REPUBLIC OF KENYA

LAKE BASIN DEVELOPMENT AUTHORITY

THE STUDY OF INTEGRATED REGIONAL DEVELOPMENT MASTER PLAN FOR THE LAKE BASIN DEVELOPMENT AREA

FINAL REPORT

Volume 7

REPORT ON PREPARATORY STUDY

October 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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LIST OF REPORTS

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Contents

Abbreviations

ACFC	Agro-Chemical and Food Company
ADT	Average Daily Traffic
AED	African Economic Digest
AESD	Agricultural Extension and Service Division
AFC	Agricultural Finance Corporation
AI	Artificial Insemination
AIRS	Ahero Irrigation Research Station
BAT	British American Tobacco Kenya Ltd.
BOD	Biochemical Oxygen Demand
CBK	Coffee Board of Kenya
CBS	Central Bureau of Statistics
CL SMB	Cotton Lint and Seed Marketing Board
CPCS	Cooperative Production Credit Scheme
DAO	District Agricultural Officer
DC	District Commissioner
DCDC	District Community Development Committee
DDC	District Development Committee
DEC	District Executive Committee
DEO	Division Extension Officer
DFCK	Development Financial Company of Kenya
DME	Distance - Measuring Equipment
DO	District Officer
EAI	East African Industries Limited
EATEC	East African Tanning Extract Company Limited
EEC	European Economic Community
EIU	Economic Intelligence Unit
ESMAP	Energy Sector Management Assistance Programme
FAO	Food and Agriculture Organization of the United Nations
FISS	Farm Input Supply Scheme
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
GTZ	Germen Agency for Technical Cooperation
HCDA	Horticultural Crops Development Authority
HFA/2000	Health for All by the Year 2000 AD.
IADP	Integrated Agricultural Development Program
IBRD	International Bank for Reconstruction and Development
ICA	International Coffee Agreement
ICDC	Industrial and Commercial Development Corporation
ICIPE	International Center for Insect Physiology and Ecology
ICOR	Incremental Capital-Output Ratio
IDA	International Development Association
IDB	Industrial Development Bank
IDS	Institute of Development Studies
IE	Industrial Estate
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
ILUS	Integrated Land Use Survey
IPA	Industrial Promotion Area
IRD	Integrated Rural Development
IRRI	International Rice Research Institute
IRS	Integrated Rural Survey
JICA	Japan International Cooperation Agency
JSCE	Japan Society of Civil Engineers
KCC	Kenya Cooperative Creawerdes
KCPE	Kenya Certificate of Primary Education
KENAFYA	Kenya - Finland
KENGO	Kenya Energy Non-Governmental Organizations Association
KETA	Kenya External Trade Authority
KFA	Kenya Farmers Association
KGGCU	Kenya Grain Growers Union
KIE	Kenya Industrial Estates Limited
KITI	Kenya Industrial Training Institute
K£	Kenya Pounds (20 Kenya shillings)
KMC	Kenya Meat Commission
KNAIS	Kenya National Artificial Insemination Service
KPCU	Kenya Planters Cooperative Union
KPLC	Kenya Power and Lighting Company Limited
KQ	Kenya Airways
KRC	Kenya Railways Corporation
KREDP	Kenya Renewable Energy Development Programme
KSA	Kenya Sugar Authority
KSB	Kenya Sisal Board
KSC	Kenya Seed Company
Kshs	Kenya Shillings
KSS	Kenya Soil Survey
KTDA	Kenya Tourism Development Authority
KTDA	Kenya Tea Development Authority

KWDP	Kenya Woodfuel Development Project
LBDA	Lake Basin Development Authority
LPG	Liquefied Petroleum Gas
LSI	Lake Shore Irrigation
LU	Livestock Unit
MCH/FP	Matenal Child Health/Family Planning
MOLG	Ministry of Local Government
MOA	Ministry of Agriculture
MOALD	Ministry of Agriculture and Livestock Development
MOERD	Ministry of Energy and Regional Development
MOEST	Ministry of Education Science and Technology
MOH	Ministry of Health
MOLD	Ministry of Livestock Development
MOPND	Ministry of Planning and National Development
MOTC	Ministry of Transport and Communication
MOWD	Ministry of Water Development
MP	Member of Parliament
MSC	Mumias Sugar Company
MSS	Multispectral Scanner
MSY	Maximum Sustainable Yield
NCC	National Construction Corporation
NCPB	National Cereals and Produce Board
NCST	National Council for Science and Technology
NEP	National Energy Policy
NEP	National Extension Project
NGO	Non-Governmental Organization
NIB	National Irrigation Board
NMWP	National Master Water Plan
NSCC	New Seasonal Credit Scheme
OD	Origin-Destination
OECD	Organization for Economic Cooperation and Development
PBME	Project Benefit Monitoring and Evaluation
PC	Provincial Commissioner
PCU	Passenger Car Unit
PHC	Primary Health Care
PIU	Provincial Irrigation Unit
RAES	Rural Afforestation Extension Service
RIDC	Rural Industrial Development Center
ROK	Republic of Kenya
RTPC	Rural Trade and Production Center
RWSDP	Rural Water Supply Development Project
SCIP	Smallholder Coffee Improvement Project
SBFC	Small Enterprise Financial Corporation
SEP	Special Energy Programme
SP1	Sessional Paper No.1 of 1986 on Economic Management for Renewed Growth
SPSCP	Smallholder Production Services and Credit Scheme
SRRP	Smallholder Price Rehabilitation Project
SSIOP	Small Scale Irrigation Development Project
SWAP	Surface Water Extraction Permit
T&V	Training and Visit
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNCEF	United Nations International Children's Emergency Fund
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VOR	Very High Frequency Ommidirectional Radio Range
WHO	World Health Organization

Abbreviations of Measures

Length

mm	=	millimeter
m	=	meter
km	=	kilometer

Area

ha	=	hectare
km^2	=	square kilometer

Volume

ℓ	=	lit = litre
m^3	=	cubic meter
MCM	=	million cubic meter

Weight

mg	=	milligram
g	=	gram
kg	=	kilogram
t	=	ton = MT = metric ton

Time

sec	=	second
hr	=	hour
d	=	day
yr	=	year

Money

Kshs.	=	Kenya shilling
K£	=	Kenya pound
US¢	=	U.S. cent
US$	=	U.S. dollar

Energy

kcal	=	kilocalorie
J	=	joule
MJ	=	megajoule
HP	=	horsepower
TOE	=	tons of oil equivalent
kW	=	kilowatt
MW	=	megawatt
kWh	=	kilowatt-hour
GWh	=	gigawatt-hour

Others

%	=	percent
°	=	degree
'	=	minute
°C	=	degree Celsius
cap.	=	capita
LU	=	livestock unit
md	=	man-day
mil.	=	million
no.	=	number
pers.	=	person
PCU	=	passenger car unit

Chapter 1 LAKESHORE IRRIGATION PROJECT

Chapter 1 LAKE SHORE IRRIGATION PROJECT

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1.1 Introduction

1.1.1 Background

The Lake Shore Irrigation (herein after called LSI) project has been selected as a high priority project for a preparatory study from among the Master Plan projects. The JICA study team has carried out this study in collaboration with LBDA irrigation counterpart through discussions, data analysis and field investigation. Available topographic maps with scale of 1 to 50,000 and information of previous studies have been utilized for the study.

National economy

In Kenya, the fifth Development Plan (1984-1988) is now under execution, having two main themes; mobilization of domestic resources and equitable development. With these themes, the Government has been undertaking the improvement of infrastructure for the purpose of promoting agriculture and manufacturing sectors. The annual growth rate projected for the Plan period increases 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 1985 is 20.1 million in total with an annual growth rate of 3.8%. With such a high growth rate, the projected population will reach 35.4 million in the year 2000, resulting in increased pressure on land and other natural resources, and more resource requirements to meet basic needs like food, education, health care,water supply and housing.

Agricultural sector has consistently shared 30 to 35% of GDP in recent years, amounting to K£2,950 million in 1982 . Agricultural outputs mainly comprise export-oriented products and their share in the total export value was around 50% of K£225 million in 1982. Many basic foodstuffs and beverages are imported to meet domestic demand and their import value is about K£ 50 million a year.

The objectives of agricultural sector in the fifth Development Plan is to increase food production, and agricultural employment, provide inputs to agro-based industries, expand agricultural exports, conserve resources and alleviate poverty, aiming also at maintaining broad self-sufficiency in basic foodstuffs. In line with this national development policy, the Master Plan for the LBDA Region has set the agriculture, livestock,fishery and forestry sector's GRDP in the Region at K£1,752 million with 5.4% target growth rate (Table 1.1).

1.1.2 Development potential

Agriculture in the Region has much potential considering present crop yields as compared to national target yields (Table 1.2). The yield potential is to be developed by improving farming practice, applying farm inputs and introducing irrigated farming.

The area in the Region defined as low gradient land covered by grasses or bush can be used for agricultural development. This expansible area for agricultural development amounts to about 1.3 million ha, and crop suitability in this area is shown in Table 1.3 by district.

Irrigation development potential

In May 1981, the Ministry of Agriculture established a policy with regard to an accelerated programme on irrigation and drainage development in Kenya. In this programme, it is emphasized that irrigation, land reclamation by drainage and flood protection are major and attractive alternatives for a sizable expansion of cultivable land in the country, in order to produce additional food and export crops, to settle people in newly developed lands and to create substantial employment opportunities.

Potential of irrigable land in the whole of Kenya has been assessed at about 540,000 ha by National Water Master Plan in 1980. According to this plan, the Lake Basin region has 200,000 ha of irrigable lands. These 200,000 ha potential areas extend along the upper marsh land, lower reaches and alluvial flood plains of the main rivers. Estimated irrigation potential by river basin is as follows:

River Basin	Location	Potential Area (ha)
Nzoia	Middle/lower	65,000
Yala	Yala Swamp	15,000
Sondu/Nyando	Kano Plain	60,000
Kuja/Migori	Lower	25,000
Mara	Upper	20,000
Other	Lake Shore	15,000
	Total	200,000

Needs for irrigation development

According to the fifth Development Plan 1984-88, ten potential sites for minor irrigation covering 17,400 ha in total were expected to be implemented during the plan period. It emphasizes a low cost approach in the implementation, and the small scale irrigation projects, and utilization of gravity flow are given preference. The irrigation schemes to be newly taken up under the fifth Development Plan have important roles as pioneers of improved crop cultivation under a year-round irrigated condition.

The LBDA region is endowed with rich water resources with six major rivers and many small rivers as well as the Lake water. The Region also has generally favourable soil. However, the Region suffers from unreliable rains and flood hazard, which alternate unpredictably so that stable food production cannot be assured without the use of irrigation.

1.2. Physical and Socio-Economic Conditions of the LSI Area

1.2.1 Delineation of LSI project area

The LSI area is generally known as a belt of 20 km "rain shadow" along the Lake shore from Uganda border to Tanzania border. This definition of LSI project area is somewhat ambiguous. In this preparatory study, the LSI project area is defined as the Lake shore land under the elevation 4,000 feet (1,219m). Areas in the six major river basins where major development projects are going on or planned such as Kano Plain, Yala Swamp, lower Kuja and lower Nzoia have been omitted in this study. Eliminating these areas, the LSI project area has 157,300 ha in total. As shown in Figure 1.1, the LSI area is divided into two parts. The southern part of 77,900 ha area belongs to South Nyanza district and the northern part of 79,400 ha extends over two districts, Kisumu and Siaya.

1.2.2 Climate

Rainfall data for selected stations in the LSI area are given in Table 1.4 and the monthly distribution patterns are shown in Figure 1.2. As shown in the isohyet map (Figure 1.3), the 1,000mm isohyet passes through the east of Siaya district and centre of southern part of LSI area. The 1,200 mm isohyet is running through the centre of northern LSI area.

The monthly mean temperature at Kisumu, Homa Bay and Macalder is also given in Table 1.4. Figure 1.4 shows the rainfall and temperature recording stations.

1.2.3 Agro-ecological zone

Although the slight difference by location is recognized in the rainfall amount especially during the short rainy season, the Lake shore agro-ecologically falls in Lower Midland Cotton Zone (LM3). LM3 is characterized by medium to long rainy cropping season during March to July followed by weak short rainy season. The total rainfalls amount to 1,100 mm to 1,200 mm, of which about 500 mm occur in the long rainy season.

In the long rainy season, early maturing varieties of maize and sorghum can grow, but most farmers plant cotton and cassava in this zone. In short rainy season, the lands remain fallow.

The natural grazing of local cattle, sheep and goats, which are highly resistant against drought, is broadly practiced. Due to low carrying capacity of grassland (0.9 LU/ha), the nutritional conditions of animals seem to be below the average level in the Region.

1.2.4 Soil

The soil occurring on the Lake shore shows complicated distribution patterns. In general, the soil is colluvial, originated from igneous rocks forming hilly lands. They can be characterized by dark yellowish to brownish color, good drainage and high gravel contents.

Besides, the black alluvial soil is locally identified along the Lake shore. It is quite similar to the soil covering the Kano Plain, imperfectly drained, deep and fertile. The origins of

these types of soil are partly the lacustrine deposits, but mainly the river alluvial deposits transported by small rivers, which incise the Lake shore and flow into the Lake.

The lands covered by the black soil are easily inundated during the rainy season due to their low topographic positions. In cases that the geological origins of soil are basic igneous or metamorphic rocks, the saline soil and/or the alkaline soil are locally formed in downstream areas. Through alternation of dry and wet in depression, for instance, the soluble salts contained in soil tend to accumulate on soil surface. Due to high content of sodium, the soil becomes extremely compact and root extension is severely restricted. In order to select the future irrigation area, therefore, a detailed soil survey will be required.

1.2.5 River discharge

A number of small rivers are crossing the LSI area. Major rivers are Awach Kibuon, Awach Tende, Muguruk, Luanda, Ndate, Seme Awach and a few others. (see Figure 1.4).

Of these rivers, only three rivers, Awach Kibuon (gauging code:1HD4), Awach Tende (1HE1) and Seme Awach (1HB5) have discharge records. Some other rivers have water level records only. Tables 1.5 through 1.7 show monthly river discharges for the three rivers. Location of each gauging station is shown in Figure 1.4.

Awach Tende

This river rises around Kisii town, flows toward the south into Oluch area and drains into the Lake Victoria near Homa Bay. The gauging station 1HE1 (CA. = 585 km^2) near Nyangweso village has seven years of discharge record. This record shows a mean annual flow of 3.65 m^3/s (Table 1.5).

About 69.4 million m^3 or 80% of annual river flow are available for irrigation. The following table shows an estimate of monthly discharge available.

(Unit : m^3/sec)

Month	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Available discharge	1.13	0.86	0.94	2.94	7.06	3.90	3.36	2.88	3.10	3.44	3.62	1.82	2.92

Awach Kabuon

Awach Kabuon River is one of the major streams in the LSI area, having catchment area of 540 km^2 at 1HD4 gauging station 4 km upstream from Kendu Bay town. Nine years record shows 9.6 m^3/sec of mean annual flow (see Table 1.6).

An 80% of annual flow is about 240 million m^3 or 7.6m^3/sec. This water available for irrigation could be distributed to each month by the share of mean monthly flow as shown below.

(Unit : m^3/sec)

Month	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Available discharge	5.23	6.35	6.70	9.46	10.59	8.87	8.22	8.29	7.69	7.38	7.02	5.86	7.64

Seme Awach

The river crossing the northern LSI area flows east end of Kisumu district. One gauging station 1HB05 (CA. = 98 km^2) located about 10km upstream from the river mouth has 17 years discharge records (see Table 1.7). This record shows a mean annual flow of 0.74 m^3/sec and specific discharge of 0.007 $m^3/sec/km^2$. The following table shows mean monthly flow and estimated monthly discharge available for irrigation (80 % of annual flow).

(Unit: m^3/sec)

Month	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Discharge	0.67	0.60	0.40	0.52	1.13	1.37	0.90	0.55	0.53	0.68	0.66	0.84	0.74
Available discharge	0.54	0.48	0.32	0.42	0.90	1.10	0.72	0.44	0.42	0.54	0.53	0.67	0.59

Other rivers

Monthly discharges of other small rivers crossing the northern LSI area are estimated by multiplying each catchment area by specific discharge of Seme Awach as shown below

(Unit: m^3/sec)

	Catchment (km^2)	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Kisyan	54	0.37	0.33	0.22	0.29	0.62	0.75	0.50	0.30	0.29	0.37	0.36	0.46	0.41
Muguruk	101	0.69	0.62	0.41	0.54	1.16	1.41	0.93	0.57	0.55	0.70	0.68	0.87	0.76
Luanda	69	0.47	0.42	0.28	0.37	0.80	0.96	0.63	0.39	0.37	0.48	0.46	0.59	0.52
Nyandiwo	54	0.37	0.33	0.22	0.29	0.62	0.75	0.50	0.30	0.29	0.37	0.36	0.46	0.41
Rabura	40	0.27	0.24	0.16	0.21	0.46	0.56	0.37	0.22	0.22	0.28	0.27	0.34	0.30
Ndate	146	1.00	0.89	0.60	0.77	1.68	2.04	1.34	0.82	0.79	1.01	0.98	1.25	1.10
Alara Yenga	57	0.39	0.35	0.23	0.66	0.80	0.52	0.32	0.31	0.40	0.38	0.40	0.38	0.49
Arese	36	0.25	0.22	0.15	0.19	0.42	0.50	0.33	0.20	0.19	0.25	0.24	0.31	0.27
Rano	16	0.11	0.10	0.07	0.08	0.14	0.22	0.15	0.09	0.09	0.11	0.11	0.14	0.12

Monthly discharges of following rivers are estimated by using specific discharge of Awach Tende river.

	Catchment (km^2)	J	F	M	A	M	J	J	A	S	O	N	D	Mean
Rangwena	55	0.11	0.08	0.09	0.28	0.66	0.37	0.32	0.27	0.29	0.32	0.34	0.17	0.28
Rangwena	93	0.10	0.14	0.15	0.47	0.12	0.62	0.53	0.46	0.49	0.55	0.58	0.29	0.47
Boosi	47	0.09	0.07	0.08	0.24	0.51	0.31	0.27	0.22	0.25	0.28	0.29	0.15	0.24
Wangupaid	17	0.03	0.02	0.03	0.09	0.21	0.11	0.10	0.08	0.09	0.10	0.11	0.05	0.09
Olambwe	313	0.6	0.46	0.5	1.57	3.78	2.09	1.80	1.54	1.66	1.84	1.94	0.97	1.56

1.2.6 Land suitability

The land suitability for irrigation of this LSI area is evaluated based on the results of reconnaissance soil survey carried out by STIBOKA/KSS (ref.1) and referring to the KSS's irrigation criteria (Tables 1.8 and 1.9), representing such factors as soil texture, salinity and land slope.

The result of land suitability classification is shown in the following table and Figure 1.5.

(Unit: ha)

LSI area	Total area	Suitable		Unsuitable
		Rice/others	Other crops	
Northern part	79,400	4,400	69,500	9,900
Southern part	77,900	8,300	57,800	20,100
Total	157,300	12,700	127,300	30,000

1.2.7 Irrigation potential

Irrigation potential depends on many factors and interacting resources such as water, soil, topography and crops. Crop selection would depend also on economic, social and political considerations. Irrigation potential within the LSI area has been estimated by using two major criteria, i.e. water availability and soil suitability, because these factors are most important limiting factors for defining irrigable area.

Land suitability

As mentioned in subsection 1.2.6, the LSI area has 12,700 ha of area suitable for rice and other crops and 127,300 ha suitable for other crops such as maize, cotton and sugarcane. (see Figure 1.5).

Water availability

There are two major water resources in the LSI area, i.e. river water and Lake water. Available river water for irrigation within the LSI area is calculated and shown in subsection 1.2.5. The water in the Lake Victoria is available for irrigation at any season and anywhere, if the water can be lifted up to the field by pump or other lifting equipment. This means that the capacity or ability of the water lifting equipment limits the availability of the Lake water.

Irrigation potential

The area irrigable by the river water is obtained by dividing the available river discharge by the irrigation requirements. Irrigation requirements are estimated by proposed cropping pattern and climate records (see Attachment).

The area irrigable by the Lake water is estimated by assuming the Lake water could be lifted up about 10 m above the Lake water level. In total, some 24,500 ha could be developed for irrigation.

The following table summarizes the irrigation potential in the LSI area.

(Unit: ha)

LSI area	Area Limited by			Existing scheme in the LSI Areas	Area to be developed
	Soil	River water	Lake water		
Northern part	69,500	2,000	9,700	5	11,695
Southern part	57,800	3,600	9,300	134	12,766
Total	127,300	5,600	19,000	139	24,461

1.2.8 Population

The demographic feature of the LSI area is the high population density. According to the latest census data (1979), average population density of the three districts (Siaya,Kisumu and South Nyanza) is 172 persons/km^2, while the average in Kenya is 27 persons/km^2. Total population of the LSI area in 1985 is estimated at about 356,000. Figure 1.6 shows estimated population of LSI area with age-sex distribution and labour force. This figure shows that about 136,000 labour force are available in the LSI area.

1.2.9 GRDP

The regional economy in the LSI area is dominated by agriculture, fishery and livestock farming which contribute to more than 60% of the GRDP in this area. The total GRDP in the LSI area is estimated at about K£42.8 million in 1985, and the following table shows the breakdown of the LSI area's gross domestic product by productive sectors.

(Unit: K£10^6)

	North LSI area	South LSI area	Total	LBDA region
Subsistence, and modern agriculture	13.9	13.0	26.9	610
Manufacturing and mining	1.7	1.6	3.3	75
Services	6.5	6.1	12.6	285
Total	22.1	20.7	42.8	970

(Source : Master Plan for the Lake Basin Development Area)

1.2.10 Land use

The present land use of the three districts (Siaya, Kisumu and South Nyanza) which include LSI areas is summarized in Table 1.10. Out of 1,112,000 ha of total area of these three districts, agricultural land occupies 372,000 ha, natural vegetation land 639,000 ha and 101,000 ha other land. About 170,000 ha (46%) of the total agricultural land are used for staple crops such as maize, rice, beans, cassava and potatoes and 43,000 ha (12%) are used for cash crops such as coffee, cotton and sugarcane. About 121,000 ha or 33% of the total agricultural land remain as fallow land.

1.2.11 Cropping pattern

In the long rainy season, the main staple crops of maize, sorghum and beans are sown in between January and March and harvested in between June and August. In the short rainy season, staple crops are sown in August or September and harvested between November and January. Figure 1.7 shows present cropping patterns in each of three districts (Siaya, Kisumu and South Nyanza).

1.2.12 Marketing

The major crops for both exports and domestic consumption are traded by several marketing boards. In Kenya, there are about 40 statutory boards, which are parastatal bodies and agencies. They 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, National Cereals and Produce Board (NCPB), Grain Growers Co-operative Union (KGGCU), Kenya Co-operative Creameries (KCC), Kenya Meat Commission (KMC) and Kenya Seed Company (KSC). Marketing of prospective crops in the LSI area is outlined below.

Maize, rice and other grains

For essential food crops, the National Cereals and Produce Board (NCPB) has a monopoly in buying and selling. The board is responsible for purchasing maize from farmers, and handles other crops such as beans, oil crops, millet, sorghum and rice. Farmers who produce any of the above crops have to send their produce to the nearest buying centre, depot, or certain agents appointed by NCPB.

Cotton

The Cotton Lint and Seed Marketing Board (CLSMB) is responsible for all the purchase of seed cotton, ginning and the sale of lint and cotton seed. The board also supplies farmers with cotton seed free of charge. Purchasing of seed cotton is mostly done by cooperative societies or unions. In the project area, however, the societies are not well functioning due to improper management, and the Board is buying directly from farmers at present.

Other products

The marketing of vegetables or fruits is mainly handled by the private sector under the general regulations of the Horticultural Crops Development Authority (HCDA). The livestock market relevant for the project area is located in Ahero, where private traders, mostly from Kisumu, buy cattle, sheep and goats from the local farmers.

1.2.13 Institutions and supporting services

Research stations

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 for carrying out research and providing information in order to improve agricultural productivity.

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 or even for land. Most of the credit lent are of short term for growing crops (mainly maize and wheat) and require no security.

Extension services

Extension services to the farmers are carried out by the 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.

Seed multiplication

The farmers generally retain seed of local varieties from their own produce. Cotton seed is available from Cotton Lint and Seed Marketing Board 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, farmers get seed tested and released from the Research Station in Ahero Irrigation Scheme, through the management of the scheme.

1.2.14 Present state of irrigation on the Lake shore

Existing project

In the Lake shore districts, there are three large scale NIB's irrigation schemes and a number of small scale irrigation schemes under the management of PIU Nyanza. Three NIB schemes, i.e. Ahero, Bunyala and West Kano, have in total 2,010 ha of paddy and sugarcane fields. The PIU's scheme of 1,400 ha in total are scattered in the area. Table

1.11 shows the inventory of these PIU schemes and Figure 1.8 shows location of PIU and NIB schemes.

NIB schemes

The NIB schemes are operated by NIB and tenant farmers. The farmers can receive such services as land preparation, supply of water, farm inputs (seeds, fertilizers etc.) and transport from NIB at a fixed rate. The farmers get revenue from selling their harvested crops to NIB after reduction of service and water charge. In 1977-1983, the average net income per tenant was Kshs. 5,200 at Ahero, Kshs. 5,900 at Bunyala and Kshs. 3,600 at West Kano. Each tenant has 3-4 acres of land on rent.

Some more details of each scheme is as follows.

Ahero scheme: This scheme has 2,100 acres (840 ha) of paddy field divided into 4-acre (1.6 ha) holdings. The irrigation water is pumped up from Nyando River and conveyed by earth canals to each plot. Double cropping of rice is a common practice. Crop intensity is about 140% and average yield in recent five years is about 3.2 tons/ha.

Bunyala scheme: Bunyala irrigation scheme has 200 ha paddy field. About 6 km long canal brings the pumped up water from the Nzoia River to the scheme. In this scheme, single cropping of rice during the short rainy season is a common practice. Average yield in recent years is about 5-6 tons/ha. In the period of 1974 to 1980 when double cropping was practiced, the average yield was about 2.5 tons/ha.

West Kano scheme: This scheme covers 970 ha of paddy and sugarcane fields. Each tenant has 2 acres of paddy field and another 2 acres designated for sugarcane. Irrigation water is pumped up from Lake Victoria and drain water is pumped back to the Lake. The scheme is fully protected by a dyke against floods from the Lake and run-off from inland. Average yield in this scheme is 3.5 tons/ha for rice with double cropping system and 102 tons/ha for sugarcane.

PIU schemes

At present 18 irrigation schemes consisting of 11 rice schemes and 7 vegetable schemes are operated by farmers themselves with the assistance of PIU. The size of each irrigation scheme is small ranging from less than one ha to 200 ha. Each scheme has, or is in the process of setting up their own organization to operate and maintain their irrigation and drainage facilities. As mentioned before, PIU assists the farmers to organize themselves as well as assisting in operation and maintenance of schemes.

About 2,100 farmers participate in rice schemes having 0.6 ha or 1.5 acres land holding on an average. Vegetable schemes of about 120 ha in the area is operated by about 1,000 farmers.

On-going and planned schemes

To identify areas for development and project implementation is one of the main tasks of PIU activities. Since PIU was set up in 1978, a number of irrigation schemes were identified and constructed. As of December 1986, three schemes are being constructed in the Lake shore districts (Siaya,Kisumu and South.Nyanza) by farmers, PIU, DAO etc. and 19 schemes are waiting for their commencement of implementation. Table 1.10 shows these on-going and planned schemes in the Lake shore districts. About 6,000 ha of paddy field and about 200 ha of vegetable lands will be developed and about 12,000 farmers will participate in these schemes. According to PIU's estimate, about Kshs 78 million will be required for implementation of planned schemes and Kshs 12 million will be needed for accomplishment of on-going schemes. Most of these schemes are located in Kano Plain or along the Kadimu Bay.

1.3 Preparatory Study for LSI Project

1.3.1 Development strategy

The basic strategy for the Region's development has been drawn up in the Master Plan as follows.

(1) To develop and control water resources for primary production activities as well as for improving sanitation of people so that development potentials in different areas of the Region can be realized based on indigenous resources in respective areas;

(2) To improve the provision of infrastructure for agriculture and related economic activities such as agro-related industries;

(3) To rationalize land use first by intensifying cultivation in existing agricultural lands and second by expanding the agricultural area in accordance with land suitability as well as existing land tenure systems; and

(4) To develop human resources to meet increasing requirements of higher technologies and wider expertises.

Based on the above basic strategy for the Region and development potential in the area, following basic strategy for irrigation development of the Lake shore area is drawn up.

(1) To provide adequate irrigation and drainage facilities in order to overcome the unfavourable conditions such as extremely heavy soil and relatively low rainfall;

(2) To enhance people's standard of living by increasing food and cash crop production; and

(3) To improve farm and water management of existing projects for smooth operation and maintenance.

In addition, following strategy is also taken into account for the development of the area. This strategy is stipulated in National Development Plan (1984-1988).

"A low cost approach to irrigation will be emphasized. Preference will be given to rehabilitation of existing schemes and to encouragement of small-scale projects where water is available through gravity flow."

Large scale pump irrigation in the Lake shore was evaluated by some studies (refs.2,10). These studies indicated that the large scale pump irrigation in the Lake shore would not be economically viable.

1.3.2 Development concept

Based on the above strategy, following basic concepts for LSI project have been drawn out.

(1) Unit yield and production of crops should be stabilized and improved through introduction of improved irrigated farming practices and irrigation and drainage facilities.

(2) Irrigation area should be expanded up to the potential maximum as far as water is available.

(3) Run-of-river flow irrigation schemes should be developed by priority.

1.3.3 Demarcation of LSI project area

Based on the reconnaissance field survey and various information on soil, hydrology, and villagers' view on agriculture, 16 promising LSI scheme areas totaling 12,450 ha of land have been selected. These 16 areas are named as follows. Figure 1.9 shows the location of these 16 LSI areas.

Scheme Name	Gross Area (ha)
Usare	300
Alungo	750
Manuanda	450
Asembo	700
Mahaya	500
Wagusu	500
Wambara	600
Yimbo	300
Alego	300
Wagwe	500
Oluch	1,100
Kimina	2,100
Ochung	750
Nyagidha	850
Olambwe	2,200
Sindo	550
Total	12,450

1.3.4 Development Possibilities

As discussed in subsection 1.2.7, water and soil are two main conditions determining the development possibilities for irrigated farming. Table 1.12 show the potential irrigation area for each scheme after evaluating water availability and land and soil suitability.

1.3.5 Present condition

(1) Usare scheme

The Usare scheme is located 12 km west of Kisumu municipality. The land is physiographically situated on the lower part of the piedomont plain formed along Kisian Hills. The land is almost flat with irregular micro relief. The soil is classified into Pellic Vertisols, similar to the soil prevailing in lower Kano Plain. However, the soil contains much gravels and boulders. As can be observed in quarry site in Usare village, the soil is generally shallow.

At present, the land is mostly covered by natural grasses and light bush. In some fields, cassava , cotton and sugarcane are planted. On the Lake side, the fields are well cultivated for the long rainy season maize.

The Muguruk River was identified as a possible water source for this scheme. The river collects the stream, e.g. Awach, Magadi etc., originated from the upper hilly land and flows into the Lake.

(2) Alungo scheme

The Alungo scheme is located about 8 km south of Awach village beside C501 road. The rather broad flat valley bottoms are formed along the Luanda River. The major soil types are derived from black alluvial deposits transported by the Luanda River and partly covered by colluvium from igneous rocks (boulder inselberg) on the left bank.

The land is mostly covered by natural grasses and used for grazing local cattle and small stock. Cotton, sugarcane, sukumawiki, tomatoes and sweet potatoes are planted for cash earnings. Forestation of eucalyptus is more or less prevailing in the area to obtain fuel wood and house building materials.

Since the Luanda River does not have sufficient discharge to irrigate the whole area of the scheme, the Lake water would be the auxiliary water source for irrigation.

(3) Manuanda scheme

The Manuanda scheme is located adjacent to the Alungo scheme. The flat valley bottoms are formed along the lower reaches of the Awach River.

The land is broadly covered by natural grasses, on which local cattle and small stock are reared. Maize and sorghum are planted to a limited extent.

(4) Asembo scheme

The Asembo scheme is located 1 km east of Asembo village. The broad lowlying tracts are formed around the skirt of Aduyo Hill. The land is flat with some depressions, which are seasonally inundated. The farmers of village adjacent to this scheme plant maize, cotton and other upland crops. The river flows of Rabura and Nyandiwo are alternative water sources for this scheme. The Lake water is another water source.

(5) Mahaya scheme

The Mahaya scheme is located west of Asembo scheme. The land, shaped like a rectangle, declines to the Lake with gentle slope of about 1%. Cotton, maize and other upland crops are planted in the area. The Arese River, crossing the center of this scheme, is possible water source for irrigation; however, the discharge of this river is not enough to cover the entire area of the scheme. The Lake water is an alternative water source.

(6) Wagusu scheme

The Wagusu scheme is located about 10 km southwest of Bondo village. The narrow lowland valley bottom is formed along the Ndate River. At present the land is used for production of maize, cotton and vegetables.

The Ndate River and the Lake water are the alternative water sources for irrigation.

(7) Wambara scheme

The Wambara scheme is located about 8 km south west of the Nyanzera market on the C501 road. The major types of soil are derived from black alluvial deposits transported by the Alara Yenga River and other small rivers. The land is very flat with some depressions, which are seasonally inundated.

The Alara Yonga River and the Lake are alternative water sources for irrigation of this scheme.

(8) Yimbo scheme

The Yimbo scheme is located 1 km south of Yimbo Village near the lake Sare. For this scheme, the Lake water is the only water source for irrigation

(9) Alego scheme

The Alego scheme is located about 3 km west of the Kendu Bay town. The land is situated on the round delta where soil is derived from alluvial deposits transported by the Ondago River. Maize, cassava and other upland crops are planted. The Ondago River or the Lake is possible water source for irrigation.

(10) Wagwe scheme

The Wagwe scheme is located about 10 km west of the Kendu Bay town. The land is flat with some micro relief situated on the Lake shore. The Lake water is only possible water source for irrigation, since there is no river around this scheme.

(11) Kimira scheme

The Kimira scheme is located west of Kendu Bay town. This area has very flat topography with an average elevation of 1,140 m. The soils in this area are Humic Gleysols and Dystric Histosols which are characterized by hydromorphic properties and are very poorly drained, very deep, very dark grey to black and firm. Due to this poor drainage condition and low topography level, part of the area is submerged during the rainy season. The area is used for grazing land at present.

The Kimira River flows crossing the center of this scheme; however, the Awach Kibuon River is the possible water source for irrigation.

(12) Oluch scheme

The Oluch scheme is located along the Homa Bay and 5 km south east of the Kimira scheme. This area is also of flat topography and poor drainage condition. The soil in Oluch area is classified into chromic Ventisols. They are cracking clay developed on lacustrine deposits mixed with volcanic ashes. The soil is imperfectly drained, very deep, slightly calcareous and moderately sodic. The area is also used for grazing land at present and a part of the area is seasonally submerged. Awach Tende River is possible water resource for this scheme.

(13) Ochung scheme

The Ochung scheme is located about 3 km north east of Homa Bay town. The narrow lowlying tract is formed along the Rongwena River. The land is rather flat. Maize and other upland crops are planted. The Lake water and the river water are alternative water sources for irrigation.

(14) Nyagidha scheme

The Nyagidha scheme is located about 6 km west of the Homa Bay town. The land is almost flat with some depressions which are seasonally inundated. The soils in this area is classified into chromic Vertisols. Due to sodicity of the soils, a part of this area is not suitable for irrigation. Many small streams are crossing the area flowing into the Lake; however those rivers do not have enough water for irrigation. Therefore, the Lake water is the water source for irrigation.

(15) Olambwe scheme

The Olambwe scheme is located about 8 km north of the Ruma National Park. The land is situated on the lower part of the Olambwe valley formed along the Olambwe River. The soil

in this area shows the similar pattern in the Nyagidha scheme. Unsuitable soil for irrigation are also there in this scheme. The Olambwe river water and the Lake water are possible water sources for irrigation.

(16) Sindo scheme

The Sindo scheme is located about 33 km west of the Homa Bay town or 15 km west of the Olambwe scheme. The land is slightly undulating. The alternative water source is the river flow of Boosi or the Lake water.

1.3.6 Cropping pattern

In formulating cropping patterns, following principles should be applied:

(1) The crops and cropping patterns must yield maximum benefits to the farmers;

(2) The crops and cropping patterns must make optimum utilization of water to be supplied by the project;

(3) The crops and cropping patterns should be practicable in view of capability of farmers;

(4) The crops and cropping patterns must conform with the existing social tradition, and be accepted by the farmers; and

(5) The crops and cropping patterns must conform to the national agricultural development policy and the regional Master Plan.

The major crops selected to be developed are maize, sorghum, rice, cotton, groundnuts, beans and others. Maize and sorghum are the main food crops in the area and rice, cotton, groundnuts, greengrams and beans are considered as the main cash crops. Cotton is the predominant cash crop in the area at present. Rice and others are also familiar to farmers and profitable in consideration of their marketing prospects and prices.

Maize

The Region has supplied large amount of maize, 72% of the national production in recent years. Considering the importance of stable supply of this crop as the main staple crop, the Region is expected to maintain the current share in the national production. Under the Master Plan, the Region must produce 4,078,000 tons or 73% of the national demand and about 46% of total production will be exported to other regions.

Rice

The Master Plan proposes the extension of the paddy fields from 3,000 ha to 30,000 ha, and 150,000 tons of paddy production are expected. The Lake shore area has much potential as compared to other areas in the Region for further paddy field expansion.

Cotton

Cotton is an important crop for smallholders in the Region for cash income. Since the natural conditions are very suitable and the large amount of manpower are available, the Region is expected to produce 13,500 tons of lint and to supply 31,500 tons of cotton seed to edible oil industry in the year 2005.

Groundnuts

At present, three districts (Siaya, Kisumu and South Nyanza) produce about 2,000 tons or 48% of the regional production of 4,200 tons. These areas are expected to maintain the current share, since the conditions of these areas are suitable for this crop.

Two types of indicative cropping patterns for this LSI schemes are formulated to determine irrigation water requirement and project benefit based on the aforementioned concept and the Master Plan. Pattern A will be adopted to the Oluch and Kimira areas and other areas will apply pattern B. The indicative cropping patterns are illustrated in Figure 1.10 and summarized below.

Pattern	Long rainy season	Short rainy season	Cropped area(%)
A	Rice	Maize-Beans	100
B	Cotton		50
	Maize-Beans		50
		Groundnuts	100

1.3.7 Water requirement

The water requirements of the cropping patterns proposed above are estimated by using calculation results of previous studies and rainfall data. The irrigation efficiency of 40% is applied for estimation of water requirement. The following table summarizes monthly water requirement for each cropping pattern (see Attachment).

(Unit: l/sec/ha)

	J	F	M	A	M	J	J	A	S	O	N	D
Pattern A	0.87	1.12	1.12	1.60	0.55	0.78	0.28	0.10	0.31	0.77	1.06	1.19
Pattern B	0.59	0.23	0.10	0.00	0.22	0.83	0.45	0.27	0.09	0.56	0.34	0.89

1.3.8 Irrigation system

The proposed irrigation system for each scheme consists of an intake facility and main, secondary and distribution canals. All canals will generally be unlined earth canals. There are two kinds of intake facility, i.e. run-of river type intake facility and pumping intake facility. Run-of river type intake facility consists of a weir to maintain river water level, intake structure with gate for diversion of river water to the canal and sand trap device if

required. Pumping intake facility consists of an intake pit, pumping equipment and outlet pipe or channel. The canal route alignment of each scheme is preliminarily designed as shown in Figures 1.11 to 1.20. Table 1.13 shows major features of each scheme.

1.3.9 Cost and benefit

Cost estimate

Construction cost for each scheme is estimated based on the preliminary project layout and unit cost. Unit costs for canal works, on-farm development works, pumping facilities etc. are estimated referring to previous study results (ref.4). Construction cost is comprised of three major items i.e. direct construction cost, physical contingency and other cost. Other cost include operation and maintenance of equipment (5% of direct cost) and administrative expenses (7% of direct cost). Physical contingency is assumed to be 10% of total construction cost (direct cost + other cost). Table 1.14 shows the total construction cost for each scheme as summarized below.

	Name	Area Gross	Area Net	Total cost	Unit cost per area
		(ha)	(ha)	(Kshs 10^6)	(Kshs/ha)
1.	Usare	300	210	9,665	46,000
2.	Alungo	750	525	24,387	46,500
3.	Manuanda	450	315	12,738	40,400
4.	Asembo	600	420	18,582	44,200
5.	Mahaya	500	350	19,273	55,100
6.	Wagusu	500	350	124,930	71,200
7.	Wambara	600	420	20,033	47,700
8.	Yimbo	300	210	13,550	64,500
9.	Alego	200	140	9,503	67,900
10.	Wagwe	400	280	17,702	63,200
11.	Oluch	1,100	770	135,294	45,800
12.	Kimira	2,100	1,470	269,787	47,500
13.	Ochung	350	245	17,270	70,500
14.	Nyagidha	400	280	19,240	68,700
15.	Olambwe	500	350	121.195	60,600
16.	Sindo	550	385	20,798	54,000
	Total	9,600	6,720	12,353,947	52,700

Benefit

The annual benefit is estimated as the difference in net production value-added under with- and without-project conditions. It is assumed that maize and beans are grown with an intensity of 10% under without-project condition. Table 1.15 shows the calculation of production value for each crop under with- and without-project conditions. Production

volume, net production value under with- and without-project conditions and incremental benefit for each scheme are calculated as shown in Table 1.16 and summarized below

(Unit: Kshs.1,000)

Scheme	With	Without	Benefit
Usare scheme	4,652	201	4,451
Alungo scheme	11,630	502	11,128
Manuanda scheme	6,978	302	6,676
Asembo scheme	9,304	402	8,902
Mahaya scheme	7,753	335	7,418
Wagusu scheme	7,753	335	7,418
Wambara scheme	9,304	402	8,902
Yimbo scheme	4,652	201	4,451
Alego scheme	3,101	134	2,967
Wagwe scheme	6,203	268	5,935
Kimira Scheme	39,080	1,407	37,673
Oluch Scheme	20,470	737	19,733
Ochung scheme	5,427	234	5,193
Nyagidha scheme	6,203	268	5,935
Olambwe scheme	7,753	335	7,418
Sindo scheme	8.528	369	8,159
Total production Value	90,408	3,451	152,359 (US$9.5 x 10^6)

1.3.10 Implementation schedule

The 16 LSI schemes should be implemented after evaluation of each scheme by a full feasibility study. The feasibility study will be carried out within 12 - 18 months. In inception period of the study, topographic map of the Lake shore belt will be prepared and data collection and review of previous studies in the area will be carried out. The implementation schedule for the LSI schemes is preliminary made and shown on Figure 1.21.

1.3.11 Organization and management

LBDA will be responsible for execution, and operation and maintenance of the schemes with the assistance of various Ministries. As shown in Figure 1.22, four Ministries will assist the operation of the schemes in the various aspects as enumerated below.

Ministry of Agriculture
- PIU will assist in design, construction and operation.
- Local agricultural extension staff will advise farmers on good land preparation and crop husbandry and will be requested to attach one Technical Assistant to each scheme.

Ministry of Water Development
- The ministry will assist farmers in the maintenance and operation of the pump, engine and pipes particularly after the withdrawal of the LBDA right.