

No.

THE REPUBLIC OF KENYA
LAKI BASIN DEVELOPMENT AUTHORITY

FEASIBILITY STUDY
ON
KANO PLAINS IRRIGATION PROJECT

VOLUME II - 2
ANNEXES

JANUARY 1992

Japan International Co-operation Agency

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VOLUME II - 2

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FEASIBILITY STUDY
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List of Reports

EXECUTIVE SUMMARY

VOLUME I MAIN REPORT

VOLUME II - 1 ANNEXES

- ANNEX I Meteorology and Hydrology
- ANNEX II Geology, Soil Mechanics and Engineering Geology
- ANNEX III Soil and Land Classification
- ANNEX IV Socio-Economy

VOLUME II - 2 ANNEXES

- ANNEX V Agriculture
- ANNEX VI Agro-Economy
- ANNEX VII Irrigation and Drainage
- ANNEX VIII Construction Plan and Cost Estimate
- ANNEX IX Project Organization
- ANNEX X Project Evaluation
- ANNEX XI Assessment of Environmental Impacts

VOLUME III DRAWINGS



Abbreviations

AFC	Agricultural Finance Corporation
AIRS	Ahero Irrigation Research Station
CBS	Central Bureau of Statistics
CLSMB	Cotton Lint and Seed Marketing Board
DAO	District Agricultural Officer
DC	District Commissioner
DDC	District Development Committee
DO	District Officer
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Production
GNP	Gross National Production
GOK	Government of Kenya
GRDP	Gross Regional Domestic Product
HCDA	Horticultural Crops Development Authority
IBRD	International Bank for Reconstruction and Development, World Bank
IDA	International Development Association
IFAD	International Fund for Agricultural Development
ILUS	Integrated Land Use Survey
JICA	Japan International Cooperation Agency
KGGCU	Kenya Grain Growers Cooperative Union
K£	Kenya Pounds (20 Kenya Shillings)
KPLC	Kenya Power and Lighting Company Limited
KR	Kenya Railway Corporation
KSC	Kenya Seed Company
Ks	Kenya Shillings
KSS	Kenya Soil Survey
LBDA	Lake Basin Development Authority
NCPB	National Cereals and Produce Board
NGO	Non-governmental Organization
NIB	National Irrigation Board
OECF	Overseas Economic Cooperation Fund
PIU	Provincial Irrigation Unit
RWSSP	Rural Water Supply and Sanitation Project
SSIU	Small-Scale Irrigation Unit, Ministry of Agriculture
T&V	Training and Visit
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
VAT	Value Added Tax

Abbreviations of Measurement

Length

cm	=	Centimeter
m	=	Meter
km	=	Kilometer
ft	=	Foot
yd	=	Yard

Area

cm ²	=	sq.cm	=	Square centimeter
m ²	=	sq.m	=	Square meter
ha	=	Hectare		
km ²	=	sq.km	=	Square kilometer

Volume

cm ³	=	cu.cm	=	Cubic centimeter
l	=	lit	=	liter
kl	=	Kiloliter		
m ³	=	cu.m	=	Cubic meter
gal.	=	Gallon		
MCM	=	Million Cubic Meters		

Weight

mg	=	Milligram
g	=	Gram
kg	=	Kilogram
ton	=	Metric ton
lb	=	Pound

Time

sec	=	s	=	Second
min	=	Minute		
hr	=	Hour		
d	=	Day		
yr	=	Year		

Electrical Measures

V	=	Volt
A	=	Ampere
Hz	=	Hertz (cycle)
W	=	Watt
kW	=	Kilowatt
MW	=	Megawatt
GW	=	Gigawatt

Other Measures

%	=	Percent
PS	=	Horsepower
°	=	Degree
'	=	Minute
"	=	Second
°C	=	Degree centigrade
10 ³	=	Thousand
10 ⁶	=	Million
10 ⁹	=	Billion (milliard)

Derived Measures

m ³ /s	=	m ³ /sec	=	Cubic meter per second
cusec	=	Cubic feet per second		
mgd	=	Million gallon per day		
kWh	=	Kilowatt hour		
MWh	=	Megawatt hour		
GWh	=	Gigawatt hour		
kWh/yr	=	Kilowatt hour per year		
kVA	=	Kilovolt ampere		
BTU	=	British thermal unit		

Money

Ks.	=	Kenya shilling
K£	=	Kenya pounds (20 Kenya shillings)
US\$	=	US dollar
Yen	=	Japanese Yen

Conversion Factors

	<u>From Metric System</u>	<u>To Metric System</u>
Length	1 cm = 0.394 inch	1 inch = 2.54 cm
	1 m = 3.28 ft = 1.094 yd	1 ft = 30.48 cm
	1 km = 0.621 mile	1 yd = 91.44 cm
		1 mile = 1.609 km
Area	1 cm ² = 0.155 sq.in	1 sq.ft = 0.0929 m ²
	1 m ² = 10.76 sq.ft.	1 sq.yd = 0.835 m ²
	1 ha = 2.471 acres	1 acre = 0.4047 ha
	1 km ² = 0.386 sq.mile	1 sq.mile = 2.59 km ²
Volume	1 cm ³ = 0.0610 cu.in	1 cu.ft = 28.32 lit
	1 lit = 0.220 gal. (imp.)	1 cu.yd = 0.765 m ³
	1 kl = 6.29 barrels	1 gal. (imp.) = 4.55 lit
	1 m ³ = 35.3 cu.ft	1 gal. (US) = 3.79 lit
	10 ⁶ m ³ = 811 acre-ft	1 acre-ft = 1,233.5 m ³
Energy	1 kWh = 3,413 BTU	1 BTU = 0.293 Wh
Temperature	°C = (°F-32) 5/9	°F = 1.8°C + 32
Derived Measures		
	1 m ³ /s = 35.3 cusec	1 cusec = 0.0283 m ³ /s
	1 kg/cm ² = 14.2 psi	1 psi = 0.703 kg/cm ²
	1 ton/ha = 891 lb/acre	1 lb/acre = 1.12 kg/ha
	10 ⁶ m ³ = 810.7 acre-ft	1 acre-ft = 1,233.5 m ³
	1 m ³ /s = 19.0 mgd	1 mgd = 0.0526 m ³ /s

Annex V

Agriculture

Feasibility Study
on
Kano Plain Irrigation Project

Annex V
Agriculture

Table of Contents

	<u>Page</u>
1. INTRODUCTION.....	V-1
2. PRESENT CONDITION OF AGRICULTURE.....	V-1
2.1 Location.....	V-1
2.2 Present Land Use.....	V-1
2.3 Present Cropping Pattern.....	V-2
2.3.1 Crops.....	V-2
2.3.2 Cropping calender.....	V-2
2.4 Present Farming Practice.....	V-3
2.4.1 Upland crops.....	V-3
2.4.2 Paddy.....	V-3
2.4.3 Variety.....	V-3
2.4.4 Agricultural inputs.....	V-3
2.4.5 Pests and diseases.....	V-3
2.5 Present Crop Yield and Production.....	V-4
2.5.1 Yield.....	V-4
2.5.2 Production.....	V-4
2.5.3 Livestock population.....	V-4
2.6 Agriculture Extension Service and Research Institutions.....	V-4
3. AGRICULTURE DEVELOPMENT PLAN.....	V-5
3.1 Agricultural Constraint.....	V-5
3.2 Basic Concepts of Agricultural Development.....	V-5
3.3 Selection of Optimal Development Scale.....	V-6
3.4 Selection of Crops.....	V-6
3.5 Cropping Pattern and Change of Land Use.....	V-7

3.6	Farming Practices.....	V-8
3.7	Anticipated Crop Yield and Production	V-9

List of Tables

		<u>Page</u>
Table V-2.2-1	Present Land Use in the Study Area	V-T-1
Table V-2.3-1	The Production of Crops in Kisumu District and Study Area (1987 - 1989).....	V-T-2
Table V-2.3-2	Production of Crops in the Study Area (1) (1987 - 1989)	V-T-3
Table V-2.3-3	The Production of Crops in the Study Area (2) (1987 - 1989)	V-T-4
Table V-2.3-4	Growth Duration and Cropping Season of Major Crops	V-T-5
Table V-2.4-1	Farm Input and Labour Requirement under Present Condition	V-T-6
Table V-2.5-1	Yield and Yield Component of Paddy	V-T-7
Table V-2.5-2	Animal Production in the Study Area (1987 - 1989).....	V-T-8
Table V-2.6-1	The Number of Technical Staffs in the Department of Agriculture, Kisumu (1989).....	V-T-9
Table V-2.6-2	The Number of Technical Staffs in the Department of Animal Development, Kisumu (1989).....	V-T-9
Table V-3.5-1	The Hectareage of Proposed Cropping Pattern.....	V-T-10
Table V-3.5-2	Changes in Land Use	V-T-10
Table V-3.6-1	Farm Inputs under Proposed Farming Practice (crop/ha).....	V-T-11
Table V-3.6-2	Labour Requirement under Proposed Farming Practice.....	V-T-11
Table V-3.6-3	Available Labour Force for Farming Practices.....	V-T-12
Table V-3.6-4	Daily Labour Requirement of Proposed Cropping Pattern (man-day/ha).....	V-T-13
Table V-3.6-5	Daily Labour Requirement of Proposed Cropping Pattern (total man-day).....	V-T-14
Table V-3.7-1	Crop Production under without- and with-Project.....	V-T-15

List of Figures

	<u>Page</u>
Fig. V-2.2-1 Land Use Map at Present	V-F-1
Fig. V-2.3-1 Present Cropping Calender.....	V-F-2
Fig. V-2.6-1 Systematic Structure of Agricultural Supporting Institutions.....	V-F-3
Fig. V-3.5-1 Proposed Cropping Calendar.....	V-F-4

1. INTRODUCTION

The study on agriculture was undertaken (i) to clarify the present constraints for agriculture development in the study area, (ii) to assess the agricultural potential and (iii) to make the optimum agricultural development plan for the maximum exploitation of the potential.

For these, the following field investigations and data collection was carried out in and around the study area.

- (1) Data collection on socio-economic data including population, labour force, farm-size and so on
- (2) Collection of data and informations on present agricultural situation including hectareage of crops, present cropping pattern, crop yield and production, farming practices, and so on.
- (3) Collection of data on existing agricultural support systems including agricultural extension service, research, credit, farm input supplies and farmer's co-operatives and
- (4) Present land use by using topography map of 1:5,000 (sub-area I to V and a part of sub-area VI and VII) and 1:50,000 and aerial photographs and by field reconnaissance.

The data and informations were mainly obtained from the government authorities concerned such as Provincial Agricultural Office, District Agricultural Offices, Divisional Agricultural Extension Offices, NIB, National Agricultural Research Stations, LBDA, NCPB and so on.

In addition, a field reconnaissance was made in and around the study area to supplement and confirm the collected data and information, being paid emphasis on cultural practices and farmers intention concerning to the irrigation development.

2. PRESENT CONDITION OF AGRICULTURE

2.1 Location

The study area is located in Kisumu and South Nyanza Districts of Nyanza Province in western Kenya and covers about 72,980 ha in the Kano and Nyakach Plains delineated by the Kibos river and Kendu Bay. In addition to this definition, the northern boundary of the study area is determined by the Nairobi - Kisumu railway, the southern and eastern boundaries are at altitude about 1,200 m ASL. The total hectareage of the area is estimated at about 72,980 ha including perennial swamp adjacent to the Lake Victoria.

In the study, the study area is divided into 3 zones and 8 sub-areas taking into the topography and extent as shown below

Zone/Sub area	Location
Zone A 15,030 ha	sub area I from Kendu bay to Sondu/Miriu river
	sub area II from Sondu/Miriu river to Asawo river
	sub area III from Asawo river to Awach Kano river
Zone B 22,150 ha	sub area IV from Awach Kano river to Nyaidho river
	sub area V from Nyaidho river to Nyando river
Zone C 35,800 ha	sub area VI from Nyando river to Oroba/Miriu river
	sub area VII from Miriu river to Ombeyi river (exclude West Kano Paddy Irrigation Scheme)
	sub area VIII from Oroba/Ombeyi river to Kibos river (include West Kano Paddy Irrigation Scheme)

2.2 Present Land Use

About 50,000 ha or 70% of the total land (73,000 ha) can be used for agriculture, about 13,000 ha or 18% of total land area is marsh and swamp which cannot be used for agriculture at present. Present land use is summarized given in below. Details are shown in Table V-2.2-1 and Fig. V-2.2-1.

	(ha)
Land use	Area
Total Agricultural Land	50,510
Paddy field	3,870
Harvested field	2,070
Non-harvested and fallow	1,800
Upland field	20,240
Harvested field	14,920
Non-harvested and fallow	5,320
Pasture	22,710
Scrub	3,690
Homestead, Road and Others	9,490
Marsh and Swamp	12,980
Total	72,980

Out of the total agricultural land, only about 17,000 ha is harvested and the rest of the land is usually left as fallow field, pasture for grazing and scrub. It is also observed that upland field and pasture land are rotated at few years interval. Fallow stage of upland and paddy fields are also used as a pasture for grazing.

2.3 Present Cropping Pattern

2.3.1 Crops

The major crops grown in the area are cereal crops (maize, sorghum and paddy) followed by pulses (beans, greengrams, cowpeas and groundnut), cotton and tuber crops (cassava and sweet potato). The hectareage of major crops in the Kisumu district and the study area are shown in Tables V-2.3-1, 2.3-2 and 2.3-3.

Sugarcane is mainly cultivated only in the northern part of the area where is close to the sugarcane factories. Upland crops are cultivated under rainfed condition. Maize and sorghum are generally grown under intercropping with several kinds of pulses, cotton plant and cassava. Lowland paddy is cultivated in a low lying area where irrigation facility has been developed under the National Irrigation Board (NIB) and/or the small scale irrigation scheme assisted by the Provincial Irrigation Unit (PIU) or LBDA. The hectareage of vegetables and fruit tree are very limited. Vegetables are mainly cultivated in the house garden or in the area close to river or irrigation canal. The root crops such as sweet potato and cassava are cultivated in almost all the area as reserve food crop for shortage of food crops damaged by flood or drought injury.

2.3.2 Cropping calender

The cropping pattern and growth period of crops are largely affected by seasonal distribution of rainfall and flooding. The planting and harvesting time have a wide range and fluctuate year by year, because these crops are usually planted at the onset of the rainy season or the end of flooding period and planting time delays with delay of the onset of rainy season and the end of flooding. The typical cropping patterns and growth duration of major crops in the area is shown in Table V-2.3-4 and Fig.2.3-1

(a) Upland crops

Maize, sorghum and pulses for the long rainy season are planted during February to April, and harvested during June to August. These crops are mostly intercropped with each other. In the short rainy season, these crops are mostly planted during September to October and harvested during December to January, however the hectareage of these crops in short rainy season is very small, only less than 15% of that of long rainy season. Cotton is mainly intercropped or relay cropped with maize or sorghum and is planted two to three months after sowing of maize or sorghum. Cotton is harvested during October to January. Vegetables are cultivated under irrigated conditions, therefore, vegetable cultivation is observed through whole year. Tuber crops are also cultivated in a whole year. The cropping intensity of upland crops are ranged from 41% to 118%. (Table V-2.2-1).

(b) Paddy

There are 25 small scale irrigation scheme (hereinafter called PIU scheme) and two NIB project in the area. The cropping season of paddy plant under the PIU scheme is largely affected by water condition, rainfall and flooding, because the irrigation water is drawn from small streams of which flow depends on direct rainfall

and much rainfall causes flooding of paddy field. Cropping season is very variable, in 1990 long rainy season, paddy plant was cultivated in four PIU schemes, and there is no observed rice double cropping at present. In NIB scheme, the duration of cropping season elongated and fallow area increased year by year due to shortage of tractor. In 1990, paddy season started at early June and ended at middle of March. In 1991, the paddy cropping is not yet started at the beginning of August.

2.4 Present Farming Practice

2.4.1 Upland crops

Farm operation in the area is mostly carried out by manpower. Animal power by oxen is used for only soil preparation and transportation of farm products. The agricultural machinery for farm operation is scarcely used except sugarcane area. Maize and sorghum are planted in a density at 90 - 120 x 30 cm in the case of intercropping with pulses and relay cropping with cotton, and in a density at 50 - 75 x 30 cm in the case of mono cropping.

Sometimes maize, sorghum, pulses and root crops are planted in the same field by intercropping method to secure the minimum food in the case of severe drought stress. Pulses are mostly intercropped with maize or sorghum and are sown at the same place with maize or sorghum, or between the row of maize or sorghum at seeding of maize or sorghum. Cotton plant is mostly cultivated in relay with maize or sorghum and the sowing of cotton plant is done about two to three months later than those of preceding crops. Cassava and sweet potato are grown as a reserve for staple food in the almost all areas through whole year. These crops are always cultivated under no chemical fertilizer applications and poor management.

2.4.2 Paddy

Cultivation of paddy plant is transplanted method in a plant density at 30 - 100 hills per m². Sowing is done in a nursery about three to five weeks before expected transplanting time. The land preparation of paddy field is mainly carried out by animal power and manpower in the PIU scheme, however, in NIB scheme, ploughing and harrowing are done by tractors and puddling done by oxen power. Other farm operations are carried out by manpower. In the PIU scheme, paddy plant are cultivated under no fertilizer and poor management and always facing to water stress. On the other hand, paddy plant in NIB scheme are grown under fertilizer application and relatively good farm management.

2.4.3 Variety

The variety of maize, sorghum and rice plant in the area are mostly improved varieties; hybrid varieties like H-600 series (long duration) and H-500 series (short duration), and composite varieties like Katumani for maize; IR 2793, BW 196, Sindano and Basmati for paddy plant; Serena, Seredo and E52R for sorghum. Traditional varieties of sorghum is still employed because of high quality, however the hectareage of traditional varieties is limited compared with improved ones. The varieties of cotton and sugarcane in the area are also improved ones; American upland for cotton; CO series such as; CO 421, CO 670 and CO 331 for sugarcane.

2.4.4 Agricultural inputs

Almost all of these crops are grown without application of fertilizers and agricultural chemicals, like herbicides, pesticides and fungicides. Only paddy plant grown under NIB scheme is applied some fertilizers and pesticides. Some farmers (very limited) applied fertilizers for rice plant and cotton plant. Cotton plant is generally applied pesticides for twice to four times a season. One of the reasons of the very low farm input can be explained by plants being always suffered by meteorological stress like flood and drought. The requirement of farm inputs and the labour per ha for each crop under present condition are summarized as seen in Table V-2.4-1.

2.4.5 Pests and diseases

Some pests and diseases are frequently observed on the crops in the area. The most common insects and diseases observed on paddy plant are stem borers and rice yellow mottling virus (RYMV) disease. In some areas, the damage of RYMV disease is observed to be very serious and rapidly extending to other areas. Damages by pests are observed on maize, sorghum, cotton and groundnut such as stem borers, aphids, midges, bugs and ball warms, but is not so serious except cotton plant. Damages by diseases for groundnuts are

observed such as rosette, leaf spot, leaf blight, especially damage of rosette is obvious. Bacterial wilt and spot disease are observed on cotton plant. Birds and animal damages on the crops are also obvious in the area.

2.5 Present Crop Yield and Production

2.5.1 Yield

Present crop yield (average value in Kisumu district) and production in the study area are presented in Table V-2.3-2. Yield of each crop is relatively low compared with average yield in the world. The information from farmers indicates that the yield and amount of production of crops are always fluctuated year by year and place by place. The main reason may be due to low farm input, poor management and some kind of stress like pest, drought, diseases, flood, nutrient. Yield of these major crops can be improved by employing improved farm management, newly bred good variety, good farm infrastructure and higher farm input.

Yield analysis of paddy was carried out in 1990 long rainy season crop by employing Matsushima's method. The results are shown in Table V-2.5-1. Average yield of harvested field was 3.6 t/ha. However, no yield or extremely low yield was observed in some paddy field where transplanting time was delayed and faced to water stress during the middle and late growth stages. In these area, the paddy plant was not harvested.

Yield components of paddy plant in the area are characterized by low sink size or smaller number of spikelets per unit field area and per panicle, and large number of panicles per unit field area and relatively high percentage of ripened grains. Relatively low yield of paddy is due to less amount of sink size or smaller number of spikelets per unit filed area. Small number of spikelets per unit field area is caused by small number of spikelet per panicle. Large number of panicle per unit field area depends on the high plant density.

From these fact, it is important to increase the sink size or the number of spikelets per unit filed area and the number of spikelets per panicle by application of fertilizer for increasing yield. In addition, it is also important to select proper cropping season to decrease non-harvest field.

By receiving the temperature data at Ahero Irrigation Research Station, it was supposed that there was observed some cold injury on paddy plant which was harvested on the middle of August. But, there was not observed a high percentage of non-fertilized grains which was damaged by low temperature. From these, it can be easily assumed that the duration of low temperature (15°C or less) is too short to damage the paddy plant.

2.5.2 Production

The production of each crops fluctuates year by year, however, it shows an increasing tendency. But staple food crop production is still short to maintain the population in the area, even if the maize production of Kenya already exceed the demand.

2.5.3 Livestock population

Livestock raising is also one of the main line in agricultural activities in the area. The population of livestock and production value are shown in Table V-2.5-2. The production value in 1989 is estimated at 22 million Kenya Shillings and equivalent to 2/7 of the production value of major crops (Table V-2.5-2). Cattle is the most important and sheep and goats are the second important. In the study area, the milk production is negligible compared with meat production, however; the number of grade cattle is increasing year by year. Some farmers earn money by poultry especially in Winam. Almost all of these animals and birds are indigenous. Cattle is also important as a source of farm power. Livestock is traditionally grazing in pasture, fallow field and the cropped field after harvest.

2.6 Agriculture Extension Service and Research Institutions

The extension service not only provide technical informations and skills to farmers for intensifications of the production process but also coordinate complementary service such as input supply, credit and marketing. The Ministry of Agriculture has Extension and Manpower Development Division headed by deputy director of agriculture under Agriculture Department at national level. At the provincial level Department of Agriculture is represented by Provincial Agricultural Officer (PAO) who is assisted by a team of specialists. At the distinct level Department is represented by a District Agricultural Officer (DAO) and a team of specialists. This line is continued up to the locational level where the locational extension office comes into direct contact with farmers. The organization lines are illustrated in Fig. V-2.6-1, and the manpower of Department of Agriculture and Animal Production, Kisumu are shown in Tables V-2.6-1 and 2.6-2.

There are three agricultural research stations around the study area, Ahero Irrigation Research Station (AIRS) at Ahero, National Sugarcane Research Centre (NSRC) at Kibos and National Cotton Research Institute (NCRI) at Kibos. These institutes are responsible to carry out experimental work and provide informations for improving crop productivity and releasing new cultivars. In these institutes, breeding of new variety and varietal selection is the first priority. Improvement of cultural practice and plant protection are also studied. The improved new technique will be extended to farmers through extension workers. AIRS are now concentrating on varietal selection and varietal adaptability trial of introduced varieties from IRRI and WARDA. NSRC and NCRI also concentrate varietal trial and breeding. NSRC recommended CO-series and released new variety EAK series and NCRI recommended BPA75, UKA59/240 and UPA/IL62 and released KSA81M.

For other crops, Regional Research Centre, Kisii covered. The institute also concentrate varietal trial and breeding of food crops. They released new variety of maize, H500 series and H600 series, however now new variety of sorghum is released after Serena and Seredo. which are excellent and widely suitable in the country. These institutes belong to Kenya Agricultural Research Institute (KARI) under Ministry of Research Science and Technology. Only AIRS belongs to the National Irrigation Board (NIB).

3. AGRICULTURE DEVELOPMENT PLAN

3.1 Agricultural Constraint

(1) Fluctuation of cropped area and yield

Most of cropped land is developed for non irrigated upland crop field and limited area is developed for irrigated paddy field. Since upland crop cultivation is generally carried out under rainfed condition, cropping pattern is directly affected by rainfall pattern. The hectareage and yield of crops are fluctuated year by year depending on rainfall pattern. Since these crops are always facing to water stress and flood damage, the farmers do not want to give high inputs and to improve cultural practices under such conditions. Therefore, the yield of each crop stays at relatively low level. Even the paddy plant grown under the irrigated condition also completely depends on rainfall pattern, because irrigation and drainage facility is not completely developed and the irrigation water is mainly drawn from small streams which flow depends on direct rainfall, and plants are always facing to drought and flood problems.

(2) Low accessibility

The road net work in the area is not well developed except main road. In the rainy season the road condition becomes muddy and lack of bridges on the streams makes transportation of farm inputs and products so difficult, especially in poorly drained areas. The present poor condition also hampers agricultural activities in the area.

(3) Traditional farming practice

As far as cultivation techniques are concerned, there is much space to improve cultural practices to increase crop production. The agricultural extension service have been concentrating to introduce advance cultivation techniques. However, the farmers in the area are mostly continuing traditional cultural practices. The reason of this is mainly due to unstable yield caused by meteorological stress, such as drought and flood as above mentioned.

(4) Shortage of farm power

Another problem in the National Irrigation Board (NIB) scheme is observed in the maintenance of agricultural machinery such as tractor due to shortage of spareparts and limited budget. The shortage of tractor causes the extension of cropping season and extend the RYMV disease. In addition, no cropped area is increased by the shortage of tractor.

The constraints which hinder the improvement of land productivity, are manifold as mentioned above. The decisive constraints among them is, however, lack of infrastructure facilities like perennial irrigation and drainage systems and farm road net work.

3.2 Basic Concepts of Agricultural Development

To solve the constraint above mentioned, agricultural development plan would be formulated taking into the following concepts:

- (1) Proper irrigation water supply and drainage of excess water would be necessary to maximize and stabilize production of crops,
- (2) Crops would be selected taking into consideration on land suitability, knowledge level of farmers, marketing and benefit, government policy etc.,
- (4) Agro-infrastructures such as farm road, post harvest and processing facilities and storage would be introduced, and
- (5) The perennial swamp adjacent to the Lake would be conserved from the viewpoint of environmental conservation.

3.3 Selection of Optimal Development Scale

According to the land evaluation in terms of irrigation development mentioned in Annex III, the study area is classified into four classes, i.e. highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and unsuitable (NS). Out of 72,980 ha of the study area, 52,200 ha (72%) is suitable for paddy and 53,700 ha (74%) are suitable for upland crops, as shown below:

Suitability Class	Paddy		Upland Crops	
	(ha)	(%)	(ha)	(%)
S1	9,160	12.6	2,850	3.9
S2	26,350	36.1	13,950	19.1
S3	16,690	22.9	36,900	50.6
Subtotal	52,200	71.6	53,700	75.6
NS	20,780	28.4	19,280	26.4
Total	72,980	100.0	72,980	100.0

In order to determine the optimum scale of development, following three alternatives of irrigated area are examined from the economical and environmental view points through the preliminary study on available water resources, land resources mentioned above, flood and inundation, combination of crops to be introduced and cropping pattern, etc.

- Case 1: 24,220 ha extends from Kendu Bay to Kibos river, consisting of subarea I to VIII
Case 2: 20,240 ha extends from Kendu Bay to Left Bank of Nyando river, consisting of subarea I to VII
Case 3: 14,930 ha extends from Kendu Bay to Right Bank of Nyando river, consisting of subarea I to V

Based on the result of the examination of alternatives, Case 3 which irrigable area is 14,930 ha is selected as the optimum development scale in terms of project economy and effects on water quality of the Winam Gulf.

3.4 Selection of Crops

Based on the national food policy, the National Development Plan, and the Five Year Development plan of the Lake Basin Development Authority, the crops and cropping pattern for the project would be formulated. The following is a basic principle for the selection of crops and the layout of the cropping pattern:

- 1) Creation of the maximum benefits for farmers and national economy,
- 2) Effective use of available water resources,
- 3) Farmers' familiarity for farming practices and
- 4) Conformity to existing social condition.

The following crops are studied and discussed prior to the selection of crops:

- 1) Tea and coffee,
- 2) Cereals, such as maize, sorghum, wheat, and paddy,
- 3) Pulses, such as beans, cowpeas, greengrams, and groundnuts,
- 4) Tuber crops, such as sweet potato and cassava,

- 5) Vegetables, such as tomato, onion, cabbage and kale
- 6) Fruit tree, such as citrus and passion fruit,
- 7) Sugarcane,
- 8) Cotton and
- 9) Forage crops for dairy and working cattle.

In due consideration of the physical and social condition, demand and supply of crops, and farming profits as mentioned in the later section, tea, arabica coffee and wheat are excluded for the layout of the cropping pattern because of less suitable for irrigation agriculture in the area. Robusta coffee and sorghum are also excluded because of low return. Tuber crops should be cultivated non-irrigated area. The selected crops are as listed below:

- 1) Cereals, such as maize and paddy,
- 2) Pulses, such as beans, cowpeas and greengrams,
- 3) Vegetables, such as tomato, onion, cabbage and kale,
- 4) Sugarcane,
- 5) Cotton,
- 6) Fruit tree, such as passion fruit, and
- 7) Forage crops for dairy and working cattle.

3.5 Cropping Pattern and Change of Land Use

Cropping area would be determined taking into account of i) demand and supply, ii) farming profits, iii) marketability, iv) processing capacity, v) soil characteristics and vi) available irrigation water. Basic principles for determination of the cropping area would be itemized as mentioned below:

- 1) Staple food production is still in short to maintain the population in the Kisumu District. Therefore, the hectareage of maize would be extended to 3,500 ha to supply in and around the project area. What is more, the hectareage of pulses also would be extended to 3,500 ha for the regional food self-sufficiency.
- 2) The hectareage of paddy field could be possibly extended as far as soil characteristics and availability of irrigation water would be allowable.
- 3) The hectareage of sugarcane and cotton would be mainly determined on the basis of the existing processing capacity of the factories around the study area. Therefore, the cropping of sugarcane in the area would be limited to about 5,000 ha.
- 4) The hectareage of vegetables and fruit tree would be determined depending on the amount of local consumption, marketability and processing capacity of factories expected in the near future.
- 5) The hectareage of forage crops for dairy cattle would be determined taking into account of the local consumption in and around the area.
- 6) The hectareage of Napier grass would be limited to requirement for working cattle, because of the least profitable among the selected crops. Rice straw, sugarcane top and other crop residue be supplementary fed to working cattle.

Based on the principles mentioned above, cropping pattern and calendar are laid out as given in Table V-3.5-1 and Fig V-3.5-1. The following is a summary of the proposed cropping pattern:

Long Rainy Season	Short Rainy Season	Hectareage
Paddy	Beans	2,690
Maize	Paddy	1,740
Maize	Cotton/Beans	1,530
Sugarcane	Sugarcane	5,130
Vegetables	Vegetables	1,570
Fruit tree	Fruit tree	1,000
Napier Grass	Napier Grass	1,270
Total		14,930

Cereals are mainly cropped during the long rainy season; and pulses and cotton, during the short rainy season. Vegetables are planted in the relatively high elevated area in order to avoid moisture stress. In short rainy season, paddy plant should be planted in early February to late March and harvested in late June to early August to avoid cold temperature during the period from panicle initiation to the flowering stage.

Sugarcane and paddy plant would be cultivated in the area covered with heavy clay soil (mainly subarea III, IV and V), meanwhile vegetables and fruit trees would be mainly planted in the area covered with light loamy sandy soil (mainly subarea I and II).

Introduction of the cropping pattern mentioned above brings about the change of land use in the project area as tabulated below. Further details are given in Table V-3.5-2.

Category of Land	(Unit:ha)		
	Without Project Condition	With Project Condition	Balance
Paddy Field	780	4,430	+3,650
Upland Field	5,920	10,500	+4,580
Pasture	7,400	0	-7,400
Scrubs	830	0	-830
Total	14,930	14,930	0

3.6 Farming Practices

Farming practices in the project area are so extensive at present, the practices are characterized with low farm input, low cropping intensity and mixed cropping. After completion of the year round irrigation system in the area, proper farming practices are essential for realizing the full exploitation of agricultural potential in the area. For this purpose, it is necessary to introduce new high yielding varieties and varieties resistance to pest and disease, good seeds, appropriate cultural practice, fertilizer application method and appropriate plant protection method along with the development of irrigation facilities. Since the hectareage of major crops and cropping intensity will increase with developing irrigation facilities, the labour requirement will increase and fallow period of field will become shorter. The farm inputs of each crop are shown in Tables V-3.3-1 and 3.3-2.

Introduction of such improved farming practices need more labour requirement. Potential labour forces in the project area are estimated at 24,220 as shown in Table V-3.6-3 based on the statistic data in the Kisumu District. In the meantime, seasonal daily labour requirement is estimated by cropping at half month basis in accordance with the proposed cropping calendar and pattern, as given in Table V-3.6-4. The half monthly labour requirement is also estimated by multiplying the daily labour requirement for the proposed cropping pattern (Table V-3.6-5) with the cropping area, as summarized below:

Month	(Man-Days)	
	Early 15 Days	Late 15 Days
January	18,650	20,430
February	22,180	21,360
March	19,690	17,940
April	16,280	16,280
May	14,600	14,040
June	13,370	14,730
July	18,020	21,230
August	<u>23,130</u>	<u>23,760</u>
September	22,280	18,760
October	17,710	15,860
November	14,850	13,940
December	15,740	16,530
Potential Labour Force	24,220	24,220

As shown above, the maximum early and late monthly requirements are estimated at 23,130 man-days in early August and 23,760 man-days in late August respectively. Both maximum requirements are nearly covered with the potential labour force which is estimated in Table V-3.6-3.

For main farm power for heavy work like soil preparation and transportation, it is proposed to use mainly oxen power and partly machinery. In spite of farm mechanization having a lot of advantage such as speedy, smooth farming, saving of labour and to release farmers from heavy work, it requires large investment,

and skilful technique for farm operation and higher cost and technique for maintenance of machinery. Taking into consideration on the requirement of machinery and present condition, it is necessary to establish an organization for use of farm machinery. However, the light mechanization is necessary for plant protection and post harvest of crops such as sprayer for chemical spray, thresher for rice, sheller for maize and groundnut. Since heavy farming works such as soil preparation and transportation of farm products would be made by oxen power, a large number of cattle are required for the farm operation in the project area. Cattle population in and around the project area is investigated and roughly estimated as given below. The number of cattle in 2010 is also estimated depending on the trends of cattle population during the period of 1984 to 1989. The cattle population in and around the project area in both the recent year('87-'89) and the near future (2010) can fully cover the cattle requirement for the farming works in the project.

Year	(head)			
	Cattle Population		Requirement of of Work Cattle	
	In & around	In	In & around	In
1987 - 1989	38,560	22,620	17,140	9,940
2010	45,730	26,830	32,800	25,600

Napier grass for cattle grazing is the least profitable with in the crops in the area under irrigated farming. Therefore, the number of cattle for the farming works in the project area would be decreased as far as possible and the shortage should be supplemented from the surrounding area at rental basis.

Furrow irrigation practices would be employed for upland crops. So, all the upland crops would be mono-cropped. Pests and diseases control by chemicals should be minimized as far as possible in view of water pollution by drainage. With this view, varieties resistant to pests and diseases would be used and ecological control of pests and diseases should be also employed under the improved farming practices.

3.7 Anticipated Crop Yield and Production

Present yield of crops in the project area remains at low level due to low input, poor farm management and some stresses. After the completion of year-round irrigation system, yield of crops is sharply increased and stabilized through being accustomed to irrigation farming practices and intensive agriculture. The target yield and production of crops in future with-project condition are set forth as given in Table V-3.7-1, making reference to various data in Kenya and in the country with a similar climatic condition and publication of FAO.

Yield of crops grown under non-irrigated condition is so assumed to stay at the same level of the present yield. Under with-project condition, cropping intensity becomes doubled; non-harvested area is sharply decreased; to the contrary, yield of each crop is sharply increased as shown in Table V-3.7-1.

Tables

Table V-2.2-1 Present Land Use in the Study Area

Land use	Zone A			Zone B			Zone C			Sub-total	Grand Total
	I	II	III	IV	V	VI	VII	VIII			
Swamp	500	790	0	1,290	200	7,360	470	10	3,650	4,130	12,980
Paddy field	0	150	370	520	240	110	1,220	80	1,700	3,000	3,870
Upland field	680	2,420	1,350	4,450	1,850	2,740	3,630	1,880	5,690	11,200	20,240
Pasture	740	2,470	2,140	5,350	2,640	2,990	3,810	1,680	6,240	11,730	22,710
Scrub	60	810	460	1,330	1,030	920	120	90	200	410	3,690
Others	270	1,040	780	2,090	920	1,150	1,830	710	2,790	5,330	9,490
Total	2,250	7,680	5,100	15,030	6,880	15,270	11,080	4,450	20,270	35,800	72,980
Cropping intensity											
Paddy field	-	0.77	0.81	0.75	0.65	0.77	0.60	NA			
Upland field	1.09	1.03	1.18	0.49	0.44	0.41	0.54	0.68			

Source : Prepared by JICA Study Team

Table V-2.3-1 The Production of Crops in Kisumu District and Study Area (1987 - 1989)

	Kisumu District			Study Area		
	Hectarage (ha)	Production (ton)	Value (Ksh.1000)	Hectarage (ha)	Production (ton)	Value (Ksh.1000)
Maize	16,230	31,120	79,880	5,145	9,351	24,348
Sorghum	9,790	10,300	16,580	3,260	3,521	5,757
Millet	128	70	120	42	20	NA
Paddy	2,080	7,240	19,280	2,070	6,850	18,235
Beans	4,310	3,270	16,330	1,191	882	4,417
Greengrams	660	320	2,400	171	83	597
Cowpeas	860	330	1,270	277	105	404
Groundnut	910	720	7,240	195	145	2,119
Cassava	1,370	9,010	17,330	503	3,189	6,273
Sweet potato	2,420	12,030	6,450	1,128	6,882	7,935
Sugarcane	33,800	1,949,800	789,520	NA	NA	NA
Cotton	6,000	1,750	6,400	2,181	655	2,343
Coffee	257	410	4,218	NA	NA	NA
Banana	110	1,500	510	NA	NA	NA
Citrus	250	290	290	NA	NA	NA
Pineapple	40	760	1,140	NA	NA	NA
Pawpaw	40	50	90	NA	NA	NA
Onion	140	740	460	NA	NA	NA
Kale	310	4,220	3,950	NA	NA	NA
Tomato	180	2,440	1,355	NA	NA	NA
Napier grass	200	NA	NA	NA	NA	NA

NA: Not available

Source : Prepared by JICA Study Team

Table V-2.3-2 Production of Crops in the Study Area (1)
(1987-1989)

	Hectarage (ha)				Yield (t/ha)			
	1987	1988	1989	Average	1987	1988	1989	Average
Maize	5,157	5,377	4,901	5,145	1.80	1.98	1.98	1.92
Sorghum	3,617	3,189	2,972	3,260	0.90	1.05	1.26	1.08
Millet	50	39	36	42	0.72	0.27	0.45	0.48
Rice	2,489	1,521	2,200	2,070	3.60	3.34	3.00	3.31
Beans	1,513	874	1,081	1,191	0.90	0.60	0.72	0.74
Greengram	155	202	156	171	0.45	0.63	0.36	0.48
Cowpea	240	340	250	277	0.45	0.32	0.36	0.38
Groundnut	198	231	156	195	0.75	1.00	0.48	0.74
Cassava	538	560	412	503	5.58	7.16	6.24	6.34
Sweet potato	1,580	1,085	718	1,128	6.00	6.54	5.88	6.10
Sugarcane	NA	800	NA	NA	40.00	62.00	55.00	52.30
Cotton	1,493	1,846	3,204	2,181	0.30	0.30	0.30	0.30
Total	16,291	14,873	15,346	15,503				

	Production (ton)				Value (1000/Ksh)			
	1987	1988	1989	Average	1987	1988	1989	Average
Maize	8,976	9,712	9,389	9,359	18,748	31,200	23,093	24,348
Sorghum	3,216	3,419	3,819	3,521	3,879	5,682	7,650	5,757
Millet	34	10	16	20	-	-	24	NA
Rice	8,514	4,827	7,201	6,850	15,097	16,360	25,949	18,235
Beans	1,369	528	779	882	6,780	2,594	3,877	4,417
Greengram	68	125	55	83	606	698	488	597
Cowpea	111	101	93	105	-	84	700	404
Groundnut	148	230	74	145	3,398	2,107	850	2,119
Cassava	3,002	4,010	2,570	3,189	5,956	7,062	5,802	6,273
Total					73,087	71,126	74,935	72,428

Source : Prepared by JICA Study Team

Table V-2.3-3 The Production of Crops in the Study Area (2) (1987-1989)

Crop	Sub total								Sub total	Total
	I	II	III	IV	V	VI	VII	VIII		
Maize	245	870	850	399	498	582	575	1,126	2,283	4,875
Sorghum	125	558	437	299	373	405	345	718	1,468	3,260
Millet	0	4	2	4	5	6	8	13	27	42
Rice	0	116	300	181	71	938	48	416	1,402	2,070
Beans	135	275	65	30	36	105	213	332	650	1,191
Greengrams	4	24	23	10	12	19	29	50	98	171
Cowpeas	18	62	40	24	30	30	23	50	103	277
Groundnut	28	72	31	7	9	12	13	24	49	196
Cassava	32	112	73	21	27	46	72	120	238	503
Sweet potato	59	205	135	13	16	100	240	360	700	1,128
Cotton	93	316	203	93	117	243	426	690	1,359	2,181
Sugarcane	0	0	0	0	80	320	0	400	720	800
Total	739	2,614	1,889	1,081	1,274	2,806	1,992	4,299	9,097	16,694

Crop	Sub total								Sub total	Total
	I	II	III	IV	V	VI	VII	VIII		
Maize	470	1,690	1,114	766	956	1,117	1,104	2,162	4,383	9,359
Sorghum	135	603	472	323	403	437	373	775	1,585	3,521
Millet	0	0	1	2	2	3	4	6	13	20
Rice	0	384	993	599	235	3,104	159	1,376	4,639	6,850
Beans	100	204	48	22	27	78	158	245	481	882
Greengrams	2	12	11	5	6	9	14	24	47	83
Cowpeas	7	24	15	9	11	11	9	19	39	105
Groundnut	21	53	23	5	7	9	10	18	37	145
Cassava	203	710	463	133	171	292	456	761	1,509	3,189
Sweet potato	360	1,251	824	79	98	610	1,464	2,196	4,270	6,882
Cotton	28	95	61	28	35	73	128	207	408	655
Sugarcane	0	0	0	0	4,184	16,736	0	20,920	37,656	41,840

Source : Prepared by JICA Study Team

Table V-2.3-4 Growth Duration and Cropping Season of Major Crops

	Growth Duration (days)	Rainy Season	Planting	Harvesting
Maize	130 - 145	Long Short	February - March August - October	June - August December - February
Sorghum	130 - 145	Long Short	February - March August - October	June - August December - January
Rice	140 - 150	Long Short	February - April August - September (variable)	July - August December - January (variable)
Greengram Beans	110 - 130	Long Short	February - March August - October	June - July December - January
Groundnut	120 - 140		March - April	July - August
Cotton	150 - 160*		April - June	October - January
Sweet potato	360 - 410		variable	variable
Cassava				

* Growth duration of cotton grown under irrigation is about 160 - 180 days.

Source : Prepared by JICA Study Team

Table V-2.4-1 Farm Inputs and Labour Requirement under Present Condition

Input	Maize	Sorghum	Rice	Green-grain	Beans	Ground-nut	Cotton	Cassava	Sugar-cane	Vegetables
Farm inputs										
Seed (kg/ha)	25	5	25	25	50	50	20	2,000	3,000	1
Fertilizer										
ASN	-	-	0 or 280	-	-	-	-	-	-	-
TSP	-	-	0 or 120	-	-	-	-	-	-	-
Agrochemicals										
Seeddress (g/ha)	-	-	-	-	-	-	-	-	-	-
Insecticide(l/ha)	-	-	-	-	-	-	3	-	-	2
Fungicide(l/ha)	-	-	-	-	-	-	-	-	-	-
Farm power										
Tractor (hrs/ha)	-	-	-	-	-	-	-	-	(2)	-
Oxen (times/ha)	2	2	2	0	-	-	-	-	2	-
Machinery(hrs/ha)	-	-	-	-	-	-	-	-	-	-
Labour (M.D/ha)	115	110	160	95	95	105	120	115	130	565
Soil preparation	20	20	50	20	20	20	20	20	20	50
Seedling	15	15	5	15	15	15	15	45	50	15
Transplanting	-	-	30	-	-	-	-	-	-	30
Fertilizer application	-	-	-	-	-	-	-	-	-	-
Plant protection	-	-	-	-	-	-	5	-	-	10
Weeding	45	45	10	20	20	20	50	10	10	50
Water management	-	-	5	-	-	-	-	-	-	250
Harvesting	20	15	40	25	25	30	20	20	50	130
Post harvest	15	15	20	15	15	20	10	20	-	30

Source : Prepared by JICA Study Team

Table V-2.5-1 Yield and Yield Component of Paddy

	No. of Hills (sq. m)	No. of Panicle (sq. m)	No. of grains per panicle	Spikelets (1000/sq. m)	Ripening (%)	1000 grain weight (g)	Sink Size (g/sq. m)	Yield (t/ha)
Wasare 1	94	687	32	21.5	79	22.5	483	3.8
Wasare 2	78	526	38	20.1	79	22.7	456	3.6
Wasare 3	94	206	26	5.3	18	22.5	119	0.2
Wasare 4*	75	156	26	4.1	13	22.8	93	0.1
Masune 1	106	584	31	18.9	83	22.6	429	3.4
Masune 2	102	520	37	19.1	83	22.6	431	3.6
Masune 3	65	316	-	-	0	-	-	0
Ahero Experiment. Stn.	25	390	78	30.3	81	22.5	681	5.5

* Non-harvested field, affected by water stress during middle and late growth stages

Sink Size : Yield capacity or eventual yield

Varieties : IR 2793

Source : Prepared by JICA Study Team

Table V-2.5-2 Animal Production in the Study Area (1987 - 1989)

	Animal Production			Income in 1989 (Ksh.)
	1989	1988	1987	
Cattle				
Upper Nyakach	13,033	12,772	38,984	
Lower Nyakach	19,592	19,200		
Nyando	15,880	14,336	10,361	2,000 Ksh./Cattle
Winam	35,200	33,120	32,471	
Total	83,705	7,948	81,816	12,977,427
Sheep				
Upper Nyakach	5,945	5,404		
Lower Nyakach	6,820	6,820		400 Ksh./Sheep
Nyando	7,100	6,454		
Winam	6,960	6,560		
Total	26,826	25,239		772,000
Goat				
Upper Nyakach	4,195	3,815		400 Ksh./Goat
Lower Nyakach	4,490	4,490		
Nyando	5,120	4,860		
Winam	9,070	9,330		
Total	22,875	18,680		1,081,970
Poultry				
Upper Nyakach	8,790	7,845		
Lower Nyakach	9,150	8,845		
Nyando	35,072	31,485		Egg 6,721,250*
Winam	81,415	51,910		Meat Ksh. 1,478,675**
Total	134,425	83,365	121,770	8,199,925

* : $134,425 \times 1/2 \times 50 \times 2$

** : $134,425 \times 1/5 \times 55$

Farm gate price egg 2 Ksh. per egg

Chicken meat 55 Ksh. per head

Source : Prepared by JICA Study Team

Table V-2.6-1 The Number of Technical Staffs in the Department of Agriculture, Kisumu (1989)

District HQ	Winam Div.	Nyando Div.	Upper		Lower		Maseno Div.	Muharoni Div.	Maseno FTC	Total	Note
			Nyakach Div.	Nyakach Div.	Nyakach Div.	Nyakach Div.					
AOs*1	1	1	0	0	0	0	1	0	12	BSC level	
AAOs*2	8	4	3	4	6	6	6	2	39	Diploma level	
AAAs*3	30	19	9	13	15	15	23	4	113	Certificate level	
JAAs*4	9	11	4	4	9	9	8	0	46	Form II level	

FTC : Farmers Training Center

*1 Agricultural Officers

*2 Assistant Agricultural Officers

*3 Agricultural Assistants

*4 Junior Agricultural Assistants

Table V-2.6-2 The Number of Technical Staffs in the Department of Animal Development, Kisumu (1989)

District HQ	Winam Div.	Nyando Div.	Upper		Lower		Maseno Div.	Muharoni Div.	MLDC	Total	Note
			Nyakach Div.	Nyakach Div.	Nyakach Div.	Nyakach Div.					
APOs*1	0	0	0	0	0	0	0	0	4	BSC level	
AAPO/ADO*2	2	2	2	1	2	2	3	1	15	Diploma level	
APA*3	0	2	1	1	1	1	2	1	10	Certificate level	
JAPA*4	0	2	1	0	1	1	0	0	4	Form II level	

MLDC : Maseno Livestock Development Center

*1 Animal Production Officers

*2 Assistant Animal Production Officers

*3 Animal Production Assistants

*4 Junior Animal Production Assistants

Source : Prepared by JICA Study Team.

Table V-3.5-1 Hectareage of Propsed Cropping Pattern

(Unit:ha)

Long Rainy Season	Short Rainy Season	Sub-area						Total
		I	II-1	II-2	III	IV	V	
Paddy	Beans	240	0	110	1,010	910	420	2,690
Maize	Paddy	0	0	0	70	990	680	1,740
Maize	Cotton/Beans	100	200	1,010	120	60	40	1,530
	Sugarcane	0	0	0	1,230	1,830	2,070	5,130
Vegetables	Vegetables	100	190	1,100	140	20	20	1,570
	Fruit tree	100	190	710	0	0	0	1,000
	Napier grass	60	70	300	210	360	270	1,270
	Total	600	650	3,230	2,780	4,170	3,500	14,930

Beans : Field beans, Green grams and Cow peas.

Source : Prepared by JICA Study Team

Table V-3.5-2 Changes in Land Use

(Unit:ha)

Item	Sub-area						Total
	I	II-1	II-2	III	IV	V	
Present Land Use							
Paddy field	0	0	100	330	240	110	780
Upland field	270	300	1,470	840	1,540	1,500	5,920
Pasture	330	310	1,470	1,380	2,200	1,710	7,400
Scrub	0	40	190	230	190	180	830
Others	0	0	0	0	0	0	0
Total	600	650	3,230	2,780	4,170	3,500	14,930
Future Land Use							
Paddy field	240	0	110	1,080	1,900	1,100	4,430
Upland field	360	650	3,120	1,700	2,270	2,400	10,500
Pasture	0	0	0	0	0	0	0
Scrub	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0
Total	600	650	3,230	2,780	4,170	3,500	14,930
Change							
Paddy field	240	0	10	750	1,660	990	3,650
Upland field	90	350	1,650	860	730	900	4,580
Pasture	-330	-310	-1,470	-1,380	-2,200	-1,710	-7,400
Scrub	0	-40	-190	-230	-190	-180	-830
Others	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0

Source : Prepared by JICA Study Team

Table V-3.6-1 Farm Inputs under Proposed Farming Practice (crop/ha)

Input	Maize	Rice	Green gram	Beans	Cotton	Sugar-cane	Napier grass	Vegetable (Tomato)	Passion fruit
Seed (kg)	15	30	20	25	20	3,000	3,000	1	
Fertilizers (kg/ha)	ASN 1 TFS 2	350 100	115 100	115 100	390 100	1,050 200	2,800 200	580 100	
Agricultural Chemicals	Seed dress (g/ha) Insecticide (l/ha) Fungicide (l/ha)	- (3) -	- (2) -	- (2) -	4	-	-	-	10 10
Farm power	Labour (M. D./ha) Oxen (times. ha) Machinery (hrs/ha)	165 2 -	154 2 -	154 2 -	190 2 -	550 2 -	985 2 -	455 2 -	

1): Ammonium sulfate nitrate

2): Triple super phosphate

3): Values at three crops (one newly planting and two ratoons)

4): Values at four years

Source : Prepared by JICA Study Team

Table V-3.6-2 Labour Requirement under Proposed Farming Practice

Working Item	(Unit:man-day/crop/ha)								
	Maize	Rice	Green-grams	Beans	Cotton	Sugar-cane	Napier grass	Vegetables	Passion fruit
Field preparation	30	35	30	30	30	30	30	50	
Seeding (Planting)	15	5	20	20	20	50	50	15	
Transplanting	-	30	-	-	-	-	-	30	
Fertilizer application	5	8	5	5	5	15	50	10	
Weeding	45	15	30	30	55	45	45	50	
Crop protection	0	0	0	0	7	0	0	10	
Water management	15	12	14	14	18	60	60	120	
Harvest	30	50	40	40	45	250	300	120	
Post harvest	25	25	15	15	10	100	450	50	
Total	165	180	154	154	190	550	985	455	

1): One cycle (with two ratoon crops) ... about 4 years

2): One cycle (four years)

Source : Prepared by JICA Study Team

Table V-3.6-3 Available Labour Force for Farming Practices

1. Potential Labour Force for Farming Practices

Age	Male	Female	Total
0 - 9	16,490	16,390	32,880
10 - 14	5,670	5,770	11,440
15 - 19	4,930	5,120	10,050
20 - 39	12,480	12,010	24,490
40 - 59	5,310	5,680	10,990
60 -	1,670	1,580	3,250
Total	46,550	46,550	93,100

2. Labour Force for Household

Age	Male	Female	Total
20 - 39	-	9,600	9,600

3. Conversion Factor to Adult Equivalent

Age	Male	Female
0 - 9	0.0	0.0
10 - 14	0.3	0.3
15 - 19	0.5	0.5
20 - 39	1.0	0.7
40 - 59	0.3	0.0
60 -	0.0	0.0

4. Potential Labour Force for Farming Practice

Age	Male	Female	Total
0 - 9	0	0	0
10 - 14	1,700	1,730	3,430
15 - 19	2,470	2,560	5,030
20 - 39	12,480	1,690	14,170
40 - 59	1,590	0	1,590
60 -	0	0	0
Total	18,240	5,980	24,220

Source : Prepared by JICA Study Team

Table V-3.6-4 Daily Labour Requirement of Proposed Cropping Pattern (man-day/ha)

Month	Paddy		Maize		Vegeta- bles		Maize		Sugar cane		Napier Grass		Animal* Feeding		Fruit tree		Dairy Animal	
	Long rainy	Short rainy	Beans	Paddy	Vegeta- bles	Cotton beans/	Sugar cane	Napier Grass	Animal* Feeding	Fruit tree	Animal* Feeding	Fruit tree	Dairy Animal					
January	1-15	0.945	1.592	1.208	2.527	0.376	0.675	0.400	0.932	2.439								
	16-31	1.029	2.228	1.498	0.376	0.675	0.400	0.932	2.439									
February	1-15	1.321	2.513	1.810	0.376	0.675	0.400	0.932	2.439									
	16-28	1.187	2.518	1.501	0.376	0.675	0.400	0.932	2.439									
March	1-15	1.537	1.418	1.046	0.376	0.675	0.400	0.932	2.439									
	16-31	1.440	0.706	0.885	0.376	0.675	0.400	0.932	2.439									
April	1-15	0.952	0.673	0.690	0.376	0.675	0.400	0.932	2.439									
	16-30	1.011	0.673	0.673	0.376	0.675	0.400	0.932	2.439									
May	1-15	0.429	0.673	0.512	0.376	0.675	0.400	0.932	2.439									
	16-31	0.432	0.350	0.512	0.376	0.675	0.400	0.932	2.439									
June	1-15	0.219	0.350	0.443	0.376	0.675	0.400	0.932	2.439									
	16-30	0.400	0.536	0.806	0.376	0.675	0.400	0.932	2.439									
July	1-15	1.211	0.834	1.187	0.376	0.675	0.400	0.932	2.439									
	16-31	1.840	1.243	1.721	0.376	0.675	0.400	0.932	2.439									
August	1-15	2.229	1.535	1.940	0.376	0.675	0.400	0.932	2.439									
	16-31	2.293	1.835	1.905	0.376	0.675	0.400	0.932	2.439									
September	1-15	1.793	1.978	1.655	0.376	0.675	0.400	0.932	2.439									
	16-30	1.179	1.440	1.036	0.376	0.675	0.400	0.932	2.439									
October	1-15	0.945	1.302	0.920	0.376	0.675	0.400	0.932	2.439									
	16-31	0.557	1.011	0.726	0.376	0.675	0.400	0.932	2.439									
November	1-15	0.557	0.429	0.726	0.376	0.675	0.400	0.932	2.439									
	16-30	0.246	0.429	0.680	0.376	0.675	0.400	0.932	2.439									
December	1-15	0.867	0.272	0.946	0.376	0.675	0.400	0.932	2.439									
	16-31	0.945	0.400	1.176	0.376	0.675	0.400	0.932	2.439									
		2,690ha	1,740ha	1,570ha	1,530ha	5,130ha	1,270ha	4,800farms	1,000ha	770ha								

* Labour requirement MD/Household

Source : Prepared by JICA Study Team

Table V-3.6-5 Daily Labour Requirement of Proposed Cropping Pattern (total man-day)

Month	2,690ha		1,740ha		1,570ha		1,530ha		5,130ha		1,270ha		4,800farms		1,000ha		770ha	
	Long rainy	Paddy	Maize	Vegeta- bles	Maize	Sugar- cane	Vegeta- bles	Cotton /beans	Sugar cane	Sugar cane	Napier Grass	Napier Grass	Animal* Feeding	Animal* Feeding	Fruit tree	Fruit tree	Dairy Animal	Dairy Animal
January	1-15	2,540	2,770	3,970	1,850	1,930	3,970	1,850	1,930	860	860	1,920	1,920	930	930	1,880	1,880	18,650
	16-31	2,770	3,880	3,970	2,290	1,930	3,970	2,290	1,930	860	860	1,920	1,920	930	930	1,880	1,880	20,430
February	1-15	3,550	4,370	3,970	2,770	1,930	3,970	2,770	1,930	860	860	1,920	1,920	930	930	1,880	1,880	22,180
	16-28	3,190	4,380	3,970	2,300	1,930	3,970	2,300	1,930	860	860	1,920	1,920	930	930	1,880	1,880	21,360
March	1-15	4,130	2,470	3,970	1,600	1,930	3,970	1,600	1,930	860	860	1,920	1,920	930	930	1,880	1,880	19,690
	16-31	3,870	1,230	3,970	1,350	1,930	3,970	1,350	1,930	860	860	1,920	1,920	930	930	1,880	1,880	17,940
April	1-15	2,560	1,170	3,970	1,060	1,930	3,970	1,060	1,930	860	860	1,920	1,920	930	930	1,880	1,880	16,280
	16-30	2,720	1,170	3,970	1,030	1,930	3,970	1,030	1,930	860	860	1,920	1,920	930	930	1,880	1,880	16,410
May	1-15	1,160	1,170	3,970	780	1,930	3,970	780	1,930	860	860	1,920	1,920	930	930	1,880	1,880	14,600
	16-31	1,160	610	3,970	780	1,930	3,970	780	1,930	860	860	1,920	1,920	930	930	1,880	1,880	14,040
June	1-15	590	610	3,970	680	1,930	3,970	680	1,930	860	860	1,920	1,920	930	930	1,880	1,880	13,370
	16-30	1,080	930	3,970	1,230	1,930	3,970	1,230	1,930	860	860	1,920	1,920	930	930	1,880	1,880	14,730
July	1-15	3,260	1,450	3,970	1,820	1,930	3,970	1,820	1,930	860	860	1,920	1,920	930	930	1,880	1,880	18,020
	16-31	4,950	2,160	3,970	2,630	1,930	3,970	2,630	1,930	860	860	1,920	1,920	930	930	1,880	1,880	21,230
August	1-15	6,000	2,670	3,970	2,970	1,930	3,970	2,970	1,930	860	860	1,920	1,920	930	930	1,880	1,880	23,130
	16-31	6,170	3,190	3,970	2,910	1,930	3,970	2,910	1,930	860	860	1,920	1,920	930	930	1,880	1,880	23,760
September	1-15	4,820	3,440	3,970	2,530	1,930	3,970	2,530	1,930	860	860	1,920	1,920	930	930	1,880	1,880	22,280
	16-30	3,170	2,510	3,970	1,590	1,930	3,970	1,590	1,930	860	860	1,920	1,920	930	930	1,880	1,880	18,760
October	1-15	2,540	2,270	3,970	1,410	1,930	3,970	1,410	1,930	860	860	1,920	1,920	930	930	1,880	1,880	17,710
	16-31	1,500	1,760	3,970	1,110	1,930	3,970	1,110	1,930	860	860	1,920	1,920	930	930	1,880	1,880	15,860
November	1-15	1,500	750	3,970	1,110	1,930	3,970	1,110	1,930	860	860	1,920	1,920	930	930	1,880	1,880	14,850
	16-30	660	750	3,970	1,040	1,930	3,970	1,040	1,930	860	860	1,920	1,920	930	930	1,880	1,880	13,940
December	1-15	2,330	470	3,970	1,450	1,930	3,970	1,450	1,930	860	860	1,920	1,920	930	930	1,880	1,880	15,740
	16-31	2,540	700	3,970	1,800	1,930	3,970	1,800	1,930	860	860	1,920	1,920	930	930	1,880	1,880	16,530

* Labour requirement MD/Household

Source : Prepared by JICA Study Team

Table V-3.7-1 Crop Production under without- and with-Project

Crop	Without Project			With Project		
	Area (ha)	Yield (t/ha)	Production (t/year)	Area (ha)	Yield (t/ha)	Production (t/year)
Paddy	420	3.3	1,390	4,430	6.0	26,580
Maize	1,490	1.9	2,860	3,270	5.0	16,350
Sorghum	940	1.1	1,020	-	-	-
Beans	490	0.7	340	3,455	1.5	5,183
Cassava	140	0.3	890	-	-	-
Sweet potato	220	6.1	1,350	-	-	-
Vegetable	-	-	-	3,140	20.0	62,800
Fruit tree	-	-	-	1,000	10.0	10,000
Cotton	430	0.3	120	765	2.2	1,683
Sugarcane	40	523	2,090	5,130	100	513,000
Napier grass	-	-	-	1,270	400	508,000
Total	4,170	-	-	22,460	-	-

Beans : Field Beans, Green grams, Cowpeas and Groundnuts

Source : Prepared by JICA Study Team

Figures

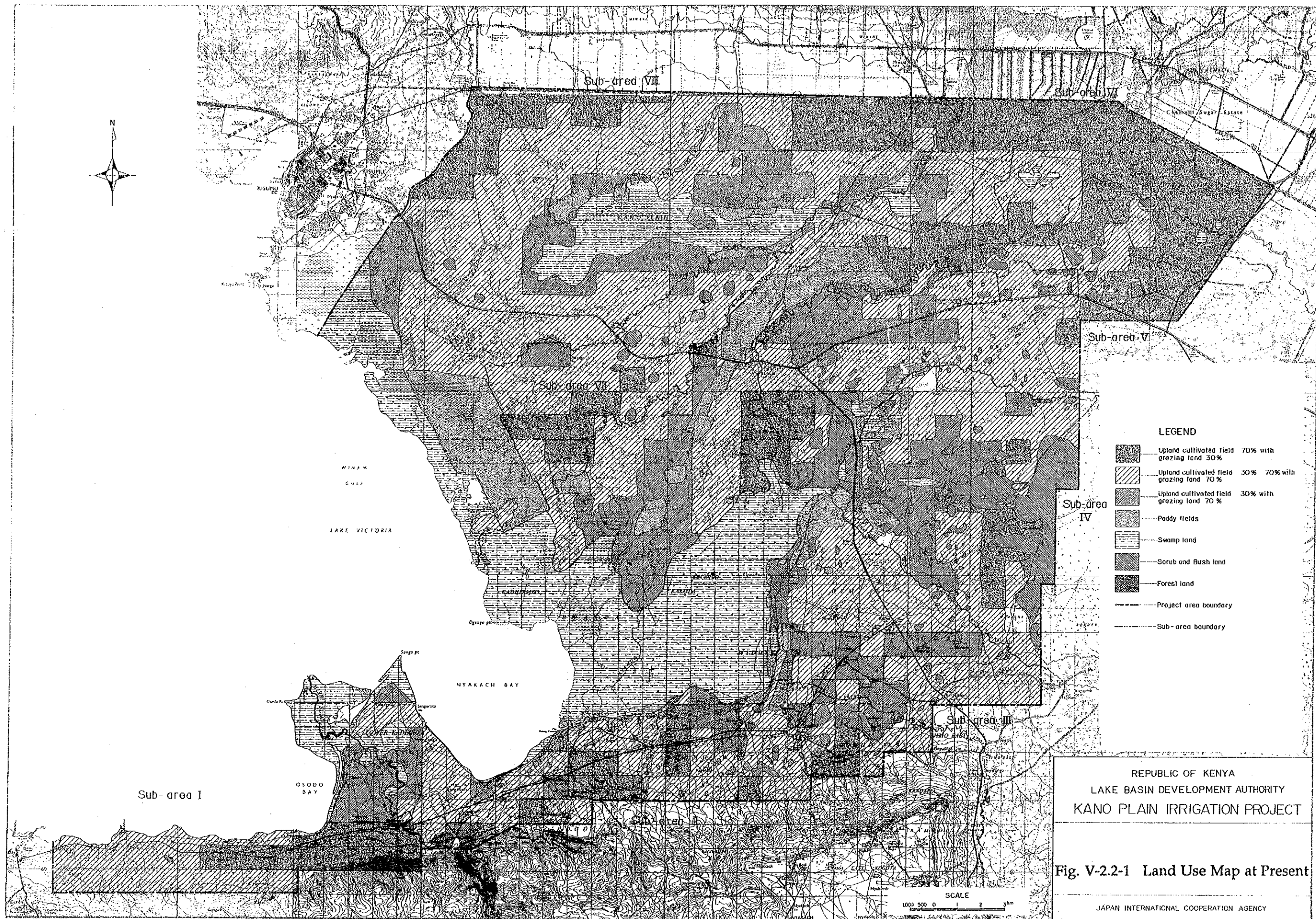
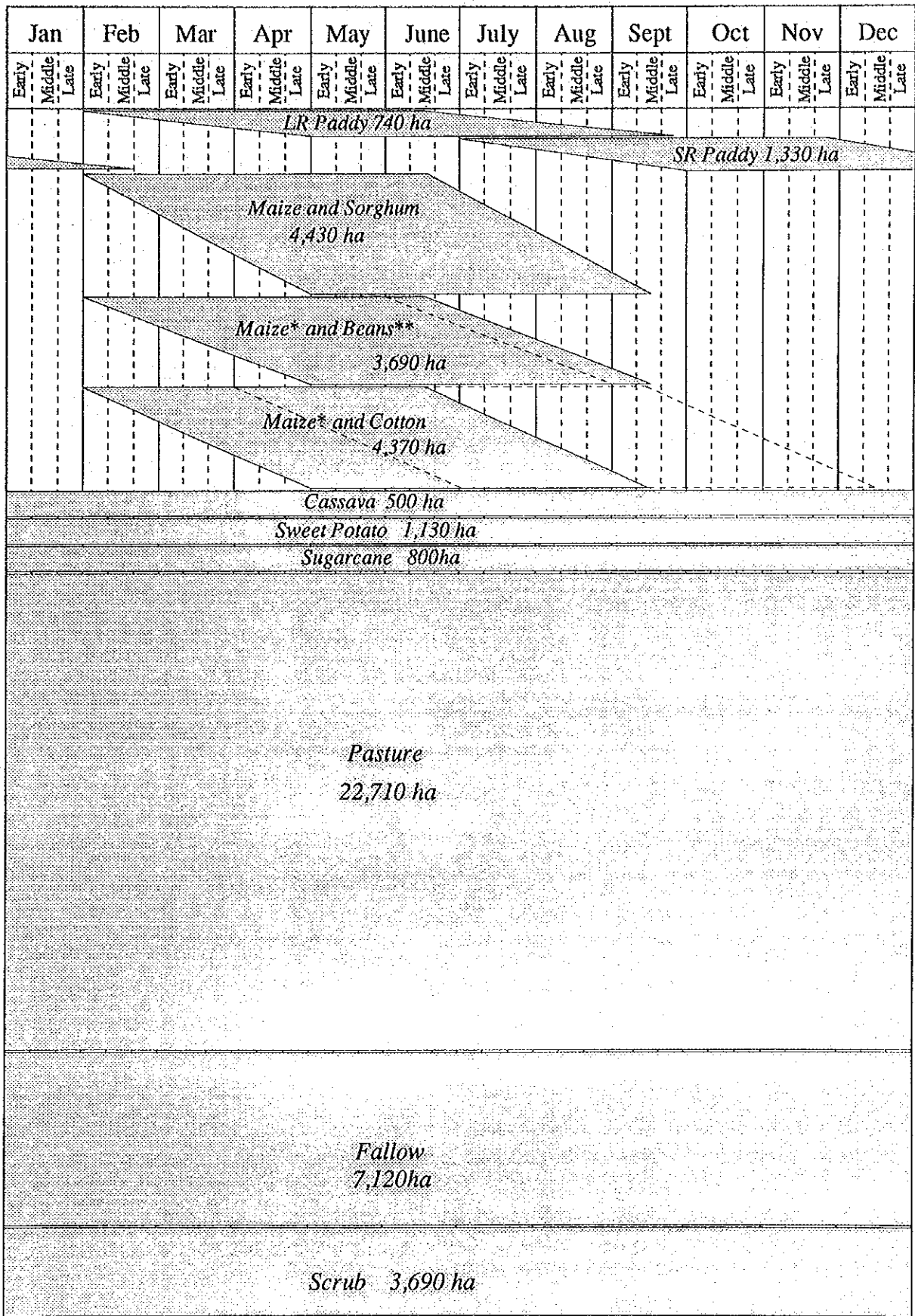
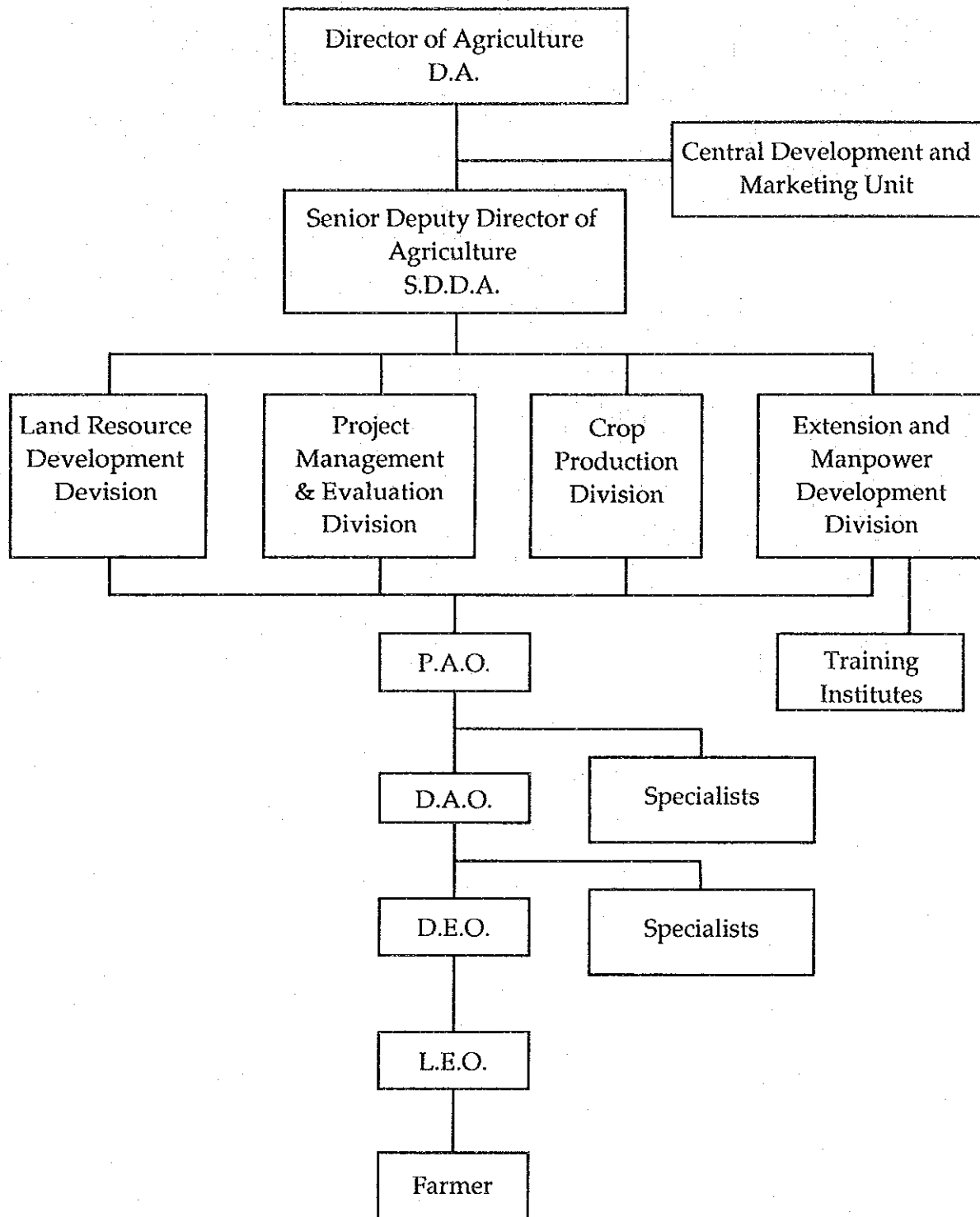


Fig. V-2.3-1 Present Cropping Calender



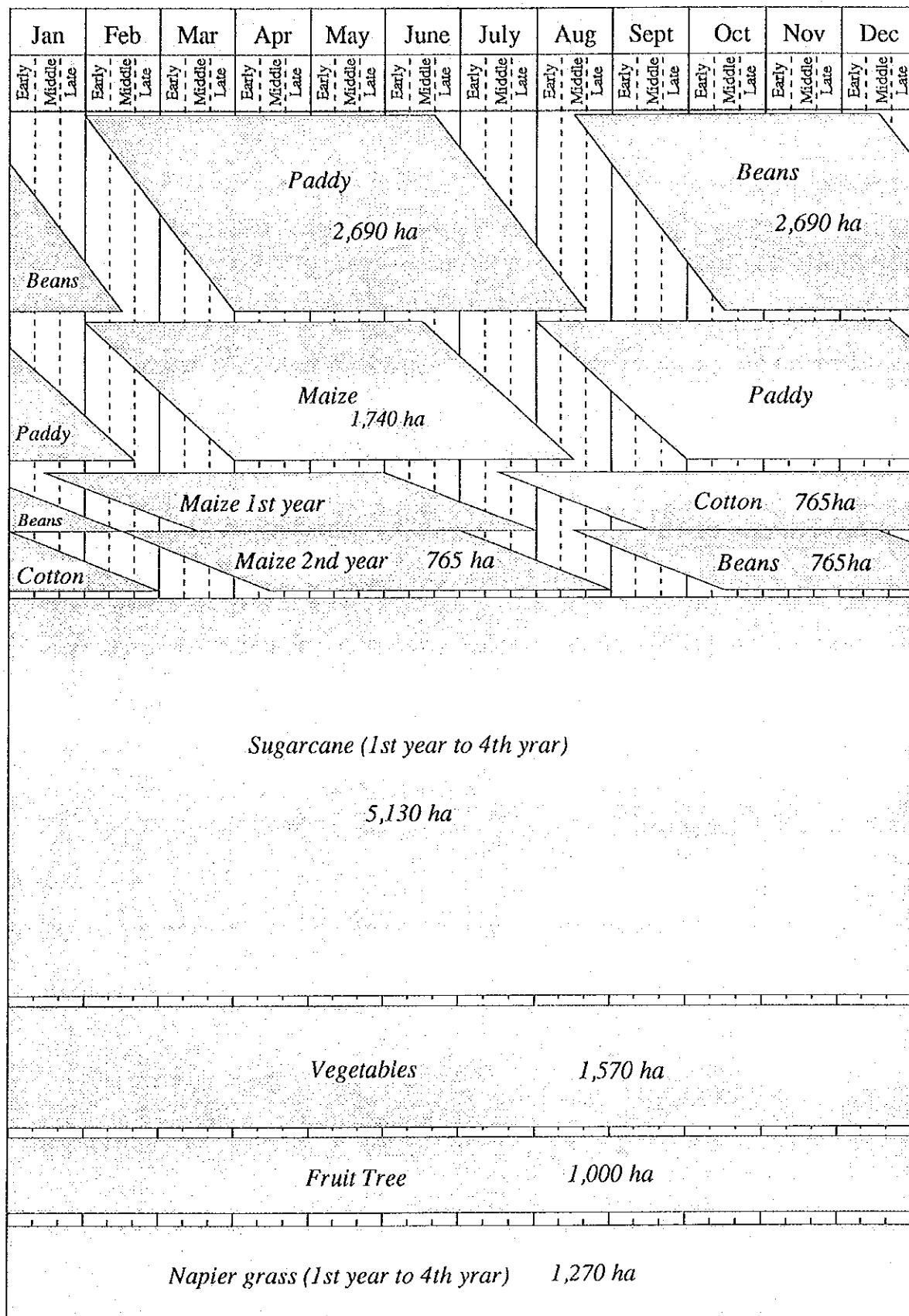
Beans**: beans, greengram, cowpeas and groundnuts
 Maize*:maoze and sorghum

Fig. V-2.6.1 Systematic Structure of Agricultural Supporting Institutions



P.A.O. = Provincial Agricultural Officer
 D.A.O. = District Agricultural Officer
 D.E.O. = Divisional Extension Officer
 L.E.O. = Locational Extension Office

Fig. V-3.5.1 Proposed Cropping Calendar



Annex VI

Agro-Economy

Feasibility Study
on
Kano Plain Irrigation Project

Annex-VI
Agro-economy

Table of Contents

	<u>page</u>
1. INTRODUCTION	VI-1
2. MARKETING AND PRICES	VI-1
2.1 Present Marketing System	VI-1
2.1.1 Food crops	VI-1
2.1.2 Cotton	VI-1
2.1.3 Sugarcane	VI-1
2.1.4 Other products	VI-1
2.1.5 Farm inputs	VI-1
2.2 Prices of Farm Inputs and Agricultural Products	VI-2
3. PROCESSING OF AGRICULTURAL PRODUCTS	VI-2
3.1 Rice Mills	VI-2
3.1.1 Large scale mills	VI-2
3.1.2 Medium scale mills	VI-2
3.2 Posho Mills	VI-2
3.3 Ginnery	VI-3
3.4 Sugar Factories	VI-3
3.5 Others	VI-3
4. INSTITUTIONAL SUPPORT SYSTEM FOR AGRICULTURE	VI-3
4.1 Agricultural Credit	VI-3
4.2 Seed Multiplication	VI-3
4.3 Cooperative Society	VI-4
5. FARM ECONOMY	VI-4
5.1 Family Size	VI-4
5.2 Land Tenure and Land Holding	VI-4
5.3 Income and Expenditure	VI-5

6.	MARKETING AND PRICE PROSPECT FOR PROJECT	VI-5
6.1	Marketing Prospect.....	VI-5
6.1.1	Food crops.....	VI-5
6.1.2	Sugarcane	VI-7
6.1.3	Cotton	VI-7
6.1.4	Vegetables	VI-7
6.1.5	Fruit tree	VI-10
6.1.6	Dairy	VI-10
6.1.7	Robusta coffee.....	VI-10
6.2	Price Prospect.....	VI-10
7.	NET PRODUCTION VALUE AND BENEFIT.....	VI-11
7.1	Unit Net Production Value by Crops.....	VI-11
7.2	Unit Net Production Value by Cropping Pattern.....	VI-11
7.3	Benefit	VI-12
8.	FARM BUDGET.....	VI-12

List of Tables

		<u>Page</u>
Table VI-2.1	Local Markets within Kisumu District	VI-T-1
Table VI-2.2	Price of Agricultural Inputs at Kisumu KGGCU (1991).....	VI T-2
Table VI-2.3	Prices of Major Agricultural Product by Parastatal Bodies and Cooperative Unions	VI-T-3
Table VI-2.4	Farmgate Price of Major Agricultural Products.....	VI-T-4
Table VI-4.1	Seed Production at Yala Seed Farm (1990)	VI-T-5
Table VI-4.2	Production of Fruits Tree Seedlings at Yala Seed Farm (1990)	VI-T-5
Table VI-6.1	Past Trend of per Capita Supply of Major Food (1/2).....	VI-T-6
Table VI-6.1	Past Trend of per Capita Supply of Major Food (2/2).....	VI-T-7
Table VI-6.2	Financial and Economic Prices for Agricultural Outputs and Inputs.....	VI-T-8
Table VI-6.3	Price Structure of Rice and Maize.....	VI-T-9
Table VI-6.4	Price Structure of Sugarcane and Cotton	VI-T-10
Table VI-7.1	Economic Crop Budget under With-Project Condition (1/3).....	VI-T-11
Table VI-7.1	Economic Crop Budget under With-Project Condition (2/3).....	VI-T-12
Table VI-7.1	Economic Crop Budget under With-Project Condition (3/3).....	VI-T-13
Table VI-7.2	Production Value of Dairy Farming under Zero Grazing (1/4).....	VI-T-14
Table VI-7.2	Production Value of Dairy Farming under Zero Grazing (2/4).....	VI-T-15
Table VI-7.2	Production Value of Dairy Farming under Zero Grazing (3/4).....	VI-T-16
Table VI-7.2	Production Value of Dairy Farming under Zero Grazing (4/4).....	VI-T-17
Table VI-7.3	Production Value of Working Cattle	VI-T-18
Table VI-7.4	Production Value of Pasture for Working Cattle.....	VI-T-19
Table VI-7.5	Production Value of Sub-products.....	VI-T-20
Table VI-7.6	Production Value of Robuster Coffee (1/2).....	VI-T-21
Table VI-7.6	Production Value of Robuster Coffee (2/2).....	VI-T-22
Table VI-7.7	Economic Crop Budget under Without-Project Condition (1/2).....	VI-T-23
Table VI-7.7	Economic Crop Budget under Without-Project Condition (2/2).....	VI-T-24
Table VI-7.8	Economic Net Production Value per Ha (Economic).....	VI-T-25
Table VI-7.9	Unit Net Production Value (Economic).....	VI-T-26
Table VI-7.10	Economic Incremental Benefit.....	VI-T-27

Table VI-8.1	Financial Crop Budget under With-Project Condition (1/2).....	VI-T-28
Table VI-8.1	Financial Crop Budget under With-Project Condition (2/2).....	VI-T-29
Table VI-8.2	Farm Budget under With-Project Condition	VI-T-30

1. INTRODUCTION

This annex report is to support the Report of the Feasibility Study on the Kano Plain Irrigation Project. This report describes the agro-economic aspects of the project based on the data and information collected during the study period from August 1990 to October 1991. The agro-economic aspects presented here includes the present condition and the future proposed condition on marketing of agricultural inputs and outputs, processing, farmers' economy.

2. MARKETING AND PRICES

2.1 Present Marketing System

Main marketing channel of agricultural products is classified into two categories, i.e., channels handled by private sectors and channels provided by the parastatal bodies. In addition to these channels, local markets under County Council and Municipal Market of Kisumu play important role on marketing of agricultural products. Main local markets in and around the study area are listed in Table VI-2.1. Local markets open periodically, usually once or twice a week, and farmers can sell their products there.

2.1.1 Food crops

Cereals such as maize, sorghum, millet, rice and pulses are marketed by private millers or agent, and also National Cereal and Produce Board (NCPB) is buying for national security food stock.

Paddy produced in NIB schemes are collected by NIB, and sold to private millers or NCPB. Paddy produced in the PIU schemes are largely collected by the private millers, and are partly sold at the local markets mainly by women's group. According to the private millers, rice is mainly transported to other districts after milling, however, they have to get permission from district commissioner and NCPB to transport rice out of Kisumu District.

Maize, sorghum, other cereals, and pulses produced are mostly for home consumption, and some surplus is sold at the local markets.

2.1.2 Cotton

Cotton growers in Kenya are supported for input supply, marketing of products and processing by the Cotton Board of Kenya, which was formerly named as Cotton Lint and Seed Marketing Board.

After harvesting, seed cotton is collected by the cotton cooperatives and is purchased by the Board. To purchase seed cotton at the cooperatives, the Board grades seed cotton to A rank or B rank. Current price of seed cotton is Ksh. 10.00 for A rank and Ksh. 6.00 for B rank per kg. After purchasing, the Board transport to the ginnery located at Kibos and Kendu Bay.

2.1.3 Sugarcane

Most of sugarcane is grown by the estates of the sugar mill factories at Chemelil, Miwani and Muhoroni and by the contract growers surrounding the factories. Farm machinery services, farm inputs, harvest, loading and transportation are provided by the contractors of factories at the cost of producer.

Some farmers sell their sugarcane to jaggery factories, which are located at Ahero, Nyagande, and some other places. These factories prepare brown sugar cluster, which is sold in local markets.

2.1.4 Other products

Vegetables and fruits are mostly sold at local markets by farmers and private dealers, and consumed in and around the study area. In the larger scale of local markets, livestock such as cattle, sheep, goats, pigs and chickens are also marketed.

2.1.5 Farm inputs

Most of farm inputs are supplied by Kenya Grains Growers Cooperative Union Ltd. (KGGCU). KGGCU has 2 branch offices in Kisumu and Muhoroni. From these branches, farm inputs are mainly handled to farmers through primary cooperative societies or private dealers called stockist. Also, individual farmers can

buy directly from the branch office. Advantage for farmers to buy inputs from cooperative societies is to utilize agricultural credit.

KGCCU procures fertilizers, chemical and vegetable seeds through import from abroad, certified seeds of grains from Kenya Seed Company at Kitale.

2.2 Prices of Farm Inputs and Agricultural Products

Prices of farm inputs are controlled by the KGCCU, however retail prices depending on the locations due to the transportation costs. Prices of main farm inputs at the KGCCU Kisumu branch office are listed in Table VI-2.2.

Prices of crops handled by the parastatal bodies such as NCPB, Cotton Board of Kenya, Kenya Planters Cooperative Union and sugar mill factories are regulated by the government. Those prices of commodities are shown in Table VI-2.3. Farmgate prices of crops dealt by the local markets are given in Table VI-2.4.

3. PROCESSING OF AGRICULTURAL PRODUCTS

There are some processing industries of agricultural products in and around the study area. These are mainly rice mills, maize mills, wheat mills, cotton ginnery, sugar mills and jaggery factories. Outline of these facilities is presented below.

3.1 Rice Mills

There are 2 large scale rice mills and some medium scale rice mills in and around the study area.

3.1.1 Large scale mills

(1) United Millers Ltd.

United Millers Ltd., located at Kisumu township has the largest rice mill in the Kisumu District, which maximum processing capacity is 125 tons per 24 hours. Formerly, United Millers processed rice for NCPB by custom milling, however they purchase paddy mainly from NIB scheme and sell to whole sellers at present.

(2) Kibos Industries Ltd.

There are two rice mills in the Kibos Industries Ltd. located at Kibos. Total processing capacities of these mills are about 48 tons per 24 hours. These mills purchased paddy from NIB scheme or contract rice farmers of PIU schemes in the study area. Most of milled rice are transported to other districts. In addition to this, they have wheat mill, oil mill for cotton seed and sunflower seeds and jaggery. Mill manager intends to expand the capacity of rice mills to 2 times of the present capacity.

3.1.2 Medium scale mills

Nyando Millers Ltd. is operating rice mills in branches located at Rabuor, Ahero, Ombeyi, Nyagande, Kattito, etc.. They installed about 15 medium scale mills, which capacities are about 4 ton per day each. Total capacity of Nyando Millers are estimated at 60 tons per day in. These mills are operated on custom milling base, and paddy are brought mainly by women's group. Milling charge is Ksh. 0.5/kg. Paddy husk and bran are sold to others for animal feed. Beside rice mills, maize mills are equipped in the branches and are operated by custom milling base.

In addition to Nyando Millers, Nyando Enterprise Ltd is located at Ahero, and two rice mills are operated by custom milling base.

3.2 Posho Mills

There exists many small scale grain mills, so called "Posho" mills, for maize, sorghum, millet and cassava by custom milling base. These mills are mainly located at local markets and operate by diesel engines. People around the market utilize these mills to grind grains and pulses for their home consumption. Milling charge ranges Ksh. 0.6/kg to Ksh. 1.5/kg.

3.3 Ginnery

Ginnery owned by Cotton Board is located at Kibos in the study area. The capacity is about 2,000 ton per season. In the South Nyanza District, there are two ginneries owned and operated by the cooperative union. One is located at Kendu Bay and the other at Homa Bay. Capacity of each mill is 2,8000 ton per season. Machineries of these ginneries are old, over 50 years. Recovery of lint from seed cotton is estimated at about 33%. Cotton seeds separated from seed cotton are partly used for seeds as planting material and remains are sold to oil millers.

3.4 Sugar Factories

Three large scale sugar mill factories are located around the study area. These are Chemelil Sugar Company at Chemelil, East Africa Sugar Industry Ltd. at Muhoroni and the other at Miwani. The sugar factory at Miwani has been rehabilitated and is under test operation at present. Those factories are operated under the management of the parastatal bodies.

The capacities are 3,000 ton at Chemelil and 2,000 ton at Muhoroni and 2,500 ton at Miwani per 24 hours. These mills stop operation for regular maintenance in the long rains season from March to April. Accordingly, annual capacities are estimated at 2,000,000 ton in total, comprising about 800,000 ton at Chemelil and 500,000 ton at Muhoroni and 700,000 ton at Miwani. Recovery rate of sugar from sugarcane ranges 8% to 11% depending upon sugar content of cane, and is averaged at around 10%. Sugar products are sold to Kenya National Trading Company.

In addition to those large scale sugar mills, sugarcanes (grown in the study area) are partly processed by the jaggery factories, which produce brown sugar cluster.

3.5 Others

Swan Millers Ltd., located at the industrial area in Kisumu, is operating mills for wheat (flour) and maize in a large scale with 6,000 ton capacity silos. Wheat and maize to be milled are supplied by NCPB. The capacity of mills are 150 ton for wheat and 120 ton for maize per 24 hours. Efficiency of flour mill is 76%. Sub-products such as bran and short are sold as animal feeds.

Butcheries are located at every local market to provide meats for local consumers. No any meat and dairy processing facilities are located in and around the study area. District cooperative office has a plan to establish milk storage at Muhoroni.

4. INSTITUTIONAL SUPPORT SYSTEM FOR AGRICULTURE

4.1 Agricultural Credit

There are five channels through which these funds are transmitted to farmers, i.e. Agricultural Finance Corporation (AFC), Co-operative Bank of Kenya (CBK), parastatal organizations, and commercial banks and companies. The main agencies involved in lending are AFC and CBK. The farmers are applicable advance credit for purchase of livestock, equipment, machinery, even for land. Most of the credit lent are short term and unsecured basis for growing crops, mainly maize and wheat.

According to the AFC Kisumu branch, agricultural credit is classified into three categories i.e. long term, medium term and short term by the type of loan. Long term credit is 7 - 30 years period for large capital investment. Medium term credit is 2 - 7 years. Short term credit is several months to 2 years periods mainly for farm inputs such as fertilizers, agro-chemical, seeds and implements. Interest rate of credits are around 12%, which is far lower than that of 15 - 16% by the commercial banks. In the study area, farmers are taking agricultural credit mostly for cash crops like cotton, dairy, vegetable, fruits through cooperative societies and parastatal bodies for commodities.

4.2 Seed Multiplication

In the study area, the farmers generally retain seeds from their own produce of the local varieties. Cotton seed is available from the Cotton Board of Kenya in free of charge. Improved seeds for all crops are available on the market as well as from Kenyan Seed Company located at Kitale.

Rice seeds which are tested and released at Ahero Irrigation Research Station are available for the farmers in NIB scheme. Farmers outside NIB scheme cannot get rice seeds, and LBDA carries out multiplication programme of rice seeds under the West Kenya Rainfed Rice Project to distribute farmers.

LBDA started to seed production of food crops and propagate fruit tree seedling at Yala Swamp Study. The production of seed in 1990 is shown in Tables VI-4.1 and VI-4.2.

4.3 Cooperative Society

According to the Kisumu District Cooperative Office, there exists 156 primary cooperative societies and cooperative unions in Kisumu district. Purchasing farm inputs and selling farm produces are made through cooperative societies. Since some of the cooperative societies are not active in their purposes, District Cooperative Office provides training programmes of the leaders to improve their activity. Number of cooperatives in the Kisumu District are listed by types as follows:

	Type	Active	Dormant	In liquidation	Total
1.	Coffee	3	-	-	3
2.	Cotton	5	-	-	5
3.	Sugarcane	39	6	-	45
4.	Dairy	3	-	-	3
5.	Multipurpose	4	14	-	18
6.	Poultry	1	1	-	1
7.	Farm purchase	3	-	-	3
8.	Consumer	1	1	-	2
9.	Housing	4	2	-	6
10.	Saving & credit (Sacco)	31	14	3	48
11.	Fisheries	10	3	-	13
12.	Transport	-	1	-	1
13.	Building and Construction	-	1	-	1
14.	Cooperative union	5	1	-	6

5. FARM ECONOMY

On the basis of the results of farm interview survey, the present status of farm household are estimated as follows:

5.1 Family Size

Family size of farm household in the study area ranged from 2 persons to 15 persons, average family size is 7 persons. Out of 7 persons, 3.8 persons are in a workable age group between 15 to 59 years old.

Age Group	(Unit:persons)		
	Male	Female	Total
Less than 14	1.3	1.5	2.8
15 to 59	1.9	1.9	3.8
Over 60	0.3	0.1	0.4
Total	3.5	3.5	7.0

5.2 Land Tenure and Land Holding

Average farm size is about 3.1 ha including pasture, cropped land and home garden as shown below. Farm size ranges from 0.4 ha to 21 ha, however, about 70% of farmers are smaller than 4.0 ha. In the case of rice farmer, farm land consists of 1.4 ha of paddy field and 0.3 ha of upland field.

Area	(Unit:ha)				
	Cultivated land	Pasture	Sub-total	Home Garden	Grand Total
	1.7	1.0	2.7	0.4	3.1

Status of land ownership of agricultural land is shown in the following. Most of the land is cultivated by owner. 96% of land is operated by owner and share cropper.

Owner	Share Cropper	Tenant	Squatter	Total
63%	33%	2%	2%	100%

5.3 Income and Expenditure

Farm Budget of average farm household is estimated as shown in Table AE5-4. It is estimated that total gross income of farm household is about Ksh.28,000 annually. This amount accounts approximately Ksh.4,000 of income per family member (7 persons per household). Out of this amount, 82% or Ksh.23,000 is generated from farm income. Out of farm income, position of animal including cattle and sheep shows larger share. Main component of non-farm income is remittance from family members stay in urban centres like Kisumu, Nairobi.

Net reserves are estimated at Ksh.2,500 or 9% of gross income by deducting gross out-go from gross income.

		(unit:Ksh.)		
	Item	Amount	Percentage	
Gross income	Farm income	Cereals	6,890	25%
		Pulses	1,130	4%
		Other crops*	4,680	17%
		Animal**	10,260	37%
		Sub-total	22,960	82%
		Non-farm income	5,130	18%
	Total income	28,090	100%	
Gross out-go	Farm expense	2,360	9%	
	Living expense	23,190	91%	
	Total out-go	25,550	100%	
Net Reserve		2,540	9%*	

*: Other crops includes cotton, sugarcane, vegetables.

** : Animal includes cattle, goat, sheep, pig, chicken, duck.

6. MARKETING AND PRICE PROSPECT FOR PROJECT

6.1 Marketing Prospect

Various crops are expected to introduce in the project, the capacity of markets are examined for crops as follows:

6.1.1 Food crops

(1) Food supply in national level

Maize, sorghum, millet, sorghum, beans, tubers like potatoes, wheat and rice is the major staple food in Kenya. These major food crops are broadly divided into 3 groups in terms of supply condition, i.e. 1) maize : dominant food crop supplied by domestic production, 2) millet, sorghum, beans and potatoes : supplemental food crops supplied by domestic production, 3) wheat and rice : food crops supplied by import as well as domestic production. Supply trend of these crops is estimated based on production and trade as shown Table VI-6.1, and summarized as follows:

Maize

Maize is the most popular staple food and its production is largest among the other major food crops. Average annual production is about 2,380,000 tons. Maize is mainly produced by the small holders for their home consumption, and only surplus is marketed to bring cash income. On the other hand, export amount is expanding recently to about 180,000 tons (7% of production) on an average during 1986 to 1990.

Average annual production is about 2,380,000 tons and import during same period is about 70,000 tons annually. Out of the production, on an average 590,000 tons (25% of production) are marketed to NCPB for strategic food reserves, and 140,000 tons (6% of production) are exported abroad. It is estimated that 2,310,000 tons of maize are supplied for food consumption (117 kg/person annum), and 1,790,000 tons are consumed by the farm household.

In the case of low production due to unfavourable weather conditions, maize was imported from abroad. In 1984, Kenya imported about 410,000 tons of maize because of low production owing to the severe draught. Supply amount of maize during 1983 to 1990 is given as follows:

Millet, Sorghum, Beans and Potatoes

Millet, sorghum, beans and potatoes are also produced by the small holders, and these food crops are supplemental for maize. Marketed amount and of these crops are small and traded amount is also negligible. Therefore production amount is equal to supply amount.

Wheat

Wheat in Kenya is mainly produced by large scale farms using agricultural machineries such tractors and combines in commercial base and most of the amount is marketed as a cash crop.

Rice

Rice is produced mainly by NIB schemes in large scale under irrigated condition. These schemes are Mwea in (Central Province), Ahero, West Kano, and Bnyala (Nyanza Province) and operate 7,600 ha of paddy field in total. In addition, small holders are expanding to produce rice in small scale under the assistance of Provincial Irrigation. Although import of rice is another source of supply, import amount fluctuates year by year, owing to the position of foreign currency reserve and foreign aid. In 1984, severe draught caused short supply of staple food and resulted in import of large amount of maize instead of rice.

Total annual supply of staple food is estimated at 3.42 million tons or 174 kg per capita on average during 1983 to 1989. This supply is 98% of the target (177 kg) in the Sixth National Development Plan. Share of crops in total supply is 67.4% by maize, 20.4% by millet and others, 10.8% by wheat and 1.4% by rice, as shown below.

Year	Maize (ton)	Millet & Others (ton)	Wheat (ton)	Rice (ton)	Total Supply (ton)	per capita Supply (kg per year)
1983	2,055,500	794,000	333,000	68,600	3,251,100	186.3
1984	1,780,000	420,500	284,700	23,800	2,509,000	139.0
1985	2,537,800	888,300	351,000	26,300	3,803,400	203.6
1986	2,670,700	1,068,900	367,300	75,500	4,182,400	216.4
1987	2,167,900	606,600	424,900	57,700	3,257,100	162.9
1988	2,594,000	620,500	309,600	30,600	3,554,700	171.9
1989	2,520,500	653,600	367,700	50,500	3,592,300	167.9
1990	2,129,700	521,400	512,700	47,600	3,217,400	145.5
Average (83-89)	2,307,000 67.4%	696,700 20.4%	368,900 10.8%	47,600 1.4%	3,420,200 100%	174.2

Total annual supply grows 2.3% on average, however, this growth is lower than the growth rate of population which is 3.34% during 1979 to 1989. Accordingly, per capita supply decrease at the rate of 1% annually.

Population in Kenya is still growing at higher rate of over 2% annually. This will bring increase of future food demand. Future population is projected base on the 1989 population and annual growth rate of 2.5%, which is rather conservative growth rate. In order to keep per capita supply level of 174 kg, required food supply is estimated on the basis of the protected population, as follows:

	unit	1995	2000	2005	2010
Population	(persons)	24,100,000	26,600,000	29,400,000	32,400,000
Necessary supply	(ton)	4,200,000	4,630,000	5,120,000	5,640,000
Present supply	(ton)	3,420,000	3,420,000	3,420,000	3,420,000
Deficit	(ton)	780,000	1,210,000	1,700,000	2,220,000

2.22 million tons of food will be required to supply additionally in the year of 2010. This amount, quite large as almost same as present production of maize, is necessary to supply by domestic production and import, and production of food crops by the project would contribute the national food security.

(2) Food supply in and around project area

On the basis of the staple food production such as maize sorghum, rice, beans and potatoes in Kisumu in 1987 to 1989, average annual production is estimated at 109 kg/person, while the target of per capita consumption of foods in National Sixth Five Year Development Plan (1989-1993) is 177 kg/person/year, as shown below.

Crops	Average Production*1	Per capita Production*2	National Target of
	1987-1989 (ton)	1987-1989 (kg/person)	per capita Consumption (kg/person)
Maize	31,120	46.2	100.0
Wheat	0	0.0	19.4
Sorghum	10,300	15.3	7.7
Rice	7,240	10.7	3.0
Beans*3	3,920	5.8	13.2
Potatoes*4	21,040	31.2	33.5
Total	73,620	109.2	176.8

*1: Annual Report of District Agricultural Office, 1987, 1988 and 1989.

*2: Population in 1989 is estimated at 674,000 according to the provisional figure of Census 1989.

*3: Beans includes greengrams and cowpeas.

*4: Potatoes includes sweet potatoes and cassava.

68 kg/person/year or 46,000 ton of foods is short of production in Kisumu District to attain the national target in 1989, and this amount is imported from the surrounding Districts.

In 2010, it is estimated that 185,000 ton of food crops would be necessary to feed 1,045 thousand of people to achieve the national target. In considering increase of production of cereals and pulse, the project would supply rice maize, sorghum and pulses to the project area and its surrounding area.

6.1.2 Sugarcane

Three large scale sugar mills are under operation at present. The annual milling capacities of these mills are 2,000,000 ton in total, 800,000 ton in Chemelil, 500,000 ton in Muhoroni and 700,000 ton in Miwani. In addition to the present capacity, these mills have a plan to expand milling capacities upto 2,500,000 ton/year. The present production of sugarcane in Kisumu District is estimated at 1,950,000 ton. Accordingly, approximately 500,000 ton of sugarcane are allowed to be harvested by the project.

6.1.3 Cotton

Two cotton ginneries are located at Kibos and Kendu Bay and their capacities are 4,800 ton in total. Present production of cotton around the project area is estimated at about 1,750 ton on an average. In addition to this, market channel of seed cotton is shifting from Cotton Board of Kenya to private dealers to bring outside the project area. Therefore, 2,000 ton to 3,000 ton of cotton are allowed to be harvested in the project area.

6.1.4 Vegetables

Vegetables introduced under the project area are tomato, onion, kale, cabbages and capsicum (sweet pepper), which are suitable in view of climate and soils in the project area. The physical condition of the project area does not allow to grow french beans, letus, or other vegetables which prefer lower temperature.

Large scale vegetable processing for domestic market and export is not considered, since only tomato is expected for processing and extended area more than 5,000 ha in one season is required to supply tomato to the processing plant at cheap price. It is necessary to consider the fresh market to maintain higher prices.

Market to be expected under the project is (1) local market for consumption in Kisumu District, (2) local market in Nyanza Province including Kisumu, (3) Domestic market in whole Kenya and (4) export market for Europe.

The first priority is given to consumption in Kisumu District because of nutrition improvement of local people, food security, and self-sufficiency. The second priority is given to the local market in Nyanza Province, where Kisumu functions as the centre of Province, because of the same reason of the first one.

Main domestic market in whole Kenya is Nairobi and Mombasa, however, the severe competition is expected with surrounding area of the market because the location of the project is disadvantage in view of transportation cost and time. Therefore, prices of these markets fluctuate so much and risk of low prices suffers the income of farmers. After starting operation of the Kisumu fresh wholesale facilities, which has been planned in 1984 and has not implemented yet, the marketing information of the main domestic markets is available to compete with the other produce area. In this regard, production for these markets can start only after implementation of the wholesale facilities in Kisumu. As for export market, tomato, onion, kale and capsicum is not suitable for export.

As a results, market possibility is examined for (1) consumption in Kisumu District, and (2) local market in Nyanza Province including Kisumu. On the basis of the vegetable production and population, the per capita vegetable production in Kisumu District and Nyanza Province is estimated as follows:

Kisumu District		1985	1986	1987	1988	1989	1990
Item	unit						
Production							
Onion	(ton)	380	0	340	800	1,800	480
Tomato	(ton)	2,410	30	350	2,000	4,980	2,140
Cabbage	(ton)	2,870	0	0	0	150	0
Kale	(ton)	2,580	0	0	8,000	4,650	3,460
Total	(ton)	7,900	30	360	10,800	11,580	6,080
Population		616,000	630,000	644,000	659,000	674,000	690,000
per capita production							
	(kg/year)	13.37	0.05	1.08	16.39	17.18	8.80

Source: Nyanza Province, Annual report 1986, 1987, 1988, 1989, 1990, Department of Agriculture (Provincial Director of Agriculture)

In Kisumu District, vegetable production is not so high and has been fluctuating year by year mainly due to weather condition. Most of vegetables is transported to Kisumu from surrounding Districts such as Kisii, Kakamega, Nandi and sometimes, from Tanzania. Per capita production in Kisumu is nearly 17 kg/year, and per capita consumption of vegetable exceeds 17 kg/year.

Nyanza Province							
Item	unit	1985	1986	1987	1988	1989	1990
Production							
Onion	(ton)	2,720	3,350	5,430	4,520	9,100	5,210
Tomato	(ton)	17,400	21,890	27,220	35,670	34,800	27,470
Cabbage	(ton)	17,040	13,910	16,840	13,590	14,270	10,820
Kale	(ton)	17,650	21,100	26,770	35,940	16,790	28,630
Others	(ton)	-	-	-	3,320	3,130	4,360
Total	(ton)	54,810	60,250	76,360	93,040	78,190	76,490
Population		3,305,000	3,365,000	3,428,000	3,492,000	3,558,000	3,624,000
per capita production							
(kg/year)		16.59	17.90	22.24	26.64	21.98	21.11

Source: Nyanza Province, Annual report 1986, 1987, 1988, 1989, 1990, Department of Agriculture (Provincial Director of Agriculture)

In Nyanza Province, Kisii is the vegetable surplus District and vegetable is transported from Kisii to other districts such as Kisumu, Nakuru, Nairobi.

Target of per capita consumption vegetable (Ministry of Agriculture) is 20.4 kg/year and the present production level in Nyanza Province has been already achieved the target. It is necessary to proceed the next step to expand production of vegetable for lifting the per capita consumption.

It is impossible to estimate the amount of vegetable transported in/out and local consumption. Since it can be easily supposed that there is no big difference between the outgoing amount of vegetables and incoming ones, the per capita production of 16.6 to 26.6 kg/year in 1985 to 1990 can be assumed at nearby per capita consumption.

Future demand of vegetable is estimated through the projection of per capita consumption and population. In the case that the per capita production is almost near the per capita consumption as mentioned in the above, the per capita consumption of vegetable in 2005 and 2010 is estimated at 31 kg/year and 36 kg/year respectively using regression analysis of per capita production during 1985 to 1990. Population in 2005 and 2010 is estimated at 4.66 million and 4.99 million for Nyanza Province, and 940,000 and 1,045,000 for Kisumu District respectively based on the Population Census 1979 and the provisional result of Population Census 1989.

On the basis of the above projections, the future demand of vegetables in 2005 and 2010 is estimated as follows:

	year	Population (persons)	per capita consumption (kg per year)	Demand (ton)
Kisumu District	2005	940,000	31	29,000
	2010	1,045,000	36	38,000
Nyanza Province	2005	4,660,000	31	144,000
	2010	4,991,000	36	180,000

Future production of vegetable is estimated on the basis of production trend during 1985 to 1990 using regression analysis. Future balance of demand and supply is summarised as follows:

	Year	Demand	Production	(unit:ton)
				Deficit
Kisumu District	2005	29,000	6,000	22,000
	2010	38,000	8,000	30,000
Nyanza Province	2005	144,000	91,000	53,000*
	2010	180,000	104,000	76,000*

Note: Those amount includes deficit of Kisumu District.

The Project will supply the deficit amount of 30,000 ton for Kisumu District to 76,000 ton for whole Nyanza Province in 2010. The Project would supply the 63,000 ton of vegetable from 1,570 ha of the project area. The present destination of their vegetable surplus from Kakamega and Nandi would be shifted to the northern dry area to satisfy the target.

6.1.5 Fruit tree

Fresh fruit market is not so large in and around the project area at present, and future market for fresh fruits is hard to estimate because of no data available for demand. However, LBDA has been promoting such a small scale of fruit processing plant as passionfruit, citrus, banana, pineapple, and some test plant is now under operation. In this regard, fruit tree represented by passionfruit is introduced in this project in small scale at the moment.

6.1.6 Dairy

Under the current condition in the study area, fresh milk produced by the farmers are directly sold to the neighbourhoods and local households surrounding the producers without processing like cooling, pasteurizing or sterilizing. LBDA's zero grazing system applies the same marketing procedure. This system contributes to nutrition improvement of local people and increase of farmers' income without establishment of rigid marketing system. On the other hand, marketing channel to KCC (Kenya Cooperative Creameries) through the dairy cooperative has not developed yet in the study area, especially in the Nyakach plain. Therefore, it is assumed that markets of milk produced under the project would be limited to the the neighbourhoods and local households same as the present system until the marketing channel of KCC would be arranged.

Population in 2005 and 2010 is estimated to be about 82,000 and 93,000 respectively. Target of per capita consumption is 91 lit. per annum according to the Sixth Five Year Development Plan. To achieve this level of per capita consumption, demand of milk is estimated at 7,460,000 lit. in 2005 and 8,460,000 lit. in 2010. To produce milk of this amount, 1,650 cow units in 2005 and 1,870 cow units in 2010 are required. To maintain these cow units, the following managed forage and annual supply of grade cattle would be necessary:

Year	Cow Units	Managed Forage (ha)	Annual Supply of Grade Cattle (heads/year)
2005	1,650	680	260
2010	1,870	770	300

6.1.7 Robusta coffee

Only Robusta coffee can be introduced for coffee farming in the project area, since climate is not suitable for Arabica coffee. To sell coffee berries, farmers (cooperatives) have to book purchase order with quality from Kenya Planters Cooperatives Union (KPCU). At the same time, farmers have to get movement permission from Kenya Coffee Board located at Kisii, Kakamega and Nandi. After getting movement permission, farmers transport coffee berries to KPCU store house in Kisumu.

Price of dried coffee berries is different based on the quality, and fluctuates depending on auction made by Coffee Board in Nairobi. Average recent price at store house of KPCU is estimated at about Ks.5.5/kg for the first class, Ks.4.5/kg for the second class, Ks.3.5/kg for the third class. Since coffee farming under the project is carried out under irrigated condition, quality and price of coffee is assumed as the first class quality of Ks.5.5/kg.

6.2 Price Prospect

Financial and economic prices at farm gate are shown in Table VI-6.2. Economic prices of paddy, maize, cotton and sugarcane are estimated on the basis of the projected international market prices as shown in Table VI-6.3. Other commodities are estimated on the basis of the financial prices and the standard conversion factor of 0.82, as shown Table VI-6.4.

Economic prices of rice, maize, sugarcane and cotton are estimated as import substitution on the basis of the projected international prices forecasted by IBRD for the year of 2005 in 1985 constant US dollars and further taking into account the costs of transportation, processing and others.

Financial farmgate prices of other products and inputs are estimated on based on the market survey during the study period.

7. NET PRODUCTION VALUE AND BENEFIT

7.1 Unit Net Production Value by Crops

On the basis of yield, farming practice and the economic prices, unit net production value for crops under the with-project condition is calculated as shown in Tables VI-7.1 to VI-7.6, and summarized as follows:

Crop	Unit Yield (ton/ha)	Gross		Net Production Value (Ks./ha)
		Production Value (Ks./ha)	Production Cost (Ks./ha)	
Maize	5.0	23,300	6,040	17,260
Paddy*	6.0	37,750	6,100	31,650
Sorghum	3.5	17,600	5,090	6,670
Greengrams/cowpeas	1.5	17,720	5,250	12,020
Groundnuts	1.5	17,600	8,550	9,050
Cotton	2.2	37,200	7,820	29,380
Vegetable	20.0	55,800	15,350	40,450
Sugarcane**	100.0	50,920	3,910	47,010
Managed fodder for dairy	400.0	34,100	7,290	26,810
Pasture for working cattle	400.0	32,480	7,290	25,190
Fruit tree (Passion fruit)	10.0	41,000	15,700	25,300
Robusta coffee	4.0	18,040	13,040	4,240

*: Net production value of paddy includes (1) Ks.38,820 of value of grains and (2) Ks.670 of value of straw to feed cattle. Details are shown in Table VI-7.5.

** : Net production value of paddy includes (1) Ks.50,600 of value of cane and (2) Ks.820 of value of cane top to feed cattle. Details are shown in Table VI-7.5.

Comparing net production value of each crop, sorghum, coffee and groundnuts are rather low value, therefore those crops are excluded in the project. On the other hand, other crops are included in the project because of higher net production value.

Unit net production value for crops under the without-project condition is calculated as shown in Tables VI-7.7 and summarized as follows:

Crop	Unit Yield (ton/ha)	Gross		Net Production Value (Ks./ha)
		Production Value (Ks./ha)	Production Cost (Ks./ha)	
Maize	1.9	8,850	3,570	5,280
Paddy	3.3	20,390	4,110	16,280
Sorghum	1.1	4,770	2,510	2,260
Beans	0.7	7,120	2,570	4,550
Cotton	0.3	5,190	3,390	1,800
Sugarcane	40.0	20,040	1,400	18,640
Tuber (cassava/sweet potatoes)	6.1	5,190	3,390	1,800
Pasture	0.0	0	2,240	2,240

7.2 Unit Net Production Value by Cropping Pattern

In the future condition under the project, double cropping would be employed by the combination of the above crops. The net production value in one ha of each cropping pattern under with-project condition is estimated as shown in Table VI-7.9, and is summarised as follows:

Pattern		Unit net production value		
Long Rainy Season	Short Rainy Season	Long Rainy Season	Short Rainy Season	Total
		(Ks/ha)	(Ks/ha)	(Ks/ha)
Paddy	Beans/Greengrams	31,650	12,020	43,670
Maize	Paddy	17,260	31,650	48,910
Maize	Cotton/Beans	17,260	20,700	37,960
Vegetable	Vegetable	40,450	40,450	80,900
Sugar cane		-	-	47,010
Managed fodder for dairy		-	-	26,810
Pasture for working cattle		-	-	25,190
Fruit tree		-	-	25,300

7.3 Benefit

Net incremental benefit of the project is defined as the difference between the net production value with the project and the net production value without the project. The net production value are calculated on the basis of the unit net production value per ha and the area of the cropping pattern.

Tables VI-7.10 shows the net production value with and without project, and net incremental benefit by sub-area. Total net incremental benefit is estimated at Ks.662.5 million annually, and summarized as follows:

With project condition

Long Rainy Season	Short Rainy Season	Unit Net Production Value (Ks./ha)	Cropped Area (ha)	Total Net Production Value (Ks.10 ³)
Paddy	Beans/Greengrams	43,670	2,690	117,470
Maize	Paddy	48,910	1,740	85,100
Maize	Cotton/Beans	37,960	1,530	58,080
Vegetable	Vegetable	80,900	1,570	127,010
Sugarcane		47,510	5,130	241,160
Managed fodder for dairy		26,810	760	20,380
Pasture for working cattle		25,190	510	12,850
Fruit tree		25,300	1,000	25,300
Total			14,930	687,350

Without project condition

Crop	Unit Net Production Value (Ks./ha)	Cropped Area (ha)	Total Net Production Value (Ks.10 ³)
Maize	5,280	420	6,840
Paddy	16,280	1,490	7,870
Sorghum	2,260	940	2,120
Beans	4,550	490	2,230
Cotton	1,870	430	800
Sugarcane	18,640	40	750
Tuber (cassava/sweet potatoes)	1,800	360	650
Pasture	2,240	10,760	24,100
Total		14,930	45,360

Net incremental benefit

Total Net Production Value			Net Incremental Benefit (Ks.10 ³)
With Project Condition (Ks.10 ³)	Without Project Condition (Ks.10 ³)		
687,350	45,360		641,990

8. FARM BUDGET

From the farmer's view point, the financial evaluation with the project is made for the average farmers. Farm budget is estimated on the basis of income and outgo in the future condition.

Average farmers are assumed to operate 3.1 ha of farm land same as the present condition. Since cropping pattern varies by sub-area, crops cultivated by farmers are different by subareas as follows:

Long Rainy Season	Short Rainy Season	Sub-area						(unit:ha)
		I	II-1	II-2	III	IV	V	
Paddy	Beans	1.24	-	0.11	1.13	0.68	0.37	
Maize	Paddy	-	-	-	0.08	0.74	0.60	
Maize	Cotton/Beans	0.52	0.95	0.97	0.13	0.04	0.04	
	Sugarcane	-	-	-	1.37	1.36	1.83	
Vegetables	Vegetables	0.52	0.91	1.06	0.16	0.01	0.02	
	Fruit tree	0.52	0.91	0.68	-	-	-	
	Pasture for dairy	0.21	0.19	0.17	0.14	0.16	0.14	
	Pasture for working cattle	0.09	0.14	0.12	0.09	0.11	0.10	
	Total	3.10	3.10	3.10	3.10	3.10	3.10	

Financial crop budget is estimated as shown in Table VI-8.1. Farm income is calculated on the basis of the cropped area and the financial crop budget, and summarized as follows (for details, see Table VI-8.2):

Item	Present Condition	Future Condition					
		I	II-1	II-2	III	IV	V
(1) Farm Income	23,000	189,900	220,700	232,900	146,400	131,400	128,900
(2) Non-farm income	5,100	5,100	5,100	5,100	5,100	5,100	5,100
(3) Gross income	28,100	195,000	225,800	238,000	151,500	136,500	134,000
(4) Farm expenditure	2,400	59,100	69,600	73,600	36,200	33,200	28,700
(5) Living expense	23,200	34,800	34,800	34,800	34,800	34,800	34,800
(6) Gross outgo	25,600	93,900	104,400	108,400	71,000	68,000	63,500
(7) Net reserve	2,500	101,100	121,400	129,600	80,500	68,500	70,500

Farm income and net reserve would be significantly increase by implementation of the project, this will enable farmers to pay water charge of about Ks. 8,000 per household (equivalent to operation and maintenance cost of the project).

Tables

Table VI-2.1 Local Markets within Kisumu District

Division/Location		Market	Open days
Kisumu Municipality (Kisumu town)		1 Kondele	Saturdays/Wednesdays
		2 Nyalenda	Daily (Evenings)
		3 Kibuye	Sundays
		4 Otonglo	Thursdays
		5 Manyatta	Daily
		6 Akala	Friday
		7 Nyamasaria	Daily
		8 Kibos	
Winam	Kajulu	9 Mambo-Leo	Tuesday
		10 Wath-Oregoo	
	East Kolwa	11 Chiga	
		12 Korowe	
	North West Kano	13 Okana	
		14 Rabour	Wednesday
	South West Kano	15 Nyangande	
		16 Kaluore	
		17 Nyamware	
		18 Ogenya	
Nyando	South East Kano	19 Ahero	Tuesday
		20 Ombaka	
	East Kano	21 Onjiko	
		22 Awasi	
		23 Mariwa	
	Lower North	24 Ramula	
		25 Kibigori	
Upper Nyakach	North Nyakach	26 Katito	Daily-evenings
		27 Kondiek	
	28 Cherwa		
Central Nyakach	29 Kusa		
	30 Onyuongo		
Lower Nyakach	West Nyakach	31 Pap-Onditi	Mondays/Wednesday
		32 Nyakwere	
	South Nyakach	33 Sango Rota	
		34 Okano wach	
		35 Nyamarimba	
		36 Andingo Opanga	
		37 Kong'ow (Koduogo)	
		38 Sondu	Monday/Thursday
		39 Atela	
		40 Bodi	
41 Oboch			
42 Kokelo			
East Kisumu	Chemelil	43 Nyamarimba	
		44 Koliech	
	Muhoroni	45 Kiboswa	Saturdays/Wednesdays
		46 Chemelil	Wednesday/Saturday
	Miwani	47 Muhoroni	Sunday
		48 Miwani	

Source : Prepared by JICA Study Team

Table VI-2.2 Price of Agricultural Inputs at Kisumu KGGCU (1991)

Item	Unit	Price (Ksh.)	Price per unit (Ksh.)
Fertilizer			
DAP	50 kg	344.80	6.90 /kg
CAN	50 kg	223.20	4.46 /kg
TSP	50 kg	275.50	5.51 /kg
SSP	50 kg	137.40	2.75 /kg
ASN	50 kg	202.90	4.06 /kg
20-20-20	50 kg	289.80	5.80 /kg
Chemicals			
Dithane M45	1 kg	174.45	174.45 /kg
Furadan	1 kg	76.35	76.35 /kg
Furadan	5 kg	367.25	73.45 /kg
Dithane	1 kg	179.80	179.80 /kg
Malation 1%	400 g	12.35	30.88 /kg
Malation 2%	400 g	21.60	54.00 /kg
Artellic 1%	400 g	17.95	44.88 /kg
	Average for powder		90.54 /kg
Ambushy	1 lit	266.80	266.80 /lit
Smithion	5 lit	930.00	186.00 /lit
Roud up	1 lit	463.00	463.00 /lit
	Average for liquid		305.27 /lit
Seeds			
Hybrid Maize	10 kg	124.70	12.47 /kg
Onion	50 g	70.45	1,409.00 /kg
Texas grana	100 g	152.95	1,529.50 /kg
Tomato (money maker)	50 g	98.15	1,963.00 /kg
Tomato (Beauty)	100 g	245.30	2,453.00 /kg
Cabbage (Drum Head)	50 g	25.00	500.00 /kg
Cabbage (Copenhagen)	50 g	29.40	588.00 /kg
Cabbage (Sugar loaf)	50 g	25.55	511.00 /kg
Kale	100 g	45.10	451.00 /kg
Pasture (Mhanana Rhodes) Mbarara			
	1 kg	50.00	50.00 /kg
Pasture (Columbus grass)	3 kg	370.00	123.33 /kg

Source: KGGCU Kisumu Brach Office, September 13th, 1990

Note: DAP:Diammonium Phosphate
 CAN:Calucium Ammonium Nitrate
 TSP:Triple superphosphate
 ASN:Ammonium sulfate nitrate

Table VI-2.3 Prices of Major Agricultural Product by Parastatal Bodies and Cooperative Unions

Item		Unit	Price (Ksh)	Unit Price (Kshs)
National Cereals and Produce Board (NCPB)				
Maize		90 kg	235.00	2.61 /kg
Rice (in husk)	Basmati	100 kg	963.20	9.63 /kg
	Sindano	75 kg	269.00	3.59 /kg
	Others	75 kg	269.00	3.59 /kg
Beans	Canadian wonder	90 kg	480.00	5.33 /kg
	Rosecoco	90 kg	480.00	5.33 /kg
	Lima	90 kg	460.00	5.11 /kg
	Mwezi moja	90 kg	460.00	5.11 /kg
	Red haricot	90 kg	440.00	4.88 /kg
	Mwitiemania	90 kg	440.00	4.88 /kg
	Other beans	90 kg	420.00	4.67 /kg
Greengram	Green	90 kg	500.00	5.55 /kg
	Yellow	90 kg	370.00	4.11 /kg
	Black	90 kg	370.00	4.11 /kg
Peas	Pegion	90 kg	370.00	4.11 /kg
	Cow	90 kg	370.00	4.11 /kg
	Dried field	90 kg	370.00	4.11 /kg
Groudnut	Nyanza type	80 kg	700.00	8.75 /kg
Sugar Company				
Sugarcane		1 ton	405.00	405 /ton
Cotton Board of Kenya				
Seed Cotton	A rank	1 kg	10.00	10.00 /kg
	B rank	1 kg	6.00	6.00 /kg
Kenya Planters Cooperative Union				
Robuster coffee	First class	1 kg	5.50	5.50 /kg
	Second class	1 kg	4.50	4.50 /kg

Source : Prepared by JICA Study Team

Table VI-2.4 Farmgate Price of Major Agricultural Products

Market Place	(Unit:Ksh./2kg)										
	Rice	Maize	Sorghum	Millet	Cow peas	Green-gram	Ground-nuts	Field beans	Other beans	Cassava	Sweet potato
Muhoroni*	25.00	-	7.50	13.00	38.00	28.00	32.00	-	14.00	-	1.78
Kondele*	28.00	6.00	8.00	13.00	-	25.00	30.00	15.00	20.00	-	-
Kondele**	25.00	8.00	-	-	26.00	-	30.00	8.00	-	8.00	2.00
Nyalenda*	28.00	7.00	7.50	-	-	27.00	25.00	-	17.00	-	2.44
Nyalenda***	-	8.00	8.00	-	-	-	22.00	14.00	-	8.00	-
Manyatta*	25.00	-	6.50	12.50	-	25.00	37.00	15.00	15.00	-	-
Ombaka/Riat*	23.00	7.00	6.00	-	25.00	-	25.00	17.00	17.50	-	-
Ahero*	24.00	6.50	6.50	16.00	33.00	35.00	32.00	15.00	14.00	1.78	-
Ahero**	23.33	5.50	4.00	-	-	-	22.50	11.00	-	-	-
Chemelil*	29.00	-	8.00	18.00	30.00	27.00	-	-	17.00	-	-
Chemelil***	-	6.00	5.00	-	-	-	-	10.00	-	4.20	2.00
Kombewa*	25.00	6.50	6.50	16.00	-	-	30.00	-	-	-	-
Kibuye*	25.00	6.50	6.00	13.00	25.00	25.00	32.00	14.00	16.00	4.50	-
Kibuye***	25.00	7.00	-	-	28.00	-	30.00	10.00	-	-	3.00
Wath-Orego*	28.00	6.50	6.00	-	25.00	28.00	35.00	-	18.00	-	-
Mambo-Leo*	22.00	7.00	7.00	13.00	25.00	27.00	30.00	13.00	-	2.33	2.67
Sondu*	25.00	5.00	6.00	-	35.00	28.00	27.00	-	13.00	-	2.22
Sondu***	22.22	5.00	4.00	-	-	-	25.00	-	-	-	-
Katito**	23.50	6.00	6.00	15.00	-	-	27.00	-	14.00	2.00	2.11
Katito***	22.22	6.00	4.00	-	-	-	25.00	10.00	-	-	-
Nyamasaria*	27.00	6.50	-	-	30.00	25.00	-	-	-	-	-
Kiboswa*	-	6.00	6.50	12.00	-	35.00	31.00	13.00	14.00	4.00	-
Miwani*	27.00	7.00	-	-	25.00	28.00	-	18.00	18.00	-	1.78
Pop-onditi**	24.00	6.00	6.00	17.00	25.00	-	-	13.00	15.00	5.00	1.56
Pop-onditi***	30.00	8.00	-	-	-	-	30.00	20.00	-	4.00	2.00
Rabuor*	23.00	6.50	6.00	-	32.00	28.00	27.00	-	13.00	-	1.56
Kibigori/Masogo*	27.00	7.50	6.50	-	-	25.00	-	13.00	17.00	-	-
Jubilee*	26.00	8.00	6.00	-	-	22.00	-	14.00	-	5.00	2.00
Nyamasaria*	-	8.00	8.00	-	-	-	25.00	8.00	-	-	2.00
Average (Ksh./kg)	12.65	3.42	3.36	7.20	14.36	13.69	14.31	6.61	7.89	2.22	1.04

Source: Interview survey by the study team.

Note: *prices as of October 1990, **prices as of March 1991, ***prices as of September 1991.

Table VI-4.1 Seed Production at Yala Seed Farm (1990)

Crop	Varieties	Area (ha)	Production	Remarks
Paddy	Sindano	125	1,500 bags	Area still being expanded Average yield being 60 bags/ha.
Maize	5 - 11 Katumani	250	9,250 bags	Average yield 37 bags/ha Not planted to the maximum.
Sorghum	Seredo Serena	400	15,000 bags	Average 42 bags/ha.
Finger millet	White Brown	15	145 bags	Average yeild 15 bags/ha Crop not sown always.
Greengram		4	14 bags	Crop did not grow well in 1990 long rainy season.
Beans	Rosecoco	50	600 bags	Area will be able to expand.
Onions	Red-Creole	0.40	1,000 kg	Area will be able to expand, if demand of seeds increases.
Tomato	Moneymaker	0.35	342 kg	
Kale	Thousandhead	0.40	2,540 kg	

Source : Prepared by JICA Study Team

Table VI-4.2 Production of Fruits Tree Seedlings at Yala Seed Farm (1990)

Crop	No of seedling	Potential
Citrus		
Grape fruits		
Washington Nable	5,000	10,000
Sweet Orange		
Avocado	200	500
Mango	200	500 - 1000
Passion fruit	200	500 - 1000

Production is normally dictated by the demand.

Source : Prepared by JICA Study Team

Table VI-6.1 Past Trend of per Capita Supply of Major Food (1/2)

1. Maize

Year	maize production (bag)	maize production (ton)	import amount (ton)	export amount (ton)	total supply amount (ton)	per capita supply (per year)
1983	24,200,000	2,178,000	0	122,500	2,055,500	117.8 kg
1984	15,800,000	1,422,000	405,400	47,400	1,780,000	98.6 kg
1985	27,000,000	2,430,000	125,500	17,700	2,537,800	135.9 kg
1986	32,200,000	2,898,000	700	228,000	2,670,700	138.2 kg
1987	26,840,000	2,415,600	0	247,700	2,167,900	108.4 kg
1988	30,680,000	2,761,200	0	167,200	2,594,000	125.4 kg
1989	29,230,000	2,630,700	0	110,200	2,520,500	117.8 kg
1990	25,440,000	2,289,600	0	159,900	2,129,700	96.3 kg
Average (83-89)		2,378,100	66,500	137,600	2,307,000	117.3 kg

Source : Economic Survey and Annual Trade Report.

2. Millet, Sorghum, Beans and Potatoes

Year	beans production (ton)	potato amount (ton)	millet amount (ton)	sorghum amount (ton)	total supply amount (ton)	per capita supply (per year)
1983	270,000	459,000	30,000	35,000	794,000	45.5 kg
1984	68,400	233,100	21,000	98,000	420,500	23.3 kg
1985	177,300	531,000	60,000	120,000	888,300	47.6 kg
1986	324,000	549,900	65,000	130,000	1,068,900	55.3 kg
1987	207,900	218,700	50,000	130,000	606,600	30.3 kg
1988	243,000	229,500	58,000	103,000	620,500	30.0 kg
1989	256,500	233,100	58,000	116,000	653,600	30.5 kg
1990	192,600	154,800	58,000	120,000	521,400	23.6 kg
Average (83-89)	217,500	326,100	46,600	106,500	696,700	35.8 kg

Source : Economic Survey, Annual Trade Report and FAO Production Year Book.

3. Wheat

Year	wheat production (ton)	import amount (ton)	export amount (ton)	total supply amount (ton)	per capita supply (per year)
1983	251,300	81,900	200	333,000	19.1 kg
1984	144,400	140,300	0	284,700	15.8 kg
1985	201,100	149,900	0	351,000	18.8 kg
1986	252,000	115,300	0	367,300	19.0 kg
1987	207,000	217,900	0	424,900	21.3 kg
1988	234,000	75,600	0	309,600	15.0 kg
1989	244,200	123,500	0	367,700	17.2 kg
1990	190,100	322,600	0	512,700	23.2 kg
Average (83-89)	215,500	153,400	0	368,900	18.7 kg

Source : Economic Survey and Annual Trade Report.

Table VI-6.1 Past Trend of per Capita Supply of Major Food (2/2)

4. Rice

Year	marketed paddy (ton)	milled rice 65% (ton)	import amount (ton)	export amount (ton)	total supply amount (ton)	per capita supply (per year)
1974	33,200	21,600	1,500	0	23,100	1.8 kg
1975	33,200	21,600	0	0	21,600	1.6 kg
1976	39,300	25,500	10,000	0	35,500	2.6 kg
1977	41,400	26,900	0	0	26,900	1.9 kg
1978	35,800	23,300	0	0	23,300	1.6 kg
1979	37,500	24,400	0	0	24,400	1.6 kg
1980	36,400	23,700	1,200	0	24,900	1.6 kg
1981	41,200	26,800	4,600	0	31,400	1.9 kg
1982	38,600	25,100	11,900	0	37,000	2.2 kg
1983	36,600	23,800	44,800	0	68,600	3.9 kg
1984	36,400	23,700	500	400	23,800	1.3 kg
1985	39,500	25,700	600	0	26,300	1.4 kg
1986	21,300	13,800	61,700	0	75,500	3.9 kg
1987	30,100	19,600	39,100	1,000	57,700	2.9 kg
1988	31,700	20,600	10,000	0	30,600	1.5 kg
1989	31,500	20,500	30,000	0	50,500	2.4 kg
Average (83-89)		22,900	26,300	200	47,600	2.5 kg

Source : Economic Survey and Annual Trade Report.

5. Total Supply of Maize, Millet, Sorghum, Potatoes, Wheat and Rice

Year	maize (ton)	millet & others (ton)	wheat (ton)	rice (ton)	total supply (ton)	per capita supply (per year)
1983	2,055,500	794,000	333,000	68,600	3,251,100	186.3 kg
1984	1,780,000	420,500	284,700	23,800	2,509,000	139.0 kg
1985	2,537,800	888,300	351,000	26,300	3,803,400	203.6 kg
1986	2,670,700	1,068,900	367,300	75,500	4,182,400	216.4 kg
1987	2,167,900	606,600	424,900	57,700	3,257,100	162.9 kg
1988	2,594,000	620,500	309,600	30,600	3,554,700	171.9 kg
1989	2,520,500	653,600	367,700	50,500	3,592,300	167.9 kg
1990	2,129,700	521,400	512,700	47,600	3,217,400	145.5 kg
Average (83-89)	2,307,000 67.4%	696,700 20.4%	368,900 10.8%	47,600 1.4%	3,420,200 100%	174.2 kg

Table VI-6.2 Financial and Economic Prices for
Agricultural Outputs and Inputs

Outputs and Inputs		Unit	(Unit: KShs./Unit)	
			Financial (1991)	Economic (2000)*1
Outputs	Rice (Import Parity)	ton	4,800	6,180 *2
	Maize (Import Parity)	ton	3,400	4,660 *2
	Cotton (Import Parity)	ton	10,000	16,910 *3
	Sugarcane (Import Parity)	ton	405	501 *3
	Beans	ton	7,250	5,950 *4
	Sorghum	ton	3,360	2,760 *4
	Millet	ton	7,200	5,900 *4
	Greengrams	ton	13,690	11,230 *4
	Cowpeas	ton	14,360	11,780 *4
	Groundnuts	ton	14,310	11,730 *4
	Cassava	ton	2,220	1,820 *4
	Sweet potato	ton	1,040	850 *4
	Tomatoes	ton	3,400	2,790 *4
	Cattle	head	4,500	3,690 *4
	Milk	ton	8,000	6,560 *4
	Robusta coffee	ton	5,500	4,510 *4
Passion fruit	ton	5,000	4,100 *4	
Inputs	(1) Seed			
	Rice	kg	6.0	4.9 *4
	Maize	kg	12.5	10.3 *4
	Beans	kg	25.0	20.5 *4
	Tomatoes	kg	1,007.3	826.0 *4
	Onions	kg	1,099.2	901.3 *4
	French Beans	kg	42.0	34.4 *4
	(2) Fertilizer			
	ASN	kg	4.1	3.3 *4
	TSP	kg	5.5	4.5 *4
	MP	kg	2.8	2.3 *4
	(3) Agro-chemicals			
	Powder	kg	90.5	74 *4
	Liquid	lit	305.3	250 *4
	(4) Labour			
Family Labour	Man-day	25.0	15.0 *5	
(5) Oxen				
Land preparation	time	1,890	680 *6	

- Note: *1: 1991 constant price.
*2: For breakdown, see Table VI-6.3 (1/2)
*3: For breakdown, see Table VI-6.3 (2/2)
*4: Using standard conversion factor of 0.82.
*5: Using shadow wage rate of 0.6.
*6: Using shadow wage rate of 0.36.

Source : Prepared by JICA Study Team

Table VI-6.3 Price Structure of Rice and Maize

Item of Calculation	Operation	Unit	1991 Constant price
Rice			
(1) International market price in 2000*		US\$/ton	292
(2) Adjustment of quality difference**	= (1) x 10%	US\$/ton	29
(3) Freight and insurance		US\$/ton	70
(4) CIF price at Mombasa	= (1) - (2) + (3)	US\$/ton	332
(5) CIF price at Mombasa in Ksh.***	= (4) x 28.00	Ksh/ton	9,310
(6) Port handling, bagging, transport, etc		Ksh/ton	1,000
(7) Value at Kisumu (wholesale price)	= (5) + (6)	Ksh/ton	10,310
(8) Transport and handling from mill to Kisumu		Ksh/ton	50
(9) Value at mill gate	= (7) - (8)	Ksh/ton	10,260
(10) Value in terms of husked rice****	= (9) x 65%	Ksh/ton	6,670
(11) Value of bran		Ksh/ton	250
(12) Milling charge		Ksh/ton	240
(13) Transport and handling charge		Ksh/ton	500
(14) Farmgate price	=(10)+(11)-(12)-(13)	Ksh/ton	6,180
Maize			
(1) International market price in 2000*		US\$/ton	123
(3) Freight and insurance		US\$/ton	33
(4) CIF price at Mombasa	= (1) - (2) + (3)	US\$/ton	156
(5) CIF price at Mombasa in Ksh.***	= (4) x 28.00	Ksh/ton	4,360
(6) Port handling, bagging, transport, etc		Ksh/ton	1,000
(7) Value at Kisumu (wholesale price)	= (5) + (6)	Ksh/ton	5,360
(8) Transport and handling charge		Ksh/ton	700
(9) Farmgate price	= (7) - (8)	Ksh/ton	4,660

Note: *: Rice:white, milled, 5% broken, government standard, export price, FOB Bangkok.
 Maize:No.2, yellow, FOB Gulf ports.
 Based on the "Quarterly Review of Commodity Markets in Fourth Quarter 1991" included in the "Price Prospects for Major Commodities, 1990 - 2005" by IBRD.
 The estimated prices are given in 1985 constant US\$, and have been adjusted by a factor of 1.6048 (MUV) to allow for price escalatoin between 1985 and 1991.

** : Quality difference for rice is assumed at 10% lower price due to higher content of brokens.

*** : Exchange rate is applied at US\$1 = Ksh.28.00

**** : Milling recovery rate is assumed at 65%.

Table VI-6.4 Price Structure of Sugarcane and Cotton

Item of Calculation	Operation	Unit	Constant 1991 price
Sugarcane			
(1) International market price in 2000*		US\$/ton	342
(2) Freight and insurance		US\$/ton	33
(3) CIF price at Mombasa	= (1) + (2)	US\$/ton	375
(4) CIF price at Mombasa in Ksh.**	= (3) x 28.00	Ksh/ton	10,510
(5) Port handling, bagging, transport, etc		Ksh/ton	1,000
(6) Value at Kisumu (ex-factory price)	= (4) + (5)	Ksh/ton	11,510
(7) Cost of processing		Ksh/ton	5,350
(8) Value in terms of sugar	= (6) - (7)	Ksh/ton	6,160
(9) Value in terms of sugarcane	= (8) x 10%	Ksh/ton	616
(10) Loss by transportation	= (9) x 3%	Ksh/ton	18
(11) Transport, loading and handling charge		Ksh/ton	97
(12) Farmgate price		Ksh/ton	501
Cotton			
(1) International market price in 2000*		US\$/ton	1,795
(2) Adjustment of quality difference	= (1) x 15%	US\$/ton	269
(3) Freight and insurance		US\$/ton	57
(4) CIF price at Mombasa	= (1) - (2) + (3)	US\$/ton	1,583
(5) CIF price at Mombasa in Ksh.**	= (4) x 28.00	Ksh/ton	44,330
(6) Port handling, bagging, transport to Kisumu, etc		Ksh/ton	1,200
(7) Value in terms of lint at ex-ginnery price	= (5) + (6)	Ksh/ton	45,530
(8) Value in terms of seed cotton	= (7) x 34.8%	Ksh/ton	15,840
(9) Value of cotton seed (subproduct)		Ksh/ton	5,800
(10) Cost of ginning		Ksh/ton	3,000
(11) Value in terms of seed cotton	= (8) + (9) - (10)	Ksh/ton	18,640
(12) Loss from farmgate to ginnery	= (11) x 5%	Ksh/ton	930
(13) Transport, strage and handling charge		Ksh/ton	800
(14) Farmgate price	= (11) - (12) - (13)	Ksh/ton	16,910

Note: *: Sugar:ISA daily price, FOB and stowed greater Caribbean ports.

Cotton:middling (1-3/32"), CIF Europe.

Based on the "Quarterly Review of Commodity Markets in Fourth Quarter 1991" included in the "Price Prospects for Major Commodities, 1990 - 2005" by IBRD.

The estimated prices are given in 1985 constant US\$, and have been adjusted by a factor of 1.6048 (MUV) to allow for price escalatoin between 1985 and 1991.

** : Exchange rate is applied at US\$1 = Ksh.28.00

Table VI-7.1 Economic Crop Budget under With-Project Condition (1/3)

Item	Unit	Paddy			Maize		
		Price (/unit)	Q'ty (/ha)	Value (Ksh/ha)	Price	Q'ty (/ha)	Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	kg	4.9	30	147	10.3	30	309
Fertilizer (ASN)	kg	3.3	350	1,155	3.3	350	1,155
Fertilizer (TSP)	kg	4.5	100	450	4.5	100	450
Insecticide	lit.	74	0	0	74.0	0	0
Fungicide	lit.	250	0	0	250.0	0	0
Labour	manday	15	180	2,700	15.0	165	2,475
Oxen	time	680	2	1,360	680	2	1,360
Miscellaneous		-	5%	290	-	5%	290
Total				6,100			6,040
(2) Production Value							
Products	ton	6,180	6.0	37,080	4,660	5.0	23,300
Subproducts*				670			
Total				37,750			23,300
(3) Net Production Value				31,650			17,260

Note : value of subproducts is shown in Table VI-7.5

Item	Unit	Sorghum			Groundnuts		
		Price (/unit)	Q'ty (/ha)	Value (Ksh/ha)	Price	Q'ty (/ha)	Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	kg	10.3	10	103	20.5	25	513
Fertilizer (ASN)	kg	3.3	230	759	3.3	1,153	3,805
Fertilizer (TSP)	kg	4.5	100	450	4.5	100	450
Insecticide	lit.	74.0	0	0	74.0	0	0
Fungicide	lit.	250.0	0	0	250.0	0	0
Labour	manday	15.0	145	2,175	15.0	134	2,010
Oxen	time	680	2	1,360	680	2	1,360
Miscellaneous		-	5%	240	-	5%	410
Total				5,090			8,550
(2) Production Value							
Products	ton	3,360	3.5	11,760	11,730	1.5	17,600
Subproducts				0			0
Total				11,760			17,600
(3) Net Production Value				6,670			9,050

Table VI-7.1 Economic Crop Budget under With-Project Condition (2/3)

Item	Unit	Greengram/beans			Cotton		
		Price	Q'ty	Value	Price	Q'ty	Value
			(/ha)	(Ksh/ha)		(/ha)	(Ksh/ha)
(1) Production Cost							
Seed/nursery	kg	25.0	20	500	25.0	20	500
Fertilizer (ASN)	kg	3.3	115	380	3.3	390	1,287
Fertilizer (TSP)	kg	4.5	100	450	4.5	100	450
Insecticide	lit.	74.0	0	0	74.0	0	0
Fungicide	lit.	250.0	0	0	250.0	4	1,000
Labour	manday	15.0	154	2,310	15.0	190	2,850
Oxen	time	680	2	1,360	680	2	1,360
Miscellaneous		-	5%	250	-	5%	370
Total				5,250			7,820
(2) Production Value							
Products	ton	11,510	1.5	17,270	16,910	2.2	37,200
Subproducts				0			0
Total				17,270			37,200
(3) Net Production Value							
				12,020			29,380

Item	Unit	Sugarcane*			Napier grass (dairy)**		
		Price	Q'ty	Value	Price	Q'ty	Value
		(/unit)	(/ha)	(Ksh/ha)	(/ha)	(/ha)	(Ksh/ha)
(1) Production Cost							
Seed/nursery	/kg	0.3	3,000	900	0.5	3,000	1,500
Fertilizer (ASN)	/kg	3.3	1,050	3,465	3.3	2,800	9,240
Fertilizer (TSP)	/kg	4.5	200	900	4.5	200	900
Insecticide	/lit.	74.0	0	0	74.0	0	0
Fungicide	/lit.	250.0	0	0	250.0	0	0
Labour	/md	15.0	550	8,250	15.0	985	14,775
Oxen	/time	680	2	1,360	680	2	1,360
Miscellaneous		-	5%	740	-	5%	1,390
Total			for 4 years	15,620		for 4 years	29,170
			for 1 year	3,910		for 1 year	7,290
(2) Production Value							
Products	ton	501	100.0	50,100			34,100
Subproducts***				820			
Total				50,920			34,100
(3) Net Production Value							
				47,010			26,810

Note : *; Sugarcane is replanted every 4 years and harvested 3 times.

**; Details of production value are shown Table VI-7.2

***; Value of subproducts is shown in Table VI-7.5

Table VI-7.1 Economic Crop Budget under With-Project Condition (3/3)

Item	Unit	Vegetables			Passion fruit*		
		Price	Q'ty (/ha)	Value (Ksh/ha)	Price	Q'ty (/ha)	Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	/kg	826.0	1	826	2.46	1,000	2,460
Fertilizer (ASN)	/kg	3.3	580	1,914	3.3	290	957
Fertilizer (TSP)	/kg	4.5	100	450	4.5	60	270
Insecticide	lit. or kg	74.0	10	740	74.0	30	2,220
Fungicide	lit. or kg	250.0	10	2,500	250.0	4	1,000
Labour	/md	15.0	455	6,825	15.0	371	5,565
Oxen	/time	680	2	1,360	680	0	0
Miscellaneous		-	5%	730	-	**	3,230
Total				15,350			15,700
(2) Production Value							
Products	ton	2,790	20.0	55,800	4,100	10.0	41,000
Subproducts				0			0
Total				55,800			41,000
(3) Net Production Value							
				40,450			25,300

Note : *; 5,000 seedlings are required every 5 years.

Planting materials such and wire are included in the miscellaneous cost.

Item	Unit	Napier grass (working cattle)*			Robusta coffee**		
		Price	Q'ty (/ha)	Value (Ksh/ha)	Price	Q'ty (/ha)	Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	/kg	0.5	3,000	1,500	0.0		0
Fertilizer (ASN)	/kg	3.3	2,800	9,240	3.3	530	1,749
Fertilizer (TSP)	/kg	4.5	200	900	4.5	160	720
Fertilizer (MP)					2.3	105	242
Insecticide	/lit.	74.0	0	0	74.0	50	3,700
Fungicide	/lit.	250.0	0	0	250.0	4	1,000
Labour	/md	15.0	985	14,775	15.0	380	5,700
Oxen	/time	680	2	1,360	680		0
Miscellaneous		-	5%	1,390	-	5%	690
Total			for 4 years for 1 year	29,170 7,290			13,800
(2) Production Value							
Products	ton			32,480	4,510	4.0	18,040
Subproducts				0			0
Total				32,480			18,040
(3) Net Production Value							
				25,190			4,240

Note : *; Details of production value are shown Table VI-7.4

**; Details of production cost and production value are shown Table VI-7.6

Source : Prepared by JICA Study Team

Table VI-7.2 Production Value of Dairy Farming under Zero Grazing (1/4)
(Economic)

1. Operation system

One cow unit consists of 1 milking cow, 1 heifer between 1 - 2 years and one calf under one year. With prevalent conditions under irrigation and properly managed forage, the holding capacity can be estimated to be two livestock units (equivalent to 1 cow unit) per acre (0.41 ha). Feeding under Zero grazing involves harvesting forage from the field, transporting it, chopping the feed and feeding. The animal will need concentrate supplementation, water and mineral salts. This systems entails use of chemicals for spraying to control ticks, veterinary drugs in case of treatment against deseases. Tchnical advice from the livestock experts from the Project would be expected.

2. Reproduction cycle

The farm households will purchase in-calf heifers (cows at first calving). A cow is expected to give up to 6 - 8 calvings. This will give 6 - 8 calves in its productive life span with assumption that the cow is first served at 18 months and first calving at 27 months. It consequently calves annually as shown below:

1st month	Calving down, start milking.
3rd month	Served -Bull.
10th month	Dried, stop milking.
11th month	Steeming (Putting a cow under high plane of nutrition in preparation to anticipated calving and subsequent location)
12th month	Steeming
13th month	calves down

The cow after calving has (i) 3 months or 90 day open days, (ii) 10 months lactation period - 300 days, (iii) 2 months for steeming up. Hence the calving interval is estimated to be minimum of 13 months under good management. The gestation period assumed to be 280 days on average.

3. Milk production

Under proper management, a good purebred cow can give upto 4,500 ltrs per lactation on average.

Hence:	Annual lactation period	=	300 days
	Daily milk production	=	15 ltrs per cow
	Annual milk production	=	4500 ltrs.
	The calf milk consumption	=	330 ltrs.
	Annual milk for sales	=	4170 ltrs.

(to be continued)

Table VI-7.2 Production Value of Dairy Farming under Zero Grazing (2/4)

Where, the calf milk consumption schedule is as follows.

1st	-	2ndweek	(2 weeks)	=	3 ltrs/day	=	42 ltrs.
3rd	-	8th week	(6 weeks)	=	4 ltrs/day	=	168 ltrs.
9th	-	11thweek	(3 weeks)	=	3 Ltrs/day	=	63 ltrs.
12th	-	14thweek	(3 weeks)	=	2 ltrs/day	=	42 ltrs.
15th	-	16thweek	(2 weeks)	=	1 ltr/day	=	14 ltrs.
Total							330 ltrs.

Early calf concentrate supplementation is very essential since this saves milk consumed by calves and improves health growth of the calf. The supplementation can start from 5th week onwards at rate of 1 kg. of early calf weaner pellets per calf per day. Under average managements, the mortality rates for calves could be rated at 5% and for adult cows at 2%.

4. Cost of Zero Grazing

Cost of zero grazing per livestock unit (1 acre) consists of 2 main components, namely (1) initial cost and (2) annual operation cost. Total cost for zero grazing is estimates at about Ks17,400/year and is summarized as follows:

Depreciation of initial cost:	Ks 4,200/year
Annual operation cost:	Ks 13,200/year
<hr/>	
Total annual cost:	Ks 17,400/year

(1) Initial Cost

The initial cost includes purchase of grade dairy cow, cattle shade including water supply, equipment necessary to operate dairy farming. The cost of these item for 1 cow unit are as follows:

Grade cow*:	Ks 10,200
Cattle shade:	Ks 15,000
Equipment:	Ks 7,000
<hr/>	
total:	Ks 32,200

*: Price of a grade cow is assumed as Ks10,000, and the additional cost is also assumed for mortality rate of 2%.

To convert the above initial cost to the annual cost, the depreciation cost is calculated as follows:

(to be continued)

Table VI-7.2 Production Value of Dairy Farming under Zero Grazing (3/4)

Depreciation period:	7 years	
Residual value:	10% of cost	
Value for depreciation:	90% of cost	= Ks 29,115
Annual depreciation cost:	Ks 4,159	= <u>Ks 4,200</u>

(2) Annual Operation Cost

The operation cost includes production cost of chemical additives, mineral salts and vitamins, supplemental concentrate feed, labour cost for carrying and cutting grass fodder and, labour cost for milking, labour cost for marketing, etc. The cost of these item for 1 cow unit are as follows:

Chemical additives:	Ks 4,000
Mineral salt and vitamins:	Ks 500
Supplemental concentrate feed:	Ks 4,300
Labour (0.8 man, 365 days, @15)	Ks 4,380
Total	Ks 13,180 = Ks 13,200

5. Revenue (Gross Production Value)

Revenue per livestock unit (1 acre) of zero grazing consists of sales value of (1) milk for consumption, (2) calf and heifer sold, (3) dry cow sold and (4) value of manure. Annual gross production value is estimated at about Ks32,800 as follows:

Sales value of milk:	Ks 25,300
Sales value of calf and heifer:	Ks 3,300
Sales of dry cow:	Ks 1,200
Value of manure:	Ks.1,600
Total gross production value:	Ks 31,400

(1) Sales value of milk

4,170 lit./y13 month @Ks 6.56 Ks 27,355/13 month
Ks 25,300/year approx.

(2) Sales value of calf and heifer

During 1 cycle of paturition of 13 months, a calf or a heifer will be sold. Value of calf and heifer is estimated as follows:

(to be continued)

Table VI-7.2 Production Value of Dairy Farming under Zero Grazing (4/4)

Calf:	@2,500
Heifer:	@5,000
Average:	@3,750
Mortality of juveniles:	5%
Value of sales:	3,750 x (100% - 5%)
	= Ks 3,563 in 13 months
	= Ks 3,289 in 12 months
	<u>Ks 3,300/year</u> approximately.

(3) Sales of dry cow

1 dry cow (550 kg) after 6 parturition will be sold in 6.25 years of 1 life span of zero grazing. In the local markets, value of cow with weight 250 kg is about Ks3,800/head. Accordingly, a dry cow of 550 kg is estimated about Ks7,700.

$$\text{Ks7,700}/6.25 \text{ years} = \text{Ks1,232}/\text{year} = \underline{\text{Ks1,200}/\text{year}}$$

(4) Value of manure

The annual amount of fresh matter produced by a well-fed adult dairy cow is about 10 tons (30% dry matter), and it is assumed that 1 cow unit produce 11 ton of manure in fresh matter including losses. These manure would be applied for crops grown in the project area or sold to other farmers as farmyard manure. In this regard, manure from a dairy cow will have the economic value, and the value is estimated as follows:

nitrogen (N) :	2%, phosphorus (P ₂ O ₅) :	1.5%
3.3 tons dry matter = 66 kg of N	= 330 kg of ASN x @3.3	= Ks.1.089
	= 50 kg of P ₂ O ₅ = 110 kg of TSP x @4.5	= Ks.495
Total value of manure = Ks.1.089 + Ks.495	= Ks.1,584	= <u>Ks.1,600</u>

6. Net Production Value

The net production value in 0.41 ha (1 acre) is estimated at Ks.16,300/year as follows:

Annual gross production value:	Ks.31,400/ac
Annual cost for zero grazing:	Ks.17,400/ac
<u>Annual net production value:</u>	<u>Ks.14,000/ac</u>

The net production value per ha is estimated at Ks.34,100 as follows:

$$\begin{aligned} \text{Ks.14,000}/0.41 \text{ ha} &= \text{Ks.34,146}/\text{ha} \\ &= \text{Ks.34,100}/\text{ha} \text{ approximately.} \end{aligned}$$

Table VI-7.3 Production Value of Working Cattle
(in Economic Value)

1. Component of 1 sets pf working cattle

(working cattle : 6 heads) + (allowance : 2 heads) = 8 heads in total per set

2. Annual working days

(30 days in 1 season) x (2 seasons in 1 year) = 60 days per year

3. Working efficiency of 1 set of working cattle for land preparation

(0.25 ha/day) x (60 days per year) = 15 ha per year

4. Value for land preparation

(@Ks.680/ha) x (15 ha per year) = Ks.10,200 per year

5. Value for sales of old cattle

(@Ks.2,870 per head) x (1 head per year) = Ks.2,870 per set per year

6. Cost for purchasing young cattle

(@Ks.940 per heads) x (1 head per year) = Ks.940 per set per year

7. Labour cost

(30 man-day per season) x (2 seasons in 1 year) = 60 man-day on season

(0.5 man-day per day) x (305 days per year) = 153 man-day out of season

(60 man-day) + (153 man-day) = 213 man-day per year

(@Ks.15 per man-day) x (152 man-day per year) = Ks.3,200 per year

8. Total value of 1 cattle (in 1 year)

a. Value for land preparation	+10,200	per year
b. Value for sales of old cattle	+2,870	per set per year
c. Cost for purchasing young cattle	-940	per set per year
d. Labour cost	-3,200	per year
e. Total of 1 set of cattle (a + b + c + d)	Ks.8,930	per set (8 cattle)
f. Value for 1cattle (d ÷ 8 heads)	Ks.1,120	per cattle

Table VI-7.4 Production Value of Pasture for Working Cattle
(in Economic Value)

1. Value of Natural Pasture (under without-project condition)

$$\begin{aligned} &(\text{rearing capacity}) \times (\text{value of cattle}^*) = \\ &(2 \text{ heads/ha}) \times (\text{Ks } 1,120 \text{ per cattle}^*) = \text{ks } 2,240/\text{ha} \end{aligned}$$

*: value of cattle:refer to Table VI-7.3

2. Value of Napier grass (under with-project condition)

(a) Production of Napier grass

$$\text{fresh matter : } 400 \text{ ton/ha} = \text{dry matter : } 64 \text{ ton/ha}$$

(b) Feed requirement of working cattle

$$\begin{aligned} &(\text{daily feed requirement}) = \\ &(\text{average weight}) \times (12\% \text{ of weight}) = \\ &(250 \text{ kg in adult cattle}) \times 12\% = 30 \text{ kg in fresh matter per day} \\ &(30 \text{ kg in fresh matter per day}) \times 20\% = 6 \text{ kg in dry matter pr day} \end{aligned}$$

$$\begin{aligned} &(\text{annual feed requirement}) = \\ &(6 \text{ kg per day}) \times 365 \text{ days} = 2.2 \text{ ton in dry matter per year} \end{aligned}$$

(c) Rearing cacity of Napier grass

$$\begin{aligned} &(\text{annual production in dry matter : a}) \div (\text{annual feed requirement : b}) = \\ &(64 \text{ ton/ha per year}) \div (2.2 \text{ ton in dry matter}) = \\ &(a) \div (b) = 29 \text{ heads/ha} \end{aligned}$$

(d) Value of Napier grass

$$\begin{aligned} &(\text{rearing capacity : c}) \times (\text{value of cattle}^*) = \\ &(29 \text{ heads/ha}) \times (1,120 \text{ per cattle}^*) = \text{ks } 32,480 \end{aligned}$$

*: value of cattle:refer to Table VI-7.3

Table VI-7.5 Production Value of Sub-products
(in Economic Value)

1. Feed requirement of working cattle

(daily feed requirement) =
(average weight) x (12% of weight) =
(250 kg in adult cattle) x 12% = 30 kg in dry matter per day
(annual feed requirement) =
(30 kg per day) x 365 days = 2.2 ton in dry matter per year

2. Value of Paddy Straw

1) Available amount of paddy straw : 1.25 ton per ha in dry matter

(production of straw) x (feeding efficiency) =
(5 ton/ha in dry matter) x (25% of paddy straw) = 1.25 ton/ha in dry matter

2) Rearing capacity of paddy straw : 0.6 heads per ha

(available amount) x (feed requirement) =
(1.25 ton/ha in dry matter) x (2.2 ton in dry matter) = 0.6 heads/ha

3) Value of paddy straw : ks 670/ha

(rearing capacity) x (value of cattle) =
(0.6 heads/ha) x (1,120 per cattle) = ks 670/ha

3. Value of Sugarcane Top

1) Available amount of cane top : 1.50 ton per ha in dry matter

(production of cane top) x (feeding efficiency) =
(3 ton/ha in dry matter) x (50% of cane top) = 1.50 ton/ha in dry matter

2) Rearing capacity of cane top : 0.6 heads per ha

(available amount) x (feed requirement) =
(1.50 ton/ha in dry matter) x (2.2 ton in dry matter) = 0.7 heads/ha

3) Value of cane top : ks 820/ha

(rearing capacity) x (value of cattle) =
(0.7 heads/ha) x (1,120 per cattle) = ks 820/ha

Table VI-7.6 Production Value of Robuster Coffee (1/2)

1. Plant cycle

Farmers will purchase nursery plants (6 month aged nursery) as planting material, and will not grow nursery by farmers themselves. After land preparation, nurseries are transplanted with spacing of 3 m by 2 m (1,500 plants/ha). No coffee berries are harvested in the first 3 years, harvesting starts from the 4th year, production of berries gradually increase and full production is expected during the 6th year to 30th year. After 30th year, coffee trees would be replanted.

2. Yield of coffee berries

Item	(unit:kg/ha)			
	year after transplanting			
	3rd	4th	5th	6th to 30th
Raw berry	3,000	7,000	9,000	10,000
Dried berry	1,200	2,800	3,600	4,000

3. Labour requirement

Operation	(unit:man-day)			
	Transplanting	years after transplanting		
		1st-2nd	3rd-5th	6th-30th
Land preparation	60	-	-	-
Transplanting	60	-	-	-
Watering	10	-	-	-
Fertilizer	-	20	20	20
Weeding	-	30	30	30
Pruning	-	30	30	30
Plant protection*1	-	30	30	30
Harvesting	-	-	120	180
Post-harvest	-	-	50	70
Miscellaneous	-	10	15	20
Total*2	130	120	295	380

Note;*1: Annual labour requirement for picking coffee berries is estimated at 180 man-day/ha (55 kg/day per labour) at the full production stage.

*2: Labour requirement for water management of irrigation is not included.

(to be continued)

Table VI-7.6 Production Value of Robuster Coffee (2/2)

4. Fertilizer requirement

Item	Net* requirement	year after transplanting		
		1st-3rd	4th-5th	6th-30th
		ASN	105 in N	260
TSP	75 in P ₂ O ₅	80	140	160
MP	50 in K ₂ O	50	95	105

Note;*: Net requirement is at the full production stage.

5. Agro-chemicals

Pesticides : 4 lit./year, Fungicides : 50 kg/year

6. Gross Production Value (Revenue)

Production of dried coffee berries:	4,000 kg/ha
Economic price of dried coffee berries:	Ks.4.51/kg
Sales value:	Ks.18,040/ha

7. Cost of Production at Full Production Stage

Item	Requirement/ha	Price	Cost
Labour	380 man-day	@15	Ks.5,700
Fertilizer	Ammonium sulphate	530 kg @3.3	Ks.1,750
	Tri-super phosphate	160 kg @4.5	Ks.720
Agro-chemicals	Liquid	4 lit @250	Ks.1,000
	Powder	50 kg @74	Ks.3,700
Others	5% of total cost		Ks.690
Total			Ks.13,800

4. Net Production Value Excluding Cost for Irrigation

Gross production value:	Ks.18,570/ha
Production cost:	Ks.13,800/ha
Net production value:	Ks.4,240/ha

Table VI-7.7 Economic Crop Budget under Without-Project Condition (1/2)

Item	Unit	Paddy			Maize		
		Price (/unit)	Q'ty (/ha)	Value (Ks./ha)	Price	Q'ty (/ha)	Value (Ks./ha)
(1) Production cost							
Seed/nursery	kg	6.0	25	150	12.5	25	313
Fertilizer							
ASN	kg	3.3	0	0	3.3	0	0
TSP	kg	4.5	0	0	4.5	0	0
Insecticide	lit.	74	0	0	74.0	0	0
Fungicide	lit.	250	0	0	250.0	0	0
Labour	man-day	15	160	2,400	15.0	115	1,725
Oxen	time	680	2	1,360	680	2	1,360
Miscellaneous		-	5%	200	-	5%	170
Total				4,110			3,570
(2) Production Value							
Products	ton	6,180	3.3	20,390	4,660	1.9	8,850
(3) Net production value							
(2) - (1)				16,280			5,280

Item	Unit	Sorghum*			Beans**		
		Price (/unit)	Q'ty (/ha)	Value (Ks./ha)	Price	Q'ty (/ha)	Value (Ks./ha)
(1) Production cost							
Seed/nursery	/kg	12.5	5	63	20.5	50	1,025
Fertilizer							
ASN	/kg	3.3	0	0	3.3	0	0
TSP	/kg	4.5	0	0	4.5	0	0
Insecticide	/lit.	74.0	0	0	74.0	0	0
Fungicide	/lit.	250.0	0	0	250.0	0	0
Labour	/md	15.0	110	1,650	15.0	95	1,425
Oxen	/time	680	1	680	680	0	0
Miscellaneous		-	5%	120	-	5%	120
Total				2,510			2,570
(2) Production Value							
Products	ton	2,760	1.1	3,040	10,170	0.7	7,120
(3) Net production value							
(2) - (1)				530			4,550

Note: *;Price of sorghum is average of millet and sorghum.

**;Beans include greengram, cowpea, field beans, groundnuts.

Table VI-7.7 Economic Crop Budget under Without-Project Condition (2/2)

Item	Unit	Cotton			Tuber*		
		Price (/unit)	Q'ty (/ha)	Value (Ks./ha)	Price (/ha)	Q'ty (/ha)	Value (Ks./ha)
(1) Production cost							
Seed/nursery	/kg	25.0	20	500	0.5	3,000	1,500
Fertilizer							
ASN	/kg	3.3	0	0	3.3	0	0
TSP	/kg	4.5	0	0	4.5	0	0
Insecticide	/lit.	74	0	0	74	0	0
Fungicide	/lit.	250	3	750	250	0	0
Labour	/md	15	120	1,800	15	115	1,725
Oxen	/time	680	0	0	680	0	0
Miscellaneous		-	5%	150	-	5%	160
Total				3,200			3,390
(2) Production Value							
Products	ton	16,910	0.3	5,070	850	6.1	5,190
(3) Net production value							
(2) - (1)				1,870			1,800

Note: *;Tuber includes cassava and sweet potatoes.

Item	Unit	Sugarcane			Pasture		
		Price (/unit)	Q'ty (/ha)	Value (Ks./ha)	Price (/ha)	Q'ty (/ha)	Value (Ks./ha)
(1) Production cost							
Seed/nursery	/kg	0.3	3,000	900	0.0	0	0
Fertilizer							
ASN	/kg	4.5	0	0	4.5	0	0
TSP	/kg	74.0	0	0	74.0	0	0
Insecticide	/lit.	250.0	0	0	250.0	0	0
Fungicide	/lit.	15.0	0	0	15.0	0	0
Labour	/md	15.0	130	1,950	15.0	0	0
Oxen	/time	Tractor	3,800	3,800	680	0	0
Miscellaneous		-	5%	330	-	5%	0
Total			for 5 years	6,980			0
			for 1 year	1,400			
(2) Production Value							
Products	ton	501	40	20,040			2,240
(3) Net production value							
(2) - (1)				18,640			2,240

Source : Prepared by JICA Study Team

Table VI-7.8 Economic Net Production Value per Ha (Economic)

Crop	Gross Production Value			Production cost	Net production value
	Price	Yield	Value		
Without Project Condition					
Paddy	6,180	3.3	20,390	4,110	16,280
Maize	4,660	1.9	8,850	3,570	5,280
Sorghum	4,340	1.1	4,770	2,510	2,260
Beans*	10,170	0.7	7,120	2,570	4,550
Cotton	16,910	0.3	5,070	3,200	1,870
Cassava/sweet p	850	6.1	5,190	3,390	1,800
Sugarcane	501	40.0	20,040	1,400	18,640
Pasture	-	-	2,240	-	2,240
With project condition					
Paddy**	6,180	6.0	37,750	6,100	31,650
Maize	4,660	5.0	23,300	6,040	17,260
Beans***	11,510	1.5	17,270	5,250	12,020
Cotton	16,910	2.2	37,200	7,820	29,380
Sugarcane****	501	100.0	50,920	3,910	47,010
Vegetable	2,790	20.0	55,800	15,350	40,450
Passionfruit	4,100	10.0	41,000	15,700	25,300
Napier grass for dairy		400.0	34,100	7,290	26,810
Napier grass for working cattle		400.0	32,480	7,290	25,190

*: Beans under without-project condition are field beans, greengram, cowpea and groundnuts.

** : Gross production value of paddy includes Ks.30,080 of grains and Ks.670 of value of straw, which is estimated in Table VI-7.5.

***: Beans under with-project condition are greengram and cowpea .

****: Gross production value of sugarcane includes Ks.50,100 of cane and Ks.820 of value of cane top, which is estimated in Table VI-7.5.

Source : Prepared by JICA Study Team

Table VI-7.9 Unit Net Production Value (Economic)

With-project condition					Without-project condition	
Cropping Pattern		Unit Net Production Value			Crop	Unit Net Production Value (ks/ha)
Long rainy season	Short rainy season	Long rainy season (ks/ha)	Short rainy season (ks/ha)	Total (ks/ha)		
Paddy	Beans	31,650	12,020	43,670	Paddy	16,280
Maize	Paddy	17,260	31,650	48,910	Maize	5,280
Maize	Cotton/beans	17,260	20,700	37,960	Sorghum	2,260
	Sugarcane	-	-	47,010	Beans	4,550
Vegetables	Vegetables	40,450	40,450	80,900	Tuber*	1,800
	Fruit tree	-	-	25,300	Cotton	1,870
	Pasture for dairy	-	-	26,810	Sugarcane	18,640
	Pasture for working cattle	-	-	25,190	Pasture	2,240

*: Tuber includes cassava and sweet potato

Source : Prepared by JICA Study Team

Table VI-7.10 Economic Incremental Benefit

(1) Cropped area			(Unit:ha)						
Long Rainy Season	Short Rainy Season							Total	
			I	II-1	II-2	III	IV		V
Paddy	Beans		240	0	110	1,010	910	420	2,690
Maize	Paddy		0	0	0	70	990	680	1,740
Maize	Cotton/Beans		100	200	1,010	120	60	40	1,530
	Sugarcane		0	0	0	1,230	1,830	2,070	5,130
Vegetables	Vegetables		100	190	1,100	140	20	20	1,570
	Fruit tree		100	190	710	0	0	0	1,000
	Pasture for dairy		40	40	180	130	210	160	760
	Pasture for working cattle		20	30	120	80	150	110	510
	Total		600	650	3,230	2,780	4,170	3,500	14,930
	Paddy		0	0	50	180	130	60	420
	Maize		70	80	370	210	390	370	1,490
	Sorghum		40	50	230	130	240	250	940
	Beans		20	20	120	70	130	130	490
	Tuber		20	20	90	50	90	90	360
	Cotton		20	20	110	60	110	110	430
	Sugarcane		0	0	10	10	10	10	40
	Pasture		430	460	2,250	2,070	3,070	2,480	10,760
	Total		600	650	3,230	2,780	4,170	3,500	14,930
(2) Total net production value			(Unit:ks. million)						
Long Rainy Season	Short Rainy Season	NPV per ha						Total	
			I	II-1	II-2	III	IV		V
<u>With-ProjectCondition</u>			(ks./ha)						
Paddy	Beans	43,670	10.48	0.00	4.80	44.11	39.74	18.34	117.47
Maize	Paddy	48,910	0.00	0.00	0.00	3.42	48.42	33.26	85.10
Maize	Cotton/Beans	37,960	3.80	7.59	38.34	4.56	2.28	1.52	58.08
	Sugarcane	47,010	0.00	0.00	0.00	57.82	86.03	97.31	241.16
Vegetables	Vegetables	80,900	8.09	15.37	88.99	11.33	1.62	1.62	127.01
	Fruit tree	25,300	2.53	4.81	17.96	0.00	0.00	0.00	25.30
	Pasture for dairy	26,810	1.07	1.07	4.83	3.49	5.63	4.29	20.38
	Pasture for working cattle	25,190	0.50	0.76	3.02	2.02	3.78	2.77	12.85
	Total		26.47	29.60	157.94	126.73	187.49	159.11	687.35
<u>Without-ProjectCondition</u>									
	Paddy	16,280	0.00	0.00	0.81	2.93	2.12	0.98	6.84
	Maize	5,280	0.37	0.42	1.95	1.11	2.06	1.95	7.87
	Sorghum	2,260	0.09	0.11	0.52	0.29	0.54	0.57	2.12
	Beans	4,550	0.09	0.09	0.55	0.32	0.59	0.59	2.23
	Tuber	1,800	0.04	0.04	0.16	0.09	0.16	0.16	0.65
	Cotton	1,870	0.04	0.04	0.21	0.11	0.21	0.21	0.80
	Sugarcane	18,640	0.00	0.00	0.19	0.19	0.19	0.19	0.75
	Pasture	2,240	0.96	1.03	5.04	4.64	6.88	5.56	24.10
	Total		1.59	1.73	9.43	9.68	12.74	10.20	45.36
(3) Incremental benefit			24.89	27.87	148.52	117.06	174.75	148.91	641.99

Source : Prepared by JICA Study Team