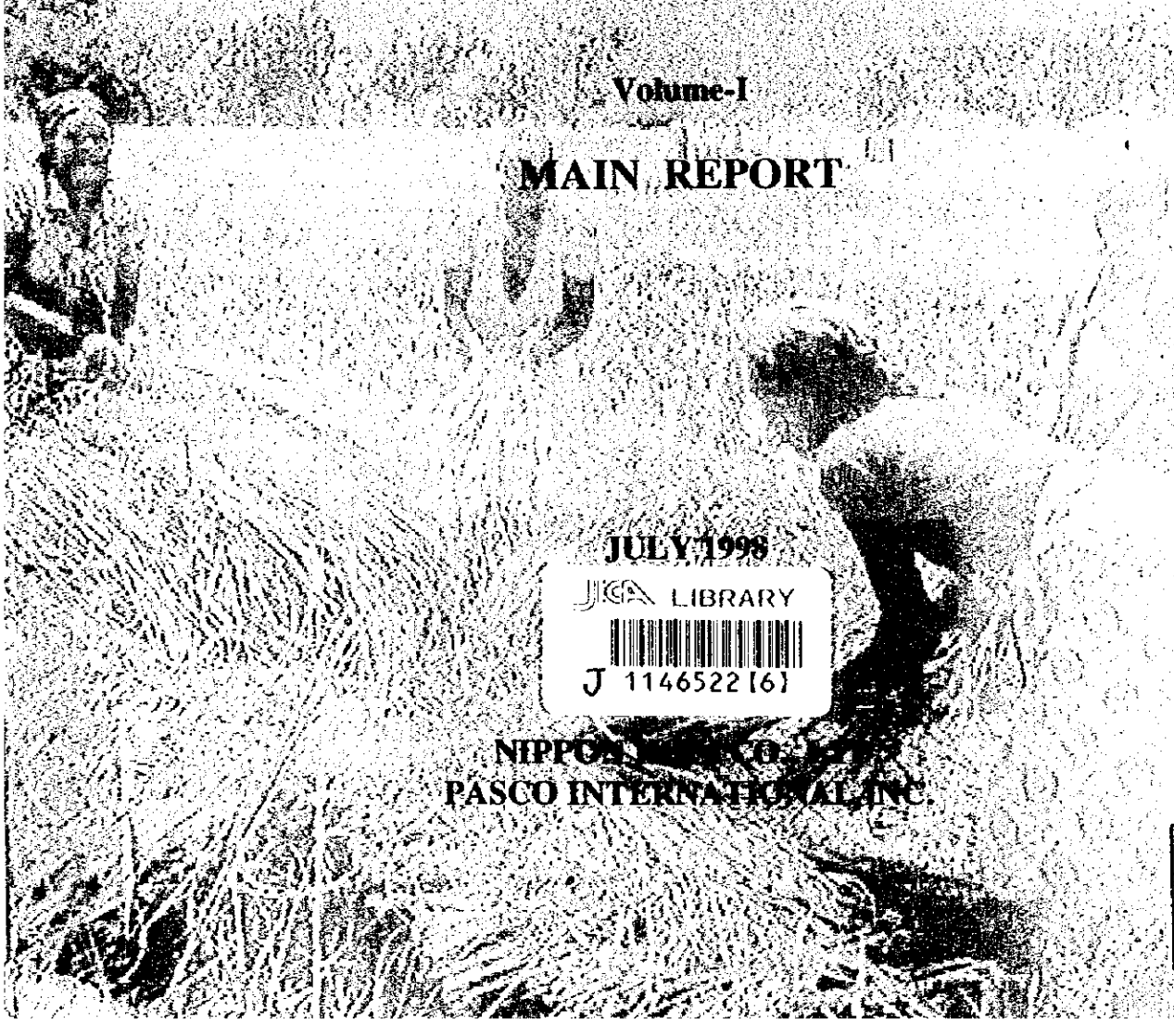
JAPAN INTERNATIONAL
COOPERATION AGENCY

MINISTRY OF AGRICULTURE
AND COOPERATIVES,
THE UNITED REPUBLIC OF
TANZANIA

THE FEASIBLITY STUDY
ON
LOWER MOSHI INTEGRATED AGRICULTURE
AND
RURAL DEVELOPMENT PROJECT
IN
THE UNITED REPUBLIC OF TANZANIA



Volume-I

MAIN REPORT

JULY 1998

NIPPON [illegible] CO.
PASCO INTERNATIONAL INC.

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NIPPON KOEI CO., LTD.
PASCO INTERNATIONAL INC.

LIST OF REPORTS

CURRENCY EQUIVALENT

(as of December 1997)

One U.S.Doller (US$1) =Six Hundreds Twenty Tanzanian Shilling (Tsh.620)
=One Hundred Twenty Five Japanese Yen (¥ 125)

PREFACE

In response to a request from the Government of the United Republic of Tanzania, the Government of Japan decided to conduct the Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to the United Republic of Tanzania a study team headed by Mr. Yusaku TOYA, Nippon Koei Co. Ltd., three(3) times between March 1997 and May 1998.

The team held discussions with the officials concerned of the Government of the United Republic of Tanzania, and conducted field survey at the study area. After the team returned to Japan, further studies were made and this report was prepared.

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

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

July, 1998

Kimio Fujita

The President of
Japan International Cooperation Agency

July 1998

Mr. Kimio Fujita
The President for
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit to you the report on the Feasibility Study on Lower Moshi Integrated Agriculture and Rural Development Project in the United Republic of Tanzania. This Report presents the results of all works performed in both Tanzania and Japan during a total period of 15 months from March 1997 to May 1998.

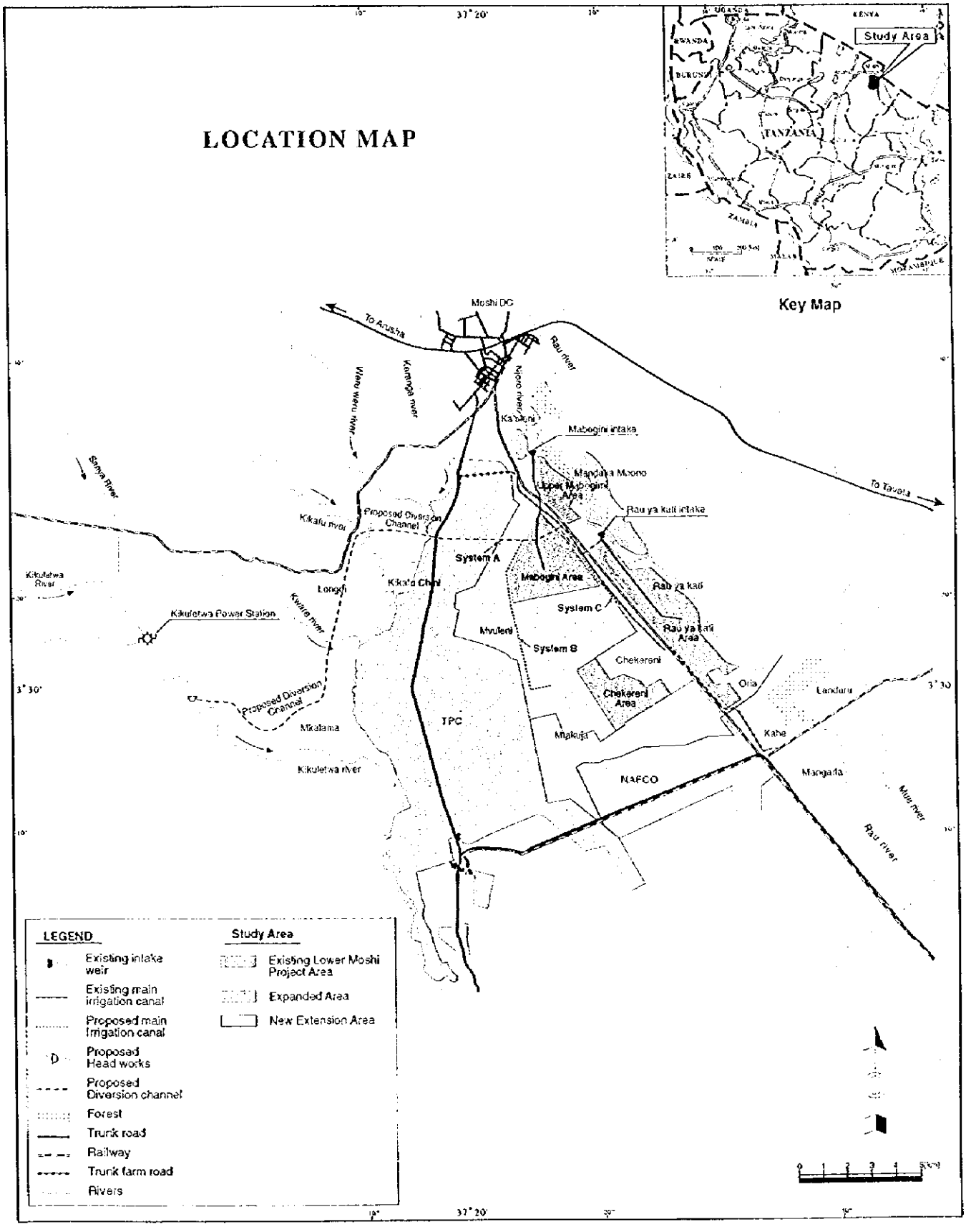
The Project is due the integrated agriculture and rural development project, covering not only agriculture development in the Lower Moshi area, but development of rural infrastructures for elevating the living standard of villagers as well. The Project also includes the strengthening plans on O&M, extension services/agricultural supporting services in order to realise the Project sustainability. It is worth to mention that almost all farmers in the Project area expressed their willingness to participate in the implementation and O&M of the Project, assuring the sustainable operation of the Project after its implementation.

We are confident that the Project, once implemented, will greatly help develop and stabilise the rural socio-economy in and around the Project area and also improve the living standards of villagers. Moreover, the Project will solve the serious water shortage problem now being faced by the existing Lower Moshi Project. Hence, we recommend to implement the Project as early as possible.

We wish to express our deep appreciation and sincere gratitude to the officials concerned of your Agency, the Ministry of Foreign Affairs, the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan for the courtesies and cooperation kindly extended to our team. We also wish to express our hearty appreciation and gratitude to the officials concerned of Tanzania Office of your Agency, the Embassy of Japan in Tanzania, the Ministry of Agriculture and Cooperatives of the Government of Tanzania, Kilimanjaro Agricultural Development Project, Kilimanjaro Agricultural Training Center, Kilimanjaro Regional Office and other authorities concerned for close cooperation and assistance extended to our Team during field investigations and studies in Tanzania.

Very truly yours,

Yusaku TOYA
The Leader of Study Team of the
Feasibility Study on Lower Moshi
Integrated Agriculture and Rural
Development Project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Chekereni Area
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Rau river
Landuru
Oria
Mvuleni
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Kaloleni
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37° 20'
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Proposed main irrigation canal
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SUMMARY

I. INTRODUCTION

Authority

1. This is the Final Report on the Feasibility Study (the Study) on the Lower Moshi Integrated Agriculture and Rural Development Project (the Project) prepared in accordance with the Scope of Work (S/W) concluded on October 31, 1996 between the Ministry of Agriculture and Cooperatives (MAC), the United Republic of Tanzania and the Japan International Cooperation Agency (JICA).

Background of the Project

2. With the expansion of urban population and the changes in food preference of the nation, the demand for rice in Tanzania has remarkably increased in recent years and the self-sufficiency of rice becomes an important target of the agriculture sector development in the country. However, about 96 % of paddy production in the country depend on small scale farmers and the production is unstable affected by climatic conditions because 90 % of paddy fields of the small holders are under rained conditions. Accordingly, the production of rice was not enough to suffice domestic demand and the import of rice increased substantially to 90,000 tons in 1993 from 60,000 tons in 1991. The amount of rice import in 1993 was US$ 18 million, which accounted for 17 % of the total import amount of the country.

   In the Existing Lower Moshi Project which was developed with the technical and financial cooperation of the Government of Japan (GOJ) under the Lower Moshi Agriculture Development Project, the successful paddy production had been carried out since its completion in 1987. However, the development of new paddy fields and the arbitrary water tapping in the upstream areas of the Existing Project brought about constant water shortage in the downstream and serious adverse effects to the performance of the Project. The annual cropped areas of paddy in the Existing Project had gradually decreased since 1990 and dropped to 647 ha in 1994, less than half of the maximum cropped areas of 1,508 ha achieved in 1990.

   Against this background, in September 1995, the Government of Tanzania (GOT) requested GOJ to execute a feasibility study (the Study) on the Lower Moshi Integrated Agriculture and Rural Development Project (the Project) for a potential area of about 6,000 ha consisting of the Existing Lower Moshi Project Area and its surrounding area. JICA responded to this request by dispatching the Preparatory Study Team in October 1996 to confirm the request and the S/W for the Study was concluded on October 31, 1996.

Objectives of the Study

3. The main objective of the Study is to conduct feasibility study and formulate an optimum integrated agriculture and rural development plan for the potential area of about 6,000 ha including the Existing Lower Moshi Project Area located in the south-eastern part of Lower Moshi in the Kilimanjaro Region, in order to effectively accelerate the extension of irrigation techniques developed in the Existing Lower Moshi Project Area and the

raising of living standards of farmers. Technology transfer to the Tanzanian counterpart personnel is also aimed at in the course of the Study.

II. GENERAL BACKGROUND

National Socio-economic Situation

4. The population of Tanzania in 1994 was estimated at 27.5 million and the annual growth rate of population from 1988 to 1994 is calculated at 3.2%. The labour forces in the country are estimated at 15.6 million. Among the same, about 11.0 million are regarded as employed and the rest are as unemployed. The agriculture sector is an important sector both for income generation and employment and about 85 % of the labour forces are employed in the sector.

5. The gross domestic products increased at 1.1 % per annum from 1980 to 1985, 3.9 % per annum from 1985 to 1990 and 4.1 % per annum from 1990 to 1994, when the GDP in 1976 is taken as the base figure. However, GDP per capita is rather stagnating and declined from US$ 154 in 1980 to US$ 149 in 1994 because of high population growth.

6. The agriculture sector is an important sector in the national economy of Tanzania and accounts for more than 50 % of GDP and 75 % of the total export earnings. The main cereal crops produced are maize, sorghum, paddy, millet, and wheat. Both cropped areas and production of paddy indicated increasing trend during 10 years from 1985/86 to 1993/94. However, the annual fluctuation of production was substantial as a result of erratic weather conditions. Tanzania imported substantial quantity of rice, maize and wheat from 1990 to 1994. According to the Annual Report of FAO(July 1996 to June 1997), the overall food requirements in 1997/98 is estimated at 7.1 million tons and a deficit of 0.6 million tons of food in the national food balance is predicted. Therefore, the national food security is one of the main agricultural policy issues of the country and the strengthening of food production and the self-sufficiency of food is an important target of the national economic development.

National Development Objectives and Policies

7. Despite the fact that the majority of population depends on the agriculture sector, the national food security has been one of the critical agricultural policy issues of GOT and the strengthening of food crops production and attainment of food self-sufficiency continue to be the main pillars of the national economic development policies. In the "Agriculture Policy of Tanzania 1996" (draft), the primary agriculture development targets are the national food balance and increased incomes of the rural population, and the similar objectives for agriculture development are set forth. At the regional level, the agriculture development is to be promoted in accordance with the national level development strategies and polices for the sector. Accordingly, the attainment of food self-sufficiency and the improvement of living standards of rural population are the primary objectives of agriculture development of GOT.

8. GOT has repeatedly declared the importance of development of rural areas where 85 % of the total population live and the main development target in these areas is poverty alleviation. Poverty prevailing in these areas is due to low income per capita and low agricultural productivity. Reflecting such policy issues, the construction of economic and social infrastructures for the expansion of food production and improvement of

living standards are set as the development objectives of rural areas in the Fourth Rolling Plan and Forward Budget (RPFB) for 1996/97 to 1998/99. Similarly, in the Kilimanjaro Region Rolling Plan and Forward Budget for 1997/98, the improvement of domestic water supply and road sectors are emphasised , however, the development funds allocated for the sectors will be too limited to achieve the ambitious objectives.

III. THE STUDY AREA

Location and Administration

9. The Study Area is located in the Kilimanjaro Region at the foot of the Mt. Kilimanjaro, in the north-east of Tanzania. The Study Area covering the proposed head works site, the proposed route of the diversion channel, the Existing Lower Moshi Project Area, the Expanded Area and the New Extension Area extends over 3 districts of Hai, Moshi (Rural) and Moshi (Urban) and 11 villages. Population in the Study Area in 1997 is estimated at 25,550 persons.

Meteo-hydrology

10. Climate of the Study Area is characterised by three seasons: rainy season from March to May, dry season from June to October and short rainy season from November to February. The mean annual rainfall at Chekereni is 560 mm. The monthly mean temperature varies from 20 C to 25 C, and the monthly mean relative humidity is 63 to 77 %. Pan evaporation varies widely from 3 mm/day in May to 8 mm in February.

11. The water sources of the Existing Lower Moshi Project are the Rau river and Njoro river which are supplied by the Mwanangurue, Njoro Ya Dobi, and Goa springs having constant discharges throughout the year. In spite of these stable water sources, the river flow of the Rau river at the Rau Ya Kati Intake Weir decreased remarkably since 1994, especially in the dry season from August to November due to haphazard water tapping in upstream areas. The mean monthly discharge at Mabogini ranges from 1.23 m^3/s to 1.59 m^3/s and at Rau Ya Kati from 2.24 m^3/s to 2.88 m^3/s.

    The investigation for the exploitation of new water sources was made on 5 rivers (Kikuletwa, Kikafu, Karanga, Weru-weru and Kuware) in the present Study. The results of the investigation revealed that the topographic conditions of the rivers do not justify the construction of reservoirs to exploit water resources in the rivers. Further, the river discharge in the dry season except for the Kikuletwa river is not dependable because of its high seasonal fluctuation. Based on the findings, the Kikuletwa river was selected as the new water sources for the Project. The runoff of the Kikuletwa river is characterised by the constant base flow from spring water. The Kikuletwa river has a mean monthly discharge of 11 to 13 m^3/s from August to March at the Gauging Station IDD1 and the same of 14 to 25 m^3/s influenced by rainfall in the remaining 4 months from April to July.

12. The results of water quality analysis indicate that Sodium Abstraction Rates (SAR) of the water samples taken at the proposed headworks site on the Kikuletwa river is low although the water contains considerable amount of Na, Ca and Mg. The water quality of the Kikafu, Rau and Njoro rivers are characterised by low salinity and low SAR and has been assessed, by applying the FAO irrigation water quality assessment criteria, as having no specific problems for irrigation purpose. In accordance with the assessment

criteria of USDA, all the water resources examined under the Study have been assessed suitable for irrigation having no specific restrictions for the use.

Soils and Land Suitability

13. All the soils in the Study Area except for strongly salt affected Eutric Cambisols are assessed suitable both for irrigated rice and upland crops. Those are generally more suitable for rice, and higher degrees of limitations for upland crop cultivation will be encountered especially due to soil salinity and drainage conditions. While, the land suitability of Eutric Cambisols, Saline/Sodic Phase is classified as currently not suitable because of high salt accumulation in the soils and subsurface soil sodicity problems. The soils are found in the southern end of the Study Area and occupy an area of about 980 ha.

14. To prevent soil degradation due to irrigation and to maintain/improve soil permeability, the proposed measures for soil management are the introduction of soil amelioration crops and the application of organic matters. In addition, the periodical monitoring on effects of such soil management practices and salinity and sodicity status of the soils are essential in the operation stage of the Project.

Agriculture

15. The present land use of the Study Area (8,444 ha) can be classified into the following 6 land use categories.

Present Land Use of the Study Area

Land Use Category	Area (ha)	Proportion(%)
Irrigated paddy fields in the Existing Lower Moshi Project Area	1,492	18
Irrigated paddy fields in the Expanded Area	510	6
Irrigable upland fields in the Existing Lower Moshi Project Area	1,162	14
Rained upland fields in the Expanded and New Extension Areas	4,160	49
Grassland and grazing land	970	11
Village and housing yards	150	2
Total	8,444	100

16. The major crops in the Study Area are paddy and maize. In the paddy fields of the Existing Lower Moshi Project Area, the cropping calendar of 3 croppings per year; rainy season paddy - early dry season paddy - late dry season paddy; is practised aiming at overcoming restriction in water supply and maximising cropped area within the available irrigation water. In the paddy fields of the Expanded Area, the prevailing cropping calendar is rainy season paddy - dry season paddy. However, because of seasonal inundation and water supply constraints, the cropping calendar of the area is rather diversified. The cultivation of maize is practised under rained conditions in the rainy season.

17. The present overall annual cropping intensity in the Study Area is estimated at 104 % and the same by area is 71 % in the Existing Lower Moshi Project Area, 163 % in the Expanded Area and 95 % in the New Extension Area. The area-wise present average crop yields of paddy are 6.6 ton/ha for the Existing Lower Moshi Project Area and 3.9 ton/ha for the Expanded Area. The present seasonal crop production in the Study Area is estimated at 2,400 and 5,600 tons of paddy respectively for the rainy and dry season. In

addition, 7,500 tons of maize are produced in the rainy season.

18. At present, the important source of income in the Study Area is agriculture, however households in the New Extension Area are obliged to earn income from non agricultural activities because of low agricultural productivity. The average annual net reserve per farm household in the whole Study Area is estimated at US$ 310. The highest average net reserve is US$ 530 per household in the Expanded Area and the lowest one is US$ 50 in the New Extension Area.

Agricultural Supporting Services

19. The agricultural supporting services in Tanzania are executed by MAC. While, in the Existing Lower Moshi Project Area, the Kilimanjaro Agriculture Development Project Office (KADP), the implementation agency of agriculture development in Kilimanjaro Region, have carried out aggressive agricultural research, extension and training activities with the Japanese technical assistance in addition to the agricultural supporting services by MAC. Presently, the Kilimanjaro Agricultural Training Centre (KATC) established in 1994 is playing the essential role for the promotion of irrigated rice farming in Tanzania. The number of courses conducted and trainees trained at KATC since its establishment are 16 and 333, respectively.

20. Financial institutions in the formal sector which deal with agricultural loans include the Cooperative and Rural Development Bank (CRDP),etc. However, for smallholders representing the majority of farmers in the country, the access to formal lending mechanisms through the existing financial institutions is practically limited due to the high transaction costs associated with lending small amounts of money to a large number of smallholders and due to the lack of collateral.

Irrigation and Drainage

21. In the Existing Lower Moshi Project Area, higher field water requirements of paddy is required than predicted mainly because of cracks in soils which are developed during the long fallow period caused by water shortage. In connection with field water requirements, a number of field monitoring on actual field water requirements were done by KADC, KADP and KATC from 1986 to 1997. The data obtained by KADC and KATC are the ones measured before the introduction of the scheduled fallow period and are about 30 % lower than those recorded by KADP in general.

22. Within the Study Area, only the Existing Lower Moshi Project Area is provided with a well-planned drainage system consisting of main, secondary, tertiary and field drains and related structures. The design drainage requirement applied is estimated at 5 l/s on the conditions that 5-year, 24-hour storm rainfall is to be drained from paddy fields within 48 hours. The drainage system constructed applying the drainage requirements has not presented any drainage problems on its network and capacity since the commencement of irrigation in 1986. While, no drainage system is constructed in the Expanded Area (Kaloleni and Mandaka Mnono areas), and a part of the Area is subject to seasonal inundation in the rainy season. The inundation problem is more profound in Kaloleni area and it is a main constraint for agriculture in the area. Further, a part of Mandaka Mnono area is susceptible to flood from the Rau river and the surrounding hills.

Rural Infrastructures

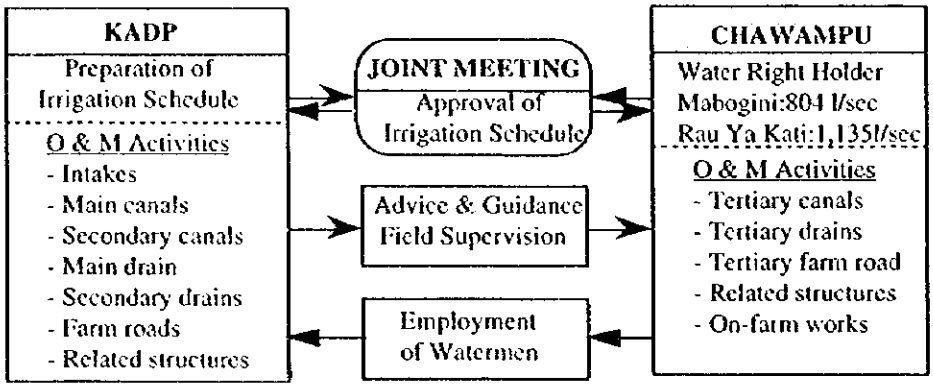
23. The existing road network in the Existing Lower Moshi Project Area consists of a trunk road, main farm roads, secondary farm roads and tertiary farm roads. These roads in the area are at poor conditions or partially not passable during the rainy season. The road conditions in the Expanded Area and New Extension Area are extremely poor and even the traffic in the dry season is restricted to a certain extent.

24. The domestic water sources in the Study Area includes public water supply, irrigation canal, well, river and spring. Although the public water supply systems are provided in the Existing Lower Moshi Project Area and the Expanded Area, the coverage of the public water supply is extremely limited. Accordingly, most of the population in the Study Area depend on irrigation canal, well, river and spring for domestic water supplies.

O & M Executing Agency

25. The O&M and water management activities in the Existing Lower Moshi Project Area are presently executed by KADP and CHAWAMPU on a co-operative basis. The coordination chart between KADP and CHAWAMPU on project operation is illustrated below.

Coordination Chart between KADP and CHAWAMPU



KADP is a government agency for O&M of the Existing Lower Moshi Project and is headed by a director. Under him, there are 5 sections: Administration Section, Irrigation Section, Machinery Section, Tractor Hiring Service Section and Extension Service Section. A total number of office staff is 67 as of May 1997. With regard to the O&M of irrigation facilities, KADP is in charge of operation of major facilities down to turnouts on tertiary irrigation canals, and CHAWAMPU is responsible for operation of water courses and respective irrigation blocks under instruction and guidance of KADP. In the Expanded Area, the O&M of irrigation systems are executed by farmers themselves within their capability.

Farmers' Organisations

26. In the Existing Lower Moshi Project Area, there is a Paddy Farmers Association (CHAWAMPU) which has legal status as a cooperative society registered under the Cooperative Act No.51. CHAWAMPU has actually dual functions; one is as an agricultural marketing cooperative and the other as a water users association. The present CHAWAMPU's By-Law, however, emphasises the functions of the cooperative

as the agricultural marketing cooperative, and the functions as the water users association are not clearly defined. Out of total beneficial farmers of 1,876 in the Existing Lower Moshi Project Area, only 783 farmers or 42 % of the total hold CHAWAMPU's membership as of December 1997. The reasons for this are considered that; 1) the present CHAWAMPU's By-Law lacks an article for the mandatory participation of beneficiaries, 2) farmers are doubtful about the capability of CHAWAMPU, and 3) farmers are reluctant to make contribution of share and member's fee as they can't expect high income because of water shortage.

27. In the Expanded Area, there are 2 irrigation systems and a Water Users Association (WUA) is organised for each system. The WUA is not functioning satisfactorily due to 1) organisational weakness, 2) financial constraints, and 3) lack of technical know-how in O&M of irrigation facilities.

Environment

28. Based on the existing information and collected data on social and natural environment, an initial environmental examination (IEE) was conducted for the Project. The results revealed that some significant negative impacts would be most likely brought about by the Project if no introduction of appropriate mitigation measures is made before its implementation. Hence, it was judged essential to execute an environmental impact analysis (EIA) for detailed assessment.

29. The results of the EIA study carried out in succession generally show that the Project activities will have no or insignificant negative impacts to most of the social and natural environmental items. It can therefore be concluded that, within the limitations of the prediction and assessment methods employed during the EIA study, the Project is considered to be environmentally viable, provided that some mitigation measures and necessary monitoring are implemented as mentioned in the "Environmental Conservation Plan".

Women in Development

30. The investigations in the Study Area revealed that women were heavily engaged in agriculture and livestock activities. Women offer the main productive forces and are involved in all production activities on the farm; covering planting, sowing, weeding, manuring and harvesting. They are also responsible for transporting products from field to home and storing and processing of them.

31. The present membership of CHAWAMPU is 783, of which only 136 or 17 % of the total are female members. No any woman is holding leadership posts to this farmers organisation from the head quarter to branches. Heavy workload and child care responsibility as well as need to get permission of their husbands prevent women from participating in social activities and education/training opportunities. Some taboos and customs are the factors explaining low participation of women in public arenas.

Public Meetings

32. Public meetings were held under the sponsorship of GOT with the assistance of JICA Study Team. The public meetings were held eight times, of which one meeting was for women. The meetings were held at eight villages and the total attendants of the meetings were about 2,100 farmers.

33. Through the discussion, many suggestions and requests were brought up. In order to assess beneficiaries' opinion to the Project , the following questions were presented to the attendants in the meetings.

(1) Do you accept the development plan of the Project narrated to you ?

(2) Do you accept farmers' duties outlined and presented to you ?

(3) Do you agree to execution of the following farmers' participation jobs ?

(a) Construction of small drains in irrigation block.
(b) Execution of sod facing for small canals.
(c) Execution of fine land levelling through land preparation activities.

The opinions of all the attendants were of one hundred percentage "yes" to the questions and all of them were eager for implementation of the Project.

IV. FORMULATION OF DEVELOPMENT PLAN

Development Constraints

34. The major agronomic and agro-economic problems and constraints common in the Study Area are 1) restricted cropping season due to climatic conditions, 2) absence of a quality rice seed supply system, 3) less intensive farming practices for upland crops, and 4) lack of efficient system for farm inputs supply and marketing of farm products. In institutional aspects, KADP and CHAWAMPU still require further strengthening on their organisation and staffing for smooth execution of operation and maintenance activities of the project facilities. In the Expanded Area and the New Extension Area, provision of agricultural and rural infrastructures are essential in addition to the above.

Basic Development Concepts

35. The integrated agriculture and rural development plan for the Study Area has been formulated by putting a focus on the increase of agricultural productivity and enhancement of living standards of rural people and in accordance with the following basic development concepts.

(1) Hardware aspects

- Exploitation of reliable water sources.
- Construction of irrigation and drainage facilities which can be easily operated and maintained.
- Provision of rural infrastructures such as rural roads, washing places and animal drinking places paying due attention to aerial equity.

(2) Software aspects.

- Introduction of irrigated rice farming.
- Strengthening of the executing agency and farmers' organisation by making best of the existing organisations.
- Provision of agricultural supporting services well co-ordinated with the project implementation schedule .
- Formulation of O&M plan of project facilities considering handing-over of O&M to farmers organisations.

As the existing agriculture infrastructures in the Study Area vary substantially depending on the areas, the agricultural supporting services strengthening plan and O&M plan of project facilities have been worked out in consideration of the present agriculture status

and existing infrastructures in respective areas.

Agriculture Development Plan

36. In the formulation of the agriculture development plan, the introduction of rice-based irrigated agriculture is aimed at for establishing profitable agriculture and for ensuring sustainable agriculture in the Study Area. In the formulation of the plan, the following basic approaches have been taken.

- To envisage integrated agriculture development well synchronised with engineering and institutional development;
- To take area-wise approaches to ensure that development approaches will duly address specific development constraints of respective areas;
- Formulation of rice cropping calendar to avoid low temperature injury in July and August;
- To formulate agriculture development plan by paying due attention to soil and water management to prevent soil degradation and by paying due attention to animal husbandry;
- To use the existing rice fields in the Existing Lower Moshi Project Area as the nucleus area of the whole Project Area and make the best use of the Area for extension and training purposes; and
- To strengthen and expand supporting services based on actual needs and well synchronised with the progress of the project implementation.

Proposed Land Use Plan

37. The agriculture land use planning are made in due consideration of the following;

- Exclusion of strongly salt affected areas covered with Eutric Cambisols, Saline/Sodic Phase which are assessed currently not suitable for irrigation farming from the Project Area;
- Consideration of present land use which reflects existing needs for specific land use as grazing land;
- Results of irrigation and drainage study;
- Location of the proposed site of the oxidation pond in the urban development plan of Moshi Municipality; and
- Future expansion of village yards in the New Extension Area.

The proposed land use plan formulated accordingly is as follows;

Proposed Land Use (in gross)

(Unit:ha)

Land Use	Present	With Project/Study Area		
	Study Area	Project Area	Outside Project Area	Change
Irrigated Paddy Fields	2,002	5,809	75	+ 3,882
Irrigable Upland Fields	1,162	0	0	- 1,162
Rained Upland Fields	4,160	0	1,510	- 2,650
Grass Land/Grazing Land	970	0	900	- 70
Village Yards	150	0	150	0
Total	8,444	5,809	2,635	-

Note: Net Development Area = 4,700 ha

Crop Production Plan

38. In accordance with the basic approaches for agriculture development, the cultivation of paddy and alfalfa are planned. The proposed cropping pattern at the full development stage presents the paddy cultivation of 100 % cropping intensity (4,700 ha) in the rainy season, and the paddy cultivation of 50 % cropping intensity (2,350 ha) and alfalfa cultivation of 20 %(940 ha) in the dry season. The alfalfa cultivation is planned in rotation with paddy once in every 5 years.

39. Based on the past crop cut survey records for paddy, the target yields of paddy in the Existing Lower Moshi Project Area and New Extension Area are conservatively set at 6.5 t/ha in the rainy season and 7.0 t/ha in the dry season, similar yield levels to the present yields in Existing Lower Moshi Project Area. Those in the Expanded Area are estimated at 6.0 t/ha in the rainy season and 6.5 t/ha in the dry season considering the adverse effects of imperfect soil drainability of the areas. The target yield of alfalfa is set at 3.0 t/ha considering the yield level at NAFCO. On the basis of the anticipated crop yields, the anticipated crop productions at the full development stage are estimated as shown below.

Crop Production under Present Conditions and With-Project

(Unit: ton)

Crops	Present	With-Project	Increment
Paddy	7,700	46,700	+ 39,000
Maize	5,800		- 5,800
Alfalfa		2,800	+ 2,800
Total Food Crops	13,500	46,700	+ 33,200

Agricultural Supporting Services Strengthening Plan

40. The strengthening plan of agricultural supporting services including experimental programs, training and extension programs, seed multiplication programs and strengthening of agriculture machinery service(tractor hiring service) are formulated in order to meet the expansion of needs for such services with the progress of the project implementation. The main executing agency for these activities is proposed to be KADP.

(1) The implementation of the experimental programs will be carried out by placing priority in the variety selection of paddy, variety adaptability trial (paddy) and crop adaptability trial (alfalfa). The implementation of variety selection and adaptability trial of paddy are scheduled to be carried out concentrically in order to meet the urgent need for the introduction of new variety which will minimise the risk of the outbreak of pests and diseases.

(2) The proposed extension programs include demonstration activities, mass guidance to farmers and field extension activities (T&V system) by KADP extension staff.

(3) The proposed training programs include farmer training in class and field practical training in paddy fields of advanced farmers, and the primary target groups of the programs should better be beneficiary farmers having no paddy fields in current upland fields in the Existing Lower Moshi Project Area and New Extension Area. The farmer training in class are to be held periodically by selecting representative farmers in the target area.

(4) Until the selection of optimal varieties is completed through the experimental programs proposed, the multiplication of the presently used variety of IR54 is to be made for the immediate replacement of seed resources of the variety in the Project Area. When the trials of new varieties are successful and attract farmers interests, demonstration of the new varieties is to be carried out and seed multiplication is to be started.

(5) Tractor hiring services rendered by KADP has been one of the key supporting activities which have supported the remarkable achievement of paddy cultivation in the Existing Lower Moshi Project Area. The procurement and operation plan of tractors are formulated in accordance with the project implementation schedule.

41. The strengthening plan of agricultural credit is proposed as the future action plan on agricultural credit for GOT and CHAWAMPU. The proposed strengthening plan indicates that GOT should not leave agricultural credit to the care of commercial banks thoroughly, but should examine the necessity of establishing a new governmental credit institution on agriculture and/or some fastening measures on agricultural credit to commercial banks. For CHAWAMPU who has the intention to participate in agriculture credit activity, strengthening should be firstly made for its financial position and system including auditing system, and then the credit activity be made after the opening of a Group Saving Scheme.

Institutional Development Plan

42. The proposed plan shall take a stage-wise approach. The 1st stage is a preparatory period for handing over the responsibility on the management of the Project to farmers' organisation, and in the 2nd stage, the water management, O&M activities and tractor hiring services are to be handed over to farmers' organisations after full completion of the preparatory period.

43. KADP is required to take more progressive activities during the 1st stage particularly in respect of O&M of irrigation facilities, agricultural supporting activities and strengthening farmers' organisations. For this purpose, the existing KADP's organisation is to be strengthened in terms of its organisational structure and staffing. The handing over of KADP's responsibility is planned to be made after 5 years from the completion of the project implementation.

44. KADP is required to make, during the preparatory period, the best effort to strengthen farmers' organisations and to transfer the necessary technology to technicians concerned so that the operation and management of the Project can be made successfully by the farmers' organisations after the handing over. CHAWAMPU is also required to strengthen its financial, organisational and human structures so as to take over the operation and management of the Project from KADP.

Irrigation and Drainage

45. Under the basic principle of the application of gravity irrigation, the irrigation development plan for the Project is formulated by giving special focus on the following:

(1) Application of irrigation water requirement estimated based on the actual measurements, soil conditions, and irrigation methods.

(2) Design of irrigation and drainage canal systems, taking into consideration administrative boundaries for easy establishment of water users' associations.

(3) Design of irrigation canal systems so as to convey irrigation water from main canals to respective field plots through secondary canals, tertiary canals and watercourses in turn for easy water management.

(4) Design of simple irrigation and drainage facilities including measuring devices, considering easy operation, maintenance and water management by farmers.

46. Taking into consideration unit irrigation water requirements, the results of a water balance study, water supply methods, and simplification of designs, the design discharges for respective irrigation canals are proposed as follows:

(1) Diversion channel : 9 m^3/s
(2) Main canal : 2.3 l/s/ha
(3) Secondary canal : 2.4 l/s/ha
(4) Tertiary canal : 60 l/s/25ha

47. In the drainage plan, the application of gravity drainage is planned and the design discharges of drains are determined by the following equations:

(1) Paddy field 5 l/s/ha
(2) Upland field estimated applying the following equation
$Q = 20.7 \times S^{1/5} \times A^{4/5}$

where, Q: flood discharge (l/s)
S: fall of main drain between the farthest point and the connection point
A: drainage area (ha)

48. The irrigation and drainage facilities required in the Project are designed by using 1/5,000 topographic maps. The main, secondary and tertiary irrigation canals are planned to be lined with concrete, and all the drainage canals are unlined. The required irrigation and drainage works are summarised as follows:

List of Required Irrigation and Drainage Facilities

Items	Ex.Lower Moshi Area	New Extension Area	Expanded Area
Irrigation area	2,150 ha	2,090 ha	460 ha
Supply canal	-	-	7.8 km
Main canal	To be rehabilitated	9.6 km	1.2 km
Secondary canal	To be rehabilitated	26.6 km	10.3 km
Tertiary canal	To be rehabilitated	70.3 km	12.1 km
Main drain	To be rehabilitated	10.5 km	-
Secondary drain	To be rehabilitated	26.5 km	7.4 km
Tertiary drain	To be rehabilitated	60.5 km	13.4 km
Related structures	To be rehabilitated	584 nos.	164 nos.
On-farm works to be executed	1,050 ha	2,090 ha	460 ha

49. In order to protect paddy fields and irrigation and drainage facilities in the Expanded Area (Mandaka Mnono Area) from floods by the Rau river and some small streams from surrounding hills, the construction of flood protection dikes is planned. The proposed length and height of the dikes are as follows:

Proposed Length and Height of Dikes

Flood Protection Dike	Length (km)	Height (m)
Northern Flood Protection Dike	7.7	1.0
Southern Flood Protection Dike	8.4	0.3 - 2.3

50. All the irrigation canals are provided with the farm roads for O & M of project facilities and transportation of agricultural inputs and outputs. A farm road network will be newly established for the Expanded Area and the New Extension Area, and that for the Existing Lower Moshi Project Area will be rehabilitated. The newly established farm road networks in each of area are as follows:

Required Length of Farm Roads

Farm road	Ex.LM Project Area*	Expanded Area	New Extension Area
Main farm road	17.7 km	1.2 km	10.0 km
Secondary farm road	38.7 km	8.4 km	29.7 km
Tertiary farm road	55.6 km	18.0 km	82.3 km

**: Existing Lower Moshi Project Area. The required length of the existing farm roads to be improved.*

51. For the introduction of irrigated rice farming, the implementation of on-farm works are also planned. The required on-farm works are 3,600 ha in total, consisting of 1,050 ha for the Existing Lower Moshi Project Area, 460 ha for the Expanded Area and 2,090 ha for the New Extension Area.

Water Source Development

52. The basic approaches to establishment of the water source development plan are as follows:

(1) First priority shall be placed upon the maximum use of the existing water sources of the Njoro and Rau rivers.

(2) The water deficit after the maximum use of the existing water sources shall be supplemented through exploitation of new water sources.

(3) The application of gravity irrigation system is taken as a basic principle for the exploitation of new water sources to the Project Area.

53. The water balance study results indicate that in maximum the aerial extent of 5,010 ha in the rainy season and that of 3,507 ha in the dry season would be irrigated. However, under such conditions, the required peak diversion requirements with 80 % dependability at the Kikuletwa river will reach 9.7 m^3/s in the rainy season and 5.5 m3/s in the dry season. Taking into consideration the provisional water right of 9 m^3/s in the rainy season and 5 m^3/s in the dry season which has been under request, the water balance study was executed again to meet the conditions of the said provisional water right and finally the irrigation areas by water sources are planned as shown below:

Irrigation Area by Water Source

(Unit : ha)

Area	River	Abstraction point	Rainy season	Dry season
Expanded Area	Rau	Mandaka Mnono	360	252
	Njoro	Kaloleni	100	70
Existing Lower Moshi Area	Njoro	Mabogini Intake Weir	257	180
	Rau	Rau Ya Kati Intake Weir	160	294
	Kikuletwa	Proposed headworks	1,733	1,031
Extension Area	Kikuletwa	Proposed headworks	2,090	1,463
Total			4,700	3,290

54. According to the measurement results for paddy at the pilot farm of KADP, the ratio of ET to (ET + P) is estimated at about 60% on an average, and the overall irrigation efficiency is set at 69% for paddy fields. With these figures, the actual water consumption by paddy is calculated to be about 40% of the supplied water, and the remaining 60% will be supplied to groundwater and finally to the Nyumba Ya Mungu dam located downstream. A water balance study in aquifer for the period of one year was conducted, setting model of a vertical soil column of unit area cross section. As the result, the required time to the Nyumba Ya Mung dam is estimated at some 40 days at the maximum.

55. The effect to the Nyumba Ya Mungu reservoir by water abstraction from the Kikuletwa river was examined, taking into consideration inflow of the Kikuletwa and Ruvu rivers to the reservoir, outflow from the reservoir, evaporation, return flow, etc. The result shows that a continuous outflow of 26 m^3/s, which is far larger than the guaranteed outflow of 14 m^3/s indicated by the Pangani River Basin Authority, could be maintained throughout a year. It was estimated that, "without abstraction", the outflow will be around 28 m^3/s. This means that the annual mean inflow to the reservoir will be decreased only by 2 m^3/s with the water abstraction for the Project.

56. The feasibility level design has been carried out for the water sources facilities to abstract and convey a peak water amount of 9 m^3/s to the irrigation area of 4,700 ha. The designed facilities are as follows:

(1) Headworks : Concrete gravity type, 28 m high and 72 m long
(2) Intake gate : 2 nos. of gates (2.3m wide x 3.0 m high each)
(3) Diversion channel : 24.5 km long
(4) Related structures : 93 nos.
(5) Inspection road : 20 km

Rural Infrastructure

57. The basic approaches for the rural road development are as follows;

(1) Maximum use of existing facilities.
(2) Appropriate scale, considering future needs.
(3) Application of planning criteria used for the Existing Lower Moshi Project Area.
(4) Simple structures for easy operation and maintenance.
(5) Coincidence with development plans formulated at village, district, regional and central levels if any.

(6) Reflection of opinions, suggestions and wishes of villagers.

58. The planned roads for rehabilitation and improvement are 9.7 km in total, consisting of 3.8 km for the Expanded Area, 1.0 km for the New Extension Area and 4.9 km for the Diversion Channel route area.

The water facility for domestic use and livestock trough are designed considering location of villages , the number of draft animals, etc. The required number of them are as follows:

Domestic Water Supply Facilities

(Unit: Places)

Location	Water facility for domestic use	livestock trough
Diversion Channel Route Area	10	5
Existing Lower Moshi Project Area	24	4
New Extension Area a	25	6
Expanded Area	8	5
	67	20

V. PROJECT IMPLEMENTATION, O & M AND WATER MANAGEMENT PLAN

Project Implementation Plan

59. The Project works will be implemented by dividing them into two(2) phases. The work items in each phase are as follows:

(1) Phase-I works:

- Headworks and diversion channel
- Diversion channel and related Structures
- Rehabilitation and enhancement works for the Existing Lower Moshi Project Area
- Development of rural infrastructures in the Existing Lower Moshi Project Area

(2) Phase-II works

- Development of irrigation and drainage system and rural infrastructures for the Expanded Area
- Development of irrigation and drainage system and rural infrastructures for the New Extension Area

The construction works of Phase-I will be commenced from 1999 and completed in 2 years in 2001. Phase-II works will be started from July 2001 and completed by June 2003, taking a period of 3 years.

60. The operation and management of the Project is planned to be undertaken by the existing KADP and CHAWAMPU in early stage of the Project operation and finally handed over to water users' associations (WUAs) to be established. Until completion of the handing-over, KADP is required to take a leading role in both O&M works and agriculture supporting services for the Project.

61. The Irrigation Department of MAC will be an executing agency for the Project implementation, under which a Project Construction Office is to be established. A Project Construction Committee will be established as the highest execution body of the project implementation. The Project Construction Office will consist of Administration

Section, Accounting Section, Supervision Section (1) and (2), Survey and Design Section, and Farmers' Participation Section. The Farmers' Participation Section will provide farmers with technical guidance for sod facing, construction of small drains, land levelling, etc. in order to encourage farmers' participation to the Project.

O & M and Water Management

62. The required number of KADP staff under the Project is estimated at 137 at peak, of which 72 are tractor operators and the remaining are agricultural and water management technical staff. Most of the tractor operators will be newly recruited and trained through on-the-job training in the Existing Lower Moshi Project Area. While, number of agricultural and water management technical staff to be newly recruited will be around 5, which could be transferred from relevant governmental institutions. Intensive guidance to and training of these newly recruited staff will be an essential issue for the efficient and successful operation of the Project. Accordingly, the introduction of technical cooperation of donor countries is proposed in this respect. The period for the staff training will be at least 3 years from 1999 to 2001.

63. At present, O&M works and water management in the Existing Lower Moshi Project Area are carried out jointly by KADP and CHAWAMPU. Under the Project, these works are planned to be handed over to Water Users' Associations to be established in accordance with the following program:

(1) 1st Stage (for 10 years from the commencement of project)

O&M will be carried out by KADP and CHAWAMPU. The handing-over of O&M works will be started in the 6th year and completed by the 10th year. GOT is required to take necessary actions by the 5th year so that WUAs/WUF can be established legally.

(2) 2nd Stage (from 11th year after the commencement of project)

O&M works of the project facilities except for headworks and diversion channel will be carried out by WUAs/WUF. O&M of the headworks and diversion channel will remain to be under KADP.

64. Water supply for paddy is planned by combining the continuous supply and rotational supply systems in the Project. Water is continuously supplied down to tertiary canals. In the tertiary block, a rotational water supply is made. The results of field investigation by KADC indicate that the percolation rate increases when the flooding depth is deeper than 60 mm. From this result, the basic application of irrigation water is proposed to be 60 mm in depth. The maximum allowable water depth is set at 80 mm so as to utilise rainfall effectively. Since the daily water consumption of paddy is 15 mm/day, an irrigation interval for paddy comes to 5 days at peak time. While, an irrigation interval of 7 days at peak time for alfalfa is proposed .

65. In parallel with proper operation, suitable and continuous maintenance of project facilities is indispensable. The maintenance works of project facilities to be implemented by the relevant organisations consist of: 1) regular maintenance works which are performed regularly to maintain and improve the project facilities, 2) emergency repair works which are concluded to repair the occasional damages of the project facilities caused by flood, heavy rainfall or other causes, and 3) annual maintenance which involves a large work quantity or requires special skill.

66. An internal network will support the management and operation of the commissioned canal system. For this purpose, an internal radio- communication network will be installed connecting the O&M office with control house of the proposed headworks and farmers' organisation. For the regular maintenance, periodic maintenance and annual maintenance, however, a certain number of construction equipment will be required and kept at the O&M office. In addition to these construction equipment, vehicles and motor cycles will be required for the staff movement for the operation and maintenance purposes.

VI. PROJECT COST ESTIMATE

67. The total project cost of the project are estimated at US$ 53.6 million. The direct costs of the Phase I Works are estimated at US$ 19.0 million and that of the Phase II Works are at US$ 15.6 million as shown in the table below.

Summary of Project Cost

Work Description	Foreign Currency (US$1,000)	Local Currency (Tsh.million)	Total (US$1,000)
(1) Phase-I Works			
- Headworks	2,597	429	3,289
- Diversion Channel	8,454	1,485	10,850
- Existing Lower Moshi Area	3,434	892	4,874
Sub-total of (1)	14,485	2,806	19,013
(2) Phase-II Works			
- Extension and Expanded Area	11,388	2,616	15,606
Sub-total of (2)	11,388	2,616	15,606
(3) O&M Equipment	1,000	-	1,000
(4) Administration Expenses	-	521	841
(5) Engineering Services	3,629	562	4,536
Sub-total of (1) to (5)	30,502	6,505	40,996
(6) Physical Contingency	3,050	651	4,100
(7) Price Contingency	2,506	3,736	8,533
Total	36,058	10,892	53,629

VII. PROJECT EVALUATION

68. The economic viability of the Project has been evaluated by the economic internal rate of return (EIRR) on the following 3 cases.

Estimated EIRR

Case	Description	EIRR (%)
Case 1:	Whole Project Are (4,700 ha)	13.4
Case 2:	Existing Lower Moshi Project Area (2,150 ha)	17.2
Case 3:	New Extension Area and Expanded Area(2,550 ha)	11.2

From the results of the evaluation, the Project is evaluated economically viable in all the 3 cases. Especially, the economic viability of the Existing Lower Moshi Project Area is high with EIRR of 17.2 %.

69. The financial sustainability of the Project was assessed using a cash flow statement analysis which presents the financial soundness of the Project by comparing all revenues collected from the beneficial farmers with the fund requirement for the project operation. The cash flow statement analysis was prepared from the viewpoint of CHAWAMPU.

Revenue sources for the project operation are:1) annual water charge of Tsh.46,500/ha (US$ 75) in the 1st stage and Tsh.40,300/ha (US$ 65), and 2) tractor hiring services fees of Tsh.50,000/ha for paddy cultivation and Tsh.12,500/ha for alfalfa cultivation. The results of the analysis indicated that the anticipated revenues collected from the beneficial farmers would be able to provide sufficient funds for O&M cost and replacement cost of O&M equipment and tractors for the Project, and thus the financial sustainability of the Project for CHAWAMPU.

70. For examining the payment capacity defined as the ability of the project beneficiary farmers to bear the expenses required for operation and maintenance of the project facilities as well as for replacement cost of O&M equipment cost, financial analysis is made for three farm size cases of 0.5 ha, 1.5 ha and 3.0 ha. The estimated per farm household annual income ranges from US$ 1,652 to US$ 1,796 for the marginal scale farmers(0.5 ha), from US$ 3,499 to US$ 3,590 for the small scale farmers(1.5 ha), and from US$ 6,025 to US$ 6,397 for the medium scale farmers(3.0 ha). Deducting the household expenditures, the forecast capacity to pay is obtained at US$ 246 to 316 for marginal scale farmers, US$ 1,852 to 2,022 for small scale farmers and more than US$ 3,938 for medium scale farmers. The estimated water charge to be born by beneficiaries ranges from 4 % to 15% of the capacity to pay (net reserve). This indicates that even the marginal scale farmers will have a substantial amount of reserve to pay the water charge including O & M cost, and that the Project is judged sufficiently viable from the financial aspects of beneficiary farmers.

71. There are various intangible benefits expected from the implementation of the Project. Major impacts expected after the implementation of the Project are described here.

(1) Technical Impacts
- Impacts of improvement of farm and access roads
- Impacts of improvement of domestic water supply for villagers and animals
- Impacts to other irrigation schemes

(2) Socio-economic Impacts
- Improvement of living conditions
- Increasing of employment opportunity
- Contribution to the national food security
- Foreign exchange savings
- Improvement of social status of women

VIII. ENVIRONMENTAL CONSERVATION PLAN

72. The results of EIA indicate that there would be no serious negative impacts of the project implementation on the environments in and around the Project Area. However, to the possible negative environmental impacts such as: 1) involuntary settlement, 2) population increase, 3) outbreak and prevalence of diseases, 4) increase of solid wastes, and 5) proliferation of hazardous species, the preventive/mitigative measures are duly considered in the project formulation. The preventive/mitigative measures incorporated in the project are: 1) alignment of irrigation canals to avoid negative impacts, 2) development of rural infrastructures, 3) design velocities above 0.65 m/s to prevent proliferation of bilharzia snails, 4) use of solid wastes as fuel resources, 5) provision of barriers to prevent crocodile from reaching villages along irrigation canals.

73. Environmental monitoring is proposed to provide constant feedback on the effectiveness of the mitigation measures instituted, to identify and define any problems encountered, and to provide the opportunity to adjust the approach to mitigation in a timely fashion. This will lead to an enhanced understanding of the impact of the Project on the environment and allow more effective planning and implementation of future projects.

IX. WOMEN IN DEVELOPMENT

74. Women play an important role in society in bringing up development. When the participation of women in crop production, marketing of farm products, post-harvest operations, transportation and varied social services is realised through the implementation of the Project, the substantial activation and enhancement of the said fields are anticipated. For the promotion of women's participation in development in the Project, the employment of the following approaches are proposed.

(1) Bestowing membership of WUAs/WUF to women and nomination of female members for board members to support women's participation in social and economic activities.

(2) Promotion of livestock farming by woman groups and production of value added farm products through activities such as quality control, cooperative marketing and processing of farm products to support financial independence of women.

Under the guidance of DALDO, WUAs/WUF and CHAWAMPU will be the organisations playing an important role in the promotion of the above activities.

X. SMALL SCALE HYDROPOWER DEVELOPMENT PLAN

75. After determination of the headworks site and route of diversion channel from technical and economical viewpoints, there found to exist about 45 m of extra water head on the diversion channel. In order to harness this extra water head effectively, it is proposed to provide two small-scale hydropower stations. In the development plan, flow discharge of the diversion channel is assumed to be 9 m^3/s throughout a year, but 4 m^3/s is released back to the Kikafu river in the dry season.

76. The general features of the proposed hydro-power development plan are as follows:

General Features of Hydro-power Development Plan

Description	No.1 Power Station	No.2 Power Station
(1) Hydraulic condition		
(a) Firm discharge(m^3/s)	9.0	9.0
(b) Effective head(m)	11.3	34.0
(2) Penstock		
(a) Diameter(mm)	1,800	1,800
(b) Length	10.0	65.0
(3) Firm output(kW)	790	2,390
(4) Transmission line (km)	8	3

The direct construction costs are estimated at US$ 2.8 million and US$ 4.6 million for No.1 and No.2 power stations, respectively. It is proposed to implement No.1 station in Phase-II and No.2 station in Phase-I.

XI. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

77. Through the feasibility study, the Project is proved to be economically viable and technically feasible from the viewpoints of national economy, engineering, institution, and environment. The Project will be conducive to increase of food production and elevation of living standard by providing agriculture and rural infrastructures, which will lead to contribution to achievement of national self-sufficiency in food as well as stabilisation and development of regional economy in Kilimanjaro. In addition, the Project will bear the social impacts such as 1) increase of employment opportunity, 2) activation of regional economy, 3) improvement of sanitary condition, and 4) saving of foreign exchange.

78. The results of hearing survey and public meetings related that the Project was fully acceptable to relevant farmers, and its early implementation was supported by them. The farmers presented an active attitude toward participation in the Project implementation through execution of such minor works as sod facing, excavation of small drains and fine land levelling of paddy fields.

79. The Project will also enable power generation of 3.2 MW by harnessing the extra water head of the proposed diversion channel. The economic analysis shows that the Project with hydropower plan will be more economically viable, presenting EIRR of 15.5 % or 2.1 % higher than that without hydropower plan.

Recommendations

80. For the early implementation as well as ensuring the sustainability of the Project, the following as well as the urgent grant of a provisional water right for the Project, are recommended:

(1) Urgent Selection of optimal rice varieties

The farming practices for irrigated paddy (IR 54 variety) recommended by KADP have been successfully practised with an average yield of over 6 t/ha. However, the introduction of other varieties in rotation should be encouraged urgently in order to minimise the risk of huge crop losses due to the outbreak of certain pest or diseases induced by the continuous cultivation of a single variety. It is therefore recommended to urgently implement the experimental programs proposed.

(2) Enactment for water users association

CHAWAMPU, which was established under the Cooperative Society Act, has been functioning as an executing agency of O&M for the existing Lower Moshi area. However, it seems difficult for CHAWAMPU to play the same role for the Project from legal viewpoints. Accordingly, it is recommended that GOT should enact necessary laws relating to water users' associations as early as possible, enabling WUAs to be established legally and to have a mandatory power on their membership and collection of water charges.

(3) Phase-wise development

Taking into account proper work scale suitable for construction, early accruement of project benefits as well as need of urgent solution in water conflict in the Existing Lower Moshi Area, the Project works are recommended to be implemented in the following two phases:

(a) Phase-I

- Kikuletwa headworks and diversion channel
- Rehabilitation and enhancement works for the Existing Lower Moshi Project Area

(b) Phase-II

- Construction works for the Expanded Area and the New Extension Area

(4) Farmers' participation works

It is important to induce the farmers' participation in the Project from the early stage so that the sense of local ownership and responsibility is created. In this Project, it is recommended that minor works such as sod facing for minor canals, construction of small drains and fine levelling of field plots be carried out by the beneficiary farmers themselves. In order to execute such works on a participatory basis, it is also recommended that a Farmers' Participation Section be established in the Project Construction Office to supervise the farmers' participation works.

(5) Monitoring for the environmental conservation

The EIA study revealed that the Project would be environmentally viable and no significant adverse impacts were identified. However, it is recommended that monitoring works should be regularly executed for the long-term environmental sustainability and conservation of the Project Area and its surrounding.

(6) Execution of the hydropower development plan

Implementation of the proposed hydropower development plan is expected to make the Project more viable economically and will also contribute much to the improvement of electricity supply conditions in the Kilimanjaro Region. Hence, it is recommended to construct these power stations as part of the Project. It is further recommended that No.2 Power Station be firstly implemented together with Phase-I works of the Project.

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Attachments

Abbreviations

Organisations

AFDB	African Development Bank
AITF	Agricultural Inputs Trust Fund
ARTI	Agricultural Research and Training Institute
BOT	Bank of Tanzania
CHAWAMPU	Paddy Farmers' Association
CISP	Center for Informal Sector Promotion
CRDB	Cooperative and Rural Development Bank
DALDO	District Agricultural and Livestock Development Officer
DEO	District Extension Officer
DIVEO	Division Extension Officer
EMP	Environmental Monotoring Program
ERP	Economical Recovery Programme
ESAP	Economic and Social Action Plan
FAO	Food and Agriculture Organisation of United Nations
GOJ	Government of Japan
GOT	Government of Tanzania
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
JICA	Japan International Cooperation Agency
KACD	Kilimanjaro Association for Community Development
KADC	Kilimanjaro Agricultural Development Centre
KADP	Kilimanjaro Agricultural Development Project
KATC	Kilimanjaro Agricultural Training Centre
KIWODEA	Kilimanjaro Women Development Association
KNCU	Kilimanjaro Native co-operative Union
KPHC	Kilimanjaro Paddy Hulling Company
KRPFB	Kilimanjaro Region Rolling Plan and Forward Budget
MAC	Ministry of Agriculture and Cooperatives
MATI	Ministry of Agricultural Training Institute
MCD	Ministry of Community Development
MNR	Ministry of Natural Resources
MOW	Ministry of Water
NAEP	National Agricultural Extension Programme
NAFCO	National Agriculture and Food Corporation
NALERP	National Agricultural and Livestock Extension Rehabilitation Project
NBC	National Bank of Commerce
NESP	National Economic Survival Programme
NGO	Non-Governmental Organisation
NMC	National Milling Company
OECF	Overseas Economic Cooperation Fund
RALDO	Regional Agricultural and Livestock Development Officer
RAS	Regional Administrative Secretary
REO	Regional Extension Officer

RPFB	Rolling Plan and Forward Budget
SAP	Structural Adjustment Programme
SKUVI	Sujaa wa Kupiga Umaskini Vita (Poverty Alleviation Association)
SMS	Subject Matter Specialists
TANESCO	Tanzania National Electric Supply Company
TCB	Tanzania Coffee Board
TDFL	Tanganyika Development Finance Company
TFA	Tanzania Farmers' Association
TFC	Tanzanian Fertiliser Company
TIB	Tanzania Investment Bank
TMAK	Tella Mandaka Agricultural Cooperative
TPC	Tanganyika Planting Company
UNDP	United Nations Development Program
UNESCO	United Nations Education Science and Culture Organization
VCV	Vuasu Cooperative Union
VEO	Village Extension Officer
WUA	Water Users' Association
WUC	Water Users' Committee
WUF	Water Users' Federation
WUG	Water Users' Group
ZIE	Zonal Irrigation Engineer
ZIO	Zonal Irrigation Office

Others

AWC	Available Water Capacity
CEC	Cation Exchange Capacity
EC	Electric Conductivity
ECe	Electric Conductivity of Saturation Extract
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EL	Elevation
ESP	Exchangeable Sodium Percentage
GDP	Gross Domestic Products
ha	Hectare
IEE	Initial Environmental Examination
SAR	Sodium Absorption Ratio
SPT	Standard Penetration Test
TOR	Terms of Reference
UTM	Universal Transverse Melkatol
WL	Water Level

Measurement Units

Length

mm = millimetre
cm = centimetre
m = meter
km = kilometre

Volume

lit. = litter
cm^3 = cubic centimetre
m^3 = cubic meter
= 1,000 lit.
MCM = million m^3
= 1×10^6 m^3

Area

cm^2 = square centimetre
m^2 = square meter
km^2 = square kilometre
ha = hectare (10,000 m^2)

Weight

g = gram
kg = kilogram
t (ton) = metric ton = 1,000 kg

Electric Measures

kW = kilowatt = 1,000 watt
MW = megawatt = 1,000 kW
GW = gigawatt = 1,000 MW
kV = kilovolt = 1,000 Volt

Time

sec = second
min = minute = 60 second
hr = hour = 60 minutes
= 3,600 seconds
yr = year

Other Measures

% = percent
° = degree
' = minute
" = second
℃ = degree in Celsius
PS = Horse Power (or Hp)

Derived Measures

m^3/sec = cubic meter per second

Currency

US$ = United State Dollars
US$ 1.0 =¥125 = Tsh.620
¥ = Japanese Yen
Tsh. = Tanzania Shillings

CHAPTER 1 INTRODUCTION

1.1 Authority

This Final Report on the Feasibility Study (the Study) on the Lower Moshi Integrated Agriculture and Rural Development Project (the Project) has been prepared in accordance with the Scope of Work (S/W) agreed upon between the Ministry of Agriculture and Cooperatives (MAC), the United Republic of Tanzania and the Japan International Cooperation Agency (JICA) on October 31, 1996 (Attachment - 1). The Report presents the results of all works performed in both Tanzania and Japan during Phase-I and Phase-II studies.

1.2 Background of the Project

Agriculture constitutes a main sector in Tanzanian economy, accounting for over 50 % of Gross Domestic Product (GDP) and approximately 75% of the export earnings. About 84% of its working population is engaged in the agriculture sector. In the Fourth Rolling Plan and Forward Budget (RPFB) 1996/97 - 1998/99, the Government of Tanzania (GOT) thus puts an emphasis on strengthening the agriculture sector through the provision of supporting services such as training, research and extension, as well as the creation of a favourable environment for participation and development by the private sector.

Of a total of about 5.9 million ha of agricultural land, the irrigated area is about 160,000 ha over the whole country, equivalent to only 4 % of the total agricultural area. It means that agriculture in Tanzania still largely depends on traditional rainfed agriculture. Although maize is the main staple food, which has reached the self-sufficiency level at the end of 1980, the population increase in urban areas and the change in consumers' taste have brought about an extreme increase in rice demand, leading to the recent significant concern on how to attain self-sufficiency in rice. Ninety six % of rice production in Tanzania is by smallholders, of which 90% depend on unstable rainfed cultivation subject to the influence of drought. Rice production is not sufficient to meet the demand every year so that rice import has remarkably increased from 60,000 tons in 1991 to 90,000 tons in 1993, costing US$ 1,800 million, i.e. equivalent to 17% of the total national import value.

In the Third Five-Year Development Plan from 1975 to 1980, GOT decided to lay stress on rural development, and requested the Government of Japan (GOJ) and other donor countries to cooperate in rural development in the respective major regions. In reply to this request, GOJ carried out the Master Plan Study on Kilimanjaro Region Development in 1977. In succession, GOJ implemented the Kilimanjaro Agriculture Development Centre Project (KADC) from September 1978 to March 1986, aiming at water resource development for irrigation, on-site verification of proposed crops at an experimental farm, farmers' training, and extension services. With the favourable results of on-site verification of rice as a staple food at KADC, a feasibility study on the Lower Moshi Agriculture Development Project was carried out in 1980, then its implementation started in 1982 under financial assistance of GOJ (¥ 3.3 billion) and was completed in 1987. GOJ further provided GOT with technical cooperation under the Kilimanjaro Agriculture Development Project (KADP) implemented from 1986 to 1993, to establish and extend farming practice and water management in the Lower Moshi Area.

Under these continuous cooperation programs extended by GOJ, agriculture production has been remarkably increased, as the farming practice centring on irrigated paddy cultivation has been extended in the KADP area (the Existing Lower Moshi Project Area). The average yield of paddy per ha from 1985 to 1992 attained 6.7 tons, largely contributing to increase of local farmers' income. The farmers living upstream of the project area became aware of this successful effect of KADP, and have reclaimed the upstream areas by themselves. These reclaimed areas are cultivated with the same variety of paddy and farming practice as those applied at the Existing Lower Moshi Project Area, and use irrigation water arbitrarily tapped upstream of the intake weirs constructed on the Rau and Njoro rivers which are the primary water sources of the Existing Lower Moshi Project Area. This arbitrary water tapping is the direct reason for shortage of irrigation water and also constitutes a critical factor in constant water shortage in the Existing Lower Moshi Project Area. The cropped area in the Existing Lower Moshi Project Area had reached 1,508 ha in 1990, but gradually declined year by year, and has fallen to 647 ha only in 1994 which is about half of that at the peak time of 1990.

Against this background, GOT requested GOJ on October 11, 1995 to conduct a feasibility study on the Lower Moshi Integrated Agriculture and Rural Development Project with a potential area of about 6,000 ha consisting of the Existing Lower Moshi Project Area and its surrounding areas, as final targets for effective promotion and extension of irrigation technique and raising of living standards of farmers. JICA responded to this request by dispatching the Preparatory Study Team in October 1996 to confirm the request, and concluded the S/W for the Study as per attached.

1.3 Objectives of the Study

The objectives of the Study are (1) to carry out a feasibility study for formulation of the optimum integrated agriculture and rural development plan for a potential area of about 6,000 ha including the Existing Lower Moshi Project Area located in the southeastern part of Lower Moshi in the Kilimanjaro region, in order to effectively accelerate the extension of irrigation technique developed in the Existing Lower Moshi Project Area and the raising of living standards of farmers; and (2) to carry out technology transfer to the Tanzanian counterpart personnel in the course of the Study.

1.4 Performance of the Study

1.4.1 The Study in Phase-I

In accordance with the S/W, the JICA Study Team submitted the Inception Report to MAC on April 2, 1997. The Report presents mainly the Approach to the Project and the Plan of Operation of the Study. The contents of the Report were principally agreed by MAC in the meetings held on April 1,2 and 3, 1997 in Dar es Salaam (Attachment - 2). In succession, the 1st Technical Steering Committee Meeting was held at the KADP office on April 11, 1997. The results of discussions are given in the Minutes of Meeting attached hereto (Attachment - 3).

According to the Plan of Operation, the field work in Phase-I was executed from April 1997 to July 1997. In this period, field investigations were carried out for grasping the envisaged problems and constraints for the agriculture and rural development in the Study Area,

through the meteo-hydrological survey, inventory survey on the existing irrigation and drainage systems, soil survey, land use survey, socio-economic survey, etc. In particular, a field investigation was carefully conducted for the soft aspects such as operation conditions of agricultural supporting services and the farmers' organisation, say CHAWAMPU. In parallel to the field investigations, geological boring, soil survey, water quality analysis, farm interview survey, and aerial photograph and ground survey were completed on a local contract basis.

The subsequent office works in Tanzania were done concentrating on the main activities of preliminary study of water source development and formulation of a preliminary basic development plan based on the results of analysis of the data collected and findings obtained from the field investigations. The water quality analysis indicated that the water of the Kikuletwa river which is planned to be exploited as an additional water source, is classified into the category of "no restriction" for irrigation water use according to the FAO Guidelines. These results of field investigation and office works in Tanzania were compiled in the Progress Report-I which was then submitted to MAC. Using the Report, the 2nd Technical Steering Committee Meeting and the Progress Meeting were held on July 4, 1997 in Moshi and on July 7, 1997 in Dar es Salaam, respectively. The Minutes of these Meetings are given in Attachment - 4 and Attachment -5.

The Phase-I study in Japan, during 2 months from the beginning of September to the end of October 1997, were carried out mainly to analyse data, information and findings obtained from field investigations in Tanzania, in order to examine various constraints and problems identified and also to study the formulation of the basic development plan of the Project which will contribute to the achievement of key objectives shown in the Fourth Rolling Plan and Forward Budget (1996/97-1998/99). All the results of Phase-I study works were compiled in the Interim Report.

The Photogrammetric mapping of 1/5,000, was also made from the aerial photographs

1.4.2 The Study in Phase-II

The Interim Report was submitted to MAC on November 7, 1997. Based on the Report, the No.3 Technical Steering Committee Meeting and the Interim Meeting were held on November 14, 1997 and November 17, 1997, respectively. In both Meetings, the contents of the Report were agreed by MAC and the Technical Steering Committee members (Attachment - 6 and Attachment - 7).

The field works in Phase-II were conducted by January 1998 after the Interim Meeting. In the field works, additional data collection was executed for respective fields using the 1/5,000 topographic maps prepared. Concurrently, water quality analysis, soil survey, soil mechanics/concrete aggregate test, and environmental impact assessment were carried out on a contract basis. The results of water quality analysis showed again that the Kikuletwa river water for irrigation and domestic use has no substantial problem. The soil survey results which pointed out the extent of salt accumulated area in the Study Area, were used for delineation of the Project area. Based on the results of scoping of the initial environmental examination (IEE), the environmental impact assessment (EIA) was executed by the University College of Lands and Architectural Studies (UCLAS) under supervision and

instruction of the JICA Study Team, aiming at detailed study of the selected environmental items during IEE, and formulation of a conservation plan consisting of possible countermeasures and a monitoring plan.

In this period, public meetings were held in the respective villages, to know the farmers' intentions and requests to the Project. In addition, one meeting was conducted specially for women only in obedience to MAC's suggestion in the Interim Meeting. Many suggestions and requests obtained were useful for formulation of the development plan.

A detailed study of the route of the diversion channel was conducted using the 1/5,000 topographic maps and the results of topographic survey. The study showed that energy heads of 11 m and 34 m occurred at 5.4 km and 11.2 km points respectively on the diversion channel from the headworks. A preliminary study of small-scaled hydropower development effectively harnessing these heads was also made. The results of these additional field investigation and studies were incorporated into the project development plan, and compiled in the Progress Report-II. The 4th Technical Steering Committee Meeting and the Progress Meeting were held on January 9, 1998 in Moshi and on January 13, 1998 in Dar es Salaam, respectively to discuss the Report. The Minutes of these Meetings are given in Attachment - 8 and Attachment - 9.

In the Phase-II study in Japan, the development plan of the integrated agriculture and rural development project was formulated based on the study results in Phase-I and also the analysis results of further collected data and information in the Phase-II field work. In particular, the agriculture development plan was worked out aiming at introduction of profitable irrigated paddy cultivation in consideration of the lessons learnt from the existing Lower Moshi Project. The development plans of water source, irrigation, drainage and related facilities were elaborated correspondent to this agricultural development plan. The rural infrastructure development plan was prepared for elevating the living standard of inhabitants in the Project Area. The Project also includes the strengthening plan on O&M, extension services, agricultural supporting services and institutions, to realise the Project sustainability. The project costs and benefits were estimated based on these development plans, and then the project evaluation was conducted. The conclusions and recommendations as well as the these study results were compiled in the Draft Final Report. The 5th Technical Steering Committee Meeting and the Draft Final Report Meeting were held on April 23, 1998 in Moshi and on April 28, 1998 in Dar es Salaam, respectively to discuss the Draft Final Report. As a result, the contents of the Draft Final Report were in principle agreed at the both meetings. The Minutes of these Meetings are given in Attachment - 10 and Attachment - 11. The comments raised in these Meetings and also further comment given by MAC, were examined and incorporated into the Final Report.

1.5 Study Team Members and Counterpart Personnel

The members of the Study Team and their counterpart personnel engaged in the field works in Phase-I and -II are listed in the next page :

List of Study Team Members and Counterpart Personnel

Position	JICA Study Team	Counterpart Personnel
Team Leader	Yusaku TOYA	G. R. Moshi
Irrigation and Drainage Engineering	Hitoshi SHIMAZAKI	D. R. Kimicho
Rural Sociology / Farmer's Organisation	Takayoshi YAMAZAKI	E. G. Malya
Water Resources / Hydrology	Takuya IGAWA	H. R. Jengo/Vincent M.H.Maro
Agriculture / Land Use	Takashi SHIRAKI	Bakari Mrisha
Water Management / O & M	Shigeo ANDO	G.Ngodoki/S.E.Matemu
Geology / Soil Mechanics	Hirohisa ISOGAI	Mtoi Kanyawanari
Rural Infrastructure	Noriyasu SHIMIZU	G. M. Nderingo
Environment	Hiroshi HASEGAWA	Adolph Matungwa
Structural Design / Cost Estimate	Saku MORIYAMA	M. E. Kessi
Agro-economy / Project Evaluation	Badri Nath ADHIKARY	U. A. M. Lyatuu/P.T.L. Ngowi
Aero-photo/Ground-Control Survey Supervision	Daikichi NAKAJIMA	Jacob Z. Moshi
Topographic Survey Supervision	Atsushi MOCHIDUKI	J.E.Ringo

1.6 Acknowledgement

During the field works in Tanzania, the JICA Study Team has received generous assistance and cooperation from the counterpart personnel dispatched from MAC, MOW, MNR, MCD, ZIO and KADP, and also kind cooperation extended by KATC and other government agencies concerned in Tanzania as well as at the project sites. Without such assistance and cooperation, the Study could not be completed successfully . The JICA Study Team would like to express many thanks to all those agencies and people concerned.

CHAPTER 2 GENERAL BACKGROUND

2.1 National Economic Situation

2.1.1 Land and Population

Tanzania is a large country having a mainland area of approximately 950,000 km^2 of which about 62,000 km^2 are occupied by inland lakes. Arable lands cover some 40 million ha of which about 6 million ha have been cultivated. However much of these lands lie in regions with limited seasonal rainfall. Cereals are the most important crops. About 58% of the total area is cultivated with cereals followed by root crops (16%), pulses (11%) ,cotton (9%) , coffee (5%), and sisal (1%). Of the total area of cereal crops, about 58% is cultivated with maize, followed by sorghum (22%), paddy (11%), millet (7%), and wheat (2%).

According to the population census of 1988, Tanzania has a population of 23.2 million. During the period from 1978 to 1988, the net population increase was about 5.7 million and the annual growth rate was 2.8%. On the other hand, the annual growth rate in the Kilimanjaro Region during the same period, was estimated at 2.2%. The population of Tanzania in 1994 was estimated at 27.5 million, and the annual growth rate was 3.2% from 1988 to 1994 according to the Central Bureau of Statistics. The total labour force was estimated at 15.6 million, of which, some 11 million were employed while the remainder were economically inactive or unemployed. Agriculture is the main source of income and employment. The majority of the economically active population (84%) depend on agriculture which is mainly traditional, rainfed, and subsistence-oriented. Other sources of employment are trade and service which absorb 6.3% and 4.2% of the economically active labour force, respectively . In Tanzania the development of the agriculture sector is important for overall economic growth and for the maintenance of macro-economic stability.

2.1.2 GDP and Per Capita Income

Tanzania is a predominantly agricultural country. In 1995 the agricultural sector contributed more than 50% to total GDP. The important non-agricultural sectors include wholesale and retail trade, restaurant (13.6%), public administration and other services (9.7%), finance, insurance and real estate (6.5%), etc. The average GDP growth rate was recorded at 1.1% per annum at 1976 constant prices between 1980 and 1985, 3.9% between 1985 and 1990, and 4.1% between 1990 and 1994 . From these growth rates, encouraging signs of economic recovery due to implementation of the Economic Reform Programme mentioned later were recognised. However, per capita income was stagnant or in declining trend due to a high population growth rate of 2.8% between 1978 and 1988 and about 3.2% between 1988 and 1994. At 1976 constant prices, per capita GDP was about US$ 154 in 1980 and decreased to US$ 149 in 1994 .

2.1.3 Trend of Food Crops Production and Imports

The main cereal crops produced are maize, sorghum, paddy, millet, and wheat as described above. Both cropped area and production of maize, sorghum and paddy have been

generally increased during 10 years from 1985/86 to 1993/94. However, there was a large fluctuation in their production year by year, as a result of erratic weather condition. This tendency has been remarkable in paddy production. The details are given in Table 2.1.

Tanzania imported a substantial quantity of rice, maize and wheat between 1990 and 1994 as shown in Table 2.2. Maize imports in 1994 were donations, while rice and wheat imports were commercial ones. It is said that there exists extensive border trade of food crops and a large portion of all traded food crops does not pass through the official channels.

According to the Annual Report of FAO on Tanzania (July 1996 to June 1997), the overall food requirement for 1997/98 is estimated at 7.1 million tons (4.4 million tons of grain and 2.7 million tons of non-grain foodstuffs). And production estimates indicate a national deficit of 0.6 million tons, which have to be covered by food imports.

2.2 National Development Plans

2.2.1 National Three-Year Plans and National Five-Year Plans

Tanzania has had the following National Three-Year and National Five-Year Plans since the country's independence in 1961:

(a) First Three-Year Plan (1961-1964)
(b) First Five-Year Plan (1964-1969)
(c) Second Five-Year Plan (1969-1974)
(d) Third Five-Year Plan (1976-1981)
(e) Fourth Five-Year Plan (1981-1986)

Since the actual growth rates were lower than the targets and in order to cope with the economic decline towards the end of the 1970s, GOT suspended the fourth Five-Year Plan and introduced the National Economic Survival Programme (NESP) in 1981-1982 and the Structural Adjustment Programme (SAP) in 1982-1985. These programmes were strengthened by the Economic Recovery Programme (ERP) in 1986, followed by the Economic and Social Action Plan (ESAP) in 1989. The objectives of these programmes were : (a) increase domestic production of foods and exports, (b) restore efficiency in the mobilisation and utilisation of domestic resources, etc. The principal areas of reform in the implementation of the policies included: (a) liberalisation of agricultural markets, including prices, purchase, export and transportation of products, (b) abolition of restrictions on trade, exchange rate, private investments and interest rates together with removal of restrictions on private banking, and (c) parastatal reforms.

The Fourth Rolling Plan and Forward Budget (RPFB) of 1996/97-1998/99, which is the annual statement of the GOT's development strategy, economic targets and budgetary projections, has set the following macro economic policy objectives and targets:

(a) Achieving an overall rate of economic growth of about 5% (1996)
(b) Reducing the rate of inflation to about 15% (end of June 1997)

These objectives and targets cannot be achieved without the development of agriculture because it is the most important sector in Tanzania's economy as mentioned above. However the current situation of the agriculture sector is that unreliable rainfed cultivation is predominant and agricultural production is still low. It is therefore essential to introduce irrigated agriculture and also to strengthen its operational performance, to heighten agricultural production, and finally to attain the said objectives and targets.

2.2.2 Agriculture Development

The agriculture sector plays a dominant role in the national economy. It employs about 85 % of the employed population and accounts for over 50 % of GDP and 75 % of foreign exchange earnings. Furthermore, it is the main source for food supply and raw materials for the industrial sector as well as the major market for industrial goods and services. Despite the fact that the majority of population depends on the sector, the national food security has been one of the critical agricultural policy issues of GOT and the strengthening of food crops production and attainment of food self-sufficiency continue to be the main pillars of the national economic development policies. The Fourth Rolling Plan and Forward Budget (1996/97 - 1998/99) is setting the major objectives for the agriculture sector and the policies to achieve the said objectives as follows:

(a) Major Objectives for Agriculture Sector

- To achieve national self-sufficiency in food and to raise the nutritional standards,
- To raise income of the rural population,
- To increase foreign exchange earnings,
- To produce and supply raw materials for the industrial sector,
- To ensure food security in the country, and
- To develop and introduce new technologies for productivity increase.

(b) Major Policies for Agriculture Sector

- Promotion of increased production by the private sector,
- Increasing exports,
- Liberalisation and rationalisation of production, processing and marketing, and
- Promotion of non-traditional crops production.

In the "Agriculture Policy of Tanzania 1996" (draft), the primary agriculture development targets are the national food balance and increased income of the rural population, and the similar objectives for agriculture development are set forth. At the regional level, the agriculture development is to be promoted in accordance with the national level development strategies and polices for the sector.

The expansion of food crops production through irrigation development envisaged under the present Project will surely contribute to attaining GOT's primary policy objectives for the agriculture sector: Attainment of food self-sufficiency in the country and increase of rural population's income.

2.2.3 Rural Development

GOT has repeatedly declared rural development as one of its priorities. There is a need to focus on development of rural areas as the majority of the country's population or 85 % of the total population lives in these areas. The main development issue in these areas is poverty. Poverty prevails in most of these areas due to low income per capita, high mortality rate, low agricultural productivity, etc. All these problems lead to low standards of living of the majority of people in the rural areas. In the Rolling Plan and Forward Budget (1996/97 - 1997/98), the major objectives, policies and strategies for the rural development sector are set forth as follows:

(1) Major Objectives of the Rural Development Sector

(a) Increase of food production,

(b) Creation of a conducive environment and provision of production infrastructure to raise the living standards of rural people,

(c) Provision of basic needs such as health, education, potable water supply, and

(d) Improvement of the quality of life in the rural areas by providing employment and encouraging the private sector's involvement in all sectors.

(2) Major Policies and Strategies for the Rural Development Sector

(a) Policy: Increase of incomes and alleviation of poverty;

(b) Strategies:

- Encouragement of the private sector involvement,
- Improvement of the extension services,
- Improvement of accessibility to areas having agricultural potential,
- Ensuring household food security, and
- Facilitating establishment of rural credit societies and marketing of agricultural produce.

(c) Policy: Promotion of investment in economic and social infrastructure;

(d) Strategies:

- Construction and maintenance of village access roads,
- Rehabilitation of the existing facilities for basic needs,
- Emphasising on health prevention and immunisation programs,
- Provision and delivery of social services to rural areas, and
- Implementing cost recovery and user charges.

In the Kilimanjaro Region Rolling Plan and Forward Budget of 1997/98 - 1999/2000 (KRPFB), the major objectives of the water and works sector in the development plan are as follows:

(a) Major objectives of the water sector

- To provide adequate, clean and safe water by the year 2002,
- To identify and develop new water sources, and
- To improve efficiency in the development and management of water supply.

(b) Major objectives of the works sector

- To provide adequate, efficient and effective transport services in the region.

The development funds allocated to KRPFB in 1997/98 are Tsh. 58 million for the water sector and 44 million for the works sector. The budget allocation to each sector will be too limited to achieve the ambitious objectives. Therefore, the enhancement of agricultural productivity, through agricultural development in rural areas as envisaged under the Project, is the basic strategy for poverty alleviation or attainment of the ultimate objective of rural development.

2.3 Lower Moshi Agriculture Development Project

To achieve a stable production of foodstuffs for self-sufficiency as envisaged in the Third Five-Year Plan (1976 to 1981), the agricultural development plan in the Lower Moshi area was taken up, and a preliminary investigation was conducted during the period from 1975 to 1977 with technical cooperation of GOJ. The plan was accepted by GOT, and selected as one of the top priority projects to be implemented under the said Third Five-Year Development Plan.

During the period from December 1979 to August 1980, a feasibility study on the plan was carried out with technical assistance of GOJ, and a feasibility report was prepared in October 1980, presenting a concrete agricultural development plan for the four schemes in the Lower Moshi area. Among the four schemes, the Rau river system (the Lower Moshi Agriculture Development Project) with a net irrigation area of 2,300 ha including 150 ha of sugar estate and pilot farm, was given priority for early implementation. Under financial assistance (¥ 3.3 billion) of the Overseas Economic Cooperation Fund of Japan (OECF) for the detailed design and implementation, the detailed design of the Lower Moshi Agriculture Development Project was executed and completed in April 1983. Before the tender call for the civil works, however, the scope of the civil works was reviewed and revised by both GOT and OECF, so as to meet the then financial and economic conditions of Tanzania. In the revised scope of works, the area to be developed as paddy field was reduced by 1,100 ha from 2,000 ha in the original plan and the upland cropping area was increased from 300 ha to 1,200 ha, the total development area remaining unchanged. The construction works were started in May 1984 and completed in April 1987, taking a period of three years.

The Lower Moshi Agriculture Development Project was successfully operated until 1990 since its cropped area attained 1,508 ha and average crop yield 6.7 tons/ha which, was largely higher than the planned 5.0 tons/ha in the feasibility study. However, the Lower Moshi Agriculture Development Project is presently facing constant water shortage because the farmers living upstream of the project area are arbitrarily taking water from the same water sources as mentioned in Section 1.2.

CHAPTER 3 THE STUDY AREA

3.1 Location and Administration

The Study Area is located in the Kilimanjaro Region, at the foot of the Mt. Kilimanjaro, in the northeastern part of Tanzania. The Kilimanjaro Region is adjacent to the border with Kenya to the north, the Tanga region to the southeast, the Arusha region to the west, and administratively consists of 6 districts, 27 divisions, 104 wards, and 382 villages. The Study Area covers the proposed site of headworks, the proposed route of the diversion channel, the Existing Lower Moshi Project Area, the Expanded Area, and the New Extension Area.

The Study Area including the Kikuletwa headworks site and diversion channel route, extends over the three districts of Hai, Moshi (Rural), and Moshi (Urban), and covers 11 villages: Mkalama, Longoi, Kikafu Chini, Mvuleni, Mabogini, Rau Ya Kati, Chekereni, Mtakuja, Mandaka Mnono, Kaloleni, and Oria. Eight of these villages are related to the Existing Lower Moshi Project Area, the Expanded Area and the New Extension Area, and their population in 1988 was 21,004 and the estimated population in 1997 using the average annual growth rate of 2.2% from 1978 to 1988 is 25,600.

3.2 Topography and Geology

3.2.1 Topography

The Study Area extends along the south foot of Mt. Kilimanjaro, and is topographically composed of the following two areas:

(a) Highland area : The proposed headworks site, and about 60 % of the diversion channel route from the headworks site

(b) Alluvial lowland area : Remaining 40 % of the proposed diversion channel route after passing through the highland area, Existing Lower Moshi Project Area, Expanded Area, and New Extension Area

The highland area is a vast plain with an elevation ranging from 760 m to 850 m, located at the southwest foot of Mt. Kilimanjaro. The Kikuletwa river forms a V-shaped valley and has a steep slope of 1/30 around the proposed headworks site. The diversion channel route runs in the highland area with a comparatively flat surface. On the other hand, the alluvial lowland area is generally composed of gently sloping land with an average gradient of 0.5 %. The highest elevation is about 760 m in the northwest of the Study Area and the lowest is about 700m in the southeast.

3.2.2 Geology

The Study Area can be geologically divided into the following areas which almost coincide with the topographic areas:

(a) Volcanic rock area : Proposed headworks site, and about 60 % of the proposed diversion channel route from headworks site

(b) Alluvial plain area : About 40 % of the diversion channel route after the highland area, Existing Lower Moshi Project Area, Expanded Area and New Extension Area

(1) Volcanic Rock Area

The area is geologically composed of the Kibo "Rhomb Porphyry Group" and "Lahar". The Rhomb Porphyry Group consists of dark gray tuff breccia, the top layer of which partly contains limestone. The Lahar with a reddish brown colour, has a high degree of consolidation and presents the appearance of tuff breccia. The highly consolidated Lahar contains numerous blocks, which appear to be phonolite characterised by mega-phonocrysts.

The proposed Kikuletwa headworks site is mainly composed of tuff breccia formed by the Rhomb Prophyry Group, and the diversion channel route consists of tuff breccia formed by the Lahar. It is considered that tuff breccia formed by the Rhomb Prophyry Group is accumulated by the volcanic activity of the Mt. Kilimanjaro and is subsequently subjected in part to the sedimentary environment of limestone. Tuff breccia formed by the Lafar is a secondary deposit of volcanic products. Tuff breccia formed by the Rhomb Prophyry lies below tuff breccia formed by the Lahar. Talus deposits and alluvium are regarded as unconsolidated deposits overlying the basement rocks. These deposits are either distributed over a small area or thinly and widely distributed. In and around the Study Area, there exist 2 prominent fault structures: one is on the right side of the Kikuletwa river (F-2) and the other is on the west side of the highland area (F-1), the boundary of high and low plain areas.

(2) Alluvial Plain Area

The alluvial plain area consists geologically of thick alluvial deposits and pyroclastic flows overlying Precambrian crystalling metamorphic rocks. Faulting and volcanism continued from place to place throughout the Miocene and Pliocene times, and terminated in recent times. Fault-trough associated with lift movement is the most important structural feature. The Precambrian rocks are the basement rocks, which lie at a depth of more than 200m.

3.3 Meteo-hydrology

3.3.1 Meteorology

Climate in the Study Area is characterised by three seasons : rainy season from March to May, dry season from June to October, and small rainy season from November to February. The rainfall data and other meteorological data, such as temperature, relative humidity, wind speed have been observed at Chekereni. The climatic records at Chekereni are summarised below:

Climatic Records at Chekereni

Month	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temperature													
Max	℃	31	32	34	31	28	27	27	28	28	32	33	33
Mean	℃	23	23	25	24	22	21	20	20	20	24	25	25
Min.	℃	17	18	20	20	19	17	16	16	16	18	20	19
Humidity	%	62	61	69	74	77	74	72	72	63	66	65	67
Evaporation	mm/d	7	8	7	4	3	3	3	4	5	7	7	6
Rainfall *	mm	40	38	68	161	100	18	10	10	6	21	30	60

Source : Chekereni, KADP (1981 - 1996)

** : Mean annual rainfall at Chekereni; total annual rainfall is 560 mm.*

Topographic characteristic caused by the foot of the Mt. Kilimanjaro creates a high correlation between precipitation and altitude. Annual precipitation reaches 2,000 mm at maximum between El.1,600 m and El.1,800 m, but declines toward the top and bottom.

The mean temperature varies from 20°C to 25°C throughout the year. Because of the altitude over 700 m, the daily minimum temperature falls below 25°C even in the hottest season. The daily variation of temperature is over 14°C in January. The monthly average of relative humidity varies from 64% to 77%. Due to the effect of rainfall, the relative humidity increases from March and reaches the maximum in May, then decreases gradually after the rainy season. Pan evaporation varies widely throughout the year from 3 mm/day in May to 8 mm in February.

3.3.2 Hydrology

The Study Area is located in the Pangani river basin. It consists of two major rivers: the Kikuletwa river and Ruvu river. Both rivers flow into the Nyumba Ya Mungu reservoir. Outflow from the reservoir is the Pangani river which flows southwards and finally discharges into the Indian Ocean.

(1) Rau river

The water source of the Existing Lower Moshi Project consists of the Rau river and the Njoro river, a tributary of the Rau river. The Rau river originates from Mt. Kilimanjaro and traverses the Study Area until it is joined by the Ruvu river, collecting water from springs in the mountainous area. The Mwanangurue spring located in Mandaka Mnono is acting as a stable water source of the river. The Njoro river, collecting water from such springs as the Njoro ya Dobi spring and Goa spring, has a relatively stable flow throughout the year. It passes along the Mabogini Intake Weir and flows into the Rau river at a place upstream of the Rau Ya Kati Intake Weir.

In spite of these stable water sources, the flow of the Rau river at the Rau Ya Kati Intake Weir has decreased remarkably since 1994, especially in the dry season from August to November due to uncontrolled water use in upstream areas. Since most discharge records are incomplete, the available discharge of the rivers is estimated by means of tank model simulation and correlation with the existing gauging stations. The available spring discharge is estimated based on the observation records. The estimated mean monthly discharge and 80% dependable flow at both locations are shown below.

Estimated Mean Monthly and 80% Dependable Flow

(Unit : m^3/s)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mabogini	Average	1.30	1.23	1.25	1.40	1.44	1.49	1.59	1.52	1.50	1.44	1.38	1.39	1.41
	80%	0.97	0.94	0.95	1.12	1.25	1.16	1.24	1.15	1.13	1.01	1.03	1.10	1.09
Rau Ya Kati	Average	2.42	2.24	2.86	4.35	3.45	2.88	2.85	2.50	2.38	2.35	2.44	3.13	2.82
	80%	1.86	1.74	1.91	2.63	2.77	2.18	2.16	2.04	1.93	1.83	1.82	2.02	2.07

Source : KADP (1986 - 1995)

The average annual runoff is estimated at 44 MCM for the Njoro river at the Mabogini Intake Weir and 89 MCM for the Rau river at the Rau Ya Kati Intake Weir.

(2) Kikuletwa river

The Kikuletwa river originates from the Mt. Meru in the Arusha Region and flows down southwestwards. It dries up from near the regional border with the Kilimanjaro Region. The flow of the river is fed mainly by water originating from springs in the Kilimanjaro Region. It joins the Sanya river just downstream of the TANESCO power station, and then flowing westwards it forms a deep valley before joining the Kikafu river at the TPC pumping station. The Kikafu river as well as its tributaries, such as Karanga, Weruweru and Kuware, originates from the Mt. Kilimanjaro.

Two gauging stations exist on the Kikuletwa river: IDD54 and IDD1. The IDD54 gauging station with a catchment area of 2,220 km^2 is located 300 m downstream of the confluence with the Sanya river, and the IDD1 gauging station with a catchment area of 3,840 km^2 at some 400 m downstream of the confluence with the Kikafu river. The estimated average annual runoffs at IDD54 and IDD1 are 480 MCM, and 740 MCM, respectively. The mean monthly discharge and 80% dependable flow at each gauging station are tabulated below:

Mean Monthly and 80% Dependable Flow at IDD1 and IDD54

(Unit : m^3/s)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
IDD54	Average	12.1	11.9	12.8	24.3	25.4	19.6	14.4	11.7	11.5	11.4	12.6	13.0	15.1
	80 %	10.4	10.5	10.6	13.2	16.4	11.8	11.1	11.0	10.7	10.9	10.4	10.3	11.4
IDD1	Average	15.6	14.2	16.1	40.3	56.4	34.0	22.6	17.4	14.6	13.7	17.9	18.8	23.5
	80 %	11.2	11.0	11.5	24.3	38.1	22.2	17.2	14.0	11.6	11.0	11.3	10.3	15.6

The runoff of the Kikuletwa river is characterised by a base flow from spring water and seasonal flood water in the rainy season during the period from April to June. A base flow of some 10 m^3/s is observed at IDD54. The annual specific discharges at IDD54 and IDD1 are 7.1 lit./s/km^2 and 5.8 lit./s/km^2, respectively. Meanwhile, in reverse, the specific discharge in May at IDD1 is higher than that at IDD54 because flood water from the Kikafu, Karanga and Weruweru rivers flow into the Kikuletwa river at a rate of 14.7 lit./s/km^2 at IDD1,but 11.4 lit./s/km^2 at IDD54.

(3) Flood

The discharge of a probable flood with 100-year, 50-year, 20-years, and 10-year re-occurrence periods at IDD54 is estimated at some 240 m^3/s, 210 m^3/s, 170 m^3/s, 140 m^3/s, respectively, that is extremely low considering its catchment area. This might be related to the rainfall intensity, vegetation or topography in the upstream area. There exists a swampy area upstream of the Kikuletwa river in the Arusha Region and it could act as a buffer to eliminate peak flood discharge.

The flood discharge of the Rau river and its tributaries is estimated using the Rational Formula, which is the same as the method applied in the detailed design of the Lower Moshi Agricultural Development Project. The flood discharges with a 20-year re-occurrence period of the Rau and Njoro rivers are 288 m^3/s and 32 m^3/s, respectively.

3.3.3 Groundwater

Hydro-geological investigation of the Study Area was carried out in the feasibility study on the Lower Moshi Agricultural Development Project in 1980 to assess the potential of groundwater development for irrigation in the Study Area. The study contained field investigation, geo-electric prospecting, pumping tests, water balance study, and estimate of recharge volume. The study results are outlined below.

Results of Hydro-geological Investigation

Groundwater Area	Aquifer Capacity	Water Quality	Development Potential
(a) Outside the Study Area			
Kibo Lava	moderate	good	high
Arusha Chini (western)	large	good to poor	high
(b) Inside the Study Area			
Arusha chini (eastern)	moderate	poor	low
Kahe	moderate	poor	low
Miwaleni upland	moderate to large	good	high

As can be seen in the table, the groundwater development potential is low in the Study Area while it is high in western Arusha Chini, where the TPC farm is located. Thus, the irrigation with groundwater will be not promising for the Study Area.

3.3.4 Water Quality

A water quality survey was carried out by the Chemistry Department of the University of Dar es Salaam in Phases-I and -II, to verify if the available water is suitable for irrigation and domestic water uses. In order to assess water quality for irrigation, the "Guidelines for Interpretations of Water Quality for Irrigation", which is derived from the FAO Irrigation and Drainage Paper No. 29 Rev. 1, has been referred to. The locations of water sampling are presented in Figure 3.1. The evaluation results are summarised below.

Summary of Water Quality Analysis Results

Location	Salinity		Infiltration	
	Phase-I	Phase-II	Phase-I	Phase-II
(a) Kikuletwa River System				
1) Proposed Headworks	SM	N	SM	SM
2) Chemuka Spring	SM	N	N	SM
3) TPC Pumping Station	N	N	SM	SM
4) Kikafu River	N	N	S	S
(b) Rau River System				
5) Mabogini Intake Weir	N	N	SM	S
6) Rau Ya Kati Intake Weir	N	N	S	S
7) Mabogini Main Canal	N	N	SM	S
8) Rau Ya Kati Main Canal	N	N	S	S

Note : N : None; SM : Slight to Moderate;
S : Severe restriction for irrigation use

Table 3.1 shows the results of the water quality analysis executed in Phase-I and -2. The results indicate that all the waters sampled at the proposed headworks site on the Kikuletwa river, which contain sodium bicarbonate, calcium bicarbonate as well as magnesium bicarbonate, have no restriction for irrigation water use in terms of salinity, and slight to moderate infiltration.

On the other hand, the waters sampled from the Kikafu river, Mabogini Intake Weir and Rau Ya Kati Intake Weir which are characterised by low salinity and low SAR, show severe and slight to moderate infiltration, which may lead to soil infiltration problem if these waters are used for irrigation for a long time. However, this problem could be overcome by keeping the soil granular structure through proper farming practices such as introduction of fodder crops in the proposed cropping pattern, and provision of organic residues. Further, the sampled waters are categorised into the low/low (C1-S1) to medium-high/medium (C3-S2) classes which are considered not to cause high hazard for irrigation, according to the United States Department of Agriculture criteria. The laboratory tests were executed for the same sampled water by the Kenya Bureau of Standards in the Phase-I time for cross check, and the results showed the similar tendency with the above.

The suitability of water for domestic use was examined referring to the "Tanzanian Temporary Standards of Quality of Domestic Water". It was observed that the sampled waters are free from substances affecting human health, such as fluoride and nitrate. The water analysis study also showed a higher BOD than the standard value at the Mabogini and Rau Ya Kati Intake Weir sites. In addition, the BOD values in the existing main canals are much higher than those at the intake sites. This might be due to washing and bathing in the canals. Taking into consideration the organic pollution of water represented by BOD, some measures to prevent pollution of the canal water should be taken to improve the environment of human life. First, it should be stressed that the inhabitants in the Study Area are strongly instructed to follow the By-Law, that prohibits bathing and washing in canals. Secondly, to make up for the prohibition, it is proposed to provide washing and drinking places near canals, where canal water will be taken by manual pumping.

3.3.5 Water Right

The Water Utilisation (Control and Regulation) Act was enacted in 1974 and then supplemented by the subsequent legislation of the Government Notice No. 242 in October, 1975. The Notice designated the major water sources in the country as national water supply sources. Granted water rights in major river basins are summarised as follows:

Some 200 water rights were granted in the Kilimanjaro Region, among which 176 are for irrigation use with a total granted discharge of 12 m^3/s. Granted water rights in the Rau river system total 3 m^3/s for 36 users including the Existing Lower Moshi Project, which is authorised to abstract 804 l/s of water at the Mabogini Intake Weir and 1,135 l/s at the Rau Ya Kati Intake Weir. Those water rights were granted on May 16, 1990, with registration No. 4807 and No.4808 for the Mabogini and Rau Ya Kati Intakes, respectively. As for the Kikuletwa river system, 4 water users were allowed to abstract 200 l/s of water in total so far.

3.4 Soil and Land Suitability

3.4.1 Soil Characteristics and Distribution

(1) General Soil Conditions

The Study Area can be classified into three geomorphologic units of old alluvial plain, colluvial plain, and recent alluvial plain. The areal extents of the latter two are limited and nearly 90% of the Area lies in the old alluvial plain.

(2) Soil Characteristics and Distribution

The soils are broadly classified into Cambisols and Fluvisols developed in moderately to well drained areas, Cambisols affected by shallow brackish groundwater, and Gleysols and Vertic soils developed in poorly drained areas, while the areal extents of distribution of soils other than Cambisols are limited. The Cambisols are classified into four soil units (phases) and the Gleysols into two. Seven soil units in total are distributed in the Study Area as follows:

(a) Eutric Cambisols, Phreatic Phase (Soil Mapping Unit Cm-1: 6,044 ha/72 %)

The soils are extensively distributed in nearly flat lands in the Study Area and are almost entirely used for crop cultivation except for some areas occupied by village yards or housing yards. The soils have good permeability and have no serious limitation for irrigated farming and are assessed moderately suitable for both rice and upland crops cultivation. However, proper soil and water management to avoid salinity/sodicity problems under irrigated farming is essential to ensure sustainability of crop production in the Area.

(b) Eutric Cambisols, Saline/Sodic Phase (Soil Mapping Unit Cm-2: 980 ha/12 %)

The soils are found in the low-lying flat lands in the southern end of the Study Area, along the NAFCO irrigation canal. The soils usually have strong saline properties at the surface and strong saline and slight to very strong sodic properties in the subsoil. Most of the lands covered with these soils have a vegetation composed of salt accumulation indicator plants. They are not used for crop cultivation and are left waste or used for grazing. These soils are assessed not suitable for irrigated rice and upland crop cultivation because of strong salinity in the entire soil profile and strong to very strong sodicity in lower horizons.

(c) Eutric Cambisols, Slight to Moderate Saline Phase (Soil Mapping Unit Cm-3:280ha/3%)

The soils are found bordering on the Saline/Sodic Phase in the southern part of the New Extension Area and usually have slight to moderate saline properties at the surface and slight to strong saline/sodic properties in the subsoil. The soils have good permeability, have no serious limitation for irrigated rice cultivation and are assessed moderately suitable. However, the suitability for upland crops is assessed to be marginal because of current salinity and danger of further salt accumulation by upland irrigation. Proper soil and water management to avoid salinity/sodicity problems under irrigation farming is essential for sustainability of crop production in the Area.

(d) Vertic Cambisols, Poorly Drained Phase (Soil Mapping Unit Cm-4: 160 ha/2%)

The soils are mainly distributed to a limited extent in paddy fields in Kaloleni, in the northern end of the Study Area. The soils have no serious limitation for irrigated rice farming and are assessed moderately suitable for rice. However, poor drainage conditions of the areas covered with these soils will present some limitation for upland crop cultivation.

(e) Mollic Gleysols (Soil Mapping Unit Gy-1: 430 ha/5%)

The soils develop mainly on narrow depressions along the Rau river and have a thick mollic horizon at the soil surface and a mottled horizon at a relatively shallow profile in

the subsoil. The soils have no serious limitation for irrigated farming and are assessed moderately suitable for both rice and upland crops cultivation.

(f) Typic Eutric Gleysols, Poorly Drained Phase (Soil Mapping Unit Gy-2: 360 ha/4%)

The soils are found mainly in low-lying areas extending in paddy fields in the northeastern end of the Study Area. The soils have no serious limitation for irrigated farming and are assessed moderately suitable for rice and marginally suitable for upland crops. Poor drainage conditions and resultant restriction on mechanisation of land preparation will present some limitation for crop cultivation, especially in the case of upland crops.

(g) Eutric Fluvisols (Soil Mapping Unit Fl: 190 ha/2%)

The soils develop on the slightly depressed land and narrow natural levee along the Rau river. The soils have no serious limitation for irrigated farming and are assessed moderately suitable for both rice and upland crops cultivation.

3.4.2 Land Suitability Classification

(1) Evaluation System

The soils in the Study Area were evaluated for irrigated rice and upland crop cultivation by applying selected land qualities and assessment criteria, in accordance with the system proposed in "A Framework for Land Evaluation, FAO Soils Bulletin No. 32". According to the evaluation results, the soils in the Study Area are classified into the following suitability classes:

Land Suitability Classes and Sub-Classes

Suitability Class	Definition
Class S2 Moderately Suitable	Land having limitations which in aggregate are moderately severe for sustainability of a given use
Class S3 Marginally Suitable	Land having limitations which in aggregate are severe for sustainability of a given use
Class N Currently Not Suitable	Land having limitations which cannot be corrected with existing knowledge at a currently acceptable cost

(2) Land Suitability Classes

The results of land classification are shown in Figure 3.2, and summarised below.

Summary of Land Classification Study Result

Soil Unit (Soil Phase)	Suitability Classes for Irrigated Rice	Irrigated Upland Crops	Areal Extent (%)
Eutric Cambisols, Phreatic Phase	S2	S2	6,044 ha (72)
Eutric Cambisols, Saline/Sodic Phase	N	N	980 ha (12)
Eutric Cambisols, Slight to Moderate Saline Phase	S2	S3	280 ha (3)
Vertic Cambisols, Poorly Drained Phase	S2	S3	160 ha (2)
Mollic Gleysols	S2	S2	430 ha (5)
Typic Eutric Gleysols, Poorly Drained Phase	S2	S3	360 ha (4)
Eutric Fluvisols	S2	S2	190 ha (2)
Total			8,444 ha (100)

As shown in the table, the soils in the Study Area, except for strongly salt-affected Eutric Cambisols, are assessed suitable both for irrigated rice and upland crops. Those are generally more suitable for rice and higher degrees of limitations for upland crop cultivation will be encountered, especially due to soil salinity and drainage conditions. The results of land suitability classification are summarised below:

(a) Suitability for irrigated paddy

All the soils in the Area except for one soil unit are classified as moderately suitable for irrigated rice (S2: 7,464 ha, 88 %) with slight to moderate limitations on soil nutrient holding capacity (CEC) and with or without slight to moderate limitations on drainability of soil or salinity. The Eutric Cambisols, Saline/Sodic Phase are classified as currently not suitable (Ns: 980 ha, 12 %) because of high salt accumulation in the soils and subsurface soil sodicity problems.

(b) Suitability for irrigated upland crops

Nearly eighty percent (79 %) or some 6,664 ha of the soils in the Area are evaluated as moderately suitable for irrigated upland crops with slight to moderate limitation on soil nutrient holding capacity (CEC). 800 ha or 9 % of the Area are assessed marginally suitable (S3) because of poor drainability or salinity of soils. The Eutric Cambisols, Saline/Sodic Phase are classified as currently not suitable (Ns: 980 ha, 12 %) because of high salt accumulation in the soils and subsurface soil sodicity problems.

3.4.3 Proposed Measures for Soil Management

The proposed measures for soil management in the Study Area to prevent soil degradation due to irrigation and the proposed approaches to fertilisation issues are as follows:

(1) Introduction of Soil Amelioration Crops

For maintaining or improving soil permeability, the introduction of soil amelioration crops having deep rooting characteristics and/or having characteristics to promote formation of soil structures is one essential soil management practice. In rice farming under the Project, the direct puddling method for land preparation by rotary tiller is practised and surface soil structures will be destroyed in every rice cropping season. The introduction of pasture grasses having characteristics of promoting formation of soil structures through their root development is not effective and, therefore, the introduction of alfalfa having deep rooting characteristics in rotation with rice is proposed in order to maintain or improve permeability of subsurface soils. In the proposed cropping pattern, the cultivation of alfalfa in rotation with rice in the late dry season in 20 % of the entire area is planned. Alfalfa products should better be used for animal feeding to improve feed quality and for the enhancement of livestock productivity in the Study Area.

(2) Application of Organic Matters

Another practice for maintaining or improving soil permeability is continuous application of organic matters through incorporation of crop residues into soils or as farm yard manure or composts. The proposed practices, therefore, are: 1) spreading rice straws after harvesting, leaving them to rot in fields and mixing them with the soils at the time of land preparation; and 2) preparation of composts or farm yard manure by utilising rice straws and

dressing them prior to land preparation. The application of organic matters in the form of farm yard manure is a more preferable measure since it uses crop residues for improvement of the animal feeding system in the Study Area.

(3) Monitoring of Effects of Proposed Soil Management Practices and Soil Salinity and Sodicity Status

The introduction of the proposed soil management practices should be started prior to their introduction in farmers' fields through verification and demonstration of the practices and the effects of the practices, on permeability and soil nutritional status should be monitored continuously. In addition, periodical monitoring of the salinity and sodicity status of the soils in the entire Study Area should be done as an important routine activity of the Agronomy Section of KADP. Such monitoring should include periodical measurements of soil pH and EC after every cropping season and of pH and EC of irrigation water on a monthly basis. If noticeable changes in soil conditions or water quality are observed through monitoring activities, detail analyses of soil or water samples should be conducted and counter-measures should be discussed with research institutes and introduced, if deemed necessary.

(4) Fertilisation

As discussed earlier, review of fertilisation practices applied in the Study Area will be necessary. For the review, fertiliser trials on: 1) effects of phosphate fertilisation, 2) comparative trial on nitrogen sources, urea and ammonium sulphate, and 3) effects of potassium fertilisation in fields having different water resources: are to be implemented from the initial stage of the development of the Project.

3.5 Agriculture

3.5.1 Present Land Use

The present land use in the Study Area can be classified into 6 categories as shown in Figure 3.2 and summarised below:

Present Land Use

Category	Gross Area (ha)	Ratio to the Study Area
(a) Irrigated paddy fields in Existing Lower Moshi Project Area	1,492	18%
(b) Irrigated paddy fields in Expanded Area	510	6%
(c) Irrigable upland fields in Existing Lower Moshi Project Area	1,162	14%
(d) Rainfed upland fields in Expanded and New Extension Area	4,160	49%
(e) Grassland and grazing land	970	11%
(f) Village and housing yards	150	2%

3.5.2 Crop Production

(1) Cropping Pattern

The cropping pattern presently adopted in the Study Area is determined basically by water availability. The prevailing cropping calendar in the Area is as shown in Figure 3.3 and described in the next page:

(a) Paddy cultivation in the Existing Lower Moshi Project Area

In the area, a high yielding variety, IR 54 with a growth duration of 135 - 145 days, is exclusively planted. In order to overcome restriction in cropped area due to water shortage and to expand cropping area to the possible extent within the availability of water sources, the following cropping calendar comprising of 3 cropping seasons per year has been adopted since 1988.

Rainy season	: February/March to June/July
Early dry season	: June/July to October/November
Late dry season	: October/November to February/March

(b) Paddy cultivation in the Expanded Area

The basic and prevailing rice cropping calendar is more or less similar to the originally recommended cropping calendar for the Existing Lower Moshi Project Area as follows:

Rainy season	: January/February to May/June
Dry season	: July/August to November/December

However, because of seasonal inundation and water supply constraints, the cropping calendar of the area is rather diversified.

(c) Upland crop cultivation

The cropping calendar of upland crops in the Study Area is adjusted to the rainfall distribution in the rainy season, in which land preparation is done in February in advance to the start of rain and seeds are sown under dry land conditions prior to the beginning of the season. There are some annual variations in the commencement of the rainy season, however the usual cropping calendar for maize and other upland crops is from March to July/August.

(2) Cropped Area and Cropping Intensity:

The present cropped areas are presented in Table 3.2 and summarised below.

Estimated Annual Cropped Area

Description	Rainy Season	Dry Season	Annual
Irrigated Paddy	600 ha	930 ha	1,530 ha
Existing Lower Moshi Project Area	140 ha	640 ha	780 ha
Expanded Area	460 ha	290 ha	750 ha
Maize	5,056 ha	0 ha	5,056 ha
Total Study Area	5,656 ha	930 ha	6,586 ha

On the basis of the said estimated cropped area, the present overall annual cropping intensity in the Study Area is calculated at 104% consisting of 89% in the rainy season and 15 % in the dry season as shown below.

Estimated Annual Cropping Intensity

Description	Rainy Season	Dry Season	Annual
Existing Lower Moshi Project Area	13 %	58 %	71 %
Expanded Area	100 %	63 %	163 %
New Extension Area	95 %	-	95 %
Overall Study Area	89 %	15 %	104 %

(3) Crop Yields and Production

The present crop yields in the Study Area are summarised below.

Cropped Yields in the Study Area

(Unit: ton/ha)

Description	Rainy Season	Dry Season	Average
Irrigated Paddy			
Existing Lower Moshi Project Area	5.9	6.5 & 7.0*	6.6
Expanded Area	3.5	4.5	3.9
Maize			
Existing & Expanded Area	2.0	-	-
New Extension Area	1.2	-	-

*Note: * Early dry season 6.5 t/ha and late dry season 7.0 t/ha*

From the estimated cropped areas and crop yields, the present seasonal crop production in the Study Area is estimated at 2,400 and 5,600 tons of paddy respectively in the rainy and dry seasons and 7,500 tons of maize in the rainy season. The annual production of paddy is around 8,000 tons.

(4) Pests and Diseases

A number of paddy insect pests in the Study Area were identified by KADP. Among them, the most destructive ones are striped stem borer, rice hispa, stalk eyed shoot fly, and army worm. Furthermore, the existence of several fungal diseases and one bacterial disease of rice were identified by the JICA experts in 1990 and 1992. Fortunately, however, no serious diseases and insects on paddy have ever been experienced in the Study Area, which is favoured by rather dry climatic conditions and a low cropping intensity due to water shortage.

(5) Farming Practices and Use of Farm Inputs

Some specific features of the prevailing farming practices for rice and maize cultivation and the use of farm inputs in the Study Area are explained below:

(a) Variety

The high yielding medium growth duration variety IR-54 selected by KADC/KADP is almost exclusively used for rice cultivation presently in the Study Area. In maize cultivation, the cultivation of self-multiplied seeds is prevailing and the use of quality seeds is limited. The varieties commonly cultivated are Tuxpeno (composite) and CG4141(hybrid).

(b) Nursery and sowing

In the Existing Lower Moshi Project Area, the communal nursery system by a tertiary block is employed in which all the farmers prepare seed beds and nurse seedlings. The seeding rate is about 45kg/ha. In the Expanded Area however, nursery is prepared individually and the seeding rate is around 55kg/ha. In the case of maize, seeds are usually drilled in line at a spacing of 75x60 cm, 80x50 cm and 90x30 cm and the optimal seeding rate is about 25kg/ha.

(c) Land preparation

Land preparation works in the Study Area are usually done mechanically except for paddy fields in the Expanded Area where poor drainage conditions restrict the use of machinery for the works. In upland fields, the use of seasonal tractor hiring services of the private sector is common for land preparation.

(d) Fertilisation

Fertilisation is a common practice in rice cultivation. The average doses in the Existing Lower Moshi Project Area is 320 kg/ha of urea and 110 kg/ha of ammonium sulphate (in total 170 kg/ha of N). In the Expanded Area, the dose is 270 kg/ha of urea (125kg/ha of N). Such fertilisers are usually applied in three top dressings and a basal dressing is not common. Other fertilisers (P and K) are seldom used in the Study Area. In contrast, fertilisation is limited in maize cultivation.

3.5.3 Post Harvest Facilities

(1) Small Scale Rice Mills in the Study Area

A total of 14 small scale rice mills are operated primarily for household consumption and partly for marketing purpose in the Study Area. All of those mills except one operated by the village government, are individually owned. Among the 6 villages having paddy fields in the Area, Mabogini, Chekereni and Oria have such rice mills, and rice milling for household consumption in the remaining 3 villages, Rau Ya Kati, Mandaka and Kaloleni, is done at mills in neighbouring villages. The milling capacity of such small scale mills is in the range of 100 to 200 kg of paddy per hour and the total milling capacity is roughly estimated at around 14 t/day. There is a little difference in milling cost depending on mills but the cost is around Tsh. 17/kg in general. The milling charge of small mills is high in comparison with KPHC (Tsh. 15/kg), but farmers use them to mill a small quantity for daily consumption because KPHC accepts paddy only in large quantity. A small scale drying yard used for final drying prior to milling is constructed generally attached to a rice mill. There are 13 such drying yards in total in the Study Area.

(2) Kilimanjaro Paddy Hulling Company (KPHC)

The rice mill of KPHC was constructed under the Japanese Grand Aid program in 1989 as the central rice milling facilities for the Existing Lower Moshi Project Area and its surroundings. In 1990, it was transferred from KADP to KNCU under a sale cum loan contract for Tsh.380 million at a 3% interest and a grace period of 5 years. The plant is presently operated by KPHC which is the subsidiary of KNCU.

The rice mill facilities consist of a milling plant (2 lines), a godown, and a drying yard. The plant has a milling capacity of 30 tons of dried paddy per day (8-hour operation) and 750 tons per month (25-day operation). The storage for short term storing of paddy and rice has a capacity of 1,800 tons. The size of the drying yard is about 3,200m^2.

KPHC presently only offers milling services to farmers and traders in and around the Study Area and is not involved in marketing of rice. The rice mill receives 4,928 tons of paddy and processes 4,515 tons in a year. The volume is about 55 % of its present annual processing

capacity of 8,250 tons. The rice mill has become popular in and around the Study Area, because rice milled in the facility is of high quality without containing foreign matters such as small stones, sand, straws or husks. Presently, nearly 50% of the annually processed paddy quantity comes from areas outside the Existing Lower Moshi Project Area.

KPHC is now facing the serious problem of operating below its capacity due to the inadequate supply of paddy as mentioned above. Other problems encountered by the management of the mill is the regular devaluation of the Tanzanian Shilling which brings about a substantial escalation of spare parts prices. Further, disposal of husks has also become a serious problem.

3.5.4 Animal Husbandry

Animal husbandry is a common activity in the Study Area as it is regarded as a source of wealth and an insurance against crop failure or any other problems. In addition, as the results of Farm Interview Survey under the present Study indicate, livestock production is an important source of supplementary income especially for small landholders. Accordingly, the number of animals possessed in villages in the Area in 1997 was substantially large as shown in the following table.

Major Animal Population by Village in 1997

(Unit: head)

Village	Cattle	Goat	Sheep	No. in Animal Unit*
Mabogini	1,239	2,471	426	1,496
Rau Ya Kati	670	1,428	724	926
Chekereni	814	2,460	632	1,220
Oria	1,880	2,802	916	2,135
Mandaka Mnono	682	1,104	439	814
Kaloleni	6	298	49	73
Mtakuja	3,024	4,000	1,800	3,398
Mvuleni	350	500	200	399
Total	8,665	15,063	5,186	10,461

**: Converted into animal unit by 0.2 x No. of goat & sheep & 0.74 x No. of cattle assuming cow/bull : heifer/steer: calf = 3 : 1 : 1*
Source: Results of Farm Interview Survey by the JICA Study Team

Animal husbandry in the Study Area is generally practised in traditional ways and animal feeding solely depends on crude feed. In the rainy season from March to August when almost the entire farmlands in the Area are used for crop cultivation, feeding of cattle in homestead under zero grazing system is commonly practised and grazing is limited to non-farm land and fallow land.

Major cattle diseases in and around the Area are tick-borne diseases such as East Coast fever, anaplasmosis, babesiosis, and heart water. Artificial insemination for improvement of genetic resources of cattle has not been introduced yet in the Area. The limitation of veterinary services, genetic resources of animals, and extension services present other constraints for animal husbandry in the Area. The provision of veterinary services, improvement of animal breeds and livestock extension activities are under the jurisdiction of the District Livestock Development Office. Presently, there is one veterinary centre in Chekereni and one Ward Livestock Extension Officer in the Study Area. However, the services rendered by the Office are limited compared with the animal population and demand for such services.