THE UNITED REPUBLIC OF TANZANIA

FEASIBILITY STUDY ON THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

VOLUME I

MAIN REPORT

JANUARY 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

THE UNITED REPUBLIC OF TANZANIA

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THE MKOMAZI VALLEY AREA

IRRIGATION DEVELOPMENT PROJECT

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PREFACE

In response to the request of the Government of the United Republic of Tanzania, the Government of Japan decided to conduct a feasibility study on the Mkomazi Valley Area Irrigation Development Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to TANZANIA a survey team headed by Mr. S. Yano from October 1982 to July 1983.

The team exchanged views with the officials concerned of the Government of the United Republic of Tanzania and conducted a rainy-season survey and a dry-season survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relationship between our two countries.

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

January 1984

Keisuke Arita
President
Japan International Cooperation Agency

Mr. Keisuke ARITA
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleasured to submit you the feasibility report on the Mkomazi Valley Area Irrigation Development Project in the Kilimanjaro Region, the United Republic of Tanzania, in accordance with the terms of reference issued by JICA.

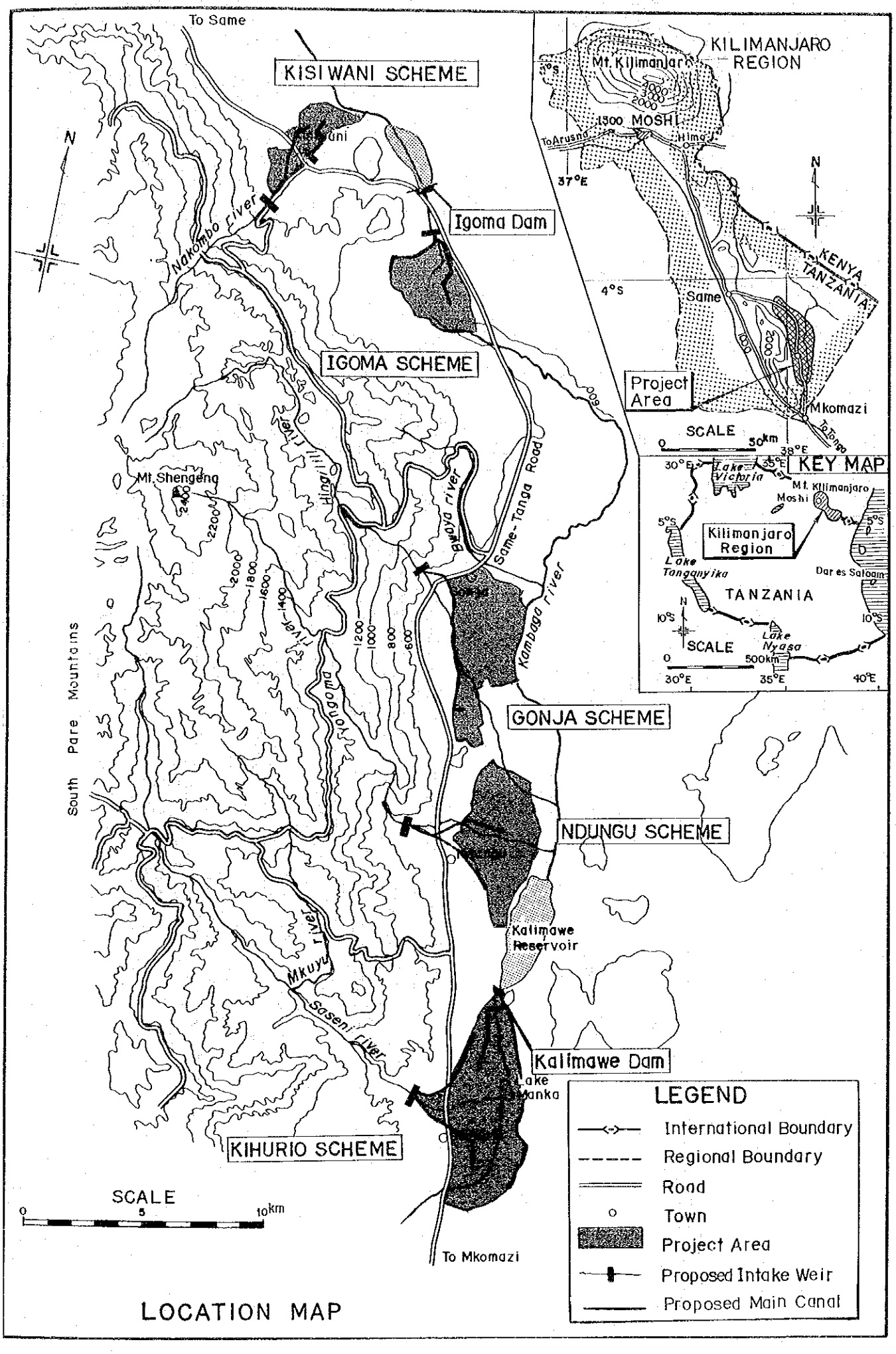
The Mkomazi Valley Area Irrigation Development Project aims at the improvement of disparity of income and raise of living standard of the farmers in the project area through the exploitation of water resources and the development of irrigated agriculture. With implementation of the project, the annual production of rice would be sharply increased in the project area and the increased amount of the product would substantially contribute to the regional economy of the Kilimanjaro Region. It is verified through the study that the project is technically sound and economically and financially viable. In view of the pressing needs and the economic contribution of the project, it is recommended that the project would be soon implemented along the conclusion presented in this report.

In submitting this report, we wish to express our sincere appreciation and gratitude to the personnel concerned of your Agency, the Embassy of Japan in Tanzania and Authorities concerned of the Government of Tanzania for the courtesies and cooperation extended us during our field surveys and studies.

Very truly yours,

S. [signature]

Shin'ichi YANO
Leader of The Study Team
for the Mkomazi Valley Area
Irrigation Development Project



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SUMMARY AND RECOMMENDATIONS

INTRODUCTION

1. This report is prepared in accordance with the Article 4.5 in the Scope of Works for the Feasibility Study on the Mkomazi Valley Area Irrigation Development Project in the United Republic of Tanzania agreed upon between the Government of the United Republic of Tanzania and the Government of Japan. The report presents the results of the field survey and feasibility study on water resources development of the Mkomazi Valley area, with particular emphasis on the irrigation development of about 4,760 ha.

2. The Government of Tanzania requested the Government of Japan to extend cooperation for the implementation of 14 projects selected from the Kilimanjaro Integrated Development Plan (KIDP) prepared by JICA in May 1978. In response to the request, the Government of Japan proposed to the Government of Tanzania the assistance program comprising six priority projects as the Outline of Japan's Possible Assistance in September, 1978.

3. In response to the request of the Government of Tanzania, the Government of Japan has decided to provide technical services for the feasibility study on the Mkomazi Valley Area Irrigation Development Project, one of the six priority projects in KIDP, as a part of the technical cooperation program of the Government of Japan.

4. In accordance with the Scope of Works for feasibility study on the Project agreed upon between the Government of Tanzania and the Government of Japan, the feasibility study was carried out by JICA (Japan International Cooperation Agency) in cooperation with the Government of Tanzania from October 1982 through October 1983.

GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

5. The economy of Tanzania has grown very steadily during the past decade of 1968 - 1978 at an annual rate of about 5.5% on an average in the Gross Domestic Production (GDP). Due to the increase in population and the decrease in food production, a negative annual growth rate of GDP has been shown in 1979 and 1980. The trade balance of Tanzania has considerably worsened in the recent 4 years. The balance deficit rose substantially from year to year and attained to TSh 5,880 million in 1980.

6. The Kilimanjaro Region occupies approximately 13,260 km^2 of land which corresponds to about 1.4% of the entire territory of Tanzania. The total population is estimated to be about 902,000 as of 1978, corresponding to 68 person/km^2. The land of the Region is broadly divided into two distinctive areas; i.e. highland and lowland areas. The population density in the highland is etimated to be as high as about 255 persons/km^2, while scarce population of about 17 person/km^2 in the lowland area.

7. Agriculture in Tanzania as well as in Kilimanjaro Region has played an important role in its economy. More than 90% of the regional population is considered to be dependent on agriculture either directly or indirectly in the Region. Coffee, sisal, cotton and tobacco are the major export crops of Tanzania, accounting for about 60% of the total exports. Kilimanjaro Region is the largest coffee producing region, accounting for about 50% of the national production. Maize is one of the main staple food in Tanzania, followed by rice. In spite of great effort on agricultural development made by the Government, food production has not been attained to its selfsufficiency so far in Tanzania.

THE PROJECT AREA

8. The project area is located at the eastern side of the Pare Mountains in the southeastern corner of Same District in Kilimanjaro Region. The area is formed by a long stretch of flat lowland with approximately 50 km from north to south at an altitude of about 500 - 700 m. The project area covers about 5,860 ha in gross comprising five schemes, i.e. Kisiwani (420 ha), Gonja (1,360 ha), Ndungu (1,340 ha), Kihurio (1,880 ha) and Igoma (860 ha) schemes.

9. Most of the project area comprises alluvial fans and some swales along the Mkomazi river as well as its tributaries. The slope of the areas ranges from 1:200 to 1:400. The present land use of the area is about 3,890 ha of arable land, about 1,760 ha of non-agricultural land including swamp, marshy land, and savanna, and about 210 ha of village yard and rivers.

10. Climate in the project area is tropical. Average annual rainfall in the flat lowland is approximately 500 mm at Kalimawe dam, while that in the high lands of the South Pare Mountains is abundant, approximately 1,400 mm which is about 3 times as much as that in the flat low land. More than 90% of the annual rainfall occur in the rainy season from November to May. The mean temperature in the low lands has rather little fluctuation ranging from 22°C to 28°C. The average annual pan evaporation at Kalimawe is 2,100 mm. The annual relative humidity is as low as about 58% at Kalimawe.

11. The water sources of the project come mainly from the four tributaries of the Mkomazi river, namely, Nakombo, Yongoma, Hingilili and Saseni rivers. These rivers originate from the South Pare Mountains ranging in elevation from 1,000 m to 2,400 m. The annual average runoff of the above four tributaries and other related tributaries is tabulated as follows:

River	Site	Catchment Area (km^2)	Runoff ($10^6 m^3$)
Nakombo	Water level gauge st.	48.5	25
Hingilili	Debouching point	55.8	39
Yongoma	Water level gauge st.	70.5	37
Other residual basin		1,317.4	65
Sub-total at Kalimawe dam		1,492.2	166
Saseni	Debouching point	198.5	68
Other residual basin		242.4	Neglisible small
TOTAL		1,933.1	234

12. Alluvial fans in the project area are mainly composed of fine sandy sediments. The yield of aquifers is considered to be generally low. The Mkomazi Lake beds developed under the lower terraces and alluvial plains are one potential aquifer, but they have a problem of brackish water because of their gypsiferous facies. It is considered that the development potentials of groundwater in the project area are low.

13. Geology of the South Pare Mountains and residual hills in the Umba Steppes are composed of the metamorphic rocks consisting of banded gneisses with metamorphosed basic and ultra basic intrusives. Geological and soil physical investigations reveal that construction materials for concrete and embankment materials for canals are sufficiently available in the project area.

14. The soils in the proposed agricultural development areas are classified into two orders, i.e. Entisols and Inceptisols. From the practical utilization point of view, the soils can be broadly grouped into five categories, i.e. Reddish brown colluvial soils, Yellowish brown colluvial soils, Grayish brown alluvial soils, Brownish gray alluvial soils and Yellowish gray alluvial soils. Except for some soils, the soils are suitable for both paddy and upland crops cultivation.

15. There exist many small scale irrigation systems under the traditional method in the project area, which cover approximately 1,200 ha in total. No systematic operation of water management is being properly made at present. The low-lying areas surrounding Lake Manka and the upstream area of the existing Kalimawe reservoir are often inundated during the rainy season and poorly drained.

16. Maize is the predominant staple food of the local inhabitants and planted extensively in the entire project area. Three types of maize cultivation are practiced. One is practiced in the elevated area during a period from November to April. The second cropping are made in the low-lying area during a period from April to August. The third one is practiced in the most low-lying area during a period from July to November. Paddy has been newly introduced in the project area. About 1,140 ha was cultivated with paddy in 1982.

Beans are also important food crops in the project area followed by groundnut, cassava and sweet potato.

17. The present farming practices in the area are still traditional, though irrigation farming has been introduced recently in certain areas. The soil preparation for most of the crops is made by hand hoe. Ploughing by tractor is rather limited. The high-yielding varieties of maize have been introduced in the irrigated land, but farmers mainly grow the traditional varieties in the rainfed area. No high-yielding varieties of paddy have been introduced so far.

18. Present crop yields in the project area are rather low. The average yield of crops in 1982 were as shown below.

Maize (high-yielding varieties/irrigated)	1.5 ton/ha
" (local varieties/irrigated)	1.0 "
" (local varieties/rainfed)	0.6 "
Paddy	1.8 - 2.8 "
Beans	0.4 "

19. The present crop production in the project area is still low at the subsistence level. Surplus of maize production in the recent four years accounts for almost nothing. A very limited surplus of paddy and beans is purchased directly by the National Milling Corporation (NMC). The surplus of perennial crops, banana, coconuts, mango, etc., are directly marketed by the farmers themselves.

20. The farm gate prices of staple cereals are controlled and fixed by the Government. The current farm gate prices of major crops in the project area are as follows:

- Maize	4.00 TSh/kg
- Paddy	6.00 "
- Beans	8.00 "

21. The Mkomazi Valley Area covers about 190,000 ha of which approximately 29,000 ha are arable. Out of the above, about 20,000 ha are located in the highland and about 9,000 ha in the low-lying plain. From the view points of topography, land capability as well as soil and forest conservations, the horizontal expansion of land in the highland would be very limited. Because of fluctuated river flows of the Mkomazi

river, the irrigated farming in the lowlying plains is limited, amounting only approximately 1,200 ha. From the climatological conditions of the Valley, irrigation is essential not only during the dry season but in the rainy season. In order to develop the irrigation land in the Valley, the effective river control, particularly run-off with creating storage dam in the upstream of rivers are obviously important. As a result of the rough study on storage dam development in the upper reaches of the Mkomazi river, approximately 6,000 ha of the flat lowland would be irrigated.

22. There exists big falls between the hilly lands in the South Pare Mountains and the flat lowland in the Valley. Utilizing the storage dams envisaged for irrigation development, approximately 36 MW of hydropower development could be conceived harnessing the big falls, when the present power capacity in the Kilimanjaro Region came to short of supply.

THE PROJECT

23. After a careful water balance study as well as economic comparison on various storage dams envisaged, it is proposed that 4,760 ha of net irrigation area comprising 360 ha in Kisiwani scheme, 750 ha in Igoma scheme with dam, 1,040 ha in Gonja scheme, 940 ha in Ndungu scheme and 1,670 ha in Kihurio scheme are to be developed as the first priority development particularly from the economical view point.

24. The project is formulated with the main concepts of:

(1) increase and stabilization of yield and production of the crops through the supply of irrigation water, proper water management and introduction of improved irrigation farming as well as improved varieties,

(2) introduction of diversified cropping pattern particularly double crops of paddy,

(3) development of new agricultural lands by means of irrigation and drainage development, from which certain resttlement of farmers from the hilly lands would be expected, and

(4) improvement of living standard and more equitable distribution of income and welfare of the people.

25. From the viewpoints of agro-climatic conditions, farm holding size, national and regional demands and the Government's agricultural development program as well as farmers' economy, double crops of paddy is first proposed for the main crop in the irrigated area. Maize and beans are also introduced as the major staple crops for rainfed cultivation. Improved high-yield varieties will be introduced in order to maximize the yield and profit.

26. After implementation of the project, the following crop yields and production are anticipated.

Crops	Yield (ton/ha)	Area (ha)	Production (10^3 tons)
Rainy season paddy	5.0	4,060	20,300
Dry season paddy	4.5	2,780	12,510
Maize	2.0	1,980	3,960
Beans	0.8	1,980	1,580

27. The irrigation requirement for the project is estimated for the proposed cropping pattern. The overall irrigation efficiency is estimated at 72% for paddy field irrigations assuming that canal conveyance losses and operation losses are to be 10% and 20% respectively. The peak diversion requirements per ha estimated in the monthly basis are shown below.

Dry season	1.47 ℓ/sec/ha
Rainy season paddy	1.33 ℓ/sec/ha

28. The following table shows the salient features of the proposed five development schemes. The layouts of irrigation and drainage facilities in each scheme are illustrated in attached Plates 1 to 7.

Scheme	Kisiwani	Gonja	Ndungu	Kihurio	Igoma
Net Irrigation Area(ha)	360	600	680	1,670	750
Max.Div.Req.(m^3/sec)	0.54	0.82	0.93	3.09	1.20
Intake-facilities	2 Weirs	1 Weir	1 Weir	1 Weir & 1 Dam	1 Weir w/dam
Irrigation Canal					
Main and Secondary	Concrete lining	Concrete lining	Concrete lining	Concrete lining	Concrete lining
Length (km)	8.7	20.9	17.6	29.7	15.8
Drainage Canal (km)	9.4	17.7	15.4	23.1	3.4
Farm Road (km)	18.1	38.6	33.0	52.8	19.2
On-farm Develop. (ha)	360	1,040	940	1,670	750
River Improvement/ Floodway (km)	2.6	4.6	4.2	9.0	5.3
Flood Dike	-	-	2.5	6.5	1.5

29. The time required for the implementation of the project is estimated to be six years including the design works and preparatory works.

30. In order to implement the project successfully it is proposed to establish the Mkomazi Valley Project Office under the superintendence of the Regional Development Director. The main functions of the Project Office are as follows:

(1) Financial arrangement needed for construction works and operation and maintenance of the project facilities,

(2) Design and construction supervision of the construction works down to tertiary system,

(3) Accounting and management of the construction works.

31. In order to attain the expected crop production, more intensive agricultural support services are essential. In this context, the agricultural extension services should be strenghthened. In addition, it is, desired to establish the water users' association for proper water management. It is further proposed that the Kilimanjaro Agricultural Development Center (KADC), implemented under the technical

and financial assistance of the Government of Japan in 1981, would provide technical guidance on farmers organization as well as on training extension workers and leading farmers.

32. The total project costs required are estimated to be about US$61.2 million equivalent which comprise US$37.7 million of foreign currency and US$23.5 million equivalent of local currency, and include the physical contingency of about 10% of direct cost and the price contingency of 5% per annum for the foreign currency portion and 15% per annum for the local currency portion as shown in attached table. The annual operation and maintenance costs are estimated to be about TSh.5.3 million per annum.

33. In addition to the agricultural and flood protection benefits, benefit of water release for potable water are counted in the evaluation. These benefits are as summarized below:

Unit: TSh. x 10^3/year

Scheme	Agricultural Benefit	Flood Protection Benefit	Potable Water Benefit	Total
Kisiwani	8,440	10	-	8,450
Gonja	17,390	30	-	17,420
Ndungu	17,450	20	-	17,470
Kihurio	44,550	40	-	44,590
Igoma	24,270	20	420	24,710
Whole Project	112,100	120	420	112,640

34. The project evaluations are made in order to ascertain the feasibility of the project in view of economic, financial and socio-economic aspect. The economic feasibility of the project is evaluated in terms of the internal rate of return (IRR) on the basis of a 50 years useful life. The calculated results are shown below and indicate that the project is quite feasible with the IRR of 19% as a whole.

	IRR %
Whole project	19.0
Kisiwani	17.3
Gonja	20.2
Ndungu	20.3
Kihurio	21.6
Igoma	12.1

35. The financial evaluation of the project is made by examining the repayment capability for the capital cost for the project. In the examination of repayment capability, the prospective water charge of TSh. 1,200/user/year is collectable on an average, which is equivalent to the required amount of O&M cost and replacement cost.

36. In the examination of repayment capability, it is assumed that the capital cost required for the project implementation will be arranged under the following conditions:

- the foreign currency portion of the capital cost is financed by bilateral or international organizations with an interest rate of 3.0% per annum for a repayment of 30 years including 10-year grace period;

- the local currency portion of the capital cost is financed by the budget allocation of the Government.

37. In addition to the benefits stipulated in the economic evaluation, the following indirect benefits and favourable intangible socio-economic impacts are expected from the implementation of the project.

(1) Saving of foreign exchange,
(2) Increase of employment opportunity to local people,
(3) Improvement of local transportation,
(4) Improvement of sanitary conditions, and
(5) Settlement from the densely populated highland.

RECOMMENDATIONS

38. The development of the Mkomazi Valley Area for irrigation in about 4,760 ha is technically and economically feasible. Thus, it is recommended that the project should be implemented as early as possible as the project will substantially provide for economical and social impacts not only in Kilimanjaro Region but in Tanzania as well.

39. The feasibility study on irrigation development for the Igoma scheme was carried out based on the topographic map of 1/50,000 scale with 50 feet contour intervals and preliminary drilling tests for the geolocical investigation for the proposed dam site conducted in 1983. For the successful implementation of the project, the following supplementary topo-survey and preparation of maps in acceptable scale, and geological and geophisical investigations are required to be carried out for the following stage of the detailed design works of the project.

- topographic maps of 1/5,000 scale with 0.5 m contour interval covering the entire irrigable and reservoir areas of Igoma scheme,
- topographic maps of 1/500 scale with 0.25 m contour interval at both proposed dam and headworks sites, and
- additional test drilling at the Igoma dam site and headwork site as well as construction materials survey for embankment materials.

40. Hydrological analysis was carried out based on the available data provided by the Authorities concerned and supplementary investigation carried out by the Feasibility Survey Team in both 1982 and 1983. Those data were insufficient for analysis particularly in the upstream of tributaries of the Mkomazi river due to shortage and some interruption in measurement of river runoff and meteorological observation. In view of the vital importance of meteoro-hydrological data on the water resources development, it is absolutely necessary to continue periodical measurement of river runoff and water level as well as for rain gauges for which Feasibility Survey Team has established some stations in collaboration with the Authorities concerned, to obtain more reliable data.

41. The empirical formula for estimation of consumptive use by crops was applied in the estimation of irrigation water requirement for the project. Only a few measurement of percolation rate in the paddy field and none field measurement of intake rate for upland were carried out. Actual field measurement of both consumptive use and percolation rate for paddy land and uplands, particularly at the lands to be newly reclaimed, are needed to be carried out in the project area.

42. The upper basin of the tributaries of the Mkomazi river, originated from the South Pare Mountains have been widely developed for perennial crops cultivation and annual food crops, resulting in acceleration of considerable amount of sediment transport due to erosion of soils and decreasing perennial flow in the dry season. The consolidated watershed management of the upper reach basin is indispensable. In this context, it is recommended to promote the reforestation work for land conservation as well as for water resources.

43. In order to exploit the full potential of the land for agricultural development and these rather intensive cropping patterns were proposed for the project, which require more improved farming techniques together with proper water management. For the successful introduction of the proposed cropping pattern and water management to the farmers in the project area, the present institutions for agricultural support services have to be strengthened through an increase of staff and budget allocation and the training of staff and leading farmers in the project area in the existing Kilimanjaro Agricultural Development Center (KADC).

Table S-1 SUMMARY OF CONSTRUCTION COST

Unit: TSh.10^3

	Item	Foreign Currency	Local Crrency	Total
1.	Preparatory Works	14,120	5,850	19,970
2.	Igoma Dam	56,800	18,400	75,200
3.	Intake Facilities	24,090	11,150	35,240
4.	Canals and Roads			
	(1) Irrigation canals	48,330	19,420	67,750
	(2) Drainage canals	19,220	8,830	28,050
	(3) Farm roads	7,680	2,230	9,910
5.	Floodway & Flood Dike	18,320	4,880	23,200
6.	Rehabilitation of Existing Dam	13,900	5,400	19,300
7.	On-farm Development	51,440	19,640	71,080
8.	Office and Quarter	9,200	5,700	14,900
	Sub- total	263,100	101,500	364,600
9.	O & M Equipment	15,000	1,000	16,000
10.	Administration Expenses	-	25,400	25,400
11.	Engineering Services	59,600	16,200	75,800
	Sub-total	74,600	42,600	117,200
	Total	337,700	144,100	481,800
12.	Physical Contingency	33,300	14,900	48,200
	Total	371,000	159,000	530,000
13.	Price Contingency	81,000	123,000	204,000
	Grand Total (US10^6$)	452,000 (37.7)	282,000 (23.5)	734,000 (61.2)

Note: Price Contingency: Foreign currency 5%, Local currency 15%

US$1.00 = TSh.12.00 = ¥240.-

FEASIBILITY REPORT

ON

THE MKOMAZI VALLEY AREA

IRRIGATION DEVELOPMENT PROJECT

VOLUME I

MAIN REPORT

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ABBREVIATIONS

1. Length and Height

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer

2. Area

cm^2	:	square centimeter
m^2	:	square meter
km^2	:	square kilometer
ha	:	hectare

3. Volume

lit.	:	liter (= 1,000 cm^3)
m^3	:	cubic meter

4. Weight

mg	:	milligram
g	:	gram
kg	:	kilogram
t (ton)	:	1,000 kg

5. Time

sec	:	second
min	:	minute
hr	:	hour
yr	:	year

6. Other Measures

%	:	percent
°C	:	centigrade
m^3/sec	:	cubic meter per second
ℓ/sec/ha	:	liter per second per hectare
cm/sec	:	centimeter per second
ppm	:	part per million
meq/ℓ	:	milli equivalent per liter
m.mho/cm	:	milli mho per centimeter
kW	:	kilowatt
MW	:	megawatt
kWh	:	kilowatt-hour
GWh	:	gigawatt-hour

7. Currency

TSh	:	Tanzanian Shillings
US$	:	US Dollar

8. Other Abbreviations

AFO	:	Assistant Field Officer
CAT	:	Coffee Authority of Tanzania
CEC	:	Cation Exchange Capacity
DADO	:	District Agricultural Development Office
DDD	:	District Development Director
ESP	:	Exchangeable Sodium Percent
FAO	:	Food and Agriculture Organization
GAPEX	:	General Agricultural Products Export Corporation
GDP	:	Gross Domestic Product
IBRD	:	International Bank for Reconstruction and Development
JICA	:	Japan International Cooperation Agency
KADC	:	Kilimanjaro Agricultural Development Center
KIA	:	Kilimanjaro International Airport
NMC	:	National Milling Corporation
RADO	:	Regional Agricultural Development Office
RDD	:	Regional Development Director
TCA	:	Tanzania Cotton Authority
TRDB	:	Tanzania Rural Development Bank
TANESCO	:	Tanzania Electric Supply Company Ltd.
TANSEED	:	Tanzania Seed Company Ltd.
TFA	:	Tanzania Farmers Association
WUA	:	Water Users' Association
OECF	:	Overseas Economic Cooperation Fund

1. INTRODUCTION

1.1 Authority

This report is prepared in accordance with the Article 4.5 in the Scope of Works dated March 3, 1982 for the Feasibility Study on the Mkomazi Valley Area Irrigation Development Project (hereinafter referred to as "the Project") in the United Republic of Tanzania agreed upon between the Government of the United Republic of Tanzania (hereinafter referred to as "Government of Tanzania") and the Government of Japan.

This Final Report presents the results of field works and studies which contain the findings of the present conditions in and around the project area, development concepts and prospective development plan, proposed major project works project benefits and cost estimates, and economic and financial justification of the Project.

1.2 Project History

In accordance with the spirit of the "Arusha Declaration" in 1967, the Government of Tanzania has laid great emphasis on the formulation of a comprehensive regional development plan for the entire country. In line with the above program the Government of Tanzania requested the Government of Japan to extend its technical aid for the preparation of the integrated development plan in Kilimanjaro Region as a part of the Third 5-Year Plan (1976-1980) of Tanzania. In response to the request, the Government of Japan decided to provide the necessary technical services for the study as a part of the technical cooperation program of the Government of Japan. JICA dispatched a study team in 1974 to this region and subsequently submitted the Report of the Kilimanjaro Integrated Development Plan (KIDP) to the Government of Tanzania in October 1977. The plan envisaged various social and economic developments covering such basic sector as agriculture, small-scale industry, water resources, infrastructure, tourism, education as well as health based on the regional socio-economic background and problems. In the Report 38 concrete development projects were listed up as the promising development potentials.

The Government of Tanzania requested the Government of Japan to extend cooperation for the implementation of 14 projects selected from the above list in May 1978. In response to the request, the Government

of Japan proposed to the Government of Tanzania an assistance program comprising 6 priority projects in the Outline of Japan's Possible Assistance in September 1978. In this line, both the Kilimanjaro Agricultural Development Center (KADC) and the Kilimanjaro Industry Development Center (KIDC) were successfully implemented in September 1981. The Lower Moshi Agricultural Development Project was also selected as the first development scheme to be implemented, for which the funds required had been provided by a loan from the Overseas Economic Cooperation Fund (OECF), Japan. Moreover, the construction of the Kilimanjaro Transmission and Distribution Network Project has been recently commenced with finance provided through an OECF loan.

In response to the request of the Government of Tanzania, the Government of Japan has decided to provide technical services for the feasibility study on the Mkomazi Valley Area Irrigation Development Project, one of the six priority projects in KIDP, as a part of the technical cooperation program of the Government of Japan.

Prior to the feasibility study, JICA dispatched a Preliminary Survey Team headed by Mr. Y. Akiyama to the site from mid November to the beginning of December 1981 to conduct a preliminary survey to delineate the proposed area to be developed. JICA further dispatched a Scope of Works Mission headed by Mr. S. Katakura to Tanzania from 21 February 1982 to 3 March 1982 for the purpose of working out the Scope of Works.

In accordance with the Scope of Works, JICA firstly dispatched an aerial photo survey team to the project area from June to July 1982 to take aerial photographs and to prepare topographic maps on a scale of 1 to 5,000 with 1.0 m contour intervals in the study area, topographic maps surrounding Lake Kalimawe on a scale of 1 to 2,500 with 0.5 m contour intervals and topographic maps of mountain side on a scale of 1 to 50,000 with 50 feet contour intervals for about 415 km^2.

Following the above mission, JICA further dispatched a feasibility study team to the site in the middle of October 1982 to initiate the field survey. The team carried out the survey in the rainy season by the end of December 1982. During the above two survey works JICA sent two Supervisory Teams, one headed by Mr. Y. Yamaguchi in June 1982 and the other headed by Mr. K. Miyazoe in mid October 1982 respectively to the site for advising the teams.

In the meantime, JICA dispatched a Supervisory Team for the feasibility study headed by Mr. T. Mase for a period from 12 to 19 December 1982 to conduct a field inspection and to exchange views with the Regional Authorities concerned prior to the preparation of the Interim Report. The Interim Report was prepared based on the results of field works and preliminary studies at the end of March 1983.

Following the preparation of the Interim Report, JICA dispatched a study team to the project site from the beginning of May 1983 to the end of July 1983 to carry out the supplementary survey in the dry season. A Supervisory Team headed by Mr. S. Katakura was also dispatched in the beginning of May 1983. During stay in Tanzania, the Supervisory Team made the field investigation in the study area and exchanged views with the Regional Authorities concerned on the Interim Report which was submitted by the survey team on 9 May 1983.

Based on the comments and suggestions offered by the Tanzanian Authorities concerned at the meeting on the Interim Report, and advices from the Supervisory Team, the feasibility study team carried out the supplementary survey and further studies and compiled the Draft Final Report. The Draft Final Report was submitted in October 1983 for the review of the Government of Tanzania.

JICA dispatched a Draft Final Report Expranation Team consisting of members of JICA's supervisory committee and feasibility study team, headed by Mr. Y. Akiyama to Tanzania in the beginning of November 1983. The Draft Final Report was discussed by the Tanzanian Authorities concerned and the feasibility study team at the presence of the Supervisory Team. The Final Reprt was prepared taking into account the comments made by the Government of Tanzania on the Draft Final Report.

1.3 Objectives of the Study

The objectives of the study are to verify the technical and economic feasibility on the irrigation development in the Mkomazi valley area with particular emphasis on about 6,000 ha in total in the Kisiwani, Gonja, Ndungu and Kihurio areas, and to undertake on-the-job training and transfer of knowledge to the Tanzanian counterparts in the course of the survey and study. The Scope of Works mutually agreed upon between the Government of Tanzania and the Government of Japan is shown in ATTACHMENT-I.

1.4 Activities of the Study Team

The activities of the study team broadly consist of field survey in the study area and home office works in Japan, in which the field survey includes the following;

(1) overall field reconnaissance,
(2) collection and review of the relevant data and information,
(3) meteorological and hydrological investigations,
(4) soil and land use survey,
(5) irrigation and drainage survey,
(6) topographic survey,
(7) agricultural, agro-economic and socio-economic survey,
(8) foundation and embankment materials investigations,
(9) geological and hydro-geological investigations,
(10) construction materials, cost survey, and
(11) on-the-job training of the Tanzanian counterparts during the course of the field works.

The home office work includes;

(1) review of the Interim Report,
(2) formulation of the basic Mkomazi valley development plan,
(3) formulation of agricultural development plan,
(4) formulation of irrigation and drainage development plan,
(5) preliminary design,
(6) preparation of construction schedule plan,
(7) benefit and cost estimates,
(8) economic and financial evaluation of the Project,
(9) preparation of implementaiton schedule plan and operation maintenance organization plan,
(10) recommendation to the Government of Tanzania, and
(11) transfer of knowledge and technical know-how to the Tanzanian counterpart personnel during the JICA training course.

ATTACHMENT-II hereof shows the counterpart personnel provided by the Government of Tanzania, the Supervisory Team members and the study team members for the Project.

The comments made by the Government of Tanzania on the Draft Final Report are attached to this report as ATTACHMENT III together with the F/S team's explanation to the comments.

2. AGRICULTURAL AND ECONOMIC BACKGROUND

2.1 General Features of Tanzania

The United Republic of Tanzania consists of Mainland, Zanzibar island and Pemba island, and the physical area is about 939,700 km^2 in total. The population, currently estimated to be about 18.5 million (19.7 persons/km^2), increased by an annual growth rate of 3.3% during the period of 1970-1980 on average.

The economy of Tanzania grew very steadily during the past decade of 1968-1978 at an annual rate of about 5.5% on an average, and the Gross Domestic Production (GDP) attained about TSh.33,580 million (US$4,365 million equivalent) at the end of 1978. The agricultural sector is the largest sector in the national economy, dominating about 40% of the GDP. However, a recession in the national economy occurred in 1979 and 1980. The reasons among others are due to the increase in population and the decrease in food production. The annual growth rate of GDP in the respective years was -2.9% and -18.7%.

The trade balance of Tanzania has considerably worsened in the past 4 years. The balance deficit rose substantially from year to year and attained TSh.5,880 million in 1980 (imports value and exports value were TSh.10,050 million and TSh.4,170 million, respectively). The major imports in 1980 were industrial machinery, transportation equipment, crude petroleum and petroleum products. This amount corresponded to about 50% of the total imports. The major exports comprised agricultural products such as coffee, tobacco, sisal and food crops. The amount corresponded to 70% or more of the total exports.

2.2 Socio-economic Features of Kilimanjaro Region

2.2.1 Land and population

Kilimanjaro Region occupies approximately 13,260 km^2 of the land area which corresponds to about 1.4% of the entire territory of Tanzania. The total population is estimated at about 902,000 persons as of 1978. The regional population density is 68 persons per km^2. This is the second highest density in the country next to Dar es Salaam, the capital of the Tanzania. The annual growth rate of the population projected in the past decade is approximately 3.0% on average.

In general, the land of the Region is broadly divided into two distinctive areas, i.e. a highland area and lowland area, according to the natural environment, particularly climate and topographic conditions as well as the present conditions of socio-economic exploitation. The highland area estimated at 2,200 km^2 is primarily the mouhtainous slope land lying mainly at an altitude between 1,000 m and 1,800 m of Mt. Kilimanjaro and the South Pare Mountains. Owing to a quite favorable climate with plentiful rainfall, the land in this highland area has been developed to its possible maximum extent. Recently, the population of this area has grown increasingly through rapid population growth, and the population density has attained about 255 persons per km^2 or more. In contrast, the lowland area, where land extends over the Arusha Chini Plateau, as well as the Pangani and Mkomazi river basins, it is characterized by the dry and hot climate. Very recently, the land has been reclaimed spontaneously by transmigrants to a certain extent, but the greater parts still remains fallow and lie waste.

The Same District, where the project area is located, has similar conditions to that in the Region. Namely, the highland in the South Pare Mountains is highly populated with a density of about 232 persons per km^2 and the arable land has been reclaimed to a possible maximum extent with such plantation crops as coffee and bananas, etc. In the lowlying area scarce population of 17.4 persons per km^2 is observed.

2.2.2 Administrative organization

The Kilimanjaro Region is administratively divided into five districts, i.e. Hai, Rombo, Moshi, Mwanga and Same. These districts are further divided into 25 divisions, 117 wards and 358 villages at present. Moshi town, the regional capital is the administrative center as well as commercial center of the Region.

The Kilimanjaro Regional Development Director (KRDD) office is given primary responsibility for regional development and for all aspects of external liaison, revenue, expenditure, budgeting, etc. Under the direction of the RDD office, 12 technical departments are organized as sectoral regional development offices. At the district level, the District Development Director (DDD) office has been established with the same organization structures. Administrative affairs of the Divisions, Wards and Villages are handled by the

respective offices concerned in each unit under the jurisdiction of DDD in accordance with the Regional policy.

The Village is the smallest unit in the present organization. Each village organizes the Village Committee for the smooth operation of administrative services. All the activities of the committee are properly steered by the three core positions of village chairman, secretary and village manager.

2.2.3 Infrastructure

The consolidation of the educational structure in the Region has progressed well, and the numbers of schools and teachers have remarkably increased in recent years. Most of all the school-aged children are attending schools and the ratio of pupils to teachers attained the reasonable range of about 53:1 in 1981. However, due to an acute shortage of qualified teaching staff as well as a lack of instruction materials, their quality is still far from adequate.

The medical and health services are well organized as far as the urban area such as Moshi Town and the capital of each district are concerned. However, facilities for medical and health control such as hospitals, health centers and dispensaries show an extremely large disparity in the rural areas.

The Region constitutes part of the traffic axis in the northern Tanzania. The road network which links the population clusters is relatively well served within the Region and provides easy communication with the surrounding areas. The railway lines which were constructed during the colonial time are also running in the Region, i.e. Moshi-Tanga line, Kahe-Nairobi line and Moshi-Arusha line. On the present operation program, trains run once a day to Arusha and Dar es Salaam and twice a day to Tanga. The Kenyan line from Kahe to Nairobi via Mombasa is not operated at present. The Kilimanjaro International Airport (KIA), which has the most modern facilities in Tanzania, is located at mid-way from Moshi to Arusha. Domestic and international air traffics use KIA.

2.3 Agricultural Setting and Production

2.3.1 Agricultural setting

Agriculture in Kilimanjaro Region has played an important role in both the national and regional economy. More than 90% of the regional population is being engaged in agriculture either directly or indirectly. Agriculture in the Region is characterized by two types of farming, i.e. plantation of perennial crops and cereal crop cultivation. These types of farming are settled in two distinctive areas reflecting the difference in rainfall according to elevation. Plantation of perennial crops such as coffee and banana have been developed since long ago in mainly the slope land (so-called highland) of Mt. Kilimanjaro and the Pare Mountains. On the other hand, cereal crop cultivation is rather practiced in new settlements in the lowlying areas, where the land receives less rainfall and has a higher temperature. In these settlements, such food crops as maize, millet, beans and paddy are the staple production. Sisal and sugarcane estates are exploited to a certain large extent in this lowlying area. Livestock grazing is also practiced extensively in this area, using wild grasses in the savanna land.

Irrigated farming has a long practice in Kilimanjaro Region, particularly in the plantation areas. Out of the total arable land of 200,000 ha in the Region, about 28,000 ha or 14% are irrigated at present. This is a quite good exploitation if compared with only 4% of that in the case of Tanzania as a whole. In most lowlying areas, however, irrigation development is still limited in extent, and almost all of the cereal cultivation is practiced under rainfed conditions.

2.3.2 Crop production

Kilimanjaro Region is one of the main producers of cash crops such as coffee, sugarcane, sisal, cotton, etc. in Tanzania. Among them, coffee is the most dominant production in the Region. At present some 14,000 to 29,000 tons of a high quality Arabica coffee is harvested annually. This production accounts for about 50% of the total national production. Besides, the Region produces about 300 tons of cotton (lint) and about 1,700 tons of sisal.

The cultivated lands, yield, and production of the major food crops

in the whole country and those of Kilimanjaro Region are summarized in Table 1. In the table, it is observed that the yield conditions of food crops in the Region, though these are still standing at a low level, are higher than that of the country's average.

2.3.3 Livestock

Various kinds of livestock are raised in the Region and they contribute significantly to the domestic income. Cattle is the main products, followed by goats and sheep. According to statistical data provided by the Regional Livestock Development Office, there are about 474,700 cattle, 490,800 goats and 292,000 sheep in the Region in 1982. Swine and chickens are also raised in this region, but their production is still small at present.

Livestock productivity is low due to inadequate disease control, frequent prolonged droughts, inadequate supplies of quality fodder crops, lack of trained extension services, lack of organized credit facilities, etc.

2.4 Land Tenure System

Under the land registration program, the Government of Tanzania specifies two land tenure systems, i.e. Kihamba and Shamba. In principle, the Kihamba is the free-holding type of tenure. The land of this tenure is, then, freely inherited, and bought/sold with the price depending on the farm conditions to be appraised by the existence of irrigation facilities, productivity of crops, etc. Shamba tenure is primarily referred to the cultivation right to be permitted by the local authority, for instance, the village committee.

In Kilimanjaro Region, the Kihamba type of tenure is mainly registered on the mountainous area where the land has been cultivated for such perennial crops as coffee, banana and fruit tree since long. On the other hand, the Shamba tenure is only found in lowlying areas where the land has been very recently exploited by spontaneous farmers.

2.5 Marketing and Food Balance

2.5.1 Marketing and price

Tanzania operates a single marketing channel called "Parastatal" (state-owned or controlled marketing board or corporation) as the principal focus of the national marketing system. Each Parastatal is responsible for marketing a different kind of crop. For instance, the National Milling Corporation (NMC) is for main food crops such as maize, paddy, wheat, sorghum and beans, the Tanzania Cotton Authority (TCA) for cotton, the Coffee Authority of Tanzania (CAT) for coffee, and the General Agricultural Products Export Corporation (GAPEX) for cardamon and oil crops such as groundnuts, sunflower, caster beans, etc. The Parastatals' buying and selling prices are set by the Central Government under approval of the Economic Committee of the Cabinet.

2.5.2 Foreign trade and food balance

Although the Government has made great efforts in agricultural development, the food production has not atteind to its self sufficiency until now due mainly to the unfavorable weather condition and high rate of population growth. The trade position in agriculgural products and food balance of the country have worsened in recent years.

Table 2 shows the past records of production, trade and domestic consumption of major crops in Tanzania. Table 3 shows the trade balance of agricultural products in value. According to both tables, the import constitution of food crops extends to 385,000 tons or US$112.4 million equivalent in 1980. Out of the food crops, imported maize has increased and attained 230,000 tons or the equivalent of US$53.0 million in 1980.

Cash crops i.e. coffee, sisal, cotton and tobacco are very important sources for the earning of foreign currency in Tanzania. In 1980, their exports amounted to 45,000 tons, 55,000 tons, 50,000 tons and 10,000 tons, respectively, and were valued at US$281.5 million in total.

The food balance in Kilimanjaro Region is estimated on the basis of data obtained from NMC as summarized in the following table.

Unit: ton

Crop Year	Inflow			Outflow		
	Purchased within Region	Imported from Outside	Total	Exported to other Region	Sold Within Region	Total
1979/80	9,302	4,425	13,727	3,828	9,899	13,727
1980/81	2,603	13,324	15,927	-	15,927	15,927
1981/82	1,084	12,457	13,541	-	13,541	13,541

NMC purchased 9,302 tons of food crops in 1979/80 within the Region, but only 1,084 tons in 1981/82. As a result, the quantities of exports to other regions were nil in 1980/81 and 1981/82. On the other hand, imports from the outside from 4,425 tons in 1979/1980 to 12,457 tons in 1981/82.

2.6 Agricultural Supporting Services

2.6.1 Researches

All the agricultural research programs are controlled by the Ministry of Agriculture. The research network covers the major agro-economic zones and all important crops in Tanzania.

In the Kilimanjaro Region, there exists the Lyamungu Agricultural Research Institute in Hai District out of the three essential commodity research stations in the country. Lyamungu Institute has 5 sub-stations within its jurisdiction: Tengeru, Miwareni, W. Kilimanjaro, Basuto and Sembwa. Since this institute was originally established for coffee experimentation, its main activities still center on coffee research. However, the Miwaleni sub-station carries out basic research on food crop cultivation techniques.

2.6.2 Training

The Government is proceeding with training programs to meet the production needs of the rural area. One long term target is to provide a formally trained Assistant Field Officer (AFO) for each village. To attain the target, tow-year Agro-Veterinary courses are executed at the "certificate" level to train AFO. The Folk Development Colleges under the Ministry of National Education also provide training courses for

producing leaders of rural villages.

In addition to the above, the Kilimanjaro Agricultural Development Centre (KADC) was established under the technical assistance and financial aid of the Japanese Government and started its training program in 1983.

2.6.3 Extension

Extension work is carried out through a four-tiered system, i.e. village level, ward level, district level and regional level. The supervisory chain works from the regional level down to the village level. In the Region, there are 190 extension staff at the district field level under the direction of the District Agricultural Development Officer (DADO). The average number of farm households per extension worker in the Region and Same District comes to approximately 910 and 730, respectively. The number of assigned extension workers seems rather moderate, but their extension services to the farmers are limited to some extent and most of work is usually burdened with administrative functions.

2.6.4 Credit

The Tanzania Rural Development Bank (TRDB) was created in 1971 to assume responsibility for rural credits. TRDB provides a dynamic mechanism for promoting rural development through the financing of productive activities in rural areas and by serving the rural population.

TRDB provides the three different terms of loan of short, medium and long term loans. Short-term loans are usually repaid within one crop season, generally for the purchase of farm inputs. Medium-term loans covers farm machinery, fishing boat, etc. The repayment period is between one and five years. Long-term loans cover livestock, storage, farm development and small industries. TRDB has increased its efforts to identify long-term development projects.

2.6.5 Farm mechanization program

The Regional Agricultural Development office of Kilimanjaro has established a farm mechanization program as one of the agricutural supporting services to the regional agricultural development. In the

program, the land preparation by the use of tractor is taken up as the main objective for promoting the agricultural production increase particularly of food crops.

2.6.6 Farmers' organization

The Tanzania Farmers' Association (TFA) was established in 1955 aiming to support the crop operation more effectively, and to better the farmers' material well-being. The primary role of this association is the smooth distribution of farm input with cheaper prices and arrangement of farmers' credit for member farmers. In the Region, TFA is stationed in Moshi town, and some 550 members, corresponding to about 0.4% of the total farmers in the region, participate in this association. Out of these, about 470 members or 85% are from the Moshi District, while only 3 members are from Same District.

Other than the above, Village cooperatives have been organized in each village. In principle, all the villagers are members of the cooperative. The cooperatives generally undertake the distribution of farm input as well as other commodities and collection of farm products to be marketed to the National Milling Board (a Parastatal) under the guidance of the Village Committee.

2.6.7 Supply of farm input

For the purpose of increasing agricultural production, several crop authorities and many branches of TRDB have been established with the view to consolidating development, collecting and selling as well as providing basic input supply service activities related to major agricultural crops.

The Tanzania Seed Company Limited (TANSEED) has responsibility for the production of foundation seeds of major food crops such as maize, paddy, beans, etc. Multiplication of the extension seeds are done by the contract farmers, and these multiplied seeds are distributed to farmers after being processed in the TANSEED factory. Distribution of the extension seeds to farmers is made by the Village Cooperatives through the institutional channel of TRDB, TFA, RADO, or stockists in each district.

In Tanzania, approximately 82-107 thousand tons of fertilizer is supplied by Tanga Fertilizer Company (TFC) of which 70-80 thousand tons

are imported per annum in recent 3 years. Most of the fertilizer used in the Kilimanjaro Region are supplied by TFC. In 1982, TFC supplied 5,950 tons of fertilizers to the Region. The large consignees in the Region are TRDB, CAT, TFA, etc.

Agricultural chemicals for food crop cultivation are mostly supplied to farmers through the TRDB channel. Chemicals for cotton and coffee cultivation are directly arranged by the Cotton and Coffee Authority and supplied to farmers at subsidized prices.

3. DEVELOPMENT POTENTIAL OF MKOMAZI VALLEY AREA

3.1 Present Situation of Mkomazi Valley Area

3.1.1 Physical features

(1) Topography

The Mkomazi Valley area is situated at the southern part of the Kilimanjaro Region. The area is bordered on the north by Kenya, by the Tossa Mountains on the east, and by the South Pare Mountains on the west, respectively. The Usambara Mountains run along the southeastern border of the area. The area, with a total land of 1,900 km^2, extends 50km in the east-west direction, 70km in the north-south direction and is broadly divided into the South Pare Mountains area and the vast plain area stretching along the strip mass of mountains with a length of about 60km from Same to Mkomazi and a width of about 15km. The Shengena Mountain is the highest with elevation of 2,460m. Since the border of the watershed of the South Pare Mountains is biased to the west, streams mainly develop on the east side of the mountains. They are the Nakombo, the Hingilili, the Yongoma and the Saseni streams and flow into the Mkomazi river via the Kisiwani and the Kambaga rivers which run in parallel to the mountains.

The Mkomazi Valley is a vast plain with a savanna view extending in the north-south direction. There exist small mountains such as the Tossa and the Kisiwani and a number of residual hills. The terraces with gentle slopes are developed at the foot of these mountains and hills and the South Pare Mountains. On the other hand, the Mkomazi river has several gorges in its river course, which divide the valley into small plains such as the Kisiwani, the Igoma, the Gonja, the Ndungu and the Kihurio. There exist many swales, (called Mbuga,) and lakes and marshes like the Lake Manka in the lowlying areas of each plain.

The existing Kalimawe dam was constructed by closing one of the gorges between the east side terrace of the South Pare Mountains and one of the residual hills.

In the southern part of Kihurio, the Mkomazi river forms a bottleneck of about 10km long, and after that, the river flows into the lower Mkomazi plain.

The Mkomazi Valley includes both forest and game reserves of about 570km^2 and 170km^2, respectively. The land use, other than these reserves, is cultivated area of 290km^2 and uncultivated and living areas of 870km^2.

(2) Climate

The Mkomazi Valley area belongs to the tropical monsoon climatic zone with the rainy season from November to May and the dry season from June to October. The annual rainfall varies substantially according to the altitude, i.e. about 1,400mm in the highlands of the South Pare Mountains and about 470mm in the flat Mkomazi plain. The mean temperature in the plains ranges from 22°C to 28°C and has little seasonal variation. The relative humidity is about 60% with small variations throughout the year. The average wind velocity at the Kalimawe station varies from 1.4 m/sec to 2.3 m/sec with its maximum in June and July. The annual average evaporation by the class A pan is approximately 2,100mm, and reaches its maximum in January to March, about 6.5 mm/day and its minimum in August, about 5.5 mm/day.

(3) Water resources

The Mkomazi river, with a drainage basin area of 1,900km^2 at Lasa bridge on the Same-Tanga road, originates in the southern end of the North Pare mountain ranges and runs in an almost southeast direction down to the confluence with the Nakombo river, passing through the Mkomazi Game Reserve. Then, it turns to the south direction. Its channel length is about 70km from the originating point to the southern end of the Valley. The four (4) tributaries, i.e. the Nakombo, the Hingilili, the Yongoma and the Saseni join with the Mkomazi river. These tributaries originate in the South Pare mountains and their total runoff occupies about 70% of the total runoff of the Mkomazi river basin despite the total basin area of only about 370km^2.

The mean annual runoff at the Kalimawe dam on the Mkomazi river is estimated at approximately $166 \times 10^6 m^3$. The mean annual runoff of the Saseni river is also estimated at about $68 \times 10^6 m^3$. Thus, the total annual runoff from the entire basin area is estimated at $234 \times 10^6 m^3$, out of which $180 \times 10^6 m^3$ occurs from December to May. According to the records for the past 20 years, the annual runoff at Lasa bridge varies widely from a $87 \times 10^6 m^3$ in minimum to a $774 \times 10^6 m^3$ maximum.

(4) Geology

The Mkomazi Valley area is underlain by metamorphic rocks of Pre-Cambrian age and superficial deposits of Quaternary age. Metamorphic rocks of Pre-Cambrian age form the basement complex and constitute the South Pare, Tossa and Kisiwani Mountains, and the residual hills scattered on extensive plains. The Pre-Cambrian formations are mostly composed of gneisses accompanied by metamorphosed basic and ultra-basic intrusives.

Most of the gneisses shows banded structure with pronounced foliations. Generally, these rocks have a simple monoclinic structure with the foliations of gneisses striking NW to NNW and dipping NE at low angles. The South Pare Mountains are the fault blocks.

The superficial deposits of the Quaternary age are developed in the diluvial uplands and alluvial lowlands in the Mkomazi Valley area. The diluvial uplands are topographically classified into higher and lower terraces. Generally, the higher terraces are characterized by the lack of sediments and exposures of the gneissose basement. The lower terraces are composed of reddish brown soils of sandy loam in texture. These soils are underlain by the Mkomazi Lake Beds composed of gypsite, gypsiferous sand and silt. Mkomazi Lake Beds are a maximum of 40 m thick and developed widely under the plains.

Alluvial lowlands are topographically classified into alluvial fans and flood plains. Sediments of the alluvial fans are mainly composed of sandy materials derived from gneisses. Development of the gravelly sediments in alluvial fans is limited at the foot of mountains. The thickness of these sediments is supposed to be about at most 15m. Sediments of the flood plains are less than 6m thick

and composed of dark gray clayey soils with gypsum patches or gypsite concretions in upper horizons. Sand or gravel beds sometimes lie in lower horizons.

3.1.2 Population

Administratively, the Mkomazi Valley area belongs to Same District and consists of 10 wards and 34 villages. The total population of the area is about 90,000 with about 60% in the Same District as of 1982, which corresponds to 95 persons per km2 if the areas for forest and game reserves are excluded. The population density in the highland is about 230 persons per km2, while that in the lowland is only 49 persons per km2. The working population from 10 years old to 55 years old in the area is about 46,000 as of 1982, corresponding approximately to 50% of the total population.

3.1.3 Agriculture

(1) Land use

Since no reliable data on agricultural land use available, the present land use is estimated mainly based on the aerial photographs on a scale of 1/30,000.

The Mkomazi Valley area covers about 190,000 ha of which about one third or 64,000 ha are highland in the South Pare Mountains and two third or 126,000 ha lie in the plains.

Unit: 10^3 ha

Land use	Highland	Plain	Total
Agricultural land	20.0	9.0	29.0
Forest/Scrub	39.7	0.3	40.0
Savannah	4.0	100.5	104.5
Swamp/Seasonal marshes	-	16.0	16.0
Village Yard etc.	0.3	0.2	0.5
Total	64.0	126.0	190.0
	(34%)	(66%)	

The agricultural land is estimated at about 29,000 ha consisting of 20,000 ha of the highland and 9,000 ha of the lowlying area.

In the highland, plantations of perennial crops such as coffee and bananas have been well developed and maize and beans are also partly cultivated. As most of the uncultivated land in the highland are forest reserves and steep slopes is covered by scrub, there remains little land to be newly reclaimed.

On the other hand, agricultural lands in the lowlying area are used for the sisal estate of 2,000 ha, sugar cane estate of 600 ha and the upland crops and paddy field of 6,400 ha. Most of the uncultivated land is composed of savanna and swamps or seasonal marshes and their acreage is about 116,000 ha including the Game Reserve area of about 57,000 ha. Soils in the uncultivated area involve such problems as salinization and alkalinization which makes the reclamation of the area only on the rainfed condition rather difficult. However, if adequate irrigation and drainage facilities are provided, the area will be made reclaimable.

(2) Agricultural setting

Agriculture in the Mkomazi Valley area is broadly divided into two (2) types, i.e. plantation of perennial crops in the highland and cereal crop cultivation in the lowlying area. The highland is blessed with abundant rainfall and agriculture has been long developed, based mainly on plantation systems for such crops as coffee and bananas. While, in the low lying area where little rainfall and high temperature prevail, cereal crops such as maize, beans and paddy are planted.

Livestock plays an important role next to crop cultivation in the regional economy. Livestock breeding is widely practiced in the savannah plain throughout the lowlying area by the hand of stockbreeders. Cereals farmers keep only a small amount of Livestock.

(3) Agricultural production

According to information collected through the field survey, crop yields in the area are generally low due to the low level of fertilizer and chemical use and because of extensive and traditional farming practices. The yield is governed by the rainfall condition because simple and rainfed farming prevails.

The production of major crops in the valley area is estimated at approximately 3,000 tons of maize, 2,600 tons of paddy, 5,500 tons of banana, 1,000 tons of beans, 600 tons of coffee, 600 tons of sisal and 3,600 tons of sugar cane, respectively, except coffee, sisal and sugar, most of these products are consumed within the area.

The population of livestock in the area is estimated at 6,000 cattle, 17,000 goat and 14,000 sheep. The number of livestock slaughtered annually is estimated at 900 cattle, 3,400 goat and 2,800 sheep.

3.1.4 Irrigation and drainage facilities

In the Mkomazi Valley area, irrigated farming has been practised since long especially in the highland. There exist a large number of small scale irrigation systems which are called "traditional furrow".

These traditional furrows generally have no permanent intake structure and only small-size canals. The canal network of the traditional furrow is very sparsely laid out. In particular, no tertiary canals and farm ditches are properly provided at the farm level. All the canals are unlined, resulting in much water wasted.

The Kalimawe reservoir is the only facility for large scale irrigation in the Mkomazi Valley area. This reservoir, which is controled by the Regional Water Office, Ministry of Water and Energy, is not yet fully utilized for irrigation purposes, because control during the farming period is not properly executed.

There exist no artificial drainage facilities in the Mkomazi Valley area.

3.1.5 Infrastructure

(1) Road net-work

The main road net-works in the Mkomazi Valley area are the Same-Tanga road and the Moshi-Tanga highway. The area is linked to such market places as Moshi, Same, Tanga and Mkomazi by these road net-works. The Moshi-Tanga highway with two (2) traffic lanes is asphalt-paved and well maintained. The highway is further connected to Dar es Salaam, capital of Tanzania, by the highway branched off at Segera. The Same-Tanga road with two (2) traffic lanes is paved by gravel. Single lane jeep road net-works connect to both the Moshi-Tanga Highway and the Same-Tanga road for transportation of farm products from the highland area and communication among the villages.

(2) Electricity supply

The power supply is under the jurisdiction of the Tanzania Electric Supply Company Limited (TANESCO). According to the feasibility study on the power supply system of Kilimanjaro Region conducted by JICA in 1979, it is expected that the power demand in Tanzania will reach, 1,186 GWh/year in 1985 and about 3,000 GWh/year in 2000 and that the annual growth rate of demand will decrease from about 9% at present down to about 6% in 2000.

Electricity in Tanzania is mainly supplied by five (5) hydro-electric power stations with a total capacity of about 250 MW including the Kidatu power station phase I (100 MW) completed in 1975 and the Kidatu power station phase II (100 MW) completed in 1981 (See Table 4). Thermal power stations with a total capacity of about 53 MW which were previously the main sources of power supply, are now on standby for emergency supply.

After extension of the coastal grid system covering major cities in Tanzania, to the Kilimanjaro Region, the power supply in the Region has rapidly increased and the system is under extension to rural areas. Construction works of the power supply transmission system in the Hai, Rombo, Mwanga and Same Districts in which the project area is included were commenced in 1982 by the use of an OECF loan. The plan of the transmission line from Same to the Mkomazi Valley area is shown in Fig. 1

3.2 Development Potential of Mkomazi Valley Area

3.2.1. Agricultural development

As stated in Chapter 3.1, agriculture in the Mkomazi Valley is obliged to remain at low productivity owing to the natural constraints and primitive and extensive farming practices which have long been followed traditionally. However, when the constraints are removed by provision of adequate infrastructure and by improvement of the farming practices, remarkbable increase of the productivity and stable production will be attained.

Among the uncultivated area which are at present abandoned as savannah and marsh lands, the lowlands of about 59,000 ha are suffered from such problems as salinization, alkalinization, floods and poor drainage, etc. However, even in these areas, new reclamation and increase of agricultural production will be realized if the water sources are secured and adequate facilities are provided.

In view of the above, the potential of the agricultural development in the Valley is assessed dividing the Valley area into the four (4) categories i.e., (i) development potential of the existing cultivated land in the highland in the South Pare mountains, (ii) development potential of the existing cultivated land in the lowlying area, (iii) development potential of the uncultivated land in the lowlying area, and (iv) development potential of livestock.

(1) Development potential of existing cultivated land in the highland area

Plantations of perennial crops such as coffee, banana and orange have been developed since long in the highland of the South Pare Mountains. Since the horizontal development reaches its maximum in view of soils and forest conservations, there is no room for further extension. However, as the area is blessed with favourable climatic conditions such as abundant rainfall, moderate temperature, etc., the intensification of land use is essential, which results in considerable increase of agricultural products. For intensification of the land use it is necessary to improve the present primitive and extensive reclamation methods to more advanced methods such as terracing method, with due attention to land conservation. In addition, establishment of farm road network will be indispensable.

The highland is generally suitable to plant vegetables owing to the large temperature fluctuation in a day. To such markets as Moshi, Tanga, and Dar es Salaam, vegetables are quite promising crops. In addition, it is noteworthy that, among vegetables, such crops as melon, tomato, egg plant, etc., have a possibility of being exported to the winter market in Europe, if quality controls are strictly applied.

In view of the above, it can be said that further agricultural development in the highland area can be attained by improvement of the reclamation method and intensification of land use which will be represented by inter-cropping of highly profitable vegetables among the main perennial crops.

(2) Development potential of the existing cultivated land in the lowlying area

The cultivated lands in the lowlying area are scattered in numerous alluvial fans developed on the tributaries of the Mkomazi river. These lands have favourable conditions for development with respect to soils, climate, topography, etc., except for the unstable rainfall. At present, the lands are mostly use for rainfed planting. Irrigation is partially practised, however, it is far from sustaining a stable production of crops due to incomplete and poor conditions.

Such being the situation, the agricultural development in this area should be directed, at first, toward the provision of adequate agricultural infrastructures such as irrigation, drainage, flood control, etc., and then to improvement of the farming practices and intensification of the land use condition. Major crops will be lowland paddy and maize in line with the policy of the Government as well as from the viewpoint of farm economy.

(3) Development potential of uncultivated land in the lowlying area

The uncultivated land of about 59,000 ha in the lowlying area is divided into two categories from the geomorphological view point, i.e. the lower terrace developed at the foot of the Pare Mountains and the alluvial plain developed on the right bank of the Mkomazi River.

The former is, in general, covered with soils having little horizon differentiation, coarse texture and low moisture holding capacity, which result in poor vegetation. The soils have been much deteriorated and a greater part of the surface soil has been eroded away. In addition to the above, the land has little water resourses to be exploited effectively, indicating an extremely low potential for development. Partially, there are lands which are blessed with soils and topography suitable for reclamation under rainfed conditions. But it faces difficulties for practical farming because of the unstable and unevenly distributed rainfall. Such being the situation, for development of the terrace area, soil conservation by means of afforestation has to be undertaken at first before any development planning and implementation are taken up. As suitable tree species to be planted, cashew and eucalyptus having broad adaptability to the various local conditions are recommended.

On the other hand, the alluvial plains are covered with saline and alkali soils, which impose severe constraints for development, in addition to flooding and poor drainage. However, since these constraints are technically solvable, development of agricultural land can be expected in the alluvial plain. Judging from the physical conditions of the land, supply of irrigation water is essential for agricultural development in this area. Cultivation depending only on rainfall will be difficult.

(4) Development potential of livestock

Next to crop cultivation animal husbandry occupies an important position in the regional economy. At present, the traditional ranching systems prevail on natives in the savanna making use of natural grasslands.

The development and promotion of animal husbandry depend largely on the availability of feed including grasses and by-products of crops. For increasing the productivity of grassland in the area of Mkomazi Valley, reclamation and improvement of the grassland are necessary. However, since it is difficult to secure new grassland, the development of animal husbandry will have to depend on the improvement of the animal nutrition condition by the use of by-products of the increased crop production.

Under the present conditions of distribution channels and processing plants in Tanzania, most of the crops produced are transported from the area without being processed. If these marketing systems are improved in the future and all crop products are processed at the sites, the by-products may become available for upgrading the quality as well as quantity of feed for livestock.

3.2.2. Irrigation development

Utilization of the highlands in the South Pare Mountains area has nearly reached its maximum through traditional furrow irrigation. For further agricultural development in these areas, a direction should be laid to more intensive land use accompanied with improvement and integration of the existing irrigation system. New provision of large scale irrigation systems in these highlands is

scarcely needed since the areas have both a longer rainfall period and a more abundant rainfall than the lowlying area.

Irrigation water is essential to the development of the lowlying area of the Mkomazi Valley. The main irrigation water source are the four (4) tributaries of the Mkomazi river, (the Nakombo, the Hingilili, the Yongoma and the Saseni, and the Kambaga river) and include the Kalimawe reservoir. From the results of field investigation, there is no groundwater potential for irrigation in the Mkomazi Valley area.

At present, runoff from the above four (4) tributaries is scarcely utilized as irrigation water since there is no artificial discharge control structures in spite of its big seasonal variation. In case of double cropping of paddy, the irrigable area of 3,310 ha in the rainy season and 1,330 ha in the dry season will be developed by optimum water use of the above tributaries under the without storage dams condition (See Sub-section 5.2.1). On the contrary, if storage dams are constructed on the upstream of the Hingilili, the Yongoma and the Saseni and on the Igoma in the main stem of the Kambaga, the irrigable area will be almost doubled, i.e., 5,160 ha in the rainy season and 4,170 ha in the dry season.

Other than the above development potential, there is water resource development potential for irrigation on the Nakombo, the Bwaya, the Talanda and the Rika rivers. However this potentials are very small, with an irrigable area of less than 200 to 250 ha each.

3.2.3 Hydropower development potential

The Mkomazi Valley area has promising hydropower development potentials because of abundant water and high head between the mountains and the plains.

Utilizing the proposed dams for irrigation, and harnessing high head, it is conceivable to generate considerable amount of hydropower. The prospective hydropower development potentials in the Mkomazi Valley area are as follows:

Item	Unit	Hingilili	Yongoma	Saseni
Catchment area	km^2	41	57	115
Annual runoff	10^3m^3	29.6	29.3	27.8
Annual discharge	m^3/sec	0.94	0.93	0.88
Firm discharge	m^3/sec	0.70	0.70	0.53
Full water level	EL m	1,451.5	1,112.5	1,013.0
Low water level	EL m	1,419.0	1,086.0	983.0
Tail water level	EL m	579.0	563.0	655.0
Rated head	m	806	512	326
Peak firm discharge	m^3/sec	2.8	2.8	2.1
Installed capacity	kW	18,600	11,900	5,700
Annual output	GWh	40.7	25.8	12.5

3.2.4 Road network

The Same-Tanga road runs along the Mkomazi Valley with a total length of about 96 km and connects the valley to such major cities as Same, Moshi, Mkomazi and Tanga. However, at present it is surfaced with only gravel and the condition is rather poor. Therefore, in keeping pace with the implementation of the Project, it should be improved so as to facilitate the transportation of the increased agricultural inputs and outputs.

In addition, there exist five (5) single-lane branch roads which connect the high population area in the South Pare Mountains to the Moshi-Tanga highway and the Same-Tanga road. These roads, with a total length of 120 km, are mostly unpaved. They should be also improved for social and agricultural developments of the Mkomazi Valley area and the access roads for the purpose of construction of dams.

3.2.5 Tourism

The area upstream of the Mkomazi Valley belongs to the Game Reserve area. The proposed Igoma reservoir under the Project is located in the Game Reserve area. Thus, the construction of the Igoma dam will provide for a big impact on wildlife conservation as well as the regional tourism.

3.3 Selection of Priority for Development

As stated in Section 3.2, the Mkomazi Valley area has various development potential such as agriculture, irrigation, hydropower, and tourism (See Fig. 2). Out of them, the irrigaiton development of the lowlying area along the Mkomazi river is accorded a top priority based on the following reasons and circumstances:

- The flat and fertile land along the Mkomazi river is most suited to utilize the limited water resources most effectively and economically.
- New reclamation of agricultural land is urgently needed to alleviate the rapid increase of the population density in the mountaineous areas.
- The slopes of the South Pare Mountains have already been developed to the possible maximum extent, and further development is difficult from the viewpoint of conservation of land and water.
- A stress on agricultural development in the mountainous areas should be placed to improve the farming practices, with inputs fertilizers and agrochemicals, along with improvement of the road conditions. Improvement of the irrigation condition would be too costly for these areas.
- The Same-Tanga road runs in the midst of the lowlying area and there is no problem in the transportation of agricultural products to markets.

- Farmers in the lowlying area are well accustomed to lowland paddy cultivation, and production increase will be attained more easily. This can meet the pressing need of the nation to increase the rice production.
- As regards hydropower generation, the supply capacity of the TANESCO is sufficient for the time being. Therefore, the development should be considered later in due consideration of the increase of the future demand.

As the area to be developed in the lowlying area, the following five areas i.e., Kisiwani, Igoma, Gonja, Ndungu, and Kihurio, are selected in view of their high potentialities for the water resources development. The Project area delineated consists of five (5) schemes of 5,860 ha in total of which breakdown is given as below.

(Unit: ha)

Scheme	Project Area
Kisiwani	420
Igoma	860
Gonja	1,360
Ndungu	1,340
Kihurio	1,880
Total	5,860

It is considered that agricultural development in these areas will meet the policy of the Tanzanian Government which aims at alleviation of population density, increase of agricultural production, areal extension of agricultural land, etc.

4. THE PROJECT AREA

4.1 Location

The project area is located at the eastern side of the Pare Mountains in the southeastern corner of the Same District, Kilimanjaro Region and connected with the capital of Kilimanjaro Region, by the Moshi-Tanga highway and the Same-Tanga road. The area forms a long stretch of flat lowland with appreximately 50 km in north-south direction and average 5 km width in east-west direction. The area with 5,860 ha in total is divided into five (5) scheme areas i.e. the Kisiwani scheme, Igoma scheme, Gonja scheme, Ndungu scheme and Kihurio scheme.

The Kisiwani scheme, covering a gross area of 420 ha, extends along the both banks of the Nakombo river, a tributary of the Kambaga river. The Kisiwani village, about 30 km south of Same, capital of the District is situated within the Kisiwani scheme is area. The Igoma scheme is located about 6 km south of the Kisiwani village and commands a gross area of 860 ha. The area is bounded by the South Pare Mountains on the north, west and south and the Same-Tanga road on the east. The Gonja scheme covers a gross area of 1,360 ha extending along the right bank of the Kambaga river, and is situated at about 55km south from Same. The Hingilili river, a major irrigation source for the scheme, runs from the South Pare Mountains to the Kambaga river through the scheme area. The village center of Gonja is situated at the uppermost part of the scheme area. The Ndungu scheme covers a gross area of 1,340 ha. This area is sandwiched inbetween the Same-Tanga road stretching from milestones 61 km to 70 km and both the Kambaga river and the Lake Kalimawe. The Yongoma river flows from the South Pare Mountains into Lake Kalimawe branching into several streams in the scheme area. The Ndungu village is located in the upper part of the scheme. The Kihurio scheme covers 1,880 ha in gross extending along both banks of the Mkomazi river and is situated on a downstream of the Lake Kalimawe. The Saseni river possessing the largest river basin in the South Pare Mountains flows into the Mkomazi river through the Kihurio scheme. The Kihurio village is situated at the most upper reach of the scheme.

4.2 Infrastructure

The Same-Tanga road running through the project area is an all-weather gravel paved road. Except for some portions, the road is rather properly maintained.

The project area is not benefited by rural electricity supply and telecommunication service systems so far. According to the Regional Development Plan, it is expected that the project area except for Kihurio village will be electrified by the end of 1984 with finance provided by an OECF loan.

The water supply system for major villages in the project area is rather adequately provided from the respective tributaries with perennial flow. The total quantities of water supply permitted from the authority concerned are about 870,000 m^3 per year.

Educational facilities and services for primary schools in the project area are provided at each village shown below while there is only one secondary school in Kihurio. The number of school illiterates has shown a rapid decrease tendency in the recent years.

	Primary School (Nos.)	Secondary School (Nos.)
Kisiwani	4	-
Gonja	6	-
Ndungu	6	-
Kihurio	5	1

Medical services in the project area are inadequate and far below the desirable standard. There is an acute shortage of doctors, dentists and nurses, as well as health facilities and medical equipment.

4.3 Natural Resources

4.3.1 Topography

Most of the Kisiwani area is covered by alluvial plains formed by the Nakombo river. The ground elevation of the irrigable land ranges from around 660 m to 715 m with a slope of approximately 1/300 in the

low land and 1:100 in the elevated land.

The Igoma area is surrounded by the South Pare Mountains on the north, west and south and Same-Tanga road on the east. The ground elevation of the area ranges from 590m to 615m. The area is comprised of alluviad fans and swales located at the central part of the area.

The Gonja area consists of alluvial plain and swales. Alluvial plain had been mainly formed by both the Hingilili river and the Bwaya river. Swales extend over the northeastern part and southeastern portion of the scheme area. The ground elevation of the area ranges from 510 m to 550 m with an average slope of approximately 1:250.

The Ndungu area comprises alluvial plains and swales. The alluvial plains extend over the area between the Ndungu village and the Kambaga river and had been mainly formed by the Yongoma river. The slope of the alluvial plains is about 1:350 on average and an elevation ranges from 507 m to 520 m. Swales are located at the northern part of the area.

The Kihurio area consists of alluvial plains and swales. The alluvial plains had been formed mainly by the Saseni river and partly by the Mkomazi river. Swales extend over along the Mkomazi river, lying in elevation of 497 to 498 m. The lower end of the swales had been clogged by materials transported from both the Saseni river and the river originated from the Usambara Mountains. The slope of the area averages 1:200 at the elevation ranging from 490 m to 510 m.

4.3.2 Climate

The project area is located at around 4^{o} to $4^{o}30'$S and $38^{o}10'$E. The area is classified as a tropical savanna area. The area is affected by the north-east and south-east winds. The north-east monsoon provides much rainfall in the area. From the rainfall distribution the year can be divided into two seasons (See Table 5). The rainy season lasts from November to May and the dry season from June to October. More than 90 % of the annual rainfall occur in the rainy season.

The amount of annual rainfall in the Mkomazi river basin varies substantially from place to place, but generally, there is much rainfall in the eastern slopes and high lands of the South Pare Mountains, and less in the flat Mkomazi Valley and the Mkomazi Game Reserve (See

Fig.3).

The mean temperature at the Kalimawe meteorological station ranges from 22°C to 28°C with little seasonal variation. The monthly mean maximum and minimum temperature recorded are 34.1°C and 16.2°C respectively. The annual average Class A pan evaporation observed at Kalimawe is 2,150 mm. The monthly average evaporation reaches its maximum in February, about 6.6 mm per day and its minimum in August, 5.5 mm per day. The annual average relative humidity is approximately 58 % at Kalimawe with very little seasonal variation. The main climatic features are summarized in Table 6 and Fig. 4.

4.3.3 Hydrology

(1) Runoff

The daily discharge at both the Kiruka station, 31.5 km^2 of its catchment area, on the Hingilili river and the Gulutu station, 192 km^2 of its catchment area, on the Saseni river during about 20 years from 1963 to 1982 were obtained from the Project Preparation Division in the Ministry of Water and Energy, Dar es Salaam. The average monthly discharges at the respective site are tabulated as follows:

Unit: m^3/sec

River	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Hingilili	0.96	0.68	0.84	1.03	0.77	0.56	0.41	0.38	0.36	0.34	0.76	1.42	0.71
Saseni	4.39	2.76	3.43	3.39	2.01	1.21	0.83	0.60	0.50	0.49	1.62	4.99	2.18

No discharge data is available for both the Nakombo and the Yongoma rivers. The average monthly discharge of the Nakombo river is estimated by the product of the specific discharge of the Hingilili river and the ratio of its basin rainfall to the Hingilili basin rainfall. On the other hand, the monthly discharge of the Yongoma river is estimated by applying the average monthly specific discharge of the Hingilili and the Saseni rivers.

The average monthly mean discharge of the above four tributaries are shown in Table 7 and summarized below. The maximum monthly discharge occurs in December and the minimum in October.

River	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Nakombo (48.5 km^2)	1.09	0.77	0.94	1.15	0.88	0.65	0.46	0.43	0.41	0.39	0.86	1.61	0.80
Hingilili (55.8 km^2)	1.70	1.20	1.48	1.80	1.37	1.00	0.72	0.68	0.64	0.61	1.35	2.52	1.26
Yongoma (70.5 km^2)	1.87	1.25	1.55	1.74	1.23	0.85	0.60	0.54	0.49	0.47	1.14	2.48	1.18
Saseni (198.5 km^2)	4.39	2.76	3.43	3.39	2.01	1.21	0.83	0.60	0.50	0.49	1.62	4.99	2.18

Based on the above discharge, the annual runoff of the above four tributaries at their respective site is shown below.

River	Site Description	Catchment Area (km^2)	Runoff ($10^6 m^3$)
Nakombo	Water level gauge station	48.5	25
Hingilili	Debouching point	55.8	39
Yongoma	Water level gauge station	70.5	37
Saseni	Debouching point	198.5	68
Total		373.2	169

The Kalimawe dam located on the southern part of the project area was constructed in 1963 aiming to control the occasional flood of the Mkomazi river and to supply irrigation water to the Kihurio scheme. It has a catchment area of 1,492 km^2 and has about 5.5 million m^3 of its effective storage capacity. The principal features of the Kalimawe dam are shown below.

Crest of dam	EL. 509.23m
Design flood water level	EL. 507.43m
Crest of spillway	EL. 504.76m
Effective reservoir capacity	5.5 x $10^6 m^3$

Runoff at the Kalimawe dam is estimated by means of a water balance computation based on the water level records of the Kalimawe reservoir during the past 20 years as shown in Fig. 5. Annual runoff at the Kalimawe dam considerably varies from 665 x 10^6 m^3 maximum to 43 x 10^6 m^3 minimum. Average annual runoff from 1963 to 1983 is 166 x 10^6 m^3 as shown below.

River	Site	Catchment Area (km^2)	Runoff ($10^6 m^3$)
Nakombo	Water level gauge st.	48.5	25
Hingilili	Debouching point	55.8	39
Yongoma	Water level gauge station	70.5	37
Other residual basin		1,317.4	65
Sub-total at Kalimawe dam		1,492.2	166
Saseni	Debouching point	198.5	68
Other residual basin		242.4	Neglisible small
TOTAL		1,933.1	234

(2) Flood discharge

Peak flood discharge for each river at each proposed weir site is estimated as shown below by using the Rational formula.

Unit: m^3/sec

River	Catchment area (km^2)	Return period in years 2	5	10	20	50	100	200
Nakombo	48.5	34	53	65	77	97	110	126
Hingilili	55.8	54	84	104	127	163	194	225
Yongoma	70.5	59	86	108	127	157	184	205
Kalimawe	1492.0	141	228	282	353	477	518	580
Saseni	198.5	91	144	176	203	251	288	320
Kambaga/1	749.0	64	119	171	208	270	333	395

Note: /1 = At the proposed Igoma dam site

(3) Water quality

Chemical tests of river water taken at 8 places are carried out. As a result, the total soluble solid of each place is less than 100 ppm. Electrical conductivity varies from 20 to 248 m.mho/cm and Sodium Absorption Ratio is less than 1.0. Water in the Mkomazi basin is suitable for irrigation.

4.3.4 Geology

(1) General

Geology of the South Pare Mountains and residual hills in the Umba Steppes are composed of the metamorphic rocks which are assigned to the Usangaran System of Pre-Cambrian age. These consist of banded gneisses with metamorphosed basic and ultra-basic intrusives.

Most of the gneisses show pronounced foliations. Generally, these rocks have a simple structure with the foliations of gneisses dipping NE of ENE at low angles (around 20°) and the liniations plunge gently in the same directions.

South Pare Mountains are the fault blocks which have been uplifted about 900 m in relation to the plains. The NW trending faults cut the South Pare block, but the nature and age of these faults are unknown.

Superficial deposits on the Umba Steppes are primarily the diluvial and alluvial deposits rather deeply underlain by the Mkomazi Lake Beds.

(2) Geology of dam site and proposed weir sites

(a) Kalimawe dam

The Kalimawe dam was constructed on the Mkomazi river narrowed by the residual hill of gneiss and the terrace of reddish brown soils. Gneiss exposed at the left bank is weakly weathered and its foliation strikes N50°W and dips 15°NE. Reddish brown soils, mainly sandy loam in texture, with more than 3 m thick crop out at the right bank of the dam site. Detailed geologic surveys by drilling have revealed that the gneiss is overlain by the gypsiferous Mkomazi Lake Beds and reddish brown soils ranging from 20 to 48 m thick in the dam site.

As the results of these surveys, it is found out that the embankment and spillway of the Kalimawe dam was constructed on the reddish brown soils. This layers are sandy loam in texture and are compact. The phenomenon which indicates a leakage through the layers is not observed at the dam site.

(b) Igoma dam site

Geological reconnaissance and drilling works were performed in the dam site.

Geology of the dam site is composed of the gneissose basement, Mkomazi Lake Beds, reddish brown soils and alluvial sediments in ascending order. The gneiss exposed at the left bank of the dam site is weakly weathered and intruded by aplite, and its foliation strikes N30°W and dips 25°E. Depth of the gneissose basement ranges from 7.0 to 7.5 meters under the terrace between the Kambaga river and Same-Tanga road, and increase in depth towards the South Pare Mountains. The overlying Mkomazi Lake Beds are mostly composed of gypsum and gypsiferous clay. These beds and the reddish brown soils of sandy loam in texture are both compact. Their N-values vary from 40 to 50 or more.

(c) Nakombo intake weir site

Alluvial terrace gravels interbedded with sandy clay layer are exposed at both banks. This gravel beds are estimated to be 10 m or more thick at the weir site

(d) Hingilili intake weir site

Gneissose rocks crop out at the left bank. The right bank consists of boulder beds of the alluvial cone. This boulder beds are estimated to be 5 m thick at the weir site.

(e) Yongoma intake weir site

Gneissose rocks are exposed at the left bank. The right bank is composed of boulder beds of the alluvial cone. The geological profile conducted from the drilling work shows that the total thickness of this boulder bed and the present river bed gravels is around 7 m thick.

(f) Saseni intake weir site

Gneissose rocks and terrace deposits of fine sand are exposed at both banks. Geological profile conducted from the drilling works in the proposed weir site shows that the older river bed gravels are buried under the terrace deposits. They overlie in having 4 to 4.5 m thick on the hard gneissose rocks.

(3) Geoelectric sounding

Geoelectric soundings were carried out at a total of 22 points by means of the Wenner's four electrods arrangement so as to examine the subsurface geologic structures in the Kisiwani, Gonja, Ndungu, Kihurio areas and the Kalimawe dam site.

According to the results of interpretation from the apparent resistivity curves, it is considered that the first stratum in the Kisiwani section is of alluvial clayey sediments, and the second and third stratum are of diluvial Mkomazi Lake Beds and/or reddish brown soils, and gneissose basement, respectively. Field evidence shows that these three strata in the section are all impermeable.

In the Gonja, Ndungu and Kihurio sections, it is considered that the first stratum is of alluvial sediments in the alluvial fans, the second stratum reddish brown soils on the lower terraces, the third stratum Mkomazi Lake Beds including gypsite beds and the fourth stratum gneissose basement. No ground water is so far found in the second and third stratum on the lower terraces. Alluvial sediments and Mkomazi

Lake Beds are 30 m or more thick in the low-lying lands. Salt crusts are often observed on the lowlying lands. This field evidence indicates a salt accumulation in the strata.

4.3.5 Groundwater

No traditional dug well exists in the project area. Major villages are supplied with drinking water from the neighboring rivers running from the South Pare Mountains by a pipe-line system which has been constructed by the District Water Office. Other small villages located at the foot of mountains and in the steppes are taking drinking water from rivers, the Kalimawe reservoir or from canals.

Few temporary dug pits for obtaining drinking water in the dry season are found in the sandy river beds of the Kambaga river near the Gonja village. Three deep bore holes have been drilled in the Mkomazi Valley area. One having a depth of 321 m and 75 mm in diameter is located at the Mkomazi Game Control Center. The yield of this bore hole is quite low at about 5 m^3/hour. Water quality shows low salinity. Two other bore holes located at the sisal estate in Kisiwani are now disused. According to information obtained on these bore holes, one is 59 m deep and 150 mm in diameter. Water of this bore-hole is not suitable for drinking water due to high salinity content.

There are two potential aquifers in the Mkomazi Valley project area. One of them is the sediments of alluvial fans and the other one is the Mkomazi Lake Beds. The strata which constitute the mountains, residual hills, higher terraces and flood plains are impermeable because of their lithological and hydrological conditions such as hard rocks, lack of superficial sediment, ill-drained fine material, and poor percolation from the ground etc.

Alluvial fans in the project area are mainly composed of fine sandy sediments and the lands are well developed for irrigated farming. However, the yield of aquifers in this land is very low (1.3 m^3/hour). Mkomazi Lake Beds lying under the lower terraces and alluvial plains consist of gypsite and/or gypsiferous sand and silt, but they have a problem of saline water because of their gypsiferous facies.

The hydrogeological constitution so far studied, suggests that the development potential of ground water for irrigation in the project area is rather low.

4.3.6 Soils

The soils in the project area are primarily derived from the colluvium and/or alluvium originated from the metamorphic rocks in the precambrian formation. Under the monsoon savanna climate, these soils have been, more or less, put under hydromorphic weathering, and have formed a varieties of soil classes. According to the Soil taxonomy system defined by the U.S. Department of Agriculture (1975), these soils are classified into two orders, i.e. Entisols and Inceptisols. These are further sub-classified into six sub-orders, six great soil groups and nine soil sub-groups in the higher categories of classification, and into 11 soil families as the lower category (See ANNEX C).

From the viewpoint of practical utilization of soils for crop production, the soils in the project area can be grouped into the following five categories:

(a) Reddish brown colluvial soils on the lower quaternary terrace,
(b) Yellowish brown colluvial soils on the lower quaternary terrace,
(c) Grayish brown alluvial soils on the alluvial fan,
(d) Brownish gray alluvial soils on the recent natural levee, and
(e) Yellowish gray alluvial soils on the alluvial depression.

The soils of the first group including the soil families (6) and (7) are primarily the sandy to loamy soils. Generally, these soils show a moderately strong alkaline reaction, and have a low degree of base saturation. Regarding their physical nature, they are rather loose in consistence, and have a low moisture holding capacity. In view of the soil-crop-water response, these soils are considered marginally suitable for paddy cultivation and moderately to marginally suitable for upland crop production.

The second soil group includes only soil family (11). These soils generally have a sandy clay texture quality throughout the profile, compact and massive structure in the sub-soil layer, high moisture holding capacity, and slow permeability coefficient. With respect to their chemical properties, these soils are slightly to moderately strong alkaline and quite free from salinity problems. Considering these conditions, the soils of this group are defined as being quite suitable

for agricultural development with irrigation.

The third group including the soil families (1), (2), (9) and (10) are the most predominant soils for agricultural utilization in the project area. Among them, family (1) is sandy soil having a rather loose consistence, low water holding capacity and perfect drainability. In the light of the physical features, the land of this soil family is graded into that moderately suitable for irrigated upland cropping, and not recommended for rice production. The other three soils (2), (9), and (10) in general consist of finer particles, and have favorable physical features for irrigation development, such as high moisture holding capacity, low permeability coefficient, imperfect drainability, etc. With regard to their chemical properties, these soils are rather deficient in plant nutrient elements except bases. In view of the fact that the soils (10) show a moderately strong salinity in the surface soils, attention should be paid to de-salinization in the future operation of irrigated farming.

The fourth soil group is primarily the sandy alluvial soils (8) developed along the Mkomazi river. Generally, these soils show a strong alkaline reaction throughout the profile but are quite free from present salinity. Because of the deficiency in soil physical features due to deep sandy stratification, and also of the frequent occurence of seasonal flooding, the land of this soil group is considered to be not suitable for cultivation.

The last group including soil families (3), (4) and (5) is wet soils developed under the seasonal inundation or marsh conditions. Generally, these soils are fine sandy clay to fine loam, and have a massive structure throughout the profile. Hard and firm consistence when dry is the primary constraint in the soil preparation for crop production. With respect to their chemical properties, these soils show a strong alkaline reaction throughout the profile. The salinity conditions varies from location to location from almost none to rather strong salinity. Deficiency in plant nutrients particularly of nitrogen is also observed in these soils. In the light of soil conditions and the environment especially of poor drainability due to the depressed topography, it is considered that these soils are suitable for paddy cultivation, but marginally suitable for upland cropping. In the agricultural utilization of these soils, attention should be paid to soil de-salinization and de-alkalinization through a proper management

of irrigation and drainage works.

In the project area covering about 5,860 ha, 11 soils families are distributed as shown below.

Unit: ha

Soil Femilies (Soil No.)	Scheme					
	Kisiwani	Igoma	Gonja	Ndungu	Kihurio	Total
1	25	-	-	55	-	80
2	-	140	-	-	-	140
3	20	-	-	5	100	125
4	200	-	335	160	255	950
5	-	-	40	-	145	185
6	75	200	105	205	180	765
7	5	60	-	-	5	70
8	-	-	255	60	-	315
9	95	170	340	475	570	1,650
10	-		180	210	30	420
11	-	290	105	170	595	1,160
Total	420	860	1,360	1,340	1,880	5,860

Taking into account the morphological and other specific characteristics of soils stated above, the land suitability for the proposed development is examined in accordance with the U.S.B.R. standard modified in 1967. As a result, approximately 3,200 ha or 55% of the project area is classified into land suitable for both rice and upland crop cultivation, and about 1,430 ha or 24% is classified into suitable land for rice cultivation but marginaly suitable for the upland crop cultivation and 845 ha or 14% is classified into suitable or marginally suitable for upland crop but not suitable for rice cultivation. The remaining about 385 ha or 7% is not suitable for both rice and upland crop cultivation. The following table shows a summary of the land classifications.

Land class		Soil families (Ser. No.)	Area extent (ha)
For rice cultiv.	For upland crops cutliv.		
A. Suitable for both paddy and upland crop cultivation			
I	I	(11)	1,160
I	IId	(9)	1,650
IIa	IIIad	(10)	390
sub total			3,200
B. Suitable for paddy cultivation but marginally suitable for upland crop cultivation			
IId	-	(4)	950
IVd	-	(2)	140
IIId	-	(3)	125
IIIad	-	(5)	185
sub total			1,430
C. Suitable for upland crop cultivation but marginally suitable for paddy cultivation			
-	I	(6)	765
-	IIIs	(1)	80
sub total			845
D. Not suitable for crop cultivation			
		(7) & (8)	385
Total			5,860

4.4 Current Situation of Socio- and Agro-Economy

4.4.1 Administration

There are 13 villages in the project area and all of them belong to the Same District as shown below.

Scheme	Respective Village
Kisiwani	Mkonga, Kisiwani
Gonja	Maore, Kadando, Mpirani,Mheza
Ndungu	Msufini, Ndungu, Kalimawe
Kihurio	Usambara, Kankokoro, Mvure, Mgandu

4.4.2 Population

According to statistical data issued by the Bureau of Statistics, the farm population and total farm families in the project area are

about 24,500 persons and 5,020 families in 1982. The population of males and females is almost balanced at 12,250 and 12,240 persons, respectively. An average family size is about 4.9 persons per family. Out of the total farm population of about 10,590 persons or an average about 2.1 persons per farm family are estimated to be engaged in farming activities.

4.4.3 Land tenure

since no land registration has been made on the present agricultural setting in the project area, all the local farmers cultivate their farm land by traditional cultivation rights. According to a sampling survey made with some 1,971 farm households, the land holding size varies from less than 0.5 to more than 5.5 ha and about 0.8 ha on the average (see ANNEX E). Generally, these farm lands consist of small plots, from 0.1 to 0.5 ha in size, scattered in few places to several locations and also to some extent other village areas. Recently, a fragmentation of land holding has proceeded due to population growth. According to the survey results, about 90% farmers have traditional cultivation rights and hold 91% of the total farm land. Remaining farmers do not have the cultivation rights and they lease the land from the cultivation right holder. They usually lease their land free of charge from their relatives.

In addition to the above, another type of land tenure is found in the project area. It is based upon the traditional cultivation right, but the farmers are seasonal migrants coming from the highlands of the South Pare Mountains. The survey results show that 1.3% of total farmers are the seasonal migrants and they occupy 1.4% of total land at present.

4.4.4 Agricultural support services

Institutional supporting services, i.e. agricultural research, agricultural extension work, technical training program at KADC, farmers' credit, farm inputs supply, etc. have been recently organized in the Kilimanjaro region. These services are being covered rather extensively in the entire region. In the project area, however, activities of the above services are limited. The present situation precludes the agriculture from its effective modernization in the

project area.

With regard to the agricultural extension works, 5 agriculturists are assigned at the respective ward offices concerned. Under the direction of the District Agricultural Development Office (DADO), the present extension works particularly on the improved farming practices is served by the said staff. Very recently, each staff has established demonstration farms of some is 200 m^2 to 800 m^2 ha in size in the respective village areas, and demonstrates such farming practices as the use of fertilizer and chemicals as well as the introduction of high-yielding varieties of maize. Due to the substantial under-staffing of the extension officers and also insufficient facilities, such propagation works for improved farming techniques are still ineffective and unsatisfactory.

The supply of the farm input is done by the production sub-committee in each village under a national program on food production increase. These services are, however, still sluggishly done due to insufficient operation funds.

No farmers' credit services have been introduced in the project area. This is mainly because all farmers cultivate their farm lands by the traditional cultivation right and these lands have not been registered yet under the land reformation program so far. Accordingly, the implementation of the land reformation and the land registration in accordance with those on the national program is one of the essential requirement in view of introducing farmers' credits for supplementing the present shortage of working capital.

Under the regional farm mechanization program, RADO provides tractor services in accordance with the farmers' request for assisting the soil preparation. There are 4 branch stations in the Same District i.e. Kisiwani, Gonja, Ndungu, and Mvure. DADO, Same has a responsibility to smoothly and effectively operate these tractors and to promote the national campaign of food production increase.

The service is primarily based upon the rental system in which farmers are obligated to pay rent by cash at TSh.650 for the plowing and TSh.250 for the harrowing in 1983. In the past four years, the services covered about 650 ha per annum on an average which corresponded to about 13% of the total cultivated area. Because of poor accessibility to the farm land due to the lack of farm roads and wet soil in the most

lowlying area, further expansion of the tractor service can be hardly expected. The payment system on rent also limits the farmers intention and motivation towards farm mechanization.

4.5 Agriculture

4.5.1 Land use

Recently, agriculture in the project area has been exploited by spontaneous farmers, and arable land has been reclaimed close to the potential maximum possible under the present natural conditions. This agricultural setting in the project area is primarily characterized by the individual and small scale land holding and cereal crop production, in contrast with the perennial crop plantation by small holders in the mountainous area.

The present conditions of land use approximated by the use of aerial photograph are summarized as follows:

Unit: ha

Land Categories	Scheme area					Total
	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	
Farm land	360	1,040	1,010	1,040	20	3,890
Non-agricultural land						
- Swamp	30	120	70	120	-	340
- Marshes	10	60	160	80	100	410
- Grass land	-	80	40	100	460	680
- Bushes	-	-	10	40	280	330
Sub-total	40	260	280	340	840	1,760
Road/River/Others	20	60	50	80	-	210
Total	420	1,360	1,340	1,880	860	5,860

Until recently, irrigation facilities (the so-called traditional furrows), have been developed by the farmers themselves. At present, approximately 29% of the total arable land is irrigated in the rainy season. In the dry season, however, irrigated land is limited to 13% mainly due to the limited runoff in the feeder rivers. Inadequate

design of intake facilities and poor maintenance of the canal system result in limitation on the extent of irrigation farming.

Approximately two thirds of the total cultivated land are more or less affected by the seasonal flooding and/or water stagnation due to lack of drainage system. In the lowlying areas where the land is submerged by flooding, farmers generally abandon rainy season cropping and cultivate maize in the dry season after the recession of standing water. With few exceptions, farmers use such seasonal flooding effectively for paddy cultivation.

4.5.2 Agricultural setting

The present agricultural setting in the area is broadly classified into two farm types, namely:

(1) Upland crop cultivation and
(2) Paddy cultivation.

Upland crop cultivation is primarily the traditional type of farming prevailing extensively in the entire project area. This type of farming could be further classified into two sub-types, i.e. (1.a) intensive farming (double cropping a year) under irrigated condition and (1.b) extensive farming (single cropping a year) under rainfed condition. In this farming, maize and beans are cultivated as main crops.

Paddy cultivation is mainly practiced in the lowlying area where the land has been developed as irrigable land and the supply of irrigation water is substantially available for paddy growing. In this paddy cultivation, two types of farming are identified mainly from the viewpoint of production system. The first type (2.a) is primarily the convertible type of (1.a), i.e. paddy is one of the staple products in the rainy season cropping followed by maize in the dry season. The second type (2.b) is characterized by the single cropping of paddy by the use of seasonal flooding supplemented by irrigation through the traditional furrow.

Cattle grazing is the other important element for the rural economy in the Mkomazi area. Generally, cattle grazing is managed by cattle farmers and is practiced extensively using wild grasses found in the savanna. In the project area, cattle grazing is also practiced by local

farmers, but it is still at sub-business level in the agricultural sector at present. Such livestock as sheep and goats as well as poultry are also raised by local farmers. Their production is, however, still limited to the home consumption.

4.5.3 Cultivation method

(1) Cropping pattern

Owing to the favourable climate for crop growth, except for the capricious distribution of rainfall, farmers grow maize, paddy and beans as the major staples and other crops including sorghum, groundnut, sweet potato, cassava, etc.

Out of the various kinds of crops, maize is the most predominant staple food of the local inhabitants. Generally, maize cultivation in the project area is practiced throughout the year. The major crop season of maize is broadly defined as the following three types.

The first cropping of maize is the most dominant practice extensively prevailing in the elevated area where the land is quite free from ill-drainage and/or seasonal flood constraints. Cultivation generally starts in November to December and is harvested in mid-February to mid-April. High-yielding varieties have been increasingly introduced particularly in the supplemental irrigable area where the land is fed by traditional furrows. Farmers mainly grow the traditional varieties in the rainfed area.

Second cropping of maize is mainly practiced in the narrow area scattered patchily in the lowlying area. Since seasonal water stagnation causes crop cultivation difficulties, farmers cultivate maize after the recession of flood. Soil moisture from flooding is fully utilized. This cropping starts generally in mid-April to May and is harvested in August. Local varieties are mainly used in this practice.

The third maize cultivation is predominant in the lowlying land in the project area. In general, cultivation of maize begins in July to August, when the seasonal stagnation or excessive soil moisture is largely drained out, and is harvested mostly in mid-October to mid-December. Furrow or border irrigation is practiced to a certain extent for this cultivation. In this maize cultivation, high yielding varieties have been recently introduced extensively. In particular

cases, where the land is regularly fed by irrigation water throughout the year, this third maize cultivation is continued to the first maize and/or followed by paddy cultivation.

Paddy is rather a new introduction in the project area, but its production has been recently given priority as a cash source income in the farm economy. According to the aerial photo-interpretation, about 1,140 ha of land were cultivated in the 1982 crop season, of which about 430 ha is fed by traditional furrows and the remaining is grown in the alluvial depression by the use of seasonal flooding. In this paddy cultivation, farmers grow traditional varieties which have a more than 140 - 150 day growing period. No high-yielding varieties of paddy have been introduced so far. In irrigated farming, paddy cultivation starts in November and is harvested in May to June. In case of paddy cultivation in the alluvial depression, preparation of the nursery is mainly made in December, transplanting to the main field in January, and harvesting in mid-May to mid-July in most cases.

Beans are the second most important food crops in the upland cropping followed by such minor crops as sweet potato, cassava, groundnut, etc. To grow these crops, mixed stand (or inner-cultivation) with maize is a common practice in this area.

The cropping acreages in each crop estimated are summarized in Table 8 and Fig. 6.

(2) Farming practices

Many of farmers still refer to traditional farming techniques, although irrigated farming has been recently introduced to a certain extent. The soil preparation for most cropping is made by small hand hoes. The use of tractors for soil preparation is limited to 1,130 ha though the agricultural office is promoting farm mechanization. Use of animal power for soil preparation is uncommon in this area.

Maize seeds are generally sown in small holes prepared by hand hoes. The regular planting spaces are at one hill per m^2 in general. In the case of the cultivation of high-yielding maize, some farmers sow seeds by 100 cm x 30 cm in plant space, in accordance with Government recommendations. Most farmers, however, still use their own judgement by traditional plant spacing. As for paddy cultivation, soil pudding and leveling are practiced by the use of hand hoes, although it

is a quite hard work in general. Regular transplanting with 25 cm x 15 cm in plant space is made in common. Nurseries are grown for about one month in small beds.

Other than the above farming practices, attention is paid by the farmers only to the weed control. Fertilizer and chemical use are few in the project area at present. Use of these inputs is being demonstrated by agricultural extension officers, but the propagation of proper practices is still ineffective.

Irrigation operation is conducted by farmers individually, while maintenance of facilities is made as a communal work in general. The family labour force is almost sufficient for covering some 1.2 ha cultivation. In case of the land holders larger than 1.2 ha, the farm owners employ seasonal labour to supplement the family labour force. The contract-based farming is also used for larger-size farms.

4.5.4 Crop yield and production

According to the crop production reported by the local farmers, the yield of maize varies from 0.3 to 2.5 tons/ha. These yielding conditions depend on the field conditions whether irrigated or rainfed. The farming practices, such as use of varieties, planting density and introduction of inner-cultivation with other crops are also the essential factor on the present maize production. The yield of maize obtained from the different cultivating conditions is summarized as follows:

- High-yielding varieties/irrigated: 1.5 tons/ha
- Local varieties/irrigated: 1.0 ton/ha
- Local varieties/rainfed: 0.6 ton/ha

With regard to the paddy, the yield is estimated based on the result of a sampling survey conducted from May to June 1983. 82 paddy samples are taken at random from the paddy fields in the project area and analyzed by each yield component such as the number of panicles per hill, number of hills per m^2, number of grains per panicle, percentage of ripended grains and weight of 1,000 grains.

The result of sampling survey of paddy yield show rather high yield as 3.8 tons/ha in Kisiwani scheme area, 2.7 tons/ha in Gonja, 2.8

tons/ha in Ndungu and 4.0 tons/ha in Kihurio respectively, in comparison with the yield reported by the local farmers, 3.5 tons/ha under well irrigated conditions and less than 1.0 ton/ha under the rainfed conditions.

Based on the result of sampling survey, the yield at the farm gate in the respective scheme area is estimated as shown below taking the present conditions of land use, processing procedure, handling and transportation methods, etc.

Unit: ton/ha

Scheme	Kisiwani	Gonja	Ndungu	Kihurio
Yield	2.8	1.8	2.0	2.8

According to farmers' informations on other crops, the production of beans varies from 0.2 to 0.5 ton/ha and about 0.4 ton/ha on an average.

Based on the crop yield preliminarily estimated above and the cropping acreages of each major crops, the annual gross production of crops is estimated as shown in Table 9 and summarized below:

Unit: tons

Major Production	Scheme					Total
	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	
Maize	200	470	545	1,155	10	2,380
-Rainy season	130	375	365	575	10	1,445
-Dry season	70	95	180	580	-	925
Paddy	365	660	685	840	-	2,550
Beans	90	165	190	490	10	945

4.5.5 Livestock production

Although livestock grazing is still at the sub-business base in agriculture in the project area, its production plays an important role for the farmers as their major source of not only diet protein but also as cash for supplementating their farm income. Cattle, goats and sheep

are the most dominant products in the project area. They are generally grazed extensively in the savanna, pasturing with natural grass and/or weeds in the farmland. During the rainy season, livestock are well fed owing to abundant grass even in the savanna but they lost weight during the dry season because of the deterioration of pasture due to drought. Most of the individual farmers raised chickens on a small scale. Free-grazing is commonly practiced in the project area.

On the basis of the data provided by the District Livestock Development Office, Same, the population of livestock in the project area is estimated at about 4,830 cattle, 13,950 goats and 11,820 sheep at present. Only 15 to 20% per annum of the livestock are used for slaughtering. Annual milk yield is at about 200 ℓ/head for cattle and 17 ℓ/head for goats and sheep per lactation. Population of chickens in the project area is estimated at about 32,090 and annual slaughtering is 20% of the total number.

4.6 Farm Economy

4.6.1 Marketing of agricultural products

In order to assess the marketable surplus of crop products in the project area, the supply-demand relation is studied for each agricultural product. On the assumption that the annual per capita consumptions are estimated at 40 Kg of rice, 90 Kg of maize and 30 Kg of beans, the marketable surplus of crops in 1981/82 is estimated at 715 tons of paddy grains (28% of the total production) 45 tons of maize (2% of the total production) 120 tons of beans (13% of the toal production). Out of these marketable surplus, 50 tons of paddy grains (7% of surplus), 85 tons of beens (7% of surplus) are collected by the National Milling Corporation (NMC). In case of maize, the whole quantity of surplus is considered to be sold to the rural markets.

NMC has a storage facility with 2,100 tons capacity at Same town. The crop products are transported from village to Same town, and from Same town to the Government storehouse at Moshi. For the transportation of these products, trucks owned by NMC or railway are used at present.

4.6.2 Processing and storehouse

There are 20 rice mills in the project area at present. The

processing efficiency is estimated at about 35 tons per day in total and seems to be enough processing efficiency for the present production. On the other hand, there are 8 storehouses in the area and the total storage capacity is calculated at approximately 2,000 tons. Therefore, the storage capacity is also satisfactory in the project area at present.

4.6.3 Farm gate prices

The farm gate prices of staple cereals are controlled as the government fixed-based price under the principal focus of the national food management program. The prices of crop production other than cereals follow in principle the free market-frices. These prices generally fluctuate seasonally depending upon their supply conditions.

The prices of farm inputs are set under the government control. The labour wages are in principle referred to the minimum wages defined in the labour law. In practice, however, the labour wages are set individually through free contracts based on the degree and extent of work. The unit wages for seasonal workers range from TSh. 19 to 27 and TSh. 23 on an average.

The current farm gate prices of the major commodities are as follows:

Major Commodities		Unit	Price (TSh.)
Crop	Maize	kg	4.00
	Paddy	kg	6.00
	Beans	kg	8.00
Livestock,	Cattle	head	1,780.00
	Goats	head	330.00
	Sheep	head	300.00
Seed (HYV),	Maize	kg	13.00
	Paddy	kg	8.75
	Beans	kg	10.60
Fertilizer,	Ammo.Sulphate	50 kg bag	94.05
	TSP	50 kg bag	105.00

4.6.4 Farm Economy

The study on the present farm economy is made based on the financial balance of crops and livestock production. The annual total net return obtained from both crop and livestock production is summarized as follows.

Scheme	Gross Return	Production Cost	Net Return	Net Return Per Farm Household
	(TSh.x10^3)	(TSh.x10^3)	(TSh.x10^3)	(TSh.)
Kisiwani	4,298	648	3,650	6,400
Gonja	8,914	1,483	7,431	5,160
Ndungu	9,216	1,599	7,617	6,350
Kihurio	15,018	2,471	12,547	7,050
Igoma	200	35	165	5,500
Total or Average	37,646	6,236	31,410	6.260/1

Note: /1 = TSh.6,260 of net return per farm household
= TSh.31,410,000 ÷ 5,020 households

In addition to the annual income from agricultural production mentioned above, farmers in the project area earn same cash averaging about TSh.500 from off-farm works such as wage earning from farm works and non-farm works, remittance from their family working at Moshi or Dar es salaam. Then the average annual income per farm household is estimated at about TSh.8,000. Out of the annual income of TSh.8,000 it is estimated that TSh.4,850 for their home consumption and TSh.500 for other food, totaling TSh.5,350 (or 79% of annual income) will be spent for their total food expense. The remaining TSh. 1,410 is considered to be used for living expenses other than food. Accordingly, it can be said that most of farmers earns a bare livelihood at present.

4.7 Irrigation and Drainage

4.7.1 Existing irrigation system

In the Mkomazi valley area, 19 furrow irrigation systems and one storage dam are listed in the District Agricultural Office. The Kalimawe dam is the only one irrigation facility maintained under the control of the Regional Water Office, Ministry of Water and Energy. Two (2) sisal estates in the area possess their own intakes for factory use as well as irrigation for the sisal nursery. There is a sugar estate with about 500 ha of land. This estate has no systematic irrigation facility though they possess the right to use about 57ℓ/sec (2 cusec) of water for irrigation purposes.

Out of the 19 intake structures in the Mkomazi Valley area, 6 intakes including 2 intakes for the sisal estates are provided with concrete or stone masonry weirs. The remainder are ephemeral ones made either with banana leaves and logs in the lowlying area or boulders with pebblestones in the upper reaches of major tributaries, i.e. the Nakombo, Hingilili, Yongoma and Saseni rivers. All the facilities from the head work to the on-farm works constructed by either the Government or farmers themselves, are primitive and superannuated except for a few recently rehabilitated facilities.

The existing canal network is very sparsely laid out, in particular no tertiary canal and farm ditche are properly provided at the farm level. All irrigation canals are unlined, resulting in much water wasted.

The irrigation area benefiting from the existing irrigation facilities in the Mkomazi valley area is estimated to be about 1,200 ha in total or 31% of the existing farm land in the area.

No systematic irrigation operation is being properly conducted in the project area. During the low flow period rotational irrigation practices are applied for the distribution of water under arrangement with the village council. No water charge is collected from the farmers at present.

As for the on-farm irrigation practice, the flood irrigation method from plot to plot is prevailing but is inefficient due to the unsuitable cultivation method adopted and the topographical condition of land. The

upland field is customarily ploughed with the use of hand hoe and planted with crops without any harrowing and ridging. Accordingly the ground surface is so rough that no effective irrigation method is applicable.

In addition, there are small undulations of the ground surface surrounding the old river courses and the alluvial deposit. Due to the undulations, certain areas are either non-irrigated or often over-irrigated.

4.7.2 Water right

Granted water rights for irrigation schemes in the Mkomazi valley area total about 0.34 m^3/sec (12 cusec) for four irrigation schemes including about 0.06 m^3/sec (2 cusec) for the Gonja sugarcane estate which is not utilized at present. In addition to the above, about 0.28 m^3/sec (10 cusec) is granted to two sisal estates and 0.03 m^3/sec (1 cusec) is for domestic use. Other irrigation systems including all traditional furrows have no legal right.

4.7.3 Present drainage conditions

In the Mkomazi valley area, the Mkomazi river acts as the main natural drain. The Kambaga river is the name of its upstream reaches from the existing Kalimawe reservoir. There are two large swamps on the lowlying land along this main stem. One is located in the Kihurio scheme area surrounding Lake Manka. The other is in the lowlying areas upstream of the existing Kalimawe reservoir.

The former swamp was formed as a result from water clogging with sediment materials transported from both the Saseni river and the small rivers originated from the Usambara Mountains. The latter also is caused by sediment materials from such rivers originated from the South Pare Mountains as the Hingilili, Yongoma, Talanda, Rika and are under the influence of backwater of the Kalimawe reservoir.

In addition to the area surrounding such swamps, a certain extent of paddy field developed in the alluvial depression along the lower reaches of such rivers originated in the South Pare Mountains as the Nakombo, Hingilili and Yongoma suffer from seasonal inundation due to lack of drainage facilities. The existing irrigation systems in the Mkomazi valley area, except for two systems i.e. Kalimawe and Kisiwani,

are not provided with intake gate to control water flowing into the canals or furrows. Such poor irrigation facilities result often in inundating the existing field during the flood period.

In addition, the river courses of all tributaries originated in the South Pare Mountains are getting narrower and shallower in the downstream after branching off to the several traditional furrows. The seasonal flood overflows into and spreads over the cultivated land through these traditional furrows.

There is no artificial drainage facility in the Mkomazi valley area. The Kalimawe dam was constructed as a flood control dam. Peak flood of the Kambaga river is effectively controlled by the dam. No proper control can be expected for rapid flooding on the sloped surface between the Ndungu scheme area and the Kihurio scheme area.

5. PROSPECTIVE DEVELOPMENT PLAN

5.1 Basic Development Concept

The Government of Tanzania has laid great emphasis on substantial increases in food production over a wide range of crops and promotion of the development of new agricultural land in the potentially arable area in order to relieve population pressure in the densely populated area. The Government also intends to accelerate a more balanced economic development in the country through the increase of agricultural production.

Agriculture in the Kilimanjaro region has played an important role in its economy, and dependence on agriculture covers almost over 90% of the population which is directly or indirectly involved in agriculture. However, the present food production in the Region can not meet its increasing demand resulting from the rapid population growth: 3% per annum. While, the food production in the Mkomazi Valley area has increased and suffice for the requirement of rural consumption at present, though the present agriculture is still at a low level which results in low income of farmers and accounts for the subsistence level of living standard.

Understanding the above-mentioned adverse condition of agriculture, the following project concepts are set forth:

(1) increase and stabilization of yield and production of rainy season paddy through supply of irrigation water, proper drainage and introduction of improved irrigation farming,

(2) introduction of diversified cropping pattern including the rainy season paddy, dry season paddy and upland crops such as maize and beans, and

(3) increase of agricultural production by opening new agricultural lands in the areas which have favorable physical conditions for agricultural development.

Beacuse of no systematic irrigation and drainage systems and no flood control work, though there exist irrigation canals constructed by farmers themselves, the existing paddy fields often suffer from long dry spell in the dry season and mal-drainage in low-lying areas in the rainy season. Therefore, most of the paddy fields are used only for one cropping in a year. The intensive agricultural development in the area is constrained by:

(1) no systematic irrigation system,

(2) poor drainage conditions,

(3) poor road network, and

(4) insufficient agricultural supporting services.

In order to achieve the projected agricultural development in success, the construction of following infrastructures and further improvement of supporting services are required:

(1) rehabilitation and new construction of irrigation networks consisting of dams, diversion weirs, main, secondary, tertiary and quaternary canals,

(2) construction of floodways and drainage network consisting of main, secondary, tertiary and quaternary drains,

(3) construction of road network which includes main, secondary and tertiary roads,

(4) reclamation of new farmland,

(5) operation and maintenance of the irrigation and drainage networks, and

(6) further improvement of the present agricultural supporting services.