scheme	Paddy Maize, Sorghum, Cotton	-
	7. Msolwa scheme	Paddy, Maize, Sugarcane	Maize
	8. Mkula scheme	Paddy, Maize, Sugarcane	Maize
	9. Sonjo scheme	Paddy, Maize	-
Zone-IV	10. Chabima scheme	Maize	Beans
	11. Lumuma	Paddy, Maize, Beans	Onion
	12. Ndole scheme	Maize, Beans	Maize, Beans
	13. Nyinga/Mgogozi Mwega	Paddy, Maize	Onion, Beans
	14. Malolo scheme	Paddy, Maize	Onion, Beans
	15. Mgogozi Kikalo scheme	Maize	Onion, Beans
	16. Chabi scheme	Maize, Beans, Paddy	Onion, Maize, Beans

In general, the crop cultivation practices prevailing in the Study Area are a simple way, and almost the same, despite the fact that each scheme is located in a different physiographical zone.

Major topics on the present farming practices are summarized as follows:

a) Direct seeding method is predominant in paddy cultivation, although transplanting method has been introduced under the Mkindo Pilot Irrigation Scheme. No application of fertilizer and agro-chemicals is commonly practiced in case of paddy cultivation by the direct seeding method. Since 1995, the Special Program for enhancement of food security has been implemented in Morogoro and Kilombero Districts under the technical and financial assistance of FAO. Advanced farming practices including transplanting and application of fertilizer are disseminated through this program.

b) As for vegetable cultivation, i.e. tomatoes, onion, cabbage, etc., agro-chemicals are applied in common, but their dosage is still low to marginal level. It is due to the fact that the prices of agro-chemicals are high, and on the other hand, plant protection technology has so far not been transferred to farmers. Poor farm inputs supply system is also a constrain.

c) In case of serial crop cultivation, chiefly maize, no fertilizers and agro-chemicals are applied in common in the Study Area. As for seeds, farmers utilize their own seeds instead of purchasing qualified seeds. As a result, contamination of crop varieties has been serious, and accordingly, deterioration of quality of harvested products appears to be significant. Harvesting is also much disturbed due to different maturation of the mixed varieties.

d) A number of farming tractors, which are owned by large holder farmers, are available in and around the Study Area. Those tractors are utilized for land preparation on a rental basis. However, those tractors could serve less than 50% of the total cultivated land, and accordingly, more than 50 % of farmers have to cultivate their land with handy implements.

e) In predominant cases, crop cultivation is practiced by the family labor force in the Study Area. The use of seasonally hired labor is observed only in the case of onion cultivation, i.e. for land preparation, transplanting of onion seedlings from nursery to main field, harvesting and sacking work.

2) Crop Production

The majority of farmland in the Study Area is not satisfactorily reclaimed and/or sufficiently consolidated so far. Therefore, the production of each crop is still at the subsistence level. The present unit yields of major crops are as follows:

Unit Yields of Major Crops

(Unit: ton/ha)

Crops	Lower Yield	Higher Yield	Crops	Lower Yield	Higher Yield
Under Rainfed Conditions:			Under Irrigated Conditions:		
Paddy	1.5	2.5	Paddy	2.5	3.5
Maize	1.0	2.2	Onion	9.0	13.0
Beans	0.5	1.0	Cabbage	10.0	15.0
Sugarcane	35.0	45.0	Tomatoes	5.0	10.0
Sorghum	0.7	1.3	-	-	-
Cotton	0.5	1.0	-	-	-
Sunflower	0.5	0.7	-	-	-

Note: Paddy yield under the irrigated conditions is referred to that from the Mkindo Pilot Scheme

The following tables show the present cultivated areas by major crop and the estimated crop production:

Cultivated Area by Crop in the Relevant Villages to the Project Area

(Unit : ha)

	Paddy	Maize	Pulse	Onion	Tomatoes	Cabbage
Zone I						
Mgeta	0	3,110	2,930	0	0	270
Zone II						
Manyenyere	520	720	-	-	-	-
Kilangali	320	190	-	-	-	-
Mgongola	2,100	670	-	-	-	-
Zone III						
Mlali	200	300	-	-	130	-
Mvumi	668	880	-	-	-	-
Msolwa	380	280	-	-	-	-
Mkula	220	310	-	-	-	-
Sonjo	130	130	-	-	-	-
Zone IV						
Chabima	-	240	20	-	-	-
Lumuma	30	340	290	280	-	-
Ndole	-	58	68	-	-	-
Nyinga	10	140	30	10	-	-
Malolo	100	490	50	130	-	-
Mgogozi	-	220	5	30	-	-
Chabi	10	100	270	100	-	-
Total	4,688	8,178	3,663	550	130	270

Annual Crop Production in Villages by Scheme

(Unit : ton)

	Paddy	Maize	Beans	Onion	Tomatoes	Cabbage
Zone I						
Mgeta	0	3,110	1,465	-	-	2,700
Zone II						
Manyenyere	832	720	-	-	-	-
Kilangali	512	190	-	-	-	-
Mgongola	3,360	670				
Zone III						
Mlali	320	300	-	-	780	-
Mvumi	1,069	880	-	-	-	-
Msolwa	608	280	-	-	-	-
Mkula	352	310	-	-	-	-
Sonjo	208	130	-	-	-	-
Zone IV						
Chabima	-	240	10	-	-	-
Lumuma	48	340	145	2,800	-	-
Ndole	-	58	34	-	-	-
Nyinga	16	140	15	100	-	-
Malolo	160	490	25	1,300	-	-
Mgogozi	-	220	3	300	-	-
Chabi	16	100	135	1,000	-	-
Total	7,501	8,178	1,832	5,500	780	2,700

3) Livestock and Inland Fishery

The livestock production is just at the subsistence level in the Study Area.

Cattle is one of the most essential livestock in the Study Area. Most of cattle herds belong to pasturalists who shift from one grazing area to another according to the seasons, and therefore, utilization of draft animals (oxen) in farming practices is not common in the area. The number of major livestock is estimated as shown in the table below:

Major Livestock in the Study Area

(Unit : Head)

		Cattle	Goat	Pig
Zone I	Mgeta	5	3,020	1,420
Zone II	Manyenyere	614	348	-
	Kilangali	-	-	-
	Mgongola	-	-	-
Zone III	Mlali	1,467	388	-
	Mvumi	-	-	-
	Msolwa	10	110	20
	Mkula	-	-	-
	Sonjo	-	50	10
Zone IV	Chabima	-	70	-
	Lumuma	300	1,000	100
	Ndole	-	-	-
	Nyinga	-	-	-
	Malolo	-	-	-
	Mgogozi	-	-	-
	Chabi	-	-	-
	Total	2,396	4,986	1,550

Inland fishery is not practiced in the area, except some minor fish cultivation in the Mgeta scheme where some farmers grow Telapia in small ponds for home consumption. In the Chabima scheme area, farmers had challenged to grow fish as one of the communal works in the village, however serious flood damage to the intake weir obliged them to give up the program.

(4) Institutional Supporting Services for Agricultural Production

1) Agricultural Extension Services

The extension services at regional level are led by the Regional Extension Officer (REO), and at the district level by the District Extension Officer (DEO) under supervision of REO. A Division Extension Officer (DIVEO) is assigned to each division office to carry out extension services under the control of DEO. Village Extension Officers (VEOs) are also deployed for extending technical guidance to farmers at the village level. At present, the number of VEOs is only 29 in total, and accordingly, their extension services merely cover 29 villages out of the 44 villages in the Study Area. The number of the extension officers developed in the respective three districts is as shown in the table below:

Deployment of Extension Officers in Three Districts Concerned

District	Division	No. of DIVEO	No. of VEO	No. of Village	Irrigation Schemes Concerned
Morogoro District	Kingolwira	1	16	19	
District Extension Officer	Mgeta	1	8	24	Mgeta
Subject Matter Specialist	Mlali	2	10	16	Mlali
Crop extension officer	Bwaikira	2	3	21	
Livestock extension officer	Mkuyuni	1	3	20	
	Mvuha	2	2	22	
	Mvomero	1	12	27	Ndole, Mgongola
	Matombo	2	3	33	
	Turiani	2	11	24	
	Ngerengere	1	5	19	
	Total	15	73	225	
Kilosa District	Kilosa / Mjini	1	3	18	
District Extension Officer	Masanze	1	5	14	Chabima, Kilangali, Manyenyere
Subject Matter Specialist	Kimamba	1	8	14	
Crop extension officer	Ulaya	1	6	9	
Livestock extension officer	Mikumi	2	10	26	Malolo, Nyinga, Chabi, Mgogozi
	Magole	2	12	29	Mvumi
	Gairo	2	12	27	
	Kidete	1	1	8	Lumuma
	Nongwe	1	0	10	
	Total	12	57	155	
Kilombero District	Kidatu	1	3	4	Msolwa
District Extension Officer	Mang'ula	2	9	12	Sonjo, Mukla
Subject Matter Specialist	Ifakara	1	8	10	
Crop extension officer	Mngeta	1	4	8	
Livestock extension officer	Mlimba	1	5	11	
	Total	6	29	45	

2) Agricultural Research and Technical Training Services

In Morogoro region, there are four research and agricultural training centres, i.e. the Ilonga Agricultural Research and Training Institute (ARTI) in the Kilosa district, the KATRIN and Chollima Agro-scientific Research Center (CSRC) established in Ifakara in Kilonbero district, and the Dakawa Research Center also established in Morogoro district.

ARTI was established as the headquarters of the research institutes in the Eastern Agro-ecological Zone. Under overall supervision of ARTI, KATRIN, CSRC and Dakawa Research Center are conducting the research works on crop cultivation technology as well as breeding of high-yielding varieties of crops and training of extension officers.

The SOKOINE University of Agriculture was established in 1984 in Morogoro city. The University has three faculties, Agriculture, Forestry, and Veterinary, and two institutes; Institute of Continuing Education (ICE) and Development Studies Institute (DSI). ICE offers short-term in-service program to field operational staff as well as training and extension services to leading farmers and community leaders. DSI acquaints undergraduate students with the challenges of today development and the way to overcome them. This university has commenced some scientific research on agro-ecological system in collaboration with the KYOTO University of Japan.

Other than the above, the Agricultural Training Institute (MATI) and Livestock Training Institute (LITI) were established in Ilonga and Morogoro, respectively, and have been functioning for education and training of extension officers at the diploma and certificate levels, and also re-training of VEOs. Besides, the Farm Development Center was established with grant aid of the Chinese Government in Msolwa village in Kilonbero district, while the Farmers Training Centre is being under construction in Mkindo village close to the Mgongola irrigation development scheme, using the Grass-Root Fund provided by the Japanese Government.

3) Supply of Farm Inputs

As for crop seeds, GOT had established a breeding-cum-multiplication system. The breeder seeds for paddy, maize, sorghum, and legumes are all controlled and preserved by ARTI and KATRIN. Then, multiplication of the foundation seeds is being undertaken by five national foundation seed farms. Two of the five farms are located in Morogoro region: The Kilangali Foundation Seed Farm in Kilosa district and Msimba Foundation Seed Farm in Morogoro district. The former farm is specified as paddy seed grower, while the latter for maize, sorghum, beans, etc. Certified seeds are multiplied in the authorized seed companies and those foundation seed farms by themselves. In general, production of certified seeds is seriously insufficient compared with usual demand. Therefore, the majority of farmers are multiplying their own seeds.

To supply chemical fertilizers and agro-chemicals, transportation of inputs is usually very difficult due to poor traficability of the access roads to most of the villages. Lack of adequate transportation means, i.e. lorries, truck, etc. has further worsened the said situation. Accordingly, such farm inputs are not always delivered on time. It is also a serious constraint that the prices of farm inputs are high due to the addition of a "premium" to the transportation cost according to the distance and road conditions. Thus at present, the majority of farmers are not so eager to use such farm inputs.

4) Agricultural Credit

In Morogoro region, the main formal lenders for the agricultural credit are the National Bank of Commerce (NBC) and the Cooperative and Rural Development Bank (CRDB). Customers of these institutions tend to be medium to large landholder farmers. The annual interest rate charged for medium and long-term credits varies from 30% (NBC) to 36% (NBC). In 1994, the Agricultural Input Trust Fund (ITF) was organized with financial support extended by FAO. ITF aims at granting credit to financially reliable stockists for purchasing agricultural inputs.

5) Marketing System of Agricultural Products

As for marketing of agricultural products, there is no public intervention in the marketing process. Accordingly, the prices of agricultural commodities are being set up freely through negotiation between traders and farmers, from time to time. The prices usually vary depending of the sales timing, namely, at the harvesting time, the prices lie at a lower level, then they gradually rise and reach a peak before the start of the next crop season (off-harvesting season).

3.1.5 Present Conditions of Smallholder Irrigation Schemes

There are at least 34 smallholder irrigation schemes in the Study Area. These schemes are generally composed of one or a few small irrigation furrow systems mostly commanding less than 100 ha each. Sixteen of these smaller schemes have been listed as prospective development schemes in NIDP.

(1) Irrigation Scheme in the Mountainous Zone

There is only one irrigation scheme, the Mgeta scheme, in the Mountainous Zone. It consists of numerous small- or minor-irrigation furrow systems lying on steep slopes ranging from 10% to 40%. Almost all intakes are simply constructed with locally available materials such as stones, soils, wood, and weed. As such, they are subject to reconstruction every year in the beginning of the dry season due to the damage caused by flood. Almost all the canals are small earth canals without any related structures. The main canal runs across the hillside and diverts water to side ditches to irrigate cultivated terraces. This type of irrigation causes soil erosion especially where water is conveyed from one terrace to another, due to extremely steep slope and fragile nature of soils. In the rainy season, no irrigation practice is generally required because of abundant rainfall, while in the dry season, rotational irrigation is practiced for growing cash crops, chiefly vegetables.

(2) Irrigation Schemes in the Alluvial Plain Zone

Out of the prospective 16 schemes in NIDP, the Manyenyere, Kilangali, and Mgongola schemes belong to the Alluvial Plain Zone. All the schemes lie in the low-lying flood plain of the Wami river basin. The schemes are generally characterized by floodwater-fed irrigation for rice cultivation in the rainy season. No cultivation is practiced in the dry season.

As for the Manyenyere and Kilangali schemes, the irrigation and drainage facilities are all very poor. Diversion weirs are of concrete overflow type, which inherently accelerates sedimentation by the backwater effect. Their scale is very small against river flood scale. Most of the canals have an irregular shape with very poor embankment so that water easily spills out through the embankment. There are no canal-related structures except those of the Kilangali scheme where four division structures have been recently constructed with technical and financial assistance provided within the framework of the Traditional Irrigation Improvement Program (TIP). These canals, however, seem to play an important role in smoothly spreading floodwater over the paddy field in the initial stage of the rainy season and in smoothly draining inundation water from the fields to rivers in the late rainy season.

The Mgongola scheme is a new scheme extended from the Mkindo Pilot scheme, which was implemented in 1984. At present the proposed scheme area is being extensively cultivated with paddy under rainfed conditions chiefly using seasonal floodwater.

(3) Irrigation Schemes in the Piedmont Plain and Fan Zone

Of the prospective 16 irrigation schemes taken in NIDP, five schemes, i.e. the Msolwa, Mkula, Sonjo, Mlali and Mvumi belong to the Piedmont Plain and Fan Zone. These schemes, except Sonjo, have been developed up to present. The Sonjo scheme is still under planning for new development.

In the Msolwa scheme, the irrigation facilities were constructed in the 1970s with grant aid of the Chinese Government. At present, the headworks and main canal of about 2 km together with their related structures are still functioning, although the intake gate and spillway gate are ruined and water leakage is observed along the main canal. Misgivings on irrigable land allocation are one of the social conflict in this scheme area, and consequently, the existing irrigation facilities are hardly utilized for crop cultivation.

The Mkula scheme was developed to irrigate 60 ha of land at the beginning of the 1980s and rehabilitated from 1993 to 1995. At present, the headworks are functioning well, though a big amount of water leaks through the bottom of the weir and the side channel spillway. The existing canal system consists of a main canal of about 1 km, a branch canal of 0.2 km, and a few field ditches. The main canal has been eroded at many points, especially in the joint of flume type between the stone and brick masonry, and the lower half section just after the diversion of the branch canal is not used. At most of the elevated sections, the outside face of the canal walls is exposed, therefore, water leakage and weakening of canal foundation have become serious. Under such canal conditions, irrigated farming is meagerly practiced only on a few hectares.

In the Mlali scheme, the headworks and canal system were constructed in the 1950s. The irrigable area actually exploited was 65 ha in the right bank area. The weir portion has been deeply buried under sand sediments. The intake conduit has also been almost buried under sediments. At present, therefore, the intake can divert very little water to the main canal. The main canal having a length of 1.4 km is still functioning although the upstream section of 200 m is suffering from sand sediment action, and serious leakage from the wetted perimeter is observed in the entire canal. The secondary canals have been ruined in most sections.

The Mvumi scheme was developed in the 1970s. However, the headworks were completely buried by sand sediment brought by the Kisangata river. The entire canal system has also been severely deteriorated.

(4) Irrigation schemes in the Valley/Riverine Terrace Zone

Seven of the 16 schemes, i.e. Chabima, Lumuma, Ndole, Malolo, Nyinga, Mgogozi and Chabi schemes, belong to the Valley/Riverine Terrace Zone. Except the Chabima scheme, all these schemes are intensively utilized for irrigated crop cultivation though the majority of the existing irrigation facilities are subject to rehabilitation and/or improvement. Most of the irrigation systems in these schemes consist of a traditional free intake and one or a few canals, and each system commands an irrigable area of less than 100 ha.

The traditional free intakes are simply made of locally available materials such as soil, wood, weed, earth bags, etc. In the rainy season, such traditional intakes are often damaged and washed away by the seasonal flood, therefore they have to be repaired or re-built at the beginning of every dry season. Intakes with permanent structures are available only in the Malolo and Ndole schemes. All the canal systems are of simple earthen type having a small capacity of less than 200 lit/s. In most cases, the canals have no related structures for efficiently controlling water diversion to irrigable lands. These canals are relatively well maintained by the water users' groups organized by farmers themselves.

The Chabima scheme was developed in 1984/85, however, upon the completion of the construction works, the intake weir was damaged to a serious extent. Since then, the system was abandoned. At present, only a few farmers are meagerly irrigating their farms by directly diverting the river stream through small primitive furrows.

In the Lumuma valley, the agricultural production has been intensified and diversified extensively through traditional irrigation development since the 1940s. The irrigable area extends astride the Lumuma river. The total irrigation area served by the Lumuma river is roughly estimated to be about 1,420 ha including the left bank area belonging to Mpwapwa district, Dodoma region. The irrigation area in the Lumuma scheme is about 480 ha consisting of 160 ha in Msowero village, 130 ha in Idole village, and 190 ha in Mkunghulu village. There exist 14 traditional intakes in the Lumuma scheme. The main and secondary canals are well maintained by communal work of the water users' groups.

In the Ndole scheme, simple headworks and a small portion of the canals were constructed in 1995. The headworks consist of an intake and a small guide wall. The intake was made of stone masonry and equipped with a steel slide gate which lacks lubrication. The earth canals traverse an extremely steep slope of about 20% to 30% but are well positioned through contours. Approximately 0.5 km has been excavated so far, and a further 2 km section is under excavation by village society members on a voluntary basis. Only an area of 10 ha is being irrigated at present.

In the Nyinga scheme, there are three traditional intakes diverting water from the Mwega river. Two intakes: the first and third ones are serving the area on the left bank of the Mwega river and the middle intake is serving that on the right bank. The total command area is estimated at 110 ha in gross.

The Malolo scheme has two irrigation systems: Malolo intake-A and Malolo intake-B. Both intake-A and -B were constructed in 1972. The intake-A is located about 1.2 km upstream of the intake-B. Both intake-A and -B have an overflow type weir of which crest length is 5 m. A main canal from the intake-A conveys diverted water to the left river terrace. The canal length and command area are about 12 km and 190 ha in gross. The left main canal of the intake-B also conveys water to the left river terrace. The canal-B has a length of about 12 km and commands a gross irrigable area of about 250 ha. The right main canal of intake-B has a length of has about 2.5 km, and irrigates a terrace area of about 60 ha in gross on the right bank of the river. At present, both intakes are suffering from sand sedimentation. The river bed upstream of both intakes is rising up almost equal to the adjacent field elevation, while the river banks have a height of only 0.5 m from the field surface. In such a situation and with insufficient crest length of the weir, river water often overflows the whole structure in the rainy season.

The Mgogozi scheme consists of the Mgogozi Mwega sub-scheme and the Mgogozi Kikalo sub-scheme. The free intake of the Mgogozi Mwega sub-scheme was completely washed away by the seasonal flood in 1995 and no water is diverted into the irrigable area at present. In and around the ruined intake site, the river meanders with a steep river gradient and is heavily eroded in the concave sides where the river bank slips down almost vertically. These facts prove that this site is not suitable for building of headworks. The Mgogozi Kikalo sub-scheme is served by four intakes diverting water from the Kikalo river. The first one is located just upstream of a concrete weir. The intake itself is of free intake type. The other three intakes are of traditional free intake type without any related structures. Seasonal floods sometimes occur due to insufficient flow capacity of the Kikalo river in the rainy season. In the dry season, the area suffers from the shortage of irrigation water due mainly to the small run-off of the Kikalo river.

The Chabi scheme consists of two sub-schemes, Chabi sub-scheme and Mohazima sub-scheme. The total irrigation area is estimated about 340 ha in gross of which 130 ha is shared by the Chabi sub-scheme and remaining 210 ha by the Mohazima sub-scheme. One intake (locally called ILO intake), which was constructed on the Mohazima river with financial assistance of the International Labor Organization (ILO), diverts water for irrigation of the area in Mpwapwa district of Dodoma region. This scheme is actually serving an area of 240 ha at present. The Mohazima sub-scheme has three intakes on the Mohazima river. These irrigation systems are developed by three big landholders and accordingly owned by them privately. All the intakes are traditional intakes simply made of earth and wooden materials. The Chabi sub-scheme abstracts water from the Chabi river through two local intakes, namely; the upper and lower Chabi intakes. Construction of the upper Chabi intake started in 1989. However the main canal has not been completed yet. Main problems are the presence of hard rocks on the canal alignment. Once the upper Chabi system becomes fully operational, water can be delivered to the Mohazima sub-scheme area. This may relieve some farmers of the necessity of abstracting water from the Mohazima river.

3.1.6 Village Community Societies and Farmers' Organizations

(1) Village Community Societies

In the Study Area, village community societies have been organized in each village, and are functioning well with good social norms of life, even thought the villagers consist of several tribes such as Sagara, Luguru, Goro, Nguu, Hehe, etc. Up to the present, no serious social problems have appeared among the tribes in the Study Area.

(2) Farmers' Organizations

1) Irrigation Water Users' Groups (WUGs)

In the Study Area, WUGs have been organized so far in 13 irrigation schemes. These WUGs are functioning well except in the Mvumi and Msolwa schemes. In the case of the Mvumi scheme, WUG has no activities at present, because the headworks of the irrigation system were damaged by the seasonal flood and are deeply buried under sand sediment. WUG of the Msolwa scheme is still affected by the land use conflict in the irrigable area since 1977.

In usual case, a WUG in the Study Area takes two regular procedures for decision making, namely the general meeting of all the members and executive committee (or water

users' committee) which consists of 5-10 representatives elected by the members. In the case of larger scale irrigation systems, several WUGs are organized on a sub-village or secondary canal basis. In the Mgeta scheme covering 15 villages belonging to 4 wards, a lot of small and/or minor irrigation furrow systems have been established, and consequently, many small WUGs are organized independently. The present conditions related to operation and maintenance (O&M) of WUG in the existing 13 schemes are summarized below:

a) O&M of the Irrigation System and Water Charge

Water distribution is decided through mutual consent of the member farmers in the general meeting of WUG. In most cases, maintenance of irrigation facilities is done by farmers themselves as one of the communal work of WUG. In the case of the Kilangali, Mgongola (existing Mkindo Pilot scheme) and Mlali schemes, WUG collects the water charges from the members either in cash or in kind (crop production) in addition to the duties to be fulfilled in the said communal work.

b) By-laws and Registration of WUG

All the existing WUGs in the Study Area are not registered yet so far, nevertheless they can register as authorized organizations under the Cooperative Act No.15, 1991. Major constraints are that the member farmers of WUG lack knowledge on the said registration act. It is also a disturbance that the district cooperative officers have a poor knowledge and business experience on how to encourage the members of WUG, and then, to satisfy necessary conditions for successful registration of WUG, etc.

Seven of the 13 WUGs in the Study Area, i.e. Kilangali, Mgongola, Mlali, Mvumi, Lumuma, Ndole, and Mgogozi, have instituted their own by-laws. Apart from their by-laws, all WUGs have a punishment rule when some one shirks the communal work and/or evades payment of water charges.

c) Water Right

The Regional Water Engineer is responsible for registration of the water rights under the Act No.42 of 1974. So far, all WUGs in the existing irrigation schemes have no registered water rights, because they are not legally authorized yet. In a special exception, RALDO acquired the registered water right for the Mkindo Pilot scheme. This registration was made when RALDO was promoting the Mkindo Pilot scheme.

(2) Farmers' Cooperatives

In Morogoro region, there are 3 cooperative unions relating to the marketing of agricultural commodities. Under administrative supervision of these three unions, a total of 73 primary cooperative societies have been organized as of September 1996. The main objectives of these cooperative unions are to maintain the marketing of crop products and to support farm inputs supply to the farmers.

In the Study Area, there are nine primary cooperative societies at present. These societies were organized for the marketing of both farm inputs and crop products, especially such storable crops as rice, maize, and cotton. Recently, however, activities of these cooperatives have been prejudiced in favor of cotton and coffee production. The membership of a cooperative is less than 300 farmers, while its management area covers several villages in all the cases. It seems that the service area of each cooperative is too

large if compared with its own management capability, i.e., no transportation and communication facilities such as lorries and telephone, structural weakness, lack of operation funds for marketing of crops and farm inputs, lack of storage facilities, as a whole.

(3) Other Organizations

In the villages within the respective irrigation scheme areas, a total of 47 women's groups have been organized up to the present. The membership of each group is not larger than 5 - 20 women. Their activities consist mostly of nursery of trees for afforestation, crop cultivation in the farm plots allocated to the group and processing of local beer by use of cereal products harvested from owned farms by the group.

In the case of the Mgongola scheme, there are 6 farmers' groups which were organized under the special program assisted by FAO for food crop production increase, especially maize and rice. This program provides technical guidance for crop cultivation technology as well as farm inputs to the member farmers under a short term loan through operation of the Farm Input Trust Fund.

3.2 Initial Environmental Examination

3.2.1 National Environmental Protection and Conservation Issues

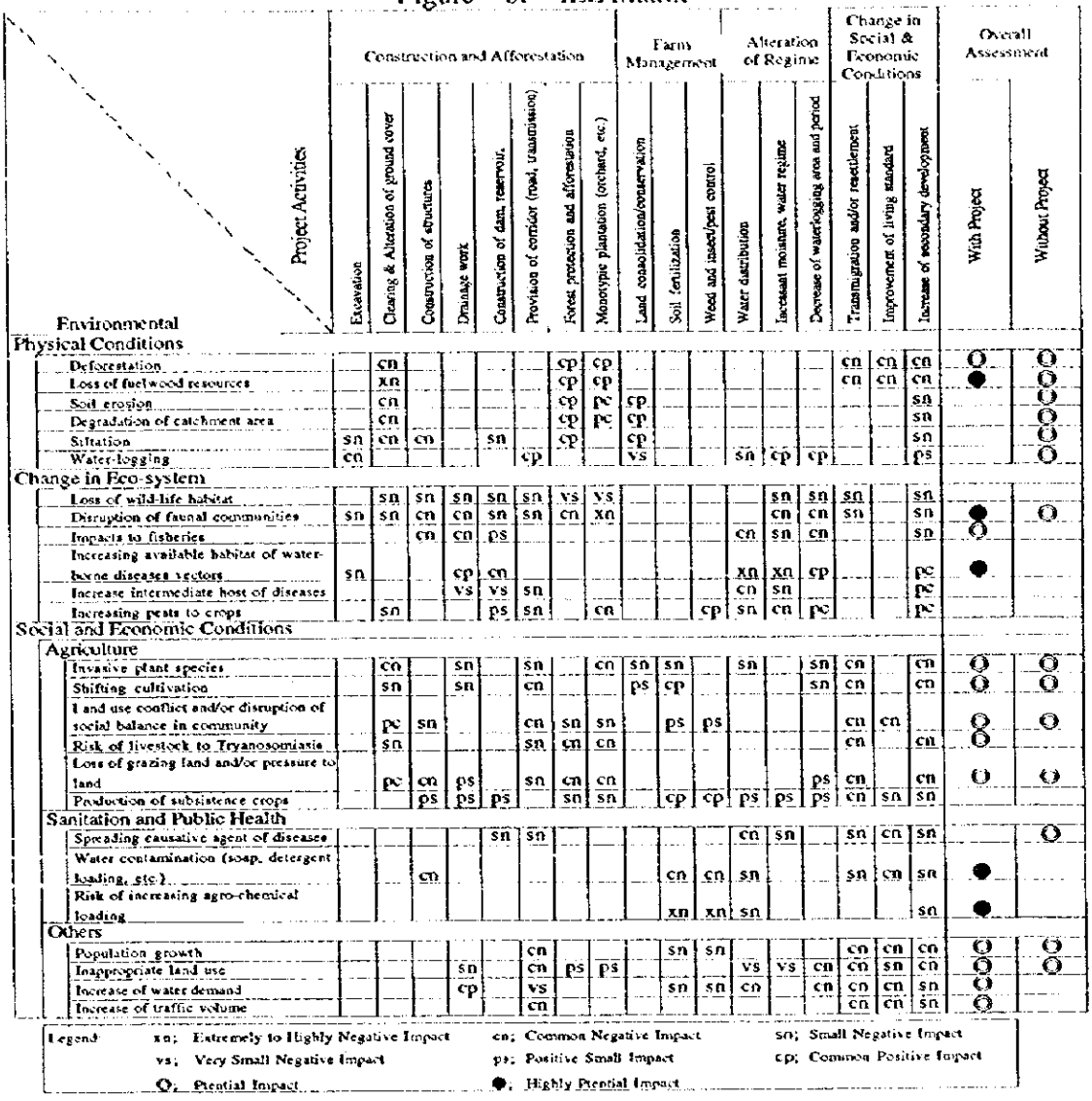
GOT has made continuous efforts to protect and/or conserve the natural as well as socio-economic environment through issuance of policy, programs and legislative frame-works. These include the National Conservation Strategy for Sustainable Development (NCSSD, 1993), the Draft National Environmental Policy (NEP, 1996) prepared by the Environmental Sector, Division of Environment of the Vice President Office; and the Overview Study Results of Existing Legislation Pertaining to Environment by the Division of Environment of the Vice President Office and National Environmental Management Council (NEMC, 1993). In succession, the National Environmental Action Plan (NEAP) was prepared by the Ministry of Tourism, Natural Resources and Environment in 1994. The policy and overall objectives envisaged in this Plan are outlined below:

- To ensure sustainable and equitable use of resources for both present and future generations without degrading the environment.
- To prevent and control degradation of life support system.
- To conserve and enhance natural and man-made heritage, including biodiversity of the unique ecosystems of Tanzania.
- To improve the condition and productivity of degraded areas for the whole.
- To raise awareness and understanding of the linkages between the environment and development and to promote participation in environmental actions.
- To promote international cooperation on the environment agenda.

3.2.2 Initial Environmental Examination (IEE)

IEE in the Study Area is made according to the results of field investigation and review of the prospective development conceived in each respective scheme. The results of IEE are shown in Figure "IEE Matrix by Prospective Development Activity and Environmental Parameter" below.

Figure of IEE Matrix



As seen in the above Matrix, the environment in the respective scheme areas is being more or less affected even under the present conditions. Through this IEE, the following four conditions are clarified as the elemental factors having negative impacts on the natural environment as well as socio-economic environment in the rural area.

a) High annual increase of human and livestock population,
b) High increase of energy consumption, chiefly of forest resources,
c) Poverty due to inactive rural socio-economy, and
d) Low education level due to poverty in the rural area.

In fact, the above factors have been exerting a certain pressure to the natural resources, and consequently, degradation not only in the natural vegetation but also soil productivity, health and welfare risks in the rural area, contamination of water due to poor sanitation facilities, social conflicts especially in utilization of the land and water resources, etc. occur.

Based on IEE made above, the following four susceptible elements have been confirmed as the most hazardous negative impacts in the proposed development plan amongst the environmental parameters.

1) Direct Impacts
   a) Incremental risk of water-borne and vector-borne diseases
   b) Biocide risks particularly on water resources
2) Indirect Impacts
   c) Degradation of vegetation, especially forest
   d) Social conflict hazard in the rural societies

The above four elemental aspects are also pointed out as one of the most essential subjects in the sectoral cum cross-sectoral environmental issues of NEP (refer to the table below).

Sectoral cum Cross-sectoral Environmental Issues

Topic	Related Sector	Outline of Related Policies
Water-borne Diseases	Water and sanitation	The fundamental objectives are to prevent environmental pollution hazard through satisfaction of the public services in water, sewer-age and sanitation sectors.
	Health	The main object is to reinforce the public health control system, not only in narrow while indispensable sense for curing diseases, but in fact encourage in a broad sense for improving the human welfare.
Agrochemical Impacts and Water Contamination	Water and sanitation	The funda-mental objectives are to prevent environmental pollution hazard through satisfaction of the public services in water, sewerage and sanitation sectors.
	Health	The main object is to reinforce the public health control system, not only in narrow while indispensable sense for curing diseases, but in fact encourage in a broad sense for improving the human welfare.
Forest Resources	Forestry	Promotion of rotational exploitation of forest re-sources by means of reforestation and/or afforestation programs up to sufficiently meet requirements of the domestic consumption. The programs are also aims at maintaining a sustainable regimes for soil an and land conservation through forest protection.
Social Conflicts due to, Inappropriate Land Use and Population Pressure on Land	Demographic dynamics	Careful attention be paid to an increment of popula-tion pressure to land, water and other natural resources. Demographic dynamics shall be closely relating with environmental sanitation and health control means.
	Land Tenure	The land ownership is a fundamental importance not only for main-taining more balanced-cum-equitable development, but in fact encourage to pay careful attention to the environment. Thus, to ensure proper management of the land resources, participatory approach to integrated land use planning, security of land resources, etc., is essential and crucial.

3.2.3 On-going Environmental Conservation Action/Programs

A few programs for environmental conservation have been conducted and attempted to contribute towards attainment of an integrated sustainable development of agriculture through coordinated efforts in the field and to alleviate environmental problems in the Study Area. The Traditional Irrigation Improvement Program (TIP), Kilosa District Rural Development Program (KDRDP), Seed Distribution Services by WWF and Integrated Sustainable Agricultural Program (SAP) in the Mgeta area are considered to be important programs for motivation of the local farmers and hence activation of the environmental conservation work by the rural people.

3.3 Development Potential and Constraints

3.3.1 Potential for Irrigated Agriculture Development

(1) Land Resources

The land resources development potential in the Study Area is determined based on the results of land suitability evaluation for irrigated farming which has been made basically according to the "Guidelines for Land Evaluation for Irrigated Agriculture" prepared by FAO (1985) and the "Tanzanian System for Paddy Irrigation".

Land Resources Development Potential by Scheme

Name of Schemes		Land Resources (Arable Land) (ha)	Land Suitability Classes			
			Paddy Field		Up-land Field	
			(Grade)	(ha)	(Grade)	(ha)
Zone-I:	Mgeta Scheme	2,000	IV	2,000	III	2,000
Zone-II:	Manyenyere Scheme	1,300	III	460	III	300
	Kilangali Scheme	720	III	720	III	60
	Mgongola Scheme	830	III	620	III	60
Zone-III:	Mlali Scheme	80	II	80	II	80
	Mvumi Scheme	330	II	330	II	70
	Msolwa Scheme	400	II	400	I	250
	Mkula Scheme	400	II	400	I	130
	Sonjo Scheme	600	II	600	I	280
Zone-IV:	Chabima Scheme	15	III	15	III	15
	Lumuma Scheme	480	III	340	II	440
	Ndole Scheme	100	III	100	II	100
	Nyinga Scheme	100	II	20	II	80
	Malolo Scheme	500	II	60	II	440
	Mgogozi Scheme	200	II	20	III	200
	Chabi Scheme	340	II	20	II	320

Remarks: Grade I: Highly suitable land for irrigated farming, Grade II: Suitable land for irrigated farming, Grade III: Marginally suitable land for irrigated farming, Grade IV: Unsuitable land for irrigated farming

(2) Water Resources

The discharges of the respective rivers are estimated on a 1/5 probability basis. The volume of available water in each scheme is then determined with due consideration of the existing water rights. The following table shows the discharges useful for irrigated farming in the critical dry season at the 1/5 probability.

As seen in the table, there is no useful water in the dry season from the Msolwa river for the Msolwa scheme and from the Mohazima river for the Chabi scheme if deducting the quantity of water authorized in the existing water rights owned by other fields, although some part of water is being utilized by farmers in the said scheme areas. Thus, an adjustment of the existing water rights is essential for implementation of irrigation development in both schemes.

Water Resources Development Potential by Scheme

Name of Schemes		Respective River	Dry Season Discharge at 1/5 Probability July (m^3/s)	Dry Season Discharge at 1/5 Probability September (m^3/s)	Existing Water Right (m^3/s)	Minimum Useful Water (m^3/s)
Zone-I	Mgeta Scheme	Small streams	-	-	none	-
Zone-II	Manyenyere Scheme	Myombo				
	Kilangali Scheme	Myombo	2.6	1.2	-	1.2
	Mgongola Scheme	Mkindo	1.5	0.9	-	0.9
Zone-III	Mlali Scheme	Mlali	0.02	0.02	-	0.02
	Mvumi Scheme	Kisangata	1.3	0.8	0.06	0.7
	Msolwa Scheme	Msolwa	0.28	0.11	0.30	-
	Mkula Scheme	Mkula	0.17	0.07	-	0.07
	Sonjo Scheme	Sonjo	0.44	0.18	-	0.18
Zone-IV	Chabima Scheme	Chabima	0.01	0.01	-	0.01
	Lumuma Scheme	Lumuma	0.38	0.24	0.12	0.24
	Ndole Scheme	Ndole	0.08	0.06	-	0.06
	Nyinga Scheme	Mwega				
	Malolo Scheme	Mwega	1.6	1.2	-	1.2
	Mgogozi Scheme	Kikalo	0.04	0.03	-	0.03
	Chabi Scheme	Chabi	0.16	0.11	-	0.11
		Mohazima	0.24	0.17	0.53	-

The Mohazima river, which is serving both the Mohazima sub-scheme of the Chabi scheme and the ILO scheme in Dodoma region, flows into the Mwega river downstream of the Malolo scheme. All water resources of the Mohazima river can be utilized for both schemes, but a water right of 0.53 m^3/s has been granted to the ILO scheme in Dodoma region. Thus, in the case of irrigation development in the Chabi scheme, an adjustment of water allocation including the review of the water right on the Mohazima river is essential. The water resources in other rivers can be utilized fully for irrigation development in the respective schemes.

(3) Human Resources

At present, the main workers of a farm household is husband and wife in most cases, while the field work is supported by the youth aged over 15 years. As such, most of farm operations are being done efficiently by the available family labor force. To meet peak labor requirement at the most busy crop season, farmers are helping each other. In case there is a shortage in labor force, farmers adjust the working duration to a certain extent. In exceptional cases such as in the Chabi, Malolo, Mgogozi and Lumuma schemes where farmers have developed traditional irrigation furrow systems and intensified crop operation for production of dry onion, beans, etc., farmers employed the seasonal labor from outside of the villages.

The following table indicates the agricultural population, numbers of farm households, average family size and working population in the respective schemes. As seen in that table, each farm household has a large family size. Thus, availability of labour force may not be a problem even when implementing the objective irrigation project. However, in order to promote intensification of farming and/or diversification of crop production under the conditions with the project, it will be necessary that the youth must be organized into working groups either in household or in community societies in each village.

Agricultural Population, Farm Households, Family Size and Working Population in the Respective Schemes

Name of Schemes		Number of Villages	Total Population	Number of Farm Households	Family Size (person/family)	Working Population
Zone-I	Mgeta Scheme	12	29,350	5,870	5	13,503
Zone-II	Manyenyere Scheme	3	11,440	1,907	6	4,390
	Kilangali Scheme	1	3,040	434	7	990
	Mgongola Scheme	3	8,470	1,694	5	4,225
Zone-III	Mlali Scheme	2	5,740	1,148	5	2,650
	Mvumi Scheme	1	7,450	1,863	4	3,910
	Msolwa Scheme	1	3,000	500	6	1,150
	Mkula Scheme	1	2,940	490	6	1,234
	Sonjo Scheme	1	1,770	253	7	580
Zone-IV	Chabima Scheme	1	700	140	5	320
	Lumuma Scheme	3	5,444	777	7	1,790
	Ndole Scheme	1	1,040	260	4	550
	Nyinga Scheme	1	200	50	4	114
	Malolo Scheme	1	3,800	475	8	2,166
	Mgogozi Scheme	1	1,265	211	6	582
	Chabi Scheme	1	1,080	180	6	410

It is also essential to upgrade quality and/or skills of labor force so as to accomplish sustainable irrigation-based agricultural production. To this end, farmers need to be advised on cultivation techniques. In contrast, however, the majority of extension officers in the Study Area do not have adequate working conditions or training facilities for satisfactorily performing the technical extension services for farmers. Thus, GOT should pay special attention to this fact and strengthen the extension service function in the course of the project implementation.

3.3.2 Problems and Constraints to Agricultural Development

The problems and constraints in agricultural development at present are mostly brought by serious drought and/or seasonal flooding caused by irregular distribution of rainfall, poor agricultural infrastructure, unsatisfactory performance of extension services to farmers as well as poverty based on the traditional custom, and their multiplier effects. Therefore, in order to implement and accomplish sustainable small-holder irrigation development, improvement and/or elimination of all the constraints are the crucial subject. To apply the farmers' participatory approach to this Project in accordance with the development policy of GOT, it is also essential to upgrade the farmers' skills as well as to organize the farmers' groups, i.e. water users' co-operative societies, through reinforcement and activation of the village community.

3.4 Basic Approach to the Project

3.4.1 Policy Issued and Development Needs

(1) Political Needs for Smallholder Irrigation Development

The current national socio-economic development plan is being implemented pursuant to the second Rolling Plan and Forwarding Budget (RPFB), covering the three

fiscal years of 1994/95-1996/97. The fundamental principles and goals envisaged in this RPFB are summarized as follows:

- To alleviate poverty so as to improve social welfare conditions of the population in Tanzania,
- To create an appropriate environment for strengthening the private sector,
- To reduce direct government involvement in productive activities,
- To improve efficiency in the use of public resources,
- To ensure macro-economic stability, and
- To keep on an environmentally sustainable development path.

In the implementation of the national socio-economic development plan, GOT has given the highest priority to the agricultural sector development with particular emphasis on attainment of the following objectives as the primary and most important issues.

- To satisfy subsistence requirement in a large part of the country,
- To generate local surpluses of main staple food products, especially maize and rice, in order to facilitate food security at both the village and regional or national levels, and
- To ensure the production of products much needed for dietary supplement, i.e. vegetables, fruit, oil seeds, etc.

At present, despite the vast rainfed arable potential, irrigation-based agriculture, especially in the traditional smallholder irrigation schemes, has a vital role to play in achieving the objectives mentioned above. Thus, GOT has given the highest priority to irrigation-based agricultural development with particular attention to "*rehabilitation or upgrading of the traditional irrigation schemes*" and "*Upgrading traditional water harvesting technology*" in line with the strategic framework of NIDP including the most promising 156 irrigation development schemes with a total of about 174,000 ha of irrigable land. In implementing NIDP, GOT highly expected that the maximum impact will be brought by beneficiaries themselves, who will have to aggressively involve in the said irrigation project based on the sense of "participatory approach to the development".

(2) Development Needs and Wishes of Irrigation Beneficiaries

The development needs of farmers are all closely related to the wishes for improvement of the present constraints and problems. All the farmers benefiting from the existing irrigation systems attach the highest priority to "improvement of the irrigation facilities."

3.4.2 Fundamental Objectives and Development Strategy

In accordance with the GOT's political needs, that are increase in food crop production and alleviation of poverty, and the development needs of regional farmers, the fundamental objectives of the Project focus on "improvement of farmer's economy through the promotion of intensification and diversification of crop production in the dry season" and "increasing and stabilizing basic food crops through irrigation in supplement to rained cropping." In addition, the Project should realize sustainable irrigation farming.

Considering the present regional agriculture confronted with various problems and constraints mentioned in the preceding section, the development strategies to achieve the above objectives are (i) improvement of agricultural production infrastructure, putting

emphasis on the rehabilitation of existing traditional irrigation systems for stabilization of crop production, and (ii) strengthening of existing WUGs and training of farmers and extension officers in order to establish effective O&M of the infrastructure.

The basic concepts for smallholders' participatory project in the central Wami river basin and the conceptual development framework conceived in line with the above fundamental objectives and development strategy are summarized in the figure in the next page.

3.5 Agriculture Development Plan

3.5.1 Basic Concept

The prospective goal of agricultural development under this Project is to increase and stabilize the agricultural production by maintaining a sustainable development of smallholder farming, and then, to contribute to the national food security program. To successfully achieve the said goal, the following approach is conceived as the basic strategy for agricultural development in each zone.

In both mountainous and valley and riverine terrace zones, there is no room for further expansion of arable land due to topographic limitation. Accordingly, efficient utilization of the existing farmland as well as establishment of a more advanced and sustainable farming system shall be the main subject. To these ends, conservation of fragile nature that is facing hazardous soil erosion, landslide, etc. is an important issue.

In the other two zones, a huge potential of both land and water resources is available for irrigation-based agriculture development. Despite continuous efforts of GOT to eliminate the constraints and problems, the present agriculture development in these zones is still at a primary stage, and accordingly, the agricultural production per farm household is still at a subsistence level. Thus, to activate agricultural development and maintain sustainable crop production in both zones, consolidation of the existing farmland as well as reinforcement of the agricultural supporting services are essential and basic requirements.

Conceptual Framework for Smallholder Irrigation Development by Specific Zone in Central Wami River Basin

	Alluvial Plain Zone (Mkata Plain : Seasonal Swamp)	Piedmont Plain & Fan Zone (Surrounding Mkata & Msolwa Plain)	Valley/Riverine Terrace Zone	Mountainous Slope Zone
Major Characteristics	- Quaternary alluvium - Lowlying flat plain, bush-grass savanna vegetation - Seasonal waterlogging, poor drainability - Vertic Fluvisols and/or Hydromorphic Gley Soils - Clayey to sandy texture, and relatively fertile - Traditional extensive farming, inclusive of shifting cultivation - Paddy growing under seasonal flooding - Maize, cotton etc. under rainfed conditions - Large potentials for agricultural development - Scarce population - Poor infrastructure, i.e. irrigation canal, road network, water and electricity supply system	- Post-Miocene deposits on Precambrian rocks - Flat to gentle slope land with grass savanna vegetation - Cambisols associated with Regosols having coarser texture, relatively fertile - Traditional crops in smallholder farming mostly under rainfed conditions - Large potential for irrigated agricultural development - Relatively good network of road & rural water supply system, while in part under rural electrification	- Quaternary alluvium - Narrow peneplain (fans) or riverine terrace - Gently sloped or undulating topography - Bush savanna vegetation - Fluvisols having coaser texture, while fertile - High irrigability & good drainability - Paddy, cotton maize, etc in smallholder farming under traditional irrigation system - Poor infrastructure, i.e. road network, electricity supply system, ect. - Poor accessbility to market in isolated valley area	- Undifferentiated soils on Pyroxene Granulite rocks - High altitude, extremely steep slopes, narrowly dissected by eroded valleys - Serious environmental hazards, i.e. soil erosion, watershed degradation, etc. - Shallow and coarser texture soils - Production of high valued crops, i.e. fruit, vegetables, etc. in smallholder farming using traditional irrigation system - Poor infrastructure, i.e. road system - High population
Key Theme	Consolidation of agricultural land and related infrastructure (road, flood protection dikes, etc.)	Irrigation development and intensification of crop production	Rehabilitation and/or improvement of irrigation system as well as trunk road	Consolidation of canal system (lining and drop structure) against erosion hazard
Development Focus	Intensification and stabilization of rice production through efficient utilization of flood water (Formation of the farm ridge be effective for harvesting the seasonal flooding water). Improvement of farming practices, including introduction of high yielding varieties of rice. Activation of Farmers' organization both for irrigation water utilization and marketing of the production	Irrigation development or rehabilitation of the existing irrigation system will make possible crop intensification cum diversification. Large increment and stabilization of crop production could be anticipated through consolidation of farm land and improvement of the farming practices. To the above, activation of farmers cooperative societies is essentially needed.	Since an arable land is limited in this zone, intensification cum diversification of agricultural production are essentially needed. Rehabilitation and improvement of the existing irrigation system will enable water distribution more efficiently and accordingly ensure stable crop cultivation even in the dry season. To effectively support the above, consolidation of the trunk road is indespensable.	Consolidation of the existing irrigation system will be the basis on further stabilization of the agricultural production. It is also an essential mean for land conservation. Afforestation with sustainable agro-forestry approach (orchard & its processing) will be effective for both protection against soil erosion hazard and rural economic development.
Major Development Schemes	1) Manyenyere Scheme 2) Kilangali Scheme	1) Mlali Scheme 2) Muvumi Scheme 3) Msolwa Scheme 4) Mkula Scheme 5) Sonjo Scheme 6) Mgongola Scheme	1) Mgogozi Scheme 2) Nyinga Scheme 3) Chabi Scheme 4) Malolo Scheme 5) Chabima Scheme 6) Lumuma Scheme 7) Ndole Scheme	1) Mgeta Scheme
Major Components for Sustainable development	- Consolidation of farm land, inclusive of ridge and side-ditch formation, farm road network, etc. - Development and/or improvement of small scale irrigation system to supplement flooding water-fed irrigation and for dry season cropping - Provision of flood control dikes and drainage system - Intensification of rice production by introduction of short growing term cum high-yielding varieties - Training of farmers on irrigated rice production technologies, including small scale mechanization - Activation of farmers' organization, i.e. furrow committee and farmers cooperatives	- Rehabilitation or improvement of the existing irrigation system - Provision of flood control dikes and drainage system in lower- reach areas - Consolidation of farm land, inclusive of ridge and side ditch formation, farm road network, etc. - Intensification cum diversification of crop production with introduction of high-valued crops - Training of farmers on irrigated crop production technology, including small scale mechanization - Activation of farmers' organization, i.e. furrow committee and cooperatives	- Rehabilitation and/or improvement of small scale irrigation system especially intake facilities and water distribution structures - Consolidation of trunk road for marketing of production - Organization of farmers' cooperatives - Provision of post-harvesting service facilities, i.e. go-down, storage, etc. - Activation of farm inputs supply services - Provision of farmers' credit	- Improvement of existing small scale irrigation system, especially intake facilities and water distribution structures - Land conservation against erosion hazard - Improvement of trunk road - Provision of post-harvesting service facilities, i.e. go-down, strage, etc. - Activation of farm inputs supply services - Provision of farmers' credit - Organization of farmers' cooperatives

Other than the above components, improvement and reinforcement of the existing Farmers' Training Center as well as activation of Agricultural Research Center and National Seed Farm are essential.
Accordingy, the agricultural extension services shall be reinforced through further training of the extension workers.

3.5.2 Crop Production Plan

The Mgeta scheme consists of numerous independent small irrigation systems scattered around Mgeta ward, but the majority is still under inventory survey. In the development plan, therefore, a typical micro scheme having 5 ha of irrigable land is tentatively taken up as the model and/or pilot scheme.

With the above consideration, the potential net irrigable area is estimated at 4,905 ha in total covering the prospective 16 irrigation development scheme areas. The proposed land use and crop production pattern in the said potential irrigable area are formulated for each scheme taking into account the agricultural development policy of GOT as well as the basic needs/wishes of the local farmers.

The seasonal crop production schedule by scheme is summarized below:

Proposed Crop Production Plan

Name of Irrigation Schemes	Rainy Season		Dry Season		
	Major Crops	Planting Area (ha)	Major Crops	Planting Area (ha)	Cropping Intensity
1 Mgeta	Beans	5	Cabbage, Beans	5	2.00
2 Manyenyere	Paddy	1,040	Paddy	690	1.66
3 Kilangali	Paddy	370	Paddy	160	1.43
4 Mgongola	Paddy	660	Paddy	660	2.00
5 Mlali	Paddy	60	Tomato	30	1.50
6 Mvumi	Paddy, Maize	260	Paddy Beans	260	2.00
7 Msolwa	Paddy, Maize	320	Maize, Beans	240	1.75
8 Mkula	Paddy, Maize	320	Maize, Beans	140	1.44
9 Sonjo	Paddy, Maize	480	Maize, Beans	380	1.79
10 Chabima	Maize	10	Beans	10	2.00
11 Lumuma	Paddy, Maize, Beans	380	Onion, Paddy	380	2.00
12 Ndole	Maize, Beans	80	Maize, Beans	80	2.00
13 Nyinga, Mgogozi Mwega sub-scheme	Paddy, Maize	150	Onion, Beans	150	2.00
14 Malolo	Paddy, Maize	400	Onion, Beans	400	2.00
15 Mgogozi (Kikalo sub-scheme)	Maize	100	Onion	50	1.50
16 Chabi	Maize, Beans	270	Onion	270	2.00
Total		4,905		3,905	1.80

To successfully implement and achieve the above crop production plan, it is proposed that DALDO office shall provide intensive extension services to the scheme areas. The Special Program as well as NAEP-II is quite helpful and effective if they are directly applied to this project implementation.

3.5.3 Prospective Crop Yield and Production

The following table shows the prospective yields of major crops.

Prospective Crop Yield (Unit: ton/ha)

Major Crops	Present Unit Yield	Prospective Yield	
		Without Project	With Project
Paddy (Direct sowing)	1.6	1.6	-
Paddy (Transplanting)	3.0	3.0	5.0
Maize	1.0	1.0	3.0
Beans	0.5	0.5	1.5
Tomato	6.0	6.0	12.0
Onion	10.0	10.0	15.0
Cabbage	10.0	10.0	15.0

As far as paddy yield is concerned, the prospective yield under the condition with project is estimated referring to various records on crop experimental works in the Agricultural Research Center in Morogoro region as well as the actual crop production in the advanced irrigation scheme areas, i.e. the Lower Moshi Irrigation Project, Ndung Irrigation scheme in Kilimanjaro region, etc. The yields of other crops are based on the higher crop production being obtained by advanced farmers within the schemes. Based on the proposed cropping acreage and the unit yield given above, the anticipated crop production in each irrigation scheme is estimated as shown below:

Anticipated Crop Production by Scheme 7(Unit: ton)

	Schemes	Maize	Paddy	Beans	Onion	Cabbage	Tomatoes
Zone-I	Mgeta	-	-	10	-	30	-
Zone-II	Manyenyere	-	8,650	-	-	-	-
	Kilangali	-	2,650	-	-	-	-
	Mgongola	-	6,600	-	-	-	-
Zone-III	Mlali	-	300	-	-	-	360
	Mvumi	180	2,000	90	-	-	-
	Msolwa	720	600	300	-	-	-
	Mkula	420	1,100	150	-	-	-
	Sonjo	1,140	1,300	330	-	-	-
Zone-IV	Chabima	30	-	15	-	-	-
	Lumuma	600	300	225	5,250	-	-
	Ndole	240	-	120	-	-	-
	Nyinga (Mgogozi Mwega sub-scheme)	420	50	15	2,100	-	-
	Malolo	1,050	250	75	5,250	-	-
	Mgogozi (Kikalo sub-scheme)	300	-	-	750	-	-
	Chabi	210	-	300	4050	-	-
	Total	5,310	23,800	1,630	17,400	30	360

3.6 Irrigation Development Plan

The irrigation development plan including improvement of the drainage conditions and access roads in each of the 16 irrigation schemes is formulated as follows:

3.6.1 Mgeta scheme

The Mgeta scheme includes numerous independent small scale irrigation systems scattered over steep mountainous slopes in Mgeta ward. In most cases, each of these irrigation systems is commanding only a few hectares of irrigable land. To improve these small scale systems, a pipeline system for conveying water by gravity is proposed as an essential counter measure against soil erosion as well as for efficient water saving. This pipeline system will also be useful to supply domestic water for farmers living on the mountainous slopes. The proposed plan of the pipeline system for a typical irrigation system of 5 ha is are as shown below.

Cropping area	5 ha
Irrigation system	Pipeline system
Headworks (intake)	Newly provided at traditional intake sites
- Design intake discharge	About 5 litre/s
- Type	Perforated PVC pipes covered with sand, gravel, and cobble stone, protected by concrete and rock riprap
- Pipe diameter	Around 10 to 30 cm
- Total pipe length	10 m
Irrigation canals	Pipeline, PVC pipe buried in the ground
- Pipe diameter	50 to 100 mm
- Length	Depending on the topography, about 600 m.
- No. of outlets	About 20 - 30 nos.
- No. of pressure relief valves	About 2 - 3 nos.

3.6.2 Manyenyere Scheme

The existing fixed overflow type weir is accelerating the seasonal flood in the upstream reaches due to a backwater effect, and moreover, the intake is not functioning well due to heavy sedimentation caught by the said weir. Therefore, the existing headworks will be replaced with new ones of "stoplog gated type". The existing canals are also required to be reshaped with provision of embankment. New drainage canals shall be provided along these canals so as to evacuate excessive water smoothly within a short time. The basic plan of irrigation and drainage development is as summarized in the table below.

Gross cropping area	1,300 ha
Net cropping area	1,040 ha
Headworks	Reconstruction
- Design flood discharge	100 m^3/s
- Design intake discharge	2.10 m^3/s
- Weir type	Stoplog gated type, 22 m in total span length.
- Intake Inlet gate	Steel slide gate, 1.6m wide x 1.6m high
Irrigation canals	Rehabilitation of 7.5 km with lining, 9.5 km earthen canal
Drainage canals	Kidago stream (natural drain) and construction of 25 km
Flood protection dike	Earth type, about 1 m high, about 7.5 km long
Farm road	16 km
On-farm development	
- Paddy field	Land leveling of 1,040 ha, field ridges and field ditches

3.6.3 Kilangali Scheme

As same to as the Manyenyere Scheme, the existing fixed overflow type weir shall be replaced with a gated type weir. The existing weir for the Kilangali Seed Farm, which lies about 30 m upstream of the weir of the Kilangali scheme, shall also be removed so as to maintain the existing river course against heavy sedimentation hazard. Flood protection dikes will be constructed along the Miyombo river. The proposed plan of the irrigation and drainage development is outlined below:

Gross cropping area	460 ha
Net cropping area	370 ha
Headworks	Reconstruction
- Design flood discharge	100 m^3/s
- Design intake discharge	0.74 m^3/s
- Weir type	Stoplog gated type, 22 m in total span length,
- Intake	steel slide gate, 0.8m wide x 0.8m high
Irrigation canals	Rehabilitation,
- Main canal	Trapezoidal shape, stone or brick masonry lining, about 3.5 km long
- Secondary canals	Earthen canal, 4 nos. about 4 km in total length
Drainage canals	New construction
- Main drains	Trapezoidal, earth type, about 3,900 m long
- Secondary drain	Earthen canal, about 12 km in total length
Flood protection dike	New construction for about 5.5 km long
Farm road	8.5 km
On-farm development	Paddy field, land leveling of 370 ha, field ridges and field ditches

3.6.4 Mgongola Scheme

To develop the Mgongola scheme, the existing intake facilities shall be enlarged through rehabilitation and renewal of the whole intake and spillway gates. In order to accommodate enough water for both the Mkindo pilot scheme and Mgongola scheme, the headrace canal section also needs to be enlarged. At the diversion point to the Mkindo pilot scheme, the head race will be followed by a main canal up to the proposed Mgongola area. Water will be conveyed by the proposed main canal, two secondary canals and then distributed to paddy fields through tertiary canals. Excess water in the fields will be drained through field drains, then secondary and main drains to the Mgongola river. Flood protection ridges will be provided around the project area. The proposed plan of irrigation and drainage development is outlined in the table below:

Gross cropping area		830 ha including existing Mkindo area
Net cropping area		660 ha including existing Mkindo area
Headworks		Minor repairing with replacement of 4 steel gates
- Design flood discharge		112 m^3/s with a 50-year return period
- Design intake discharge		1.4 m^3/s
- Type		Fixed weir on the top of natural fall
- Intake	inlet gate	Steel slide gate, 1 m wide x 1 m high x 2 sets
	scouring gate	Steel slide gate, 1 m wide x 1 m high x 2 sets

(to be continued)

Irrigation canals	All newly constructed
- Headrace	Replaced, stone or brick masonry lining, about 1 km long
- Main canal	lined canal type, about 2.5 km long
- Secondary canals	earthen canal, 2 canals, about 9 km in total
- Tertiary canals	earthen canal, commanding about 24 ha each, about 700 - 1,000 m long each
Drainage canals	All newly constructed
- Main drains	Trapezoidal, earth type, about 250 m long
- Secondary drains	Earth type, 2 drains, about 8 km long
- Tertiary canals	Earthen canal, commanding about 24 ha each, about 700 - 1,000 m long each
Flood protection dike	15 km long
Farm road	Two-way road 2.3 km, and one-way road 17 km
On-farm development	Land leveling of 620 ha, and field ditches

3.6.5 Mlali Scheme

Instead of the existing buried headworks, new headworks are proposed to be constructed about 240 m upstream of the existing headworks where the river is slightly meandering to the left and the water route is biased to the right. The proposed headworks consist of only an intake without weir, as the water level is kept high enough owing to the backwater effect of the existing weir. A new headrace will be connected to the existing main canal. The existing main and secondary canals be rehabilitated with provision of lining. The proposed plan of irrigation and drainage development is summarized below:

Gross cropping area	80 ha
Net cropping area	60 ha
Headworks	Only an intake be constructed 240 m or 600 m upstream
- Design flood discharge	64 m^3/s with a 50-year return period
- Design intake discharge	0.12 m^3/s
- Type	Intake without weir
- Intake	Stoplog type, 2 m wide x 0.6 m high
Irrigation canals	
- Headrace	Newly provided, stone or brick lining, 250 m
- Main canal	Rehabilitated with masonry lining, about 1,400 m long
- Secondary canals	Newly constructed, earthen canal, about 1.2 km in total
Drainage canals	Main 2.1 km, secondary 1.2 km
Flood protection dike	Earth type, about 1.5 m high, 1.3 km long
Farm road	Improvement of the Mgeta road to the present weir and new road thereafter to new intake, total 1.5 km

3.6.6 Myumi Scheme

The irrigation facilities developed some 20 years ago have been completely buried under the sediment, thus, these shall be renewed entirely. In this scheme, it is planned that the headworks will be set up at about 1.5 km upstream of the buried headworks where the river depth is about 3 m and water never overflows the existing natural embankment. From this diversion point to the scheme area, a headrace will be 4 km long constructed along the existing local road. Irrigation water will be conveyed to farm plots via the main, secondary and tertiary canals. Flood protection dikes will be provided so as to surround

the scheme area. The basic features of the proposed facilities are shown in the following table.

Gross cropping area	330 ha
Net cropping area	260 ha
Headworks	New construction at 1.5 km upstream of the present buried intake
- Design flood discharge	244 m^3/s with a 50-year return period
- Design intake discharge	0.5 m^3/s
- Weir type	Stoplog gated type
- Intake	Steel gate, 0.8 m wide x 0.8 m high
Irrigation canals	New construction
- Headrace	lining, about 4 km long
- Main canal	lining, about 3 km long
- Secondary canals	Earthen canal, 6 km in total, about 500 m/ 25 ha each
Drainage canals	New construction
- Main drains	Trapezoidal, earth type, along right & left boundaries, about 3.3 km long each
- Secondary drain	Earthen canal; 6 km, commanding about 25 ha each,
Flood protection dike	about 8.5 km long
Farm road	Improvement: 5 km, new road in area: 3 km
On-farm development	
- Paddy field	Land leveling of 200 ha, field ridges and field ditches
- Upland field	Field ditches for 60 ha

3.6.7 Msolwa Scheme

It is proposed that the headworks will be repaired and reinforced with cement mortar plaster. The existing two ruined gates shall be replaced with larger gates. The existing main canal and related structures shall also be repaired mainly at the leakage points including the level-crossing structure. The canal walls will be heightened to a certain extent to increase the flow capacity. The main canal to be extended will be lined as same as the existing sections. The secondary canals will run in parallel with the contour lines. The proposed irrigation development plan is outlined in the following table.

Gross cropping area	400 ha
Net cropping area	320 ha
Headworks	Rehabilitation of existing weir and intake, replacement of gates
- Design flood discharge	97 m^3/s with a 50-year return period
- Design intake discharge	0.3 m^3/s
- Weir type	Fixed overflow type
length	about 17 m
- Intake type	A gated inlet followed by a sand trap pond
inlet gate	Steel slide gate existing, 0.9 m wide x 1.2 m high
sand flush gate	Steel slide gate existing, 0.9 m wide x 1.3 m high
Irrigation canals	
- Headrace	Rehabilitation at leakage points and increase of capacity, 1.3 km long
- Main canal	Newly constructed, lining 3.8 km long
- Secondary canals	Newly constructed, earthen canal, about 13 km in total
- Major related structures	Culverts for crossing farm roads and division structures

(to be continued)

Drainage canals	
- Main drains	Newly constructed, earthen type, about 5 km long
- Secondary drains	Newly constructed, earthen type, about 13 km long in total
Flood protection dike	Earth type, about 1 m high, 1.2 km long
On-farm development	Land leveling of 100 ha, and field ditches for paddy fields Field ditches for 220 ha of upland crop fields

It is noted that adjustment of water allocation between beneficiaries of this scheme and the existing water right holders is an essential subject in the implementation of this scheme.

3.6.8 Mkula Scheme

The prospective irrigable land of the scheme is estimated to be 320 ha in gross. Water discharges of the Mkula river largely fluctuate seasonally, and accordingly, irrigation in the dry season is limited to around 150 ha only.

The existing headworks will have to be rehabilitated entirely. A concrete membrane will be provided in front of the existing weir in order to reduce the water leakage hazard. The existing headrace will be replaced at the uppermost reaches of 175 m. Increased conveyance capacity of this portion is required. The walls of the rectangular flume will be heightened for increasing water conveyance capacity throughout all the sections of the main canal. The rectangular flume especially after crossing of the trunk road B127 (Ifakara - Mikumi road) shall also be repaired so as to eliminate water leakage hazard. Then the main canal will be extended along the existing village road. The basic features of the proposed irrigation and drainage facilities are shown in the following table:

Gross cropping area	400 ha
Net cropping area	320 ha
Headworks	Rehabilitation of existing head works, intake and apron
- Design flood discharge	59 m^3/s with a 50-year return period
- Design intake discharge	0.3 m^3/s
- Weir type	Fixed overflow type
length	About 11 m
- Intake inlet gate	Steel slide gate, 0.6 m wide x 0.6 m high
Irrigation canals	
- Headrace	Replaced with new one, lining about 175 m
- Main canal	Raising walls height by 30 cm for total 450 m length and repair of leakage points Newly constructed, lining, 3 km long
- Secondary canals	Newly constructed, earthen canal, about 11 km in total
Drainage canals	
- Main drains	Newly constructed, earth type, about 5 km long
- Secondary drains	Newly constructed, earth type, about 11 km long in total
Flood protection dike	Earth type, 2.5 km long
On-farm development	Land leveling of 220 ha, and field ditches for paddy fields Field ditches for 100 ha of upland crop fields

3.6.9 Sonjo Scheme

The Sonjo scheme is one of the new irrigation development schemes. Headworks will be provided on the Sonjo river, about 100 m upstream of the existing bridge on the trunk road B127 (Ifakara - Mikumi road). The proposed headwork site

outcrops and has firm rock foundation. The water head at the site is sufficiently high to distribute water to all the irrigable area by gravity. The basic features of the proposed canal system are shown in the following table.

Gross cropping area	600 ha
Net cropping area	480 ha
Headworks	Newly provided
- Design flood discharge	154 m^3/s with a 50-year return period
- Design intake discharge	0.5 m^3/s
- Weir type	Fixed overflow type
length	About 15 m
- Intake inlet gate	Steel slide gate, 0.9 m wide x 0.9 m high
Irrigation canals	
- Main canal	Stone or brick masonry lining, 3.5 km long
- Secondary canals	Stone or brick masonry lining, 3 km long
- Other secondary canals	Mainly earthen canal, about 12 km in total
Drainage canals	
- Main drains	New construction on both sides, earth type, about 4 km long
- Secondary drains	New construction, earth type, about 12 km long in total
Flood protection dike	2.4 km long
On-farm development	Land leveling of 260 ha, and field ditches for paddy fields Field ditches for 220 ha of upland crop fields

3.6.10 Chabima Scheme

The prospective irrigable area is estimated at about 10 ha extending along the left bank of the Chabima river. The scheme itself is very small, therefore, no heavy infrastructure is required for irrigation and drainage except the headworks. The proposed development scheme is outlined in the following table.

Gross cropping area	15 ha
Net cropping area	10 ha
Headworks	Rehabilitation of cracked portions, reinforcement of apron & right wing, intake is newly provided
- Design flood discharge	16 m^3/s with a 50-year return period
- Design intake discharge	0.01 m^3/s
- Weir type	Fixed type weir
- Intake type	A stoplog gated inlet, 0.5m wide x 0.8m high
Irrigation canals	New construction
- Main canal	Earthen canal, about 1 km long
- On-farm development	10 ha

3.6.11 Ndole Scheme

This scheme does not require any important infrastructure pertaining to irrigation and drainage as same as the Chabima scheme. The basic features of this development scheme are shown in the following table:

Gross cropping area	100 ha
Net cropping area	80 ha
Irrigation canals	Rehabilitation of existing canal & extension of main canal
- Headrace	Increase of canal height, about 250 m long
- Main canal	Flume type , lining, about 2.5 km long
- Secondary canal	Provision of lining, about 0.3 km long
- Major related structures	Construction of stepped chute and division box on main canal
Farm road	2 km with a bridge for river crossing
On-farm development	Field ditches for 80 ha

3.6.12 Lumuma Scheme

The total net cropped area served by the Lumuma river is about 1,100 ha in the Lumuma river basin including Mpwapwa district of Dodoma region, of which 380 ha belong to the Lumuma scheme. Water resources are not sufficient to irrigate all the cropped area in the Lumuma river basin especially in the mid-dry season. In the case of the Lumuma scheme, however, majority of farmers could practice irrigation throughout the year since the area is located in the upper reaches of the Lumuma river basin and blessed with good water distribution. Thus, for irrigation development in this scheme, it is emphasis should be put on the improvement of irrigation efficiency with provision of water saving measures, and then, to keep surplus irrigation water as much as possible for supply to farmers in the lower reaches. To this end, it is essential to integrate various existing traditional intakes into a few permanent intakes, to line the main canals, and to provide night storage ponds, etc. The basic features of the development scheme are as follows:

It is noted that adjustment of the water right on the basis of mutual understanding with Mpwapwa district, Dodoma region is an essential and crucial subject in the implementation of the proposed development plan.

Gross cropping area	480 ha		
Net cropping area	380 ha		
	First System	Second System	Third System
Headworks	Traditional intakes are replaced with permanent headworks.		
- Design flood discharge	161 m^3/s with a 50-year return period		
- Design intake discharge	0.13 m^3/s	0.10 m^3/s	0.15 m^3/s
- Weir type	Fixed overflow type	Stoplog gated type	Stoplog gated type
- Intake inlet gate	Steel slide gate, gate leaf size: 0.6 m wide x 0.6 m high x 1 set		
Irrigation canals			
- Main canal lining	4.5 km	5 km	11 km
- Night storage pond, capa.	2,800 m^3	2,200 m^3	3,200 m^3

3.6.13 Nyinga and Mgogozi Mwega Scheme

New headworks will be provided in the uppermost part of the Nyinga area instead of the existing three traditional intakes in the Nyinga scheme. In the case of the Mgogozi-Mwega scheme, there is no suitable site for diverting the river water to the irrigable area. Therefore, a canal coming from the above proposed headworks will be extended up to the Mgogozi area and connected with the existing canal system. Major features of the development scheme are summarized in the following table:

Gross cropping area	180 ha
Net cropping area	150 ha
Headworks - Design flood discharge - Design intake discharge - Weir type - Intake inlet gate	Newly constructed, integrating traditional intakes 99 m^3/s 0.15 m^3/s Stoplog gated type Steel slide gate, gate leaf size: 0.5 m wide x 0.5 m high x 1 set
Irrigation canals - Proposed main canal - Proposed secondary canal to Mgogozi area	 3.2 km, lining 4.4 km, lining

3.6.14 Malolo Scheme

The existing canal-A and canal-B are running in parallel with each other at an interval of 100 m to 250 m and commanding very long and narrow strips of land extending on the left bank of the river terrace. In this plan, it is proposed to utilize the canal-A as main canal for all the irrigable area on the left bank of the river terrace, and the canal-B as secondary canal of the canal-A system. The existing intake-A has not enough flow capacity to evacuate the seasonal floodwater and worsens flooding conditions causing a backwater effect. The weir is also accelerating hazardous sedimentation in the upstream reaches, and making the river unstable. Thus, the existing intake-A shall be replaced with a new one of stoplog gated type in its upper portion. The intake-B has also the same problem as the intake-A, but the foundation of the weir is expected to be firm on the right side portion. Thus, it is planned that the weir section should be widened to the right side, so certain increase of flow capacity could be expected. The weir should be all of stoplog type. The sill elevation will be set a little lower than the present riverbed downstream of the weir in order to mitigate sedimentation in the upstream reaches. Major features of the development scheme are shown in the following table:

Gross cropping area	500 ha	
Net cropping area	400 ha	
	Intake-A system (Left bank area)	Intake-B system (Right bank area)
Net irrigation area	350 ha	50 ha
Headworks	Replaced with new one	Improvement
- Design flood discharge	117 m^3/s	
- Design intake discharge	0.35 m^3/s	0.05 m^3/s
- Weir type	Stoplog gated type	Stoplog gated type
- Intake type	An inlet and a sand trap pond with slide gates	
gate (leaf size)	0.9 m x 0.9 m	0.5 m x 0.5 m
Irrigation canals - Main canal - Proposed connecting canal from canal-A to existing canal-B	Main canal-A, 10.5 km 6 canals, 2.2 km in total	-

3.6.15 Mgogozi-Kikalo Scheme

It is estimated that only half of the existing cropped area (100 ha) is irrigable in the case of a drought with a five-year return period, while almost all the area can be irrigated in the case of a drought with a two-year return period. Thus, the irrigation development plan should put an emphasis on the improvement of irrigation efficiency for extending irrigation to more area. For this purpose, unification of existing traditional intakes into a permanent

intake, lining of main canals, and provision of night storage ponds are proposed. The proposed plan is shown in the following table:

Gross cropping area	130 ha
Net cropping area	100 ha
Headworks - Design flood discharge - Design intake discharge - Weir - Intake	Improvement of weir and new construction of intake 8 m^3/s with a 50-year return period 0.10 m^3/s Existing, fixed overflow type, repairing leakage point Steel slide gate, gate leaf size: 0.5 m wide x 0.5 m high x 1 set
Irrigation canals - Main canal, Left and right - Major related structures	 Lining, 2 km long each A night storage pond for each of left and right main canal Effective storage volume: 900 m^3 to 1,300 m^3 for each
River improvement	Enlargement, about 1 km in the lower reaches
On-farm development	Small earthen canals, about 3 km in total

3.6.16 Chabi Scheme

The Chabi scheme consists of the Chabi sub-scheme and Mohazima sub-scheme. In the case of the Mohazima sub-scheme, water rights on the Mohazima river are granted only to the beneficiaries is Mpwapwa district, Dodoma region. The granted amount is 0.53 m^3/s, which is larger than the Mohazima river discharge in the mid-dry season. Thus, there is no room for allocation to the Mohazima scheme in the mid-dry season, although by mutual understanding, river water is fairly taken by both the Chabi scheme and the Mpwapwa side at present. However, the Mohazima sub-scheme will continuously suffer from water shortage in the dry season due to absolute insufficiency of water resources. Meanwhile, even in the dry season, the water resources of the Chabi river still remain without utilization even when all the area of the Chabi sub-scheme is irrigated. About 240 ha can be irrigated by the water resources of the Chabi river in the mid-dry season. Thus, in addition to the Chabi sub-scheme area of 100 ha, the Mohazima sub-scheme area of 140 ha out of 170 ha should be covered by the Chabi river. Water of the Chabi river can be conveyed to the Mohazima area by gravity. The proposed development scheme is outlined in the following table:

Gross cropping area	340 ha
Net cropping area	270 ha, only 240 ha be irrigated by proposed Chabi system
Headworks - Design flood discharge - Design intake discharge - Weir type - Intake inlet gate size	Construction of permanent headworks on the Chabi river 33 m^3/s with a 50-year return period 0.27 m^3/s Fixed type weir Steel gate, 0.6m wide x 0.6m high
Irrigation canals - Main canal - Secondary canals	New construction & rehabilitation of existing canal Lining, about 5 km long New construction of 0.5 km & improvement of about 3 km by lining
On-farm development	Small earthen canals, 11 km in total

3.6.17 Access Road Improvement Plan

The present condition and improvement plan for all the access roads are summarized in the following table.

Name of Scheme	Name of Trunk Road	Distance from Trunk R. to Scheme	Access Road Condition	Improvement Work Items
Mgeta	A-7	35 km	First 25 km: -Laterite road in flat area -Relatively well maintained Last 10 km: -Mountain road -Appearance of rock due to soil erosion	-Road surface improvement about 0.5 km -Rock cutting & filling
Manyenyere	B-127	20 km -13 km up to Tindiga village -7 km up to intake	-Earth road without embankment -Difficult to pass during the rainy season	-Embankment & side ditches about 4.5 km -Provision of some cross drains
Kilangali	B-127	15 km	-Earth road without embankment -Difficult to pass during the rainy season, especially in last half portion	-Embankment & side ditches -about 5.0 km -Provision of some cross drains
Chabima	B-127	21 km	First several km :Difficult to pass during the rainy season Last half: Appearance of rock due to soil erosion	-Embankment about 2 km -Rock cutting & filling about 0.5 km
Lumuma	Railway connected to Dar es Salaam	10 km from Kidate railway station	-Earth road -Relatively well maintained -Passing some depressions -Few longitudinal steep portions	-Provision of some cross drains -Improvement of alignment & embankment about 0.5 km
Ndole	B-127	37 km from Mvomero	First 10 km: -Laterite road in flat area -Relatively well maintained Last 27 km: -Mountain road -Appearance of rock due to soil erosion -No superstructure of one bridge -Big gully portion at one road side	-Surface improvement about 3 km -Provision of 7 cross drains -Construction of 10m superstructure for one bridge -Provision of gabion
Malolo	A-7	25 km up to Malolo village	-Flat road without any embankment -Relatively good surface condition -Passing some depressions	-Provision of some cross drains
	Chabi road	4 km up to Malolo intake B	-Very bad surface condition near canal B -Wash away superstructure of bridge on Mwega river -Soil erosion of one road side	-Embankment about 1.2 km -Construction of 13m superstructure for one bridge -Provision of gabion
Nyinga	Malolo village	9 km from Malolo to Nyinga	-Earth road -Insufficient drainability -Few longitudinal steep portions	-Provision of some cross drains -provision of side ditches -Improvement of alignment & embankment about 0.5 km

3.7 Plan of Community Development and Reinforcement of Farmers' Organizations

Reinforcement of the present farmers' organizations is one of the essential subjects to efficiently perform O&M work for the rural and agricultural infrastructure, as well as to successfully maintain sustainable development of irrigation-based agriculture in the Study Area. Activation of the village community society is the primary basis of this approach.

3.7.1 Strengthening of Existing Water Users' Groups (WUGs)

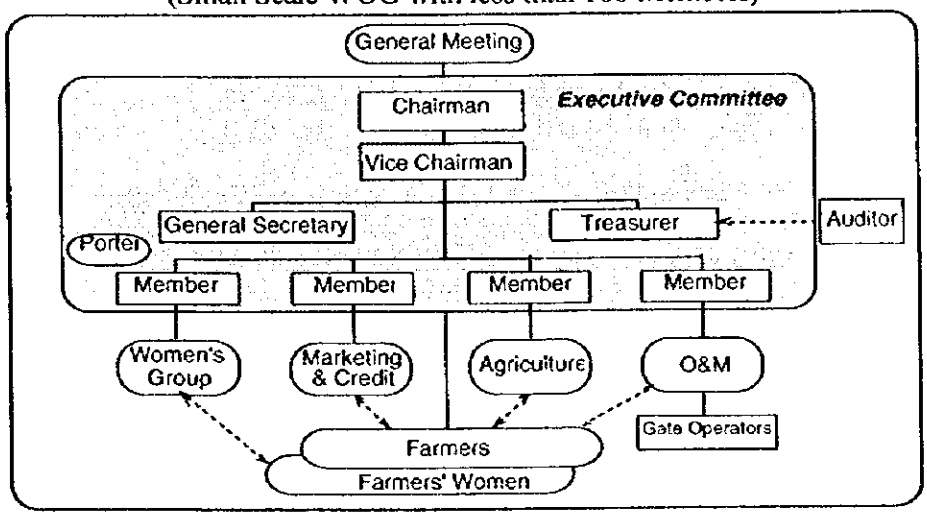
GOT has issued the basic policy that all the irrigation systems should be maintained through farmers' participatory approach. In the Study Area, it is essentially needed in the first place to strengthen and/or further improve the existing water users' groups through restructuring or to organize them into a new WUG so as to respond to the said policy, and hence, farmers to enable successfully undertake O&M work by themselves in each scheme. Access to marketing and credit services is also one of the elemental functions of WUG.

For the purpose, all the beneficiary farmers in each scheme shall participate in WUG, and accordingly, its membership be permitted to all the beneficiaries, irrespective of their gender and/or social and cultural background.

(1) Proposed Organization and Prospective Activities

The proposed organization structure of WUG will have two types, i.e. Type-A and -B as demonstrated below:.

Proposed Water Users' Association Type-A
(Small Scale WUG with less than 100 Members)

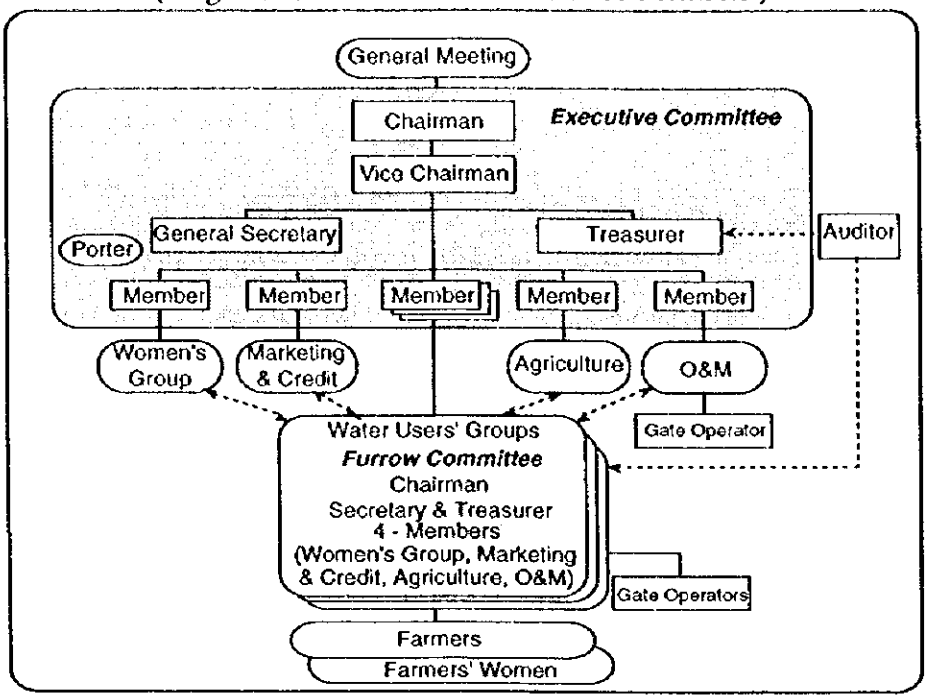


The above Type-A will be applicable to small scheme a having less than 100 farm households each. In this organization, the member farmers will carry out necessary activities directly under management of the executive committee.

The following Type-B is recommendable for larger schemes having over 100 farm households each. In the Type-B organization, the member farmers will be grouped into several sub-groups by each irrigation block on the secondary canal basis or the respective village units. Each group will be functioning separately under management of the

executive committee. To organize farmers into WUG, it is recommended that members of a unit group shall be limited to less than 100 farm households, so that a face to face communication among the members could be maintained smoothly and satisfactorily.

Proposed Water Users' Association - Type-B
(Large Scale WUG with more than 100 Members)



(2) By-laws, Water Right and Registration of WUG

The articles or by-laws should be enacted in accordance with the Co-operative Act 15. In the preparation of the articles or by-laws, following items shall be taken into account so as to enable fair and satisfactory management of WUG:

- WUG has the right to collect Irrigation Service Charges (ISC) from the beneficiaries, and the beneficiaries have the duty to pay ISC to WUG.
- WUG inflicts a punishment on the beneficiaries who use irrigation water and facilities illegally and are not able to pay ISC.
- The beneficiaries have the duty to participate in the communal works on O&M.
- The tenant beneficiaries have the right to join WUG and to be elected as executive members, and are bound to pay ISC and membership fees .

All WUGs established in each scheme shall be registered under administration of MAC before commencement of the project implementation, and then, acquire the water right. DALDO office shall provide necessary supporting services to WUG for their registration and acquisition of the water rights.

(3) Irrigation Service Charges

All the financial costs required for O&M of the irrigation facilities will be covered by ISC collected from the beneficiary farmers. ISC shall be collected immediately after each cropping season. All the members of the executive committee will collect ISC directly from the beneficiary farmers. The collected ISC will be deposited in the

respective bank account of WUG. The treasurer shall manage all these transactions, and auditors should check all the financial statements and balance sheet periodically.

3.7.2 Participation of Women in Irrigation Development

Women in the scheme area play an important role in not only household keeping but also various activities in agriculture production as well as in community society. Over the years, however, women, especially those in the scheme area, have lagged behind in receiving updated knowledge of improved practices and/or methods, technology, etc. which are necessary in their socio-economic activities. Many of the messages provided in the education system are not directed towards the needs of poor households, and even less, towards the specific needs of women. A limited access to the educational and/or training institutes has so far made it difficult for girls/women to improve their present illiteracy condition as well as to upgrade their technical skills. Poverty of families is also a constraint and large disturbance. Limitation of women's access to economic resources and their lower social status are perhaps a consequence of each other. Women farmers have, in most cases, been neglected by the technical extension service system despite their ample contribution to farm production and accordingly farm income. However, actual involvement is not up to the mark mainly due to their illiteracy, social and cultural background, and lack of access to new technology.

Implementation of the Project will induce further activation of crop production, post harvest activities, marketing and transportation of farm inputs, crop products, etc., social or culture-based community services, etc. Thus, women in each scheme area will also have greater opportunities to participate in those economic and social activities. To encourage women's participation to the project work, the following shall be emphasized:

i) To establish the women's groups and encourage their promotion and activation of income generation, i.e. processing of value-added crops, livestock farming, etc.

ii) To appoint women's leaders in the executive committee of WUG especially for activation of the social welfare and cultural aspect.

The objectives of women development have been rightly defined by recognizing their work, enabling them to develop their skills and confidence in decision making, and not merely increasing their income and employment levels. Thus, in the proposed irrigation schemes, it is very essential to implement WID program to extend knowledge of improvement of irrigation-based crop cultivation technology and skills, thereby increasing crop productivity and also enhancing the status of women by giving them recognition. An important component of the program is induction of women extension officers in DALDO office, ensuring that intensive extension and training services will reach farm women so smoothly and effectively.

3.7.3 Supporting Services for O&M Work by Farmers

The majority of beneficiary farmers in each scheme have been more or less experienced to do O&M work through operation of the existing irrigation facilities. However, as far as O&M of WUG are concerned, it seems that members of the existing WUG have the following difficulties, and hence, they need technical and financial assistance from the Government:

- Difference in opinion among the members due to vested interests;
- Financial limitation for further improvement of irrigation facilities;
- Limitation of accessibility to the present credit support service, especially at the initial stage of co-operative work;
- Lack of education/ technical skills in operation and management of the co-operative society; and
- Shortage of guidance to the members in respect of technical matters, accounting and auditing system.

To eliminate the above constraints and improve the background of co-operative activities, it is crucial to reinforce the extension and training services especially at the on-farm level to a maximum extent. To this end, training of the front-line staff of DALDO office is essentially required at the initial stage of the project implementation as their experiences are not sufficient as far as technology on operation and management of WUG is concerned.

3.8 Project Evaluation

The feasibility of the respective development schemes is evaluated based on both economic and financial internal rate of returns estimated on a preliminary basis. In this evaluation, the capacity to pay annual O&M cost as well as amortization cost on the development fund in the farm economy of the typical farm household and the capacity of contribution to the regional economy and the national food security program from the macro-economic viewpoint are also taken into account.

3.8.1 Economic and Financial Viability of Each Scheme

(1) Incremental Benefits and Project Costs

Incremental Benefit by Respective Scheme (Unit: million Tsh.)

Name of Scheme	Prospective Benefits			Name of Scheme	Prospective Benefits		
	Without Project	With Project	Incremental Benefit		Without Project	With Project	Incremental Benefit
Mgeta	1.06	2.94	1.88	Sonjo	36.15	275.34	239.19
Manyenyere	62.99	712.14	649.15	Chabima	1.21	5.21	4.00
Kilangali	22.83	218.17	195.34	Lumuma	162.17	375.15	212.98
Mgongola	75.27	543.36	468.09	Ndole	8.02	41.71	33.69
Mlali	13.89	35.99	22.10	Nyinga/Mgogozi -Mwega	24.74	175.72	150.98
Mvumi	21.73	195.94	174.21	Malolo	107.75	409.40	301.65
Msolwa	33.37	167.08	133.71	Mgogozi-Kikalo	25.35	70.97	45.62
Mkula	30.96	156.10	125.14	Chabi	73.02	263.03	190.01
				Total	700.51	3,648.26	2,947.75

The above table shows the incremental benefits brought about by the implementation of this Project. These benefits are estimated based only on the essential crop products obtainable under the conditions with and without the Project.

The table below shows the development costs of main and on-farm facilities and O&M costs estimated on a Financial basis for each scheme.

Project Cost on Financial Basis

(Unit: million Tsh)

Scheme	Development Costs			O&M Costs
	Main facilities	On-farm Dev.	Total	
Mgeta	11.84	0.00	11.84	0.18
Manyenyere	3,337.42	990.48	4,327.90	50.57
Kilangali	1,345.02	352.39	1,697.41	20.38
Mgongola	1,970.15	590.48	2,560.63	29.85
Mlali	158.31	0.00	158.31	2.40
Mvumi	1,075.21	65.45	1,140.66	16.29
Msolwa	608.12	72.48	680.60	9.21
Mkula	605.39	68.29	673.68	9.17
Sonjo	1,006.39	101.82	1,108.21	15.26
Chabima	25.50	1.99	27.49	0.39
Lumuma	1,051.39	0.00	1,051.39	15.93
Ndole	151.29	15.96	167.25	2.29
Nyinga/Mgogozi-Mwega	366.44	0.00	366.44	5.55
Malolo	811.20	0.00	811.20	12.29
Mgogozi-Kikalo	232.75	6.36	239.11	4.61
Chabi	489.12	14.46	503.58	7.63

1) Above costs do not include contingencies (physical and prices)
2) On-farm dev. costs include works to be carried out exclusively by farmers. Other on-farm works which are not carried out by farmers themselves are already included in the development costs of main facilities.

(2) Financial and Economic Internal Rate of Return (IRR)

Based on the direct net benefits and project costs shown above, the financial IRR has been calculated for each scheme. After converting the financial direct net benefits and project costs into economic ones, the corresponding economic IRR is also calculated as summarized in the table below:

Financial and Economic Internal Rates of Return (%)

Name of Scheme	Financial IRR	Economic IRR	Name of Scheme	Financial IRR	Economic IRR
Mgeta	10.30	10.40	Sonjo	15.90	16.40
Manyenyere	12.00	12.20	Chabima	10.20	11.60
Kilangali	9.20	10.00	Lumuma	13.60	17.30
Mgongola	15.90	16.20	Ndole	14.90	15.90
Mlali	10.20	15.30	Nyinga/Mgogozi-Mwega	25.80	31.90
Mvumi	10.60	13.60	Malolo	23.70	29.10
Msolwa	14.70	15.00	Mgogozi-Kikalo	12.70	15.90
Mkula	13.90	14.10	Chabi	24.50	28.70

If an IRR of 12% is considered to be the acceptable minimum level of feasibility of a project, all the schemes except the three schemes of Mgeta, Kilangali, and Chabima could be considered as viable. The latter three schemes, which have an economic IRR below 12%, are marginally acceptable.

(3) Financial Capacity to Pay of Typical Farm Household

The financial capacity to pay of the farmers has been analyzed so as to determine whether a typical farm household can cover the amortization cost for the development fund

(or replacement cost for the project facilities) and O&M cost. The following table shows the financial capacity to pay of a typical farm household.

Financial Capacity to Pay of a Typical Farm Household per Scheme

Scheme	Income at Present (TSh)	Income with Project (TSh)	Net Value (TSh/ha)	Financial Burden			Proportion of Burden * (%)
				Const.Cost (Tsh./ha)	O&M (Tsh./ha)	Total Cost (Tsh./Ha)	
Mgeta	55,483	157,446	127,455	2,195	24	2,219	2
Manyenyere	33,070	374,592	421,633	9,158	99	9,257	2
Kilangali	51,967	502,201	349,019	45,269	490	45,759	13
Mgongola	40,944	321,079	172,923	9,590	104	9,694	6
Mlali	11,913	31,869	27,337	12,507	135	12,642	46
Mvumi	11,023	106,203	109,402	12,080	131	12,211	11
Msolwa	66,738	334,162	148,569	20,684	224	20,908	14
Mkula	61,914	316,323	197,216	21,011	227	21,238	11
Sonjo	143,025	1,088,686	685,262	4,510	49	4,559	1
Chabima	8,442	36,499	16,408	99,121	1,073	100,194	-
Lumuma	208,898	492,621	333,792	19,378	210	19,588	6
Ndole	30,987	128,466	216,621	39,583	90	39,673	18
Nyinga/Mgogozi-Mwega	206,981	1,338,148	890,682	112,662	1,219	113,881	13
Malolo	225,114	868,158	502,378	23,235	251	23,486	5
Mgogozi-Kikalo	177,476	496,760	207,327	88,576	1,252	89,828	43
Chabi	408,199	1,461,450	675,161	54,769	610	55,379	8

Note) Mgogozi scheme is divided into two sub-schemes, that is Mgogozi-Mwega and Mgogozi-Kikalo, based on river sour
Mgogozi-Mwega sub-scheme is joined into Nyinga scheme, in order to promote water resources and rational rehabilitation of water management

*1 : Proportion of the total cost of financial burden to the net value

The table above indicates that, if the financial capacity to pay is taken as a proportion (%) of the net value for each typical farm household, in the case of Chabima, the household may be able to cover the O&M costs but not the amortization costs for the development fund. The main reason is that the total area to be benefited by irrigation is too small if compared to the investment development cost. The typical farm families in the Mlali and Mgogozi-Kikalo schemes can cover both the development fund amortization and O&M costs, while their income may have to bear a heavy burden to cover those costs. For the other schemes, the households may not face problems in covering the subject costs as the proportion of the costs relative to their income is less than 20%.

3.8.2 Macro-economic Evaluation

(1) Contribution to the Regional Economy

Once the Project's production target has been fully attained, it is expected that, at 1996 prices, the gross production value from all the schemes will attain Tsh. 5,589 million per year. This represents 5% of the regional agricultural GDP for the year 1994. Contribution to the regional economy can be expected at Tsh. 4,566 million from the incremental crop production, annually.

(2) Contribution To National Food Security

After the Project's full production target has been attained, the contribution of cereals from the respective 16 schemes will be 25,190 tons, annually. This represents

6% of the total present production of cereals in Morogoro Region. As far rice production, RPFB contemplates a target of 800,000 tons for the year 2000; the rice contribution by the Project, 23,800 tons, will represent 3% of such target.

3.8.3 Project Feasibility from Other Viewpoints

GOT and the village community in each scheme have the basic function to implement the Project though structural reinforcement is required. Thus, the development capability of each scheme is considered to be generally acceptable from the institutional and organizational viewpoints. It is also assessed that the traditional village community being organized in each scheme area is functioning well to manage farmers' activities. In most scheme areas, the local farmers have more or less experience in irrigated farming since a long time ago, and accordingly, they can judge whether irrigation development is required or not. Therefore, from the technical viewpoint, the farmers' participatory approach to the project implementation could be achieved without serious problems.

The initial environmental examination pointed out that the Project would bring about such misgivings as influence of water-bone diseases, water contamination by use of chemical fertilizers and agro-chemicals, degradation of vegetation due to increased fuel wood consumption and social conflicts on utilization of the land and water resources. However, these negative impacts could be satisfactorily managed and minimized since all of the proposed schemes are small in development scale.

3.9 Conclusions and Recommendations

3.9.1 Conclusions

According to the results of the preliminary feasibility study on the respective 16 irrigation schemes in the Central Wami River Basin, which had been taken up in NIDP, all the schemes except the Mgeta, Kilangali and Chabima schemes are evaluated as technically and economically viable and promising for development investment. Although the Mgeta, Kilangali and Chabima schemes show a EIRR relatively lower than the standard rate of 12% specified by GOT, these schemes could also be acceptable if the access roads to those schemes would be improved/consolidated jointly under other rural development programs in the said areas.

3.9.2 Recommendations

The present master planning study revealed that the Central Wami River Basin has a large development potential for irrigation-based agriculture. It has also justified that the respective 16 irrigation schemes taken up in NIDP are highly expected to bring about certain large impacts on the rural, regional and national economy, as well as they are viable for development investment.

In the Central Wami River Basin, there are many small scale traditional irrigation schemes other than the said 16 irrigation schemes. However, the inventory survey on these schemes has not been completed yet. Especially in the Mkata plain which lies in the central part of the Basin, the existing traditional schemes might have large land and water potentials for irrigation-based agriculture development though complete flood protection works as well as sophisticated irrigation and drainage systems would be required for

prevention of frequent seasonal flooding by the Wami river and its tributaries. In reality, however, no detailed hydrological observation on the respective river system has been started up to present. It has also become apparent through the present master planning study that an enormous investment would be required to successfully materialize the development of those schemes. In contrast, most of the villages have no more arable land, and consequently, the holding size per farm household has been reduced to a marginal level through fragmentation of land title due to current population increase and generation change in the rural area. In order to deal with the above fact and efficiently maintain sustainable agricultural development in the Wami river basin, it is essential to undertake a comprehensive investigation, i.e. hydrological observation on the Wami and its major tributaries, assessment of the land resources as well as environmental impact assessment on the Mkata plain to demarcate the possible development area for implementation of the resettlement program as it would be required in the near future.