REPUBLIC OF KENYA

LAKE BASIN DEVELOPMENT AUTHORITY

SONDU RIVER MULTIPURPOSE

DEVELOPMENT PROJECT

VOLUME - III

PRE-FEASIBILITY REPORT ON KANO PLAIN IRRIGATION PROJECT

DECEMBER, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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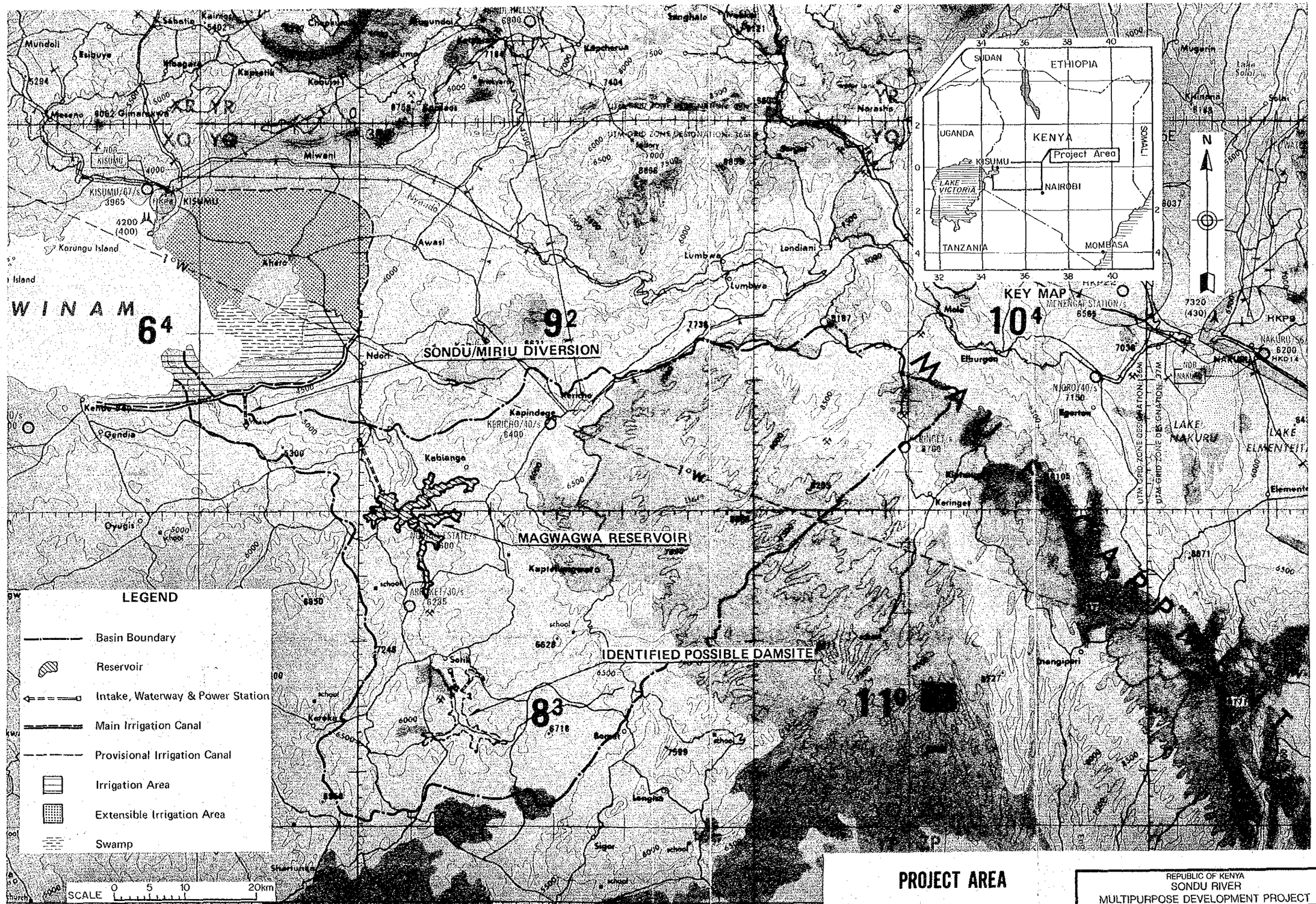
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3. FAO Irrigation and Drainage Paper No. 24 " Crop Water Requirements", 1977
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NOTATIONS AND CONVERSION FACTORS

mm	Millimetre	KW	Kilowatt
cm	Centimetre = 10mm	MW	Megawatt = 1000KW
m	Metre = 100cm	KVA	Kilovolt Ampere
km	Kilometre = 1000m	1	Litre
m^2	Square metre	m^3	Cubic Metre
ha	Hectare = 10,000m^2	MCM	Million Cubic Metre = $10^6 m^3$
km^2	Square kilometre = 100ha	KShs	Kenyan Shilling
mg	Milligramme	KL	Kenyan Pound = Kshs 20
g	Gramme = 1000mg	US$	US dollar = Kshs 15 = Yen 240
kg	Kilogramme = 1000g	EC	Electrical Conductivity
t	Ton = 1000kg	ECe	EC of Saturation Extract
sec	Second	CEC	Cation Exchange Capacity
min	Minute = 60sec	ESP	Exchangeable Sodium Percentage
hr	Hour = 60min		

LBDA	Lake Basin Development Authority
NIB	National Irrigation Board
AIRS	Ahero Irrigation Research Station
AIS	Ahero Irrigation Scheme
KSS	Kenya Soil Survey
NCPB	National Cereals and Produce Board
CLSMB	Cotton Lint and Seed Marketing Board
HCDA	Horticultural Crops Development Authority
KGGCU	Kenya Grain Growers Cooperation Union
UNDP	United Nations Development Programme
FAO	Food and Agricultuval Organization of the United Nations
USDA	United States Department of Agriculture
JICA	Japan International Cooperation Agency

Chapter 1. INTRODUCTION

This report is prepared in accordance with Article IV of the "SCOPE OF WORK FOR THE FEASIBILITY STUDY ON THE SONDU RIVER MULTI PURPOSE DEVELOPMENT PROJECT" (S/W) agreed upon between the Lake Basin Development Authority (LBDA) and The Japan International Cooperation Agency (JICA) on October 28, 1983.

The study level of this report is pre-feasibility study as prescribed in the said S/W and the study area of this pre-feasibility study is about 14,000 ha in gross, bounded by the Awach kano river on the east and by the Kendu Bay on the west as shown in the location map. (Figure 3.1)

The JICA study team visited Kenya three times, twice in 1984 and once in 1985. During the first stay (January 22 - March 23), the team conducted field survey and submitted the Inception Report. During the second stay (June 10 - November 30), the team performed the field investigation, data collection and analysis. Prior to the third visit (March 11 - March 25) the Interim Report was sent to the LBDA and the team discussed with LBDA about the Interim Report.

This report presents the study results dealing with findings on the present conditions, development concept and formulation of irrigation project reflecting the LBDA's comments for the said Interim Report.

Details of study was discussed in the separate Volume V "SUPPORTING STUDY REPORT FOR IRRIGATION PLAN". That Volume has following six appendixes;

Appendix I.	Landsat Image of Project Area
Appendix II.	Climate
Appendix III.	Soil and Land Evaluation
Appendix IV.	Agriculture and Agro-Economic Study
Appendix V.	Irrigation and Drainage
Appendix VI.	Cost Estimate

Chapter 2. BACKGROUND

2.1 National Development Plan

In Kenya, the Fifth Development Plan (1984-1988) is now under execution, setting main themes; mobilization of domestic resources for equitable development. In line with these themes, the Government is undertaking to improve infrastructure of the economy in general for the purpose of promotion of agriculture and manufacturing sectors in particular during the Plan period. The Plan projected annual growth rate for the Plan period to go up from 3.9% in 1984 to 5.6% in 1988.

Kenya has a total land area of 569,249 km^2. The estimated population as of 1983 is 18.8 million in total with an annual growth rate of 3.8%. Under such a high growth rate, the projected population will reach 35.4 million in the year 2000. This increases pressure on the national economy in respect to meeting basic needs like food, education, health care, water supply and housing.

Agricultural sector has constantly shared 30% to 35% of GDP and its provisional amount in 1982 was reported to have been K.£ 2,950 million. Agricultural outputs mainly comprise export-oriented products and their share in the total export value is around 50% or K.£ 225 million as of 1982. On the contrary, basic foodstuffs and beverages are imported to meet domestic demand and their import values reach K.£ 50 million a year.

The objectives of agricultural sector in the Fifth Development Plan are to increase food production, to grow agricultural employment, to expand agro-based industries, to promote agricultural exports, to conserve resources and to raise the farmer's income. A major strategy is put to achieve in broad self-sufficiency of basic foodstuffs. The target rate of sector's growth in GDP has been set at 4.5% per year over the period of 1984 to 1987, and to 5.9% in 1988. The projected value of agricultural sector for 1988 is K.£ 1,184 million,

sharing 30% of K.Ł 3,870 million of total GDP at 1982 prices. (see Table 2.1)

2.2 LBDA's Five Year Development Plan

In February 1983, LBDA released Five Year Development Plan for developing the Lake basin area. This development plan is aiming to increase the per capita income in the region to the national average level and to raise the standard of living above the national average. To achieve these objectives, LBDA attaches high priority to agricultural development in the region. The LBDA has the authority to exploit the production potential of major food crops and industrial crops such as maize, rice, sorghum, cotton, coffee, tea etc. LBDA proposed about K Ł 670 million development programs during the Plan period as shown in Figure 2.1.

Chapter 3. THE PROJECT AREA

3.1 Location

The Project area for this Pre-feasibility study has a gross area of 14,000 ha (8,540 ha in net irrigation area) and is situated in the central part of Nyanza Province in Western Kenya. Administratively, the Project area extends over Kendu Division in South Nyanza District and Nyakach Division in Kisumu District as shown in Figure 3.1. Geographically, the Project area stretches between latitudes 0° 12'S and 0° 22'S and between longitudes 34° 40'E and 35° 03'E. The area lies on the almost flat terrain which is bordered by Winam Gulf of Lake Victoria on the north and Nyabondo escarpment on the south. The eastern portion of the area is demarcated along the Awach Kano river and the area elongates to the west until Kendu Bay village. The Sondu river forms a boundary of both districts. The left bank of the Sondu river belongs to Kendu Division and the right bank area belongs to Nyakach Division. The right bank area can be divided by the Asawo river into two. The project area is divided by the two major rivers into the following three sub-areas:

Sub-area	Location	Project Area (ha)
I	Kendu Bay - Sondu R.	1,790
II	Sondu R. - Asawo R.	7,190
III	Asawo R. - Awach Kano R.	5,000
Total		13,980

3.2 Land and Soils

In order to select suitable land for the proposed irrigation development, the semi-detailed soil survey was carried out with the total coverage of 57,000 ha in and around the project area. Since there is the high possibility of the future extension of irrigation area, the survey covers almost whole of Kano Plain and its surrounding.

The pedology of the area has led to close relation between physiography and soil formation. In the present study, therefore, the soil survey has been performed by physiographic approach.

The landscapes of the project area are physiographically recognized as uplifted horst and downthrown graben of the Rift Valley system. The area can be classified into seven physiographic units, i.e. hills, piedmont plain, cuspate delta, uplands, fan base, lacustrine plain (Kano Plain) and swamps.

With the aid of aerialphoto interpretation, seven physiographic units are further divided into thirty-four (34) mapping units. For those units the soils are observed at seventy-one (71) points according to the FAO guideline. Besides, eighty-one (81) soils are sampled from the representative soil profiles for the laboratory analyses in order to reveal the physical and chemical characteristics of the soils. The study result is presented as a physiographic soil map in Figure 3.2.

On the basis of the soil survey, the land suitability is evaluated referring to the criteria of Kenya Soil Survey (KSS) in which the following four factors are considered

1) Soil(s); texture, depth, alkalinity and salinity
2) Topography(t); slopes and micro relief
3) Vegetation(T); density of trees relating cost, and
4 Drainage(d).

The result of land suitability classification is summarized in Table 3.1 and Figure 3.3.

3.3 Climate

The climate in this area is characterized by bimodal rainy seasons i.e. long rainy season from March to June and short rainy season from October to December. There is no meteorological station in the Project area except Nyakwere rain gauge station. For establishing the optimum cropping pattern and for estimating the irrigation water requirement, the meteorological data observed at Ahero meteo station was used. Nyakwere's rainfall data and Ahero's meteo-data are presented in Appendix II of Volume V and summarized as follows.

J	F	M	A	M	J	J	A	S	O	C	D	Year
Nyakwere rainfall (mm)												
59	68	111	150	143	67	64	97	58	61	84	86	1,048
Ahero rainfall (mm)												
71	91	133	187	131	75	74	81	77	79	124	85	1,208
Max. temperature (^{o}C)												
31.0	31.5	31.6	29.6	28.8	28.6	28.6	28.6	30.0	30.9	30.1	30.3	30.0
Min temperature (^{o}C)												
13.6	13.9	14.6	15.5	15.3	14.3	13.7	13.7	13.4	13.9	14.2	13.8	14.2
Absolute min. temperature (^{o}C)												
8.0	7.6	9.0	10.5	8.0	7.0	7.9	8.0	7.5	8.4	9.4	6.7	-
Relative humidity (%)												
65	65	67	73	74	75	75	73	66	63	66	67	69
Wind velocity (km/hr)												
5.36	5.57	5.29	4.78	4.09	4.09	3.95	4.35	4.65	4.65	4.61	4.92	4.70
Sunshine hours (hrs)												
8.5	8.5	7.9	7.3	7.3	7.2	6.8	6.8	7.0	7.4	7.1	8.1	7.5
Solar radiation (cal/cm^2/day)												
606	627	614	586	574	547	533	549	572	593	572	600	582
Pan Evaporation (mm/day)												
6.9	7.3	7.3	6.1	5.5	5.1	5.0	5.4	5.8	6.3	6.0	6.3	6.1

3.4 Hydrology

3.4.1 The Sondu River

The Sondu river, the water source of this project, has a drainage area of 3,360 km^2 at Sondu/Miriu dam site. The annual mean-monthly discharge is 41.6 m^3/sec. The maximum discharge 83.3 m^3/sec occurs in March and minimum discharge 13.7 m^3/sec in February. The seasonal pattern of stream flow at 1JG1 gauge station and the dam site are as follows. Detail hydrology of the Sondu is discussed in Appendix III of Volume IV.

Mean Monthly Runoff (m^3/sec)

J	F	M	A	M	J	J	A	S	O	N	D	annual mean
1JG1 (CA=3,260 km^2)												
16.7	13.7	18.3	51.2	83.3	57.0	45.3	51.1	57.4	36.1	34.6	33.6	41.6
Dam site (CA=3,360 km^2)												
17.2	14.1	18.8	52.8	85.8	58.7	46.7	52.7	59.2	37.2	35.7	34.7	42.8

3.4.2 Stream Flow

A number of small streams rising from Nyabondo and Nyakach escarpment cross the project area and flow into the Lake. Those small streams have catchment area ranging 3 km^2 to 20 km^2. Since there is no gauging station for those streams, the flood runoff discharge is estimated using specific discharge of the Sondu and the Nyando river. The flood discharge for two medium streams , the Asawo and the Awach Kano river also estimated in the same manner. These flood discharges will be used for design of drainage system and river crossing structures.

3.5 Agro-Climate

For assessing climatical suitability for various land use alternatives, KSS prepared the agroclimatic zone map covering all Kenya. This zoning system consists of two components, i.e. water availability (r/Eo; rainfall divided by evaporation) and temperature. According to the boundary criteria for the zoning system as given in Table 3.2, the project area falls in the zone of III-3 which means semihumid and fairly warm. The crop suitability range on the basis of the agroclimatic conditions is shown in Table 3.3 and Table 3.4. In the tables, relatively wide range of crops is suited to the zone III-3 assuming that the soil conditions are not a limiting factor.[1/]

Referring to the agroclimatic zone map, the Ministry of Agriculture (MoA) has established the agroecological zoning system, in which soil conditions are also considered in addition to moisture and temperature conditions. Considering soil conditions, cotton and maize are selected as the most suitable crops among various alternatives. In that zoning system, the project area is classified into Lower Midland Cotton Zone (LM3) and Marginal Cotton Zone (LM4).

Besides, the crop productivity for each agroecological zone is roughly estimated by the probability of yields. The crop productivity of zone LM3 is good to fair for cotton and fair for maize, but it is risky for maize without irrigation. The productivity of zone LM4 is fair to poor for cotton and maize due to low soil fertility, particularly nitrogen.

3.6 Human Resources

According to the latest population census (1979) the total number of people and households within the project area (14,000 ha) is estimated at 36,300 and 7,120 respectively. Table 3.5 shows the area, population, number of household and density in each sublocation of the project area. The average growth rate in the area is about 3.3% per annum.

In the population census, the workable population (15-59 years old) in Kisumu District is given at about 49% of the total population. This means that 2.5 persons are available for family labour on an average. (36,300 persons/7,120 households x 49% = 2.5 persons/household)

3.7 Land Use

Several types of natural vegetation are recognized in the area. The hilly lands are generally covered by evergreen or semi-evergreen forests and grasses due to moderately high rainfall and soils of free drainage. The lowlands are mostly grassland with scarce forests as a result of comparatively lower rainfall and soil of imperfect drainage.

Traditionally the economy of the people is dependent on agriculture and on animal husbandry mainly at subsistence level. The present land use status of the area is given in Table 3.6 and Figure 3.4. The main crops are sorghum and maize which are extensively cultivated. Other common crops are peas, beans, groundnuts, sweet potatoes, cassava and bananas.

3.8 Present Agricultural Condition

3.8.1 Land Holding System

There are three types of land ownership in Kenya, i.e. Government land, trust land and private land. According to the information obtained through Land Adjudication Office at Kisumu and Survey of Kenya at Nairobi, the land in Nyakach Division has been completely adjudicated and registered in title of private freehold. The average holding size of agricultural land per household in the project area are estimated as follows:

	Sub-area		
	I	II	III
Land holding size per household (ha)	2.0	1.9	1.9

(Refer to 2.5 in Appendix IV of Volume V)

3.8.2 Cropping Pattern

The main crops in the project area are maize and sorghum followed by cotton and beans. Maize and sorghum are staple food crops, generally cultivated in intercropping method with cotton or several kinds of beans, i.e. cowpea, green gram etc. Cotton is an important cash crop in the area. In addition to various upland crops, rice is also planted in a part of the lowlying land of Kano plain by Small Scale Irrigation Project.

Based on the district annual report (MoA) and the present land use survey, the planted areas of main crops are estimated. The following table presents the planted area by crops and the crop season in the area.

Crops	Cultivated area (ha)	Crop season Planting	Harvesting
1. Upland crops:			
Maize	370	Feb-Mar	May-Aug
		Sep-Oct	Dec-Jan
Sorghum	250	Feb-Mar	May-Aug
		Sep-Oct	Dec-Jan
Cotton	370	Feb-Jun	Oct-Jan
Groundnut	125	Mar-Apr	Jul-Aug
Cassava and others	125	Mar-Apr	Jul-Aug
2. Rice (Small-Scale Irrigation)	130	Apr-Aug	Aug-Jan
Total	1,370		

3.8.3 Farming Practice

The crop cultivation is generally carried out by man power only. Animal power of oxen is sometimes used for field preparation. The agricultural machinery is not commonly used yet.

As mentioned above, maize and sorghum are generally cultivated in the intercropping method with beans or cotton. In some fields they are planted in alternate row. Since sorghum is more resistant to drought hazard, this method is enable to secure the minimum food in case of failure of maize due to severe drought. Those crops are mostly cultivated without chemical fertilizers and agro-chemicals. The farm inputs and labor requirements for prevailing farming practices are presented in Table 3.7.

3.8.4 Crop Yield and Production

The crop yield and production in the project area is estimated on the basis of cropped area and production data obtained from Kisumu District Agricultural Office, Nyakach Division Agricultural Extension Office, Kendu Division Agricultural Extension Office and Farm Management Handbook of Kenya. Besides these data, some interviews with farmers were made to collect the information about unit yield and production.

Based on the above data and information, unit yield of the main crops in the project area under present condition is estimated as follows:

Crops	Yield (ton/ha)
Maize & Beans:	
Maize (Hybrid)	1.3
Beans	0.2
Sorghum (Local)	1.2
Rice (Small-Scale)	2.4
Groundnut	0.5
Cotton	0.2
Green gram	0.2
Sweet Potato	5.0
Cassava	3.0

Present crop production in the project area is estimated based on the unit yield of crops mentioned above and the cropped area with the present cropping pattern. The estimated crop production is as follows:

Crops	Planted area (ha)	Unit yield (ton/ha)	Production (ton)
Maize	370	1.3	480
Sorghum	250	1.2	300
Cotton	370	0,2	70
Groundnut	125	0.5	60
Cassava	125	3.0	380
Rice	130	2.4	310

3.8.5 Livestock Production

Livestock raising is not mainline of agricultural activities, though it is important for farm power and also for form of saving as a security against years of crop failure. Cattle is the most important livestock. For a long time, most of the farmers have been keeping indigenous one, say zebus. Sheep and goat are the second important livestock species. Livestock is mostly grazing in the natural grassland or fallow field after harvest and managed in traditional techniques.

The present number of livestock in the area is estimated as follows:

	Description	Livestock	Total
1.	No. of household		5,660
2.	Average number per household	Cattle	3
		Goat	1
		Sheep	2
		Poultry	3
3.	Estimated number of livestock	Cattle	16,980
		Goat	5,660
		Sheep	11,320
		Poultry	16,980

3.8.6 Marketing and Prices

(1) Marketing system

The various agricultural produce in the country and from abroad are dealt with mainly through the parastatal marketing bodies. Some of the bodies also provide quality control services for crop development through licensing producers, and make available credit and extension services, as well as providing research services. These parastatal and farmers organizations marketing bodies established in Kenya include Kenya Tea Development Authority (KTDA), Kenya Tea Packers Ltd. (KETEPA), Coffee Board of Kenya, Kenya Planters Co-operative Union (KPCU), Pyrethrum Board of Kenya (PBK), Sisal Board of Kenya, Horticultural Crop Development Authority, Cotton Lint and Seed Marketing Board. With regard to food crops and certain other crops, National Cereals and Produce Board (NCPB) acts as the monopoly in buying and selling. Kenya Grain Growers Co-operative Union (KGGCU) acts as an agent to deal with wheat besides NCPB. There are other marketing bodies such as Kenya Co-

operative Cremeries (KCC), Kenya Meat Commission (KMC). Most of farm inputs are distributed by KGGCU and the co-operative unions and societies. With regard to seeds, Kenya Seed Company (KSC) is responsible for the supply of commercial seeds for most crops. Various chemicals and equipment are also handled by private companies, as well as by KGGCU.

(2) Prices

In 1972 the Government introduced price control system for important basic food and other items. This system fixes the purchasing prices of major crops and foods like rice, maize etc. time to time. Those currently controlled prices on various commodities are shown in Table 3.8.

(3) Existing processing facilities (Rice Mills)

Paddy produced in and around the project area is processed at the privately owned rice mills in Kisumu and Ahero, and also processed by hand pounding for home consumption.

The total milling capacity of mills in Kisumu and Ahero is estimated at about 20,000 tons per year, and it is more than two times of the annual total production of paddy to be processed at present.

3.9 Institutions and Supporting Services for Agriculture

3.9.1 Research Stations and Pilot Schemes

There are three research stations around the project area, i.e. Ahero Irrigation Research Station (AIRS) in Ahero, Cotton Research station in Kibos and Sugarcane Research Station in Kibos.

These research stations are responsible to carry out research and provide information to improve agricultural productivity.

In the Kano Plain, there are two pilot schemes, Ahero Pilot Scheme and West Kano Pilot Scheme. Ahero Scheme has about 800 ha of rice field with pump irrigation facilities. West Kano Scheme has ben developed to grow rice and sugarcane in 900 ha using pump irrigation water from the Lake.

3.9.2 Credit Services

There are five channels through which credit funds are transmitted to farmers, i.e. Agricultural Finance Corporation (AFC), Co-operative Bank of Kenya (CBK), parastatal organizations, and commercial banks and companies. It is possible to advance farmers credit for purchase of livestock, equipment, machinery, even for land etc. Most of the credit lent are short term basis for growing crops (mainly maize and wheat) and require no security.

3.9.3 Extension Services

Extension services to the farmers are carried out by the Agricultural Extension Office. The sub-area I comes under Kendu Division Agricultural Extension Office and the sub-area II & III under Nyakach Division Agricultural Extension Office.

The extension services not only provide technical information and skills to farmers for intensification of the production process, but also coordinate complementary services such as input supply, credit and marketing.

3.9.4 Seed Multiplication

In the project area, the farmers generally retain seed from their own produce for the local varieties. Cotton seed is available from Cotton Lint and Seed Marketing Board in free of charge. Improved seeds for all crops are available on the Kenyan market as well as from Kenyan Seed Company. As for rice seed, the farmers get seed tested and released from the Research Station in Ahero Irrigation Scheme, through the

management of the scheme.

3.10 Present Irrigation Project

Kano plain has 60,000 hectares of potential irrigation area extending on the flood plains of major rivers such as the Sondu, the Nyando and the Kibos. In this high potential area, however, only about 2,700 ha are exploited for irrigation projects by National Irrigation Board (NIB) and Provincial Irrigation Unit (PIU) which belongs to the Ministry of Agriculture (MOA). About 1,800 ha, out of 2,700 ha, has been operated by NIB's two projects i.e. Ahero and West Kano pilot scheme which located out of the project area. PIU has operated another 900 ha of small scale irrigation projects of which three schemes, Awach Kano delta, Awach Kano and Wasare, are located in the present project area (See Figure. 3.5). Table 3.9 shows some characteristics of these irrigation projects.

Apart from the above-mentioned on-going projects, there are a few projects which are now in the process of the planning or implementation. Major ones are South Kano Irrigation Project and Kano Plain Irrigation Scheme which was identified by UNDP in their Kano Plain Master Plan.

The South Kano project aims at irrigation and drainage of about 2,400 ha of low land situated on the shores of the Lake about 20 km south-east of Kisumu. The feasibility study has been finished and funds are now being sought for implementation of the project.

The Kano Plain Master Plan is being worked out by UNDP team. This plan aims at swamp reclamation and irrigation and drainage of about 15,000 ha of Kano plain. According to the draft final report prepared by the UNDP team in May 1985, the most prospective is irrigation and drainage development in the Kano plain of 15,000 ha using the Sondu and the Nyando rivers as water sources for irrigation. Table 3.10 and Figure 3.6 show the outline of this master plan. This plan estimated that the transferred discharge from the Sondu river is about

3.9 m3/sec at peak time, which will cover about 5,000 ha of irrigation area.

As shown in the Figure 3.5, a southern part of this master plan's study area is overlapping with a northern part area of the present project area.

3.11 Environmental Aspect

The primary effect of the proposed irrigation project would be a long-term aggravation of public health viz. spreading infection diseases such as malaria and schistosomiasis in and around the project area.

Short-term impacts would include increases in population, employment and income. The area's schools and public services would experience short-term pressures, but their impacts are not expected to be significant.

Environmental parameters that would not be significantly impacted include settlement, land issues and compensation, recreation, wild life, vegetation and water quality.

A detailed evaluation of the environmental impacts of the Sondu river multipurpose development project is presented in Volume VI.

3.11.1 Malaria Control

Malaria is one of disease probably to be evolved by the project in and around the area. Then the following countermeasures are recommended.

(a) Chemoprophylaxis and Chemotherapy

Control priority should be aimed at the control of mortality (by chemotherapy readily accessible and available) and of morbidity (by chemoprophylaxis). These activities should go together with health education and deliberate efforts to involve the community in the

planning and implementation of the services.

(b) Vector control

Mechanical control measures: This is the elimination of larval habitats by appropriate water management e.g. draining or filling.

Residual spray: This is an antiadult mosquito measure. The houses should be sprayed regularly with an appropriate insecticides.

Larvicides: All temporary or permanent water pools which cannot be eliminated mechanically should be covered regularly by larvicides.

Biological methods: This is to use other living organisms that attack the vector, e.g. introducing fish into irrigation ponds, such as Tilapia nilotica that eat the mosquito larva.

3.11.2 Schistosomiasis Control

This disease caused by trematode worms whose vector is aquatic snail. Schistosoma could grow only in aquatic snail of particular species i.e. Biomphalaria and Bulinus. To eradicate the Schistosomiasis from the area following countermeasures are recommended.

(a) Chemotherapy

This is treatment by drugs of infected persons to reduce the number of viable eggs being released into the environment. The role of mass chemotherapy in schistosomiasis control is increasing due to the development of greatly improved drugs. In particular, oxamniquine (against S. mansoni) and praziquantel (against all three major schistosome species) are likely to become key weapons in major control programmes of the future.

(b) Snail control

Appropriate channel design: With a certain combination of water velocity, channel lining, and vegetation regime, snails will be unable to colonize a stretch of water channel.

Adequate drainage: The drainage or filling-in of natural shallow pools and seepages helps to reduce the number of snail habitats.

Improved irrigation practices: Efficient irrigation management is good for snail control. Regular maintenance of irrigation channels to prevent blockage by vegetation will also help to control snails. Intermittent irrigation can also be remarkably effective in reducing snail habitats.

Barriers to prevent snail drifting: As snails often breed in an irrigation water reservoir or pond, barriers should be placed on the irrigation channels leading from it.

Fluctuation of water levels: This is a method of rapidly fluctuating water levels in order to strand snails on the banks where they may die through desiccation or be subsequently flushed downstream as water levels suddenly rise.

Assistance to chemical control of snails: Good engineering design and efficient maintenance of channels will considerably reduce the costs of molluscice.

Miscellaneous measures: Irrigation systems require periodic maintenance, to clear vegetation and accumulated silt, and to prevent seepage and leakage of water.

Biological methods: Introduction of snail enemies can result in disappearance of vector snails, e.g. a certain large bug is an obligatory snail-eater and a single bug will kill about 125 snails in its life.

Chapter 4. AGRICULTURAL DEVELOPMENT

4.1 Basic Concept

The project area is a dense population area and most of the area is covered with upland crop field including very limited irrigated rice field. Most of the population in the area are engaged in agriculture and related activities. In spite of high potentials for agricultural development, the project area has not been fully developed mainly due to the lack of water in one hand and maldrainage in another.

Existing irrgation facilities for rice fields are drawing the water from small streams that entirely depend on rain. The cultivation pattern is, therefore, directly affected by seasonal distribution of rainfall, and the crop cultivation area and production fluctuate year by year, depending on available rainfall.

As far as cultivation technique is concerned, there is much room for improvement. The agricultural extension services have been making much efforts to improve present cultivation technique, however the farmers are continuing their cultivation with very low inputs level. In addition to the above, the present poor road condition except main road make the transportation of farm inputs and outputs so difficult and also hampers agricultural activities in the area.

The present irrigation development project aims at increasing agricultural production and thereby improvement of the farmer's living standard in the area through implementation of irrigation facilities. Maximum effective use of water and land resources, and introduction of improved irrigation farming are the most important key for the development of the project area. With this in view, the major concept for agricultural development in the irrigation area would be set up as follows;

(1) Unit yield and production of staple food crop should be stabilized and increased through establishment of irrigation system and introduction of improved irrigation farming practices,

(2) Irrigation area should be extended to a maximum extent as dictated by the available water in conformity with the Government policy for equalization, as well as maximum total benefits,

(3) Improvement of land use through increasing of cropping area and intensity should be promoted with year-round irrigation system,

(4) Production of industrial crops to supply raw materials to agro-based industries should be promoted,

(5) Present farm road network should be improved, and

(6) The agricultural development should be strengthened, especially in the field of agricultural extension services and water management.

4.2 Demarcation of Irrigation Area

As mentioned in Section 3.1, the project area is extending over Nyakach and Kano plains. In selecting irrigation area, data was collected and analysed on all interrelated natural conditions. Systematic appraisal for land, soils, topography and so on, has been conducted in selection of land suitable for irrigation farming. Following the land suitability classification, the cultivable area for rice and upland crops in the project area is selected by eliminating the unsuitable lands as follows: (see Table 3.1)

Description	Sub-area (ha)			
	I	II	III	Total
Project area	1,790	7,190	5,000	13,980
Unsuitable area for irrigation	600	2,090	610	3,300
Commanded area	1,190	5,100	4,390	10,680
20% deduction for road, canal, village, stream, etc.	240	1,020	880	2,140
Net irrigable area	950	4,080	3,510	8,540

4.3 Proposed Cropping Pattern

The most promising crops with irrigation are selected in due consideration of the results of investigation on the natural and social conditions in the irrigation area. Besides the above, the basic agricultural data collected through relevant national agricultural or irrigation stations were carefully referred to clarify the possibility of introduction and improvement of cultivation of these crops. The major crops selected to be developed are; Maize, Beans, Rice, Cotton, Groundnuts, Green Grams and Fodder crops.

Three types of cropping patterns to be adopted to the project area are formulated. The differences among the patterns are mainly based on the locational soil conditions in the area. The proposed cropping patterns are as follows and illustrated on Figure 4.1.

Cropping Patterns	Cropping per Year		Proportion of Cropped area	Cropping Intensity
	Long rain season	Short rain season		
			(%)	(%)
Pattern A	Rice	Green gram	40	
(1,990 ha)	Maize & Beans	Maize & Beans	40	
	Fodder	Fodder	20	
(Total)			(100)	200
Pattern B	Rice	Green gram	40	
(500 ha)	Maize &Beans	Rice	40	
	Fodder	Fodder	20	
(Total)			(100)	200
Pattern C	Cotton	Groundnuts	40	
(6,050 ha)	Maize & Beans	Groundnuts	40	
	Fodder	Fodder	20	
(Total)			(100)	200

4.4 Proposed Farming Practices

Proper irrigation farming supported by efficient water management, proper application of fertilizers and agricultural chemicals, is most essential for realizing full exploitation of the agricultural potentiality of the area.

Though mechanization farming has a lot of advantage such as speedy and smooth farming and emancipation of farmers from labourous work etc., it requires much amount of investment and guidance services for proper farm mechanization. However, the light mechanization is necessary especially for plant protection and quality control of production, such as sprayer for chemical application, thresher for rice, sheller for groundnuts, etc.

The inputs and labour requirement for the proposed farming practices for each crop to be developed are summarized in Table 4.1. The farm labour balance between the labour requirements and the available farm family labour (see Table 4.2) indicates necessity to employ some labours besides the family labour in the time of peak requirements.

4.5 Anticipated Yield and Production

With introduction of improved farming practices as well as proper water management, the crop yield is expected to increase remarkably. The anticipated crop yield and production of each crop at the full development stage are shown below:

Crop	Yield (ton/ha)	Area (ha)	Production (ton)
Rice	5,0	1,196	5,980
Green gram	1.2	996	1,195
Maize	5.0	4,212	21,060
Beans	0.9	4,212	3,791
Cotton	2.0	2,420	4,840
Groundnuts	2.0	4,840	9,680
Napier	120.0	854	102,480
Alfalfa	80.0	854	68,320

Chapter 5. PROJECT WORKS

5.1 Demarcation of Sub-area

As mentioned in Section 3.1, the project area is divided into three sub-areas according to the topographic conditions and the net irrigation area of 8,540 ha is selected. The acreage of each sub-area is reiterated from Section 3.1 as follows:

	Sub-area			
	I	II	III	Total
Project area	1,790	7,190	5,000	13,980 ha
Net irrigation area	950	4,080	3,510	8,540 ha

(1) Sub-area I

This sub-area is located in the most western part of the proposed area. It is a narrow strip of land sandwiched by the Escarpment and the Lake; the width is only about 1 km, while the length almost reaches to 15 km. The topography is rather complex and there are a number of rivers and streams traversing from the Escarpment to the Lake. Because of these conditions, it is disputable whether or not this sub-area will be suited to irrigated agriculture in economical point of view.

(2) Sub-area II

This sub-area is located in the centre of the proposed irrigation area occupying a half of the whole acreage. The provincial road of No.C19 runs in the midst of the area to the A-1 national highway. Influence of the hill-wash from the Escarpment is distinctly observed, and soils seem more coarse-textured and permeable compared with those in sub-area III. Besides, the land surface is rather steep with gradient of about 1/50-1/70. Owing to these characteristics, the area is suitable for upland crops such as maize, beans and cotton.

(3) Sub-area III

This sub-area is located in the east part of the proposed area astride the national highway A-1. Most of the soil is of lacustrine deposits and fertile, and the land surface is more gentle than sub-areas I and II. Owing to these favorable characteristics, this sub-area is provisionally assessed as the most suitable land for irrigated rice cultivation.

5.2 Irrigation and Drainage Water Requirements

5.2.1 Irrigation Water Requirement

The consumptive use of water for foregoing proposed cropping patterns are calculated by production of crop factor (Kc) and evapotranspiration (Eto). Kc for each crop is referred to the experimental results of AIRS[2/] except fodder crops. For fodder crops constant Kc value, 0.5 is adopted throughout the year.

The modified Penman formula[3/] and climatological data observed at Ahero experimental farm (see Appendix II of Volume V) are used for calculation of Eto. Table 5.1 shows monthly Eto over 14 years from 1970 to 1983 and mean monthly Eto is summarized as follows.

(mm/day)

J	F	M	A	M	J	J	A	S	O	N	D
5.89	6.11	5.93	5.22	4.72	4.39	4.31	4.68	5.32	5.69	5.32	5.53

The effective rainfall is estimated using FAO's method[4/] by application of rainfall records at Nyakwere rainfall gauge stations.

Net water requirements are calculated by deducting effective rainfall from the consumptive use of water. Gross irrigation water requirements are estimated dividing net water requirement by irrigation efficiency.

The irrigation efficiency, combined canal conveyance efficiency, operation efficiency and application efficiency is assumed at 40%. Table 5.2 shows the gross water requirements of proposed three cropping patterns and the following table summarizes the gross irrigation requirement.

Unit: m3/sec

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Sub-area I (950 ha)												
Pattern A (0 ha)	-	-	-	-	-	-	-	-	-	-	-	-
Pattern B (0 ha)	-	-	-	-	-	-	-	-	-	-	-	-
Pattern C (950 ha)	0.56	0.21	0.22	0.23	0.48	0.68	0.36	0.08	0.31	0.76	0.74	0.66
Sub-total	0.56	0.21	0.22	0.23	0.48	0.68	0.36	0.08	0.31	0.76	0.74	0.66
Sub-area II (4,080 ha)												
Pattern A (290 ha)	0.16	0.08	0.18	0.25	0.17	0.22	0.11	0.05	0.17	0.25	0.23	0.22
Pattern B (70 ha)	0.03	0.02	0.04	0.06	0.04	0.05	0.03	0.01	0.06	0.11	0.07	0.05
Pattern C (3,720 ha)	2.19	0.82	0.86	0.89	1.90	2.68	1.41	0.30	1.23	2.98	2.90	2.57
Sub-total	2.38	0.92	1.08	1.20	2.11	2.95	1.55	0.36	1.46	3.34	3.20	2.84
Sub-area III (3,510 ha)												
Pattern A (1,700 ha)	0.92	0.49	1.07	1.48	1.02	1.29	0.66	0.27	1.00	1.48	1.38	1.29
Pattern B (430 ha)	0.16	0.11	0.27	0.37	0.26	0.33	0.17	0.08	0.40	0.67	0.41	0.33
Pattern C (1,380 ha)	0.81	0.30	0.32	0.33	0.70	0.99	0.52	0.11	0.46	1.10	1.08	0.95
Sub-total	1.89	0.90	1.66	2.18	1.98	2.61	1.35	0.46	1.86	3.25	2.87	2.57
TOTAL (8540 ha)	4.83	2.03	2.96	3.61	4.57	6.24	3.26	0.90	3.63	7.35	6.81	6.07

5.2.2 Drainage Requirements

The drainage requirements are estimated for removal of excess water from field and for evacuation of flood in small streams. The basis adopted for the former estimation is three-days maximum rainfall exceeded only once in five years and for the latter, specific discharge of the Nyando and the Sondu are referred to. The design specific runoff used for drainage system is 1.9 1/sec/ha (paddy land) and 11.6 1/sec/ha (upland) for extracting field excess water and 0.1 to 0.9 $m^3/sec/km^2$ for flood discharge.

5.3 Irrigation and Drainage System

5.3.1 Irrigation System

The proposed irrigation system consists of main, secondary, tertiary and distribution irrigation canals. Design of these canals and the related structures are carried out according to the following programme, and the route alignment of the proposed canals are shown in Figure 5.1.

(1) Main canal

In the project, two main canals, i.e. Left Main Canal and Right Main Canal, are required. Both main canals start from the intakes provided at the tailrace bay of the proposed hydroelectric power station with the intake water level of El. 1,205 m.

The Left Main Canal with a total length of about 5.6 km is proposed to run westward along the Nyakach escarpment from the intake to the end point near Nyakwere bridge. The irrigation area of this canal is 1,670 ha in net and the canal capacity at its head is about 1.4 m^3/sec.

The Right Main Canal will be constructed with dual functions i.e. (1) to supply the irrigation water for the area of 6,870 ha, and (2) to regulate diurnal outflow from the power station.

This canal runs eastward from the intake along the foot of the escarpment, after crossing A-1 highway, the canal runs northward and terminates at the Awach Kano River. This main canal has 18.7 km length and 5.9 m^3/sec canal capacity at its head.

The alignments of both main canals are made based on the field canal route survey executed by the Contractor (Gauff, Nairobi). All the main canals are designed principally as unlined earth canal.

(2) Secondary canal

Secondary canals are to be branched off from the main canal at several locations to command topographic units of about 100 ha to 1,500 ha. The locations of secondary irrigation canals are preliminary decided on the maps of scale 1:50,000 with a contour interval of 50 ft. Seventeen secondary canals may be needed with the total length of about 66 km. Because of rather steep topography, a number of drops and water level regulating structures will be necessary.

(3) Tertiary and distribution canal

Tertiary canals distribute the water within so-called "Terminal Irrigation Units" which encompass about 20 ha. Typical layout of distribution canals and farm plot with 0.4 ha (1 acre) unit is shown in Figure 5.2.

(4) Irrigation method

To supply the irrigation water to rice and upland field, surface irrigation methods are recommended. These are basin irrigation and furrow irrigation. Basin irrigation is applied for rice cultivation and furrow irrigation for upland crop.

5.3.2 Drainage System

The functions of drainage canals are to drain water out to outlets or disposal points and to control the ground water table. The layout of the irrigation system and topography are the main factor for determining the location of the drainage canal. The natural streams are used for

the drainage canal as much as possible.

Using unit design drainage discharge (See Section 5.2.2), the drainage system is preliminary designed as shown on Figure 5.1. Since the project area situated above the highest water level of the Lake, all the drainage system are designed in gravity.

5.4 Alternative Study on Water Source for Sub-area I

As described in Section 5.1, strip land of the sub-area I is sandwiched by the Escarpment and the Lake and located left bank of the Sondu.

The Lake's water could be the alternative source of irrigation water for this area. This alternative of pumped irrigation from the Lake is studied for comparison with gravity irrigation in economic viewpoint.

(1) Gravity irrigation

About 18 km length of secondary canal crosses over the Sondu river (80m width) after branch off the left main canal and run westward along the escarpment keeping the elevation of about 1160m. The total economic cost including construction of irrigation facilities and O&M cost is estimated at US$ 5.3 million.

(2) Pump irrigation

Net 950 ha of irrigation land will be divided into 16 pump irrigation units. Each pump irrigation unit has one pump station, electric facilities and main pipeline. The irrigation water will be pumped up from the Lake and deliver to each farm plot by open canals. The total economic cost for this system including O&M cost is estimated at US$ 6.1 million.

From the above economic comparison, the gravity irrigation method is finally proposed for the Sub-area I.

5.5 Proposed Project Works

As a result of the study made in previous chapters, the selected irrigable area and proposed canal network for irrigation development are shown in Figure 5.1 of "General Layout". The irrigation water of about 7.35 m^3/sec will be delivered to each farm plot via irrigation canals branched off from the tailrace of the power station. The main drainage systems are connected to the existing streams which drain principally to the Lake. The auxiliary drainage canals are designed to collect excess water from the farm plot. The main features of the proposed irrigation and drainage system are presented below.

Description	
(1) Irrigation System	
Main canals	
- Canal length	24.3 (km)
- Related structures (Nos.)	
Turnout	30
Check	8
Culvert	14
Drop	3
Siphon & aqueduct	10
Cross drain	20
Spillway and wasteway	9
Secondary canals	
- Canal length	65.9 (km)
- Related structures (Nos.)	
Turnout	122
Check	110
Culvert	152

	Drop	650
	Spillway and wasteway	23
	Siphon and cross drain	20
	Tertiary Canal	180 (km)
	Distribution Canal	400 (km)
	Related structures (Nos.)	
	- Tertiary division box	900
	- Field division box	5,400
	- Culvert	900
(2)	Drainage System	
	Tertiary drainage canal	180 (km)
	Field drain	400 (km)
	Related structures (Nos.)	
	- Drainage culvert	900
(3)	Farm Road	
	Main farm road	24 (km)
	Secondary farm road	66 (km)
	Tertiary farm road	180 (km)
	Field road	445 (km)

5.6 Implementation Schedule

The proposed implementation schedule is presented in Figure 5.3. About ten years will need to construct irrigation and drainage facilities and farm plot development including feasibility study and detailed design periods.

5.6.1 Feasibility Study

As explained later, the feasibility study is the first follow-up undertaining for the implementation of this project. This study will require 16 months period.

5.6.2 Detailed Design Works

Prior to the construction works, the detailed design work will be carried out to spend two and half years. Loan arrangement and tender bidding will also be included in this period. During this period, necessary lands for this project should be acquired by LBDA for commencing civil works smoothly.

5.6.3 Construction Works

The construction of civil works for this project will extend over five years, commencing in the end of 1990 and ending in the beginning of 1996. It is scheduled that first 1000 ha of land will be brought under irrigation in August 1992. After 1992, every 1000 ha of land will be irrigated in each half year, until February 1996. Construction of project head office and staff quarters will also be carried out within first one year of this period.

In this schedule, the following consideration is taken into account. The implementation of irrigation project is usually affected by the progress of construction of the tertiary and on-farm units. Especially the on-farm development should require participation of the farmers, who have the land, and land levelling and reformation sometimes. Moreover, most of the farmers are not so familiar with irrigation farming and probably need a considerable time for water management. It is, therefore, deemed practical to develop the tertiary units by 2,000 ha or so successively every year.

5.7 Construction Cost

The construction cost of irrigation development was estimated on the basis of the current prices in Kenya for the local currency portion and of the prevailing prices in the international contracts for the foreign currency portion at the price level in 1984. The contingency for price escalation is included in the cost estimate applying the annual

escalation rates of 3 % for the foreign currency portion and 9 % for the local currency portion respectively.

The details of the cost estimate are given in Appendix VI of Volume V and the following table presents the summary of the project construction cost.

	Description	Foreign currency (1,000US$)	Local currency (1,000KShs)	Total (1,000KShs)
1.	Preparatory Works	2,035	10,222	40,747
2.	Main Irrigation System	5,331	34,461	114,426
3.	Secondary System	3,906	19,652	78,242
4.	Tertiary & On-Farm development	8,044	35,761	156,421
5.	Land Levelling	1,942	6,718	35,848
6.	Office & Quarters	1,125	5,625	22,500
	Sub-total (1-6)	22,383	112,439	448,184
7.	Land Acquisition	-	8,494	8,494
8.	O & M Equipment	852	666	13,446
9.	Administration Expenses	-	31,373	31,373
10.	Engineering Services	5,976	-	89,640
11.	Price Escalation	8,507	164,171	291,776
	Sub-total (1-11)	37,718	317,143	882,913
12.	Physical Contingency	3,772	31,714	88,294
	Total	41,490	348,857	971,207

Chapter 6. PROJECT EVALUATION

6.1 General

This chapter deals with economic feasibility of the irrigation sector of the Sondu Multipurpose Development Project. Overall feasibility and feasibility of the hydropower sector are discussed in Volume II, "Feasibility Report on Sondu Hydropower Development Project".

For the evaluation, the following basic assumption are considered:

- Economic life is taken as 50 years, starting from the completion of civil works.

- Construction cost of intake facilities, tunnel, power house and tailrace are not counted.

- The construction period and on-farm developing area are as shown in Figure 5.3.

- Only direct benefit is counted and any indirect or intangible benefits are not taken into account.

- The economic prices of trade goods such as maize, rice and cotton are estimated on the basis of the international market price projected by IBRD

- The economic prices of non-trade goods such as beans, groundnuts, and green gram are employed their financial price.

6.2 Economic Cost

The financial construction cost stream for the irrigation development is summarized in Table 6.1. The economic cost is obtained by deducting price contingency, land acquisition cost and transfer payment from the financial cost. The total economic cost of the irrigation development is estimated to be KShs 617.1 million.

The economic cost is disbursed according to the construction schedule as follows: (See Table 6.3)

(KShs million)

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Total
2.6	9.0	34.3	150.0	147.0	101.7	57.5	57.5	57.5	617.1

The annual operation and maintenance cost are estimated to be 2% of the economic direct cost.

6.3 Project Benefit

The project benefit is estimated as the difference of the annual net production values under future with and without project conditions. The crop production gradually increases after commencement of the partial operation of the project. The build-up period for full development production is assumed to be 5 years.

The annual benefit of project amounts to KShs 176 million or KShs 20,600 per ha at the full development stage as shown below.

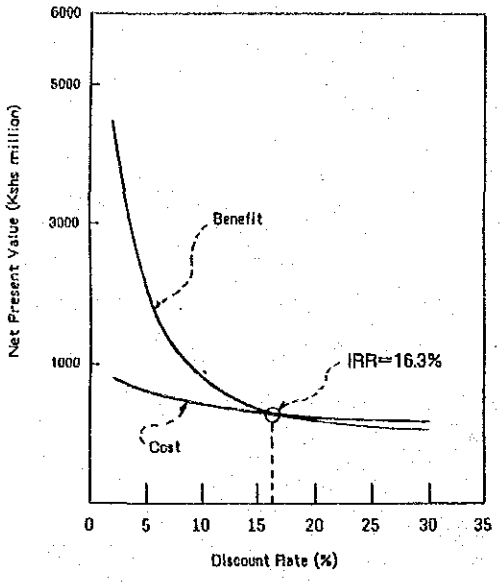
	Crops	Planted area (ha)	Net production value (KShs/ha)	Amount (KShsx10^3)
I.	With Project:			
	Maize & Beans	4,212	17,081	71,945
	Cotton	2,420	10,322	24,979
	Rice	1,196	11,641	13,923
	Green gram	996	5,619	5,597
	Groundnut	4,840	12,886	62,368
	Fodder *	1,708	-	-
	Total			178,812
II.	Without Project:			
	Maize	370	1,266	468
	Sorghum	250	2,516	629
	Cotton	370	-1,034	-383
	Groundnut	125	2,457	307
	Cassava	125	6,765	846
	Rice	130	5,601	728
	Total			2,595
III.	Incremental Production Value (I - II)			176,217

* : Net production value for fodder crop is counted as raising cost of of oxen for farm power.

6.4 Economic Evaluation

The economic feasibility of the project is evaluated in terms of the economic internal rate of return (EIRR). Using the assumptions described in Section 6.1 and the cost and benefit streams shown in Table 6.2, the following graph is derived. From this graph, the EIRR is

obtained as abscissa of intersection point of Cost and Benefit curve.



As seen in the above, the EIRR for the irrigation sector is obtained at 16.3% before allocating the cost of the diversion facilities such as intake weir, intake structure, tunnel and tailrace channel.

6.5 Farm Budget

The prospective annual farm profit of a standard irrigated farm is obtained by deducting the annual direct farming expense from annual gross income. The following table shows the farm budget of the typical farm household of 2 ha for each proposed cropping patterns in the project area.

Item	Cropping Pattern (KShs) A	B	C
I. Gross Income			
Rice	11,468	22,936	-
Green gram	6,400	6,400	-
Maize & Beans	41,072	20,536	20,536
Cotton	-	-	6,192
Groundnut	-	-	28,800
Total	58,940	49,872	55,528
II. Direct Farming Expense			
Farm input	9,681	9,729	12,269
Hired labour	968	1,353	666
Total	10,649	11,082	12,935
III. Net Farm Income	48,291	38,790	42,593

As be seen above, the annual net farm income under the proposed cropping patterns A, B and C is estimated at about KShs 48,300, 38,800 and 42,600 respectively.

Chapter 7. FUTURE INVESTIGATION AND STUDY

7.1 Feasibility Study

Since establishment of LBDA in 1979, many investigation and studies on water resources development in the Kano Plain were carried out by various foreign Consultants, Kenyan Government and LBDA. Those studies have identified irrigation projects, flood control projects, land reclamation projects and hydropower projects for the Kano plain and every study concluded that the water resources development for the Kano plain is needed to be carried out as in early stage as possible. The feasibility of hydropower project has been verified by the present feasibility study on Sondu Multipurpose Development Project. While the feasibility of agricultural development in the whole Kano plain has been verified only by master plan study or pre-feasibility study.

The implementation of the Sondu hydropower project is to be undertaken soon by the Government and LBDA. To this end, it is necessary to carry out the feasibility study of the Kano Plain Irrigation Project as early as possible, in view of the effective utilization of water to be available for the Kano plain by the hydropower development.

7.2 Scope of Work for Feasibility Study

The feasibility study of Kano Plain Irrigation Project will be carried out in two stages. In the first stage, topographic map of the project area, a prerequisite to the Study will be prepared, and then review of the previous studies and supplemental data collection relevant to the project area will be carried out. In the second stage, field survey, project formulation and design, will be conducted. The scope of work for each stage will consist of following items.

- First Stage Work

(1) To conduct ground control survey for aerial photography and topographic mapping.

(2) To conduct aerial photoshooting at a scale of 1/20,000 covering the project area of some 1,300 km^2.

(3) To prepare topographic map of the project area at a scale of 1/5,000 with 1 m contour interval.

(4) To collect and review the relevant data and reports to the Study on the following items.

(a) Topography
(b) Hydro-meteorology
(c) Geology
(d) Soil
(e) Agriculture
(f) Irrigation and drainage
(g) Agro-economy
(h) Socio-economy
(i) Flood damage
(j) Dam and reservoir
(k) Power generation
(l) Others

- Second Stage Work

(1) To carry out field investigations and surveys on the following items.

(a) Hydro-meteorological survey
(b) Geological survey
(c) Topographic survey
    i) Nyando diversion weir
    ii) Irrigation system
(d) Agriculture and agro-economic survey

(e) Irrigation and drainage survey
   i) Delineation of irrigation area
   ii) Main and secondary supply canals and drainage canals
(f) Construction material survey

(2) To carry out the following analysis and studies, and formulate the irrigation development plan
(a) Land use planning
(b) Selection of proper crops and formulation of cropping patterns and irrigation farming practices
(c) Irrigation and drainage requirements
(d) Basic designs of the required structures for the irrigation and drainage system
(e) Construction planning of the irrigation plan
(f) Organization for operation and maintenance of the system
(g) Cost and benefit studies of the plan
(h) Economic and financial evaluation

7.3 Study Schedule

The tentative time schedule of Study will be set out as shown Figure 7.1.

TABLES

Table 2.1 GDP Growth Targets (in 1982 Prices)

Sector	1982	1983	1984	1985	1986	1987	1988
Agriculture, Forestry and Fishery	903.7	944.5	987.3	1,031.8	1,078.6	1,127.4	1,183.8
Mining & Quarrying	5.6	5.6	5.7	5.9	6.0	6.2	6.4
Manufacturing	371.3	378.7	390.1	411.1	437.8	468.5	503.6
Building and Construction	118.2	114.7	114.7	116.4	121.1	126.5	132.9
Electricity and Water	45.4	47.2	50.0	53.0	56.2	59.6	63.2
Transport & Communication	158.5	164.8	172.2	180.0	189.8	198.8	209.7
Trade, Restaurants & Hotels	299.2	299.2	305.2	316.2	328.8	343.6	360.8
Business Service	194.9	210.5	221.0	233.0	246.9	264.2	282.7
Government Services	486.2	502.1	521.5	544.5	671.6	602.2	635.0
Other Services	203.2	215.4	228.3	242.1	256.9	273.1	290.4
Non Monetary	164.5	169.9	175.8	182.0	188.4	195.0	201.8
Total GDP at Factor Cost	2,950.6	3,052.6	3,171.8	3,316.0	3,481.3	3,665.1	3,870.3

Source: Development Plan 1984 - 1988

Table 3.1 Land Suitability Classification and Cropping Pattern

Unit: ha

Suitability for U.Crops	Suitability for Rice	Physio-graphic Unit	Proposed Cropping Pattern	Sub-area I	Sub-area II	Sub-area III	Total
S2sd	S1	K21	A	0	360	2130	2490
S2t	S3t	P31		1190	3580	0	4770
S2t	S3t	P32		0	650	0	650
			C	1190	4230	0	5420
S3d	S1	K22	B	0	90	540	630
S3d	S3t	F11		0	0	0	0
S3d	S3t	F12		0	0	670	670
S3d	S3t	F22		0	0	620	620
S3sd	S3st	K13		0	0	0	0
			C	0	0	1290	1290
S3t	N2st	P2		0	420	0	420
S3d	N2t	F3		0	0	240	240
S3std	N2t	F4		0	0	190	190
S3sd	N2t	K12		0	0	0	0
			C	0	420	430	850
Land Suitable for Irrigation				1190	5100	4390	10680
S3s	N2s	D2**		110	320	0	430
S3t	N2t	K4**		0	0	0	0
N2t	N2st	P11		0	120	0	120
N2s	N2st	P33		0	180	0	180
N2s	N2st	P34		0	120	0	120
N2s	N2s	D11		50	520	0	570
N2s	N2s	D12		400	260	0	660
N2s	N2s	D13		0	180	0	180
N2s	N2s	D14		40	240	0	280
N2s	N2std	U1		0	0	0	0
N2s	N2st	U2		0	0	30	30
N2s	N2st	F21		0	0	460	460
N2s	N2sd	K11		0	0	0	0
N2s	N2st	K3		0	150	70	220
N2s	N2st	K5		0	0	50	50
N2d	N2d	S2		0	0	0	0
				600	2090	610	3300
Land Unsuitable for Irrigation				600	2090	610	3300
Total				1790	7190	5000	13980

Remarks: * Project includes for improvement of the seasonal swamp (S1).

** Units are suitable for crop productive the KSS criteria, but they are currently planted under the proposed irrigation plan.

Table 3.2 Boundary Criteria for Agro-Climatic Zone

Boundary criteria for the moisture availability zones and their climatic designation

Zone	r/Eo ratio	r/Eo ratio in %	climatic designation
I	>0.8	>80	humid
II	0.65 - 0.80	65 - 80	sub-humid
III	0.50 - 0.65	50 - 65	semi-humid
IV	0.40 - 0.50	40 - 50	semi-humid to semi-arid
V	0.25 - 0.40	25 - 40	semi-arid
VI	0.15 - 0.25	15 - 25	arid
VII	<0.15	<15	very arid

r = average annual rainfall
Eo = average annual potential evaporation

Boundary criteria for the temperature zones; their mean annual temperatures and their climatic designation

zone	altitude (feet)	mean annual temperature (°C)	climatic designation
9	>10,000	<10	cold to very cold
8	9,000 - 10,000	10 - 12	very cool
7	8,000 - 9,000	12 - 14	cool
6	7,000 - 8,000	14 - 16	fairly cool
5	6,000 - 7,000	16 - 18	cool temperate
4	5,000 - 6,000	18 - 20	warm temperate
3	4,000 - 5,000	20 - 22	fairly warm
2	3,000 - 4,000	22 - 24	warm
1	0 - 3,000	24 - 30	fairly hot to very hot

Table 3.3 Moisture Range of Crops, Types of Animal Production and Types of Forestry Species

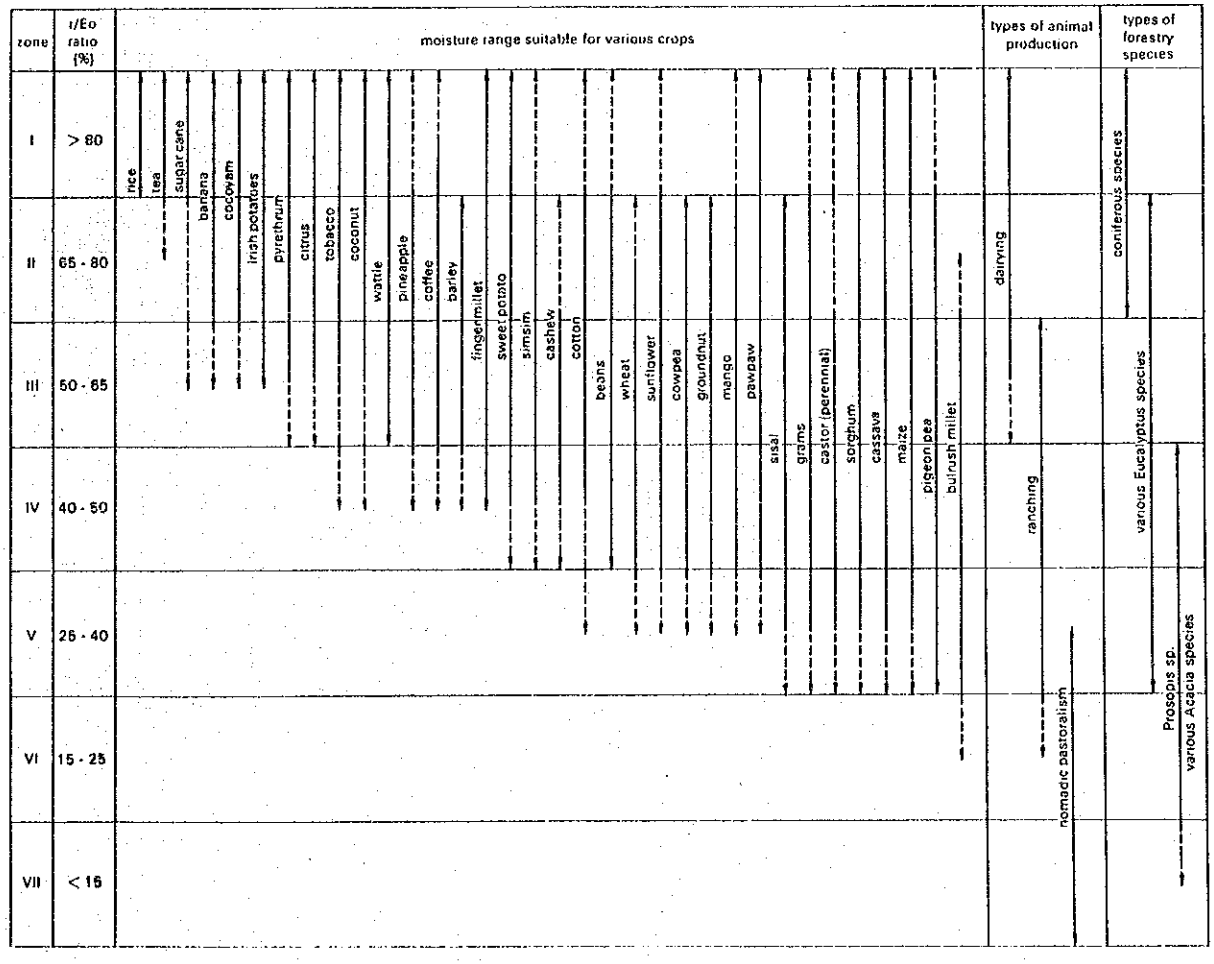


Table 3.4 Altitude and Temperature Range of Various Crops

Temperature zone	Altitude (feet)	Average Annual Temperature (°C)	Range of various crops (after Acland, 1971)
9	>10,000	<10	
8	9000 - 10,000	10 - 12	
7	8000 - 9000	12 - 14	
6	7000 - 8000	14 - 16	
5	6000 - 7000	16 - 18	
4	5000 - 6000	18 - 20	
3	4000 - 5000	20 - 22	
2	3000 - 4000	22 - 24	
1	< 3000	24 - 30	

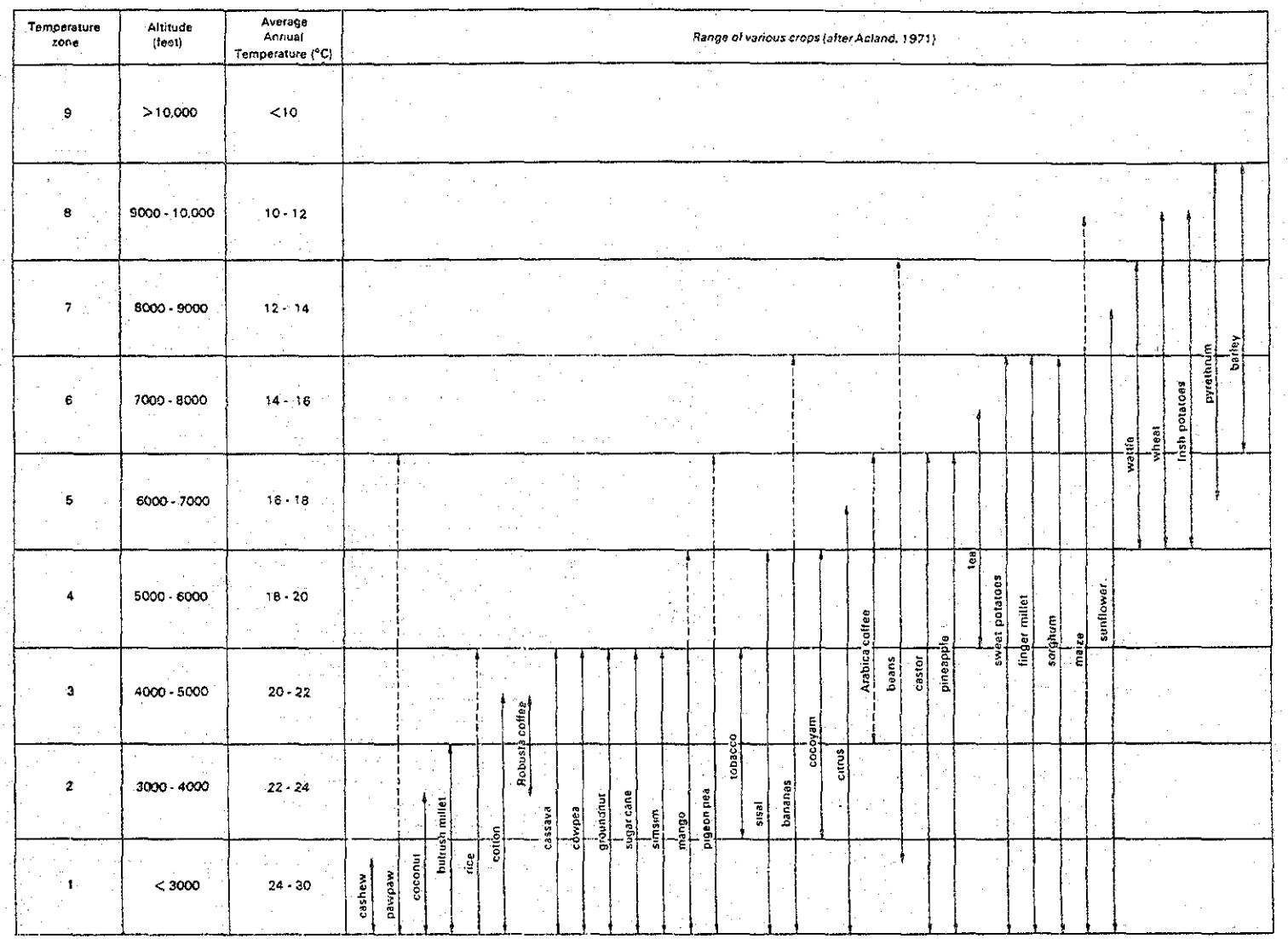


Table 3.5 Population Distribution in Nyakach and Kendu Division by Sub-location (1976)

Division: Location, Sub-location	Male	Female	Total	Number of House-hold	Area (km2)	Density (person/ km2)	No. of Household per km2	No. of Person per Household
1. Nyakach Division:	36,046	41,079	77,125	14,747	359	215	41	5.2
North Nyakach,	15,959	18,170	34,129	6,489	183	186	35	5.3
Kabodho East	4,719	5,474	10,193	1,725	40	251	43	5.9
Kabodho West	3,738	4,233	7,971	1,481	48	164	31	5.4
Agoro East	1,909	2,159	4,068	895	16	244	56	4.5
Jimo Middle	1,563	1,830	3,393	666	29	114	23	5.1
Jimo East	1,159	1,387	2,546	528	13	186	41	4.8
Gem Rae	1,729	1,908	3,637	728	21	166	35	5.0
Agoro West	1,142	1,179	2,321	466	12	180	39	5.0
West Nyakach,	8,995	10,062	19,057	4,025	97	195	41	4.7
Lower Kadianga	2,279	2,433	4,712	954	19	241	50	4.9
Kadianga West	3,191	3,651	6,842	1,544	33	170	47	4.4
West Koguta	3,525	3,978	7,503	1,527	43	195	36	4.9
2. Kendu Division								
Wang Chieng,	9,711	10,242	19,953	3,291	92	216	36	6.1
Kamser-Seka	2,156	2,261	4,417	845	15	285	56	5.2
Karabondi	1,368	1,504	2,872	464	16	178	29	6.2
Kobala	2,050	2,124	4,174	445	16	253	28	9.4
Kobuya	2,103	2,244	4,344	678	25	172	27	6.4
Kajieni	1,434	1,204	2,338	484	13	168	37	4.8
Kogmeno/Rakmano	900	908	1,808	375	5	353	75	4.8

Data source: Kenya Population Census 1979, Control Bureau of Statistics

Table 3.6 Present Land Use and Vegetation of the Project Area

Land Use	Sub-area			Total
	I	II	III	
	(ha)	(ha)	(ha)	(ha)
A. Project Area	1,790	7,190	5,000	13,980
B. Unsuitable Area for Irrigation	690	2,090	610	3,300
C. Commanded Area (A - B)	1,190	5,100	4,390	10,680
1. Arable land:	540	1,340	1,150	3,030
Upland crops	240	550	450	1,240
Paddy field	0	0	130	130
Fallow	300	790	570	1,660
2. Natural vegetation:	420	3,000	2,610	6,030
Tree and bush	120	900	400	1,420
Grass (Grazing)	300	2,100	2,210	4,610
3. Others	230	760	630	1,620

Table 3.7 Farm Inputs and Labour Requirements under Present Condition (per crop per ha)

Input/Operation	Unit	Maize	Cotton	Maize & Beans	Sorghum	Groundnut	Green gram	Rice	Vegetable
I) Inputs									
1) Seed	(kg)	25	22.5	Maize 25 Beans 40	5	50	25	45	0.25
2) Fertilizer									
- T.S.P. 1/	(kg)	-	-		-	-	-	-	-
- C.A.N. 2/	(kg)	-	-		-	-	-	-	-
- Urea	(kg)	-	-		-	-	-	-	-
3) Agro-chemicals									
- Insecticide	(lit.)	-	3		-	-	-	-	2
- Fungicide	(kg)	-	-		-	-	-	-	-
II) Farm Power									
1) Tractor	(hrs)	-	-	-	-	-	-	-	-
2) Oxen ploughing	(times/ha)	2	2	2	-	2	-	2	-
III) Labour	(man/day)	115	120	135	102	90	85	157	600
- Nursery preparation		-	-	-	-	-	-	3	13
- Soil preparation		20	20	20	20	20	10	50	75
- Sowing		15	10	20	12	15	20	2	2
- Transplanting		-	-	-	-	-	-	30	30
- Fertilizing		-	-	-	-	-	-	-	-
- Spraying		-	5	-	-	-	-	-	5
- Weeding		45	55	45	40	20	20	10	60
- Water management		-	-	-	-	-	-	2	250
- Harvesting & threshing		15	20	40	13	20	20	40	130
- Transportation, Drying		15	5	5	12	10	10	15	30
- Miscellaneous		5	5	5	5	5	5	5	5

Note, 1/: Triple Super Phosphate
2/: Calcium Ammonium Nitrate

Table 3.8 Purchasing Prices at Depot of NCPB for 1983/84

	Weight per bag	Price of gunny bag	Price in net
	(kg)	(Kshs)	(Kshs)
White maize	90	14.00	134.00
Rosecoco beans	90	8.00	300.00
Canadian Wander beans	90	8.00	300.00
Mixed beans	90	8.00	150.00
Red Haricot beans	80	8.00	250.00
Tender Green beans	80	8.00	200.00
Mevezi Moja	80	8.00	250.00
Mwitamenia	80	8.00	250.00
Soda bean	80	8.00	250.00
Yellow beans	80	8.00	150.00
Red boston beans	80	8.00	150.00
Green gram	90	8.00	250.00
Groundnut S/N type	80	8.00	550.00
Groundnut Uganda type	80	8.00	500.00
Wimbi Red mixed	80	8.00	135.00
Wimbi Black mixed	80	8.00	120.00
Mtama Red mixed	80	8.00	80.00
Mtama White mixed	80	8.00	90.00
Sim Sim brown	80	8.00	380.00
Caster seed	65	14.00	150.00
Sunflower black	40	8.00	96.00
Sunflower white	40	8.00	50.00
Sunflower Str. grey	40	8.00	46.00
Sunflower mixed	40	8.00	46.00
Non irrigated paddy	75	8.00	150.00
Cassava	50	-	50.00

Data source: NCPB Kisumu Area Office

Table 3.9 Irrigation Project in Kano Plain

Description	Ahero Pilot Scheme	West Kano Pilot Scheme	Awach Kano	Awach Kano Delta	Wasare	Kore	Alungo	Obange	Ombaka	Aguko
Status	on-going	on-going	UC 1/	UC	UC	UC	UC	UC	UC	UC
Area (ha)	770	900	150	250	150	100	40	250	3	3
Nos. of farmer	519	553	-	-	-	-	-	-	-	-
Net ha/farmer	1.6	1.6	-	-	-	-	-	-	-	-
Major crops	rice	rice sugarcane	rice	rice	rice	rice	rice	rice	Vegetable	Vegetable
Cropped area (ha)	1,307	849(rice) 330(cane)	-	-	-	-	-	-	-	-
Yield (ton/ha)	3.1	3.9(rice) 102(cane)	-	-	-	-	-	-	-	-
Farmers' net income (kshs/farmer)	2,311	4,421	-	-	-	-	-	-	-	-
Excuting body	NIB	NIB	PIU	PIU	PIU	PIU	PIU	PIU	PIU	PIU

1/ UC: Under Construction

Table 3.10 Outline of Kano Plain Development Project

Item	Description	
Water Source	Sondu/Miriu dam	(8,000 ha)
	Nyando run of river	(3,000 ha)
	Kano swamp	(1,200 ha)
	Yala, Nandi forest dam	(2,800 ha)
Irrigation area	15,000 ha	
Crop area	Rice	4,500 ha
	Sugarcane	2,100 ha
	Cotton	3,150 ha
	Maize & others	12,900 ha
Crop intensity	165%	
Peak Water requirement	203 mm (0.78 1/sec/ha)	
Construction cost	80.25 Million kshs	
Direct benefit	182.09 Million kshs	
EIRR	15.8%	

Remarks - This is cited from "UNDP final report on Lake Basin River Catchment Development River Profile Studies" by LOTTI/ WLPU, MAR 1985.

- Construction cost is not allocated the cost of Yala and Sondu Schemes.

Table 4.1 Farm Inputs and Labour Requirements under Proposed Farming Practices (per crop per ha)

	Input		Unit	Maize & Beans	Cotton	Rice	Green gram	Groundnut	Alfalfa	Napier grass
1.	Seed		Kg/ha (Maize)	15	20	30	20	90	10	20 (ton)
			(Beans)	20						
2.	Fertilizers	A.S. 1/	Kg/ha	300	450	-	-	100	270	700
		Urea	Kg/ha	-	-	225	-	-	-	-
		T.S.P. 2/	Kg/ha	100	100	100	-	100	140	150
3.	Agr. Chemicals	Seed dress	g/ha	-	-	90	-	270	-	-
		Insecticide	lit./ha	3	4	3	2	3	2	2
		Fungicide	lit./ha	2	2	3	-	3	2	2
4.	Farm Power	Labour	M.D/ha	150	160	190	90	110	170	200
		Oxen	time/ha	2	2	3	-	2	2	2
		Machinery	Hrs./ha	10	20	20	5	20	5	5
5.	Miscellaneous (about 15% of item 1 to 4)									

Remarks,

1: Machinery required are sprayer, thresher and sheller etc. for light mechanization.

2: Cane of Napier grass of 20 tons/ha is required very 4 years for renewal.

Note,

1/: Ammonium Sulfate

2/: Triple Super Phosphate

Table 4.2 Demographic Condition of Irrigation Area

Sub-area	I	II	III	Total
Irrigation area	1,190	5,100	4,390	10,680
No. of Household per Km2	36	41	41	-
No. of Household	430	2,090	1,800	4,320
No. of Person per Household	6.1	4.7	5.2	5.0
Population	2,620	9,820	9,360	21,800
Workable population per household	3.0	2.3	2.5	2.5

Table 5.1 Potential Evapotranspiration

Unit: mm/day

Year	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1970	4.81	6.01	5.21	5.05	4.72	4.55	4.42	4.12	5.14	5.79	5.37	5.42
1971	5.08	6.48	6.20	4.98	4.28	4.10	4.27	4.63	5.38	6.07	5.76	5.15
1972	6.18	4.96	6.17	5.97	5.18	4.04	4.27	4.81	5.51	5.27	4.98	5.63
1973	5.63	5.76	6.33	5.73	4.61	4.43	4.35	4.92	5.60	6.07	5.71	6.12
1974	6.30	6.78	4.96	4.96	4.67	4.53	3.75	4.92	4.77	5.65	5.24	5.89
1975	6.68	6.80	6.12	5.16	4.83	4.22	4.24	3.85	4.47	4.99	5.67	5.74
1976	6.39	6.01	6.47	5.29	4.24	4.22	3.79	4.69	5.41	5.86	5.67	5.41
1977	5.02	5.60	6.03	4.45	4.78	4.36	4.61	4.94	5.83	6.21	4.50	5.34
1978	5.85	5.84	4.75	4.94	4.92	4.14	4.30	4.75	5.25	5.57	5.58	5.19
1979	5.44	5.28	6.32	5.27	4.94	4.27	4.71	5.16	5.80	6.15	5.40	5.86
1980	6.33	6.64	6.40	5.81	4.37	4.44	4.67	4.87	5.73	6.14	5.00	5.88
1981	6.58	6.93	5.16	5.16	5.06	4.87	3.98	4.73	5.02	5.86	5.45	5.69
1982	5.85	6.02	6.41	4.69	4.30	4.60	4.50	4.53	5.37	5.08	4.76	5.17
1983	6.27	6.41	6.53	5.57	5.22	4.64	4.41	4.55	5.18	4.97	5.45	4.97
Mean	5.89	6.11	5.93	5.22	4.72	4.39	4.31	4.68	5.32	5.69	5.32	5.53

Table 5.2 Water Requirement for Each Cropping Pattern

Cropping Pattern A

Crop	Area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
LR Paddy	0.8 ha		0.18	0.93	1.44	0.61	0.69	0.24					
Green gram	0.8 ha	0.16							0.09	0.53	0.82	0.70	0.50
LR Maize	0.8 ha		0.14	0.18	0.26	0.53	0.70	0.42	0.04				
SR Maize	0.8 ha	0.68	0.06						0.08	0.44	0.69	0.78	0.86
Fodder	0.4 ha	0.24	0.20	0.15	0.04	0.06	0.12	0.11	0.11	0.20	0.22	0.14	0.15
TOTAL	(l/sec/2 ha)	1.08	0.58	1.26	1.74	1.20	1.51	0.77	0.32	1.17	1.73	1.62	1.51
	(l/sec/ha)	0.54	0.29	0.63	0.87	0.60	0.76	0.39	0.16	0.59	0.87	0.81	0.76

Cropping Pattern B

Crop	Area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
LR Paddy	0.8 ha		0.18	0.93	1.44	0.61	0.69	0.24					
Green gam	0.8 ha	0.16							0.09	0.53	0.82	0.70	0.50
LR Maize	0.8 ha		0.14	0.18	0.26	0.53	0.70	0.42	0.04				
SR Paddy	0.8 ha	0.35							0.13	1.11	2.05	1.06	0.86
Fodder	0.4 ha	0.24	0.20	0.15	0.04	0.06	0.12	0.11	0.11	0.20	0.22	0.14	0.15
TOTAL	(l/sec/2 ha)	0.75	0.52	1.26	1.74	1.20	1.51	0.77	0.37	1.84	3.09	1.90	1.51
	(l/sec/ha)	0.38	0.26	0.63	0.87	0.60	0.76	0.39	0.19	0.92	1.55	0.95	0.76

Cropping Pattern C

Crop	Area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Cotton	0.8 ha		0.04	0.12	0.18	0.42	0.61	0.22					
Groundnut	1.6 ha	0.94	0.06							0.46	1.38	1.42	1.23
LR Maize	0.8 ha		0.14	0.18	0.26	0.53	0.70	0.42	0.04				
Fodder	0.4 ha	0.24	0.20	0.15	0.04	0.06	0.12	0.11	0.11	0.20	0.22	0.14	0.15
TOTAL	(l/sec/2 ha)	1.18	0.44	0.45	0.48	1.01	1.43	0.75	0.15	0.66	1.60	1.56	1.38
	(l/sec/ha)	0.59	0.22	0.23	0.24	0.51	0.72	0.38	0.08	0.33	0.80	0.78	0.69

Table 6.1 Annual Disbursement Schedule of Financial Construction Cost

Description	TOTAL		1988		1989		1990		1991		1992		1993		1994		1995		1996	
	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Preparatory Works	2,035	10,222	-	-	-	-	610	3,067	1,425	7,155	-	-	-	-	-	-	-	-	-	-
2. Main Irrigation System	5,331	34,461	-	-	-	-	-	-	3,199	20,677	2,132	13,784	-	-	-	-	-	-	-	-
3. Secondary Irrigation System	3,906	19,652	-	-	-	-	-	-	391	1,965	1,953	9,826	1,562	7,861	-	-	-	-	-	-
4. Tertiary and On-farm Development	8,044	35,761	-	-	-	-	-	-	-	-	1,608	7,153	1,609	7,152	1,609	7,152	1,609	7,152	1,609	7,152
5. Land Levelling	1,942	6,718	-	-	-	-	-	-	-	-	389	1,343	389	1,343	388	1,344	388	1,344	388	1,344
6. Office and Quarters	1,125	5,625	-	-	-	-	225	1,125	900	4,500	-	-	-	-	-	-	-	-	-	-
Sub-total(item 1 to 6)	22,383	112,439	-	-	-	-	835	4,192	5,915	34,297	6,082	32,106	3,560	16,356	1,997	8,496	1,997	8,496	1,997	8,496
7. Land Acquisition	-	8,494	-	849	-	4,247	-	3,398	-	-	-	-	-	-	-	-	-	-	-	-
8. O&M Equipment	852	666	-	-	-	-	-	-	213	166	-	-	639	500	-	-	-	-	-	-
9. Administration Expenses	-	31,373	-	628	-	2,197	-	4,079	-	4,079	-	4,078	-	4,078	-	4,078	-	4,078	-	4,078
10. Engineering Services	5,976	-	119	-	418	-	777	-	777	-	777	-	777	-	777	-	777	-	777	-
11. Price Escalation	8,507	164,171	15	605	66	3,479	306	7,934	1,588	31,989	1,851	35,822	1,492	24,492	943	17,226	1,054	19,866	1,192	22,758
Sub-total(item 1 to 11)	37,718	317,143	134	2,082	484	9,923	1,918	19,603	8,493	70,531	8,710	72,006	6,468	45,426	3,717	29,800	3,828	32,440	3,966	35,332
12.Physical Contingency	3,772	31,714	13	208	48	992	192	1,960	849	7,053	871	7,201	647	4,543	372	2,980	383	3,244	397	3,533
TOTAL	41,490	348,857	147	2,290	532	10,915	2,110	21,563	9,342	77,584	9,581	79,207	7,115	49,969	4,089	32,780	4,211	35,684	4,363	38,865

F/C : Foreign Currency (1,000 US$)
L/C : Local Currency (1,000 Kshs)

Table 6.2 Cost and Benefit Stream

Unit: 1000 kshs

Year	Cost		Benefit
	Capital	O&M	
1	2,549		
2	8,953		
3	34,328		
4	149,976		
5	147,010		
6	101,686		
7	57,522	7,139	18,957
8	57,522	7,883	46,878
9	57,522	8,626	78,925
10		8,626	118,651
11		8,626	143,721
12		8,626	158,183
13		8,626	168,519
14		8,626	174,727
15		8,626	176,217
16		8,626	176,217
17		8,626	176,217
18		8,626	176,217
19		8,626	176,217
20		8,626	176,217
21		8,626	176,217
22		8,626	176,217
23		8,626	176,217
24		8,626	176,217
25		8,626	176,217
26		8,626	176,217
27		8,626	176,217
28		8,626	176,217
29		8,626	176,217
30		8,626	176,217
31		8,626	176,217
32		8,626	176,217
33		8,626	176,217
34		8,626	176,217
35		8,626	176,217
36		8,626	176,217
37		8,626	176,217
38		8,626	176,217
39		8,626	176,217
40		8,626	176,217
41		8,626	176,217
42		8,626	176,217
43		8,626	176,217
44		8,626	176,217
45		8,626	176,217
46		8,626	176,217
47		8,626	176,217
48		8,626	176,217
49		8,626	176,217
50		8,626	176,217
51		8,626	176,217
52		8,626	176,217
53		8,626	176,217
54		8,626	176,217
55		8,626	176,217
56		8,626	176,217

Table 6.3 Annual Disbursement Schedule of Economic Construction Cost

Description	TOTAL		1988		1989		1990		1991		1992		1993		1994		1995		1996	
	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Preparatory Works	2,035	8,689	-	-	-	-	610	2,607	1,425	6,082	-	-	-	-	-	-	-	-	-	-
2. Main Irrigation System	5,331	29,292	-	-	-	-	-	-	3,199	17,575	2,132	11,717	-	-	-	-	-	-	-	-
3. Secondary Irrigation System	3,906	16,704	-	-	-	-	-	-	391	1,670	1,953	8,352	1,562	6,682	-	-	-	-	-	-
4. Tertiary and On-farm Development	8,044	30,397	-	-	-	-	-	-	-	-	1,608	6,080	1,609	6,080	1,609	6,079	1,609	6,079	1,609	6,079
5. Land Levelling	1,942	5,711	-	-	-	-	-	-	-	-	389	1,143	389	1,142	388	1,142	388	1,142	388	1,142
6. Office and Quarters	1,125	4,781	-	-	-	-	225	956	900	3,825	-	-	-	-	-	-	-	-	-	-
Sub-total(item 1 to 6)	22,383	95,574	-	-	-	-	835	3,563	5,915	29,152	6,082	27,292	3,560	13,904	1,997	7,221	1,997	7,221	1,997	7,221
7. O&M Equipment	852	566	-	-	-	-	-	-	213	141	-	-	639	425	-	-	-	-	-	-
8. Administration Expenses	-	26,667	-	532	-	1,866	-	3,467	-	3,467	-	3,467	-	3,467	-	3,467	-	3,467	-	3,467
9. Engineering Services	5,976	-	119	-	418	-	777	-	777	-	777	-	777	-	777	-	777	-	777	-
Sub-total(item 1 to 9)	29,211	122,807	119	532	418	1,866	1,612	7,030	6,905	32,760	6,859	30,759	4,976	17,796	2,774	10,688	2,774	10,688	2,774	10,688
10. Physical Contingency	2,921	12,281	12	52	42	187	161	703	691	3,276	686	3,076	498	1,780	277	1,069	277	1,069	277	1,069
TOTAL	32,132	135,088	131	584	460	2,053	1,773	7,733	7,596	36,036	7,545	33,835	5,474	19,576	3,051	11,757	3,051	11,757	3,051	11,757

F/C : Foreign Currency (1,000 US$)
L/C : Local Currency (1,000 Kshs)