No. 54

THE UNITED REPUBLIC OF TANZANIA

FEASIBILITY REPORT ON LOWER-MOSHI AGRICULTURAL DEVELOPMENT PROJECT

MAIN REPORT

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MAIN REPORT

OCTOBER 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

It is with great pleasure that I present a feasibility study on the Lower-Moshi Agricultural Development Project to the Government of the United Republic of Tanzania.

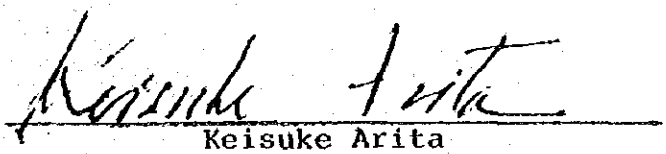
This report embodies the result of the feasibility study which was carried out in the whole Lower-Moshi area, from December, 1979 to March, 1980 by a Japanese survey team commissioned by the Japan International Cooperation Agency following the request of the Government of the United Republic of Tanzania to the Government of Japan.

The survey team, headed by Mr. T. Otani, had a series of consultations with the officials concerned of the Government of the United Republic of Tanzania and conducted an extensive field survey and data analyses.

I hope that this report will be useful as a basic reference for development of the project.

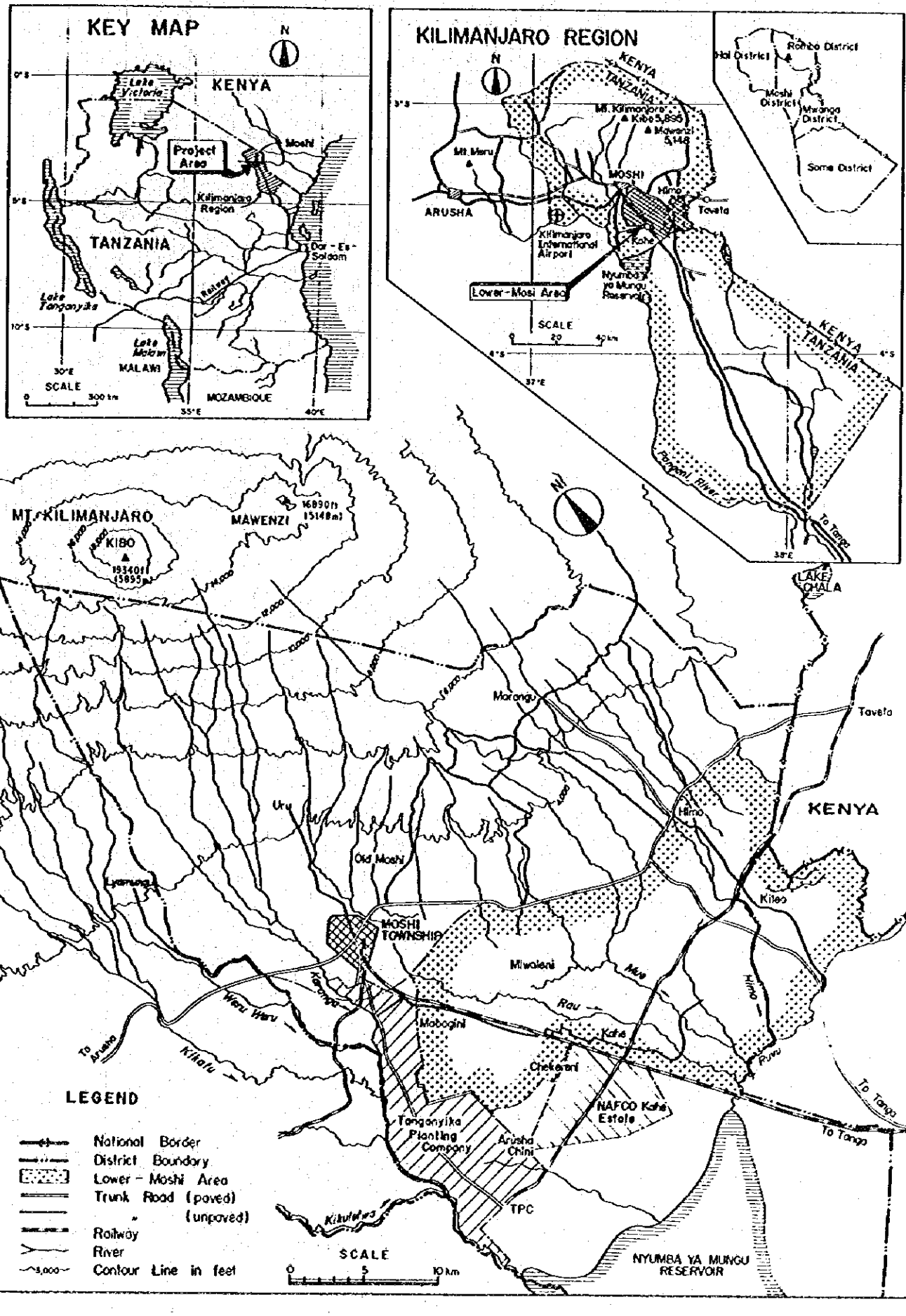
I wish to express my deep appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the Japanese team.

November, 1980



Keisuke Arita
President
Japan International Cooperation Agency

LOCATION MAP



GENERAL LAYOUT OF THE PROJECT

KILIMANJARO REGION

KENYA
TANZANIA
Mt. Kilimanjaro
MOSHI
ARUSHA
Lower-Moshi Area
Pangani River
SCALE
0 20 40 60 80 100km

MOSHI TOWNSHIP
Bypath Proposed by Moshi Master Plan
Mandaka floodway
NORTH GROUNDWATER SCHEME
NO.1 NO.2 NO.3 NO.4 NO.5 NO.6 NO.7 NO.8 NO.9 NO.10 NO.11 NO.12 NO.13 NO.14
Main distribution power line
Existing power line
UPPER MABOGINI SCHEME
MABOGINI SCHEME
Miwaleni floodway
Nanga floodway
Miwaleni Experimental Sub-station
Uchira floodway
Mue floodway
MIWALENI PUMP LIFT SCHEME
MAKUYUNI SCHEME
RAU YA KATI SCHEME
Trunk farm road
NURANDI
CHEKERENI
CHEKERENI SCHEME
Left dike
Nafco canal Crossing Structure
Nafco Canal
Right dike
NO.1 NO.2 NO.3 NO.4 NO.5 NO.6
EAST GROUNDWATER SCHEME
KHONA & KILEO SCHEME
KENYA
ARUSHA-CHINI
MANGARIA
TANGANYIKA PLANTING COMPANY
Ruvu (Rufu)
Pangani or Ruvu
SCALE
0 1 2 3 4 5km

LEGEND
- Boundary of Lower-Moshi Area
- Boundary of scheme
- Proposed intake weir
- Existing intake weir (imp.)
- Irrigation canal
- Pump station
- Pipe line
- Tube well
- Distribution power line
- Trunk farm road
- Flood protection dike
- Floodway
- Open dike

SUMMARY REPORT

Project Background

The Lower-Moshi Agricultural Development Project was formulated by Japanese experts on a preliminary basis and later incorporated in the Kilimanjaro Region Integrated Development Plan in 1977. The Government of Tanzania selected the Project one of the top priority projects during the Third Five-Year Plan period (1957-81).

The feasibility study on the Project commenced in December, 1979. The field survey was conducted from December 1979 to March, 1980, followed by preparation of the final report in Japan.

Conclusion

The final report concludes that the Project is technically feasible and economically viable. Of the nine irrigation development schemes, those in the Rau river system have advantages over other schemes in terms of IRR, construction cost per hectare and operation cost. Therefore, it is recommended to implement the Rau river system as the first stage of development.

This summary report covers the main details of the study according to the following topics:

- Necessity of the Project
- Selection of Project Scheme Areas
- Project Facilities
- Project Costs
- Project Benefits
- Project Viability
- Project Organization and Implementation Schedule

Necessity of the Project

Agriculture is the backbone of Tanzania's economy. Agriculture employs about 90% of the population and approximately 40% of the Gross Domestic Product is derived from agriculture. Agricultural exports account for nearly 80% of the total foreign exchange earnings.

In the Kilimajaro region, agriculture also employs about 90% of the population, although most of the population is so concentrated in the highland slopes of Mt. Kilimanjaro and the Pare mountains on belts from 800 to 1800 m in altitude, that the highland area has one of the highest population densities of the country. This area, roughly defined by the Moshi-Himo Highways, is so favoured with abundant rainfall, moderate temperature, fertile soils and ample irrigation water that a highly intensive mixed cultivation of coffee and banana has been practiced for many years. Coffee is not only the cash source for farmers, but the biggest foreign exchange earner of the country. Banana is the stable food for inhabitants on the slope.

The highland, however, already accommodates its maximum population and the land use is fully extended. In addition, land ownership has been so fragmented in the course of generations of inheritance that the present holdings per family have decreased to as little as 0.66 ha on average. Consequently, many highland farmers have sought farms in the lowland where they can cultivate maize on an absentee basis to supplement their food production while continuing to live in the highlands.

In contrast, areas below 800 m, the so called lowlands (which include Lower-Moshi), generally have insufficient rainfall for cropping. Moreover, soils in certain areas are saline and/or subject to yearly flooding. Reflecting these conditions drought resistant crops such as maize and beans have been cultivated very extensively and cattle grazing has also been practised. Due to such conditions, population settlement is sparse.

People in the lowlands have to endure severe living conditions such as high temperatures, drought, flood, saline soils, scarce water, malaria and schistosomiasis. The living style is nearly primeval; most people live in simple huts with mud wall, banana leave roofs and without floors. Due to the absence of investment in public facilities and social infrastructures, most villages have been developed very poorly. Poverty increases as one goes away from the mountain zones. According to one estimate, per capita annual income of people who live in the highlands is Ts. 894, while for those who live in the lowland it is Ts. 444.

In spite of the generally inferior natural conditions, the overall orientation of regional development has been directed toward the lowlands, large scale irrigation developments have taken place in the lowlands such as the Tanganyika Planting Company (TPC) in Arusha Chini for sugarcane cultivation and the National Agricultural and Food Corporation (NAFCO) in Kahe for cultivation of cereal crops.

Water is the key to the future agricultural development of the Region. About 28,000 ha or 14% of the cultivated area of the Region (195,000 ha) is under irrigation, which is much higher percentage than that for the whole country. Nevertheless, more irrigation is needed to stabilize agricultural production and to increase agricultural acreage to cope with ever increasing population pressures.

A considerable extent of the lowlands, including the Lower-Moshi area, still remains underdeveloped, yet it has a favourable development potential to make it worthwhile to invest in the infrastructure.

Selection of Project Scheme Areas

Selection of the project schemes was based on three main factors:

(1) the availability of water sources
(2) the availability of suitable arable land as determined primarily by soil analysis

(3) the existence of water use rights whether originating in law or custom.

In the Lower-Moshi area, the dependable water systems with significant flows were determined as follows:

(1) Rau river system (including the Njoro river)

The Rau river presently serves areas extending on both its banks. In view of its geographical location, the left bank area can be efficiently served from the Miwaleni springs, whereas, the right bank area has no water source except the Rau river and the Njoro river. Thus, the principal plan of the Rau river system is to preferentially allocate water to the right bank area, while compensating the existing water use in the left bank area from the Miwaleni springs.

Four irrigation schemes are planned to take water from the Njoro and the Rau rivers: two on the Njoro river (Upper Mabogini and Mabogini) and the other two on the Rau river (Rau ya Kati and Chakereni) in consideration of topography and the existing water use. The prospective land use plan shows that all the land extending along the Rau river is suitable and used for paddy cultivation.

The result of water balance study indicates that the Rau river and the Njoro river can ensure irrigation for 2,300 ha and 950 ha in the rainy and dry seasons, respectively.

(2) Miwaleni springs

The Miwaleni springs have been used by NAFCO Kahe, and legal water rights have been given for the major part of the flow. NAFCO, however, has not utilized the full amount of water granted by the water rights, since the NAFCO scheme is less developed than the original plan due to greater salinity problems surrounding the original scheme which reduced its original extent. Since the Miwaleni springs discharge downstream without effective use in the Lower-Moshi area, such surplus flow is planned for productive use by introducing it to the Miwaleni upland area.

The available water of the Miwaleni springs for the Lower-Moshi area is estimated assuming that the present cultivated area of NAFCO Kahe scheme will not be expanded more than the present area of 1,400 ha, and as the village irrigation plans are drawn up to use the NAFCO lead canal, the water supply to these areas will be ensured.

The water balance study shows that the area of 2,000 ha can be irrigated in the rainy season and of 750 ha in the dry season.

(3) Himo river system

The Himo river exists independently from the other water sources. Therefore its water is planned to be supplied to the areas lying along the river course as effectively as possible by two irrigation schemes (Makuyuni and Ghona/Kileo). According to the results of the water balance study, the irrigation area of 1,000 ha and 480 ha in the respective rainy and dry seasons can be ensured.

(4) Groundwater system

In the Lower-Moshi area, abundant groundwater has been confirmed and the hydrogeological investigation revealed the development potential of a groundwater scheme. In the northern part of the Project area, good acquifers are also disclosed. As those areas have no dependable surface water, groundwater development schemes are planned for those areas.

Of the acquifers underlying the Project area, the Miwaleni and Kiomu groundwater zones were provisionally selected in view of productivity of acquifers and water quality. The Arusha Chini zone, in which the Chekereni and Mabogini areas are located, is doubtful in respect to productivity and water quality. Therefore, the north groundwater scheme is proposed in the Miwaleni zone and the east groundwater scheme in the Kiomu zone.

In the north groundwater scheme, 14 numbers of well are proposed, which command an area of 840 ha. In the east groundwater scheme, 6 numbers of well commanding an area of 180 ha are proposed due to the limited amount of the available water.

The Project in total will provide irrigation for 6,320 ha net. The Nine irrigation schemes proposed are summarized as follows:

Summary of Project Irrigation Schemes

System	Schemes		Command Area	Paddy Field	Upland Field	Maximum Water Requirements
			(ha)	(ha)	(ha)	(m^3/sec)
Rau River System	Upper Mabogini	Njoro river	150	150	-	0.20
	Mabogini		850	750	100	1.08
	Rau ya Kati	Rau river	450	400	50	0.58
	Chekereri		850	700	150	1.11
Miwaleni Springs	Miwaleni Pump Lift		2,000	900	1,100	2.00
Hino River	Makuyuni		500	-	500	0.44
	Ghona and Kileo		500	150	350	0.48
Ground-water System	North Gronndwater(14 wells)		840	-	840	0.76
	East Groundwater (6 wells)		180	-	180	0.17

Project Facilities

The major components of the Project are summarized as follows (see attached map):

- Construction of nine irrigation schemes covering at total of 6,320 ha. Each irrigation scheme will include following main works:

  i) head work either a concrete weir or pumping station or deep well;

  ii) concrete lined main and secondary canals and related structures;

  iii) unlined tertiary and quarternary canals and related structures;

  iv) on-farm works including land levelling for paddy fields and land grading for upland fields together with boundary realignment where necessary;

  v) drainage system; and

  vi) farm-road network.

- Construction of 19.3 km of flood protection dikes and 28.2 km of floodways;

- Improvement of 24.8 km trunk farm roads and construction of new farm roads as follows: main (32.4 km), secondary (270.3 km) and tertiary (171.7 km).

- Drilling of 20 tube wells: 14 in the north groundwater scheme to supply 60 ha each and 6 in the east groundwater scheme to supply 30 ha each.

- Procurement and installation of a pumping station with 4 pumps including one spare for backup.

A list of the major project facilities is shown in the table below by scheme.

SUMMARY OF PROJECT FACILITIES

Summary of Project Facilities	Unit	RAU RIVER SYSTEM				MIWALENI SCHEME	MIMO RIVER SYSTEM		GROUND WATER SYSTEM	
		UPPER MABOGINI	MABOGINI	RAU YA KATI	CHEKERENI	MIWALENI PUMP LIFT SCHEME	MAKUYUNI	GHONA & KILEO	NORTH G.W. SCHEME	EAST G.W. SCHEME
A. Main Construction Works										
I. Irrigation Facilities										
1. Tube Well (dia 300mm depth 100m)	total ha (each ha x no)								840 (60 x 14)	180 (30 x 6)
2. Pump Station or Intake Weir	type/No.	F	F	F	F	P x 4	R	R	S	S
3. Main Canal	km type	0.60 T	3.53 T	3.52 T	3.35 T	(E) 5.4 (W) 6.5 T	5.17 H/T	4.10 H/T	0.05 T	0.05 T
4. Secondary Canal	km/No. type	0.45/2 T	7.98/7 T	3.21/3 T	7.45/3 T	19.20/11 T	5.42/4 T	7.21/3 T	1.1	0.42
5. Farm/Regulation Pond	capacity (m^3)	-	-	-	-	1-6,500 4-4,100 2-1,900 5-4,900 3-3,700	1-7,300 2-2,300	10,500	1,300 x 14	650 x 6
II. Drainage Facilities (TE)										
1. Main Drain	km	-	5.10	0.25	5.08	2.1	-	-	-	-
2. Secondary Drain	km	0.65	11.89	8.67	12.15	17.4	4.64	4.15	-	-
3. Catch Drain	km	-	2.90	-	1.70	11.90	3.20	-	-	-
III. Farm Road										
1. Trunk (W = 7 m)	km		(Joint works 19.0 km)			5.8	-	-	-	-
2. Main (W = 7 m)	km	0.60	3.53	6.15	3.35	11.9	2.83	4.10	-	-
3. Secondary (W = 5 m)	km/No.	4.20 x 3	9.61 x 3	2.55	9.95 x 3	15.8	8.47 x 4	4.61	-	-
IV. Flood Protection										
1. Floodway*	km	-	-	-	-	1-6.3 3-2.75 2-3.0	-	-	4-11.55 5- 4.55	-
2. Flood Protection Dike	km	2.7	1.3	5.2	4.4	5.7	-	-	-	-
B. On Farm Development Works										
1. Tertiary Irrigation Canal	km	7.01	28.71	14.35	22.98	71.4	21.52	18.41	2.75	1.35
2. Tertiary Drain	km	2.29	24.27	13.69	21.00	71.6	25.59	17.14	4.5	2.25
3. Tertiary Farm Road (W = 4 m)	km	3.73	33.55	24.25	32.20	35.0	22.74	13.15	4.8	2.3
4. Land Clearing, Leveling and/or grading	ha	150	780	450	780	2,000	500	500	60	30
5. Field Ditch, Drain & Road	service area (ha)	150	780	450	780	2,000	500	500	840	180

Symbols indicating types of facilities

- P = Floating concrete intake weir
- H = Head reach, rectangular concrete flume
- P = Horizontal - shaft double - suction volute - type pump
- R = Rehabilitation of intake weir
- S = Submersible type pump (see ANNEX VII-1.3.2)
- T = Trapezoidal concrete lined canal
- TE = Trapezoidal earth canal

* Floodways

1 - Miwaleni
2 - Mue
3 - Uchira
4 - Mandaka
5 - Nanga

Project Cost

On the basis of the financial cost/price at current market price levels in early 1980 and price escalation factor at 7.5% for the foreign currency portion and 10% for the local currency portion per annum, the project costs are calculated to total Ts 633 million for the 1987 calendar year as shown below. In this estimate, the physical contingencies include about 10% of the basic cost including the cost for engineering services.

Total Project Cost

Work Item	Foreign Currency Portion (10^3 US$)	Local Currency Portion (10^3 TS)	Total Cost (10^3 TS)
Preparatory Works	810	2,900	9,530
Civil Works			
A. Main Construction Works			
1. Irrigation Facilities	10,537	46,783	132,970
2. Drainage Facilities	811	5,568	12,200
3. Farm Roads	1,547	10,139	22,790
4. Flood Protection	1,889	14,220	29,670
Sub-total	14,784	76,710	197,630
B. On-farm Development Works			
1. Tertiary Canal	3,062	15,479	40,530
2. Tertiary Drain	447	2,401	6,060
3. Tertiary Farm Road	1,402	7,963	19,430
4. Land Levelling	3,233	14,536	40,900
5. Field Ditch, Drain and Road	610	9,841	14,830
Sub-total	8,744	50,220	121,750
Office and Quarters	400	9,760	13,030
O & M Equipment	734	300	6,300
Administrative Expenses and Consultants Services	4,110	7,500	41,120
Contingencies	16,328	109,760	243,330
Total Project Costs	45,910	257,150	632,690

Exchange rates: 1US$ = TS 8.18 1US$ = ¥250

The breakdown of civil works costs including main construction and on-farm development works by system is shown below.

Summary of Direct Construction Cost of Each System

	Foreign Currency Portion (10^3 US$)	Local Currency Portion (10^3 TS)	Total (10^3 TS)	Percent of Total (%)
Rau River System	6,368	37,020	89,100	27.9
1. Upper Mabogini Scheme	428	2,460	5,960	1.9
2. Mabogini Scheme	1,984	11,040	27,270	8.5
3. Rau ya Kati Scheme	1,338	7,540	18,480	5.8
4. Chekoreni Scheme	2,068	11,680	28,590	9.0
5. Joint Facilities	550	4,300	8,800	2.7
Miwaleni Pump Lift Scheme	9,033	44,320	118,210	37.0
Himo River System	3,014	18,420	43,080	13.5
1. Makuyuki Scheme	1,576	9,610	22,500	7.1
2. Ghona & Kileo Scheme	1,438	8,810	20,580	6.4
Groundwater System	5,113	27,170	68,990	21.6
1. North Groundwater Scheme	4,022	21,780	54,680	17.1
2. East Groundwater Scheme	1,091	5,390	14,310	4.5
Total Direct Construction Cost (10^3 TS)			319,380	100.0

Project Benefits

The project benefits anticipated from the Project implementation include both direct and indirect benefits.

The direct benefits come from the increment of crop production due to irrigation development, flood protection and drainage improvement. The value of these benefits by scheme is estimated in the economic terms at the 1980 price level as shown below.

Incremental Annual Net Production
Benefit in Each Scheme Area

(Unit: Ts x 10^3)

System	Name of Scheme	Conditions		Increment
		Without Project	With Project	
Rau River System	1. Upper Mabogini Scheme	730	2,960	2,230
	2. Mabogini Scheme	5,080	14,770	9,690
	3. Rau ya Kati Scheme	3,460	7,840	4,380
	4. Chekereni Scheme	4,260	13,590	9,330
Miwaleni Springs	5. Miwaleni Pump Lift Scheme	5,800	32,570	26,770
Himo River System	6. Makuyuni Scheme	3,200	5,770	2,570
	7. Ghona and Kileo Scheme	2,250	7,060	4,810
Groundwater System	8. North Groundwater Schme	3,820	12,420	8,600
	9. East Groundwater Scheme	530	2,280	1,750
	Total	29,130	99,260	70,130

The indirect benefits are the secondary profits to be anticipated from the project implementation. Although most of these are, in general, intangible, their contributions to the rural and national economy make the project all the more viable.

For example, with the Project, it is anticipated that a large increment of rice production in the project area will not only contribute to attainment of regional self-sufficiency in rice but will also help meet the national demand for rice. In addition, an increment of oil-seeds production will contribute to both external and internal trade and also induce the agro-industrial development in the region.

Paddy rice: 11,530 tons x 0.62 x US$ 750 = US$ 5.36 x 10^6
Oil-seeds : 940 tons x 1.00 x US$ 840 = US$ 0.79 x 10^6
Total US$ 6.15 x 10^6

In addition, the increase of crop production will bring a considerable increase in the net profit to farmers. These profits will not only enable farmers to improve their living standard, but will also help to give a stable base to the rural economy by stimulating economic activities.

Improvement of local transportation and communication systems can also be anticipated by the project implementation particularly of the farm road network. This will also contribute to the improvement of rural economic activities including agricultural activities.

A large increase of employment opportunities can be expected by project implementation, and in operation/maintenance works of the project facilities. In addition, employment opportunities will also increase in the agro-business, particularly of oil-milling which might be induced in the Region by the large quantity of oil-seeds production in the Project area.

Stabilization of the crop productivity is also a large benefit in this project. As a result the capacity for settlement will increase far beyond that at present.

Through the project implementation and the operation/maintenance works, the people will gain more experience, technical know-how and skillfulness in the many working fields. This accumulation will provide the motive force for further beneficial developments in the Kilimanjaro Region.

Project Viability

On the basis of the project costs and benefits the internal rates of return (IRR) of the Lower-Moshi Agricultural Development Project were calculated individually for four irrigation systems and for the whole project. In this calculation, economic project benefits were estimated for only the direct benefits derived from the crop production to be attributable to both flood protection and irrigation development. The benefits derived from livestock

production, which will also be improved with the proposed project implementation, are conceptionally excluded from this evaluation. The calculation is made based on 50 years of the project life starting from 1981 which will be a starting year of the project implementation, and assuming that attainment of the project target is primarily 5 years after completion of the construction works. The results are summarized below indicate that the project is quite feasible with an average IRR of 12.1%.

	IRR %
Total Project	12.1
- Rau River System	15.3
- Miwaleni Pump Lift Scheme	12.4
- Himo River System	9.8
- Groundwater Schemes	8.1

A sensitivity analysis was also made with respect to the following critical conditions, to test the sensitivity of the project to possible changes in its economic assumptions.

(1) if the project cost runs over the price and physical contingencies.

(2) if the market prices decline.

(3) if the attainment to the Project target is delayed.

The results shown below suggest that the project is not so sensitive to the most adverse conditions since a 20% price decline and 20% cost over-run only reduces the IRR by 4.2% to 7.9% as shown below.

COST OVER-RUN	Internal Rate of Return (%)			
	Production or Price Decline			Target Attainment Delay
	0	-10%	-20%	3 years
0	12.1	10.9	9.7	11.7
+10%	11.0	9.9	8.7	10.7
+20%	10.1	9.0	7.9	9.8

Project Organization and Implementation Schedule

The project executing organization (the Project Office) is to be established under the jurisdiction of RDD. The Project Office should have responsibility for planning, design, construction and operation & maintenance of the Project (refer to Figs. 10 and 11).

An engineering consultants firm should be employed to assist and advice the Project Office in every aspects of Project implementation.

All civil works are to be constructed by a civil engineering contractor or contractors selected through international competitive bidding.

The construction is to be completed within 80 months including the preparatory period of 18 months from the commencement of the Project.

FEASIBILITY REPORT

ON

THE LOWER-MOSHI AGRICULTURAL DEVELOPMENT PROJECT

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FEASIBILITY REPORT

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ABBREVIATIONS

ARI	:	Agricultural Research Institute, Ministry of Agriculture.
FAO	:	Food and Agriculture Organization of the United Nations.
IDP	:	Integrated Development Plan, Kilimanjaro Region.
JICA	:	Japan International Cooperation Agency.
NAFCO	:	National Agricultural and Food Corporation.
RDD	:	Regional Development Director.
TANESCO	:	Tanzania Electric Supply Company.
TPC	:	Tanganyika Planting Company.

GNP	:	Gross national product.	El.	:	Elevation.
GDP	:	Gross domestic product.	W.L.	:	Water level.
B/C	:	Benefit cost ratio.	E.C.	:	Electric conductivity.
IRR	:	Internal rate of return.	Fig.	:	Figure.
L.S.	:	Lump sum.	No(s).	:	Number(s).

Length

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
ft	:	feet (= 0.3048 m)

Volume

lit	:	litre
m^3	:	cubic meter
MCM	:	million cubic meter (= 10^6 m^3)

Area

cm^2	:	square centimeter
m^2	:	square meter
km^2	:	square kilometer
ha (Ha)	:	hectare (= 4.047 acre)
ac	:	acre (= 0.247 hectares)

Weight

mg	:	milligramme
g	:	gramme
kg	:	kilogramme
t	:	ton (= 1,000 kg)

Electric Measure

V	:	Volt
kV	:	kilovolt
W	:	Watt
kW	:	kilowatt
MW	:	Mega watt
A	:	Ampere
Hz	:	Hertz (cycle)
kWh	:	kilowatt hour

Other Measures

ppm	:	Parts per million
%	:	Percent
HP	:	Horse power (1 HP = 0.746 kW)
^oC	:	Degree centigrade
μS/cm	:	Microsiemens per centimeter
m.mhos	:	Millimohs
m.eq/l	:	Milli equivalent per litre
m^3/sec	:	Cubic meter per second

Currency and Equivalents as of 1980

TS (Shs)	:	Tanzanian Shillings (= $0.122 = ¥30.6)
$	:	U.S. Dollar (= TS8.18 = ¥250)
¥	:	Japanese Yen (= $0.004 = TS0.033)

BASIC COUNTRY DATA

Area	Total area:	945,050 km^2		
	Arable area:	41,000 km^2 (4% of total area)		
Population	Total population:	16.7 million (in 1978)		
	Growth rate:	2.9% per annum (1968 - 1977)		
	Population density:	18 persons/km^2		
Product	Gross domestic product (GDP):	TS. 25,048 million (in 1977)		
	Growth rate:	4.2% per annum (1968 - 1977)		
	Per capita GDP:	TS. 1,530 (US$ 187)		
	Trend and Agro-Component:			
		1968	1972	1977
	GDP (million TS.)	7,182	10,032	25,048
	Per capita GDP (TS.)	571	719	1,530
	Agricultural sector component (%)	43.2	40.1	38.6

Trade

(Unit: million TS.)

	1975	1976	1977
Total exports	2,765	4,109	4,536
Leading export commodities			
1. Coffee (unroasted)	483(17%)	1,282(31%)	1,870(41%)
2. Raw cotton	297(11%)	613(15%)	542(12%)
3. Cloves	321(12%)	261(6%)	244(5%)
Total imports	5,694	5,421	6,199
Trade balance	-2,929	-1,312	-1,663

Other Indices

	1975	1976	1977
Consumers' price index (year 1975 = 100)	100.0	106.9	119.2
International reserves (US$ million)	65.4	112.0	281.8

- to be continued -

Government Finance

	1975/76	1976/77	1977/78
A. Revenue (million TS)			
1. Recurrent revenue	3,919(66%)	5,204(80%)	5,572(57%)
2. Development revenue			
a. External sources	1,033(17%)	1,402(21%)	2,352(24%)
b. Internal sources	1,016(17%)	-69(-1%)	1,872(19%)
Total revenue	5,968	6,537	9,796
B. Expenditure (million TS)			
1. Economic services	2,204	2,519	4,258
a. Agriculture, Forestry	(845)	(706)	(973)
b. Mining, manufacturing and construction	(114)	(444)	(916)
c. Water supply and electricity	(516)	(545)	(728)
d. Other economic	(729)	(824)	(1,641)
2. Other purposes	3,764	4,018	5,538
Total expenditure	5,968	6,537	9,796

Basic Data on Kilimanjaro Region

A. Area and Population

District	Human Settlement Area		Population			
	Area (km)	Percent (%)	Population (1979) (10^3per.)	(%)	Density (per./km^2)	Annual Growth Rate (67-79) (%)
Hai	1,516	15.9	156.7	17.8	103.4	2.8
Moshi	1,532	16.1	359.1	40.9	234.4	2.3
Moshi Town	-	-	(74.0)	(8.4)	-	(8.8)
Rural Moshi	-	-	(285.1)	(32.5)	-	(1.2)
Lower-Moshi	(476.2)	(5.0)	(43.93)	(5.0)	(92.3)	-
Rombo	504	5.3	154.6	17.6	306.7	2.6
Mwanga/Same	5,960	62.7	208.1	23.7	34.9	2.8
Total	9,512	100	878.5	100	92.4	2.5

B. Land Use

Unit: %

District	Agricultural Use	Game Res. & Forest	Water Surface	Other Land Use	Total
Hai	28.5	30.0	1.1	42.4	100
Moshi	30.7	15.4	9.0	44.9	100
Lower-Moshi	(73.3)	(4.1)	(3.6)	19.0	100
Rombo	24.7	51.5	7.7	11.8	100
Mwanga/Same	5.7	28.4	6.0	58.2	100
Total	14.7	30.4	6.0	48.9	100
(10^3 ha)	(194.7)	(401.3)	(79.5)	(645.5)	(1,321)

Product	Gross regional product (GRP)	TS 1.036 million (in 1975) (6.1% of GDP)
	Per Capita GRP	TS 1,632 (US$200)

Public Expenditure

Total expenditure	TS 103.4 million (1977/78)
Agricultural development	TS 4.6 million (1977/78)

I INTRODUCTION

1.1 Project History

In as early as 1970, the Government of the United Republic of Tanzania first requested the Government of Japan to assist with the development of Tanzania, specifically, with the Kilimanjaro Region. Since then, Japan has offered assistance to Tanzania in various ways such as sending long-term experts and survey missions, donating agricultural machinery, and preparing development plans.

The Kilimanjaro Integrated Development Plan (KIDP), October 1977, is one of the outcomes of Japan's assistance. It is a long-term perspective plan for the period up to 1955 and also presents a medium-term development programme for up to 1985. The Plan not only embrances such macroframe elements as the economy, society, administration, government finances, and physical planning but also embodies a wide spectrum of sectoral development components, including resources, environment, industry, infrastructure and community planning. The KIDP was authorized through approval of the Regional Assembly as the basic development plan of the Kilimanjaro Region.

Prior to the preparation of KIDP, certain irrigation schemes were conceived in the Lower-Moshi area on a preliminary basis by Japanese Experts who had stayed in Kilimanjaro Region during the years from 1975 to 1977 under the technical cooperation programme of Japanese Government. The schemes were later incorporated into the KIDP under the name of the Lower-Moshi Agricultural Development Project. The Project was further selected by Tanzania Government as one of the top priority projects to be implemented during the Third Five-Year Plan period (1975-1981).

In April, 1979, the implementation schedule of the Lower-Moshi Agricultural Development Project was discussed between RDD and the Japanese Preliminary Survey Mission. On this occasion RDD expressed its strong desire to advance the general time schedule of the Project and to commence the actual construction work not later than the end of

June, 1981. The implementation schedule was revised so that all necessary time periods for the mapping, feasibility study and loan arrangement could be reduced to a minimum. Mapping of the Project area was undertaken by JICA at the scale of 1:5000 in August thru December, 1979.

1.2 Feasibility Study

In November, 1979, JICA invited Nippon Koei Co., Ltd. to submit proposals to undertake the feasibility study. A contract was concluded between the JICA and the Consultants dated 7 December, 1979.

JICA appointed a Supervisory Team for the feasibility study to arrange the "Scope of Work" for the study with the Kilimanjaro Regional Development Director (RDD) and to supervise the Consultants' study on its behalf.

The consultants commenced work in Tanzania with the arrival of the Study Team in Dar es Salaam on 9 December, 1979. An interim report was prepared at the close of field surveys in March, 1980, and this final report was completed at home office in Japan.

II BACKGROUND

2.1 General

Since the independence of Tanganyika from Great Britain in 1961 and the establishment of the United Republic of Tanzania between Tanganyika and Zanzibar in 1964, Tanzania has been integrating its 120 national tribes into a single country for political stability, building socialism, and promoting africanization under the leadership of President Nyerere. In 1967 the Arusha Declaration set forth the national goals to be pursued and to be achieved through the efforts of each and every citizen on the basis of the principles of self-reliance and decentralization and placing agriculture as the foundation of the economy.

Tanzania's territory extends over 945,000 km^2, of which only 41,000 km^2 or 4% is arable land with the rest being perm crops, pasture, forest and woods, etc. The population, which current estimates put at about 17 million, increased by 2.9 percent a year during the 1968 - 1977 period.

The economy of Tanzania has grown steadily during the last decade. The Gross Domestic Production (GDP) which grew at an annual rate of 4.5% during 1968 - 1977 attained TS 25,048 million (equivalent US$3,062 million) in 1977. Per capita GDP was estimated at US$187 in 1977.

Agriculture is the backbone of the country's economy and will remain so for many years to come. It employs about 90% of the population and approximately 40% of the GDP is derived from agriculture. In 1976 and 1977 agricultural exports accounted for approximately 75 and 78% respectively of the total foreign exchange earnings.

A total of 2.1 million tons of food crops are produced in Tanzania including maize, paddy, sorghum, millet, wheat, dry beans and other pulses. Maize is the most important food grain. In 1978, total production of maize was about 1,000 thousand tons or 47% of the food grains produced. Though it made a recovery in 1975/76, production of food grains declined drastically in 1973/74 and 1974/75 due to adverse

weather conditions. Unprecedented large quantities of food grains had to be imported in 1974 and in the first half of 1975 to meet the domestic shortfall. The major grains imported were maize, rice and wheat. Imports in calendar year 1974 amounted to about 446,400 tons at a total cost of Ts 783 million. Although the food production situation started to improve in 1976/77 and became even better 1977/78, it is still necessary for the country to import maize, rice and wheat worth Ts 230 million to supplement the production of Tanzanian farmers.

In order to overcome the extremely weather-reliant nature of agricultural production, the Government has made efforts to expand the irrigated agriculture by implementing national, regional and local irrigation schemes. According to FAO data in 1978, however, the irrigable area in Tanzania is only 58,000 ha or 1.4% of the existing arable land of 4.1 million ha. Scarcity of technical manpower together with scarcity of funds are also major constraints to the poor accomplishment of irrigated acreage.

Tanzania launched a long term perspective plan covering the period of 1964 - 1981, which has been implemented in three medium term plans: the First Five-Year Plan in the 1964-69 period, the Second in the 1969-74 period, and the Third in the 1975-81 period. The projected GDP growth rates during the First and Second Five-Year Plan periods were 6.7% and 6.5% respectively, whereas actual achievements were 5.0% and 4.8%. In both Plans, the decline in the production of crops was responsible for not attaining the projected growth rates. The decline resulted from a combination of various factors: drought, insufficient investment and faulty allocation of investment. Drought was particularly severe after 1970.

In the Third Five-Year Plan, priority has been placed on achieving self-sufficiency on meeting food requirements by 1981. For this objective, a capital investment of Ts 3,332 million or 12.35% of the total public investment amount was allocated to the agricultural sector. The GDP growth rate during the Plan period was targeted at 6%, while the growth rate of the agricultural sector was set at 5.1%.

2.2 Kilimanjaro Region

The Kilimanjaro Region, located in the northeastern part of Tanzania, borders on Kenya to the north, the Tanga Region to the Southeast and the Arusha Region to the west and covers an area of 13,209 km^2 or 1.4% of the area of the entire country.

Mt. Kilimanjaro (5,895 m), the highest summit of the African Continent, and the Pare mountains (1,800-2,400 m) form the backbone of the Region. Above 1,800 m on Mt. Kilimanjaro are located the Kilimanjaro National Park, Game Reserve and Forest Reserve areas. On the north side of the Pare mountains lies the Mkomazi game reserve and on the south side lie the Nyumba ya Mungu Dam and the Pangani river basin which extends extends to the Masai Stepppe.

The regional population in 1979 stoood at 878,500, or 5.3% of the national total. During the past 12 years (from 1967 to 1979), the population in the Region has increased at a rate of 2.5% per annum. It will reach 1,479,000 in 2000 according to a population projection made by the Regional Water Department Office.

Administratively the Kilimanjaro Region is divided into 5 districts: Moshi, Hai, Rombo, Mwanga and Same districts, which are subdivided into 19 Divisions, 75 Wards and 419 Villages. The Regional capital is Moshi town which had a population of about 74,000 in 1979. Regional Development Director (RDD) has the primary responsibility for the Regional development and for all aspects of external liaison, revenue, expenditure, budgeting, etc. Regional office of each central ministry have been subject to the jurisdiction of RDD since establishment of the decentralization policy. At District level, the District Development Director (DDD) has a similar responsibility to the RDD.

Most of the population is so concentrated on the slopes of Mt. Kilimanjaro and the Pare mountains in belts from 800 to 1800 m in altitude that the area has one of the highest population densities of the country. This area, above the Moshi-Himo Highway called the highlands, is so favoured with abundant rainfall, moderate temperature, fertile soils and ample irrigation water that a highly intensive mixed

cultivation of coffee and banana has been practised for many years. Coffee is not only a source of cash for farmers but also the biggest foreign exchange earner of the country. Banana is the staple food for inhabitants on the slope.

The highlands, however, already accommodate the maximum population and the land use has reached its limit. Under the traditional land tenure system called Kihamba (land distribution to offsprings), land ownership has been fragmented by generations of inheritances, and at present the holdings per family has decreased to as little as 0.66 ha on average. Consequently, many farmers in the highlands are absentee owners of farms in the lowlands where they cultivate maize to supplement their food production while living on the highlands.

On the other hand, areas below the Moshi-Himo Highway and 800 m, called the lowlands, are very sparsely populated. In the lowlands rainfall is generally insufficient for cropping, and moreover, soils in certain areas are salinized and/or subjected to yearly flooding. Reflecting these conditions, drought resistant crops such as maize and beans have been cultivated very extensively and cattle grazing has also been practiced.

People in the lowlands have had to endure severe living conditions such as high temperatures, drought, flood, saline soils, scarce water, malaria and schistosomiasis. People are living a nearly primeval type of life, mostly in simple huts with mud walls, banana leave roofs and without floors. Due to the lack of public investment in facilities and social infrastructure, most villages have been very poorly developed. Poverty increases as distance from the mountain zones increases. According to one estimate, per capita annual income of people who live in the highlands is TS 894, while for those who live in the lowlands, it is TS 444.

In spite of generally inferior natural conditions, the overall orientation of regional development has been directed toward the lowlands. Large-scale irrigation developments have been taken place

in the lowlands such as the Tanganyika Planting Company (TPC) in Arusha Chini for sugar cane cultivation and the National Agricultural and Food Corporation (NAFCO) in Kahe.

A considerable extent of the lowlands, including the Lower-Moshi area, still remains underdeveloped, yet it has a favourable development potential which makes it worthwhile for infrastructure investment.

Under the present practice of land use in the Kilimanjaro Region, only 195,000 ha or 15% of total acreage is agricultural land, 30% is game and forest reserves, 6% is water surface and the remaining 49% is other uses. The low ratio of the agricultural land use is undoubtedly attributable to the dryness in most areas of the Region.

Water is of vital importance to the agriculture of the Region. About 28,000 ha or 14% of the cultivated area of 195,000 ha is under irrigation, which is a much higher percentage than that for the whole country. Nevertheless, more irrigation is needed to stabilize agricultural production and to increase agricultural acreage to cope with the ever increasing pressure of population.

III THE PROJECT AREA

3.1 General Conditions

The area envisaged under the Lower-Moshi Agricultural Development Project (hereinafter referred to as the Lower-Moshi area or the Project area) occupies the southeastern skirt of Mt. Kilimanjaro and extends over about 42,000 ha at altitudes between 700 and 800 m above mean sea level. The Lower-Moshi area is bounded by the Moshi-Himo road in the north, the Kenyan border in the east, the Ruvu river and the northern boundary of NAFCO Kahe in the south, and the eastern boundaries of Moshi Urban Development area and TPC in the west. It extends about 30 km fromeast to west and 15 km from north to south, and is located at about 5 to 24 km southeast of Moshi town, the state capitol of the Kilimanjaro Region (see the Project Location Map).

The Lower-Moshi area is administratively divided into 20 villages of which 19 villages are located in the Moshi District and one in the Mwanga District. All of these villages have been traditionally established by the spontaneous transmigrants since long ago, but only put in the national registration in the very recent years of 1970 to 1977. Each village is administered by three village executives: chairman, secretary and manager. Thevillage executive councils and village general assembly are the village decision making organs.

In the lowlands of the Kilimanjaro Region there are presently 17 Ujamaa villages (multi-purpose cooperative societies), of which 5 exist in the Lower-Moshi area; namely, Chekereni, Kiomu, Mangaria, Makuyuni and Uchira. The Ujamaa village is characterized by its holding of communal lands. Villagers work together on the communal lands under the leadership of village executives and share the benefits produced. However, Ujamaa activities have decreased recently except at Chekereni village.

The total population in the Lower-Moshi area is about 44,000 as of October, 1979, according to thevillage census executed by the District Ujamaa Village Corporation Office, Moshi. The population

density averages 92 persons/km^2 with a variation by village ranging from 50 to 230 persons/km^2. The number of households is about 8,700. The average family size is estimated at 5 persons, out of which 2.4 persons are grouped as working population.

Although no statisticaldata is available, a considerable number of non-resident farmers, who live either on the upper slopes of Mt. Kilimanjaro or in Moshi town, own farms in the Lower-Moshi area. According to information obtained from villages, more than 9,300 non-resident farmers own lands not exceeding one hectare each in the Lower-Moshi area.

3.2 Topography

The Lower-Moshi area is generally composed of gently sloping land with an average gradient of 0.5% ranging from 5% near the Moshi-Himo road to 0.2% close to the Ruvu river. The highest elevation is about 800 m at the northwest corner of the Lower-Moshi area and the lowest is about 700 m at the southeast corner.

3.3 Meteorology

There is three seasons characteristic in the Lower-Moshi area: namely, the rainy season from March to May, the dry season from June to October and the short-rain season from November to February. Annual rainfall in the Lower-Moshi area averages 590 mm, of which 370 mm or 63% falls in the rainy season, 60 mm or 10% in the dry season and 160 mm or 27% in the short-rain season.

On the southern slope of Mt. Kilimanjaro orographic precipitation dominates. There is a close relation between the amount of rainfall and altitude. Maximum annual rainfall, averaging as high as 2,000 mm, occurs in a belt between altitudes from 1,600 to 1,800 m. Annual rainfall decreases from this belt both upwards and downwards along the slope of Mt. Kilimanjaro reaching 200 mm near the summit of the mountain and 400 mm far down in the vicinity of the Nyumba ya Mungu reservoir. In the Lower-Moshi area, the 800 mm isohyet runs east to west near the northern boundary, and the 500 mm isohyet near the southern boundary some 15 km apart.

As the annual evaporation exceeds 2,000 mm, cropping in the northern part of the area is marginally possible only in the rainy season with considerable risk of failure due to the likelihood of occasional dry periods. No cropping is possible in other seasons without irrigation. Although the Lower-Moshi area generally has a dry condition, it suffers from yearly floods not only in lowlying areas but also higher lands closer to Mt. Kilimanjaro. Daily rainfall of more than 100 mm is not uncommon on the slope of Mt. Kilimanjaro.

Mean temperature in the Lower-Moshi area varies from 21°C to 26°C throughout the year. The average daily maximum temperature rises above 30°C from October to April, while the daily minimum temperature falls close to 16°C in July and August. In planning the cropping patterns of the project, due consideration has been taken of the low temperature in the winter season.

Relative humidity averages 63% in the year, being high from March to September with its maximum in May. Pan evaporation varies widely throughout the year from 3 mm/day in May to 9 mm/day in January. Yearly evaporation amounts more than 2,000 mm.

Winds are light from April to August and moderate from September to March. South and southeast winds are predominant. Shelter belts were provided in the TPC farm to secure a better distribution pattern of splinkler irrigation.

Meteorological data of Miwaleni station which is situated nearly at the center of the Lower-Moshi area is presented in Table 1, and illustrated in Fig. 1.

3.4 Hydrology

Three major tributaries of the Ruvu river traverse the Lower-Moshi area: namely, the Himo, the Mue and the Rau rivers. Mt. Kilimanjaro maintains numerous springs on its skirts. Major springs in the Lower-Moshi area are the Miwaleni, Njoro, Soko and Kileo springs. There are twelve seasonal rivers between the Rau and the Mue rivers. Their water courses lose definition in the midst of the gentle slope a few kilometers down from the Moshi-Himo road and cause yearly flood damage to crops in the downstream fields.

Fig. 1 METEOROLOGY OF THE LOWER-MOSHI AREA

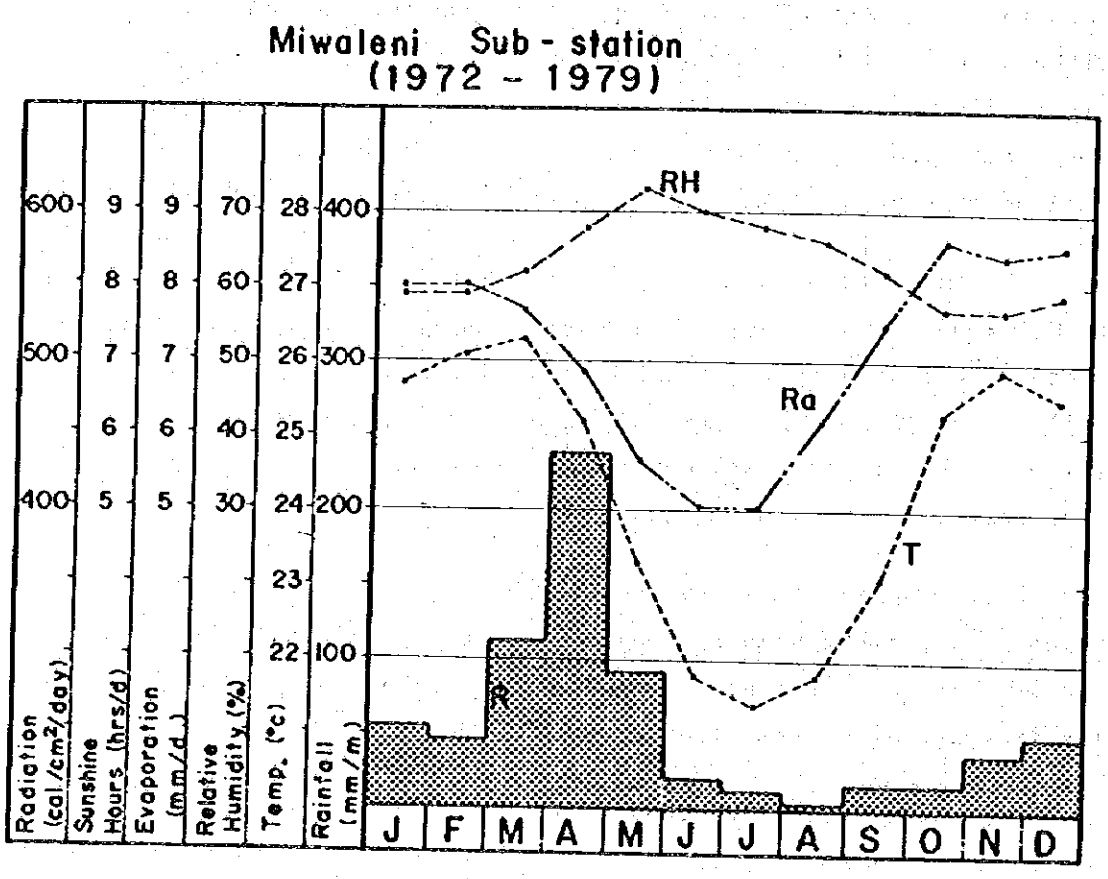

Table 1

METEOROLOGICAL RECORDS

Station: Miwaleni Sub-station Lat. 3°25', Long. 37°27', Alt. 770 m
(Registered Number: 93.37/131)

Period : From 1972 to 1979 (8 years)

ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL/ AVERAGE
	Light Rainy Season		Rainy Season				Dry Season				Light Rainy Season		
	Hot Season						Cool Season				Hot Season		
1. Daily Max. Temperature (°C)	32.8	32.9	32.7	30.2	27.7	26.5	26.6	27.4	29.5	31.9	32.4	32.1	30.2
2. Daily Min. Temperature (°C)	18.5	19.2	19.8	20.1	18.8	17.0	16.1	16.1	16.7	18.5	19.4	18.8	18.3
3. Daily Mean Temperature (°C)	25.7	26.1	26.3	25.2	23.3	21.8	21.4	21.8	23.1	25.3	25.9	25.5	24.3
4. Relative Humidity at 9 am (%)	73	73	76	80	82	80	80	79	76	71	71	72	76
5. Relative Humidity at 3 pm (%)	44	44	47	56	64	59	56	52	47	43	43	45	50
6. Mean Relative Humidity (%)	59	59	62	68	73	70	68	66	62	57	57	59	63
7. Piche Evaporation (mm/day)	9.0	8.6	8.4	4.4	3.0	3.5	4.1	5.2	6.2	8.0	8.1	8.5	2,320
8. Radiation (cal/cm^2/day)	551	551	534	493	438	402	402	460	523	581	570	578	507
9. Monthly Rainfall (mm/month)	55	46	112	238	92	21	13	6	17	17	38	50	705

Table 1

The discharge of the three major rivers and springs has been observed since 1952. However, most records are incomplete and hence available discharge for rivers was estimated by means of reservoir model simulation. Available spring discharge is estimated based on the observation records.

The average annual runoff is estimated at 50.3 MCM for the Rau river, 48.7 MCM for the Njoro river, 125.3 MCM for the Miwaleni spring, 50.4 MCM for the Himo river and 15.1 MCM for the Mue river (at the Moshi-Himo road).

The Project will use the Rau and Himo rivers and the Miwaleni and Njoro springs as the water source for irrigation, while the other rivers as well as the Soko and Kileo springs are excluded from project use because of low development potential.

The upstream part of rivers on the slopes of Mt. Kilimanjaro have gradients of 1/5 at higher altitudes and 1/30 at lower altitudes near the Moshi-Himo highway. The rivers have carved deep valleys and gullies on steep slopes. On the gentler slopes in the Lower-Moshi area, sedimentation processes become more dominant. All rivers become too narrow and shallow to carry their flood discharge into the Lower-Moshi area. The peak flood discharges for the Rau, Mue and Himo are estimated by using the Rational formula at 193, 130 and 312 m^3/sec, respectively. These figures will be used for the flood protection plan of the Project.

3.5 Hydrogeology

The Lower-Moshi area geologically consists of thick alluvial deposits and pyroclastic flows overlying Precambrian crystalline metamorphic rocks. Faulting and volcanism continued in this part of the world throughout Miocene and Pliocene times. The fault-trough is the most important structural feature in the Lower-Moshi area. The Precambrian basement rocks lie more than 200 m deep.

Ample water bearing formations composed of lava, sand and gravel have been known to exist in this fault-trough. Since 1964, 25 deep wells (i.e. 11 in the Lower-Moshi area and 14 in the TPC estate).

have been dug mainly for irrigation purposes, Their total production is estimated at about 56,000 m^3/day or 20 MCM per year.

The geo-electric prospecting conducted by the Study Team disclosed the hydrogeological conditions in the Lower-Moshi area. Analyses on ρ -a curves associated with the hydrogeological information obtained from existing deep wells identified five groundwater areas as follows:

i) Kibo lava area:

It lies directly on the mud flow around Moshi town. Almost all springs around Moshi town emerge from this groundwater body with good quality. Aquifers are capable of yielding moderate quantities of water.

ii) Arusha Chini area (TPC area):

An impermeable formation exists at depths of around 100 m. This impermeable formation is overlain by moderate to large quantities of water bearing formations.

iii) Miwaleni upland area:

This area extends on the southern slope of Mt. Kilimanjaro. According to drilling information on existing wells, aquifers in this area are capable of yielding moderate to large quantities of water.

iv) Kahe area:

Geological formation is alternating formations of clay and sand. Both deep and shallow groundwaters are characterized by the presence of salinity with high electric conductivity. Aquifers are capable of yielding moderate quantities of water.

v) Kiomu area:

An unconsolidated formation is underlain by precambrian basement rocks in this area. Aquifers are capable of yielding moderate quantities of water.

The groundwater in the Lower-Moshi area flows from Mt. Kilimanjaro to the Nyumba ya Mungu reservoir through the fault-trough. It is obviously recharged by the lateral flow from Mt. Kilimanjaro through the weathered lavas and pyroclastic flows. In order to quantify the recharge volume, both water balance analysis and flow pattern analysis have been conducted. Both analyses give fairly similar results and it is estimated that approximately 500 MCM of water is recharged annually into the groundwater in the fault-trough. Subtracting the volume of water presently discharging from spring and existing wells from the above recharge volume, potential development quantities of groundwater were estimated at 41 and 9 MCM per year for the Miwaleni upland area and Kiomu area, respectively. (See Annex II 4.5).

Water quality of springs, deep wells and rivers were examined by means of electric conductivity and chemical analysis. Generally, water quality was found satisfactory for irrigation use. However, careful attention should be paid to the artesian water character (categorized into the Miwaleni Soil group, C2-S1 class) when crops with low salt tolerance are cultivated.

3.6 Soils

The soils of the Lower-Moshi area are broadly classified into four varieties; namely, (1) the soils on steep hills, (2) soils on the colluvial plain widely extended on the foot of Mt. Kilimanjaro, (3) soils on the alluvial plain mainly lying over the right bank of Rau river and down the reaches of the Himo river, and (4) soils on the recent flood plain.

Summary of Soil Suitability in Lower Moshi Area

Soil Location	Acreage (ha)	% of Total	Suitability for Agriculture
1. Steep hills	1,200	3	None
2. Colluvial plain	18,520	45	80% high for upland paddy only
3. Alluvial plain	14,990	35	50% high potentiality
4. Recent flood plain	7,290	17	For paddy with flood protection
Total	42,000	100	Roughly 29,600 ha (70%)

The soils on the steep hills are the stony soils. They are patchily scattered over the north-easternmost of the Lower-Moshi area and their total acreages are estimated at about 1,200 ha (or 3% of the total area). The soils generally have loamy to sandy origins and very shallowly underlie the volcanic hard formation or base-rocks in pre-cambrian formation. In light of the soil features and topographic conditions, the lands of these soils have no potential for agricultural development.

The soils on the colluvial plain are the most predominant soil type in the Lower-Moshi area. These soils occupy about 18,520 ha (or 45% of the total area). Out of the total acreages of these soils, about 80% of the land has been recently exploited as the agricultural land and cultivated extensively with upland crops. The soils of this area are generally dark to dull reddish brown soil and they have very large depth, clay to silty clay texture throughout the profile, rather hardly consolidated, with many wide and deep cracks when dry, and girgai formation on the soil surface. They are slightly alkaline, but quite free from the salinity constraints. The land of these soils is highly suitable for the irrigated upland farming, while not capable for paddy rice cultivation in the light of the hydrodynamic characteristics of the soils.

The remaining 20% of the colluvial soils are primarily calcareous soils. These soils are generally rich in calcium carbonate, but sodium accumulation has recently proceeded in the soil formation. Thus, the soils have not only high salinity but also strong alkalinity ranging from 8.5 to 15 m.mhos/cm/25°C EC and from 8.5 to 9.5 pH. The effective soil depth of these soils is less than 50 cm in general due mainly to the lime crust formation and concretional formation in the shallow profile. These soils have very slight capability of future agricultural development.

The soils on the alluvial plain occupy about 14,990 ha (or 35% of the total area). Almost half of these soils, which mainly develop on the lowlying area extending over the lower reaches of the Rau and Himo rivers, are strongly affected by the salinity and alkalinity

of the soil formation. A brackish groundwater stands at the relatively shallow depth of 100 cm even in the dry season. To develop the agriculture in this soil area, a large capital investment and recurrent cost for operation would be required particularly for moderation of soil salinity cum alkalinity and protection from the seasonal flooding.

The other half of these alluvial soils are mainly found in the upper streams of the rivers. They are generally neutral to slightly acid, clay to silty clay, quite free from the saline and alkaline constraints. They have large effective soil depth, high moisture holding capacity, and a low permeability coefficient. In the light of the soil features, the soils are highly capable for both irrigated upland crop and paddy cultivation.

The soils on the recent flood plain develop narrowly along the Rau, Mue, Himo and Ruvu rivers. Their total extent is about 7,290 ha (or about 17%). They are primarily gleyic soils. Almost all of the soils are, more or less, affected by salinity and are regularly submerged in the rainy season. These soils have capability for paddy cultivation but very little for upland cropping. To develop the land of this soil area, flood protection is indispensable.

3.7 Land Use

Recently, agriculture in the Lower-Moshi area has been almost completely been done by the spontaneous transmigrants and the arable land has been reclaimed almost to its possible maximum for agricultural production.

Out of the 41,930 ha of the whole Lower-Moshi area, approximately 30,750 ha (or 73%) are agricultural lands, of which about 19,760 ha is used for the upland crop cultivation, 740 ha for paddy rice, 1,180 ha for small-scale estates (i.e. sugarcane and sisal) and 9,070 ha for grazing land. Some 890 ha (or about 2%) is used for the village compounds including small extents of orchards and vegetable gardens. The remaining 10,290 ha (or about 2.5%) is the virgin land such as swamp, shrub land, forest land, etc.

Up to now, irrigation facilities (traditional furrows) have been developed by the farmers themselves, and part of the system was improved by the local government under the rural development programme. At present, about 3,700 ha in net of upland field and 655 ha in net of paddy field are fed by river and spring waters. Owing to poor irrigation facilities, steady supply of irrigation water is rather difficult even in the rainy season. The irrigation facilities, which can irrigate in the dry season, are limited only to the Mabogini, Rau ya Kati, Chekereni and Makuyuni/Lotima, while their commanding areas are about 740 ha (or 20% of the total irrigable land) in which banana is the most dominant crop. The annual crops cultivated in the dry season, however, are few and limited to about 245 ha (or 4% of the total irrigated land).

3.8 Land Tenure and Land Holding Size

In the Lower-Moshi area, there are two types of the land tenure for land holding; namely, Kihamba and Shamba. Kihamba, as a means of freeownership type of tenure system, is limited to only few percent of the farmers.

Shamba is the main type of land ownership in this area. In the Shamba, farmers are given certain acreages of arable land with the cultivation permission from the village committee. If a certain land is fallow for three years, the holder is not entitled to object that the cultivation right of the land be transferred to other by the village committee.

There used to be several privately owned sisal estates in the Lower-Moshi area. However, recently, all of these estates ceased operation/management, and the lands were transferred to the Government. These lands are now being used as grazing reserves.

The total gross acreage of farm land in the Lower-Moshi area is estimated at 20,480 ha, while total numbers of farm household both settled and unsettled are estimated at 7,900 and 9,340, respectively. Hence, the average farm size is counted to be 1.2 ha.

3.9 Agricultural Setting

Generally speaking, the agricultural setting in the Lower-Moshi area is characterized by small individually owned farm and by cereal crop and livestock production, in contrast with the coffee and banana plantation in the Highland area.

The agricultural setting in the area is broadly classified into three zones; namely (1) Upland crop cultivation, (2) Paddy rice cultivation and (3) Livestock grazing.

(1) Upland crop cultivation is the most predominant agriculture in the area. It traditionally prevails in all of the villages except Kochakindo and some parts of Mangaria, Kisangesangeni, Kiomu, Makuyuni and Kileo where the soils are strongly affected by salinity and alkalinity. In this setting, farmers grow maize, beans and cotton as the major staples and other various crops, such as finger-millet, sorghum, sunflower, groundnut, sesame, sweet-potato, cassava, onion, cabbage, tobacco, etc. are also grown for supplemental home consumption and cash sources.

(2) Paddy rice cultivation has been recently introduced by the farmers in Mabogini, Mandaka, Rau ya Kati and Chekereni villages, in the lowlying area. Irrigation water comes from Njoro and other small springs. In other villages, such as Kisangesangeni, Mangaria, Kitereni and Kileo, some farmers also develop paddy field, but to a small extent, at present, due mainly to the shortage water for irrigation. Because of little research on paddy rice cultivation and also on the traditional cropping practices in the area, the yield and production of this paddy rice are still at subsistence levels.

(3) Livestock grazing is the most important agricultural element other than the cereal crop production in the Lower-Moshi area. At present, there are in total about 25,490 cattle, 9,750 sheep and 26,820 goats in the Lower-Moshi area. Of them, almost all of the cattle, which mainly consist of Zebu, are concentrated in Kahe and Kileo wards and their grazing is rather extensively practiced by

cattle farmers, using the wild grasses reserved in about 9,070 ha. Generally, sheep and goat populations are even distributed over the whole Lower-Moshi area and their grazing is mainly for home consumption and cash earning by full use of the by-products from cereal crop cultivation. The milk production from the above live stocks is, at present, very limited to only local consumption. Poultry is also raised, but still at a subsistence level in the area.

3.10 Crop Cultivation and Production

(1) Cropping Pattern

Owing to relatively mild climate for crop growth, excluding the uneven distribution of rainfall each year, various kind of crops have been introduced in the Lower-Moshi area. Of them, maize is the most predominant crop not only as a staple food product, but also as a cash source and followed by beans and cotton. Due to the small farm size and short rainy season or limitation of available irrigation water, a mixed standing of these crops is the common production practice in the Lower-Moshi area.

Under the national maize campaign, such high yielding varieties as UCA (Ukiliguru Composit A.) and ICW (Ilonga Composit White) and Hibrids (serial No. 622 and 632) have been introduced in the irrigated area where the land is fed by traditional furrows. In the rainfed area, however, farmers mainly grow the local varieties of maize and mostly without farm-inputs. Maize cultivation in the area is generally started in early March and harvested in mid-May in the case of local varieties, while in mid-June to July in case of high-yielding varieties. For dry season cropping of maize, the high yielding varieties are generally applied and grown during the months from October to February.

Beans are the second most important food crops in the upland field and followed by such minor crops as millet, sorghum, pigeon pea, sunflower, sesame, sweet-potato, cassava, groundnut, tobacco. These crops are generally cultivated by a mixed cropping system along with maize production.

Banana and plantations are normally planted close to the living quarters and/or in a small part of the Shamba where irrigation water is available.

For paddy cultivation, high yielding varieties are not introduced yet. The local varieties, prevalent in this area, are the oriva-sativa kind having more than 140 days growing period. The main crop season is from January to May and no secondary cropping of paddy is practiced, at present.

Cotton is grown during the months from mid-May to mid-November with the supplemental irrigation. For the same season described in the preceding paragraph, cotton is also grown sometimes in mixed stands with maize, beans, sweet-potato, etc.

(2) Farming practices

The soil preparation for both paddy field and upland field is mostly made by the use of farm tractors with disc ploughs which are owned and managed by the District Agricultural Development Office, Moshi. Harrowing practices in soil preparation are very rare at present.

Use of animals for the soil preparation and other farming practices is very limited in this area. The farming practices other than the soil preparation are done by manual operation. During the growing period of each crop, attention is paid by the farmers only to weed control.

Fertilizers and chemicals are used only for high yielding varieties of maize, cotton and vegetables. Although these imputs have been rarely used in past years, in the last two to three season application has been increasing due to the farmers' credit programme established by the Tanzania Cotton Authority and Tanzanian Rural Development Bank. Use of seeds of high yielding variety and chemical inputs is being demonstrated by agricultural extension workers, but proper practices are still limited to effective propagation, at present.

Irrigation operation is performed by farmers' individually, while maintenance of facilities is made as communal work in general.

(3) Farm inputs and labour requirements

Farm inputs such as seeds of high yielding varieties of maize and cotton, and fertilizers and chemicals are only used under the farmers' credit programme. However, the actual dosage of fertilizers and chemicals is generally small. The fact is that the farmers use these inputs over wider areas than that specified in the credit or use a part for other purposes particularly for vegetable cultivation.

For crop production other than the above, farmers do not use any fertilizers and chemicals. Seeds which are obtained from the farmers own production are generally used.

All the works for farming except harvesting of cotton are operated by family labour which is sufficient. In case of cotton harvesting, some seasonal labourers are employed to supplement a shortage in the family labour force.

(4) Crop yield and production

At present, about 17,470 ha of the land or 85 % of the total farm land is under cultivation with such crops as maize, cotton, beans, etc. The remaining about 15 % or 3,000 ha is left fallow under a shifting cultivation schedule. Out of the total net cultivation area, maize growing occupies about 15,180 ha or 87 % of the total cultivation area in the rainy season, of which about 2,260 ha is tilled with supplemental irrigation. The cultivation area by crops and unit yield of major crops are summarized below:

Cultivated Area by Crops

(Unit: ha)

Major Crops	Rainy Season Cropping Irrigated	Rainy Season Cropping Rainfed	Dry Season Cropping Irrigated	Total
Maize	2,265	12,805	105	15,175
Cotton	640	-	-	640
Beans	-	775	120	895
Paddy	655	-	-	655
Vegetables	180	-	20	200
Other crops	-	590	-	590
Banana	-	-	495	495
Total	3,740	14,170	740	18,650

Unit yield of each crop is as follows:

Present Unit Yield of Major Crops

(Unit: tons/ha)

Major Crops	Rainy Season Cropping Irrigated	Rainy Season Cropping Rainfed	Dry Season Cropping Irrigated
Maize	1.76	0.92	1.76
Cotton	0.40	-	-
Beans	-	0.43	0.89
Paddy	1.40	-	-
Vegetables 1/	5.13	-	5.13
Other crops 2/	-	0.46	-

Note: 1/: Figures are shown based on average yield of dry onions.
2/: Figure is shown based on average yield of finger-millet.

As seen in the above Table, the effect of irrigation combined with the application of fertilizers clearly indicates that the unit yield under irrigated conditions is almost two times higher than that under the rainfed conditions. According to local opinion, however, after damage from a drought and/or water standing long after the seasonal

flooding, the unit yield of each crop sharply decreases to about 50% - 80% of the yield in a normal year. In this Lower-Moshi area, the drought and/or seasonal flooding not only directly affect the crop yield, but they also decrease the cropping acreages to a certain extent even in the irrigable area because of the small discharge capacity of rivers in the dry season.

Based on the cropping acreages and average unit yield in each crop presented above, the total production of major crops is estimated and summarized in the following Table.

Production of Major Crops

(Unit: tons)

Major Crops	Rainy Season Cropping		Dry Season Cropping	Total
	Irrigated	Rainfed	Irrigated	
Maize	3,990	11,780	180	15,950
Cotton	260	-	-	260
Beans	-	330	110	440
Paddy	920	-	-	920
Vegetables 1/	920	-	100	1,020
Other crops 2/	-	270	-	270

Note: 1/: The production is converted to dry onion basis.
2/: The production is converted to finger-millet basis.

Because of poor nutiritive conditions of wild grasses for animal grazing, the fatting or slaughter rate for cattle and sheep/goats is as low as 0.2 and 0.25 % per annum respectively. The annual milking rate is 200 ℓ/head for cows and 17 ℓ/head for sheep and goats. Annual total production of livestock is estimated below. Poultry in the area is, at present, a very small part of the farm economy and its production is at a subsistence level.

Annual Livestock Production

Major Products	Annual Production
Meat	
- Cattle	5,100 head[1/]
- Sheep	2,440 "
- Goats	6,710 "
Milk	
- Cattle	760 kl
- Sheep	58 "
- Goats	160 "

1/: number of head slaughtered on average.

3.11 Marketing and Processing Facilities

Under the national system, almost all of the agricultural commodities are traded through a single marketing channel, and crop production is purchased by the National Milling Board (NMB, a Parastatal Organization) and farm inputs are supplied through the farmer's credit by the Tanzanian Rural Development Bank (TRDB). In this marketing system, the price of crop production is set by the central Government with the approval of the Economic Committee of the Cabinet. A large part of the price of farm inputs is subsized by the Government. Cotton seeds alone are directly supplied to the cotton growers by the Tanzanian Cotton Authority (TCA) free of charge.

Marketable surplus of the crop production except fruits and vegetables is directly purchased by the regional agencies of the National Milling Board, namely, maize, paddy and other cereals by NMC; seed cotton by TCA, oil-seeds by GAPEX, etc. In the past, the crop production surplus in the Lower-Moshi area was limited only to maize, cotton and oil-seeds, among the various kinds of crops. The average amount of these productions purchased by the National Milling Board are about 7,800 tons of maize, 230 tons of seed cotton, and 60 tons of oil-seeds. Most of the balance is used for home consumption including the seed stocks partially for the next cropping and partial for direct sale to the local market.

The regional agencies of the National Milling Board have set 6 buying posts at major locations in the Lower-Moshi area. Each buying post has a godown facilities with a capacity of from 100 tons to 300 tons. In addition, the agencies have main store-building and milling plants in Moshi. Transportation of production from buying post to Moshi and from Moshi to outside is managed by the agencies themselves and by use of their own transportation facilities, such as trucks and railway wagons.

There are small flour mills in several villages. These are mostly managed by village committees. The operation is mainly for the local consumption with the milling charges at TS 0.5/kg.

Banana and vegetables are generally sold directly to the local market or to central market in Moshi township by the farmers themselves. In the case of the livestock production, it is also priced under the free market system. Generally, the farmers sell live animals to the slaughter-houses, which are managed by village in case of the local market and the town council in case of the Moshi market, and thereafter, meat is sold directly to consumers. Small surpluses of milk and eggs are sold individually. The prices of these productions fluctuates widely season by season.

3.12 Present Conditions of Farm Economy

The study on the present farm economy in terms of production return of each crop and livestock was made based on the data and information obtained by farm economic surved and agricultural investigation in and around the Lower-Moshi area.

Based on the agronomic and farm economic data, the present condition of the financial balance of agricultural production is estimated as shown in ANNEX Tables VI-32 and VI-33. The following is the summary of financial budget for major products.

Financial Budget for Major Products

(Unit: TS per ha)

Major Products	Gross Return	Production Cost	Net Return
Crop production:			
Maize			
- Irrigated	1,750	808	942
- Rainfed	920	598	322
Paddy rice	2,100	1,049	1,051
Pulses	1,347	534	813
Cotton	1,028	794	234
Vegetables	25,000	11,250	13,750
Other crops	460	390	70

Based on the financial balance of each crop and the total cultivated area in the whole Lower-Moshi area, gross production return and net production return are estimated at Ts 25,764,000 and Ts 12,164,000, respectively (see ANNEX Table VI-34). These values correspond to about Ts 2,500 gross return and Ts 1,260 net return per farm household on average.

Livestock is another important product for cash earning in the Lower-Moshi area. The annual return of livestock production is estimated at TS 10,131,600 in gross and TS 5,312,600 in net return (see ANNEX Table VI-35). These values correspond to about TS 1,280 gross and TS 670 net return per farm household on average.

Annual total net return obtained from both crop and livestock production is, then, estimated at TS 17,476,600 in the whole Lower-Moshi area, and the net annual income level of farm household is at TS 1,930. The net annual income per capita is at about TS 380 (equivalent to about US$47).

3.13 Agricultural Supporting Services

Agricultural extension

In the Kilimanjaro Region, broadly speaking, two agricultural extension service systems have been organized:

(1) One system is general agricultural service in the network under the direction of Ministry of Agriculture. The services cover technical demonstration by means of establishing the demonstration farm, farm guidance on modern farming practices, and assistance in the application of farmer's credit. These services are made through systematic organization from the Regional Agricultural Development Office to the District Agricultural Development Office and down to field extension workers in village.

(2) The other system is the special service programme for cotton growers. The services, which cover technical guidance for cotton cultivation and arranging of credit, are made by the Tanzanian Cotton Authority separately from the former services.

At present, the agricultural extension staff in Kilimanjaro Region is about 250 in total. Out of them, about 70 persons are engaged in general administration as senior officials in both Regional and District offices. The remaining 180 persons are field extension workers at village level. An average commanding area per field extension worker is about 1,100 ha, corresponding to about 850 farm households per staff. These figures are about one half the average density of extension staff in developed countries.

In the Lower-Moshi area, the field extension offices are still substantially understaffed, and their facilities are not sufficient to cover the whole area. This situation makes contact with farmers difficult and also severely limits the impact of extension workers.

The Kilimanjaro Agricultural Development Center (KADC), which has been designed and is now under construction at Chekereni village under the technical and financial assistance of the Japanese Government, will be a very effective facility for technical training of the extension workers and also the leading farmers, and in strengthening agricultural extension services in the future.

Agricultural research

Crop research especially on the food crops, and technical demonstration of such crop cultivation are being made by the Miwaleni Experimental Sub-station, which is located at the center of the Lower-Moshi area, under direction of the Lyamungu Agricultural Research Station.

In the course of the above programme, such technical demonstration as introduction of high yielding varieties of maize, use of fertilizers and chemicals is made at several locations, using the yards of primary schools and also the fields under the national maize campaign, in close collaborating with extension workers. Under the regional agricultural development programme, oil-seeds crops such as sunflower, soybeans, groundnut, etc. are also examined as a line of crop research.

Seed multiplication work

Specific seed multiplication to improve varieties of crops is made in several seed centers under the direction of the Ministry of Agriculture. In addition, the certified seeds are distributed by the state farms. Only the multiplication of paddy seeds has not yet started in Tanzania. To promote the rice production increase expected in the Third Five-Year Development Plan, it is recommended to establish a paddy seed farm as early as possible.

Farmers credit

With regard to financial assistance to farmers, two types of public credit are in use in the Lower-Moshi area. One of the credits programs is by the Tanzanian Cotton Authority and the credit is applied only to cotton growers. Through this credit, purchase of fertilizers and chemicals are arranged at subsidized prices. Conditions of credit include a one year grace period and an interest rate of 8 % per year.