Republic of Kenya
Ministry of Water, Sanitation and Irrigation,
National Irrigation Authority

Data Collection Survey on Irrigation Development Plan in the Lake Victoria Basin Region

Final Report

December 2019

Japan International Cooperation Agency (JICA)

Nippon Koei Co., Ltd.
Sanyu Consultants Inc.

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The Areas of the Survey

Source：JICA Survey Team

Republic of Kenya

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Chapter 3 CURRENT CONDITIONS AND ANALYSIS IN EACH SECTOR

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Annex

Abbreviations

ASDS	:	Agricultural Sector Development Strategy
AfDB	:	African Development Bank
BADEA	:	Arab Bank for Economic Development in Africa
CARD	:	Coalition for African Rice Development
CaDPERP	:	Capacity Development for Enhancement of Rice Production in Irrigation Schemes in Kenya
CIDP	:	County Integrated Development Plan
CSA	:	Climate Smart Agriculture
FAO	:	Food and Agriculture Organization of the United Nations
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit, the German Federal Enterprise for International Cooperation
JICA	:	Japan International Cooperation Agency
KCSAIF	:	Kenya Climate Smart Agriculture Implementation Framework
KEFRI	:	Kenya Forest Research Center
KeRRA	:	Kenya Rural Roads Authority
KeNHA	:	Kenya National Highways Authority
KFS	:	Kenya Forest Service
KFW	:	Kreditanstalt für Wiederaufbau
KPLC	:	Kenya Power and Lighting Company
KURA	:	Kenya Urban Roads Authority
LBDA	:	Lake Basin Development Authority
LBDC	:	Lake Basin Development Company
MoALF	:	Ministry of Agriculture, Livestock, and Fisheries (new name)
MoALFI	:	Ministry of Agriculture, Livestock, Fisheries and Irrigation (previous name)
MDG	:	Millennium Development Goal
MTP III	:	The Third Medium Term Plan
MWS	:	Ministry of Water and Sanitation (previous name)
MWSI	:	Ministry of Water, Sanitation and Irrigation (new name)
NIA	:	National Irrigation Authority
NIB	:	National Irrigation Board
NCPB	:	National Cereal and Produce Board
NRDS	:	National Rice Development Strategy
NGO	:	Non-Governmental Organization
OFID	:	OPEC Fund for International Development
O&M	:	Operation and Management
RVC	:	Rice Value Chain
SFR	:	Strategic Food Reserve

SHDP	:	Small Holder Development Project
SIVAP	:	Small Scale Irrigation and Value Addition Project
SRA	:	Strategy for Revitalizing Agriculture
TICAD	:	Tokyo International Conference on African Development
FiT	:	Feed-in-Tariff
WB	:	World bank
WKRM	:	Western Kenya Rice Mill
WRA	:	Water Resource Authority

Measurement Unit

Length

mm = millimeter(s)
cm = centimeter(s) (cm = 10 mm)
m = meter(s) (m = 100 cm)
km = kilometer(s) (km = 1,000 m)

Area

cm^2 = square centimeter(s) (1.0 cm × 1.0 cm)
m^2 = square meter(s) (1.0 m × 1.0 m)
km^2 = square-kilometer(s) (1.0 km × 1.0 km)
ha = hectare(s) (10,000 m^2)
Acre = 0.4047 hectare(s) (4,047 m2)

Volume

cm^3 = cubic centimeter(s) (1.0 cm × 1.0 cm × 1.0 cm, or 1.0 ml)
m^3 = cubic meter(s) (1.0 m × 1.0 m × 1.0 m or 1.0 kl)
L = liter (1,000 cm^3)
MCM = million cubic meter(s)

Weight

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

Time

sec = second(s)
min = minute(s)
hr = hour(s)

Others

ppm = parts per million = mg/L
° = degree
°C = degrees Celsius
% = percent
mS = millisiemens

Currency

US$ = United State dollar(s)
JPY = Japanese yen(s)
Ksh. = Kenyan shilling(s)

CHAPTER 1 GENERAL

1.1 Background of the Survey

Kenya's agricultural sector is a key sector of the rural economy, accounting for 32.4% of gross domestic product GDP, 40% of total employment (70% of rural population), and 65% of exports. The Government of Kenya places the agriculture sector as one of the priority development issues in Kenya Vision 2030, the basic policy for the long-term national development. However, in the Republic of Kenya, most of the land (58 million ha) is arid/semi-arid areas; thus, the suitable agricultural land (9.9 million ha) is about 17% only and the farmland under irrigation is no more than 0.2 million ha. Most of the farmland is rainfed agriculture, which is susceptible to bad weather and droughts. Therefore, Kenya's agriculture is greatly affected by climate change that has been heightened in recent years and the stabilization of agricultural production by irrigation is considered a major issue from the viewpoint of food security as well.

In particular, rice in Kenya is a crop whose consumption has increased in recent years compared with other staple crops and domestic demand continues to greatly exceed production. Furthermore, in 2018, the government certified rice as “food security crop”, an important staple crop for food security, and it is expected that the demand for rice will grow significantly in the future.

Under such circumstance, the Kenyan government has a strong interest in the irrigation development projects in the Lake Victoria basin in the western part of the country, which still has the second largest rice production in the country with relatively fertile soil and a stable water source.

On the other hand, Japan International Cooperation Agency (JICA) has continued to focus on giving support since the establishment of the Coalition of African Rice Development (CARD) at the Tokyo International Conference of African Development IV (TICAD IV) held in Japan in May 2008 in Kenya and other African regions. Furthermore, since the CARD Phase 2 started in 2019, JICA will continue to support the development of rice production in Africa.

Based on the above background, JICA decided to conduct the “Data Collection Survey on Irrigation Development Plan in the Lake Victoria Basin Region” for the purpose of collecting and organizing information for studying irrigation development scenarios prior to the formulation of a certain project.

1.2 Purpose of the Survey

The purpose of the Survey is to collect necessary basic information for appropriate project formation in order to contribute to the feasible irrigation development scenario around Lake Victoria which can also be the model case in the Republic of Kenya (hereinafter referred to as Kenya) as well as a preliminary analysis for the determination of JICA's financial assistance in the area.

1.3 Area of the Survey

The target areas of the Survey are listed in the table below. The four irrigation schemes with 10,676 ha in total are in the two river basins. The three irrigation schemes of Ahero, West Kano, and Lower Kuja out of the four were selected as the potential irrigation schemes which are feasible to be developed as a result of the water balance analysis conducted in the Project for the Development of the National Water Master Plan 2030 completed in October 2012.

The three irrigation schemes in the water basins of the Nyando River were developed 40-50 years ago. On the other hand, Lower Kuja has been partially developed since June 2011 with the detailed design by the National Irrigation Board, hereinafter referred to as NIB.

Table A1.3-1 Summary of the Survey Areas

River Basin	Area (Sub-county/ County)	Benefited Area	No. of Farm Household	Start Year for Water Supply	Water Source	Irrigation Method	Major Crop	Water Management Organization	Other
Nyando	Ahero (Muhoroni/ Kisumu)	867 ha	2,000	1969	Nyando River	Pump irrigation	Paddy	Main canals: NIB Tertiary canals:	JICA's CaDPERP is ongoing.

River Basin	Area (Sub-county/ County)	Benefited Area	No. of Farm Household	Start Year for Water Supply	Water Source	Irrigation Method	Major Crop	Water Management Organization	Other
								Water Users' Association	
	West Kano (Nyando/ Kisumu)	892 ha	837	1976	Lake Victoria	Pump irrigation	Paddy	Main canals: NIB Tertiary canals: Water Users' Association	JICA's CaDPERP is ongoing. Drainage by pumps to Lake Victoria
	Southwest Kano (Nyando/ Kisumu)	1,800 ha	N/A	1989 (Construction completion)	Nyando River and drained water from Ahero irrigation area	Gravity irrigation	Paddy, maize, sorghum and vegetables	Main canals: NIB Tertiary canals: Local community	-
Kuja	Lower Kuja (Nyatike/ Migori)	7,717 ha (40,000 ha)	2,797	None	Kuja River	Gravity irrigation	Paddy and upland crops	N/A	Construction by NIB (Lot1 is ongoing.

Source: JICA Survey Team

1.4 Survey Period

The Survey has been started in July 2019 and completed in November 2019 with two field surveys for around 2.3 months in total as shown below:

- 1st trip: from July 2019 to August 2019, for data collection, present condition analysis, and cost estimation
- 2nd trip: from September 2019 to October 2019, for formulation of concrete development scenarios with rough estimation of project costs

1.5 Counterpart Agency

At the initial stage of the Survey, the following agencies are the counterpart organizations:

- State Department for Irrigation, Ministry of Agriculture, Livestock, Fisheries and Irrigation of the Republic of Kenya (hereinafter referred to as MoALFI)
- National Irrigation Board of the Republic of Kenya

During the Survey period, however, the State Department for Irrigation was transferred from the Ministry of Agriculture, Livestock, Fisheries and Irrigation to the Ministry of Water, Sanitation and Irrigation (MWSI) in September 2019. In addition, NIB changed its mandate and named to "National Irrigation Authority (NIA)". The NIA has an additional mandates for supporting communal and private irrigation schemes at small and medium sizes. Please refer to Section 5.1 (4) for new mandates of NIA in Chapter 5.

Finally, the followings are the current counterpart organizations:

- State Department for Irrigation, Ministry of Water, Sanitation and Irrigation of the Republic of Kenya (hereinafter referred to as MWSI)
- National Irrigation Authority of the Republic of Kenya

CHAPTER 2 BACKGROUND INFORMATION

2.1 Kenya Country Status

2.1.1 Population and Economic Status

Kenya's population was reported at 38.6 million during the 2009 Census compared with 28.7 million inhabitants in 1999, 21.4 million in 1989, and 15.3 million in 1979. This was an increase of 2.5% over the past 30 years. As a result, Kenya's projected population in 2018 was estimated at around 51.4 million in the total national land, which is 569,140 km^2.

Kenya's real gross domestic product (GDP) was estimated at 5.9% in 2018, from 4.9% in 2017. On the supply side, services accounted for 52.5% of the growth, agriculture for 23.7%, and industry for 23.8%. Real GDP is projected to grow by 6.0% in 2019 and 6.1% in 2020. Domestically, improved business confidence and continued macroeconomic stability will contribute to the growth. Externally, tourism and the strengthening global economy will contribute as well.

Kenya continues to face the challenges of inadequate infrastructure, high income inequality, and high poverty exacerbated by high unemployment, which varies across locations and groups (such as young people). Kenya is exposed to risks related to external shocks, climate change, and security. The population in extreme poverty (living on less than USD 1.90 a day) declined from 46% in 2006 to 36% in 2016. However, the trajectory is inadequate to eradicate extreme poverty by 2030.

2.1.2 National Plans and Agriculture Policy

(1) Kenya Vision 2030 The Third Medium Term Plan (MTP III) of the Kenya Vision 2030

(I) Kenya Vision 2030

(a) Purpose

The main purpose is to transform Kenya into a newly industrialized, middle income country providing a high-quality life to all citizens by the year 2030.

(b) Pillars

The vision is based on three pillars: economic, social, and political. The goal of the economic pillar is to improve the prosperity of all Kenyans through economic development program. The goal for the social pillar is to build a just and cohesive society with social equity in a clean and secure environment, while that of political pillar is to realize a democratic political system founded on issue-based politics that respects the rule of law and protects the rights and freedom.

(c) Approaches of Agriculture Development in Kenya

The approach is to:

- Conserve water sources and start new ways of harvesting and using rain and underground water;
- Promote agricultural productivity and area under irrigation;
- Rehabilitation of hydro-metrological data gathering networks; and
- Construction of multipurpose dams.

(2) The Third Medium Term Plan (MTP III) of the Kenya Vision 2030

(a) Purpose

The Third Medium Term Plan (MTP III) of the Kenya Vision 2030 outlines the main policies, legal and institutional reforms as well as programs and projects that the government plans to implement during the period of 2018 to 2022. It builds on the achievements of the first and second MTPs and prioritizes the implementation of the "Big Four" initiatives.

(b) Goal

The "Big Four" initiatives are:

- increasing the manufacturing share of GDP from 9.2% to 15% and agro-processing to at least 50% of the total agricultural output;
- providing affordable housing by building 500,000 affordable houses across the country;
- enhancing food and nutrition security (FNS) through construction of large-scale multi-purpose and smaller dams for irrigation projects, construction of food storage facilities, and implementation of high impact nutritional interventions and other FNS initiatives; and
- achieving 100% universal health coverage.

Additionally, the MTP III targets to improve Kenya's ranking in the Ease of Doing Business Indicator from position 80 to at least 45 out of 189.

Table A2.1.2-1 Real and Sectoral Growth Targets (%) 2018-2022

	2018	2019	2020	2021	2022
Overall GDP	5.8	6.0	6.6	6.8	7.0
Agriculture	5.7	5.5	6.0	6.7	5.9
Industry	5.8	6.4	7.5	8.6	7.9
Services	6.0	6.4	6.7	6.8	7.0

Source: Table 2.5: Real and Sectoral Growth Targets (%) 2018-2022, Third Medium Term Plan 2018-2022

For Agricultural Sector (2.2 Third Medium Term Macro–Fiscal Framework and Growth Strategy Prospects in MTP III)

The prioritization of FNS under the "Big Four" initiatives is expected to contribute to a higher growth of the agricultural sector through development of 1.2 million acres (500,000 ha) of commercial irrigated production to enhance food production. This will entail implementation of measures to ensure rapid attraction for 10,000 acre (40,000 ha) plots with performance management. The growth will be supported by, among others, provision of extension services and subsidized inputs for small holder farmers. The other measures will include livestock and crop insurance scheme, development of the blue economy and fisheries, and measures to promote exports of agricultural and livestock products in the regional and international markets that will further boost the sector's value addition.

(3) The Agricultural Sector Development Strategy (ASDS) 2010-2020

(a) Purpose

The Kenyan government launched the Strategy for Revitalizing Agriculture (SRA) in 2004. It is noted that the implementation of the SRA has been largely successful. As a result, the sector surpassed the growth target that had been set to 3.1% to be able to reach as high as 6.1% in 2007.

The Agricultural Sector Development Strategy (ASDS) 2010-2020 is intended to build further on the gains made by the SRA. It is intended to provide a guide for the public and private sectors' efforts in overcoming the outstanding challenges facing the agricultural sector in Kenya. Besides ensuring food and nutritional security for all Kenyans, the strategy aims at generating higher incomes as well as employment, especially in the rural areas. Moreover, it is expected to position the agricultural sector as a key driver in achieving the 10% annual economic growth rate envisaged under the economic pillar of Vision 2030.

(b) Goal/Vision

The vision of the ASDS is: A food-secure and prosperous nation. Since the agricultural sector is still the backbone of Kenya's economy—and the means of livelihood for most of the rural population—it is inevitably the key to food security and poverty reduction.

- The overall goal of the agricultural sector is to achieve an average growth rate of 7% per year over the next five years.
- Given the critical strategic issues that need to be addressed, the strategic mission for the sector is: An innovative, commercially oriented, and modern agriculture.
- The overall development and growth of the sector is anchored in two strategic thrusts:
  - · Increasing productivity, commercialization, and competitiveness of agricultural commodities and enterprises; and
  - · Developing and managing key factors of production.

Assuming a conducive external environment and support from enabling sectors and factors, the agricultural sector has set the following targets to be achieved by 2015:

- To reduce the number of people living below the absolute poverty lines to less than 25%, to achieve the first Millennium Development Goal (MDG).
- To reduce the food insecurity by 30% to surpass the MDGs.
- To increase the contribution of agriculture to the GDP by more than Ksh. 80 billion per year as set out in Vision 2030.
- To divest from all state corporations handling production, processing, and marketing that can be better done by the private sector.
- To reform and streamline agricultural services such as in research, extension, training, and regulatory institutions to make them effective and efficient.

(4) National Irrigation Policy 2015

(a) Purpose

The main purpose is to develop a policy that seeks to facilitate and guide irrigation development by addressing the challenges and constraints in the irrigation sector. The policy aims to address these through the following:

· Formulation of appropriate institutional and legal framework;

- Establishment of mechanisms for resource mobilization, investment, and financing of the sub-sector;
- Harmonization of roles and functions in the development, operation, and management of the irrigation in the country;
- Capacity building, research, innovations, science and technology;
- Mainstreaming of the use of existing and emerging water sources and technologies such as recycled water, stormwater, geothermal water, desalinated, and wastewater; and
- Putting up mechanism for improved coordination, monitoring, and evaluation.

(b) Goal

The goal is to enhance increased food security, wealth and employment creation, and poverty reduction through accelerated development. The specific objectives to achieve the goals are:

- Enhance the sustainable exploitation of the irrigation potential by increasing the area under irrigation by 40,000 ha per year in line with the Vision 2030;
- Increase the available water for irrigation through innovative technologies including water harvesting, use of wastewater, and sustainable exploitation of groundwater;
- Mobilize the resources for investments from various stakeholders and increase the government financial allocation to irrigation by at least 5% of the annual national budget;
- Undertake irrigation research and development;
- Build capacity of technical personnel and irrigators;
- Promote participation of stakeholders in irrigation development and management;
- Adopt an integrated approach to sustainable commercial irrigation farming including crops, livestock, and aquaculture production;
- Formulate an appropriate, legal, institutional, and regulatory framework for the sub-sector; and
- Guide the implementation process of the policies and strategies for the irrigation development in the country.

(5) National Rice Development Strategy - II (2019-2030) (NRDS-II) (Draft version)

NRDS-II is under preparation as of October 2019 and has been developed to build on the achievements made in NRDS-I. NRDS-II includes the expansion of irrigation areas, increasing rice productivity, increasing market competitiveness, and promoting private sector participation in agribusiness from 2019 to 2030.

1) Goal, Vision, Mission, and Objectives of NRDS-II

The goal, vision, mission, and objectives of the NRDS-II are as follows:

Goal: To enhance national food and nutrition security through self-sufficiency in rice production, value-addition, and marketing.

Vision: A dynamic rice industry for improved economic growth and sustainable livelihoods.

Mission: To increase rice production and market competitiveness through increased productivity and area under cultivation, in collaboration with stakeholders.

Objectives: The overall objective is to attain rice self-sufficiency through an 11-fold increase in domestic production, from 115,000 tons in 2017 to 1,300,000 tons by 2030 through the following:

a) Expansion of physical area under rice cultivation by 104,000 ha by 2030 (areas under irrigation by 70,000 ha, rainfed lowland by 30,000 ha, and rainfed upland by 4,000 ha);

b) Increased on-farm productivity of rice cultivated under irrigation from 4.0 tons/ha to 7.5 tons/ha, rainfed lowland from 2.0 tons/ha to 3.5 tons/ha, rainfed upland from 1.4 tons/ha to 2.5 tons/ha;

c) Reduced dependence on imported rice (from 625,147 tons in 2017 to negligible) by increasing production and market competitiveness of locally produced rice; and

d) Promoting private sector participation in agribusinesses by adding at least 100 micro, small, and medium enterprises in the rice value chain, at least three new value-added rice products and at least three new producer-marketing organizations.

2) Rice Production Targets in NRDS-II

The details of the rice production targets in different ecologies towards achieving the targets in the above specific objectives are shown in the table below.

Table A2.1.2-2 Rice Production Targets by NRDS-II (2019-2030) in Kenya

Year	Irrigated				Rainfed Lowland			Rainfed Upland			Total
	Area (ha)	Annual Total Area (ha)	Yield (ton/ha)	Production (Paddy) (ton)	Area (ha)	Yield (ton/ha)	Production (Paddy) (ton)	Area (ha)	Yield (ton/ha)	Production (Paddy) (ton)	Area (ha)
Baseline											
2017	19,000	31,350	4.0	76,000	5,000	2.0	10,000	4,000	1.4	5,600	28,000
2018	23,600	40,120	4.2	99,120	6,400	2.1	13,120	4,231	1.4	6,092	34,231
Projected											
2019	28,775	51,795	4.6	131,646	7,800	2.1	16,380	4,462	1.5	6,603	41,037
2020	36,020	68,438	5.0	178,299	9,200	2.2	19,780	4,692	1.5	7,132	49,912
2021	50,510	101,020	5.3	268,966	10,600	2.2	23,320	4,923	1.6	7,680	66,033
2022	65,000	130,000	5.7	370,500	12,000	2.3	27,000	5,154	1.6	8,246	82,154
2023	68,125	136,250	5.9	403,641	14,875	2.4	35,793	5,385	1.7	9,221	88,385
2024	71,250	142,500	6.2	438,188	17,750	2.6	45,484	5,615	1.8	10,248	94,615
2025	74,375	148,750	6.4	474,141	20,625	2.7	56,074	5,846	1.9	11,327	100,846
2026	77,500	155,000	6.6	511,500	23,500	2.9	67,563	6,077	2.1	12,458	107,077
2027	80,625	161,250	6.8	550,266	26,375	3.0	79,949	6,308	2.2	13,640	113,308
2028	83,750	167,500	7.1	590,438	29,250	3.2	93,234	6,538	2.3	14,875	119,538
2029	86,875	173,750	7.3	632,016	32,125	3.3	107,418	6,769	2.4	16,162	125,769
2030	90,000	180,000	7.5	675,000	35,000	3.5	122,500	7,000	2.5	17,500	132,000

NOTE: The total area includes area for the first season crop in irrigated, rainfed lowland, and rainfed upland ecologies; The annual total area for irrigated includes first season, second season, and ratoon crops in irrigated ecologies; The yield is for the first season crop, while the second season and ratoon crops have lower yields.

Source: National Rice Development Strategy - II (2019 - 2030) (NRDS-II) (Draft)

The following table shows the roadmap of projected rice production and consumption in Kenya to achieve rice self-sufficiency by 2030.

Table A2.1.2-3 Roadmap of Projected Rice Production and Consumption in Kenya

Year	Production (Paddy) (ton)	Milled Rice (ton)	Total Consumption (Milled Rice) (ton)	Gap in Milled Rice Production (Expected Imported Rice)
Baseline				
2017	125,325	75,000	604,585	530,000
2018	166,099	108,000	620,304	512,000
Projected				
2019	224,264	146,000	636,432	490,000
2020	307,436	200,000	652,979	453,000
2021	465,538	303,000	669,956	367,000
2022	629,346	409,000	687,375	278,000
2023	699,099	454,000	705,247	251,000
2024	772,864	502,000	723,583	222,000

Year	Production (Paddy) (ton)	Milled Rice (ton)	Total Consumption (Milled Rice) (ton)	Gap in Milled Rice Production (Expected Imported Rice)
2025	850,663	553,000	742,397	189,000
2026	932,520	606,000	761,699	156,000
2027	1,018,459	662,000	781,503	120,000
2028	1,108,503	721,000	801,822	81,000
2029	1,202,676	782,000	822,670	41,000
2030	1,301,000	846,000	844,059	-2000

Note: Conversion ratio of milled rice (ton) is 65%.

Source: National Rice Development Strategy - II (2019 - 2030) (NRDS-II) (Draft)

3) Development Opportunities in Rice Production in Kenya Mentioned in NRDS-II

- To increase the rice production and productivity in order to achieve rice self-sufficiency by 2030, this strategy has identified the priority areas of focus in the different rice ecologies with the highest cultivation potential, and priority areas for increased and sustainable rice productivity.
- National Irrigation Board (NIB) has initiated the development of several new large-scale irrigation schemes and dams in the country. Community-based irrigation schemes also augment rice production in the country. There is also a need to rehabilitate and maintain existing infrastructure. The irrigation schemes will be expanded and/or improved by 70,000 ha in areas.
- As a long-term measure, this will not only improve productivity, profitability, and climate resilience but also allow crop intensification and achieve food and nutrition security.
- Under irrigated field, opportunities exist in growing other crops such as grain legumes and vegetables using residual moisture. This will enable rice farmers to raise their farm income, enhance family nutrition, and enable incorporation of aquaculture production systems.
- There is a need to increase production under rainfed areas through expansion of area, promotion of certified seeds, on-farm water harvesting for supplementary irrigation, improved harvest and post-harvest handling, and promotion of mechanization along the value chain. In addition, intercropping can be introduced in upland rainfed ecologies.
- The total target area under rainfed rice production by 2030 is 35,000 ha for rainfed lowland and 7,000 ha for rainfed upland. However, there exists opportunity in rice production which is more profitable than other arable crops, especially under waterlogged conditions. Rice also offers comparably higher number of on-farm and off-farm job opportunities especially for women and youth; hence, it holds wider scope for poverty reduction in rural areas.
- There are vast waterlogged areas in Bungoma, Busia, Siaya, Kisumu, Kakamega, Kilifi, Kwale, Meru, Isiolo, Migori, Homa Bay, Embu, Elgeyo-Marakwet, and Lamu that can be used for ratooning of rainfed rice and even double cropping. The provisions of community-based water storage and rivers can be used for supplementary irrigation.
- Capacity building of extension agents and farmers organizations on rice production; use of high yielding certified seeds, and stress-tolerant and market-oriented varieties; and processing and marketing will also be addressed. There are also problems of low soil fertility, diseases (especially blast and rice yellow mottle virus), insect and vertebrate pests (i.e., white stem borer, stalk eyed fly, quelea birds, and rodents). The use of fertilizers and agro-chemicals in irrigated and rainfed ecologies will also be addressed through public/private investments (production, agro-dealerships).

4) Priority Objectives and Approaches of NRDS-II

The priority objectives and approaches of NRDS-II are categorized into the following four strategic/ specific objectives:

(i) Expansion of area under rice cultivation

(ii) Increase of on-farm productivity

(iii) Increase of the competitiveness of locally produced rice

(iv) Promotion of private sector participation in agribusinesses

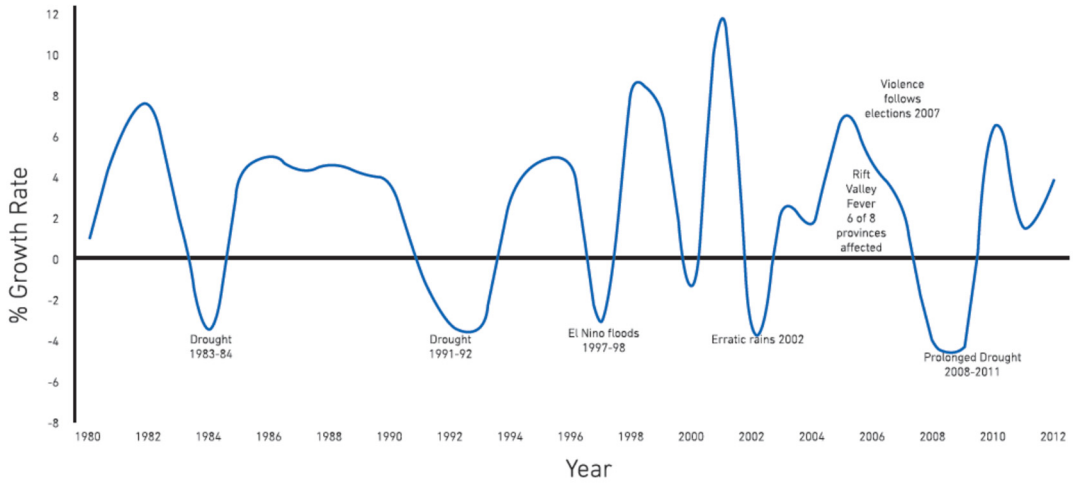
The priority objectives and approaches of NRDS-II are summarized in Table B2.1.2-1.

(6) Kenya Climate Smart Agriculture Implementation Framework, 2018-2027 (KCSAIF)

1) Background

The Kenya Climate Smart Agriculture Implementation Framework 2018-2027 (KCSAIF) has been developed by MoALFI to provide a guide to various initiatives and practices that strive to address challenges brought about by climate change. It is envisioned to ensure increased agricultural productivity and sustainably build resilience of the national agricultural systems.

The following figure shows growth rates of agricultural sector and major extreme events in Kenya. It shows that the agricultural sector of Kenya is vulnerable to natural disasters.



Source: Government of Kenya (2015)

Figure A2.1.2-1 Growth Rate of Agriculture Sector and Major Natural Disasters in Kenya 1980-2012

2) Goal and Objectives

The summary actions outlined in the framework provide broad guidelines from which the counties and other stakeholders in the sector are expected to develop appropriate activities towards building the resilience of the agricultural systems and value chain actors. The major contents of the framework are as follows:

Goal: The overall goal of the framework is to achieve a long-term national low carbon, climate resilient development pathway, while realizing the development goals of Kenya Vision 2030.

Objectives: The framework has four objectives:

a) To develop a sustainable system for achieving a coordinated, coherent, and cooperative governance of climate resilience and low carbon growth in the agricultural sector.

b) To mainstream climate smart agriculture to support the transformation of Kenya's agricultural sector into an innovative, commercially oriented, competitive, and modern industry that contributes to poverty reduction and improved food security in Kenya.

c) To reduce vulnerability of agriculture systems by cushioning them against the impacts of climate change and reduce green house gas (GHG) emissions where possible.

d) To strengthen the communication systems on Community Supported Agriculture (CSA) extension and agro-weather issues.

3) Agricultural Productivity and Integration of Value Chain Approach

The agricultural productivity and integration of value chain approach are mentioned in the second component in the framework. It is mainly composed of access to and use of adaptive technologies, increased area under efficient irrigation, value addition and products development, enhanced competitiveness and market access for climate smart products, and food and feed storage and distribution.

The framework also aims at increasing the area under efficient and renewable energy powered irrigation systems, as well as improving water resource use efficiency in existing and new irrigation systems as adaptation measures. Some of the climate change challenges the irrigation sub-sector experiences include: inadequate infrastructure development for irrigation, drainage and water storage, low productivity, and poor water management. The following actions are mentioned in the framework:

- Increase the use of appropriate renewable energy technologies in irrigation systems.
- Incorporate the gravity fed system in distribution of water to reduce energy used in irrigation.
- Use of efficient water technologies in irrigation.
- Increase the area under micro-irrigation schemes.
- Ensure that the water used for irrigation is safe.
- Promote the development and dissemination of appropriate efficient small-scale irrigation technological packages.
- Build capacity of extension workers and farmers on participatory irrigation management.
- Build the capacity of water users associations in agricultural water management and their obligations as major beneficiaries.
- Undertake comprehensive management needs assessment of the existing large-scale irrigation schemes.
- Conduct studies on the irrigation potential and identify sites in various river floodplains and underground water sources for micro-irrigation systems.
- Provide technical backstopping and training of local artisans on irrigation technologies.
- Integrate the water needs of livestock and fish in all new irrigation designs.
- Design and develop water harvesting and storage structures.
- Climate proof water harvesting, storage structures, and infrastructure.
- Promote development of flood control infrastructure.

(7) Kisumu County Integrated Development Plan II, 2018-2022 (Kisumu CIDP II)

Kisumu CIDP II was prepared to outline programs and projects intended for implementation from 2018 to 2022. Global targets outlined in blueprints such as Sustainable Development Goals (SDGs), Agenda 2063, and Vision 2030 anchor implementation arrangements. The following ten-point priority areas are integrated into Kisumu CIDP II. Revitalizing agriculture for food security and agribusiness is one of the priority areas in Kisumu CIDP II.

The development policies on water, irrigation, environmental, and natural resources are also mentioned in Chapter 4.4.5 in Kisumu CIDP II as measures to attain the key priority areas. The details of the development policy related to irrigation development are as follows:

Vision: A county with a clean and healthy environment supplied with quality water for domestic and irrigation purposes.

Mission: To enhance access to a safe and healthy environment with sustainable water supply and irrigation systems through a multi-sectorial approach.

Programs under the development policies on water, irrigation, environmental, and natural resources are summarized in the table below.

Table A2.1.2-4 Summary of Programme in Kisumu CIDP II Related to Irrigation Development

Programme	Objective	Outcome	Sub Program	Key Outcome
Irrigation and drainage program	Increase the area under irrigation from 15% to 45% in the next five years	Increased area of land under crop production	Rehabilitation and expansion; including lining of conveyance canals in all existing irrigation schemes and construction of new schemes along the three river basins/clusters (River Nyando, Ombeyi and Awach Kano)	Increased land acreage under irrigation from 15% to 45%
			Development of new irrigation schemes	Increased new command area under irrigation from 5% to 30%
			Development of treated waste water management for irrigation purposes	Improved agricultural production and economic growth
			Desolatation of channels in irrigation rice schemes	Increased land acreage under irrigation from 10% to 45%
Water storage and flood control program	Conserve and preserve water for irrigation by 2022	Increased water storage for agricultural production	Dam construction along the three river basins (River Asawo, Awach-Kano, and Awach-Seme)	Increased water storage for irrigation purposes.
Land reclamation	Reclaiming and protecting wasted areas by 2022	Increased arable land for agricultural production	Rehabilitation of gullies	Increased arable land for agricultural production
Resource mobilization for irrigation sector	To enhance work environment	Improved service delivery	Construction of county irrigation HQs and satellite offices	Office block constructed
Capacity building	Sector learning, knowledge management, and development by 2022	Improve the capacity of irrigation personnel	Continuous strengthening of the county irrigation	Active and responsive irrigation forum

Source: Kisumu County Integrated Development Plan II, 2018-2022 (Kisumu CIDP II)

(8) Migori County Integrated Development Plan II, 2018-2022 (Migori CIDP II)

Migori CIDP II identifies key policy actions, programs and projects that the Migori County Government will implement during the plan period in line with the long-term objective of Vision 2030 and the County Development Agenda. The Kenya demographic roadmap and the community needs assessment have four key pillars namely: Pillar 1) Infrastructure development, Pillar 2) Food security, Pillar 3) Socio-economic transformation, and Pillar 4) Good governance. Under the Pillar 2: Food security, the following four strategies are set in Migori CIDP II.

1) Increasing the availability of food by sustainably increasing agricultural production and productivity.
2) Improving access to food by meeting immediate food needs and addressing longer-term accessibility through sustainable livelihoods.
3) Strengthening sustainable management of the food value chain.
4) Supplementing efforts of donors and other development partners like the World Bank, European Union, and IDA for agricultural development to help address the food security needs of the vulnerable population.

During the medium term, priority investments shall include: better land husbandry that addresses the totality of the farm household livelihood system with regard to the management of inputs, outputs, and land resources that aims at improving the productivity and sustainability of production systems, research and extension services, marketing, value addition, and agricultural extension services; development of appropriate policies and strategies aimed at minimizing the role of the middlemen in the marketing of agricultural products; and establishment of community and village markets to improve food security and increase household income. Expansion of agricultural mechanization and subsidization of the agricultural inputs such as fertilizer and seeds to enhance agricultural productivity among small-scale holders shall also be explored.

In order to promote agribusiness and value chain development as a source of increased income, reduced malnutrition, and improved livelihood in the county, concerted efforts shall be made to promote and mentor entrepreneurs, individuals, and groups who are engaged in food crop production such as sorghum, millet, soya bean, and sweet potatoes resulting to comparative advantage. Additional hectares of land shall be put into irrigation targeting both small-scale and large-scale schemes.

In order to reduce pressure on maize as the staple food, greater efforts will be placed in diversification of enterprises which include drought tolerant crops, upland rice (NERICA), and soya beans farming.

The summary of program in Migori CIDP II related to irrigation development under Pillar 2: Food security is shown in the table below.

Table A2.1.2-5 Summary of Program in Migori CIDP II Related to Irrigation Development

Program	Objective	Outcome	Sub Program	Key Outcome
Policy, planning, general administration, and support services	To provide efficient and effective support services for agricultural programs	Efficient and data management of agriculture	Field extension services and support program	Efficient and effective extension services and support program
			Agriculture, research training, and infrastructure development	Improved agriculture technology
			Agricultural mechanization	Increased access and utilization of agriculture mechanization services
Crop development and	To increase agricultural productivity	Increased food security and income	Crop development	Increased food security and income
			Agribusiness and information	

Program	Objective	Outcome	Sub Program	Key Outcome
management	and outputs		management	
			Agricultural value addition and markets	Strengthened produce marketing systems for local and export markets
				Agro-processing and value addition
			Climate smart agriculture interventions, practices and technologies.	Promotion of farmers adopting climate smart agriculture interventions
			Sustainable agricultural land use and environmental management	Improved and sustained agricultural production

Source: Migori County Integrated Development Plan II, 2018-2022 (Migori CIDP II)

According to Migori CIDP II, the county has a total land area of 2,596 km^2 out of which 1,800 km^2 or 89.3% receives medium to high rainfall (750 mm and above), while the rest is arid and semi-arid. This translates to 25,000 ha of land area suitable for irrigation. In order to harness this potential, the county government in collaboration with the national government and other development partners shall put emphasis on viable irrigation and water conservation strategies especially the Lower Kuja basin and the lake shore stretching from Muhuru Bay to Karungu. However, coupled with water storage facilities, this potential can increase to 40,000 ha of land under irrigation.[1]

2.1.3 Supports of Irrigation Development by Development Partners and the Government

(1) Irrigation Development Projects supported by JICA

There are two irrigation development projects by JICA in the past, such as Mwea Irrigation Project and Tana Delta Irrigation Project.

The details of the area are summarized in Table B2.1.3-1.

(2) Other Irrigation Projects Supported by Other Development Partners and Government

(a) Lower Nzoia Irrigation Development Project by WB and KFW

The Lower Nzoia Irrigation Development Project Phase-1 is currently undergoing construction, which is funded by the World Bank (WB) and KFW (*Kreditanstalt für Wiederaufbau*) of Germany in Siaya County in the Lake Victoria Region. The detailed information is given in Section 2.2.3 below.

(b) Small Scale Irrigation and Value Addition Project (SIVAP) by AfDB

The project is supported by African Development Bank (AfDB) emanating from the lessons learned and the need to upscale the recently concluded Small Scale Horticulture Development Project (SHDP-1). The project also seeks to offer alternatives to alleviate dependency on the inadequate and natural rainfall for agricultural production.

The Small-Scale Irrigation and Value Addition Project (SIVAP) aims to increase income, food, and nutritional security along the agricultural value chain by raising agricultural productivity and improving agricultural market access for the poor and marginalized communities in order to improve livelihoods in 11 counties in arid and semi-arid regions. The project intends to increase the

[1] Source: Migori County Integrated Development Plan II, 2018-2022 (Migori CIDP II)

productivity of traditional high value crops, as well as small livestock, through the construction of nine new irrigation schemes and the rehabilitation of three existing schemes.

The project has four components;

- Enhanced water infrastructure development;
- Improved access to markets and strengthening value chains;
- Institutional strengthening, capacity development, and project coordination, and
- Management.

"Component 1: Enhanced Irrigation Infrastructures and Water Resources Development" component has two sub-components:

i) Irrigation development and rehabilitation: The project is supposed to rehabilitate/ develop 12 irrigation schemes in eight counties (Bomet, Nyandarua, Nyeri, Muranga, Meru, Tharaka Nithi, Kajiado, and Makueni) covering a total area of 2,905 hectares.

ii) Enhanced Soil and Water Conservation: Under this sub-component the project is supposed to develop micro-irrigation schemes, construct water harvesting and storage structures, develop watershed command areas, develop erosion control infrastructure, perform ground water exploration, extraction & recharge, and protect watershed catchment and command areas upstream. The tasks under this component will be concentrated in four counties namely: – Tana River, Kitui, Machakos, and Makueni.

(c) Bura Irrigation Rehabilitation Project by Kuwait Fund for Arab Economic Development

The Project aims to enhance the standard of living of the inhabitants of Bura and resettling about 2,500 farming families in the said area. The Project emphasizes at enhancing national food security through installation of gravity irrigation system to lower the cost of production and increase the area under irrigation in the Bura Irrigation Scheme to 15,000 acres from the current 6,000 acres on the west bank of the River Tana.

The project components include construction of gravity intake in Kora Kora on the River Tana as follows:

- Construction of the diversion facilities at the Kora Kora site, river bank protection works, and sedimentation basin.
- Construction and lining of connecting canal with a discharge capacity of 11 m^3/sec and 26.3 km in length.
- Rehabilitation and lining of the existing main canal (53 km), existing irrigation command area infrastructures (canals, canal structures, night storage reservoirs, drains roads) for Bura, Chewele, Pumwani, and Masabubu commands.
- Rehabilitation of buildings, domestic water supply, and electricity supply.

Construction works for Bura Irrigation and Settlement Scheme Rehabilitation Project was contracted to the IVRCL Company. The Government of Kenya (GoK) is financing 70% of the project cost, while 30% is financed by Arab partners comprising the Kuwait Fund for International Development, Arab Bank for Economic Development in Africa (BADEA), and OPEC Fund for International Development (OFID).

The project construction commenced on 27 May 2013, however its scheduled completion has been affected by low funding. The contractor has requested for an extension of additional 12 months to completion date of 30 March 2019 and the concurrence of the donor is being sought. More efforts are being put in place to secure the financing to meet the cost of completing the project as planned.

2.2 Current Conditions and Information in the Target Area

2.2.1 Basic Data of Kisumu and Migori Counties

The Survey area consists of two counties, i.e., Kisumu County and Migori County. Several important key data shall be presented in Chapter 3, the basic data of Kisumu and Migori counties are given in this section.

The basic data of the two counties are summarized in the table below.

Table A2.2.1-1 Basic Information of Kisumu and Migori Counties

	Kisumu County	Migori County
Targeting Irrigation Schemes (I.S.)	Ahero I.S. (Muhoroni Sub-county) West Kano I.S. (Nyando Sub-county) Southwest Kano I.S. (Nyando Sub-county)	Lower Kuja I.S. (Nyatike Sub-county)
Population in 2009 Census (persons)	968,909 persons	917,171 persons
Population in 2020 Projection (persons)	1,289,983 persons (growth 2.6%/annum)	1,165,974 persons (growth 3.1% /annum)
Area	2,085.9 km^2	2,696.5 km^2
Average Temperature	22.9 °C, With an average of 23.6 °C, February is the warmest month. July has the lowest average temperature of the year. It is 21.7 °C.	21.2 °C, February is the warmest month of the year. The temperature in February averages 22.0 °C. July has the lowest average temperature of the year. It is 20.1 °C.
Average Rainfall	1,321 mm The driest month is January. There is 62 mm of precipitation in January. With an average of 228 mm, most precipitation falls in April.	1,369 mm The driest month is July, with 41 mm of rain. With an average of 229 mm, most precipitation falls in April.
Remarks	- Population of Kisumu City: 404,160 persons in 2009 Census: 538,089 persons in 2020 projection: - Population of urban centre 49,338 persons	- Population of urban centre 223,258 persons

Source: CIDP 2018-2022 Kisumu and Migori counties, and https://en.climate-data.org

The CIDPs for Kisumu and Migori counties are summarized in Section (6) and (7) in "2.1.2 National Plans and Agriculture Policy". In the CIDPs various information are described for each county.

2.2.2 Social Conditions in Kisumu and Migori Counties

There are several data which show the conditions of several indicators in all 47 counties, such as:

- County Fact Sheets (Commission on Revenue Allocation, June 2013);
- County Statistical Abstract (Kenya National Bureau of Statistics, 2015); and
- Basic Report of Kenya Integrated Household Budget Survey (Kenya National Bureau of Statistics, 2015/2016).

The table below shows the abstract summary of "County Fact Sheets (Commission on Revenue Allocation, June 2013)" for Kisumu and Migori counties.

Table A2.2.2-1 Basic Social Indicators of Kisumu and Migori Counties

	Kisumu County	Migori County	National Average
(A) Health and Education Outcomes			
- Fully-immunized population under 1-year old child	63.2% (Rank 32/47)*	64.9% (Rank 29/47)	64.0%
- Malaria burden	317.6% (Rank 42/47)	314.5% (Rank 41/47)	27.7%
- Population with primary education	62.0% (Rank 42/47)	68.0% (Rank 24/47)	66.6%
- Population with primary education	13.0% (Rank 16/47)	10.3% (Rank 32/47)	12.7%
- Literacy	65.8% (Rank 30/47)	75.2% (Rank 17/47)	66.4%
(B) Access to Infrastructure			
- Improved water at households	60.1% (Rank 29/47)	47.8% (Rank 39/47)	66.5%
- Improved sanitation at households	87.4% (Rank 26/47)	66.8% (Rank 34/47)	87.8%
- Electricity	18.3% (Rank 9/47)	5.3% (Rank 36/47)	22.7%
- Paved road	4.9% (Rank 7/47)	0.5% (Rank 33/47)	9.4%
(C) Service Coverage			
- Delivered in a health centre	45.6% (Rank 15/47)	32.5% (Rank 22/47)	37.5%
- Qualified medical assistance during birth	46.1% (Rank 15/47)	35.1% (Rank 22/47)	37.6%

** Rank of all the 47 counties*

Source: Kenya County Fact Sheets, Commission on Revenue Allocation (June 2013)

For examining the current status of Kisumu and Migori counties, it is highly recommended to compare with the following:

(i) The national average in Kenya;

(ii) The urban area's average and rural area's average;

(iii) The adjacent counties, i.e., Homa Bay, Siaya, and Busia counties; and

(iv) The other counties which are known as rice production counties, i.e., Kirinyaga, and Tana River counties.

Annex 2.2.2-1 shows the comparisons among the data mentioned above derived from the "Basic Report of Kenya Integrated Household Budget Survey (Kenya National Bureau of Statistics, 2015/2016)".

It shows that the following general observations:

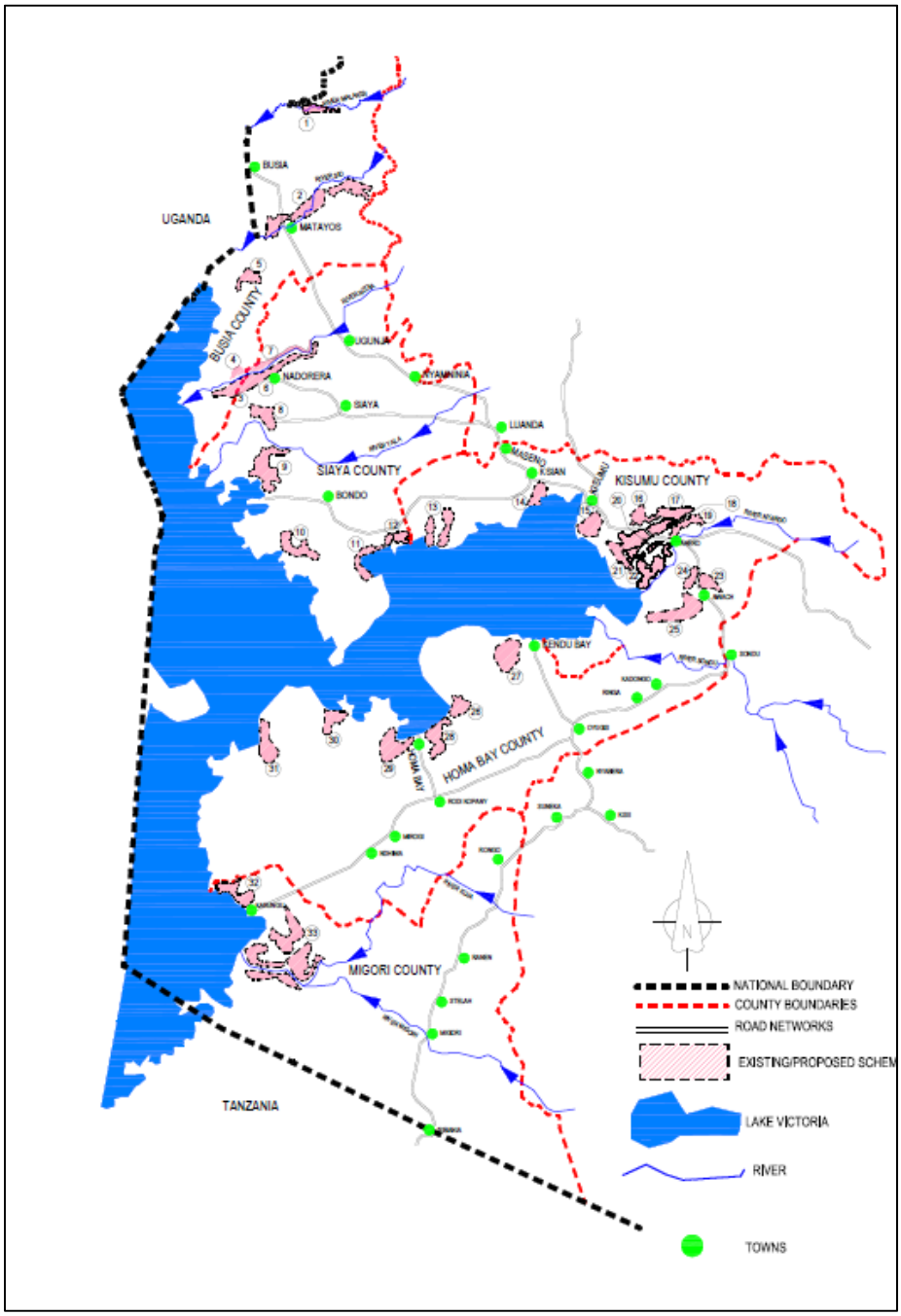
- Kisumu County has the same tendencies as the urban area's averages in several indicators. The indicators in Kisumu are mostly more than the rural area's averages and some indicators are higher than the rural averages.
- On the other hand, conditions in Migori County are relatively similar to the rural area's average. Some indicators in Migori County are less than the rural averages, such as toilet facility and cooking conditions with traditional ways.

- Migori County has relatively high education rate in comparison with other indicators.

2.2.3 Irrigation Infrastructure in/around the Target Area

(1) Location of Projects

There are 33 irrigation schemes including the four target schemes (namely No.19; Ahero, No.21; West Kano, No.22; Southwest Kano, No.33; Lower Kuja) that have been implemented and planned in the Lake Victoria basin from the Uganda border to Tanzania border as shown in Figure A2.2.3-1. The paddy cultivation including plans have been implemented in most of the schemes. Rice production is enhanced and promoted in those areas.



Source: JICA Survey Team

Location of No.34, No.35, No.36: Unknown

Figure A2.2.3-1 Location Map of Irrigation Schemes in the Lake Victoria Basin

Table A2.2.3-1 List of Irrigation Schemes in the Lake Victoria Basin

No.	Project	County	Status	Implementation	Management	Water resources	Irrigation sytem	Irrigates area (ha)	No. of farmers	Main crop
1	Upper Sio	Busia	Plan	NIA	NIA	Sio &Malakisi	Gravity	4,000	1,513	Paddy&Food Crops
2	Lower Sio	Busia	On going	NIA	NIA	Sio, Namanderema stream and Munana	Gravity	6,660	3,400	Paddy&Food Crops
3	Bunyala Phase 1	Busia	Existing	NIA	NIA	Nzoia	Pump	774	-	Paddy
4	Bunyala Phase 2	Busia	Existing	NIA	NIA	Nzoia	Pump	100	1,394	Paddy
5	Funyula	Busia	-	-	NIA	-	-	-	-	-
6	Lowe Nzoia Phase 1	Busia/Siaya	On going	NIA	NIA	Nzoia	Gravity	4,075	13,273	Paddy&Food Crops
7	Lowe Nzoia Phase 2	Busia/Siaya	Plan	NIA	NIA	Nzoia	Gravity	3,622	5,000	Paddy&Food Crops
8	Dominion Farms	Siaya	Suspended	Private	Private	Yala	Gravity	6,820	-	Paddy
9	Yalah System	Siaya	Plan	NIA	NIA	Yala	Gravity	2,193	6,784	Paddy&Food Crops
10	Wagusu	Siaya	Plan	NIA	NIA	Lake Victoria	Pump	420	329	Paddy&Food Crops
11	Great Nam	Siaya	Plan	NIA	NIA	Lake Victoria	Pump	478	447	Paddy&Food Crops
12	East Asembo	Siaya	Plan	NIA	NIA	Lake Victoria	Pump	394	522	Paddy&Food Crops
13	Seme	Kisumu	Plan	NIA	NIA	Awach Seme	Gravity	1,169	-	Paddy & commercial crops(baby corn, cut flowers, oinions short season)
14	Kisian	Kisumu	Plan	NIA	NIA	Mugruk	Gravity	692	-	Paddy & commercial crops(baby corn, cut flowers, oinions short season)
15	Nyamthoe	Kisumu	Existing	MoA	Community	Nyamasaria	Gravity	-	-	Paddy
16	Chiga	Kisumu	Existing	NIA	NIA	Lielang'o	Gravity	132	-	Paddy & commercial crops(baby corn, cut flowers, oinions short season)
17	Ombeyi	Kisumu	Existing	NIA	NIA	Ombeyi/Oroba	Gravity	742	-	Paddy & commercial crops(baby corn, cut flowers, oinions short season)
18	Kasiru Kolal	Kisumu	Existing	MoA	Community	Nyalbiego	Gravity	-	-	Paddy
19	Ahero	Kisumu	Existing	NIA	NIA	Nyando	Pump	867	570	Paddy
20	Ahero Extension	Kisumu	Plan	NIA	NIA	Nyando	Gravity	3,414	-	Paddy
21	West Kano	Kisumu	Existing	NIA	NIA	Lake Victoria	Pump	892	780	Paddy
22	South West Kano	Kisumu	Existing	MoA	Community	Nyando	Gravity	1,800	3,900	Paddy
23	Awach Kano	Kisumu	Existing	NIA	Community	Awach	Gravity	377	-	Paddy
24	Gem Rae	Kisumu	Existing	MoA	Community	Awach	Gravity	-	-	Paddy
25	MagwagwanPilot	Kisumu	Plan	NIA	NIA	Sondu/Nyando	Gravity	3,036	Unknown	Commercial maize
26	Oluch	Homa Bay	-	Lake basin	Lake basin	-	-	-	-	-
27	Oluch Kimira	Homa Bay	Existing	Lake basin	Lake basin	Awach Kibuon	Gravity	2,000	8,400	Paddy&Food Crops
28	Ragwena	Homa Bay	Plan	NIA	NIA	Lake Victoria	Pump	409	792	Paddy
29	Nyagidha	Homa Bay	Plan	NIA	NIA	Lake Victoria	Pump	921	888	Commercial maize
30	Olambwe	Homa Bay	Plan	NIA	NIA	Lake Victoria	Pump	600	571	Paddy
31	Sindo	Homa Bay	Plan	NIA	NIA	Lake Victoria	Pump	723	828	Commercial maize
32	Konyango	Migori	Plan	NIA	NIA	Lake Victoria	Pump	803	1,713	Paddy&Food Crops
33	Lower Kuja	Migori	On going	NIA	NIA	Kuja	Gravity	7,717	2,797	Paddy&Food Crops
34	Ogera	Homa Bay	Plan	NIA	NIA	Awach Kabondo	Gravity	320	-	Paddy&Food Crops
35	Greater Wang' Chieng	Homa Bay	Plan	NIA	NIA	Sondu &L.Victoria	Gravity & Pump	1,000	1,687	paddy & food crops
36	North-West Karachuonyo	Homa Bay	Plan	NIA	NIA	Lake Victoria	Pump	325	336	Paddy

Source: JICA Survey Team

(2) Outline of Topical Projects

(a) No.3: Bunyala Phase 1 and No.4 Bunyala Phase 2

Bunyala Irrigation Scheme was started in 1959 with an initial of 534 acres under rice production. Irrigation water of the left bank is pumped up from the Nzoia River and flows by gravity to the farmland. Due to the increased demand for paddy cultivation, two pumps were installed in 2005 and two more pumps were also installed in 2007. The combined discharge is 1.2 m^3/s. On the right bank, two pumps were installed in 2007. The summary of the scheme is shown in Table A2.2.3-2 and existing conditions of the facilities are shown in Table A2.2.3-3

Table A2.2.3-2 Summary of Bunyala Project Phase 1 and Phase 2

Items	Details
County	Busia
Construction/ operation	1964/ 1969
No. of farming households	1,394
Initial/ current scheme area	534/ 1,934 acres
Average farm holding per farmer	1 to 4 acres
Irrigation/ drainage system	Pumping/ gravity
Water resources	Nzoia River
Dependant population	Approx. 20,000
Rice variety grown	IR2793, ITA310 and Basmati370
Average yield	2,500 kg/acre

Source: JICA Survey Team based on NIB Bunyala

Table A2.2.3-3 Photographs of Bunyala Project

		
Pump station (Phase 1)	Rice drying yard	Rice products collecting and shipping facility

Source: JICA Survey Team

(b) No.6 Lower Nzoia Phase 1 and No.7: Lower Nzoia Phase 2

The Lower Nzoia Irrigation Development Project has two phases as shown in Table A2.2.3-4. Now Phase 1 is under implementation. The headworks and a conveyance canal of Phase 1 are under construction as of October 2019, as shown in Table A2.2.3-5. The conveyance canal is a concrete lining type due to sandy soil. The selection of crops depends on topographical conditions. The upland crops are selected for steep slope and paddy is for gently slope. Irrigation Block 1 to 7 are upland crops, in Block 8 to 14 are paddy. The flood dykes are planned to be constructed on both sides of the Nzoia River, where each length has 17 km, which is 34 km in total.

Table A2.2.3-4 Summary of Lower Nzoia Irrigation Development Project

<table>
<tr><td rowspan="8">Overview</td><td>Name of project</td><td>Lower Nzoia Irrigation Development Project</td></tr>
<tr><td>Implementation body</td><td>NIA (NIB)</td></tr>
<tr><td>County</td><td>Siaya and Busia</td></tr>
<tr><td>Major river</td><td>Nzoia River</td></tr>
<tr><td>Population of area</td><td>54,201</td></tr>
<tr><td>Farming households</td><td>13,273</td></tr>
<tr><td>Farmland ownership</td><td>Community or private free hold</td></tr>
<tr><td rowspan="3">Agriculture</td><td>Beneficiary area</td><td>Phase 1: 4,075 ha, Phase 2: 3,622 ha</td></tr>
<tr><td>Crops</td><td>Phase 1 (Season 1 and 2)
<table>
<tr><th>Crops</th><th>Current</th><th>Plan</th></tr>
<tr><td>Maize/Beans</td><td>2,115</td><td>672</td></tr>
<tr><td>Sorghum/Beans</td><td>808</td><td>-</td></tr>
<tr><td>Soy beans</td><td>-</td><td>866</td></tr>
<tr><td>Beans</td><td>232</td><td>127</td></tr>
<tr><td>Sweet potatoes</td><td>254</td><td>26</td></tr>
<tr><td>Cassava</td><td>263</td><td>-</td></tr>
<tr><td>Green grams</td><td>92</td><td>-</td></tr>
<tr><td>Vegetable</td><td>164</td><td>169</td></tr>
<tr><td>Fruits</td><td>16</td><td>-</td></tr>
<tr><td>Rice</td><td>474</td><td>2534</td></tr>
<tr><td>Groundnut</td><td>-</td><td>91</td></tr>
<tr><td>Pawpaw</td><td>-</td><td>185</td></tr>
<tr><td>Banana</td><td>-</td><td>371</td></tr>
<tr><td>Passion fruit</td><td>-</td><td>456</td></tr>
<tr><td>Mangoes</td><td>-</td><td>185</td></tr>
<tr><td>Total</td><td>4,417</td><td>5,682</td></tr>
</table>
Phase 2 (Season 1 and 2)
<table>
<tr><th>Crops</th><th>Current</th><th>Plan</th></tr>
<tr><td>Maize/Beans</td><td>2,280</td><td>691</td></tr>
<tr><td>Sorghum/Beans</td><td>573</td><td>-</td></tr>
<tr><td>Soy beans</td><td>-</td><td>879</td></tr>
<tr><td>Beans</td><td>244</td><td>138</td></tr>
<tr><td>Sweet potatoes</td><td>164</td><td>22</td></tr>
<tr><td>Cassava</td><td>240</td><td>-</td></tr>
<tr><td>Green grams</td><td>-</td><td>-</td></tr>
<tr><td>Vegetable</td><td>104</td><td>178</td></tr>
<tr><td>Fruits</td><td>19</td><td>-</td></tr>
<tr><td>Rice</td><td>85</td><td>2,055</td></tr>
<tr><td>Groundnut</td><td>414</td><td>88</td></tr>
<tr><td>Pawpaw</td><td>-</td><td>169</td></tr>
<tr><td>Banana</td><td>-</td><td>349</td></tr>
<tr><td>Passion fruit</td><td>-</td><td>349</td></tr>
<tr><td>Mangoes</td><td>-</td><td>180</td></tr>
<tr><td>Total</td><td>4,123</td><td>5,098</td></tr>
</table></td></tr>
<tr><td>Rice variety</td><td>IT2793, ITA310, Basmati370</td></tr>
<tr><td rowspan="2">Irrigation plan</td><td>Dam</td><td>Flood control only</td></tr>
<tr><td>Weir</td><td>10 m^3/s</td></tr>
</table>

	Canal	<table><tr><td></td><td>Phase 1</td><td>Phase 2</td><td>Management</td></tr><tr><td>Main</td><td>31.3 km</td><td>36.6 km</td><td rowspan="2">NIA (NIB)</td></tr><tr><td>Branch</td><td>30.0 km</td><td>17.1 km</td></tr><tr><td>Tertiary</td><td>51.0 km</td><td>38.7 km</td><td>IWUA</td></tr></table>
Cost	Investment cost	Phase 1: Ksh. 6,020.7 million
		Phase 2: Ksh. 5,106.1 million
	Operation cost	Phase 1: Ksh. 75.3 million
		Phase 2: Ksh. 63.8 million

Source: JIID report (March 2018)

Table A2.2.3-5 Photographs of Lower Nzoia Irrigation Development Project

		
Headworks	Conveyance canal	Spillway of conveyance canal
		
Sedimentation of conveyance canal	Division box	Aqueduct of conveyance canal

Source: JICA Survey Team

(c) No.8: Dominion Company Farm

Dominion Farms, an American-based company, planned to develop an irrigation project (irrigated area: 6,820 ha) in lower Yala River basin. In 2003, the regional government authority granted a 25-year lease for rice cultivation to Dominion Farms. The agreement was approved by the local authorities in Bondo and Siaya County Council that Dominion would conduct rice production in part of Area I, this portion of Area I was the land, which was previously used by the Lake Basin Development Authority (LBDA) for agricultural activity. Dominion got a license in 2004, for rice irrigation.

However, instead of the originally intended rice cultivation in Area I, which is previously owned by LBDA, Dominion embarked on other additional agricultural and developmental activities in the swamp that went beyond rice cultivation. These were construction of irrigation dykes, construction of weirs, water-drilling, and airstrip and road construction. Also Dominion Farms engaged in major aquaculture ventures.

The households in Yala Swamp realized that they could not meet their basic needs, since they no longer own the arable swamp-land for cottage industries and their economic power started to diminish. The rivers and lakes could no longer produce enough fish for commercial purposes. In addition to that, forests were cleared because of herbal medicines, roofing grass, edible birds, wild vegetables, and disappearance of honey and fruits. Moreover, hunting and logging stopped. This led to residents of Kadenge and Obambo to demonstrate and have open confrontations with the management of Dominion Farms.

After long disputes in court among the Dominion management and local people, Dominion Farms lost the case and decided to withdraw from the farm management business in 2017.

The detailed information about this issue is given in Annex 2.2.3-1.

CHAPTER 3. CURRENT CONDITIONS AND ANALYSIS IN EACH SECTOR

3.1 Irrigation

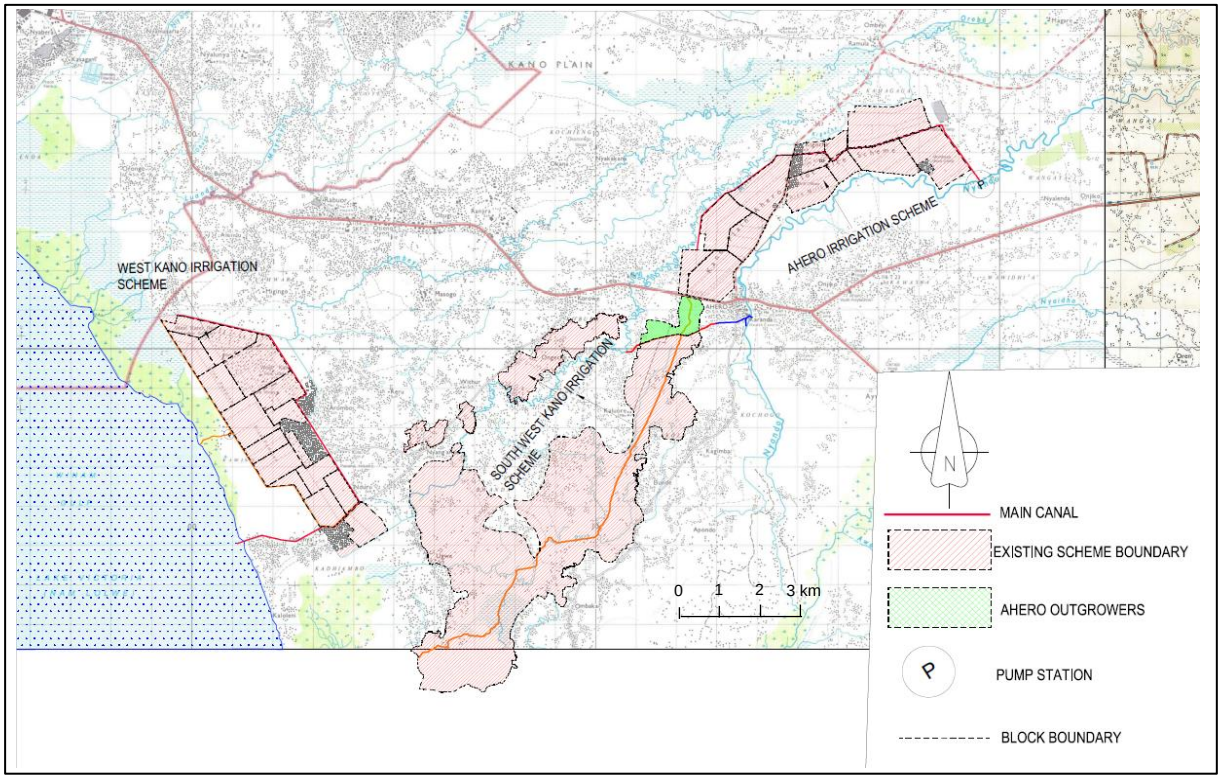
3.1.1 Target Schemes

(1) Irrigation Schemes in Nyando River Basin

1) Location

There are three target irrigation schemes in the Nyando irrigation basin, namely; the Ahero Irrigation Scheme (867 ha[1)]), West Kano Irrigation Scheme (892 ha[1)]), and Southwest Kano Irrigation Scheme (1,800 ha[1)]). The location is shown in Figure A3.1.1-1. The border of the Southwest Kano Irrigation Scheme is not clear. It is considered based on project documents and satellite data.

Note 1): Irrigation area by NIA (July 2019).

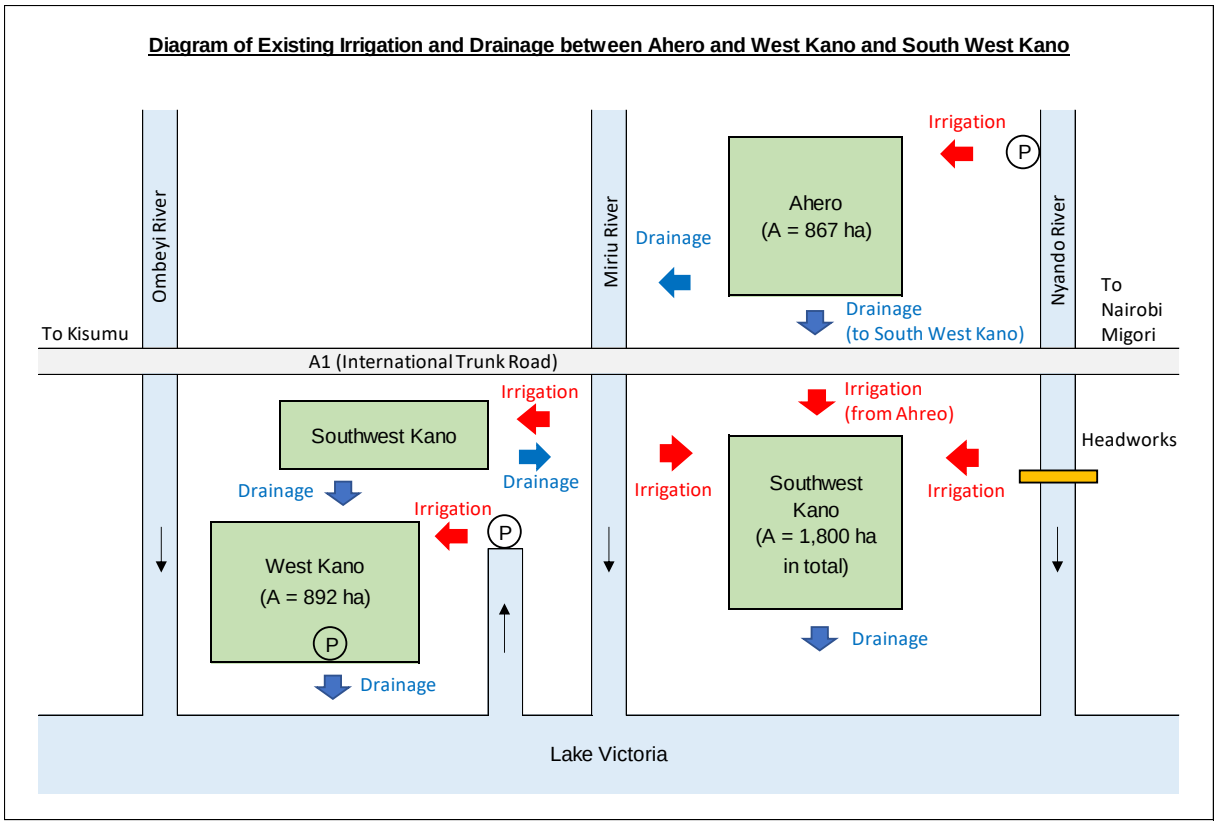


Source: JICA Survey Team

Figure A3.1.1-1 Location Map of the Three Irrigation Schemes in the Nynado River Basin

2) Irrigation and Drainage Networks

The irrigation network of the three irrigation schemes is shown in Figure A3.1.1-2. The Ahero Irrigation Scheme is located upstream of the Nyando River. The Southwest Kano Irrigation and West Kano Irrigation schemes are located downstream of the Nyando River. The irrigation and drainage network of the three schemes is closely connected.



Source: JICA Survey Team

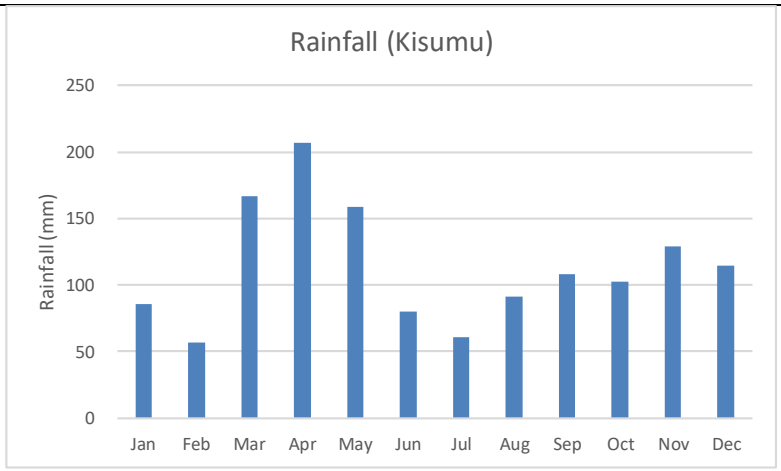
Figure A3.1.1-2 Diagram of Irrigation and Drainage Network for the Three Irrigation Schemes

3) Rainfall

The rainfall data for 29 years from 1990 to 2018 is shown in Table A3.1.1-1. There are two rainy seasons. The long rainy season is from March to June and the short rainy season is from October to December. Seventy percent of the 1,362 mm average rainfall count in a year concentrates during the rainy season.

Table A3.1.1-1 Rainfall in Kisumu

Month	Rainfall (mm)
Jan	85.8
Feb	56.7
Mar	167.0
Apr	206.6
May	158.8
Jun	80.1
Jul	61.1
Aug	91.3
Sep	108.2
Oct	102.8
Nov	128.9
Dec	114.6
Total	1362.0



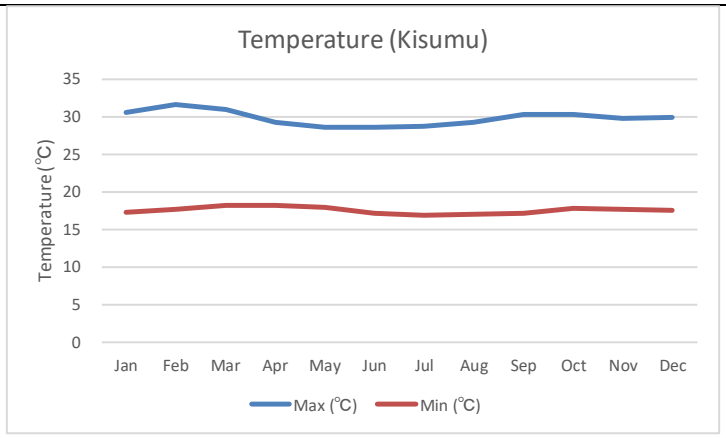
Source: NIA

4) Temperature

The temperature data for 29 years from 1990 to 2018 is shown in Table A3.1.1-2. The average maximum temperature is 31.7 °C in February and the average minimum temperature is 16.8 °C in July.

Table A3.1.1-2 Temperature in Kisumu

Month	Max (℃)	Min (℃)
Jan	30.6	17.2
Feb	31.7	17.7
Mar	31.0	18.2
Apr	29.2	18.2
May	28.7	17.9
Jun	28.5	17.2
Jul	28.8	16.8
Aug	29.3	17.0
Sep	30.3	17.1
Oct	30.3	17.8
Nov	29.8	17.7
Dec	30.0	17.5
Avregare	29.8	17.5



Source: NIA

(2) Irrigation Scheme in Lower Kuja Basin

1) Location

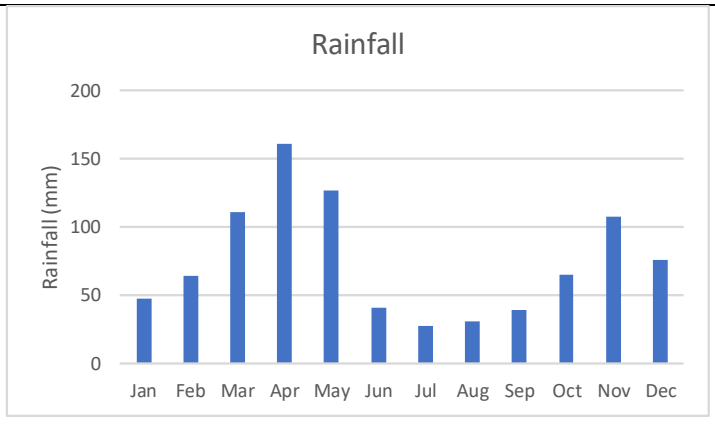
There is one target irrigation scheme in the Lower Kuja basin, namely: the Lower Kuja Irrigation Scheme (7,717 ha). The scheme is located in the lower Kuja River.

2) Rainfall

According to the "Consultancy Services for Feasibility Study, Detailed Design, and Preparation of Tender Documents for Lower Kuja Irrigation Development Project" (hereafter abbreviated as Lower Kuja D/D report), there are three weather stations around the lower Kuja basin, namely: Muhuru, Macalder, and Karungu. The average rainfall data of those stations is shown in Table A3.1.1-3. Seventy-seven percent of the 893.6 mm average rainfall count in a year concentrates during the rainy season from March to June and from October to December.

Table A3.1.1-3 Rainfall in Lower Kuja Irrigation Scheme

Month	Rainfall (mm)
Jan	47.5
Feb	63.7
Mar	110.6
Apr	160.6
May	126.3
Jun	40.2
Jul	26.9
Aug	30.9
Sep	38.7
Oct	64.7
Nov	107.8
Dec	75.7
Total	893.6



Source: NIA

3.1.2 Ahero Irrigation Scheme

(1) Current Conditions

1) Outline

(i) Brief History of Development

The construction of the Ahero Irrigation Scheme was started in 1966 and operation was started in 1969. The irrigation area in 1969 was 990 ha and the main crop was paddy. The current irrigation area is 867 ha and the beneficiaries are 570 farmer households. The average cultivation area per farmer is 4 acres (1.6 ha). The irrigation system is a pump type and the water source is the Nyando River.

After the start of its operation in 1969, cultivation of this scheme was suspended during 1999 to 2004. When two pumps were installed by the Food and Agriculture Organization (FAO) in 2005, cultivation of the scheme restarted. An additional of two pumps were installed by NIA. Farmers have paid Kha 3,100 for the O&M cost of NIA. The briefly history is shown in Table A3.1.2-1.

Table A3.1.2-1 Brief History of Ahero Irrigation Scheme

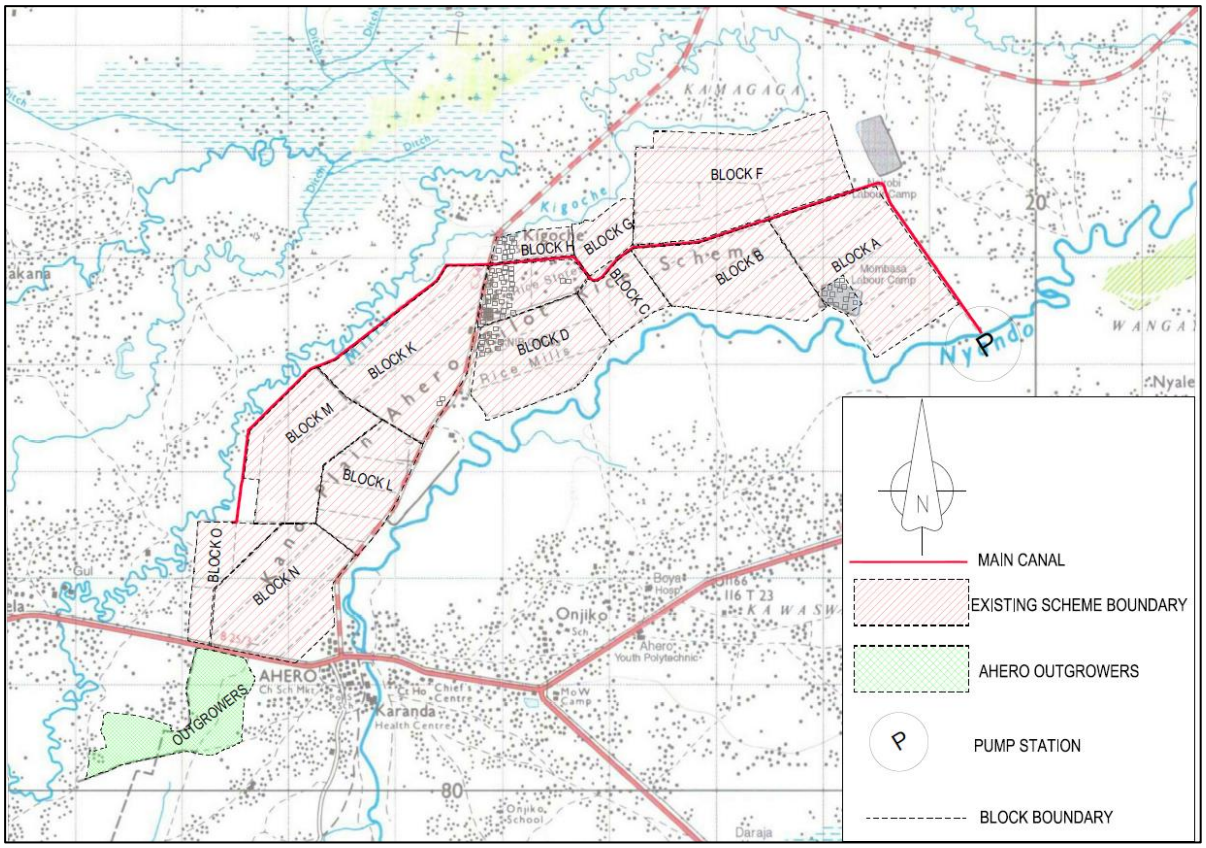
Year	Description
1966	The scheme was started.
1969	The scheme became operational. It covered a gross area of 1,540 ha and a net area of 900 ha for rice production.
1999	The scheme stopped the cropping activities.
2005	The scheme resumed the cropping activities. Two new pumps were donated by FAO at a cost of Ksh 20 million. Two new additional pumps were installed by the Ministry of Water and Irrigation at a cost of Ksh 25 million. The capacity of the two pumps is 1.1 m^3/s and the other two pumps is 0.66 m^3/s. All of them are made by ABS (Suzer) Company.

Source: JICA Survey Team

(ii) Summary

This scheme is located on the north side of Ahero City as shown in Figure A3.1.2-1. The water source of the scheme is the Nyando River and its irrigated area is 867 ha. There is a command area (82 ha) of out growers[1)] that is located downstream of the scheme.

[1)]: Out growers are not official beneficiaries. They cultivate paddy by using drain water from the Ahero Irrigation Scheme. The out growers do not have priority to use irrigation water. If they do not receive drain water from the Ahero Irrigation Scheme, they cannot cultivate.



Source: JICA Survey Team

Figure A3.1.2-1 Location Map of Ahero Irrigation Scheme

Summary of the Ahero Irrigation Scheme is shown in Table A3.1.2-2.

Table A3.1.2-2 Summary of the Ahero Irrigation Scheme

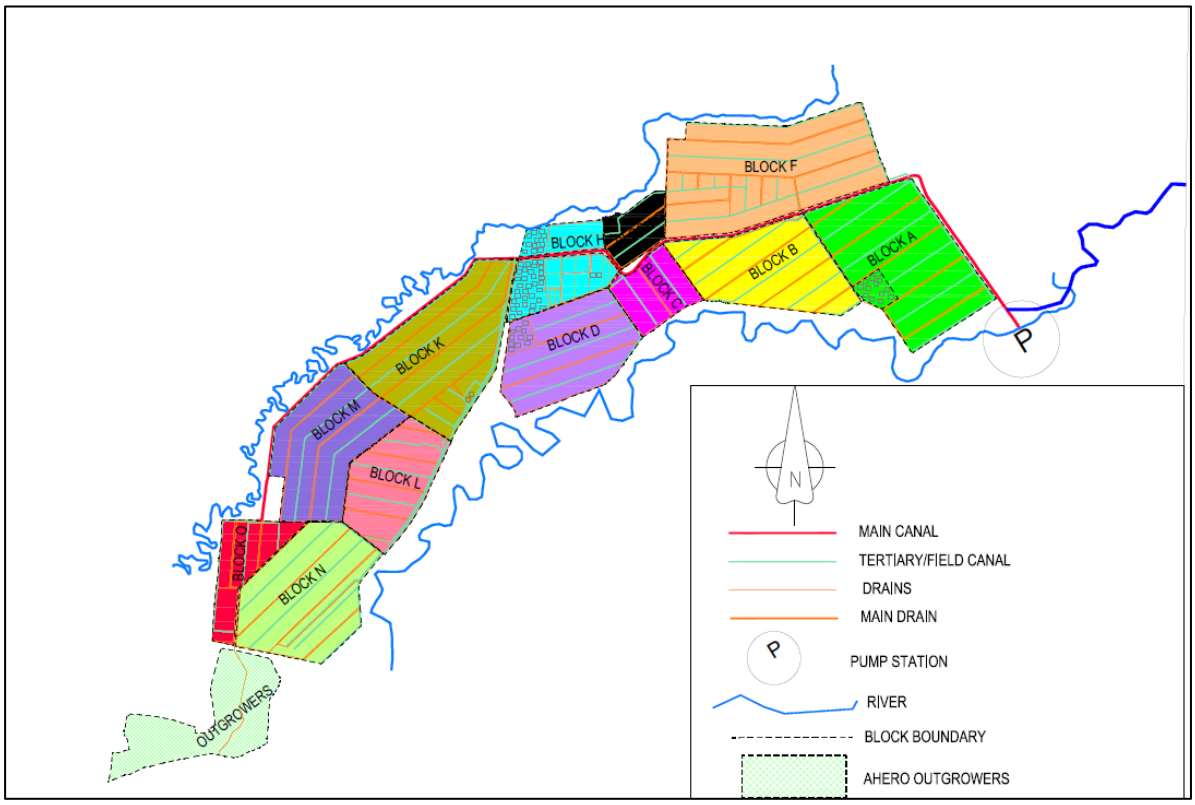
Items	Description
Implementation body	NIA Ahero
County	Kisumu
Location	In the Kano Plains between Nandi escarpment and Nyabondo plateau
Access	Nairobi to Kisumu by air: 1 hour, Kisumu to Ahero by road: 1 hour
Type of project	Rehabilitation
Construction/ operation	1966/1969
No. of farmers	570 households, 2,000 persons
Irrigated area	867 ha
Farm size per harmer	4 acres (1.6 ha)
Irrigation system	Pumping
Drainage system	Gravity
Source of water	Nyando River
No. of pumps	4 pumps
Pump capacity	1.1 m^3/s (two pumps) and 0.66 m^3/s (two pumps) (H: actual pump head = 10 m)
Drainage system	Gravity
Source of drainage	Miriu River and Southwest Kano
No. of dependents	Approximately 30,000

Cultivated crop	Paddy (single cropping, 100% paddy)
Variety grown	Basmati 370 variety etc.
Average yield	4.0 t/ha
O&M	NIA Ahero
Water charge	Ksh 3,100/ac/season

Source: JICA Survey Team

2) Irrigation Blocks

The Ahero Irrigation Scheme is divided into 12 irrigation blocks as shown in Figure A3.1.2-2 and its main crop is paddy.



Source: JICA Survey Team

Figure A3.1.2-2 Irrigation Block of Ahero Irrigation Scheme

3) Existing Facilities

This scheme is a pump irrigation system that is composed of a pump station, main canals, branch canals, and farm roads. The details of these facilities are shown in Table A3.1.2-3. The facilities have low efficiency due to deterioration. The high operation cost of irrigation pumps is paid by NIA. The main and branch canals are eroded and covered with heavy weeds.

Table A3.1.2-3 Existing Irrigation Facilities in Ahero Irrigation Scheme

Facilities	Photographs		Dimension
Irrigation pump station			Pump: Q = 1.1 m^3/s * 2 nos., 0.66 m^3/s * 2 nos.
Canal			Main canal: Q = 1.76 m^3/s, L = 9.7 km Branch canal: L = 85.4 km
Farm road			L = 70 km, gravel pavement, W = 5 m

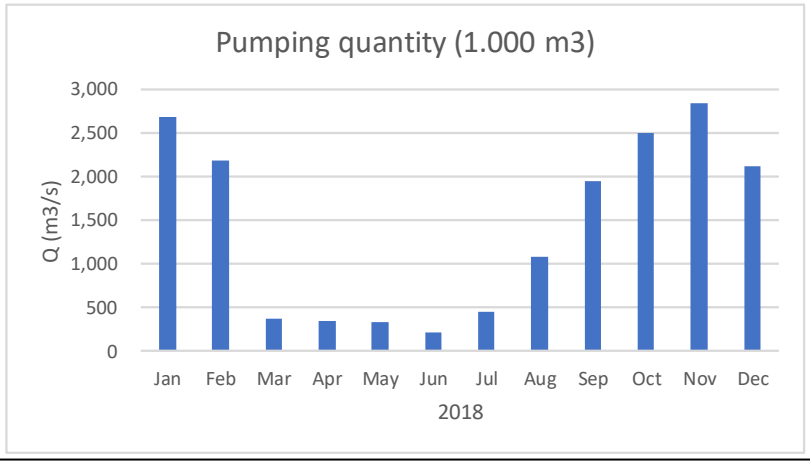
Source: JICA Survey Team

4) Pump Operation and Cost

Monthly pumping quantity based on daily data of Ahero Pump Operation is shown in Figure A 3.1.2-3. According to the data, pumping quantity from August to February is more than that from March to July. The period from March to July is almost the rainy season.

Ahero pump operation quantity (Year: 2018)

Month	Amount (1.000 m^3)
Jan	2,684
Feb	2,187
Mar	364
Apr	345
May	328
Jun	207
Jul	449
Aug	1,081
Sep	1,944
Oct	2,493
Nov	2,839
Dec	2,115
Total	17,036



Source: JICA Survey Team based on NIA Ahero data

Figure A3.1.2-3 Monthly Pumping Quantity of Ahero Pump Station

Operation cost (electricity) of the pumping is approximately Ksh 12.1 million per year as shown in Table A3.1.2-4. The cost is a big issue in the operation the scheme by NIA and the farmers. In

December 2017, the total pumping quantity is approximately 2.632 million m^3 and the total cost is Ksh 663,634. This unit cost is Ksh 0.252/m^3.

NIA Nairobi paid 99% of payment of the operation cost, while NIA and the farmers paid the maintenance cost of the pumps in 2018.

5) Flood Damage

Flood causes damage in the lower area of the Ahero Irrigation Scheme. The flood is from the Nyando River as shown in Figure A3.1.2-4.

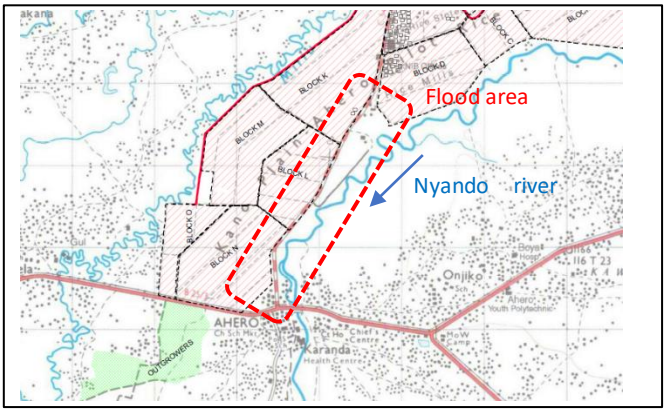
Table A3.1.2-4

Operation Cost of Pumps

(Year: 2017)

Month	Amount (Ksh)
Jan	1,080,026.00
Feb	1,109,439.00
Mar	264,076.00
Apr	1,192,483.00
May	528,675.00
Jun	1,238,294.00
Jul	1,185,485.00
Aug	1,123,961.00
Sep	1,111,974.56
Oct	1,178,178.00
Nov	1,440,539.00
Dec	663,634.00
Total	12,116,764.56

Source: NIA Ahero



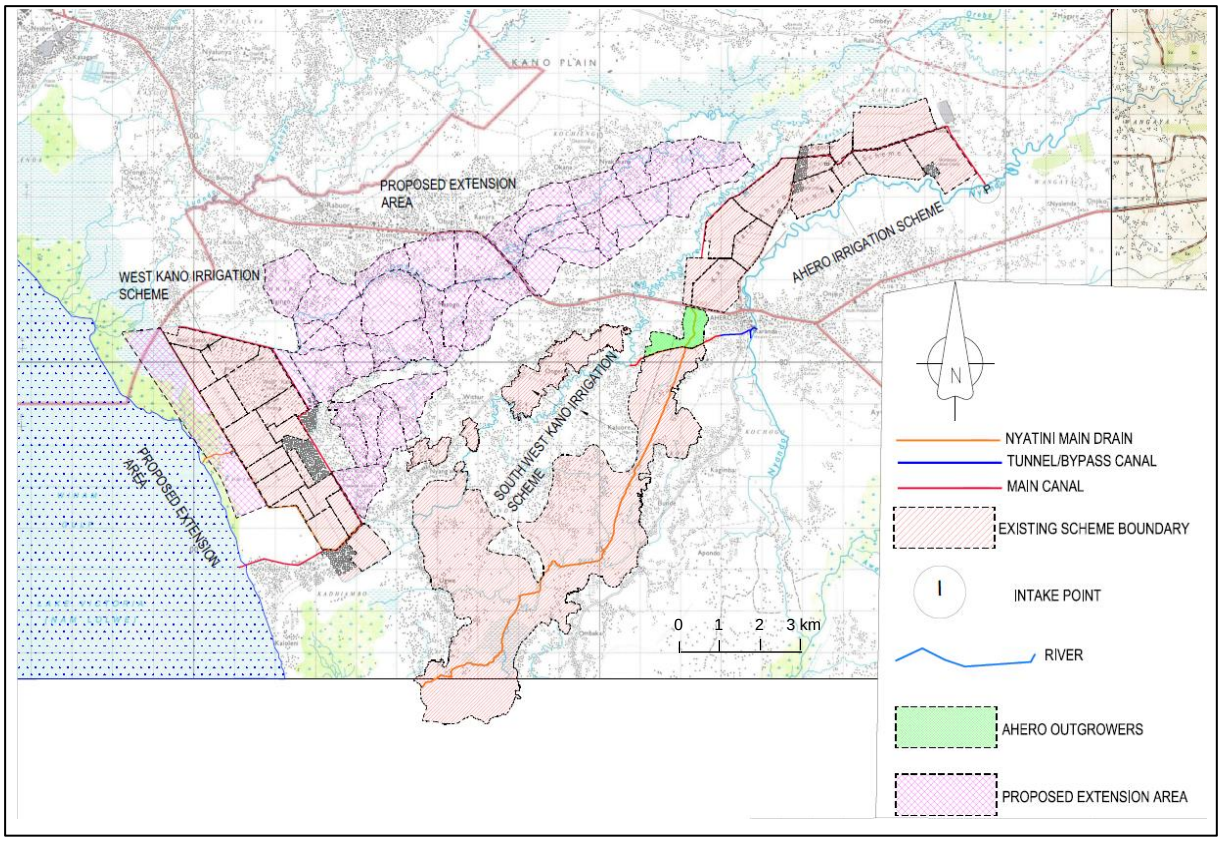
Source: JICA Survey Team

Figure A3.1.2-4 Flood Damage in Ahero Irrigation Scheme

6) Extension Plan

(i) Location and Irrigation System

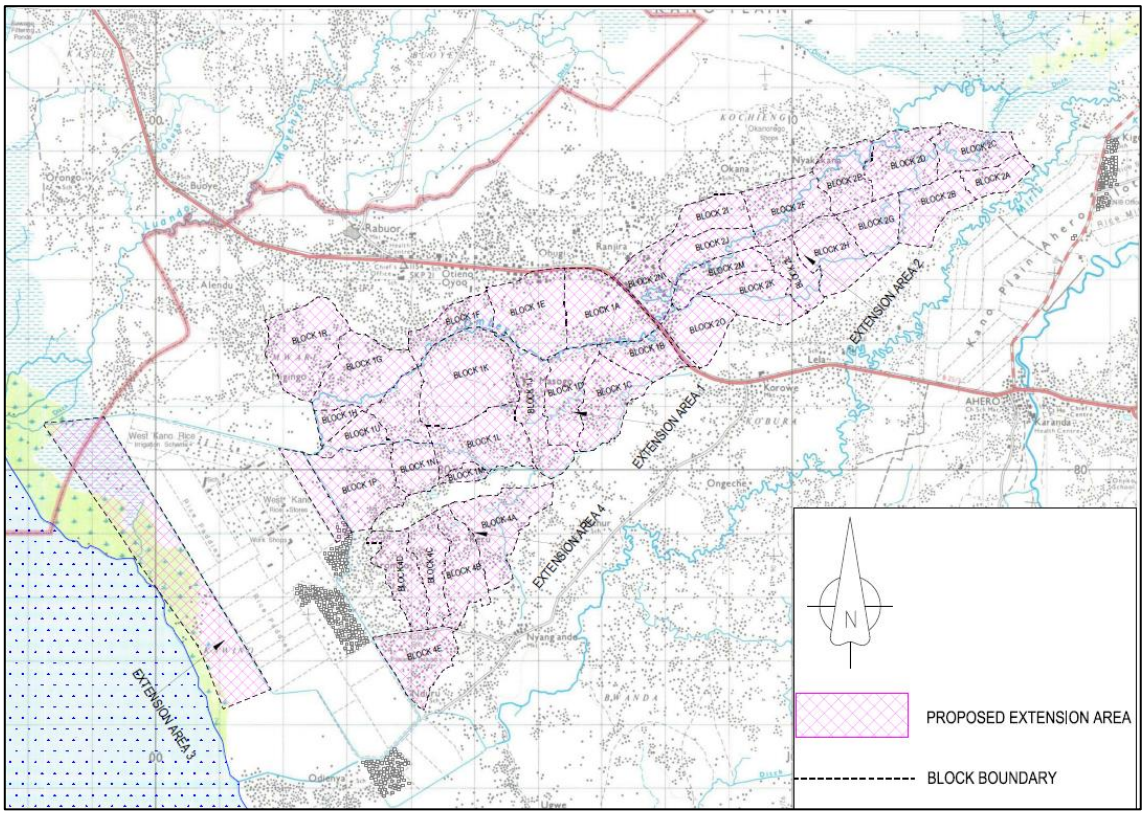
Command areas of the extension plan are located on the right bank of the Miriu River, between the Ahero Irrigation Scheme and the West Kano Irrigation Scheme as shown in Figure A3.1.2-5. The water source of the plan is the Soin-Koru Dam. An intake structure will be constructed downstream of the dam. In the plan, the irrigation system will switch from pumping to gravity.



Source: JICA Survey Team

Figure A3.1.2-5 Location Map of Extension Area and Existing Irrigation Schemes

The extension area of 3,414 ha is divided into four areas, namely; Extension Area 1 (1,466 ha), Extension Area 2 (1,049 ha), Extension Area 3 (283 ha), and Extension Area 4 (616 ha). These are shown in Figure A3.1.2-6.

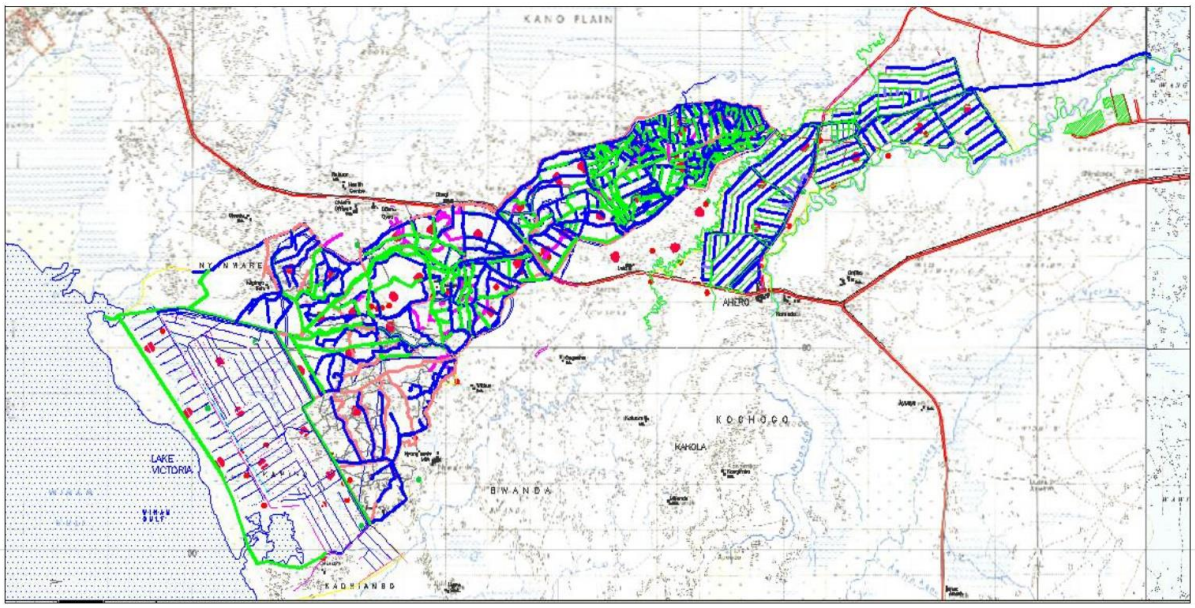


Source: JICA Survey Team

Figure A3.1.2-6 Location Map of Extension Areas

(ii) Facility Plan

The facilities are shown in Figure A3.1.2-7 and Table A3.1.2-5 are proposed for irrigation development of the extension areas (3,414 ha).



Source: Detailed design and preparation of bidding documents for the Ahero and West Kano Irrigation Schemes Development Project Final Design Report.

Figure A3.1.2-7 Extension Facility Development Plan

Table A3.1.2-5 List of Facilities for Extension Plan

Facility	Dimension	Quantity
Headworks	L=58.5 m, H=5.5 m	N= 1 set
Conveyance canal	Open channel, Q=6.6 m^3/s	L= 10 km
Headworks	L=58.5 m, H=5.5 m	N= 1 set
Main canal	Q= 1.76 m^3/s	L= 9.7 km
Secondary canal	Q= m^3/s	L= 85.4 km
Farm road	W=5m, Soil pavement	L= 70 km
Main canal (expanded)	Q=3.2 m^3/s	L= 4.9 km
New main canal 1	Q=0.89 m^3/s	L= 1.3 km
New main canal 2	Q=2.2 m^3/s	L= 1.6 km
Secondary canal (area 1)	B=1.2 m	L= 37.9 km
Secondary canal (area 2)	B=1.2 m	L= 30.1 km
Secondary canal (area 3)	B=1.2 m	L= 7.6 km
Secondary canal (area 4)	B=1.2 m	L= 8.3 km
Secondary drainage (area 1)	B=1.0 m	L= 35.8 km
Secondary drainage (area 2)	B=1.0 m	L= 20.9 km
Secondary drainage (area 3)	B=1.0 m	L= 5.1 km
Secondary drainage (area 4)	B=1.0 m	L= 3.4 km
Tertiary canals		L= 90.6 km
Tertiary drainages		L= 93.3 km

Source: Detailed design and preparation of bidding documents for Ahero and West Kano Irrigation Schemes Development Project Final Design Report.

(iii) Evaluation of Extension Plan

This study mainly targets the rehabilitation plan of the existing Ahero Irrigation Scheme because the implementation of the Soin-Koru Dam construction is not clear, as of October 2019.

7) Soin-Koru Dam Construction Plan

(i) Project Objectives

The Soin-Koru Dam will be constructed using water from the Nyando River, which is one of the main rivers flowing into Lake Victoria. The Soin-Koru Dam will be for flood control, irrigation, hydropower generation, and water supply. The dimension of each objective is shown in Table A3.1.2-6.

Table A3.1.2-6 Objectives and Dimension of Soin-Koru Dam

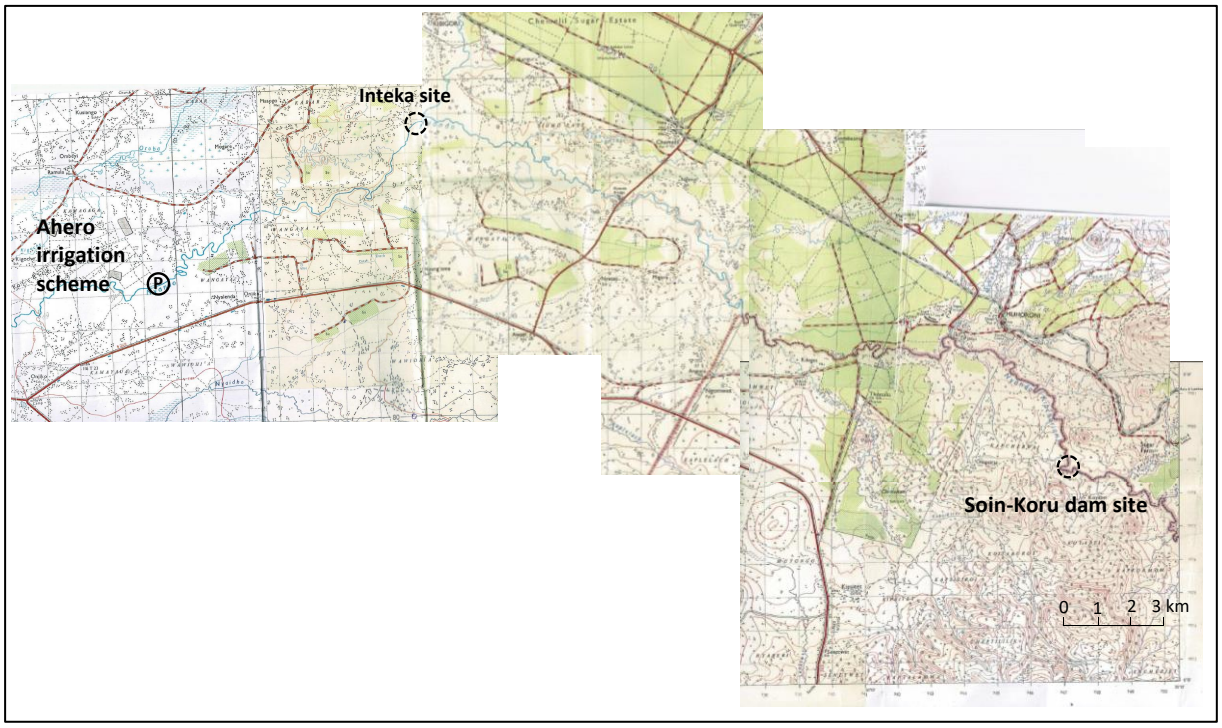
Objectives	Dimension	Remarks
Flood control	Return period: 1 in 1,000 years Design flow: 660 m^3/s Storage capacity: 57.0 mcm (million cubic meter)	-
Irrigation	Target area: 10,900 ha (potential area of Ahero and West Kano) Maximum flow: 19.998 m^3/s (February)	Irrigation water will be abstracted approximately 30 km downstream of the dam.
Hydropower generation	Hydropower potential: 2.5 MW	-

Water supply	Type: domestic, educational institutions, health institutions, livestock, industrial, and commercial	51,225 m^3/s (0.593 m^3/s) out of the ultimate water demand (111,225 m^3/s) in 2035

Source: Soin-Koru Multipurpose Dam, Final Design Report-Volume I

(ii) Location

The Soin-Koru Dam is located approximately 5 km upstream of Mohoroni Town, between Got Alila and Koitatui Hills, on the border of Kericho County and Kisumu County as shown in Figure A3.1.2-8.



Source: JICA Survey Team

Figure A3.1.2-8 Location of Soin-Koru Dam and Intake Site

(iii) Outline of the Embankment Design

- Embankment height: 54 m
- Total embankment volume: 5,635 (1,000 m^3)
- Volume of core zone: 1,002 (1,000 m^3)
- Embankment crest elevation: 1,356 m asl
- Dam gross free board: 5 m
- Full reservoir level: 1,351 m asl
- Dam crest length: 1,354 m
- Dam crest width: 10 m
- Upstream slope: 1:3
- Downstream slope: 1.2
- Live storage: 71.7 mcm

- Spillway design flood return period: 1:1,000
- Spillway design flood: 660 m^3/s

Source: Soin-Koru Multipurpose Dam, Final Design Report-Volume I

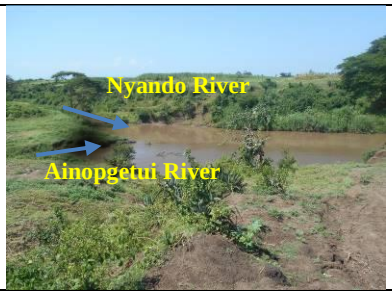
(iv) Progress

According to an interview with NIA, the detailed design is already completed. A land acquisition plan has been prepared, but has not yet been implemented, as of October 2019.

(v) Photographs

New intake site (upper 10 km from the Ahero Irrigation Scheme Pump Station)

Table A3.1.2-7 Photographs of New Intake and Soin-Koru Dam Site

		
Intake site	Confluence of Nyando and Ainopgetui rivers	Intake site

Soin-Koru Dam site

	
Reservoir site	Embankment site

Source: JICA Survey Team

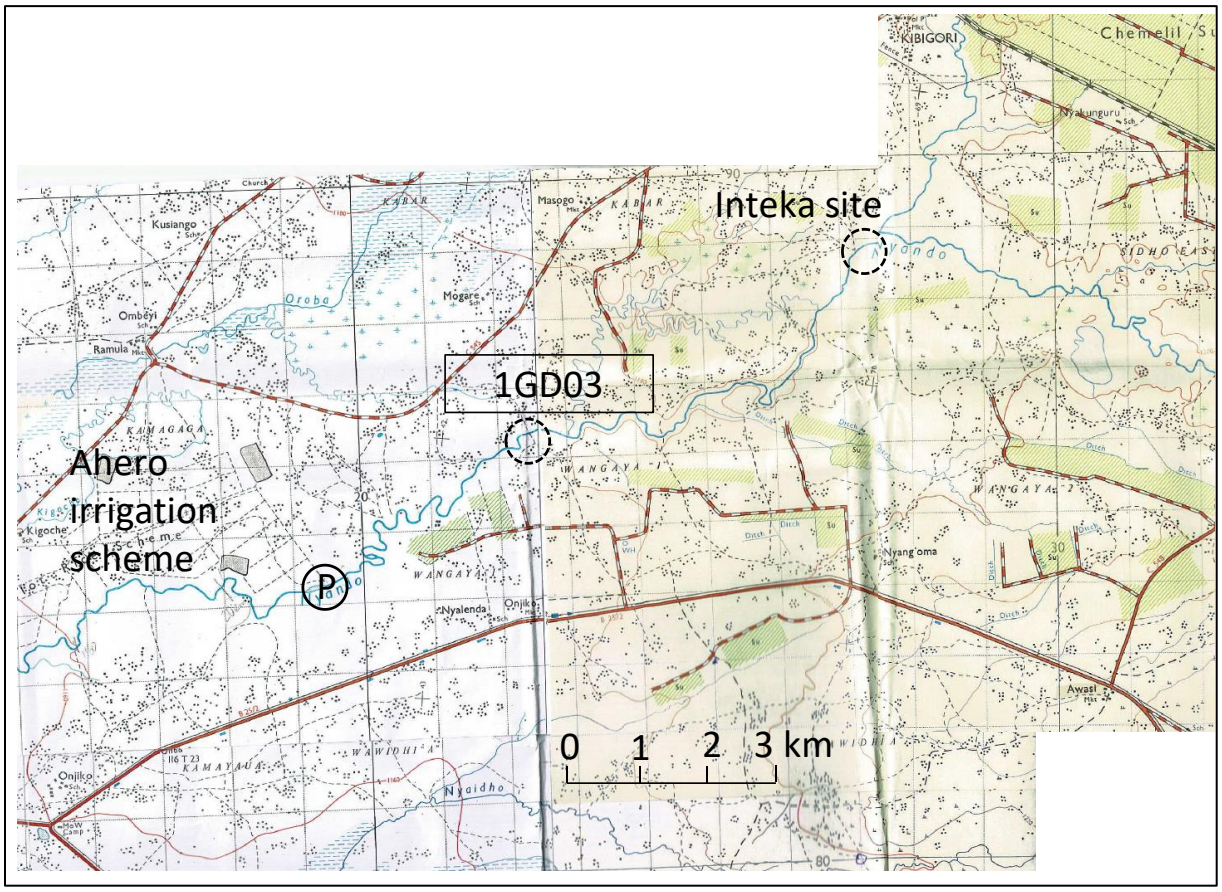
(2) Analysis, Considerations, and Plans

1) Irrigation Plan

(i) Scheme Irrigation Water Availability

River flow:

Irrigation water is planned to be taken from the Nyando River at the existing pump station site. Its water availability at the intake point has been studied in detail and compiled in Table 3-8: Mean Monthly and the 80% Reliability Mean Monthly Flow for Nyando 1GD03 in the report "Detailed Design and Preparatory of Bidding Document for Ahero and West Kano Irrigation Project (Final Design Report) April 2010" and Table 2-2 in the report "Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Schemes Development Project (May, 2013)" as shown in Figure A3.1.2-9. The applied river flow data is shown in the next table.



Source: JICA Survey Team

Figure A3.1.2-9 Location of 1GD03

Effective rainfall:

Results of the effective rainfall data in the report "Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Schemes Development Project (May 2013)" was applied for the water requirement analysis. The applied effective rainfall data is shown in the table below.

Table A3.1.2-8 Mean Monthly, the 80% Reliability Mean Monthly Flow for Nyando 1GD03 and Effective Rainfall

	Mean Monthly Flow [m3/s]	80% (Q80) Mean Monthly flow [m3/s]	Effective Rainfall [mm/month]
Jan	14.10	2.82	59.60
Feb	8.20	1.64	56.40
Mar	10.10	2.02	79.80
Apr	28.30	5.66	126.20
May	37.90	7.58	82.20
Jun	19.00	3.8	51.60
Jul	18.30	3.66	46.00
Aug	23.70	4.74	62.00
Sep	20.50	4.1	46.80
Oct	11.80	2.36	58.80
Nov	12.80	2.56	57.40
Dec	11.80	2.36	41.40

Source: Derived from the report "Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Schemes Development Project (May 2013)".

The data in the above table was applied for water requirement analysis and calculation of water availability in the data collection survey.

In addition to the river water availability data, the conveyance capacity of existing facilities should be taken into consideration in the water requirement analysis. Thus, the following conditions are applied to the calculation:

- Pumping capacity: 1.76 m^3/s (= 1.1 + 0.66)
- Canal conveyance capacity: 1.76 m^3/s (same as the pump capacity)

(ii) Cropping Pattern and Water Requirement Analysis

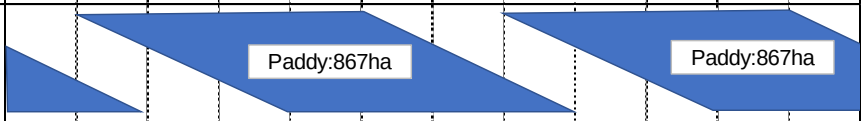
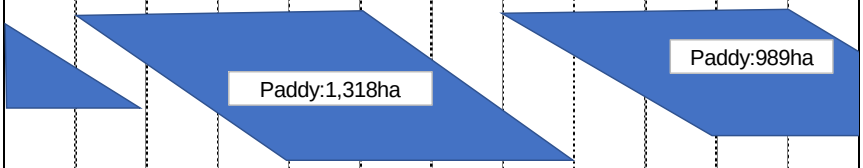
Based on the availability of water, limited conveyance condition due to the existing facilities, climate, and other required considerations, the following two patterns of cropping schedule were formulated.

Pattern-1: Irrigation for the original irrigation area, i.e., 867 ha, of Ahero Irrigation Scheme only. In this case, the irrigation intensity became 200% of paddy with a maximum required water of 1.56 m^3/s in October.

Pattern-2: Utilization of maximum available water, i.e., 1.76 m^3/s, and the expansion of the irrigation area. In this case, the irrigation intensity was calculated as 175% on the irrigation area of 1,318 ha (Ahero: 867 ha + extension 329 ha).

Kc, Eto, and other required coefficients for water requirement analysis were derived from the report "Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction works of Ahero and West Kano Irrigation Project (May 2013)".

The calculation results are summarized in the following figures. The detailed calculation is given in Table B3.1.2-1 and Table B3.1.2-2.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pattern-1 Irrigation area 867ha Crop Intensity:200% Required water (peak): 1.56m3/s@Oct	867ha												
Total Required Flow in Canal	m3/s	0.83	0.62	0.76	0.85	1.37	1.30	0.87	0.56	0.91	1.29	**1.56**	1.38
Total Area - Paddy	ha	578	578	578	867	867	867	578	578	578	867	867	867
River flow Q80	m3/s	2.82	1.64	2.02	5.66	7.58	3.80	3.66	4.74	4.10	2.36	2.56	2.36
Canal design discharge	m3/s	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
Pattern-2 Irrigation area 1318ha (867 + extension329) Crop Intensity:175% Required water (peak): 1.76m3/s@Mar&Oct	1,318ha												
Total Required Flow in Canal	m3/s	0.73	1.39	**1.76**	1.67	1.68	1.30	0.87	0.94	1.56	**1.76**	1.46	1.03
Total Area - Paddy	ha	769	879	1,318	1,318	1,318	879	769	659	989	989	989	659
River flow Q80	m3/s	2.82	1.64	2.02	5.66	7.58	3.80	3.66	4.74	4.10	2.36	2.56	2.36
Canal design discharge	m3/s	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76

Source: JICA Survey Team

Figure A3.1.2-10 Cropping Pattern in the Ahero Irrigation Scheme

2) Rehabilitation of Irrigation Facilities

The functions of existing facilities including the pump station and main canal are declining due to the operation period of nearly 50 years. Those facilities need to be rehabilitated.

3) Extension Plan

It is difficult to implement the extension plan in the lower part of the Ahero Irrigation Scheme as of October 2019 because water resources for irrigation is limited without the dam construction (Soin-Koru Dam).

4) Soin-Koru Dam Construction Plan

The Soin-Koru Dam was planned by the National Water Harvesting Agency (NWHA). The detailed design of Soin-Koru Dam is already completed. The land acquisition plan has not yet been implemented and the construction plan has not yet been decided. The implementation schedule of the Soin-Koru Dam is not clear. The progress of land acquisition and implementation of the Soin-Koru Dam should be surveyed in the next study.

5) Comparison of Pump and Gravity Irrigation System (Existing Scheme)

(i) Purpose

Irrigation water of the Ahero Irrigation Scheme is pumping from the Nyando River. This scheme was developed in 1969, suspended due to trouble of the pumps in 1999, and restarted after the repair of pumps in 2005. The pump operation cost is the issue for NIA and the farmers. The reduction of the pump operation cost and the possibility of using gravity irrigation were studied.

(ii) Options and Evaluation

Below four options are compared.

Option 1-1 : Simple rehabilitation by replacing existing pumps

Option 1-2 : Reduction of pump operation cost by introducing a solar panel system

Option 2-1 : Introduction of gravity irrigation system by constructing new headworks (H=5.5 m) at the upper 10 km from the pump station and a new conveyance canal. Use of the conveyance canal after the Soin-Koru Dam construction.

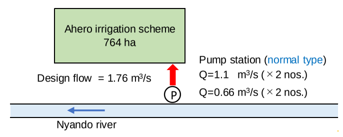
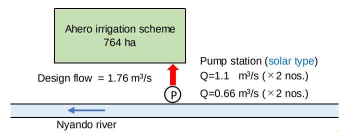
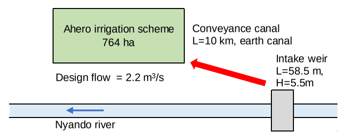
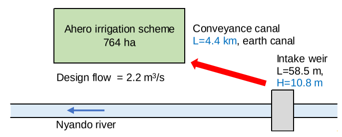
Option 2-2 : Introduction of gravity irrigation system by constructing new headworks (H=10.8 m) at the upper 4.4 km from the pump station and new conveyance canal. Use of the conveyance canal after the Soin-Koru Dam construction.

In the results, Option 1-2 is selected in view of an economical point. The solar panel system might be advanced in the future to realize a lower cost. The gravity system is not economical in the view of initial cost but the operation and maintenance costs are lower.

As shown in Table A3.1.2-8, if only the Ahero irrigation area is targeted, the gravity irrigation is less economical than the pump irrigation. Selection of the gravity irrigation depends on the implementation of the Soin-Koru Dam construction and the Ahero expansion. If the construction of the Soin-Koru Dam and Ahero extension are certain, the gravity irrigation will be adopted according to the expansion plan. At present time, although the design of Soin-Koru Dam has been completed, land acquisition has not yet started. The dam construction is unclear. According to the standard of Kenya, the life cycle time of the pump is 15 years. If the dam construction and Ahero Expansion Project can be implemented within 15 years, the gravity irrigation will be adopted. If this is not feasible, then the pump irrigation will be continued. Detailed calculation is given in Table B3.1.2-3 to Table B3.1.2-8.

Solar technology has made remarkable progress in recent years. The system of buying and selling electricity generated by solar will be developed in the future. The technology and the system should be explored in the next study.

Table 3.1.2-9 Comparison of Pump and Gravity Irrigation System for Rehabilitation Plan

Option	Option 1-1 Pump irrigation system (normal type)	Option 1-2 Pump irrigation system (solar type)	Option 2-1 Gravity irrigation system (10 km)	Option 2-2 Gravity irrigation system (4.4 km)
Diagram				
Irrigation area	764 ha [1]	764 ha [1]	764 ha [1]	764 ha [1]
Water resources	Nyando River	Nyando River	Nyando River	Nyando River
Design flow	1.76 m^3/s [2]	1.76 m^3/s [2]	2.2 m^3/s [2]	2.2 m^3/s [2]
Facilities [3]	Rehabilitation: -Pump (Q=1.1 m^3/s); 2 nos. -Pump (Q=0.66 m^3/s); 2 nos.	Rehabilitation: -Pump (Q=1.1 m^3/s); 2 nos. -Pump (Q=0.66 m^3/s); 2 nos. New construction: -Solar system	New construction: -Weir; L=58.5 m, H=5.5 m -Conveyance canal; Q=2.2 m^3/s, L=10 km, earth canal	New construction: -Weir; L=58.5 m, H=10.8 m -Conveyance canal; Q=2.2 m^3/s, L= km, earth canal
Maintenance	Pump repair	Pump repair and solar system	Weir and conveyance canal	Weir and conveyance canal
Operation	Pump electricity	Pump electricity	-	-
Direct cost (30 years)	Ksh 740 million	Ksh 559 million	Ksh 1,296 million	Ksh 1,571 million
Break down				
Initial cost	Ksh 200 million	Ksh 280 million	Ksh 996 million	Ksh 1,208
O&M cost	Ksh 540 million	Ksh 279 million	Ksh 300 million	Ksh 363
Evaluation	-	**Better**	-	-

Remarks
1): Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, p.12-3 (D/D Report for Ahero and West Kano)
2): Maximum pumping up quantity: 1.1+0.66 = 1.76 m^3/s, Option 2: 1.76/0.80=2.2 m^3/s (20% conveyance loss)
3): Prepared by the JICA Survey Team based on the D/D Report for Ahero and West Kano
4): Nyando River slope=1/575 (based on the topo map), distance=10-4.4=5.6 km, h=5,600/575=9.8 m, drops in total=4.5 m, net h=9.8-4.5=5.3 m, finally weir H=5.5+5.3=10.8 m

Source: JICA Survey Team

6) Comparison of Pump and Gravity Irrigation System (Expansion Plan)

(i) Purpose

According to the extension plan prepared by NIA, the irrigation is based on a gravity system. In case of the extension, the pump irrigation system and the gravity irrigation system are compared and evaluated.

(ii) Options and Evaluation

Below four options are compared.

Option 1-1 : Simple rehabilitation by replacing existing pumps

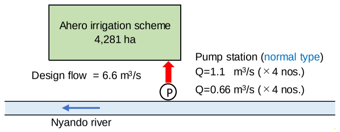
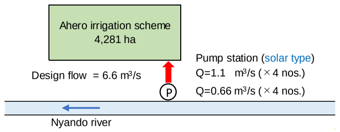
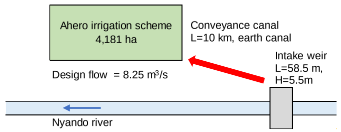
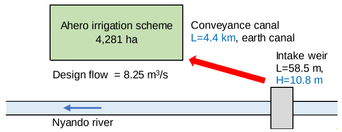
Option 1-2 : Reduction of pump operation cost by introducing a solar panel system

Option 2-1 : Introduction of gravity irrigation system by constructing new headworks (H=5.5 m) at the upper 10 km from the pump station and a new conveyance canal.

Option 2-2 : Introduction of gravity irrigation system by constructing new headworks (H=10.8 m) at the upper 4.4 km from the pump station and a new conveyance canal.

As shown in Table 3.1.2-10, Option 2-2 is selected in view of an economical point. In the future, the location of the headworks should be studied regarding detailed conditions of the intake water level, Nyado River channel, soil mechanic, etc. Detailed calculations are given in Table B3.1.2-9 to Table B3.1.2-13.

Table 3.1.2-10 Comparison of Pump and Gravity Irrigation System for Extension Plan

Option	Option 1-1 Pump irrigation system (normal type)	Option 1-2 Pump irrigation system (solar type)	Option 2-1 Gravity irrigation system (10 km)	Option 2-2 Gravity irrigation system (4.4 km)
Diagram				
Irrigation area	4,178 ha [1)]	4,178 ha [1)]	4,178 ha [1)]	4,178 ha [1)]
Water resources	Nyando River	Nyando River	Nyando River	Nyando River
Design flow	6.6 m^3/s [2)]	6.6 m^3/s [2)]	6.6 m^3/s [2)]	6.6 m^3/s [2)]
Facilities [3)]	Rehabilitation: -Pump (Q=1.1 m^3/s); 8 nos. -Pump (Q=0.66 m^3/s); 8 nos.	Rehabilitation: -Pump (Q=1.1 m^3/s); 8 nos. -Pump (Q=0.66 m^3/s); 8 nos. New construction: -Solar system	New construction: -Weir; L=58.5 m, H=5.5 m -Conveyance canal; Q=6.6 m^3/s, L=10 km, earth canal	New construction: -Weir; L=58.5 m, H=10.8 m -Conveyance canal; Q=6.6 m^3/s, L=4.4 km, earth canal
Maintenance	Pump repair	Pump repair and solar system	Weir and conveyance canal	Weir and conveyance canal
Operation	Pump electricity	Pump electricity	-	-
Direct cost (30 years)	Ksh 2,966 million	Ksh 2,236 million	Ksh 2,585 million	Ksh 2,137 million
Break down				
Initial cost	Ksh 800 million	Ksh 1,120 million	Ksh 1,988 million	Ksh 1,645 million
O&M cost	Ksh 2,166 million	Ksh 1,116 million	Ksh 597 million	Ksh 492 million
Evaluation	-	-	-	**Better**

Remarks

1): Ahero (764 ha) + Extension (3,414 ha) = 4,178 ha

2): Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project (D/D Report)

3): Prepared by the JICA Survey Team based on the D/D Report for Ahero and West Kano

4): Nyando River slope=1/575 (based on the topo map), distance=10-4.4=5.6 km, h=5,600/575=9.8 m, drops in total=4.5 m, net h=9.8-4.5=5.3 m, finally weir H=5.5+5.3=10.8 m

Source: JICA Survey Team

7) Evaluation of Pump Operation

The irrigation water demand and water supply in 2018 were evaluated. The irrigation water supply as a single paddy cropping is the actual operation data in 2018. The total amount is 17,036,1,000) m^3. The water demand is estimated by the standard cropping pattern as shown in Table A3.1.2-11. The total amount is 14,186,000 m^3. The balance is 2,850,000 m^3. The unit cost of pumping irrigation water is Ksh 0.252/m^3 based on the December 2017 records. The total cost of balance is Ksh 718,200. If the operation of the pumps followed the abovementioned cropping pattern, an amount of Ksh 0.72 million/year may be saved.

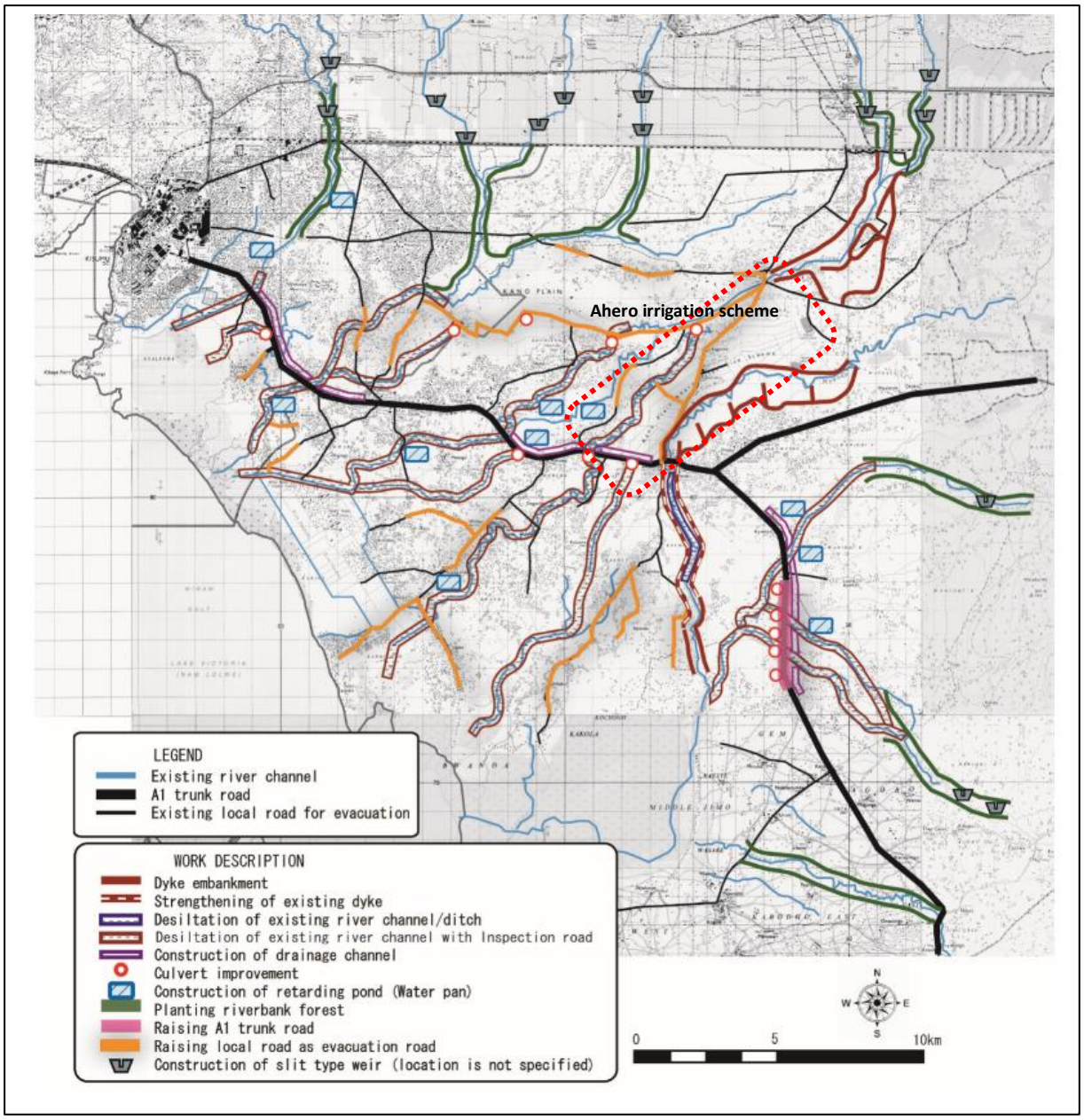
Table A3.1.2-11 Water Requirement Calculation (Ahero Irrigation Scheme in 2018)

Condition: Planting period-3months		1.10	1.10	1.15	0.95	<= Kc (paddy)							
Crop: Paddy only													
PADDY Area1		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc				**1.10**	**1.10**	**1.15**	**0.95**						
Crop water need (Eto*Kc)	mm/day	0.00	0.00	5.58	5.50	5.68	4.63	0.00	0.00	0.00	0.00	0.00	0.00
	mm/month	0.00	0.00	172.89	165.00	176.11	138.80	0.00	0.00	0.00	0.00	0.00	0.00
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
PERC	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment requirement	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	59.5	61.7	189.3	277.7	187	54.3	34.3	36.9	38.7	165.4	121.6	136.4
Effective Rain	mm/month	38.1	39.5	121.2	177.7	119.7	34.8	22	23.6	24.8	105.9	77.8	87.3
Irrigation water Need IN	mm/month	0.00	110.50	241.69	77.30	146.41	194.00	0.00	126.40	165.20	0.00	12.20	2.70
Irrigation water Need IN	mm/day	0.00	3.95	7.80	2.58	4.72	6.47	0.00	4.08	5.51	0.00	0.41	0.09
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	7.89	15.59	5.15	9.45	12.93	0.00	8.15	11.01	0.00	0.81	0.17
Flow (unit water req)	l/s/ha	0.00	0.91	1.80	0.60	1.09	1.50	0.00	0.94	1.27	0.00	0.09	0.02
Area	**ha**	**0**	**289**	**289**	**289**	**289**	**289**	**0**					
Flow in Canal	l/s	0	264	522	172	316	433	0	0	0	0	0	0
Flow in Canal	**m3/s**	**0.00**	**0.26**	**0.52**	**0.17**	**0.32**	**0.43**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
PADDY Area2		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		**0.00**			**1.10**	**1.10**	**1.15**	**0.95**			**0.00**	**0.00**	**0.00**
Crop water need (Eto*Kc)	mm/day	0.00	0.00	0.00	5.50	5.43	5.60	4.60	0.00	0.00	0.00	0.00	0.00
	mm/month	0.00	0.00	0.00	165.00	168.45	168.02	142.54	0.00	0.00	0.00	0.00	0.00
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	0	0	0	0
PERC	mm/month	0	0	0	90	90	90	90	0	0	0	0	0
WL establishment requirement	mm	0	0	0	100	0	0	0	0	0	0	0	0
Rainfall	mm/month	59.5	61.7	189.3	277.7	187	54.3	34.3	36.9	38.7	165.4	121.6	136.4
Effective Rain	mm/month	38.1	39.5	121.2	177.7	119.7	34.8	22	23.6	24.8	105.9	77.8	87.3
Irrigation water Need IN	mm/month	0.00	0.00	28.80	177.30	138.75	223.22	210.54	0.00	0.00	0.00	0.00	0.00
Irrigation water Need IN	mm/day	0.00	0.00	0.93	5.91	4.48	7.44	6.79	0.00	0.00	0.00	0.00	0.00
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	0.00	1.86	11.82	8.95	14.88	13.58	0.00	0.00	0.00	0.00	0.00
Flow (unit water req)	l/s/ha	0.00	0.00	0.22	1.37	1.04	1.72	1.57	0.00	0.00	0.00	0.00	0.00
Area	**ha**	**0**	**0**	**289**	**289**	**289**	**289**	**289**	**0**	**0**	**0**	**0**	**0**
Flow in Canal	l/s	0	0	62	395	300	498	454	0	0	0	0	0
Flow in Canal	**m3/s**	**0.00**	**0.00**	**0.06**	**0.40**	**0.30**	**0.50**	**0.45**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
PADDY Area3		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		**0.00**	**0.00**			**1.10**	**1.10**	**1.15**	**0.95**			**0.00**	**0.00**
Crop water need (Eto*Kc)	mm/day	0.00	0.00	0.00	0.00	5.43	5.36	5.57	4.64	0.00	0.00	0.00	0.00
	mm/month	0.00	0.00	0.00	0.00	168.45	160.71	172.55	143.72	0.00	0.00	0.00	0.00
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	0	0	0
PERC	mm/month	0	0	0	0	90	90	90	90	0	0	0	0
WL establishment requirement	mm	0	0	0	0	100	0	0	0	0	0	0	0
Rainfall	mm/month	59.5	61.7	189.3	277.7	187	54.3	34.3	36.9	38.7	165.4	121.6	136.4
Effective Rain	mm/month	38.1	39.5	121.2	177.7	119.7	34.8	22	23.6	24.8	105.9	77.8	87.3
Irrigation water Need IN	mm/month	0.00	0.00	0.00	0.00	238.75	215.91	240.55	210.12	0.00	0.00	0.00	0.00
Irrigation water Need IN	mm/day	0.00	0.00	0.00	0.00	7.70	7.20	7.76	6.78	0.00	0.00	0.00	0.00
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	0.00	0.00	0.00	15.40	14.39	15.52	13.56	0.00	0.00	0.00	0.00
Flow (unit water req)	l/s/ha	0.00	0.00	0.00	0.00	1.78	1.67	1.80	1.57	0.00	0.00	0.00	0.00
Area	**ha**	**0**	**0**	**0**	**289**	**289**	**289**	**289**	**289**	**0**	**0**	**0**	**0**
Flow in Canal	l/s	0	0	0	0	515	482	519	454	0	0	0	0
Flow in Canal	**m3/s**	**0.00**	**0.00**	**0.00**	**0.00**	**0.52**	**0.48**	**0.52**	**0.45**	**0.00**	**0.00**	**0.00**	**0.00**
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Total Flow in Canal Paddy only	m3/s	0.00	0.26	0.58	0.57	1.13	1.41	0.97	0.45	0.00	0.00	**0.00**	0.00
Total Area - Paddy	**ha**	**0**	**289**	**578**	**867**	**867**	**867**	**578**	**289**	**0**	**0**	**0**	**0**
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	**2.82**	**1.64**	**2.02**	**5.66**	**7.58**	**3.8**	**3.66**	**4.74**	**4.1**	**2.36**	**2.56**	**2.36**
Canal design discharge	m3/s	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**	**1.76**
Required volume of water	m3/month	**0**	**638,837**	**1,563,776**	**1,471,927**	**3,028,950**	**3,660,278**	**2,607,867**	**1,214,751**	**0**	**0**	**0**	**0**
												Total(m3/year)	**14,186,386**

Source: JICA Survey Team

8) Flood Countermeasures

According to the flood control plan of the Nyando River, a flood dyke along the Nyando River in the Ahero Irrigation Scheme will be developed as shown in Figure A3.1.2-11. After the implementation of the plan, flood conditions in and around the scheme will be improved. The scheme is developed in accordance with the plan. A dyke construction on the right bank of the Nyando River is included in the scheme.



Source: The Study on Integrated Flood Management for the Nyando River Basin in the Republic of Kenya, Final Report (March 2009)

Figure A3.1.2-11 Flood Control Plan of the Nyando River

3.1.3 West Kano Irrigation Scheme

(1) Current Conditions

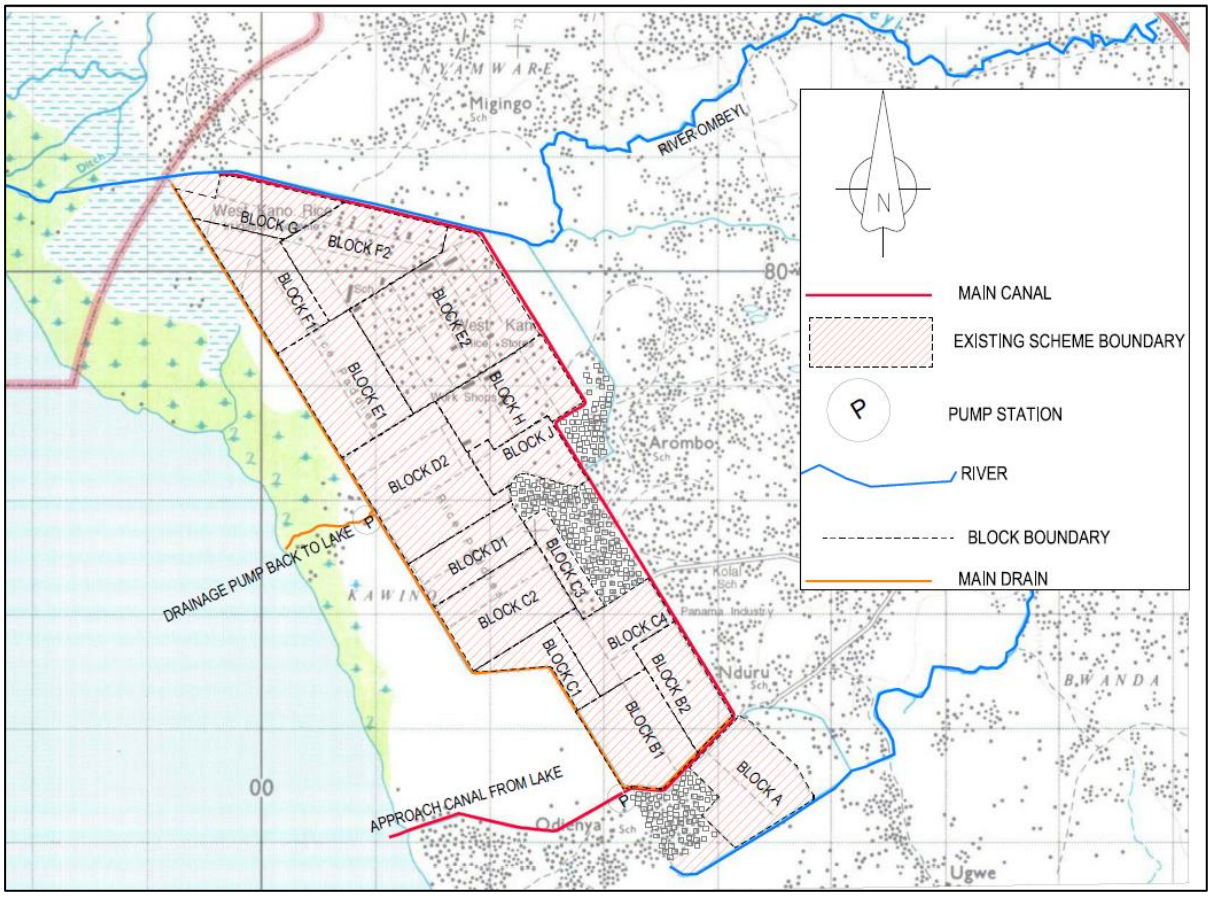
1) Outline

(i) Brief History of Development

The West Kano Irrigation Scheme is located along the Lake Victoria as shown in Table A3.1.3-1. This scheme was started in 1974 and operated in 1976. The main crop of the scheme is paddy. This irrigated area is 892 ha and beneficiaries are 780 households. The average farmland per farmer is 4

acres (1.6 ha). The irrigation and drain systems are both of a pumping type. In addition, both irrigation and drain water resources comes from the Lake Victoria.

Farming activities of this scheme were suspended from 1999 to 2003. Initially three irrigation pumps (each 0.75 m^3/s) and five drain pumps were installed. Farmers have paid Ksh 3,640 /acre/season to NIA for pump operation charge and maintenance.



Source: JICA Survey Team

Figure A3.1.3-1 Location Map of West Kano Irrigation Scheme

(ii) Summary

Summary of West Kano Irrigation Scheme is shown in Table A3.1.3-1.

Table A3.1.3-1 Outline of West Kano Irrigation Scheme

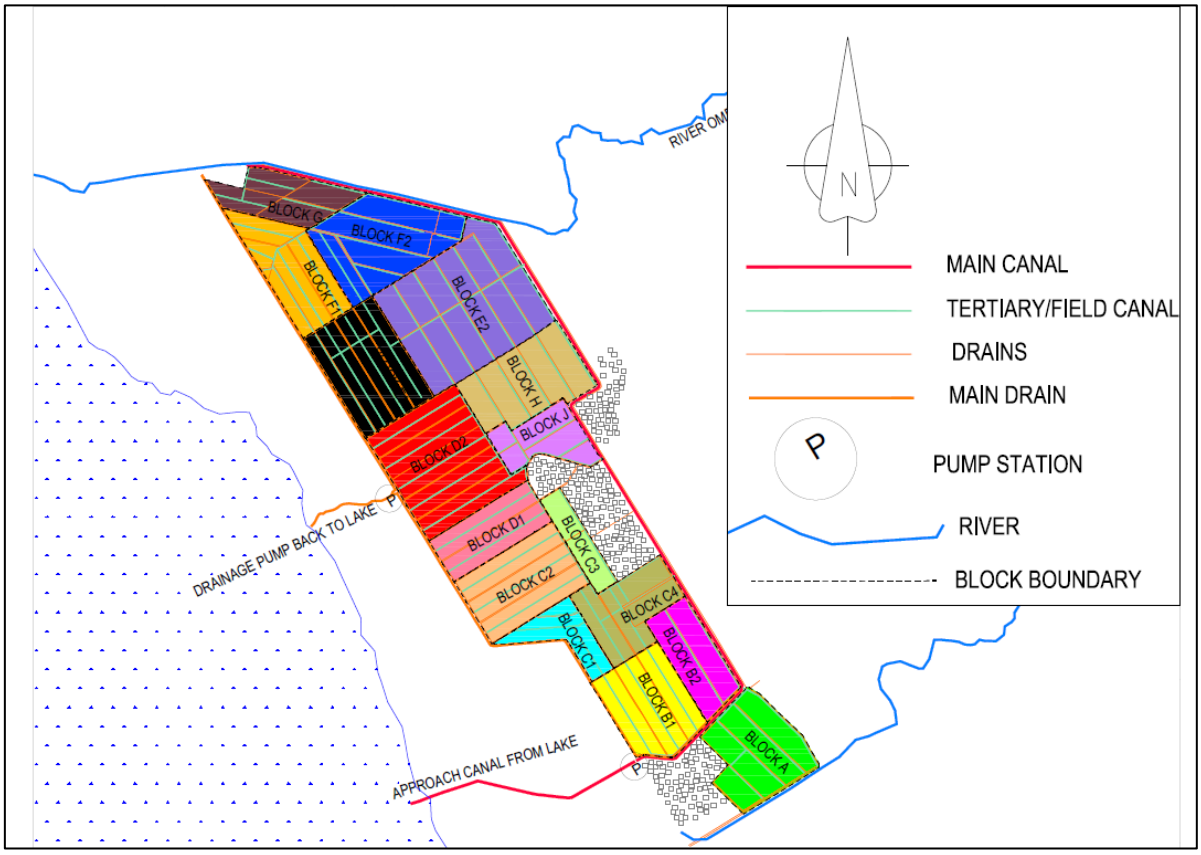
Items	Description
Implementation body	NIA West Kano
County	Kisumu
Location	In the Kano Plains between Nandi escarpment and Nyabondo plateau on the shore of Lake Victoria
Access	Nairobi to Kisumu by air: 1 hour and Kisumu to West Kano by road: 1 hour
Type of project	Rehabilitation
Construction/ operation	1974/1976
No. of farmers	780 households, 2,200 persons
Irrigated area	892 ha

Farm size per harmer	4 acres (1.6 ha)
Irrigation system	Pumping
Source of irrigation water	Lake Victoria
No. of pumps of irrigation	3 nos.
Pump capacity of irrigation	Each 0.75 m^3/s (three pumps in total, one pump of these: reserve)
Drainage system	Pumping
Source of drainage water	Lake Victoria
No. of pumps of drainage	4 nos.
Pump capacity of drainage	0.13 m^3/s (two pumps) and 0.5 m^3/s (two pumps)
No. of dependant	Approx. 20,000
Cultivated crop	Paddy
Variety grown	Basmati 370 variety etc.
Average yield	3.5 t/ha
O&M	NIA West Kano
Water charge	Main crop: Ksh 3,640/acre/season, minor crop: Ksh 2,000/acre/season

Source: JICA Survey Team

2) Irrigation Blocks

Irrigation area of the Wes Kano Irrigation Scheme is divided into 16 irrigation blocks as shown in Figure A3.1.3-2.



Source: JICA Survey Team

Figure A3.1.3-2 Irrigation Block of West Kano Irrigation Scheme

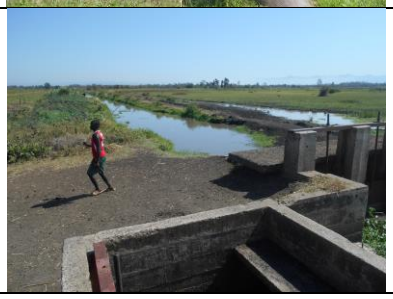
3) Water Rights of the Lake Victoria

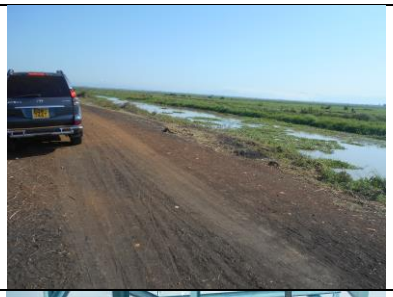
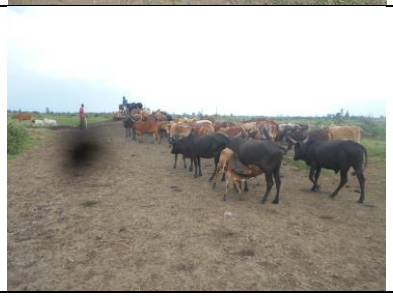
Water resources of the West Kano Irrigation Scheme come from Lake Victoria. The area of Lake Victoria is 68,800 km^2 and the catchment area extends to 184,000 km^2. The Nile River only flows out from the Lake Victoria at Jinja in Uganda. Related countries manage the water resources of the Lake Victoria. Ten countries, including Kenya, established the Nile Basin Initiative (NBI). According to the regulations of NBI, there is a restriction in using the water flowing out of Lake Victoria. On the other hand, there is no restriction to use the resources of Lake Victoria and the rivers flowing into the lake. Therefore, four target schemes including the West Kano Irrigation Scheme adopted the regulations (water rights) of Kenya to use the water resources of Lake Victoria and other rivers.

4) Existing Facilities

Facilities of the scheme consist of an approach canal, an irrigation pump station, irrigation canals, a drain pump station, and drainage canals. Those facilities are of low efficiency and need to be rehabilitated as shown in Table A3.1.3-2. The operation cost of irrigation and drain pumps is high and is paid by NIA. Irrigation canals and drainage canals are eroded. Additionally, the main problem of the scheme is the accumulation of a lot of water weeds that affect water quality. In case of rehabilitation, removing the weeds from canals should be considered. (For example; installation of screen, approach roads to bed of canals, inspection reads, etc.)

Table A3.1.3-2 Existing Conditions of West Kano Irrigation Scheme

Approach canal from Lake Victoria			L = 2.2 km
Irrigation pump station			Pump: Q = 0.75 m^3/s * 3 nos.
Irrigation canal			Main canal: L = 8.7 km Tertiary canal: L = 55.5 km

Drainage canal			Main drainage: L = 9.1 km, Tertiary drainage: L = 10.5 km
Drain pump station			Pump: 0.13 m^3/s * 2 nos. and 0.5 m^3/s*2 nos.
Farm road			L = 70 km

Source: JICA Survey Team

5) Pump Operation and Cost

\The operation cost of irrigation and drain pumps was approximately KES 7.2 million as shown in Table A3.1.3-3. NIA paid all the operation costs (Ksh 7.2 million), while NIA and farmers paid the maintenance cost.

Table A3.1.3-3 Operation Cost of West Kano Irrigation Scheme

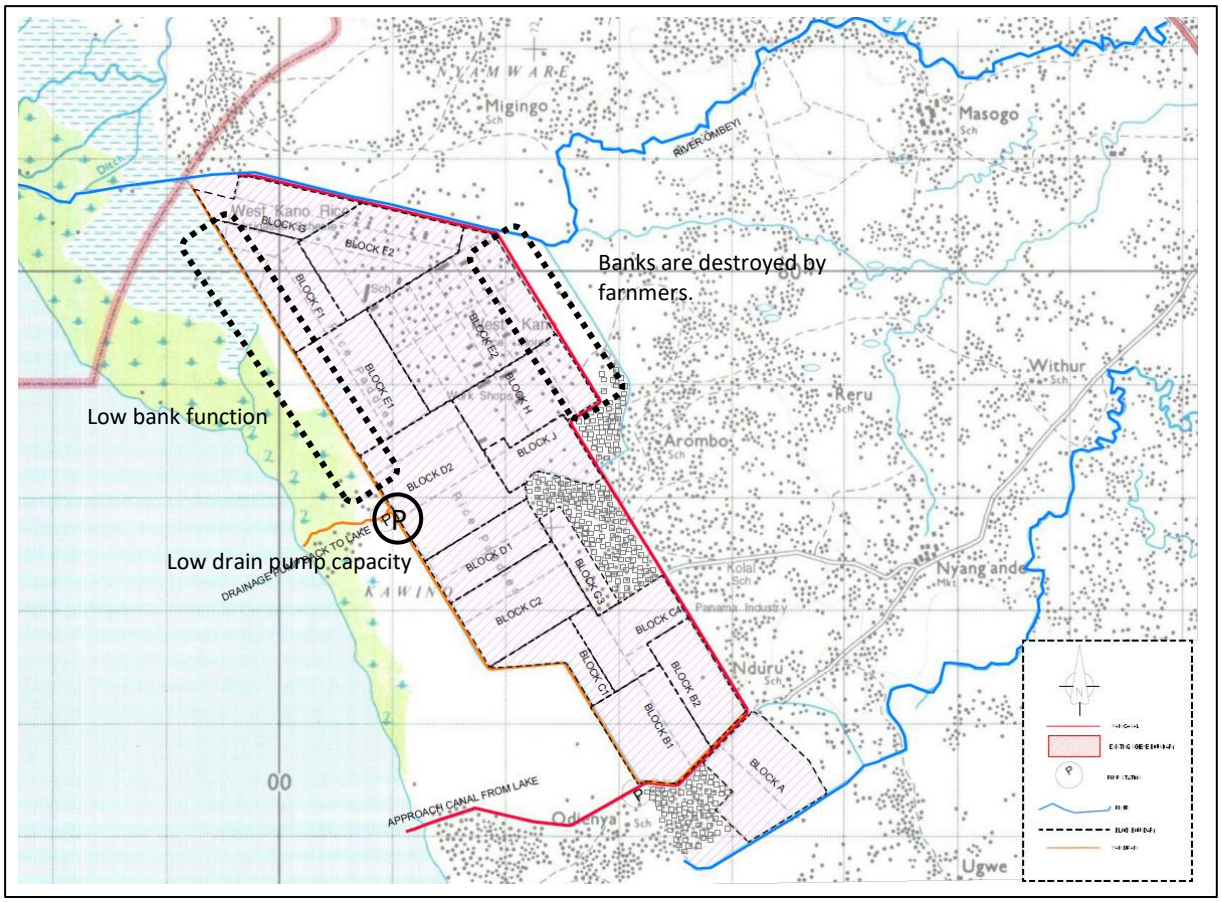
(irrigation and drain)

Month	Amount (Ksh)
Dec-16	859,434
Jan-17	562,321
Feb-17	461,902
Mar-17	478,540
Apr-17	485,701
May-17	373,093
Jun-17	403,038
Jul-17	675,090
Aug-17	734,566
Sep-17	1,024,504
Oct-17	N/A
Nov-17	1,172,155
Total	7,230,344

Source: NIA

6) Flood Damage

The West Kano Irrigation Scheme is surrounded by dykes as shown in Figure A3.1.3-3. Water gets over the dykes from the Lake Victoria in case of the rising water level of Lake Victoria due to the subsidence of the dykes. Drain water is not sufficiently drained from the command areas due to inefficient drain pumps. Upper dykes are destroyed to avoid flood damage of properties of farmers who lived in the upper villages.



Source: JICA Survey Team

Figure A3.1.3-3 Flood Conditions in the West Kano Irrigation Scheme

(2) Analysis, Considerations, and Plans

1) Irrigation Plan

(i) Scheme Irrigation Water Availability

Irrigation water is planned to be taken from Victoria Lake at the existing pump station site. Consequently, there is no any limitation of water availability in this scheme. Since the West Kano Irrigation Scheme is located very near the Ahero Irrigation Scheme, the effective rainfall data of the Ahero Irrigation Scheme was applied in the analysis for the West Kano Irrigation Scheme.

The conveyance capacity of the existing facilities, however, should be taken into consideration in the water requirement analysis. The following conditions were applied to the calculation:

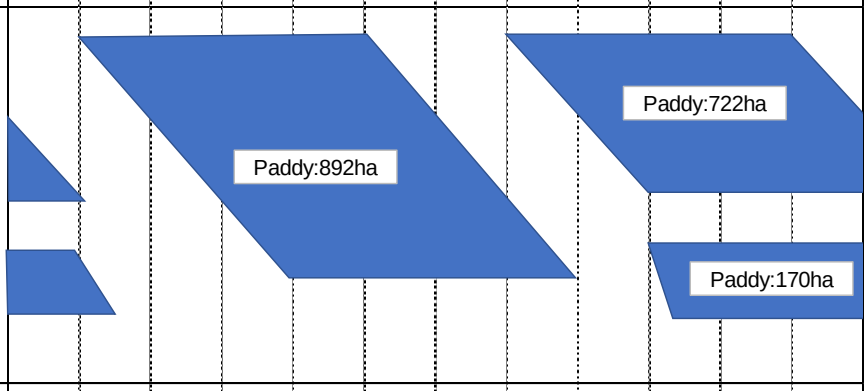
- Pumping capacity: 1.50 m^3/s (0.75 x 2 nos)
- Canal conveyance capacity: 1.50 m^3/s (same as the pump capacity)

(ii) Cropping Pattern

Based on the water availability, limited conveyance condition due to the existing facilities, climate, and other required considerations, the following pattern of cropping schedule was formulated.

Kc, Eto, and other required coefficients for water requirement analysis were derived from the report "Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Project (May 2013)".

The calculation results are summarized in the following figures. The detailed calculation is given in Table B3.1.3-1.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Irrigation area 892ha Crop Intensity:200% Required water (peak): 1.50m3/s@Nov	892ha												
Total Required Flow in Canal	m3/s	0.74	0.46	0.78	0.88	1.41	1.34	0.89	0.62	1.14	1.48	**1.50**	1.41
Total Area	ha	531	467	595	892	892	892	595	658	722	892	892	892
Canal design discharge	m3/s	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

Source: JICA Survey Team

Figure A3.1.3-4 Cropping Pattern in Ahero Irrigation Scheme

2) Rehabilitation of Irrigation Facilities

The functions of existing facilities including the irrigation, drain pump stations, and the main and drain canal are declining due to continuous operation for the past 40 years. Those facilities need to be rehabilitated.

3) Introduction of a Solar Panel System for Pump Operation

Both of the irrigation and drain water in the scheme depend on a pumping system. The operation cost was more than Ksh 7 million in 2017. The solar panel system is proposed to reduce the pump operation cost.

4) Flood Countermeasures

(i) Flood Damage

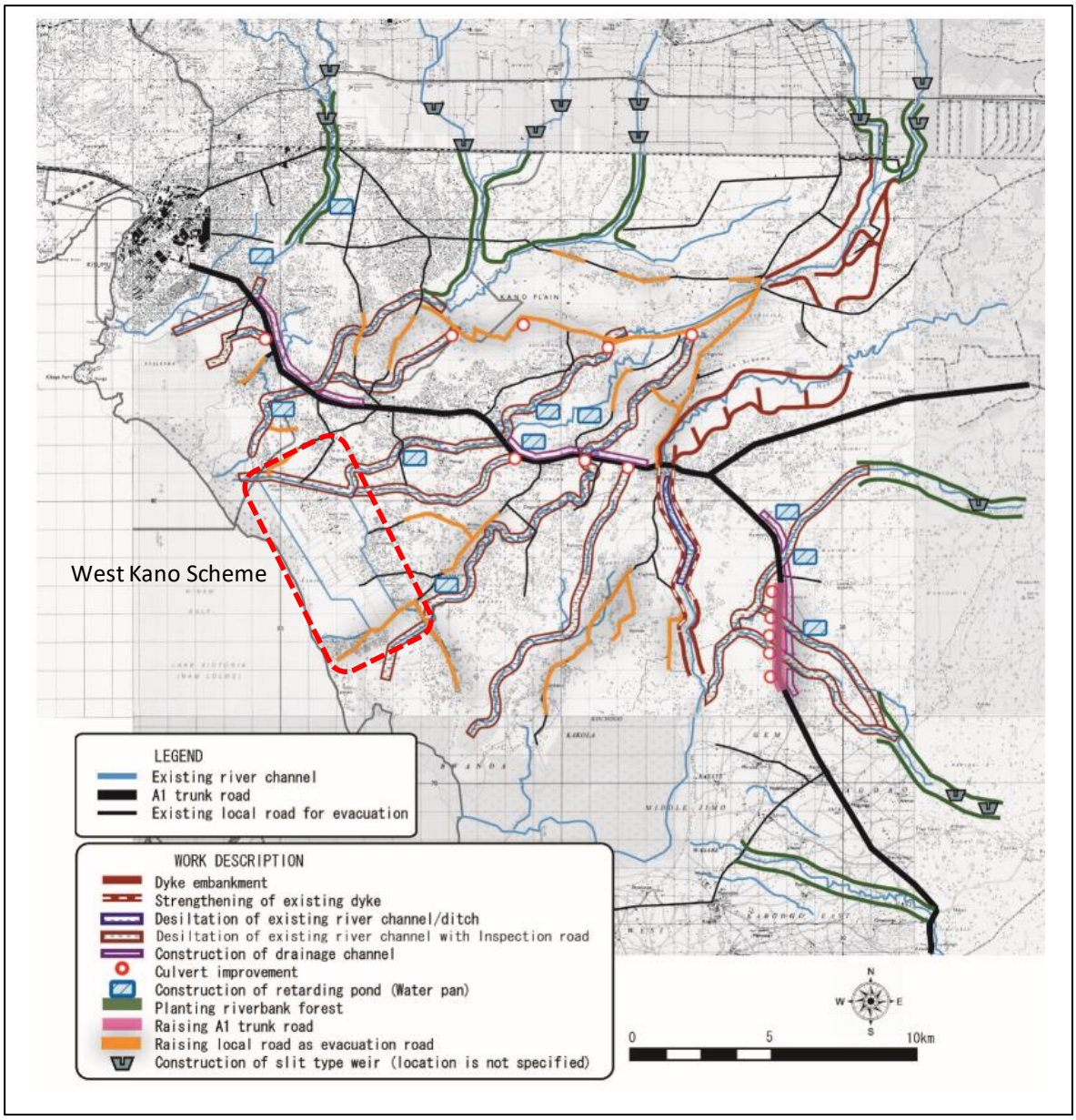
The drain system of the West Kano Irrigation Scheme is a pumping type. Initially, four drain pumps (0.13 m^3/s: 2 nos. and 0.5 m^3/s: 2 nos.) were installed. Now only one pump is under operation and the other three pumps are not functioning. Additionally, the villagers of the upper side of the scheme destroy the dykes to avoid flood damage to their properties.

The scheme is located in the lower areas along Lake Victoria. The command areas below 1,135 m must be submerged by water from Lake Victoria due to the leakage of the dykes and natural drain gates at the drain pump station.

Therefore, the flood damage is caused by the inefficiency of drain facilities and the water level of Lake Victoria.

(ii) Flood Control Plan of the Nyando River

According to the flood control plan of the Nyando River, road improvement of the southwest side in the scheme for dykes and dredging of the Ombeyi River are planned as shown in Figure A3.1.3-5. The flood damage in and around the scheme will be improved. However, specific issues of the scheme should be improved as a part of this development plan.



Source: The Study on Integrated Flood Management in the Nyando River Basin in the Republic of Kenya (March 2009)

Figure A3.1.3-5 Nyando River Flood Control Plan

(iii) Analysis of Water Level of Lake Victoria

- Point

The measuring point of water level is located at Kisumu Airport as shown in Figure 3.1.3-6.

Figure 3.1.3-6 Measuring Gauge of Water Level of the Lake Victoria

- Period

The water level data was obtained from the Water Resource Authority, Lake Victoria South Catchment Area (WRA LVSCA). The period of the available data is from October 1, 1964 to August 30, 2014. There is no data due to the malfunctioning of the measuring devices after August 31, 2014.

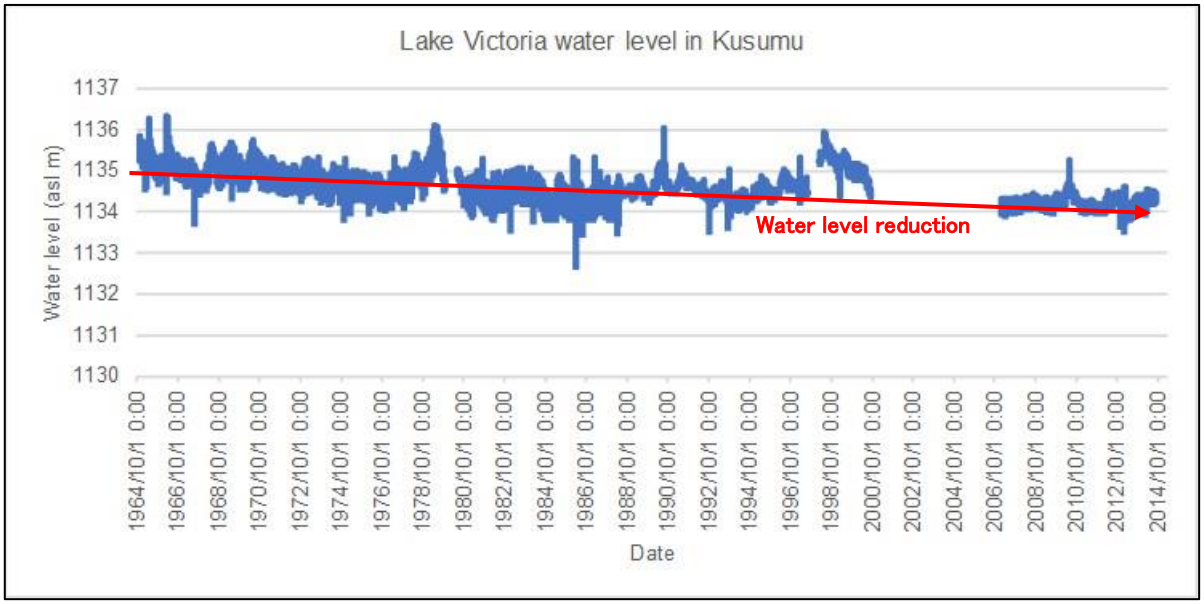
- Correction of Data

There was a difference between the water level collected from WRA LVSCA and topographic data prepared by the JICA Survey Team. Both data were corrected based on the elevation of a known point.

(iv) Fluctuation of Water Level at Lake Victoria

- Trend of Long Term

The water level of Lake Victoria has a decreasing trend as shown in Figure A3.1.3-7. The average water level from October 1, 1964 to December 31, 1960 is 1,135.11 m. The average water level from January 1, 2010 to August 30, 2014 is 1134.22 m. The difference between the two water levels is 0.89 m (reduction).

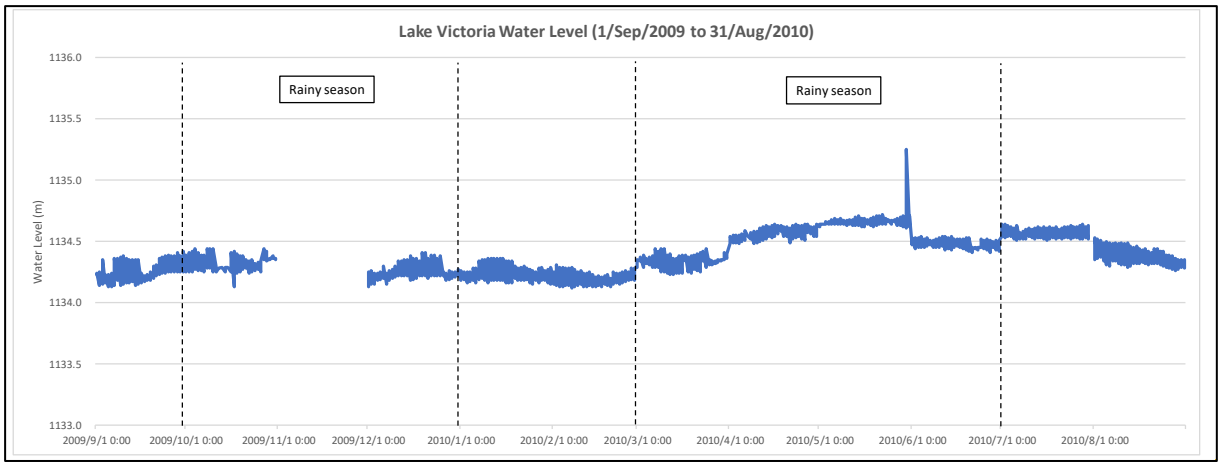


Source: JICA Survey Team

Figure A3.1.3-7 Fluctuation of Lake Victoria Water Level (Oct 1964 to Oct 2014)

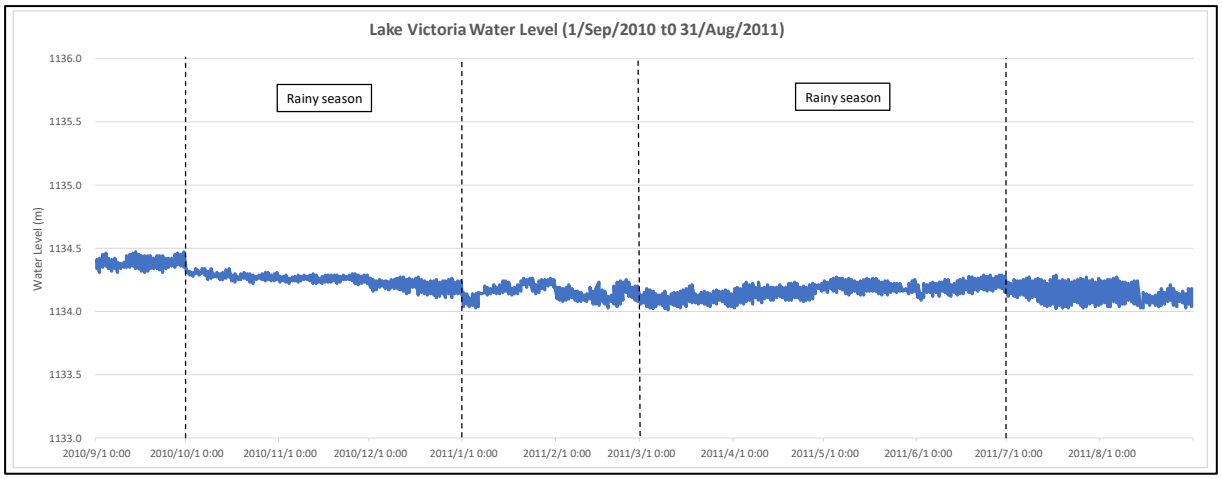
- Yearly Fluctuation

Water level of Lake Vitoria during the last five years gradually fluctuated between 1,134 m and 1,135 m as shown in Figure A3.1.3-8 to A3.1.3-12



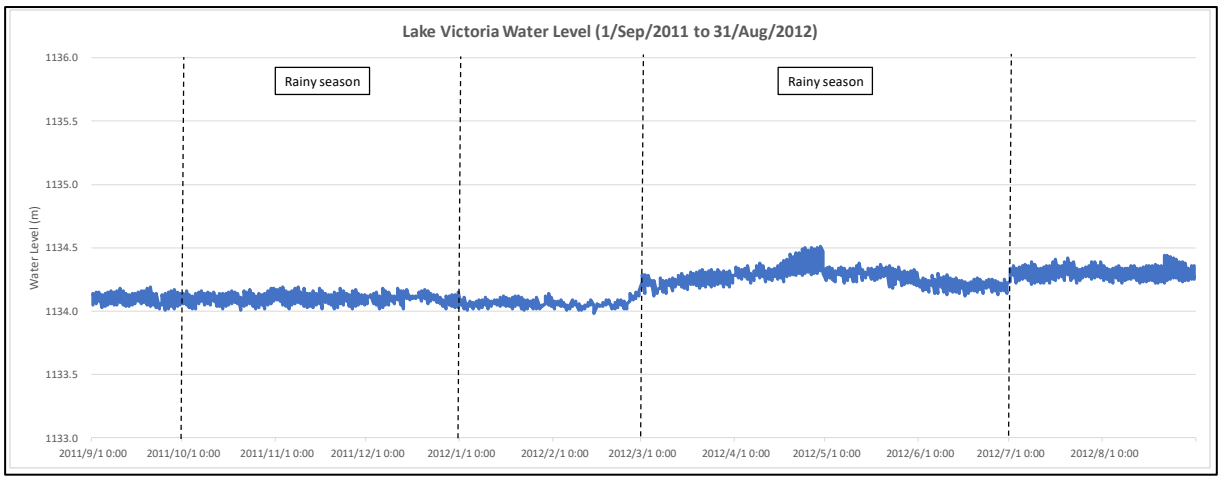
Source: JICA Survey Team

Figure A3.1.3-8 Fluctuation of Lake Victoria Water Level (Sep 2009 to Aug 2010)



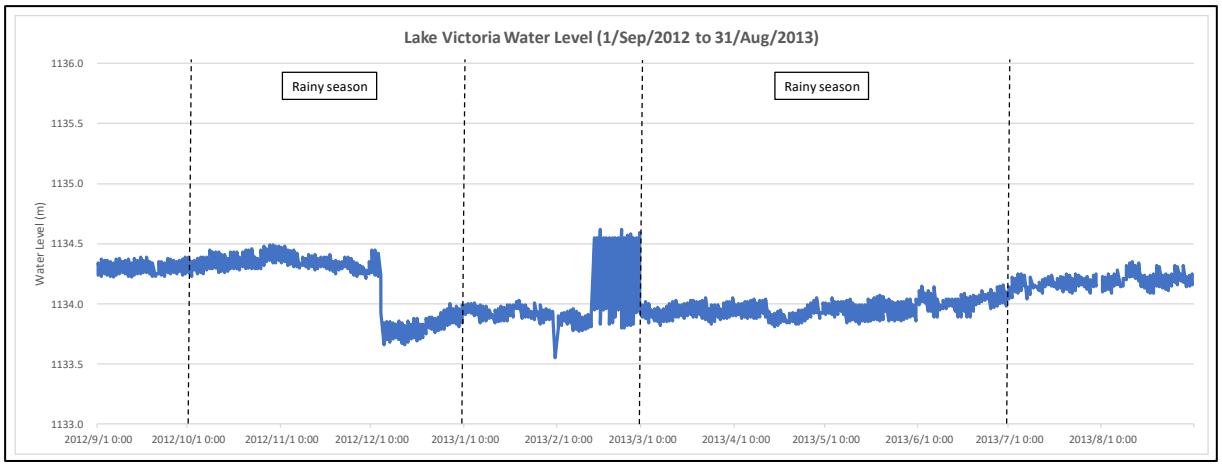
Source: JICA Survey Team

Figure A3.1.3-9 Fluctuation of Lake Victoria Water Level (Sep 2010 to Aug 2011)



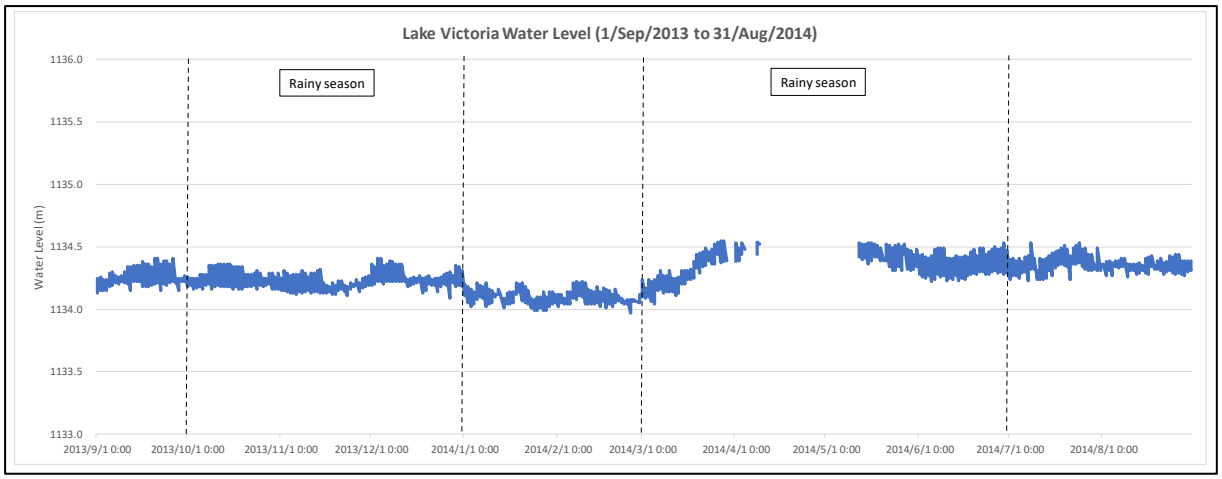
Source: JICA Survey Team

Figure A3.1.3-10 Fluctuation of Lake Victoria Water Level (Sep 2011 to Aug 2012)



Source: JICA Survey Team

Figure A3.1.3-11 Fluctuation of Lake Victoria Water Level (Sep 2012 to Aug 2013)



Source: JICA Survey Team

Figure A3.1.3-12 Fluctuation of Lake Victoria Water Level (Sep 2013 to Aug 2014)

The difference between the rainy and dry season is small and the water level is not influenced by seasons as shown in Table A3.1.3-4

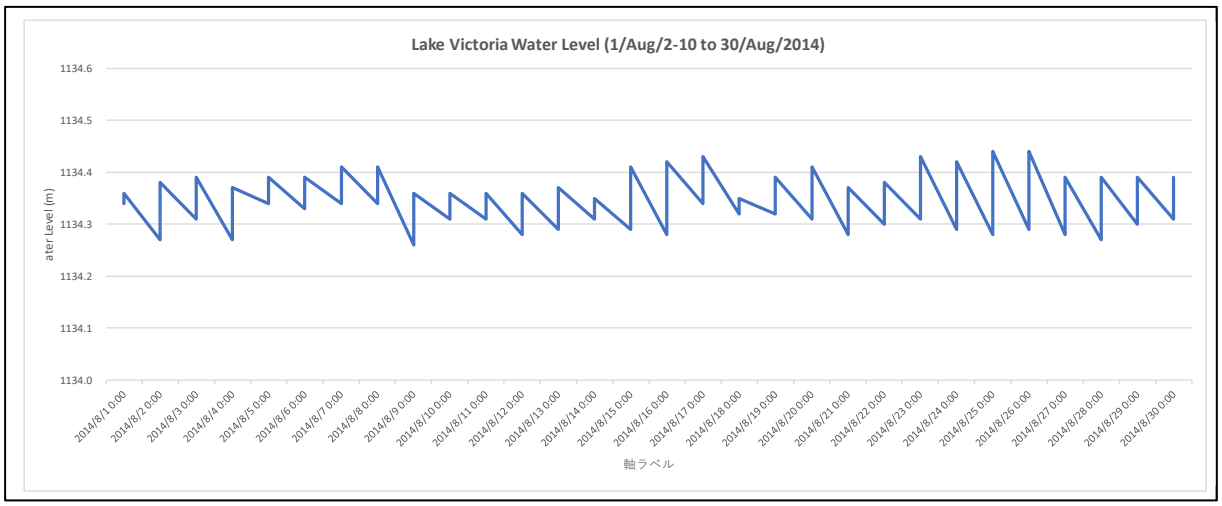
Table A3.1.3-4 Comparison of Rainy and Dry Season

Period	Rainy Season* (m)	Dry Season* (m)	Difference (m)
1/9/2009 to 31/8/2010	1134.44	1134.33	0.11
1/9/2010 to 31/8/2011	1134.20	1134.20	0.00
1/9/2011 to 31/8/2012	1134.19	1134.17	0.02
1/9/2012 to 31/8/2013	1134.06	1134.13	-0.07
1/9/2013 to 30/8/2014	1134.31	1134.23	0.08
Average	1134.24	1134.21	0.03

**: Rainy season Oct. to Dec., Mar. to Jun; Dry season Sep., Jan. to Feb., Jul. to Aug.*

- Daily Fluctuation

The water level is measured twice a day (9:00 A.M. and 4:00 P.M. in 2014). The average difference between 9:00 A.M and 4:00 P.M. is 12 cm as shown in Figure A3.1.3-13.



Source: JICA Survey team

Figure A3.1.3-13 Daily Fluctuation of Lake Victoria Water Level

(v) Summary of Water Level of Lake Victoria

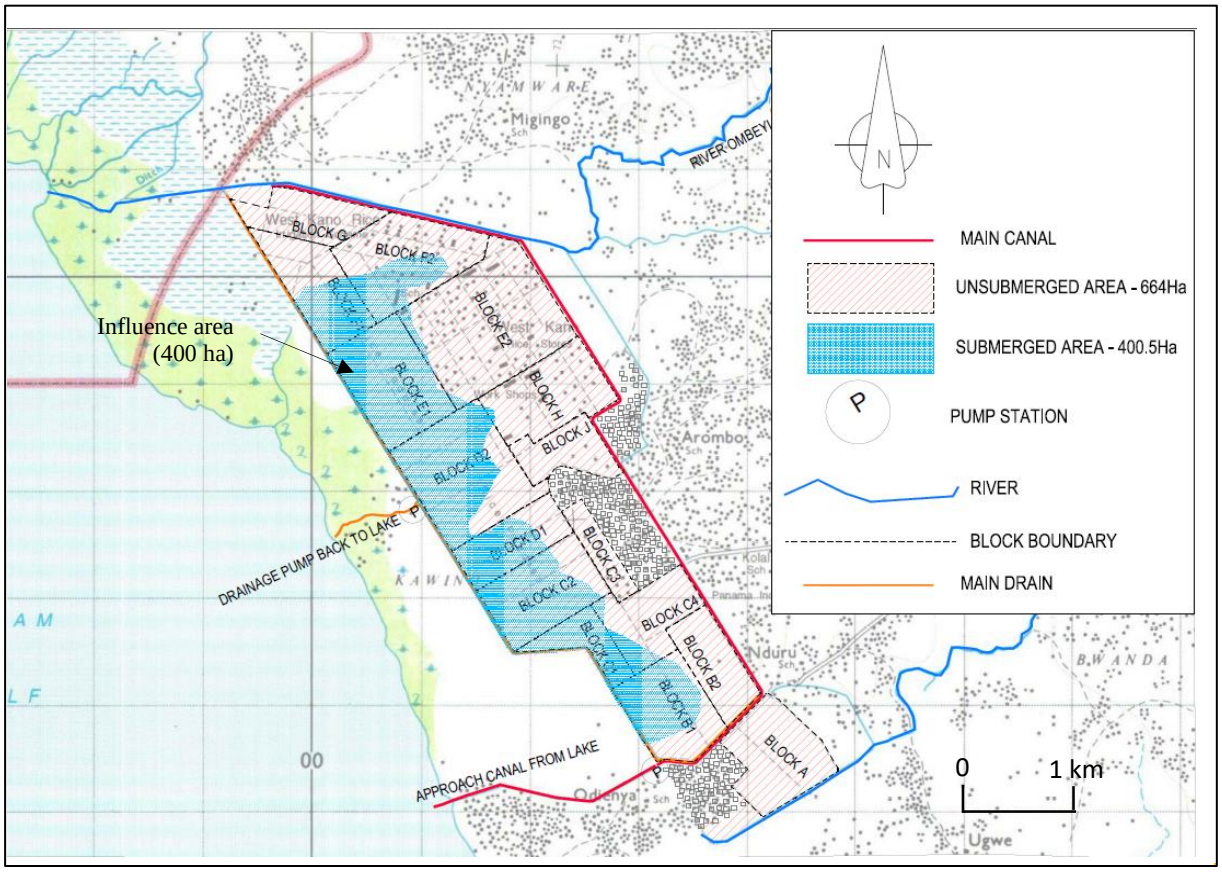
a) Reduction trend in long term

b) Small yearly fluctuation

c) Small daily fluctuation

(iv) Influence Area by Water Level of the Lake Victoria

Although the water level of Lake Victoria has a decreasing trend, the influence area is evaluated based on the water level (1,135 m) considering wave action and fluctuation. The lower command area is around 1,135 m and the higher command area is 1,137 m. The residential area is around 1,138 m. The influence (submerged) area based on 1,135 m is approximately 400 ha (45% of 892 ha of total area) as shown in Figure A3.1.3-14.



Source: JICA Survey Team

Figure A3.1.3-14 Influence Area of Lake Victoria Water Level (1,135 m)

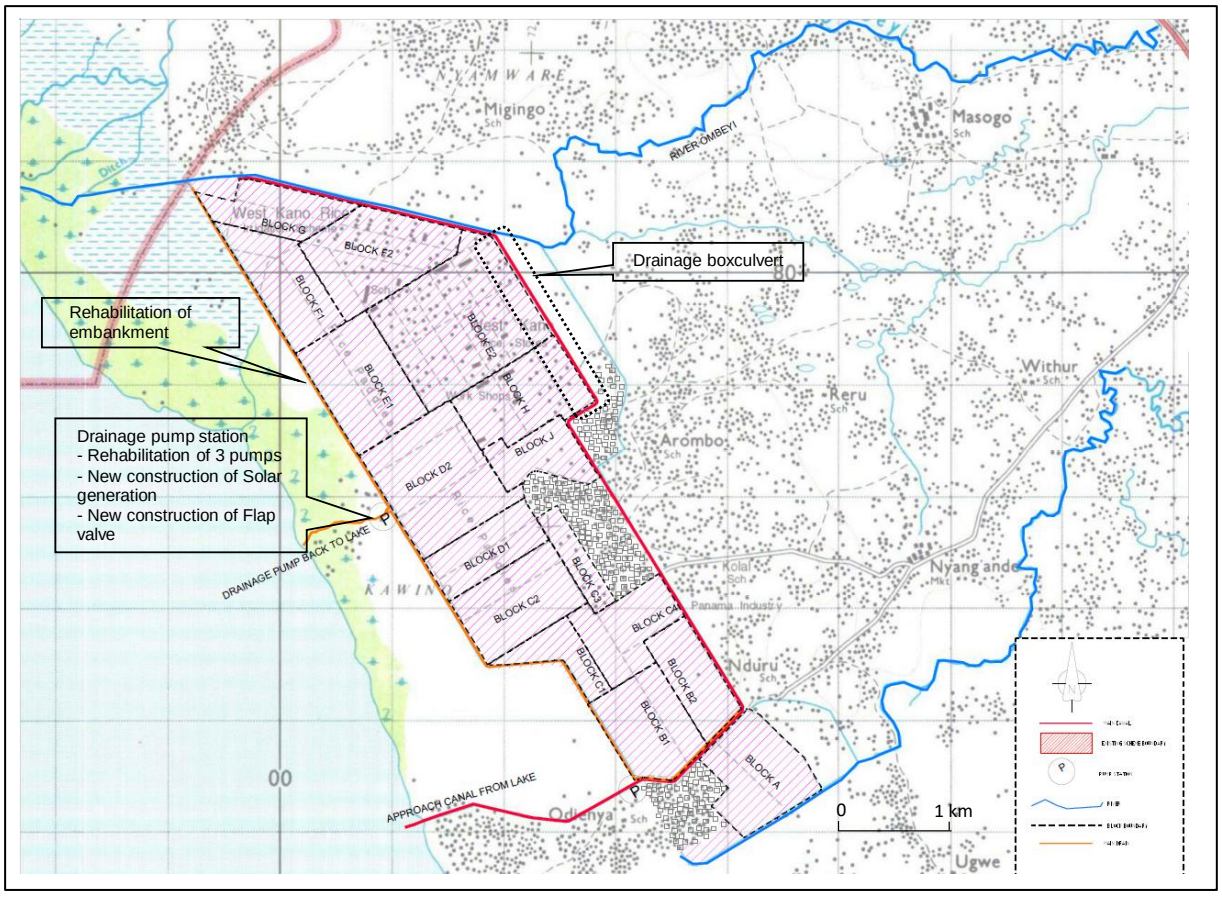
(iv) Countermeasures of West Kano Irrigation Scheme

The countermeasures of flood and submerge are shown in Table A3.1.3-5 and Figure A3.1.3-15.

Table A3.1.3-5 Countermeasures of Flood and Submerge

Facilities	Items	Contents
Rehabilitation of drain pump station	a. Rehabilitation of pumps	Only one out of four pumps is in function. Three pumps are rehabilitated.
	b. Introduction of solar panel system	Introduction of solar panel system to reduce pump operation cost.
	c. Rehabilitation of natural drain gates	Replacement sluice gates to flap gates to reduce pump operation cost and to improve drain naturally.
Rehabilitation of dykes	d. Strengthen of dykes	Embankment and reshape to reduce leakage and subsidence. Length is 18 km.
	e. Installation of drain culverts	Installation of box culverts to drain water from the upper area.

Source: JICA Survey Team



Source: JICA Survey Team

Figure A3.1.3-15 Countermeasures of Flood and Submerge

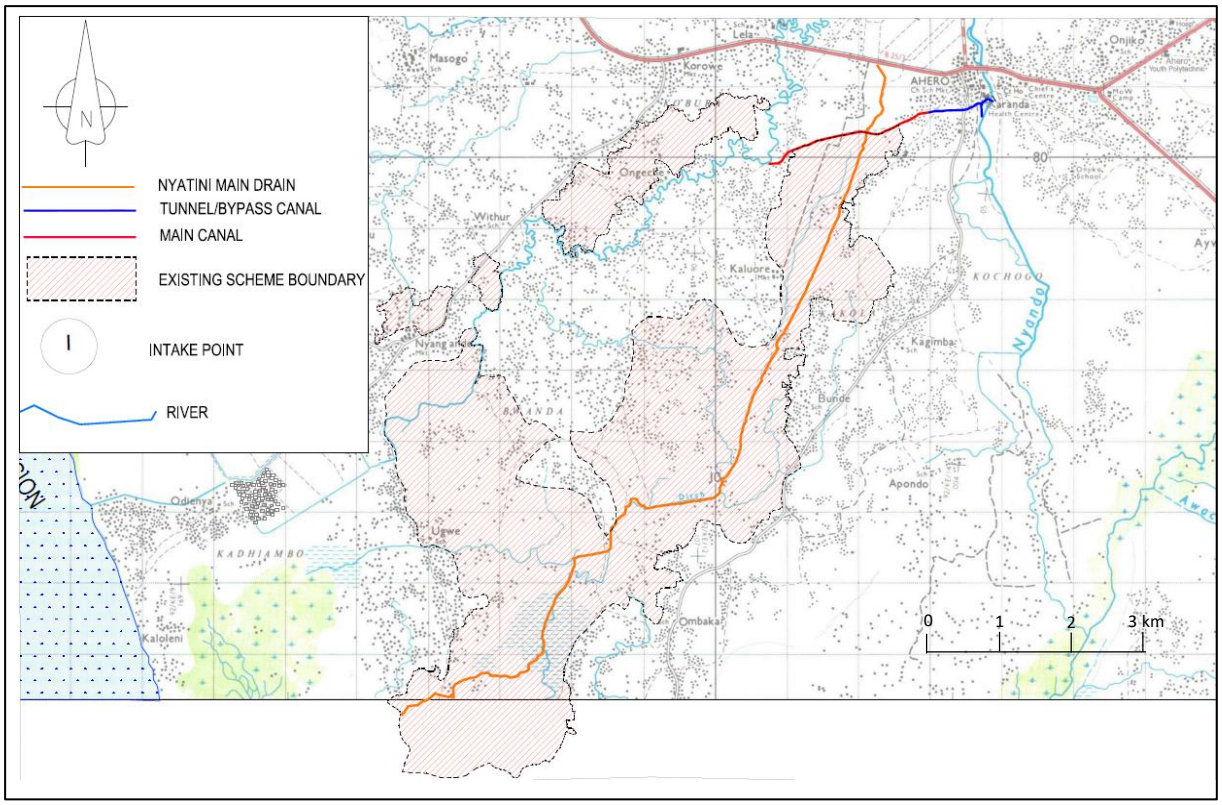
3.1.4 Southwest Kano Irrigation Scheme

(1) Current Conditions

1) Outline

(i) Brief History of Development

The Southwest Kano Irrigation Scheme was supported by the European Union (ECC) and the Dutch government. The scheme is located downstream of the Ahero Irrigation Scheme as shown in Figure A3.1.4-1. Initial irrigated area is 860 ha and the beneficiaries are 2,434 households. Water resources come from the Nyando River and the irrigation system is a gravity type.



Source: JICA Survey Team

Figure A3.1.4-1 Location Map of Southwest Kano Irrigation Scheme

(ii) Summary

Summary of Southwest Kano Irrigation Scheme is shown in Table A3.1.4-1.

Table A3.1.4-1 Outline of Southwest Kano Irrigation Scheme

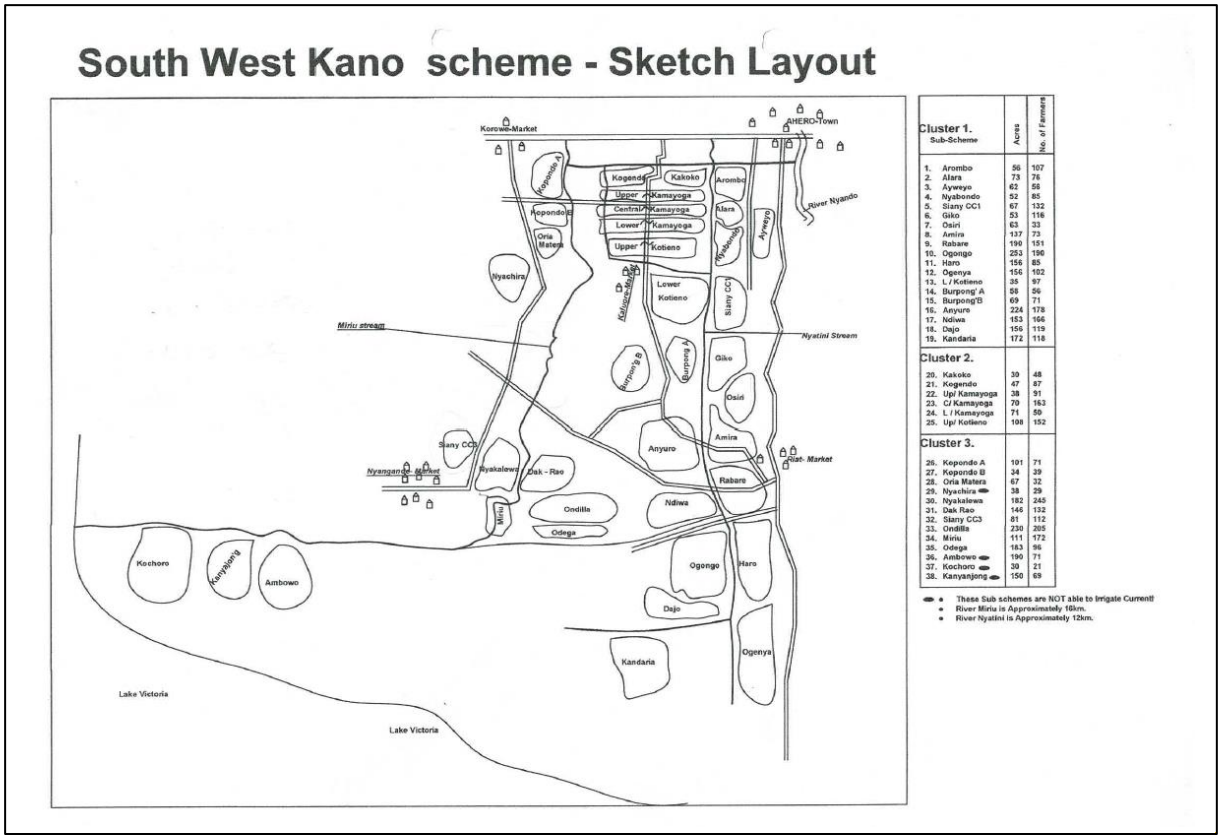
Items	Description
Implementation body	Ministry of Agriculture and Farmers
County	Kisumu
Location	Westend of the Kano Plains some 20 km east of Kisumu
Access	Nairobi to Kisumu by air: 1 hour and Kisumu to Southwest Kano by road: 1 hour
Type of project	Rehabilitation
Construction/ operation	1989/ 1990
No. of farmers	3,900 persons
Irrigated area	1,800 ha
Farm size per farmer	1 (0.4 ha) to 4 acres (1.6 ha)
Irrigation system	Gravity
Source of water	Nyando River
Drainage system	Gravity
Source of drainage	Lake Victoria
No. of dependant	Approx. 40,000
Cultivated crop	Paddy

Variety grown	Basmati 370 variety etc.
Average yield	4.0 t/ha
O&M	Farmer community (Assistance: NIA West Kano and Kisumu County)
Water charge	Ksh 2,000/acre/season

Source: NIA (July 2019)

2) Sub-schemes

The Southwest Kano Irrigation Scheme is divided into three clusters and 38 sub-schemes (small irrigation areas) as shown in Figure A3.1.4-2 and Table A3.1.4-2.



Source: Southwest Kano Office

Figure A3.1.4-2 Location Map of Sub-schemes in the Southwest Kano Irrigation Scheme

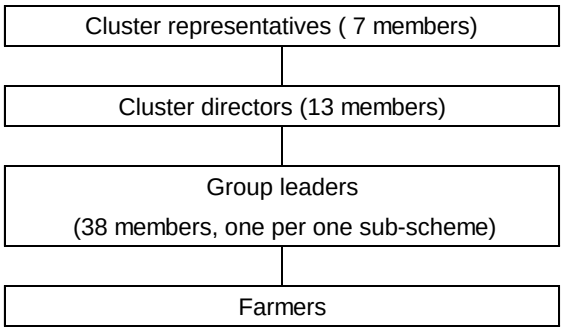
Table A3.1.4-2 Detail Conditions of Sub-schemes in the Southwest Kano Irrigation Scheme

Clusters	No.	Sub-Scheme	Area		No. of Farmers
			(acre)	(ha)	
Cluster 1	1	Arombo	56	22.4	107
	2	Alara	73	29.2	76
	3	Ayweyo	62	24.8	56
	4	Nyabondo	52	20.8	85
	5	Siany CC1	67	26.8	132
	6	Giko	53	21.2	116
	7	Osiri	63	25.2	33
	8	Amira	137	54.8	73
	9	Rabare	190	76.0	151
	10	Ogongo	253	101.2	190
	11	Haro	156	62.4	85
	12	Ogenya	156	62.4	102
	13	L/Kotieno	35	14.0	97
	14	Burpong A	53	21.2	56
	15	Burpong B	69	27.6	71
	16	Anyuro	224	89.6	178
	17	Ndiwa	153	61.2	166
	18	Dajo	156	62.4	119
	19	Kandaria	172	68.8	118
	Sub-total		2,180	872.0	2,011
Cluster 2	20	Kakoko	30	12.0	48
	21	Kogendo	47	18.8	87
	22	Up/ Kamayoga	38	15.2	91
	23	C / Kamayoga	70	28.0	163
	24	L/ Kamayoga	71	28.4	50
	25	Up/ Kotieno	108	43.2	152
	Sub-total		364	145.6	591
Cluster 3	26	Kopondo A	101	40.4	71
	27	Kopondo B	34	13.6	39
	28	Oria Matara	67	26.8	32
	29	Nyachira	38	15.2	29
	30	Nyakalewa	182	72.8	245
	31	Dak Rao	146	58.4	132
	32	Siany CC3	61	24.4	112
	33	Ondilia	230	92.0	205
	34	Miriu	111	44.4	172
	35	Odago	183	73.2	96
	36	Ambowo	190	76.0	71
	37	Kochoro	30	12.0	21
	38	Kanyanjong	150	60.0	69
	Sub-total		1,523	609.2	1,294
Total			4,067	1626.8	3,896

Source: JICA Survey Team based on Southwest Kano Office data

3) Farmer's Organization

Farmers select a group (sub-scheme) leader by election, which is implemented every three years. The group leaders select a cluster director from among the group leaders. Cluster directors select cluster representatives from among the cluster directors as shown in Figure A3.1.4-3. This organization is supported by NIA for technical points and the Kisumu County for administration. The positions held are chairman, secretary, treasurer, water guard in group leaders, and cluster directors.



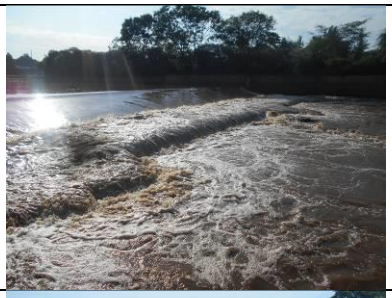
Source: Kisumu County

Figure A3.1.4-3 Organization Structure of Southwest Kano Irrigation Scheme

4) Existing Facilities

This scheme is gravity irrigation and drain system that is composed of a main canal, a drain canal, and small irrigation facilities. The dimensions of those facilities are shown in Table A3.1.4-3. Those facilities have a low efficiency due to deterioration. The main canal and drainage are eroded and covered with weeds. Silting of the by-pass canal and the upper main canal is a serious problem. Maintenance cost is high and there is no place to dispose of the soil.

Table A3.1.4-3 Existing Irrigation Facilities in Southwest Kano Irrigation Scheme

Facilities	Photographs		Dimension
Intake structure			Weir: L = 44 m By-pass canal: L=100 m
Main canal			Pipeline: L=750 m Earth : L=2.4 km
Main drain			Main drain L = 13.4 km

Source: JICA Survey Team

5) Flood Conditions

The flood from the Nyando River happens about once every three years. The water depth of the flood is around 1 m along the farm roads in the scheme.

6) Silting Soil

Silting soil from the Nyando River flows into the main canal. Sediments are removed once a year after the rainy season. The storage site of removed soil is limited as shown in Figure A3.1.4-4 and the maintenance cost of which is high.

Source: JICA Survey Team

Figure A3.1.4-4 Silting Conditions of the Southwest Kano Irrigation Scheme

(2) Analysis, Considerations, and Plans

1) Irrigation Plan

(i) Scheme Irrigation Water Availability

River flow:

Irrigation water is planned to be taken from the Nyando River at the existing headworks. Its water availability at the intake point was calculated based on the balance of available water at the Ahero Pump Station and the result of the water requirement for the Ahero Irrigation Scheme, which is located upstream of this scheme.

Table A3.1.4-4 Q80 at Southwest Kano Intake Point

	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(1) River flow Q80 in Ahero Intake	m3/s	2.82	1.64	2.02	5.66	7.58	3.80	3.66	4.74	4.10	2.36	2.56	2.36
(2) Intake discharge in Ahero Intake (Pattern-1)	m3/s	0.83	0.62	0.76	0.85	1.37	1.30	0.87	0.56	0.91	1.29	1.56	1.38
(3) River flow Q80 in Southwest Kano Intake =(1)-(2)	**mm/ day**	**1.99**	**1.02**	**1.26**	**4.81**	**6.21**	**2.50**	**2.79**	**4.18**	**3.19**	**1.07**	**1.00**	**0.98**

Source: JICA Survey Team

Effective rainfall:

Results of the effective rainfall data in the report "Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Project (May 2013)" was applied for the water requirement analysis as shown in the table below.

Table A 3.1.4-5 Mean Monthly, the 80% Reliability Mean Monthly Flow at the Southwest Kano Intake and Effective Rainfall

	80% (Q80) Mean Monthly flow [m3/s]	Effective Rainfall [mm/month]
Jan	1.99	59.60
Feb	1.02	56.40
Mar	1.26	79.80
Apr	4.81	126.20
May	6.21	82.20
Jun	2.50	51.60
Jul	2.79	46.00
Aug	4.18	62.00
Sep	3.19	46.80
Oct	1.07	58.80
Nov	1.00	57.40
Dec	0.98	41.40

Source: JICA Survey Team

The data in the above table was applied for the water requirement analysis and calculation of water availability in the data collection survey.

In addition to the river water availability data, the conveyance capacity of the existing facilities should be taken into consideration in the water requirement analysis. In the calculation, the following conditions are applied:

- Canal conveyance capacity: 2.80 m^3/s (derived from "Southwest Kano Project – Final Report May 2, 1997" by Provincial Irrigation Unit)

(ii) Cropping Pattern and Water Requirement Analysis

Based on the water availability, a limited conveyance condition due to the existing facilities, climate, and other required considerations, the following cropping pattern is formulated.

Since the Ahero Irrigation Scheme and Southwest Kano Irrigation Scheme are adjacent to each other with the same climate conditions, the JICA Survey Team applied the same coefficients, such as Kc, Eto, and others, for this water requirement analysis.

The calculation results are summarized in the following figures and the detailed calculation is given in Table B3.1.4-1.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
irrigation area 1,800ha Crop Intensity:141% Required water (peak): 2.14m3/s@May	1,800ha					Paddy:1,800ha						Paddy:738ha	
Total Required Flow in Canal	m3/s	0.53	0.60	1.19	1.32	2.14	2.02	1.35	0.70	0.58	0.82	0.99	0.88
Total Area	ha	554	819	1,085	1,350	1,800	1,800	1,350	1,085	819	554	738	738
River flow Q80	m3/s	1.99	1.02	1.26	4.81	6.21	2.50	2.79	4.18	3.19	1.07	1.00	0.98
Canal design discharge	m3/s	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80

Source: JICA Survey Team

Figure A3.1.4-5 Cropping Pattern in Ahero Irrigation Scheme

2) Rehabilitation of Irrigation Facilities

Main facilities were developed with support from the EEC and the Dutch government. Sub-schemes were developed by farmers. The main facilities and sub-scheme facilities are of low efficiency due to deterioration. Those facilities need to be rehabilitated. The sub-scheme facilities will be rehabilitated by farmers, same as it was 30 years ago.

3) Reduction of Silting Soil

The silting of soil in the main canal is a problem. The intake structure and by-pass canal are improved with desilting facilities to trap soil flowing into the main canal.

4) Flood Countermeasures

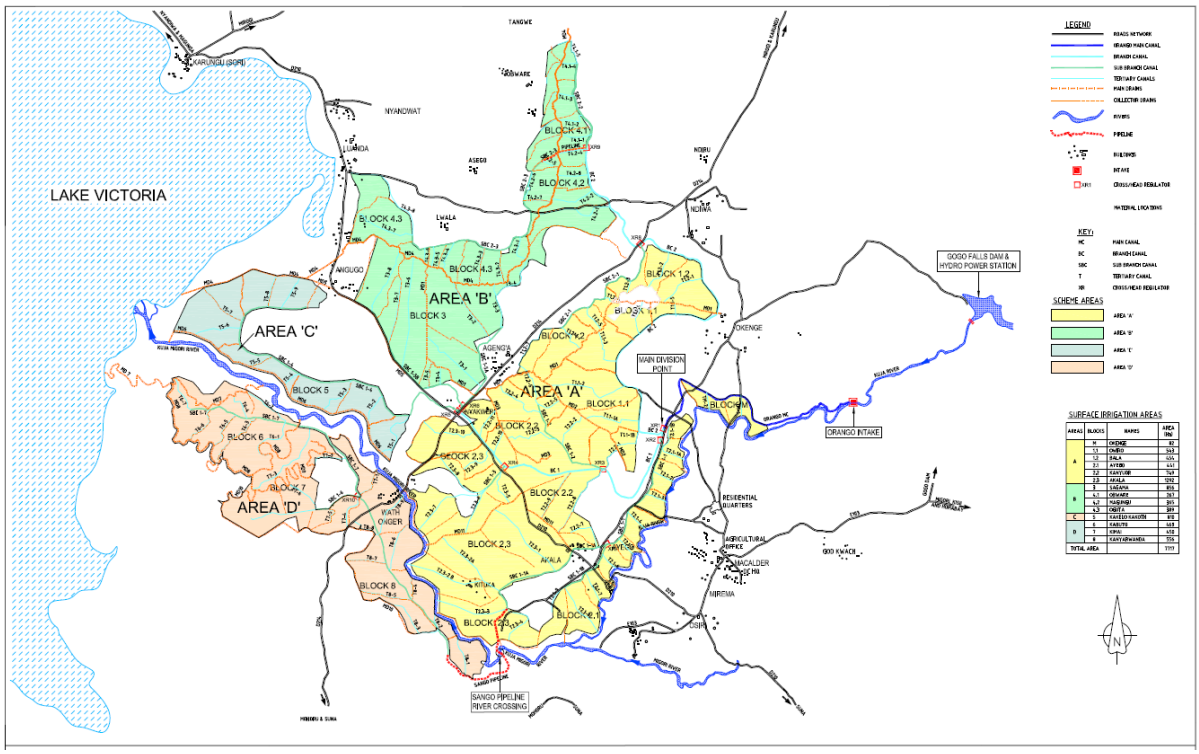
Dykes along the Nyando River are rehabilitated to reduce flood damage. The scheme is located on the right bank of the Nyando River. The development plan of the scheme includes the rehabilitation of the right bank dykes.

3.1.5 Lower Kuja Irrigation Scheme

(1) Current Conditions

1) Outline

Lower Kuja Irrigation Scheme is located in the lower Kuja River along Lake Victoria as shown in Figure A3.1.5-1. The Lake Basin Development Authority (LBDA) surveyed and identified water resources of the Kuja-Migori River and irrigation potential in the 1980s. NIA and the Ministry of Water and Irrigation prepared the feasibility study (F/S) in 2010 and the detailed design (D/D) in 2011 as shown in Table A3.1.5-1.



Source: Consultancy Services for Feasibility Study, Detailed Design and Preparation pf Tenser Documents for Lower Kuja Irrigation Development Project, Volume 1 Final Detailed Design Report (Lower Kuja D/D Report)

Figure A3.1.5-1 Location Map of the Lower Kuja Irrigation Scheme

Table A3.1.5-1 Outline of the Lower Kuja Irrigation Scheme

Items	Description
Implementation Agency	NIA Lower Kuja
County	Migori
Location	Lower Kuja-Migori River
Access	Nairobi to Kisumu by air: 1 hour and Kisumu to Lower Kuja by road: 4 hours
Type of project	New construction
Construction/ operation	2013/ -
No. of farmers	2,797
Irrigated area	7,717 ha
Farm size per harmer	2.75 ha
Irrigation system	Gravity
Drainage system	Gravity
Source of water	Kuja River
Drainage system	Gravity
Source of drainage	Lake Victoria
No. of dependant	N/A
Cultivated crop	Paddy and upland crops
Variety grown	N/A
Average yield	N/A
O&M	NIA Lowe Kuja

Source: JICA Survey Team

2) Irrigation Blocks

The Lower Kuja Irrigation Scheme is divided into 14 irrigation blocks as shown in Table A3.1.5-2. Cropping patterns are prepared for each block.

Table A3.1.5-2 Irrigation Blocks

Unit: ha

Block	Paddy	Upland crops				Total
		Food	Horticulture		Indusrrial crops	
			Vegetables	Fruit trees		
Block M	60	13	9	0	0	82
Block 1-1	240	182	45	15	61	543
Block 1-2	65	233	58	19	78	454
Block 2-1	0	264	66	22	88	441
Block 2-2	0	450	112	37	150	749
Block 2-3	0	775	194	65	258	1,292
Block 3	795	52	13	4	17	856
Block 4-1	213	32	21	0	0	267
Block 4-2	286	47	12	4	16	365
Block 4-3	266	59	15	5	20	389
Block 5	305	303	76	25	101	810
Block 6	0	280	70	23	93	463
Block 7	145	183	46	15	61	450
Block 8	0	362	91	30	121	556
Total	2,377	3,204	820	263	1,053	7,717

Source: Lower Kuja D/D Report

3) Existing Facilities

(i) Development Plan

According to the Lower Kuja D/D report, the development plan of irrigation facilities in the Lower Kuja Irrigation Scheme has already been prepared by NIA in 2011 as shown in Table A3.1.5-3.

Table A3.1.5-3 List of Facilities

No.	Facility	Quantity		
1	Headworks	N=	1	no
2	Main canal	L=	7.3	km
3	Branch canal	L=	21.4	km
4	Sub-branch canal	L=	55.7	km
5	Sango pipeline	L=	3.9	km
6	SBC 2-3 pipeline	L=	1.4	km
7	Tertiary canal	L=	122.9	km
8	Tertiary pipeline	L=	15.5	km
9	Feeder canal	L=	304.2	km
10	Main drain	L=	90.9	km
11	Field drain	L=	230.6	km
12	Collector drain	L=	115.4	km
13	Access road	L=	212	km

Source: Lower Kuja D/D Report

(ii) Progress of Construction

The construction started from the headworks by NIA in 2013. The implementation of Lot 1 was started by NIA in May 2015. The construction of the facilities below is completed as of October 2019, while the construction of Block 1.1 (Lot 1) will start soon. NIA implements construction works based on the initial lot plan. The Lower Kuja Irrigation Scheme is under construction and the implementation schedule will be modified based on the site conditions. The progress of construction and detailed design should be confirmed in the next study.

- Headworks (weir and intake)（Construction year: 2013）
- Sedimentation basin (Lot 1)
- Main canal (L=7.3 km) (Lot 1)
- Infield infrastructure for Block M（82 ha) (Lot 1)

(iii) Completed Facilities

Conditions of completed facilities by NIA are shown in Table A3.1.5-4. A part of the headworks is damaged by flood. The left bank and both sides of the downstream of the weir are eroded. Rehabilitation is required to avoid more damage and to recover the function.

Table A3.1.5-4 Existing Irrigation Facilities in Lower Kuja Irrigation Scheme

Facilities	Photographs		Dimension
Headworks			Weir: L = 60 m, H = 4 m
Sedimentation basin			
Main canal			L = 7.3 km

Block M			

Source: JICA Survey Team

(vi) Movement of Donors

The Lower Kuja Irrigation Scheme has not been supported by any donors until October 2019 and does not have a plan to be supported.

4) Flood Damage

The flood damage is caused by the Kuja-Migori River during March to April of every year. Submerged depth in the 1997 flood was 60 cm. The Ministry of Water and Irrigation constructed dykes along the left bank of the Kuja-Migori River. The material of embankment for the dykes is block cotton soil, which is not suitable for earth structures.

5) New Dam (new Gogo Falls Dam)

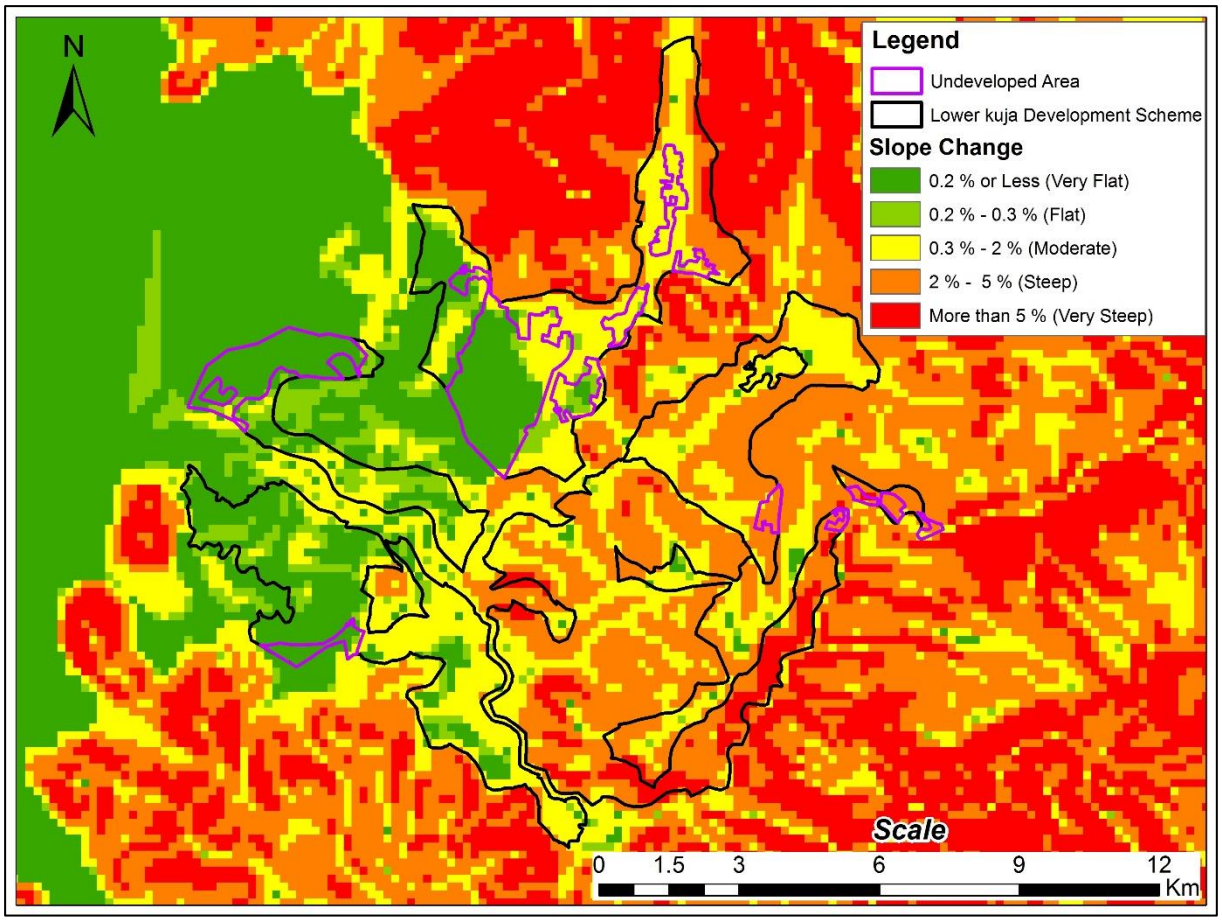
New construction dam named new Gogo Falls Dam is planned to be located at the upper stream of the existing Gogo Falls Dam, which is for hydro-power. The feasibility study of the new Gogo Falls Dam has already been done and the results of the study were prepared for the Gogo Falls Dam Report Final Feasibility (2010). The implementation plan of the dam is not clear as of October 2019.

(2) Analysis, Considerations, and Plans

1) Land Use Plan

(i) Land Classification

The development plan was prepared. The land use plan indicates an area of paddy equating to 2,375 ha and the upland crops is 5,344 ha (7,717 ha in total). The command areas are classified into three types, namely, steep slope areas, hilly areas, gently slope areas, and low swamp areas along Lake Victoria. The command areas are classified based on the slope using GIS as shown in Figure A3.1.5-2.



Source: JICA Survey Team

Figure A3.1.5-2 Land Classification of the Lower Kuja Irrigation Area

(ii) Proposed Land Use

Based on the slope and the approach to produce paddy, the proposed land use is prepared as given below. The area for paddy is 4,670 ha, while for upland crops is 3,047 ha as shown in Table A3.1.5-5.

- Paddy block: Areas of less than 2% slope occupy more than 50%.
- Upland crop block: Areas of less than 2% slope occupy less than 50%.

(Construction of Block M has been completed, land use of Block M is based on the original plan.)

Table A3.1.5-5 Proposed Land Use

Block	Area	Class-1		Class-2		Class-3		Class-4		Class-5		upto 2.0%	Paddy	Upland
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(%)	(ha)	(ha)
Block M	82	0	0.0	0	0	7.8	9.5	69.5	84.8	4.7	5.7	9.5	60	22
Block 1-1	543	3.4	0.6	1.6	0.3	205.4	37.8	332.6	61.3	0	0.0	38.7		543
Block 1-2	454	6.4	1.4	3.2	0.7	266.1	58.6	176.1	38.8	2.2	0.5	60.7	454	
Block 2-1	441	1.9	0.4	0	0	22.1	5.0	240.1	54.4	176.9	40.1	5.4		441
Block 2-2	749	2.9	0.4	5.9	0.8	234.7	31.3	494.8	66.1	10.7	1.4	32.5		749
Block 2-3	1,292	9.3	0.7	10	0.8	390.1	30.2	740.4	57.3	142.2	11.0	31.7		1,292
Block 3	856	431.4	50.4	110.7	12.9	303.7	35.5	10.2	1.2	0	0.0	98.8	856	
Block 4-1	267	2.6	1.0	0	0	160.1	60.0	87.6	32.8	16.7	6.3	60.9	267	
Block 4-2	365	0	0.0	6.8	1.9	205.4	56.3	131.9	36.1	20.9	5.7	58.1	365	
Block 4-3	389	106.4	27.4	37	9.5	203.1	52.2	39.6	10.2	2.9	0.7	89.1	389	
Block 5	810	460.5	56.9	174.3	21.5	175.2	21.6	0	0.0	0	0.0	100.0	810	
Block 6	463	295.4	63.8	116.6	25.2	51	11.0	0	0.0	0	0.0	100.0	463	
Block 7	450	280.5	62.3	53	11.8	114.8	25.5	1.68	0.4	0.02	0.0	99.6	450	
Block 8	556	108.6	19.5	59	10.6	371.5	66.8	16.8	3.0	0.1	0.0	97.0	556	
Total	7,717	1,709.3		578.1		2,711.0		2,341.3		377.3			4,670	3,047

Class-1: very flat: 0.2% or less
Class-2: flat: more than 0.2% upto 0.3%
Class-3: moderate slope: more than 0.3% upto 2.0%
Class-4: steep slope: more than 2% upto 5%
Class-5: very steep slope: more than 5%

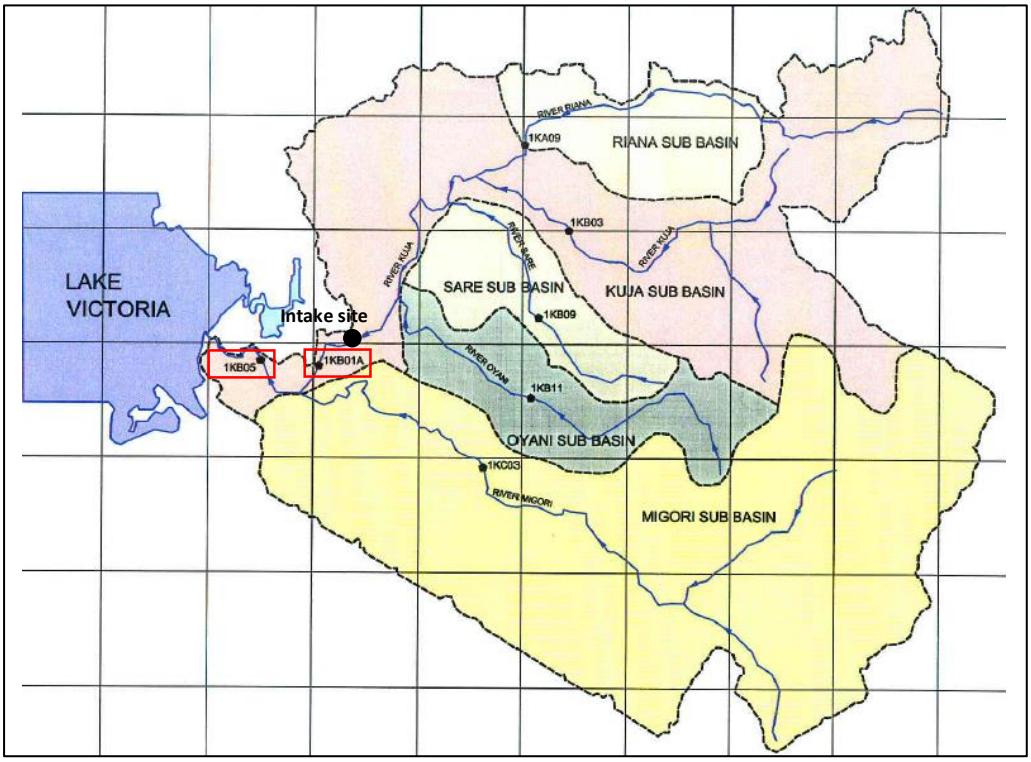
Source: JICA Survey Team

2) Irrigation Plan

(i) Scheme Irrigation Water Availability

River flow:

Irrigation water is planned to be taken from the Kuja River at the existing headworks. Its water availability at the intake point has been studied in detail and compiled in "Table 2-10 Flow at Kuja/Migori at 1KB01/1KB05" in the report "Consultancy Services for Feasibility Study, Detailed Design and Preparation of Tender Documents for Lower Kuja Irrigation Development Project (June 2011) (Lower Kuja D/D Reprot) " as shown in the table below.



Source: Lower Kuja D/D Report

Figure A3.1.5-3 Location Map of Gauging Station

Effective rainfall:
Data of the effective rainfall in "Annex 6 Crop Water Requirement" of the report "Consultancy Services for Feasibility Study, Detailed Design and Preparation of Tender Documents for Lower Kuja Irrigation Development Project (June 2011)" was applied for the water requirement analysis as shown in the table below.

Table A 3.1.5-6 Mean Monthly, the 80% Reliability Mean Monthly at the Headworks Flow for the Kuja River and Effective Rainfall

	Mean Monthly Flow [m^3/s]	80% (Q80) Mean Monthly Flow [m^3/s]	Effective Rainfall [mm/month]
Jan	16.10	5.40	18.50
Feb	13.80	4.50	28.22
Mar	26.50	5.60	63.48
Apr	67.50	17.80	103.48
May	107.20	58.00	76.28
Jun	47.20	24.10	14.12
Jul	22.60	10.10	6.14
Aug	17.20	8.10	8.54
Sep	39.60	9.20	13.22
Oct	26.80	10.80	28.82
Nov	45.3	10.53	61.16
Dec	45.2	7.80	35.64

Source: "Annex 6 Crop Water Requirement" of the report "Consultancy Services for Feasibility Study, Detailed Design and Preparation of Tender Documents for Lower Kuja Irrigation Development Project (June 2011)"

The data in the above table was applied for the water requirement analysis and calculation of water availability in the data collection survey.

In addition to the river water availability data, the conveyance capacity of the existing facilities should be taken into consideration in the water requirement analysis. Thus, the following conditions were applied to the calculation:

- Intake capacity: 8.55 m^3/s
- Canal conveyance capacity: 8.55 m^3/s (same as the intake capacity)

(ii) Cropping Pattern and Water Requirement Analysis

In the survey, the following three patterns of irrigation area for paddy and upland crop were considered.

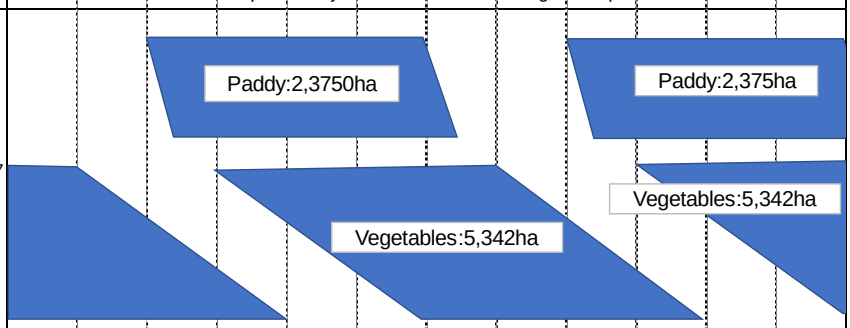
- Pattern 1: Original plan in "Consultancy Services for Feasibility Study, Detailed Design and Preparation of Tender Documents for Lower Kuja Irrigation Development Project (June 2011).
- Pattern 2: One of the Survey Team's recommendations, which includes expansion of the paddy area up to 4,670 ha based on geographical situation, i.e., land slope, of farm land. In concrete, all the plots in Block B, C, and D where the land slope is not so steep shall be developed as paddy fields.
- Pattern 3: One of the JICA Survey Team's recommendations, which is to develop all the farmland, i.e., 7,717 ha, into a paddy area despite of its geographical condition and land slopes.

Pattern 1: Original plan in the previous DD study

The irrigation areas, crop intensity, and cropping patterns for each cultivation are as shown in the table and figure below:

Table A3.1.5-7 Irrigation Areas and Crop Intensities (L.Kuja-Pattern 1)

Pattern	Total Area	Paddy	Vegetables (tomato, onion, kale, etc)
Pattern 1	7,717 ha	2,375 ha (crop intensity: 200%) 1st Planting: March 2nd Planting: September	5,342 ha (crop intensity: 200%) 1st Planting: Apr.-Jun. 2nd Planting: Oct.-Dec.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pattern1 Paddy:2,375ha (200%) Vege:5,342ha (200%) Required water (peak): 7.41m3/s@Jun	7,717												
Total Required Flow in Canal	m3/s	4.93	5.93	6.72	2.72	3.52	**7.41**	4.89	6.17	4.77	3.49	1.28	4.26
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Design Canal discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	ha	0	2,375	2,375	2,375	2,375	2,375	0	2,375	2,375	2,375	2,375	2,375
Area-Vege	ha	5,342	3,561	1,781	1,781	3,561	5,342	5,342	3,561	1,781	1,781	3,561	5,342
Area-Total	ha	5,342	5,936	4,156	4,156	5,936	7,717	5,342	5,936	4,156	4,156	5,936	7,717

Source: JICA Survey Team

Figure A3.1.5-4 Cropping Pattern in the Lower Kuja Irrigation Scheme (Lower Kuja-Pattern 1)

As shown in the figure above, the planting period of the paddy should be one month, while for vegetables, the planting period is three months.

The detailed calculation results for the above figure are given in Table B3.1.5-1.

Pattern 2: All the plots in Block B, C, and D are developed as paddy.

There are two cropping patterns in this case such as:

Pattern 2-1: This is a case for the maximization of crop intensity in the paddy area up to 200%.

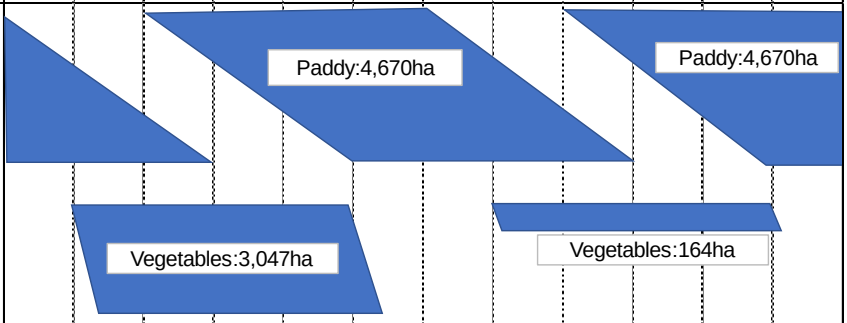
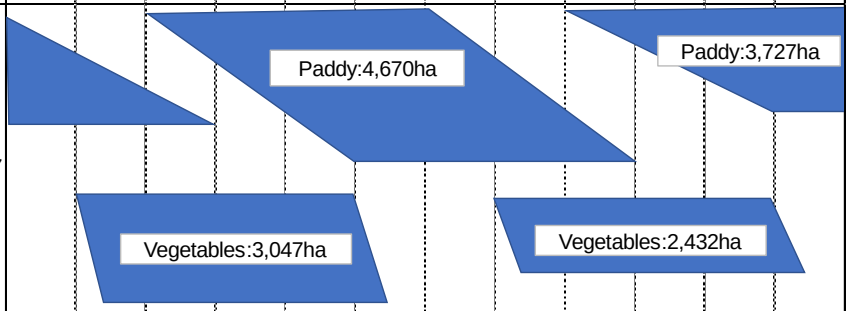
Pattern 2-2: This is a case for the proportional crop intensity in paddy and upland crop areas, i.e., 180%.

The irrigation areas, crop intensity, and cropping patterns for each cultivation are as shown in the table and figure below:

Table A3.1.5-8 Irrigation Areas and Crop Intensities (Lower Kuja-Pattern 2)

Pattern	Total Area	Paddy	Vegetables (tomato, onion, kale, etc)
Pattern 2-1	7,717 ha	4,670 ha (crop intensity: 200%) 1st Planting: Mar.- May. 2nd Planting: Sep.-Dec.	3,047 ha (crop intensity: 110%) 1st Planting: February 2nd Planting: August
Pattern 2-2	7,717 ha	4,670 ha (crop intensity: 180%) 1st Planting: Mar.- May. 2nd Planting: Sep.-Dec.	3,047 ha (crop intensity: 180%) 1st Planting: February 2nd Planting: August

Source: JICA Survey Team

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pattern 2-1 Paddy:4,670ha (200%) Vege:3,047ha (110%) Required water (peak): 8.55m3/s@Oct	7,717												
Total Required Flow in Canal	m3/s	5.51	5.24	6.30	6.88	7.98	7.84	5.44	4.32	5.95	**8.55**	8.24	7.51
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Design Canal discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	ha	3,113	3,113	3,113	4,670	4,670	4,670	3,113	3,113	3,113	4,670	4,670	4,670
Area-Vege	ha	0	3,047	3,047	3,047	3,047	0	0	164	164	164	164	164
Area-Total	ha	3,113	6,160	6,160	7,717	7,717	4,670	3,113	3,277	3,277	4,834	4,834	4,834
Pattern 2-2 Paddy:4,670ha (180%) Vege:3,047ha (180%) Required water: 8.55m3/s@Nov	7,717												
Total Required Flow in Canal	m3/s	4.92	4.70	6.30	6.88	7.98	7.84	5.44	3.92	5.71	8.46	**8.55**	7.54
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Design Canal discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	ha	2,799	2,799	3,113	4,670	4,670	4,670	3,113	2,799	2,485	3,727	3,727	3,727
Area-Vege	ha	0	3,047	3,047	3,047	3,047	0	0	0	2,432	2,432	2,432	2,432
Area-Total	ha	2,799	5,846	6,160	7,717	7,717	4,670	3,113	2,799	4,917	6,159	6,159	6,159

Source: JICA Survey Team

Figure A3.1.5-5 Cropping Pattern in the Lower Kuja Irrigation Scheme (Lower Kuja-Pattern 2)

As shown in the figure above, the planting period of the paddy should be three months, while for vegetables, the planting period is one month.

The detailed calculation results for the above figure are given in Table B3.1.5-2 to Table B3.1.5-3.

Pattern 3

The irrigation areas, crop intensity, and cropping patterns for each cultivation are as shown in the table and figure below:

Table A3.1.5-9 Irrigation Areas and Crop Intensities (L.Kuja-Pattern 3)

Pattern	Total Area	Paddy	Vegetables (tomato, onion, kale, etc)
Pattern 3	7,717 ha	7,717 ha (crop intensity:200%) 1st Planting: Mar. - Jun. 2nd Planting: Sep. – Dec.	0 ha

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pattern3 Paddy: 7,717ha (177%) Required water: 8.55m3/s@Jun	7,717	Paddy:1,996ha	Paddy:1,486ha	Paddy:1,929ha	Paddy:1,267ha	Paddy:1,929ha	Paddy:2,592ha			Paddy:1,486ha	Paddy:975ha		
Total Required Flow in Canal	m3/s	5.26	4.48	5.44	5.33	8.02	**8.55**	5.65	4.80	5.02	6.64	7.04	6.30
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Design Canal discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	ha	4,967	5,411	5,192	5,125	7,717	7,717	5,788	6,007	5,053	3,946	5,942	5,942
Area-Vege	ha	0	0	0	0	0	0	0	0	0	0	0	0
Area-Total	ha	4,967	5,411	5,192	5,125	7,717	7,717	5,788	6,007	5,053	3,946	5,942	5,942

Source: JICA Survey Team

Figure A3.1.5-6 Cropping Pattern in the Lower Kuja Irrigation Scheme (Lower Kuja-Pattern 3)

As shown in the figure above, the planting period of the paddy should be four months due to the restriction of the available water.

The detailed calculation results for the above figure are given in Table B3.1.5-4.

3) New Construction and Rehabilitation Plan

(i) Plan

A part of the original development plan was implemented. Those facilities were damaged by flood and are needed to be repaired. Other facilities are constructed based on the original development plan of the Lower Kuja Irrigation Scheme as shown in Table A3.1.5-10.

Table A3.1.5-10 List of Rehabilitation Facilities

No.	Facility	Unit	Rehabilitation	New Construction	Total
1	Headworks	Nos.	1	0	1
2	Main canal	km	7.3	0	7.3
3	Branch canal	km	0	21.4	21.4
4	Sub-branch canal	km	0	55.7	55.7
5	Sango pipeline	km	0	3.9	3.9
6	SBC 2-3 pipeline	km	0	1.4	1.4
7	Tertiary canal	km	1.1	121.8	122.9
8	Tertiary pipeline	km	0	15.5	15.5
9	Feeder canal	km	4.8	299.4	304.2
10	Main drain	km	0	90.9	90.9
11	Field drain	km	4.7	225.9	230.6
12	Collector drain	km	1.6	113.8	115.4
13	Access road	km	0	212	212
14	Land consolidation	ha	88	7,717	7,717
	Paddy	ha	60	4,610	4,670
	Upland crop	ha	22	3,025	3,047

Source: JICA Survey Team

(ii) Development Level of Canals

According to the D/D report, the original development plan of canals is an earth type. The main canal has been constructed as an earth type. There is no problem as of October 2019. The canals of the Mwea Irrigation Project are basically earth types. A part of the canals is a concrete lining due to soil conditions (seepage). Considering existing conditions and the Mwea Irrigation Project, the earth canal is suitable for the Lower Kuja Irrigation Scheme.

4) Countermeasures of Flood and Drain

(i) Damage of Flood and Drain

Flood from the Kuja-Migori River is a frequent occurrence. Both sides of the lower Kuja-Migori River are planned to be constructed with dykes. The dyke of the left bank was constructed by MoW. The rehabilitation of the dyke is required due to the use of unsuitable material, which was mentioned previously. The lower side of Block 5 is a low land along Lake Victoria and is affected by the water level of the lake.

(ii) Analysis of Water Level of the Lake Victoria

Refer to the 3.1.3 West Kano Irrigation Scheme.

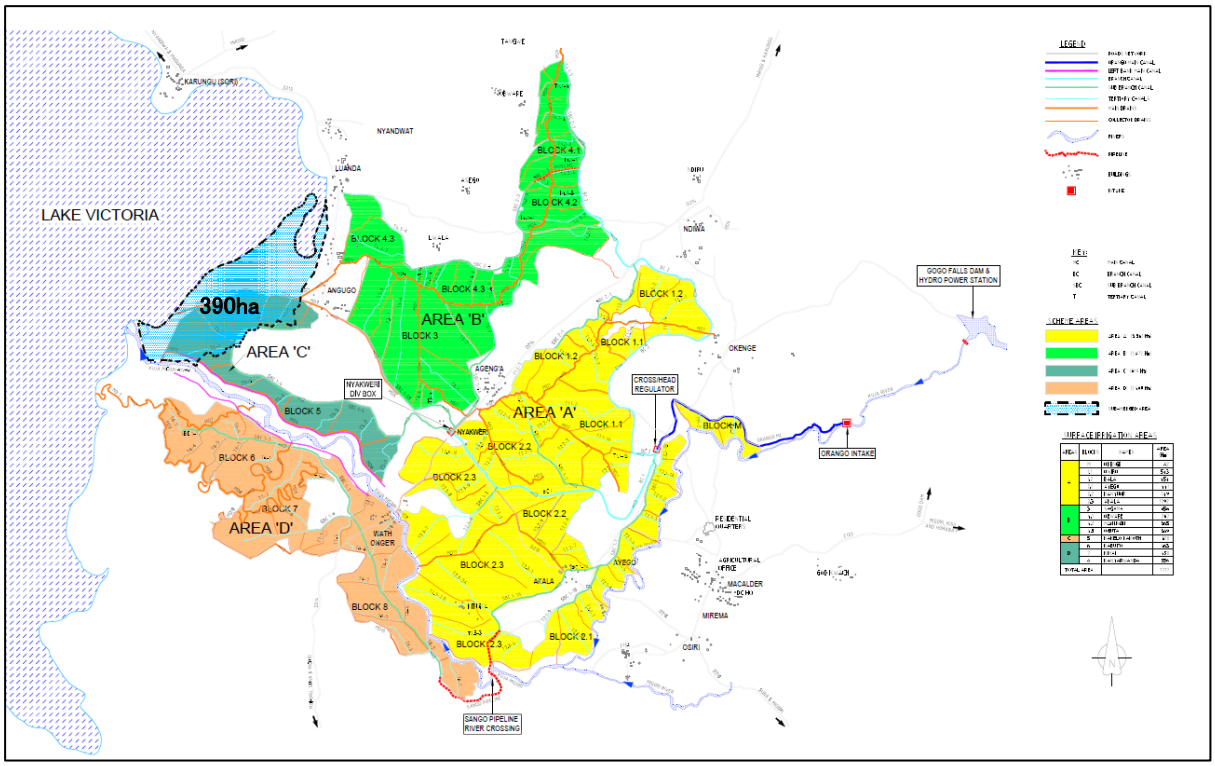
(iii) Influence Area by Water Level of Lake Victoria

Although the water level of Lake Victoria has a decreasing trend, the influence area is evaluated based on the water level (1,135 m) considering wave action and fluctuation. Block 5 of the Lower Kuja Irrigation Scheme is low land (swamp) along Lake Victoria based on the satellite data (July 13, 2018) as shown in Figure A3.1.5-6. According to the original development plan, this low land is planned to be developed into a paddy field.

Source: JICA Survey Team

Figure A3.1.5-6 Satellite Data of Lower Kuja

The influence (submerged) area based on 1,135 m is approximately 390 ha of Block 5 as shown in Figure A3.1.5-7.



Source: JICA Survey Team

Figure A3.1.5-7 Submerged Area of Lower Kuja Irrigation Scheme (Block 5)

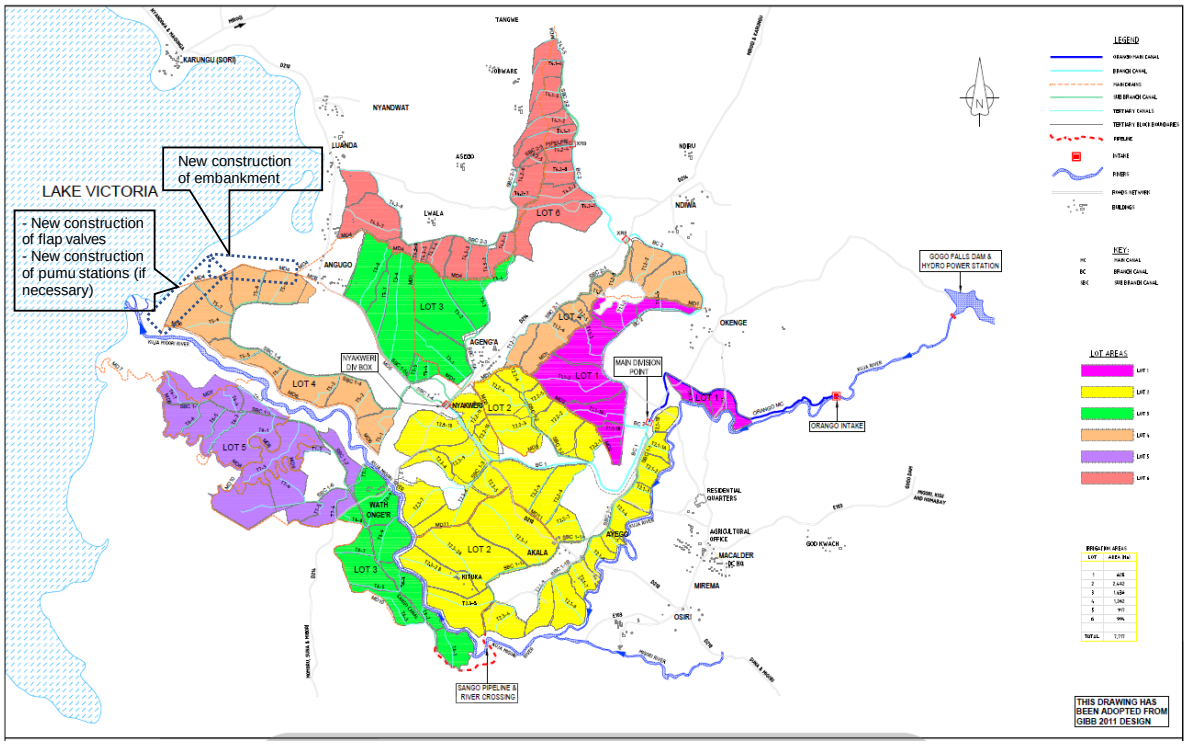
(iv) Countermeasures

a.) Construction of dykes along Lake Victoria

The dykes, which is 6 km in length, along Lake Victoria are constructed due to the reduction of the influence of water level in Lake Victoria as shown in Figure A3.1.5-8.

b.) Installation of flap gates for a natural drain

The flap gates are installed for the drainage of inland water in Block 5. Pump stations for drainage (solar system) are considered if they are necessary as shown in Figure A3.1.5-8.



Source: JICA Survey Team

Figure A3.1.5-8 Flood Countermeasures of Lower Kuja Irrigation Scheme

5) Comparison of Sango Pipeline and the New Intake

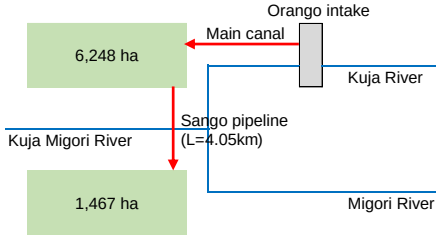
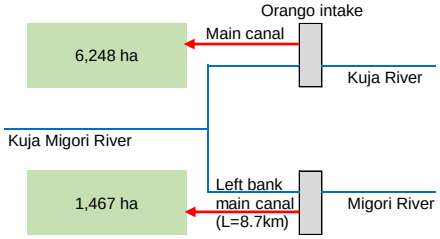
(i) Purpose

According to the original development plan, the Sango Pipeline crosses over the Kula-Migori River, which has a length of 4.05 km. The new intake at the Migori River is evaluated through its comparison with the original plan.

(ii) Comparison

Based on the design water level at the starting point of the Sango Canal and the canal longitudinal slope (1/2,500), the intake point is located at the upper 8.7 km form the pipeline. This length is more than the Sango Pipeline (4.05 km). The Sango Pipeline is better than the new intake option as shown in Table A3.1.5-11.

Table A3.1.5-11 Comparison of the Two Irrigation Systems

Option	Option 1 Sango Pipeline	Option 2 New Intake and Left Bank Main Canal
Diagram		
Irrigation area	Right bank: 6,248 ha Left bank: 1,467 ha (7,717 ha in total)	Right bank: 6,248 ha Left bank: 1,467 ha (7,717 ha in total)

Water resources	Kuja River (right and left bank)	Kuja River (right bank) Migori River (left bank)
Design flow	1.11 m^3/s	1.17 m^3/s 1)
Facilities	Sango pipeline: L=4.05 km 2), Diameter=800 to 600 mm, steel pile	Weir: L=60 m, Left bank main canal: L=8.7 km, steel pipe
Cost	Ksh 117 million	Ksh 395 million
Evaluation	**Better** (Sango Pipeline length is less than left bank main canal length.)	-

1): 1.11/0.95=1.17 m^3/s (5% conveyance loss)

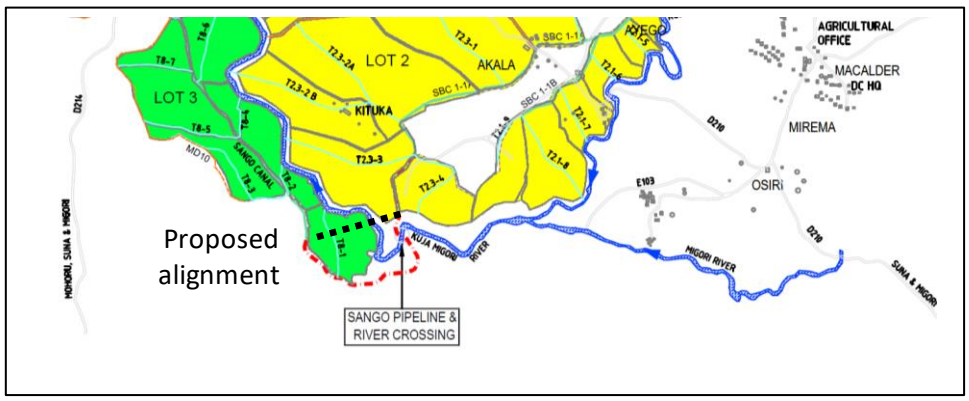
2): Based on the latest design drawings

Source: JICA Survey Team

6) Improvement of the Sango Pipeline

(i) Alignment

In case that the end point of SBS 1-1A (beginning point of Sango Pipeline) and the beginning point of the Sango Canal (end point of Sango Pipeline) is connected by a straight alignment, the pipeline length will only be 2.1 km as shown in Figure A3.1.5-9. The balance 1.95 km is reduced and the pipe diameter may be also reduced due to the reduction of energy loss.



Source: JICA Survey Team

Figure A3.1.5-9 Proposed Alignment of the Sango Pipeline

(ii) Pipe Diameter

According to the original design, the pipe diameter is reduced from 800 mm to 700 mm at the chainage 1,520 m after crossing the Kuja-Migori River. If the pipe diameter is reduced before crossing the river, the size of the river crossing structures might be smaller than the original design.

(iii) Related Structures

The location of the sluice valves, air valves, and blow off structures are reviewed with the approaches presented below:

- Sluice valve: Installation at the starting point due to repair for accident and maintenance work.
- Air valve: Installation at suitable locations, these are limited to only three (3) valves every 4.05 km and are not positioned at convex points.

- Blow off structure: Installation at suitable (concave) location for example; Kuja-Migori River, around a chainage of 2,140 m, 3,000 m, 3,240 m, etc.

7) Impact of Environment

This scheme is a new irrigation development. Existing land use of the command areas is evaluated using satellite data. Upland and pasture areas are identified as developed land, while the swamp area is classified as undeveloped land. A part of the irrigation blocks is classified as undeveloped land. These occupy 7.1% of the total command area as shown in Table A3.1.5-12. The land use is evaluated by using satellite data in this survey. Ownership and land category should be surveyed to evaluate JICA environment category.

Table A3.1.5-12 Evaluation of Land Use

Block	Area (ha)	Development		Undevelopment	
		(ha)	(%)	(ha)	(%)
Block M	82	82.0	100.0	0.0	0.0
Block 1-1	543	514.4	94.7	28.6	5.3
Block 1-2	454	454.0	100.0	0.0	0.0
Block 2-1	441	432.1	98.0	8.9	2.0
Block 2-2	749	749.0	100.0	0.0	0.0
Block 2-3	1,292	1292.0	100.0	0.0	0.0
Block 3	856	856.0	100.0	0.0	0.0
Block 4-1	267	249.0	93.3	18.0	6.7
Block 4-2	365	290.2	79.5	74.8	20.5
Block 4-3	389	316.4	81.3	72.6	18.7
Block 5	810	512.9	63.3	297.1	36.7
Block 6	463	463.0	100.0	0.0	0.0
Block 7	450	402.9	89.5	47.1	10.5
Block 8	556	556.0	100.0	0.0	0.0
Total	7,717	7,170	92.9	547	7.1

Source: JICA Survey Team

<Alternative>

Low land (swamp) areas occupy a large part of undeveloped land. Although uncommand areas between Block 5 and Block 3 are not suitable for cultivation according to the original development plan, the areas should be evaluated for paddy field based on the detailed soil survey in the next stage.

8) Compensation Areas

Compensation (land acquisition) areas as changed land category without a main canal and Block M are completed as shown in Table A3.1.5-13. Ninety-five percent of the compensation is completed as of August, 2019, based on NIA. Detailed calculation is given in Table B3.4-5 to Table B3.4-11.

Table A3.1.5-13 Compensation Area of the Lower Kuja Irrigation Scheme

Facility		Area (ha)	Remarks
Canal	Main	0.0	
	Branch	42.7	
	Sub-branch	117.5	
	Tertiary	379.1	without Block M
Drain	Main	57.9	
	Collector	71.9	without Block M
Dyke		37.5	
Total		706.5	

Source: JICA Survey Team

9) Gogo Falls Dam Plan

(i) Project Objectives

The primary purpose of the proposed dam is to provide storage to irrigate additional areas in the Lower Kuja basin.

(ii) Development Scenario

Two different development scenarios are considered to size the reservoir as shown in Table A3.1.5-14.

- Estimation of reservoir volume corresponding to the maximum supportable irrigation area
- Estimation of reservoir volume for 15,000-ha irrigation area

(iii) Basic Features

Two cases are proposed based on the development scenarios.

Table A3.1.5-14 Two Cases Based on Scenarios

	Case 1: Maximum irrigation area	Case 2: 15,000-ha irrigation area
Demand efficiency	45%	45%
Domestic water demand (m^3/s)	1.5	1.5
Live storage (Mm^3)	127.0	82.0
Total reservoir volume (Mm^3)	155.0	110.0
Supportable area (ha)	25,000	15,000

Source: Gogo Falls Dam Report (December 2010)

(iv) Proposed Dams

Two dam types are proposed as shown in Table A3.1.5-15.

Table A3.1.5-15 Summary of Dam Options

Items	Gogo Falls Dam		Katieno Dam	
Dam height	34 m	36 m	21 m	23 m
Crest length	440 m	460 m	780 m	820 m
Total storage volume	110 Mm^3	155 Mm^3	110 Mm^3	155 Mm^3
Reservoir area	17 km^2	23 km^2	20 km^2	26 km^2
Dam type	RCC/ CFRD	RCC/ CFRD	RCC/ CFRD	RCC/ CFRD

Source: Prepared by the JICA Survey Team based on "Gogo Falls Dam Report".

3.1.6 Potential Cooperation Program

(1) Ahero Irrigation Scheme

The development plan for the Ahero Irrigation Scheme is prepared based on the mentioned analysis and considerations. Main points are the intake system (pumping system or gravity system), the canal system (no expansion or partly expansion or full expansion), and the flood dyke to prevent flood damage.

The components for the development plan are proposed below.

1-1. Intake by pump: Rehabilitation or upgrading of pumps

1-2. Intake by gravity: Existing or expansion of irrigation area

1-3. Canals: Rehabilitation of areas with no expansion, partial expansion based on water availability, or full expansion

1-4. Flood dyke: Improvement

The development plan is prepared with respect to the components shown in Table A3.1.6(1)-1.

Table A3.1.6(1)-1 Development Plan of the Ahero Irrigation Scheme

Category	Components		No.	Details			Quantity	Remarks
1-1. Intake by pump	Rehabilitation of Pump system (normal)	Rehabilitation	1	1-1	Pump type 1	Q=1.1m^3/s	N= 2 nos.	
				1-2	Pump type 2	Q=0.66 m^3/s	N= 2 nos.	
	Upgrading of pump system with new technology (e.g. solar system)	Upgrading	2	1-1	Pump type 1	Q=1.1m^3/s	N= 2 nos.	
				1-2	Pump type 2	Q=0.66 m^3/s	N= 2 nos.	
				2-1	Solar system	Q=1.1m^3/s	N= 1 set	
				2-2	Solar system	Q=0.66 m^3/s	N= 1 set	
1-2. Intake by gravity	Introduction of the gravity system without dam (no expansion, Ahero: 867ha)	New construction	3	3-1	Headworks	L=58.5 m, H=5.5 m	N= 1 set	(4)
				3-2	Conveyance canal	Q=2.2 m^3/s, Open cannel	L= 10 km	(4)
	Introduction of the gravity system with Koru dam upto (Extenshion: 3,414 ha, including existing Ahero (867ha) and West Kano (892ha) : 5,173 ha in total)	New construction	4	4-1	Dam	Live storage = 71.7 MCM	N= 1 set	(2) p.ii -
				3-1	Headworks	L=58.5 m, H=5.5 m	N= 1 set	(4)
				4-2	Conveyance canal	Open channel, Q=6.6m^3/s	L= 10 km	(4)
1-3. Canal	Rehabilitation of existing canal system (no expansion, Ahero: 867 ha)	Rehabilitation	5	5-1	Main canal	Q= 1.76m^3/s	L= 9.7 km	(6)
				5-2	Secondary canal	Q= m^3/s	L= 85.4 km	(6)
				5-3	Tertiary drain		L= 93.5 km	(6)
				5-4	Farm road	W=5m, Soil pavement	L= 65 km	(3) p.3-22
				5-5	Farm road (evacuation road)	Height: half of dyke	L= 5 km	(5)
	Introduction of new canal system in extension aera (a part of extension area: 451 ha)	New construction	6	6-1	Canal system		A= 451 ha	
	Introduction of new canal system in extension aera (Extension: 3,414 ha+W Kano: 892ha = 4,306 ha)	New construction	7	7-1	Main canal (expanded)	Q=3.2 m^3/s	L= 4.9 km	(1) p.11-9
				7-2	New main canal 1	Q=0.89 m^3/s	L= 1.3 km	(1) p.11-9
				7-3	New main canal 2	Q=2.2 m^3/s	L= 1.6 km	(1) p.11-9
				7-4	Secondary canal (area 1)	B=1.2 m	L= 37.9 km	(1) p.11-9 -
				7-5	Secondary canal (area 2)	B=1.2 m	L= 30.1 km	(1) p.11-9 -
				7-6	Secondary canal (area 3)	B=1.2 m	L= 7.6 km	(1) p.11-9 -
				7-7	Secondary canal (area 4)	B=1.2 m	L= 8.3 km	(1) p.11-9 -
				7-8	Secondary drainage (area 1)	B=1.0 m	L= 35.8 km	(1) p.11-9 -
				7-9	Secondary drainage (area 2)	B=1.0 m	L= 20.9 km	(1) p.11-9 -
				7-10	Secondary drainage (area 3)	B=1.0 m	L= 5.1 km	(1) p.11-9 -
				7-11	Secondary drainage (area 4)	B=1.0 m	L= 3.4 km	(1) p.11-9 -
				7-12	Tertiary canals		L= 90.6 km	(1) p.11-9 -
				7-13	Tertiary drainages		L= 93.3 km	(1) p.11-9 -
1-4. Flood dyke	Improvement of flood protection dyke	Improvement	8	8-1	Dyke (protection from flood caused by upper area of Ahero area)	Height: half of Nyando river dyke	L= 13.7 km	(1) p.11-9 -
				8-2	Dyke (protection form flood caused by Nyando river)	Size: Nyando river dyke	L= 8.0 km	(5)

Remarks:
(1) Detailed Design and preparation of bidding documents for Ahero and West Kano Irrigation Schemes Development Project, Final Design Reprt (Ahero and West Kano D/D Report)
(2) Soin-Koru Multipurpose Dam, Final Design Report Volume I
(3) JIID Report (2018)
(4) Consultancy services for review of detailed design and tender documents and supervision of construction works (May. 2013)
(5) The study on integrated flood management for Nyando river basin in republic of Kenya, Final report (2009 JICA)
(6) JICA Survet Team based on location map

Source: JICA Survey Team

(2) West Kano Irrigation Scheme

The development plan for the West Kano Irrigation Scheme is prepared based on the mentioned analysis and considerations. Main points are the intake system (normal pump or solar pump), the canal rehabilitation to improve water distribution, and flood dykes to prevent flood damage.

The components for the development plan are proposed below.

1-1. Intake by pump: Rehabilitation or upgrading of pumps

1-2. Canals: Rehabilitation

1-3. Flood dyke: Improvement

The development plan is prepared with respect to the components shown in Table A3.1.6(2)-1.

Table A3.1.6(2)-1 Proposed Development Plan of the West Kano Irrigation Scheme

Category	Components		No.	Details			Quantity		Remarks
1-1. Intake by pump	Rehabilitation of Pump system (normal)	Rehabilitation	1	1-1	Pump type 1 (Irrigation)	Q=0.75m^3/s	N=	3 nos.	Replace, (2)
				1-2	Pump type 2 (Drainage)	Q=0.13 m^3/s	N=	2 nos.	Replace, (2)
				1-3	Pump type 3 (Drainage)	Q= 0.5 m^3/s	N=	2 nos.	Replace, (2)
				1-4	Flap gate		N=	2 nos.	Replace, Proposal
	Rehabilitation of pump system with new technology (solar system)	Rehabilitation	2	1-1	Pump type 1 (Irrigation)	Q=0.75m^3/s	N=	3 nos.	Replace, (2)
				1-2	Pump type 2 (Drainage)	Q=0.13 m^3/s	N=	2 nos.	Replace, (2)
				1-3	Pump type 3 (Drainage)	Q= 0.5m^3/s	N=	2 nos.	Replace, (2)
				2-1	Solar system 1 (Irrigation)	Q=0.75m^3/s	N=	2 set	New
				2-2	Solar system 2 (Irrigation)	Q=0.13 m^3/s	N=	1 set	New
				2-3	Solar system 3 (Irrigation)	Q= 0.5m^3/s	N=	1 set	New
				1-4	Flap gate	H:1.5m, W=1.5m	N=	2 nos.	Replace, Proposal
1-2. Canals	Rehabilitation of existing canal system	Rehabilitation	3	3-1	Approach canal		L=	2.2 km	(4)
				3-2	Main canal	Earth	L=	8.7 km	(4)
				3-3	Tertiary canal	Earth	L=	55.5 km	(4)
				3-4	Main drainage canal	Earth	L=	9.1 km	(4)
				3-5	Tertiary drainage canal	Earth	L=	102.5 km	(4)
				3-6	Farm road	W=5m, Soil pavement	L=	70 km	(3)
				3-7	Farm road (evacuation road)	Height: half of Nyando river dyke	L=	2 km	(4)
1-3. Flood dyke	Improvement of flood protection dyke	Rehabilitation	4	4-1	Dyke	Height: half of Nyando river dyke	L=	15 km	(4)

Remarks:
(1) Detailed Design and preparation of bidding documents for Ahero and West Kano Irrigation Schemes Development Project, Final Design Reprt (Ahero and West Kano D/D Report)
(2) Field survey (17 /Jul./ 2019)
(3) JIID Report (2018)
(4) Drawings (prepared by JICA Survey Team)

Source: JICA Survey Team

(3) Southwest Kano Irrigation Scheme

The development plan for the Southwest Kano Irrigation Scheme is prepared based on the mentioned analysis and considerations. The main points are the intake structure to prevent silting from the Nando River, the canal rehabilitation to recover function and to remove silting soil from the canals, and flood dykes to prevent flood damage.

The components for the development plan are proposed below.

1-1. Intake by gravity: Improvement

1-2. Canals: Rehabilitation

1-3. Flood dyke: Improvement

The development plan is prepared with respect to the components shown in Table A3.1.6(3)-1

Table A3.1.6(3)-1 Proposed Development Plan of the Southwest Kano Irrigation Scheme

Category	Components		No.	Details			Quantity	Remarks
1-1. Intake by gravity	Improvement fo intake structure	Improvement	1	1-1	Improvement fo intake structure	H=1.3 m, concrete	L= 44 m	(1)
1-2. Canals	Rehabilitation of canal system	Rehabilitation	2	1-2-1	Rehabilitation of canal system	By pass canal, earth	L= 500 m	(5)
				1-2-2		By pass canal, dredging	V= 20,000 m^3	(5)
				1-3		Pipeline, concrete, D=1500mm	L= 750 m	(1)
							L= 750 m	(1)
				1-4		Main canal, open channel, W=12.25m, B=3.25m, H=2.0m, earth	L= 2,400 m	(1)
				1-5		Main dranage	L= 13,400 m	(3)
				1-6		Tertiary canal	L= 4,000 m	(5)
				1-7		Tertiary drain	L= 4,000 m	(5)
				1-8		Road	L= 40,000 m	(5)
1-3. Flood dyke	Improvement of flood protection dyke	Improvement	3	1-6	Improvement of flood protection dyke (right bank)	Size: Nyando river dyke	L= 7 km	(4)

Remarks:
(1) South West Kano Irriagtion Project Phase 1, Draft Final Design Drawings (March 1987)
(2) JIID Report (2018) p.3-52
(3) Prepared by JICA Survey Team based on the existing plan
(4) Field survey
(5) Google map

Source: JICA Survey Team

(4) Lower Kuja Irrigation Scheme

The development plan for the Lower Kuja Irrigation Scheme is prepared based on the mentioned analysis and considerations. Main points are the intake rehabilitation to avoid more damage, the canal system to irrigate paddy fields (2,345 ha or 4,670 ha or 7,717 ha), and flood dykes to prevent flood damage.

The components for the development plan are proposed below.

1-1. Dam: Construction of the New Gogo Falls Dam

1-2. Intake by gravity: Rehabilitation of headworks

1-3. Canal plan A: 7,717 ha (Paddy; 2.375 ha, upland crop; 5,342 ha)

1-4. Canal plan B: 7,717 ha (Paddy; 4,670 ha, upland crop; 3,047 ha)

1-5. Canal plan C: 7,717 ha (Paddy; 7,717 ha, upland crop; 0 ha)

1-6. Canal plan (new development): 16,400 ha (paddy; 5,047 ha, upland crop; 11,353 ha) [1)]

1-7. Flood dyke: New construction

Note 1): Extension area is 16,400 ha (41,000 acre) based on the interview with NIA Lower Kuja. According to the Gogo Falls Dam Report (December 2010), the irrigable area is 15,000 ha. The JICA Survey Team evaluated the extension area to be 16,400 ha.

The development plan is prepared with respect to the components shown in Table A3.1.6(4)-1.

Table A3.1.6(4)-1 Development Plan of the Lower Kuja Irrigation Scheme

Category		Components		No.		Details		Quantity	Remarks
1-1. Dam		Dam development	New construction	1	3-1	Dam	Live storage = MCM	N= 1 set	
					3-2				
1-2. Intake by gravity		Rehabilitation of headworks	Rehabilitation	2	2-1	Headworks	L=60m, H=4m	N= 1 set	
					2-2				
Canal	1-3. Plan A (paddy: 2,375ha)	Rehabilitation of existing canal system	Rehabilitation	3	3-1-A	Main canal		L= 7.3 km	(1)p.5-7
					3-2-A	Branch canal		L= 0 km	(1)p.5-7
					3-3-A	Sub-branch canal		L= 0 km	(1)p.5-7
					3-4-A	Sango pipeline		L= 0 km	(1)p.5-8
					3-5-A	SBC 2-3 pipeline		L= 0 km	(1)p.5-8
					3-6-A	Tertiary canal		L= 1.1 km	(1)p.5-9
					3-7-A	Tertiary pipeline	Q=0.18～0.92 m3/s (GI)	L= 0 km	(1)p.5-9
					3-8-A	Feeder canal		L= 4.8 km	(1)p.5-10
					3-9-A	Main drain		L= 0 km	(1)p.5-11
					3-10-A	Field drain		L= 4.7 km	(1)p.5-11
					3-11-A	Collector drain		L= 1.6 km	(1)p.5-11
					3-12-A	Access road		L= 0 km	(1)p.5-15
		New development canal system upto 7,717ha	New construction	4	3-1-A	Main canal		L= 0 km	(1)p.5-7
					3-2-A	Branch canal		L= 21.4 km	(1)p.5-7
					3-3-A	Sub-branch canal		L= 55.7 km	(1)p.5-7
					3-4-A	Sango pipeline		L= 3.9 km	(1)p.5-8
					3-5-A	SBC 2-3 pipeline		L= 1.4 km	(1)p.5-8
					3-6-A	Tertiary canal		L= 121.8 km	(1)p.5-9
					3-7-A	Tertiary pipeline	Q=0.18～0.92 m3/s (GI)	L= 15.5 km	(1)p.5-9
					3-8-A	Feeder canal		L= 299.4 km	(1)p.5-10
					3-9-A	Main drain		L= 90.9 km	(1)p.5-11
					3-10-A	Field drain		L= 225.9 km	(1)p.5-11
					3-11-A	Collector drain		L= 113.8 km	(1)p.5-11
					3-12-A	Access road		L= 212 km	(1)p.5-15
		Land consolidation	Rehabilitation	5	3-13-A	Paddy field		A= 60 ha	
			New construction		3-14-A	Paddy field		A= 2,315 ha	
			Rehabilitation		3-15-A	Upland crop		A= 22 ha	
			New construction		3-16-A	Upland crop		A= 5,320 ha	
	1-4. Plan B (paddy: 4,670 ha)	Rehabilitation of existing canal system	Rehabilitation	6	3-1-B	Main canal		L= 7.3 km	(1)p.5-7
					3-2-B	Branch canal		L= 0 km	(1)p.5-7
					3-3-B	Sub-branch canal		L= 0 km	(1)p.5-7
					3-4-B	Sango pipeline		L= 0 km	(1)p.5-8
					3-5-B	SBC 2-3 pipeline		L= 0 km	(1)p.5-8
					3-6-B	Tertiary canal		L= 1.1 km	(1)p.5-9
					3-7-B	Tertiary pipeline		L= 0 km	(1)p.5-9
					3-8-B	Feeder canal		L= 4.8 km	(1)p.5-10
					3-9-B	Main drain		L= 0 km	(1)p.5-11
					3-10-B	Field drain		L= 4.7 km	(1)p.5-11
					3-11-B	Collector drain		L= 1.6 km	(1)p.5-11
					3-12-B	Access road		L= 0 km	(1)p.5-15
		New development canal system upto 7,717ha	New construction	7	3-1-B	Main canal		L= 0 km	(1)p.5-7
					3-2-B	Branch canal		L= 21.4 km	(1)p.5-7
					3-3-B	Sub-branch canal		L= 55.7 km	(1)p.5-7
					3-4-B	Sango pipeline		L= 3.9 km	(1)p.5-8
					3-5-B	SBC 2-3 pipeline		L= 1.4 km	(1)p.5-8
					3-6-B	Tertiary canal		L= 121.8 km	(1)p.5-9
					3-7-B	Tertiary pipeline		L= 15.5 km	(1)p.5-9
					3-8-B	Feeder canal		L= 299.4 km	(1)p.5-10
					3-9-B	Main drain		L= 90.9 km	(1)p.5-11
					3-10-B	Field drain		L= 225.9 km	(1)p.5-11
					3-11-B	Collector drain		L= 113.8 km	(1)p.5-11
					3-12-B	Access road		L= 212 km	(1)p.5-15
		Land consolidation	Rehabilitation	8	3-13-B	Paddy field		A= 60 ha	
			New construction		3-14-B	Paddy field		A= 4,610 ha	
			Rehabilitation		3-15-B	Upland crop		A= 22 ha	
			New construction		3-16-B	Unland crop		A= 3,025 ha	
	1-5. Plan C (paddy: 7,717ha)	Rehabilitation of existing canal system	Rehabilitation	9	3-1-C	Main canal		L= 7.3 km	(1)p.5-7
					3-2-C	Branch canal		L= 0 km	(1)p.5-7
					3-3-C	Sub-branch canal		L= 0 km	(1)p.5-7
					3-4-C	Sango pipeline		L= 0 km	(1)p.5-8
					3-5-C	SBC 2-3 pipeline		L= 0 km	(1)p.5-8
					3-6-C	Tertiary canal		L= 1.1 km	(1)p.5-9
					3-7-C	Tertiary pipeline		L= 0 km	(1)p.5-9
					3-8-C	Feeder canal		L= 4.8 km	(1)p.5-10
					3-9-C	Main drain		L= 0 km	(1)p.5-11
					3-10-C	Field drain		L= 4.7 km	(1)p.5-11
					3-11-C	Collector drain		L= 1.6 km	(1)p.5-11
					3-12-C	Access road		L= 0 km	(1)p.5-15
		New development canal system upto 7,717ha	New construction	10	3-1-C	Main canal		L= 0 km	(1)p.5-7
					3-2-C	Branch canal		L= 21.4 km	(1)p.5-7
					3-3-C	Sub-branch canal		L= 55.7 km	(1)p.5-7
					3-4-C	Sango pipeline		L= 3.9 km	(1)p.5-8
					3-5-C	SBC 2-3 pipeline		L= 1.4 km	(1)p.5-8
					3-6-C	Tertiary canal		L= 121.8 km	(1)p.5-9
					3-7-C	Tertiary pipeline		L= 15.5 km	(1)p.5-9
					3-8-C	Feeder canal		L= 299.4 km	(1)p.5-10
					3-9-C	Main drain		L= 90.9 km	(1)p.5-11
					3-10-C	Field drain		L= 225.9 km	(1)p.5-11
					3-11-C	Collector drain		L= 113.8 km	(1)p.5-11
					3-12-C	Access road		L= 212 km	(1)p.5-15
		Land consolidation	Rehabilitation	11	3-13-C	Paddy field		A= 60 ha	
			New construction		3-14-C	Paddy field		A= 7,657 ha	
			Rehabilitation		3-15-C	Upland crop		A= 0 ha	
			New construction		3-16-C	Upland crop		A= 0 ha	
	1-6. New development of canal system upto 16,400 ha (41,000 acre)		New construction	12	4-1	Canal system	Rehabilitaion	A= 82 ha	
					4-2	Canal system	New construction	A= 16,318 ha	
					4-3	Land consolidation (paddy)		A= 5,047 ha	
					4-4	Land consolidation (upland)		A= 11,353 ha	
Flood dyke	1-7. New development of flood dyke		New construction	13	6-1	Flood protection (dyke)	Kuja river	L= 15.0 km	(1)p.5-15
							Lake Victoria	L= 6 km	(2)
					6-2	Drain pump station	(if necessary)	N= 1 nos.	
					6-3	Flap valve	H:1.5m, W:1.5m	N= 6 nos.	

Remarks:
(1)Final Detailed Design Report (june 2011) (Lower Kuja)
(2) Prepared JICA Survet Team

Source: JICA Survey Team

3.2 Agricultural Practice and Extension

3.2.1 Rice Production

(1) Rice Production in Kenya

In Kenya, small-scale farmers have produced rice as a commercial food crop in irrigation schemes, non-irrigated lowland and upland areas over the years. Rice production in Kenya is estimated at 91,600 tons from about 28,000 ha of land in 2017/18.[1] The following table shows rice production in three major production conditions in Kenya in 2017/18.

Table A3.2.1-1 Overall Rice Production in Kenya in 2017/18

Production Condition	Area (ha)	Annual Total Area (ha)	Production (paddy) (ton)	Average Yield (paddy) (ton/ha)
Irrigated Land	19,000	31,350	76,000	4.0
Rainfed Lowland	5,000	5,000	10,000	2.0
Rainfed Upland	4,000	4,000	5,600	1.4
Total	28,000	-	91,600	3.3

Source: National Rice Development Strategy (2008-2018) Evaluation Report, MoALFI

In Kenya, small-scale farmers in major irrigation schemes such as Mwea, Ahero, West Kano, and Bunyala mainly produce rice. The table below shows rice productions in the major irrigation schemes in Kenya from 2011/12 to 2016/17. Ahero and West Kano Irrigation schemes are the second and the third largest schemes and important rice production areas in Kenya.

Table A3.2.1-2 Rice Production in Major Irrigation Schemes in Kenya

Major Scheme	Item	Year					
		2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Mwea	Area Planted (ha)	10,629	10,629	10,629	10,629	10,629	17,146
	Number of Plots-holders	7,176	7,178	7,178	7,178	7,178	7,178
	Production (ton)	50,476	64,672	70,416	91,624	78,760	59,291
	Yield (ton/ha)	4.7	6.1	6.6	8.6	7.4	3.5
Ahero	Area Planted (ha)	1,215	1,215	1,249	1,687	939	718
	Number of Plots-holders	946	946	946	946	566	899
	Production (ton)	7,484	8,326	7,405	7,942	6,494	7,752
	Yield (ton/ha)	6.2	6.9	5.9	4.7	6.9	10.8
West Kano	Area Planted (ha)	1,299	484	387	387	670	892
	Number of Plots-holders	780	780	780	780	817	817
	Production (ton)	5,994	5,165	4,345	2,039	4,634	4,083
	Yield (ton/ha)	4.6	10.7	11.2	5.3	6.9	4.6
Bunyala	Area Planted (ha)	682	607	618	694	694	658
	Number of Plots-holders	253	253	253	253	1,394	1,393
	Production (ton)	4,666	4,278	4,289	4,600	4,522	3,632
	Yield (ton/ha)	6.8	7.0	6.9	6.6	6.5	5.5
All Schemes	Area Planted (ha)	21,101	18,600	19,411	13,988	14,586	21,949
	Number of Plots-holders	15,828	15,828	15,828	13,055	13,055	16,326
	Production (ton)	80,244	90,703	96,029	116,473	101,510	81,198
	Yield (ton/ha)	3.8	4.9	4.9	8.3	7.0	3.7

Source: NIA and Kenya National Bureau of Statistics

In recent years, large-scale producers are emerging, for example the Dominion Farms in Siaya County. According to the MoALFI, about 300,000 small-scale farmers derive a greater part of their livelihood from rice production. The consumption of rice is increasing at an annual rate of 12% as compared with 4% for wheat and 1% maize. This trend has been attributed to changing eating habits due to increased urbanisation and middle-class growth. The annual national rice consumption is estimated at 300,000 tons compared with an annual estimated production of 80,000 tons. The deficit is compensated through imports, which is valued at KES 10 billion in 2014. The promotion of rice production and market access

[1] Source: NRDS 2008-2018 Evaluation Report, MoALFI

among smallholder producers could therefore improve food security, increase smallholder farmers' income, and eventually reduce the rice import.[2]

Table A3.2.1-3 Overall Rice Production in Kenya from 2011/12 to 2016/17

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Area Planted (ha)	13,222	15,940	23,106	16,457	16,734	17,315
Production (ton)	49,290	57,941	64,840	47,256	73,141	75,167
No. of 50 kg Bags	986,801	1,158,929	1,296,811	945,118	1,462,820	1,503,340
Average Yield (ton/ha)	3.7	3.6	2.8	2.9	3.0	3.2
Value (KES billion)	1.3	0.9	3.3	2.7	2.4	2.6
Consumption (ton)	270,200	279,800	286,000	293,722	295,600	301,000
Surplus/Deficit (ton)	-220,910	-221,859	-221,160	-246,466	-227,859	-225,833
Annual Deficit as % of Total Requirement	82%	79%	77%	84%	76%	74%

Source: MoALFI

(2) Rice Production in the Lake Victoria Basin Region

In the Lake Victoria Basin Region, rice is mainly produced either from the NIA irrigation schemes or from community-managed irrigation schemes. NIA irrigation schemes include the Ahero and West Kano Irrigation schemes. Focused group discussions with farmers by the International Fertiliser Development Centre (IFDC)[3] revealed that rice productivity and production in NIA irrigation schemes is higher than community-managed ones. Generally, farmers of the NIA irrigation schemes reported that they produced 25 bags of 90 kg compared with 15 bags of the community-managed schemes. The difference was mainly attributed to better water management and agronomic practices and better use of inputs such as certified seeds and fertiliser in NIA irrigation schemes unlike in the community-managed ones.[4]

In the Kisumu County, rice is increasingly becoming one of the most important cereals with demand being higher than its production. Paddy production increased from 15,460 tons in 2013/14 to 23,200 tons in 2017/18 as shown in the table below. The actual cultivated area for rice was 5,800 ha. However, about 50% is utilised annually for rice production and some horticultural crops in sequence.[5]

Table A3.2.1-4 Rice Production and Consumption Requirement in Kisumu County in 2017/18

Cultivated Area	5,800 ha
Average Production	4.0 ton/ha (50 bags) of paddy 2.2 ton/ha milled rice
Average Annual paddy production (ton or bag)	23,200 ton or 290,000 bags of paddy 12,760 ton of milled rice
Annual consumption requirement of milled rice	22,000 ton of milled rice
Average annual deficit	9,240 tons
Average paddy price per ton	KES 36,000

Note: Current annual consumption of rice per person is 18 kg. Current recovery rate of paddy is 55%.

Source: Office of the County Director of Agriculture, Kisumu County

In the Migori County, the main food crops produced in the county include cereals (maize, sorghum, rice, millet), pulses (beans, cow peas, green grams, soya beans), roots and tubers (sweet potatoes, cassava). Rice is one of the important food crops in the county. Rice is mainly produced in the Lower Kuja area under the NIA irrigation schemes. Rice productions in Migori County are as shown in the table below.

[2] Source: Identifying constraints to formal market access by small-scale rice farmers in Ahero Irrigation Scheme, Kisumu County, Joel K. Tanui, 2017

[3] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

[4] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

[5] Source: Office of the County Director of Agriculture, Kisumu County

Table A3.2.1-5 Rice Productions in Migori County during 2012/13-2014/2015

Item	2012/2013	2013/2014	2014/2015
Area Cropped (ha)	3,395	4,930	4,540
Production (ton)	14,598	18,633	18,390
Yield (ton/ha)	4.3	3.8	4.1

Source: County Statistical Abstract, Migori County, 2015

In 2018/2019, paddy was cultivated in 1,000 acres in Block 3 in the Lower Kuja Irrigation Scheme as a trial basis along with the main irrigation canal. According to the agronomists of NIA Kuja, actual production and yield were as follows. [6]

Table A3.2.1-6 Yield of Rice Production in Lower Kuja Irrigation Scheme in 2018-2019

Variety	Nov. 2018 - April 2019 (ton/ha)	May 2019 - Oct. 2019 (ton/ha)
IR 2793	7.0	6.9
Basmati	-	5.5
NERICA 4	-	3.2
Komboka	-	6.9

Source: Interview with the NIA extension agents by the JICA Survey Team

3.2.2 Rice Variety and Seed Production

(1) Rice Variety

Major irrigated rice and NERICA varieties in the Lake Victoria Basin Region and those characteristics are shown in the tables below.

Table A3.2.2-1 Major Irrigated Rice Varieties in the Lake Victoria Basin Region

Variety	Height (cm)	Duration to Maturity (days)	Yield (ton/ha)	Cooking Quality	Rice Yellow Mottle Virus (RYMW) Resistance	Blast Resistance
Basmati 217	118	122	4.6	Very good	Resistant	Susceptible
Basmati 370	118	122	5.3	Very good	Resistant	Susceptible
IR 2035-25-2	86.2	128	5.5	Good	Moderately susceptible	Moderately resistant
IR 2793-80-1	89	142	6.4	Good	Susceptible	Moderately resistant
BW 96	68	135	9.0	Fair	Susceptible	Moderately resistant
UP 254	84.2	124	6.4	Good	Moderately susceptible	Moderately resistant
AD 9246	78.2	128	5.1	Good	Moderately resistant	Moderately susceptible
IR 19090	96.6	122	5.8	Good	Moderately susceptible	Moderately resistant

Source: KENYA SEED (http://kenyaseed.com/gallery/rice/) and interview with the Ahero Irrigation Research Station (AIRS)

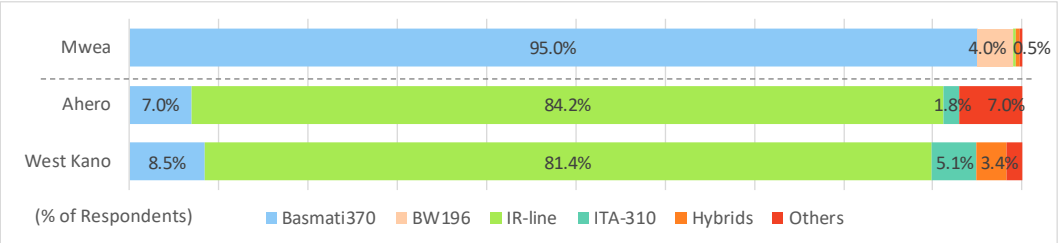
Table A3.2.2-2 Major NERICA Varieties in the Lake Victoria Basin Region

Type	Optimal Production Altitude (m)	Duration to Maturity (days)	Yield (ton/ha)	Special Attributes
NERICA 1	0-1,700	110-115	4.5	Aromatic medium tolerance to blast. Good tolerance to lodging. Long grains
NERICA 4	0-1,700	100-130	5.0	High aromatic rice. Medium tolerance to blast. Good tolerance to lodging, long rains.
NERICA 10	0-1,700	90-105	6.0	High aromatic rice. Early maturing. Long grains. Good tolerance to blast. Moderate tolerance to lodging. 6000
NERICA 11	0-1,700	130	7.0	Long grains. Good tolerance to blast. Tolerance to lodging.

Source: KENYA SEED (http://kenyaseed.com/gallery/rice/) and interview with the Ahero Irrigation Research Station (AIRS)

Currently, rice varieties planted in the Ahero and West Kano Irrigation schemes are mainly IR lines such as IR2793, while the major variety in the Mwea Irrigation Scheme are Basimati 370. The results of the questionnaire survey by CaDPERP regarding rice varieties are shown in the figure below.

[6] Source: Status Report for Lower Kuja Project, NIA, 2019



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.2-1 Cultivated Rice Variety in the Mwea, Ahero, and West Kano Irrigation Schemes

IR2793 in Lower Kuja Irrigation Scheme

Basmati in Lower Kuja Irrigation Scheme

NERICA 4 in Lower Kuja Irrigation Scheme

Source: JICA Survey Team

Figure A3.2.2-2 Pictures of Major Rice Varieties in the Lake Victoria Basin Region

(2) Seed Production and Distribution

In the Lake Victoria Basin Region, rice seeds are produced by both informal and formal seed suppliers. While the formal seed sector accounts for only about 15% of rice seeds planted in Kisumu County, the informal sector accounts for over 85% of the seeds planted. The major actors in the informal seed sector are the farmers and the non-governmental organizations (NGOs). The actors in the formal rice seed sector include the Kenya Agricultural & Livestock Research Organisation (KALRO), NIA, and the Mwea Irrigation Agricultural Development Centre (MIAD). No major private seed companies have been involved in the rice sector in the Lake Victoria Basin Region.[7]

KALRO and MIAD are also engaged in variety development. Rice seed production, multiplication and distribution in Kenya are currently under the monopoly of the MIAD. The distribution of seeds to rice farmers is through NIA or regional organisations such as the Lake Basin Development Authority (LBDA). Currently, limited rice seed is distributed through agro-dealer channels. For example, in the Ahero Irrigation Scheme, the cooperative society orders the certified seeds from MIAD through the Revolving Fund Committee and distributes to farmers in the Ahero and sometimes West Kano Irrigation Scheme and other farmers in the surrounding schemes. Major issues in the seed production are frequent late supplies, inadequate quantities, wrong type of seed, and poor-quality seed. These are the key issues around the seed system.[8] The seed production and distribution system in the Lake Victoria Basin Region is shown in the table below.

Table A3.2.2-4 Rice Seed Production and Distribution System in the Lake Victoria Basin Region

Seed Type	Production Centre	Production Quantity	Responsible Person
Breeder ↓	- Kenya Agricultural Research Institute (KARI)-Kibos - KARI-Mwea - MIAD - Baob Company	1 - 10 kg	- Researchers - Kenya Plant Health Inspectorate Service (KEPHIS)
Foundation Seed ↓	- KARI-Kibos - KARI-Mwea	100 kg	- Researchers - KEPHIS

[7] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

[8] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

Seed Type	Production Centre	Production Quantity	Responsible Person
	- Mwea Irrigation Agricultural Development Centre (MIAD) - Baob Company		
Registered Seed ↓	- KARI-Kibos - KARI-Mwea - MIAD - Baob Company	3,000 kg	- Researchers - KEPHIS - Seed Merchants
Certified Seed	- KARI-Kibos - KARI-Mwea - MIAD - Baob Company - KEPHIS	As per Market requirement	- Seed merchants - Farmers - Seed growers - Researchers - KEPHIS

Source: NRDS, MoALFI

3.2.3 Agronomic Practices in Rice Cultivation

The rice farmers' major agronomic practices are land preparation, planting, crop protection (weeding and spraying for pest/disease/bird control), fertiliser application, harvesting, threshing, drying and winnowing. The farmers' organisations and cooperative societies play important roles in training farmers on cultivation practices, group purchase of farm inputs, storage, and collective marketing.

Cultivation in Irrigated Fields: In the Lake Victoria Basin Region, rice is mainly grown in irrigated fields such as Ahero, Bunyala, West Kano, and other irrigation schemes. Rice production in those irrigation systems depends on a continuous water supply for irrigation and soils with higher water holding capacities. Moreover, if there is water scarcity during times of drought, it means that those irrigation schemes will seriously suffer from the reduction of productivity.

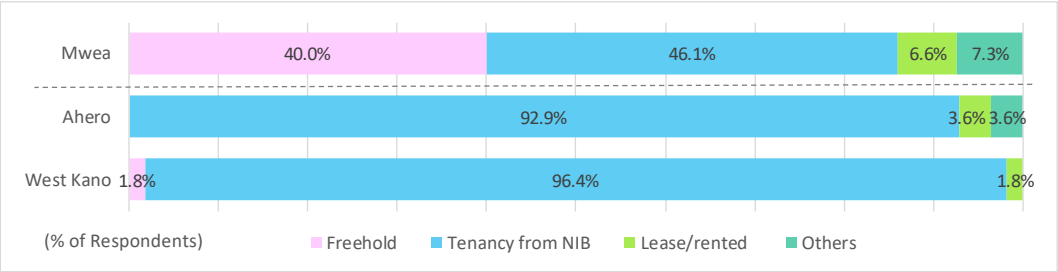
Cultivation in Upland Fields: Rice production in upland field is about 1.0 ton/ha in Kenya (Kijima et al., 2006; Africa Rice Centre, 2008). Such a low yield of rice in upland conditions is due to many constraints such as nutrient depletion, loss of organic matter in the soil, and drought. Production of rice is also easily affected by pests and diseases such as bird damage, rice midge, blast, leaf blight, and weeds.

The current situations of rice cultivation in major irrigation schemes in the Lake Victoria Basin Region are described as follows with a comparison with the Mwea Irrigation Scheme, which is recognised as one of the succeeded irrigation schemes in Kenya.

(1) Land Ownership

Over 20,000 smallholder farmers in Kisumu County are engaged in rice production as a key source of their income in the various irrigation schemes but majority of the farmers (95%) do not hold their lands.[9] In Ahero and West Kano Irrigation schemes, the land basically belongs to the government and the farmers are allocated four acres per farmer as tenants. According to the results of the questionnaire survey conducted by CaDPERP in 2019, more than 90% of farmers do not have land ownership in the Ahero and West Kano Irrigation schemes, while 40% of farmers own their land in the Mwea Irrigation Scheme as shown in the following figure. It implies that the lack of ownership would be one of the reasons of 1) poor access to credit for many farmers to buy suitable and enough farm inputs for rice cultivation, 2) hasty selling of their paddy to traders at a low price due to lack of cash in hands, and 3) demotivating farmers to use their tenanted lands maintaining soil fertility in a sustainable manner.

[9] Source: Office of the County Director of Agriculture, Kisumu County



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A.3.2.3-1 Land Ownership in the Mwea, Ahero, and West Kano Irrigation Schemes

In the Lower Kuja Irrigation Scheme, land ownership was mainly freehold with about 69.8% of households with deeds and titles. For the remaining 24.2%, they were under the registration process. Plot sizes vary between 0.02 ha – 58 ha and the average plot size of the whole area was 14.35 ha.[10] As of September 2019, works to clarify each plot boundary are still in progress by NIA.

Source: JICA Survey Team
Works to clarify plot boundaries by NIA in Lower Kuja Irrigation Scheme

(2) Cropping Calendar and Pattern

Major Rice Cropping Calendar: In Kisumu County, main rice cultivation season is from May to December of every year, with one crop cycle. Although it is naturally possible to cultivate twice, but due to market-related challenges and irrigation water availability, most farmers are not able to cultivate rice twice a year. The following table shows the typical rice cultivation works in Kisumu County.[11] The first paddy rice is transplanted from July to latest in October. The rice basically takes about four months for harvesting from November to February. Ratoon crops are often grown from October and these mature in about one and a half months although those yields are low. The main reason for late staggering planting/production is inadequate credit, farm inputs, and machinery availability.

Table A3.2.3-1 Typical Rice Cultivation Works in Kisumu County

Activity	Month
Land preparation	April/May/June
Nursery Establishment	May/June/July
Transplanting	July/August/September/October
Weeding	August/September/October
Harvesting	November/December/January/February

Source: Office of the County Director of Agriculture, Kisumu County

Cropping Pattern: Paddy rice has traditionally been the most dominant crop grown in the existing schemes in the Lake Victoria Basin Region. The current practice is to plant rice once a year followed by ratoon crop with intercrops of various horticultural and field crops. The main rice varieties grown are the non-aromatic IR-lines, BW196, ITA 310. Basmati 217 as aromatic rice is also grown but it is not very popular. The main reasons for the low uptake of basmati variety are its susceptibility to the rice blast, pest infestation, and lower yields. However, the rice variety attracts big commercial buyers such as Capwell Industries, National Cereals and Produce Board (NCBP), and United Millers, but low production due to disease and pest infestation has hampered its widespread cultivation.[12] Major cropping seasons in the Lake Victoria Basin Region are shown in the following figure.

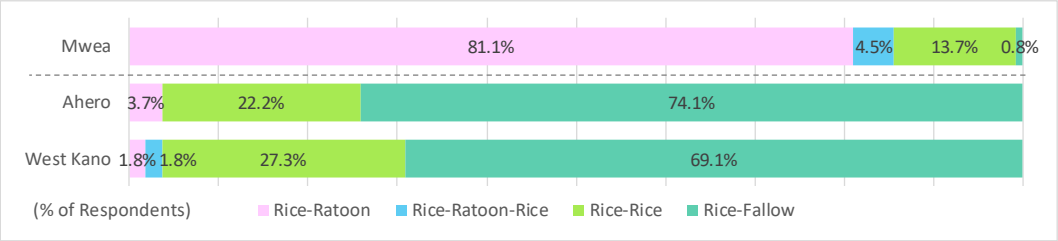
[10] Source: Final Detailed Design Report, Lower Kuja Irrigation Development Project, NIA, June 2011
[11] Source: Identifying Constraints to Formal Market Access by Small-scale Rice Farmers in Ahero Irrigation Scheme, Kisumu County, Joel K. Tanui, 2017
[12] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB and interview with NIA by the JICA Survey Team

Crop	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Rice Main Crop												
Rice Ratoon Crop												
Maize												
Sorghum												
Horticultural Crop												

Source: Interview with NIA by JICA Project Team

Figure A3.2.3-2 Major Cropping Patterns in the Lake Victoria Basin Region

The following figure shows rice production pattern in a year in the Mwea, Ahero, and West Kano Irrigation schemes. More than 80% of farmers cultivate rice in a main season followed by ratoon cultivation in a secondary season in the Mwea Irrigation Scheme. On the other hand, about 70% of farmers cultivate rice only in the main season in the Ahero and West Kano Irrigation schemes. It shows that ratoon cultivation could increase rice production in those schemes if irrigation water is available in the secondary season for the effective use of ratoons.



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-3 Cropping Patterns in Mwea, Ahero, and West Kano Irrigation Schemes

(3) Seed Use and Transplanting

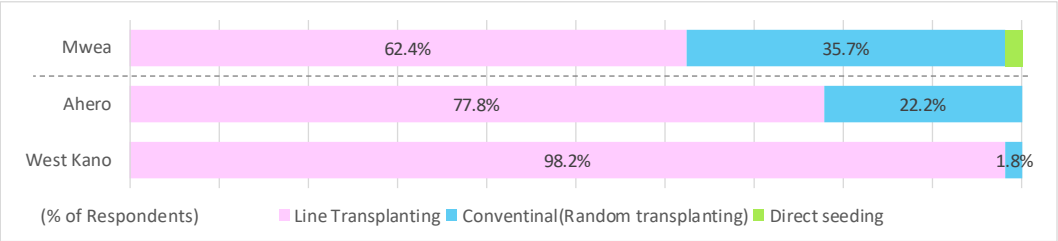
Seed Use: Rice farmers prepare land mechanically by tractors or using oxen ploughs. Only about 15% of farmers in the Ahero and West Kano Irrigation schemes reported using certified seeds. Although NIA Ahero stock and distribute certified seeds to the farmers in Ahero and West Kano. A significant number of farmers (35%) from these schemes still planted recycled seeds. One reason for the low adoption of certified seeds is the inadequate supply of certified seeds. Generally, most farmers relied on retained seed, neighbours, local market purchases, and other government agencies.[13] According to the questionnaire survey by CaDPERP, farmers recycle seeds for five years in the Ahero and West Kano Irrigation schemes.

Source: JICA Survey Team
Nursery in Mwea Irrigation Scheme

Transplanting: Seedlings are transplanted manually. Line planting method is one of the effective methods to increase rice yield by activating photosynthesis and better ventilation. According to CaDPERP Baseline Survey conducted in May 2019, the line planting method was the main practice in the Ahero and West Kano Irrigation schemes compared with the Mwea Irrigation Scheme. In addition, most farmers in the Lower Kuja Irrigation Scheme have already adopted the method due to the effort of agronomists of NIA Kuja who had been trained at the long-term training course organised by JICA Tsukuba Centre.

Source: JICA Survey Team
Line planting adopted to Lower Kuja Irrigation Scheme

[13] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)



Source: CaDPERP Baseline Survey, JICA, May 2019

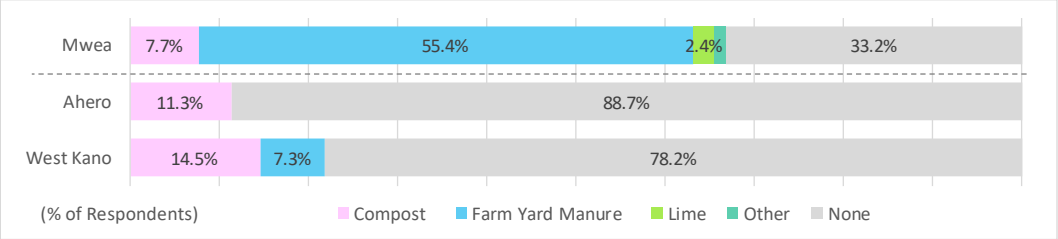
Figure A3.2.3-4 Rice Planting Methods in the Mwea, Ahero, and West Kano Irrigation Schemes

(4) Fertiliser Application

Fertiliser Supply: In Ahero and West Kano Irrigation schemes, fertilisers recommended for rice cultivation such as muriate of potassium (MOP), ammonium sulphate (SA), and urea are not easily available at private farm input dealers around Kisumu City. Apart from private farm input dealers, the National Cereal and Produce Board (NCPB) also supply fertilisers in the Lake Victoria Basin Region. NCPB sells subsidised fertilisers from the National Accelerated Agriculture Input Access Programme (NAAIAP). NGOs, CARE, FAO, Lake Basin Development Authority (LBDA), and KALRO also supply fertilisers, pesticides, and fungicides to farmers in the Ahero and West Kano Irrigation schemes.[14]

According to the interview with farmers, the cost of farm inputs such as seeds, pesticides, chemical fertiliser is high. If farmers bought these inputs as groups, they would be able to bargain for better prices. The cooperative societies in the area and other farmer groups should provide farm inputs to the member farmers at reduced costs on behalf of the individual farmers.[15]

Organic Fertiliser Application: The following figure shows the situation of organic fertiliser application at land preparation in the Mwea, Ahero, and West Kano Irrigation schemes. More than 60% of farmers in the Mwea Irrigation Scheme apply compost and livestock dung as basal fertiliser before transplanting. On the other hand, only 11.2% and 21.8% of the farmers in the Ahero and West Kano Irrigation schemes apply them, respectively. It shows that the application of an adequate amount of organic fertiliser is needed to increase rice quality and yield in the Ahero and West Kano Irrigation schemes in comparison with Mwea Irrigation Scheme where high quality rice was produced.

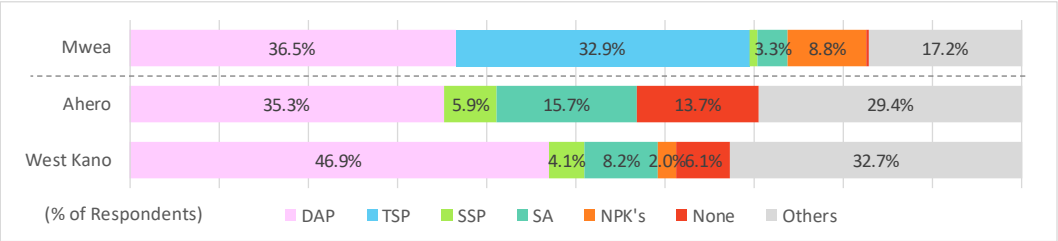


Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-5 Organic Fertiliser Use at Land Preparation in the Mwea, Ahero, and West Kano Irrigation Schemes

Chemical Fertiliser Application: Major chemical fertilisers used at the transplanting of rice are diammonium phosphate (DAP), triple superphosphate (TSP), single superphosphate (SSP), ammonium sulphate (SA), nitrogen-phosphatic-potassium fertiliser (NPK), and urea. The following figure shows the fertilisers used at the transplanting in the Mwea, Ahero, and West Kano Irrigation schemes. DAP is the most common chemical fertiliser in these areas followed by TSP in Mwea and SA in the Ahero and West Kano Irrigation schemes.

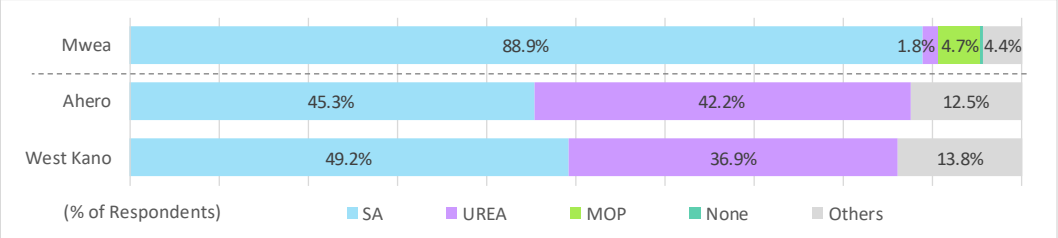
[14] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)
[15] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-6 Fertiliser Use at Transplanting in the Mwea, Ahero, and West Kano Irrigation Schemes

The following figure shows fertiliser use as top dressing in the Mwea, Ahero, and West Kano Irrigation schemes. Most farmers in Mwea use SA for top dressing. On the other hand, about 50% of the farmers in the Ahero and West Kano Irrigation schemes use urea.



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-7 Fertiliser Use as Top Dressing in the Mwea, Ahero, and West Kano Irrigation Schemes

<u>Constraints of Soil Nutrition Management</u>: The survey conducted by IFDC found that the use of fertilisers is high in the Ahero and West Kano Irrigation schemes managed by NIA compared with the community managed schemes in the Lake Victoria Basin Region. The lack of soil testing and recommendations of suitable fertilisers to farmers, and the high cost of fertiliser are the major reasons for poor nutrient management among rice farmers. In addition to the low use of fertilisers by farmers, the method of application, time, and application rates affect rice growth. Moreover, farmers apply the fertiliser late (more than 30 days after transplanting) and these application rates are low (less than 50 kg/acre). These cause the low and poor quality of the products.[16]

(5) Pest and Disease Control

In the Ahero and West Kano Irrigation schemes, rice blast is one of the major diseases. Farmers rarely apply agrochemicals to control pests and diseases, even though rice blast spreads. In addition, agro-chemicals and used bottles are not properly managed by farmers. It means that technical trainings for farmers to properly use and manage agro-chemicals and used-bottles for safety are needed.

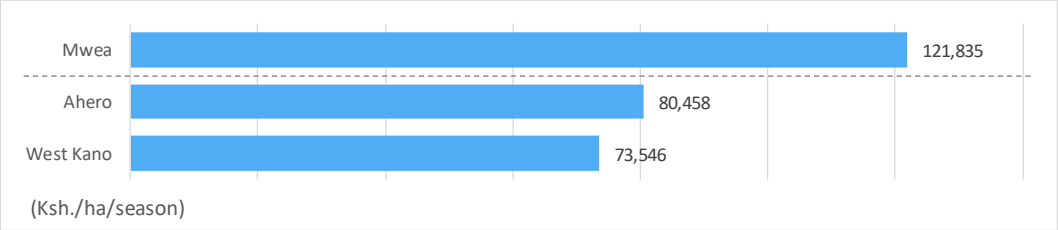
Source: JICA Survey Team
Spraying of agro-chemicals to prevent rice blast in the Lower Kuja Irrigation Scheme

Source: JICA Survey Team
A used bottle of agro-chemicals thrown away in an irrigation canal

[16] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

(6) Labour

The following figure shows the cost of labour for rice production in the Mwea, Ahero, and West Kano Irrigation schemes. The cost in the Mwea Irrigation Scheme is KES 121,835/ha/season, but those of the Ahero and West Kano Irrigation schemes were KES 80,458/ha/season and KES 73,546/ha/season, respectively, which was about 60-70% of Mwea. This implies that working in Mwea is more attractive for labourers than the Lake Victoria Basin Region because of the higher wages.



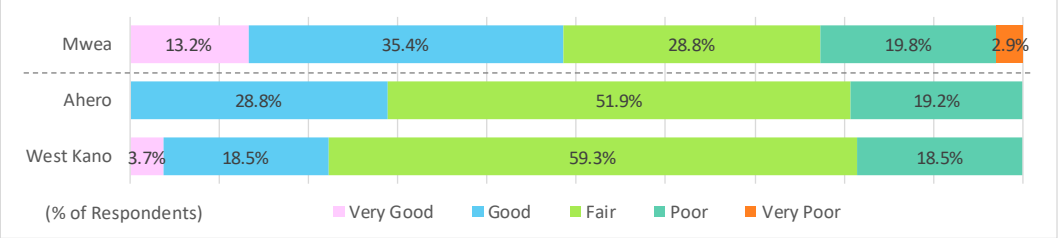
Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-8 Labour Costs in Mwea, Ahero and West Kano Irrigation Schemes

(7) Irrigation Water Availability at Farmer Level

Inadequate water supply is one of the major issues in rice production in the Lake Victoria Basin Region. NIA is in charge of supplying water to farmers in the current irrigation scheme and it comes with a lot of challenges because water users do not contribute to the maintenance of the canals. Water users may not follow the agreed watering schedule and steal the water before it is their turn. This can lead to the erratic flow of the irrigation water.

The following figure shows answers by farmers on irrigation water availability in the Mwea, Ahero, and West Kano Irrigation schemes. Farmers who answered "very good" and "good" were about 50% in the Mwea Irrigation Scheme but less than 30% in Ahero and West Kano. It implied that the improvement of irrigation water availability and proper water distribution are needed in the Ahero and West Kano Irrigation schemes.

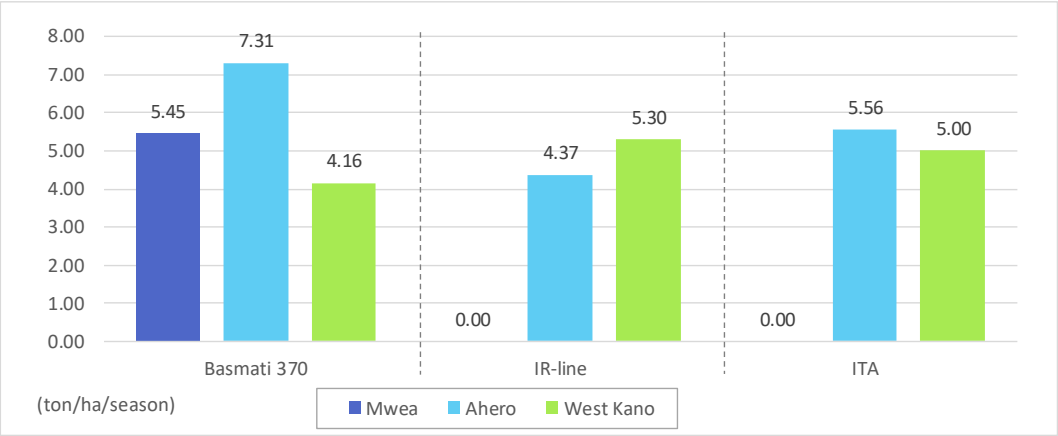


Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-9 Answers by Farmers on Sufficiency of Irrigation Water in the Mwea, Ahero, and West Kano Irrigation Schemes

(8) Yields

It is said that rice yields are lower than the potential due to poor agronomic practices as mentioned above. These are low skills of farmers, weather fluctuations, and poor irrigation infrastructure in Kenya. The following figure shows average yields of Basmati 370, IR-line, and ITA. The average yield (7.31 ton/ha/season) of Basmati 370 in Ahero was higher than that of Mwea (5.45 ton/kg/season) although the major variety in Ahero is the IR-line.

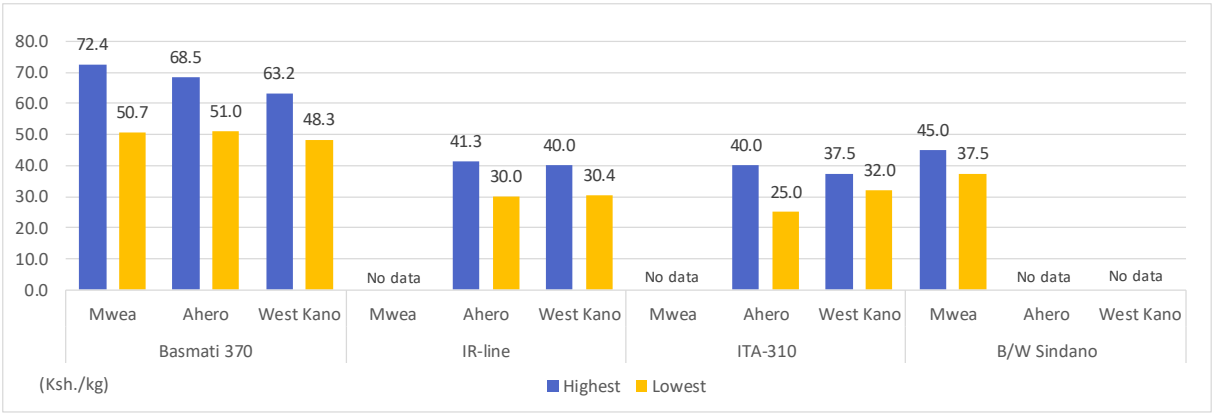


Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-10 Average Rice Yield in the Mwea, Ahero, and West Kano Irrigation Schemes

(9) Marketing

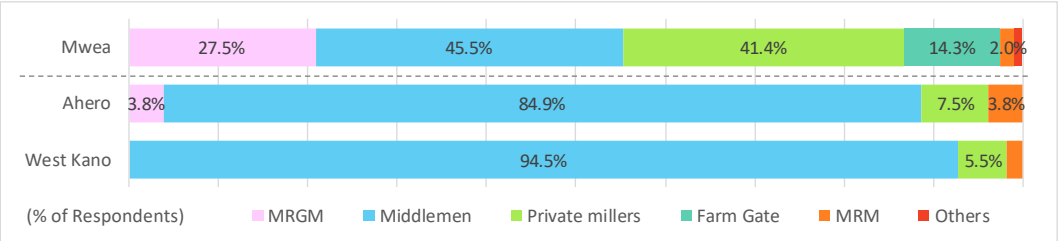
Selling Prices: The following figure shows sales prices of paddy by farmers in the Mwea, Ahero, and West Kano Irrigation schemes. It shows the price difference among rice varieties: Basmati 370, IR lines, ITA-310, and B/W Sindano. The highest was Basmati 370, which was produced in the Mwea Irrigation Scheme. The prices of Basmati 370 in the Ahero and West Kano Irrigation Schemes tended to be lower than that in Mwea. The prices of IR-lines and ITA-310 and B/W Sindano tended to be lower than that of Basmati 370 in all the schemes.



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-11 Sales Prices of Rice by Farmers in the Mwea, Ahero, and West Kano Irrigation Schemes

Market Channels: Most farmers in Ahero and West Kano Irrigation schemes highly depend on middlemen as their market channels as shown in the following figure. On the other hand, market channels of farmers in the Mwea Irrigation Scheme diversified to Mwea Rice Growers Multipurpose Cooperative Society (MRGM) and direct selling to private rice millers. It can be said that organising farmers' cooperatives and existing private rice millers within an accessible location from the irrigation schemes could benefit farmers in diversification of their market channels to sell their paddy at a higher price.



Source: CaDPERP Baseline Survey, JICA, May 2019

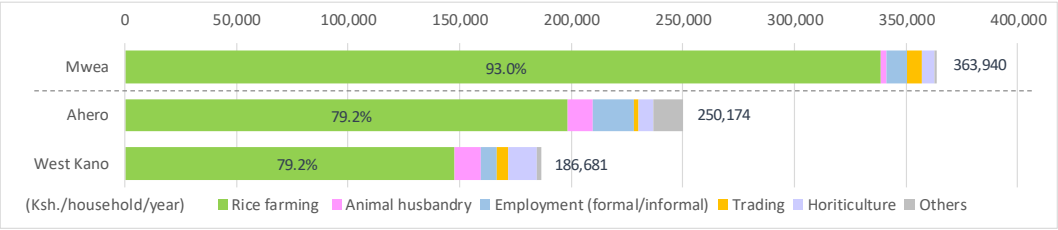
Figure A3.2.3-12 Market Channels of Farmers in the Mwea, Ahero, and West Kano Irrigation Schemes

Selling Methods: Most of the farmers sell their paddy individually thereby being unable to have any bargaining power with the traders. This situation affects the prices offered in the market and hence the income that farmers receive from the rice production.

Constraints of Marketing: Rice marketing is one of the main constraints of farmers in the Lake Victoria Basin Region due to information gap among farmers and other market actors about rice product quality. This is mainly because of limited access to rice market information and limited group marketing by taking advantage of the economies of scale. Other constraints are the limited use of storage, lack of marketing strategy, excessive numbers of intermediaries in rice value chains, and seasonal price fluctuation in market price. Paddy rice is mainly sold largely to brokers, traders, and small-scale millers at local markets, who collect and sell to rice millers and exporters. Most small-scale farmers sell their produce at prevailing local prices immediately after harvest to meet immediate cash demands. Majority of farmers lack appropriate storage facilities for their produce causing heavy paddy losses.

(10) Farmers' Income

The following figure shows farmers' income (KES/household/year) in 2018 in the Mwea, Ahero, and West Kano Irrigation schemes. The average farmers' income in Mwea was 145% of Ahero and 195% of West Kano. It implies that the rehabilitation of irrigation facilities and capacity development of farmers could enhance farmers' income effectively.



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-13 Farmers' Income in the Mwea, Ahero, and West Kano Irrigation Schemes

(11) Farmers' Organisations

Rice cultivation requires well-developed farmers organisations capable of working together to manage irrigation water, production, and marketing. Ahero and West Kano Irrigation schemes have the following farmers' organisations.

Water Users Associations: Ahero and West Kano Irrigation schemes have Water Users Associations (WUA) which are organisations responsible for the operation and maintenance of water flow systems. All schemes have WUAs whose members are elected by the farmers for a period of three years. WUA has been constituted in all the rice schemes in Kisumu County. NIA is responsible for scheme management, operation, and maintenance of the major structures. The branch level and the infield level

will be the responsibility of the WUAs. The following items are the main functions of the WUAs in the schemes:[17]

- Collect water fees from WUA members
- Ensure reliable and equitable distribution among water users
- Maintaining and improving irrigation structures
- Resolving disputes that concern water use in an appropriate, transparent, and democratic manner
- Act as a link between management and farmers

According to an interview with NIA Mwea, the establishment of administrative structure is functioning, and this is one of the keys for success. The administration structure of irrigation scheme management in Mwea is shown in the following table.

Table A3.2.3-2 Administration Structure of Irrigation Scheme Management in Mwea

Meeting Name	Role of Meeting	Member	Frequency
Block Leaders Meeting	- Progress of scheme programs - Implementation of scheme program - Operation and maintenance collection fee - Work plan implementation - Discipline and order maintenance - fines,	NIA and 67 block leaders	Once every month
Line leaders Meeting	- Work plan implementation per unit/acre - O&M fee collection per acre and forward to block leader - Ensure scheme program is adhered to	NIA and 347 line leaders	Once every year
Steering Committee Meeting	- Intervention and providing solution for water shortage - Determination of minimum rice prices - Advice Mwea Rice Miller (MRM) and NCPB in setting prices - Handles major outbreaks of disease and birds - Handles food security issue - Intervene in major disputes	Sub-county Ministry of Agriculture Officer, MIAD, KALRO, representative from Member of Parliament, representative from Member of County Assembly Office, MRGM officials, WUA officials, NIA, MRM, NCPB, County Commissioner	- Meetings commence before cropping program - Meeting called when some issue occur-relevant participants meet
Advisory Committee*	- Settling land disputes	-	When need arises

Note: *It was suspended as of August 2019 because it was replaced with alternate dispute resolution committee

Source: Interview with NIA Mwea by the JICA Survey Team

Cooperative Societies: The Ahero and West Kano Irrigation schemes have Ahero Multipurpose Rice Cooperative Society and West Kano Scheme Farmers' Cooperative Society, respectively, mainly for the purposes of rice production and marketing. Farmers took an initiative to form cooperatives to cope with production and marketing challenges. However, due to weakness within the cooperative societies and lack of commitments by the members, the positive impacts of the cooperatives have not been fully realised in Kisumu County. Most of the rice production and marketing activities are basically not group-based but individual-based. About 20% of farmers in those schemes registered to the societies in Ahero and West Kano Irrigation schemes.[18] Collective purchasing of farm inputs and marketing through the societies could enable small-scale farmers to utilise the economies of scale in production, as well as marketing.

(12) Farm Machinery Use

Poor access to farm machineries especially for land preparation, weeding, harvesting, threshing, and winnowing is one of the major constraints to rice production in the Lake Victoria Basin Region. Majority of farmers use tractors and oxen plough in paddy fields for land preparation. Farmers are yet to use farm machinery in planting, weeding, harvesting, and threshing. These activities are currently

Source: JICA Survey Team
Rotavation using tractor partially introduced in Ahero Irrigation Scheme

[17] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB

[18] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

done manually, consuming a lot of labour force, which cause low production efficiency and high production costs.

(13) Harvest and Post-harvest at Farmer Level

Harvesting, threshing, drying and winnowing are manually done in the Lake Victoria Basin Region. This exposes the rice grains to high moisture from the soil surface and mixing with small stones causing poor quality. Mechanising the harvest process at the farmer level with small combine harvesters that can harvest, thresh, winnow and bag the grains without letting the grain touch the ground could improve the situation. Mechanised harvesting and threshing have become popular in the Mwea Irrigation Scheme through JICA's support. After harvesting and threshing, the straws and rice husks as by-products are used for the dairy farmers as feed to the livestock in the Mwea Irrigation Scheme.

Source: JICA Survey Team
Harvesting and piling rice straws by farmers in Ahero Irrigation Scheme

(14) Agricultural Credit

Various banks and micro financing institutions are available in Kisumu County, providing agricultural credit to individual rice farmers. These include Equity Bank, Kenya Commercial Bank, Cooperative Bank, Agriculture Finance Cooperation and other financial service providers such as Cent Sacco Society Limited. The main services offered by those financial service providers are 1) loans that are categorised as agricultural, assets, business, microfinance or group loans, 2) savings accounts, 3) commodity financing and working capital, 4) financing for agricultural production and livestock production enhancements. It has been said that the lack of a comprehensive agricultural credit system has been a major constraint to agricultural development in Kenya. Particularly, its availability and accessibility to smallholder farmers has been inadequate.[19]

(15) Other Crop Cultivation except for Rice

Except for rice, other crops such as cereal, pulses, root crops, horticultural crops and fruit crops are also common crops in the Lake Victoria Basin Region. Those crops are also indispensable as supplemental cash crops in the irrigation schemes. Most of those crops are generally grown under rain-fed conditions except for horticultural crops, which are irrigated close to rivers and Lake Victoria. The main cropping season for most of the crops is during the long rain season from March to July. Horticultural crops are grown under irrigation during July - December and to lesser extent from December - March to get higher prices in the off-season. Multiple cropping systems such as mixed intercropping is also common and helps small-scale farmers to mitigate the risks of market price fluctuations and production failures caused by unstable natural conditions. Major crops cultivated in the Lake Victoria Basin Region are summarised in the following tables.

Table A3.2.3-3 Major Crops Cultivated in the Lake Victoria Basin Region except for Rice

Category	Crops
Cereals	Maize, sorghum and finger millet
Pulses	Beans, green grams, cowpeas and ground nuts
Root crops	Cassava, sweet potatoes
Horticultural crops	Kales, cabbages, tomatoes, sweet peppers, onions, butternuts, watermelons
Fruit crops	Bananas, pineapples, pawpaw, mangoes, citrus
Other crops	Sisal, sunflower, sugarcane, tobacco

Source: Interview with Kisumu and Migori County offices by the JICA Survey Team

[19] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB

 *Pump irrigation to horticultural crops using a small diesel pump*	 *Irrigated kale (Sukuma) cultivation*	 *Tobacco seedling production*
 *Irrigated sweet pepper cultivation*	 *Irrigated cabbage production*	 *Collection of harvested watermelons*

Source: JICA Survey Team

Figure A3.2.3-14 Pictures of Other Crop Cultivations in Lower Kuja Irrigation Scheme

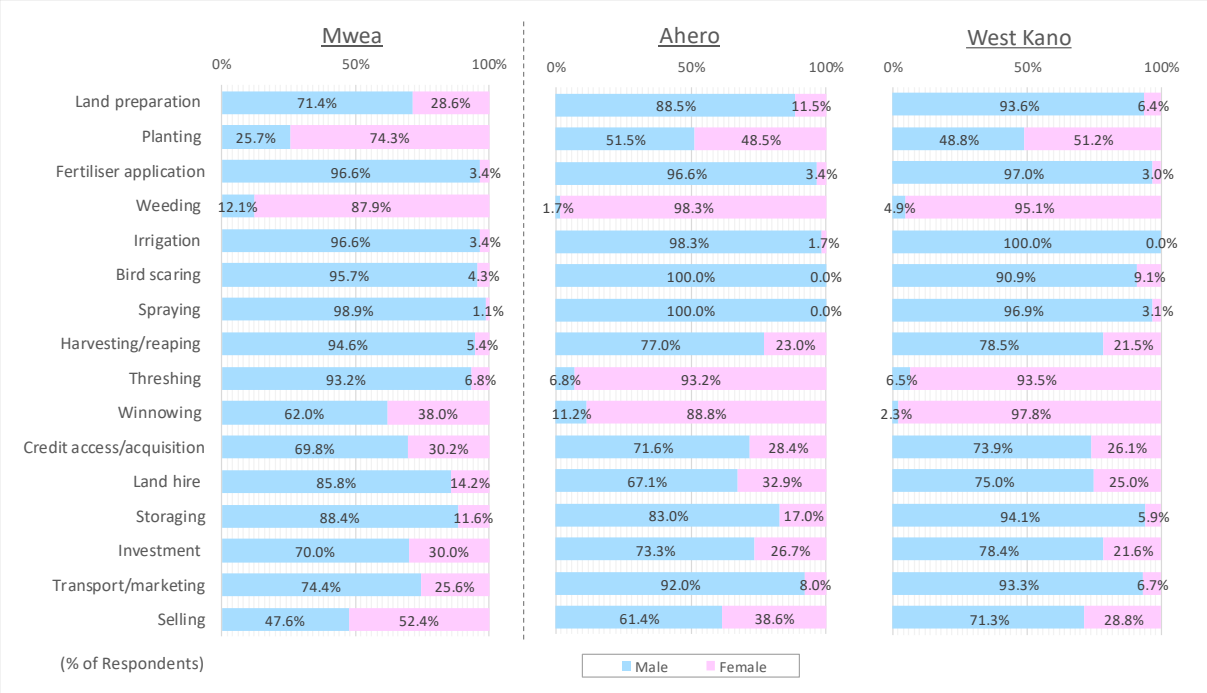
(16) Division of Labour between Male and Female Farmers in Rice Cultivation

Female farmers perform important roles in agricultural works such as seeding, transplanting, weeding, threshing, and other related works. However, they are hardly involved in decision making concerning the farm land that they work on. The major decisions are basically made by male farmers who sometimes do not participate in cultivation works.[20]

The following figure shows division of labour in rice cultivation between male and female farmers in the Mwea, Ahero, and West Kano Irrigation schemes. It implies that most of the cultivation works are mainly done by male farmers except for planting, weeding, and post-harvest works in all the schemes. In the Ahero and West Kano Irrigation schemes, post-harvest works of threshing and winnowing are mainly done by female farmers although those are mainly done by male farmers in the Mwea Irrigation Scheme.

Source: JICA Survey Team
Weeding by female farmers in Lower Kuja Irrigation Scheme

[20] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.3-15 Division of Labour between Male and Female Farmers in Rice Cultivation in the Mwea, Ahero, and West Kano Irrigation Schemes

Most farmers in the scheme did not adopt good farming practices especially for female farmers because they have limited time to attend the training sessions and educational events due to their heavy workload in cultivation and household works. Traditionally female farmers are not allowed to inherit property especially land. In this regard, in the irrigation schemes, farm lands are conventionally registered under the name of male farmers and they are invited for the training. Once male farmers acquire and bring knowledge and information home, they rarely share with their wives. In addition, customs on land holdings make it difficult for female farmers to acquire credit as they lack collateral. This unequal distribution of resources has caused poverty especially among female farmers. [21]

(17) Soil Issues in Lower Kuja Irrigation Scheme

Soil Classification: The soil survey report in final feasibility report[22] prepared by NIA describes the environmental attributes of the proposed irrigation development project in Lower Kuja. The study involved quantitative investigations of soil situations, inventory of land use, and an assessment of the ecological potential and constraints regarding soil. Lower Kuja Irrigation Scheme is classified to six soil categories. The classification and those characteristics are summarised in the following table and map.

Table A3.2.3-4 Summary of Soil Classification and Characteristics of the Lower Kuja Irrigation Scheme and Recommendations

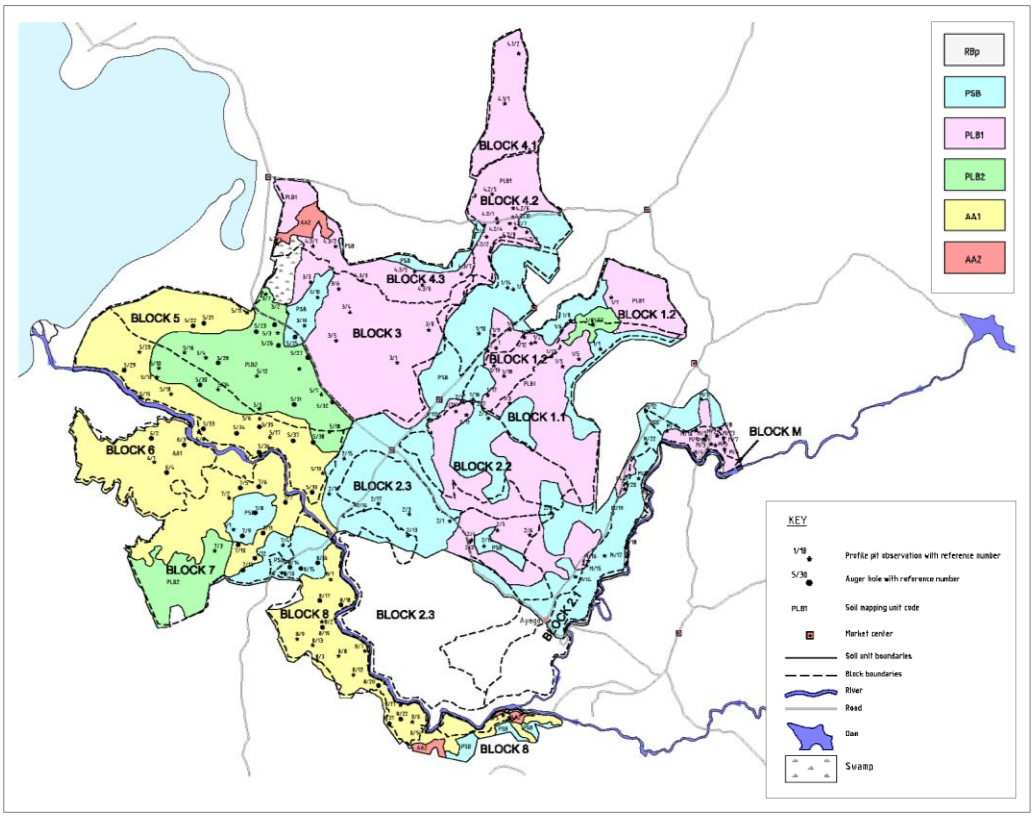
Soil Classifications		Characteristics and Recommendations
Footridges	RBP	- The soils are excessively drained, very shallow and very stony and rocky. This is a narrow strip of land along the River Kuja and is predominantly bush.
Sedimentary Plains	PSB	- The soils are well drained, shallow to moderately deep. The colour ranges from very dark grey to reddish brown. They are firm to friable, clay loam to clay in most places over marram.
Lacustrine Sedimentary Plains	PLB1	- Imperfectly drained deep to very deep, black to very dark grey, firm calcareous clay overlying calcium rich material. - Although considered marginally suitable for general irrigated agriculture; it can be upgraded to highly suitable if paddy rice were to be the main crop. Rice can do well with ESP's of up 20 and

[21] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB

[22] Source: Semi-Detailed Soil Survey for the Proposed Lower Kuja Irrigation Development Project, J. P. Mbuvi, S. K. Tirop, T. R. Wachira, and M. Kimani, June 2010

Soil Classifications		Characteristics and Recommendations
		the range in this unit is 2.3 to 18.0 and the EC is very low; 0.3 to 0.4 ds/M. Workability which puts the unit to marginally suitable would be an advantage to paddy rice and with proper drainage and good water quality the excess salts can be reclaimed.
	PLB2	- Poorly drained to imperfectly drained, moderately deep to deep, very dark grey to black, firm to friable sandy clay loam to clay, strongly saline to very strong sodic. - The soils are very strongly alkaline pH-H20>9; extremely sodic ESP%>35; very high exchangeable sodium 18.0 to 46.0 Cmol/kg. **Because of these attributes, the soils are rated unsuitable for irrigated agriculture.**
Alluvial Plains	AA1	- Moderately well drained to well drained very deep, yellowish brown to dark brown, friable to loose, loam to clay loam. - Some suggested crops are paddy rice for the moderately well drained area and horticultural crops like tomatoes; spinach; pepper and kales among many others.
	AA2	- Excessively drained, very deep, yellowish brown, loose, loamy sand to sand. **They are rated unsuitable for irrigated agriculture because of their texture which is very high in the sand fractions 75 to 89%.**

Source: Semi-Detailed Soil Survey for the Proposed Lower Kuja Irrigation Development Project, J. P. Mbuvi, S. K. Tirop, T. R. Wachira, and M. Kimani, June 2010



Source: Semi-Detailed Soil Survey for the Proposed Lower Kuja Irrigation Development Project, J. P. Mbuvi, S. K. Tirop, T. R. Wachira, and M. Kimani, June 2010

Figure A3.2.3-16 Soil Classification Map in the Lower Kuja Irrigation Scheme

Soil Salinity Issues: According to the soil survey conducted in 2010, it was evaluated that the classified soils such as PLB2 and AA2 was unsuitable for irrigated agriculture. Eventually, PLB2 was excluded from the planned project areas because the soils are strongly alkaline pH-H20>9; extremely sodic ESP%>35; very high exchangeable sodium 18.0 to 46.0 Cmol/kg.

Source: JICA Survey Team
Vegetation in the area of PLB2 in Lower Kuja Irritation Scheme

3.2.4 Agricultural Extension and Research

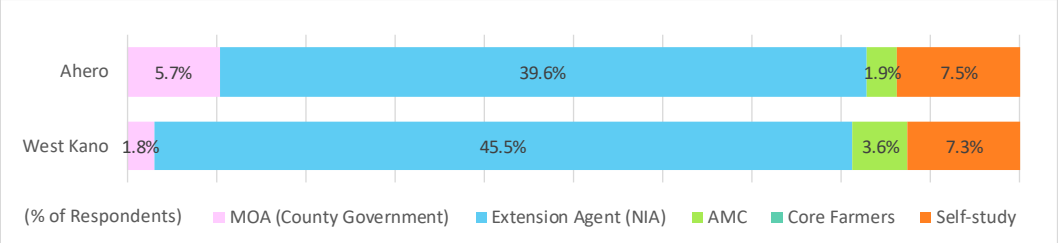
(1) Agricultural Extension

In the Lake Victoria Basin Region, extension services for rice farmers are mainly provided by MoALFI, local NGOs, community-based organisations (CBOs), KALRO, county offices, and NIA. The role of agricultural extension is to provide farmers with relevant agricultural information, which helps them to optimise their use of limited agricultural resources. It is said that those organisations offer agricultural extension services but those are inadequate due to high ratios of farmer/extension staff, lack of efficient transport facilities for field visits and following-up. In addition, the following constraints were also identified in the reports prepared by NIA: [23]

Source: JICA Survey Team
Yield survey by an Extension Agent of NIA Kuja

- Understaffing in the MoA: this has led to inefficient transfer of appropriate technology.
- Poor technology adoption rate: farming practices have remained traditional.
- Inadequate transport facilities for follow-ups after training farmers.
- Lack of other extension service providers in the area to complement the MoA extension services.
- Lack of training facilities and demonstration plots in the district for farmer training.

The following figure shows questionnaire survey results on training organisations in the Ahero and West Kano Irrigation schemes. It shows that more than 40% of farmers answered that they were provided extension services from NIA extension agents.



Source: CaDPERP Baseline Survey, JICA, May 2019

Figure A3.2.4-1 Training Organisations in the Ahero and West Kano Irrigation Schemes

(2) Agricultural Research

NIA Ahero Irrigation Research Station (AIRS) is basically in charge of research for rice production in the Lake Victoria Basin Region. According to the interview by IFDC with a researcher of AIRS in 2016, there had been no new rice varieties released for irrigated rice ecosystems in the last 15 years. It was also noted that the linkage between extension and research for rice is still weak. An urgent need exists for the role of the various institutions to be spelt out clearly and to increase research efforts in the development of new rice varieties suitable for the Lake Victoria Basin Region. [24]

Source: JICA Survey Team
Laboratory of AIRS at the Ahero Irrigation Scheme

[23] Source: Final Detailed Design Report, Lower Kuja Irrigation Development Project, NIB, June 2011
[24] Source: Rapid Assessment of Rice Value Chain Development in Western Kenya, Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship Project (2SCALE), International Fertiliser Development Centre (IFDC)

3.2.5 Consideration and Proposed Approaches for Countermeasures

1) Upscaling Certified Seed Production

Upscaling certified seed production and distribution system are required to meet farmers' needs in the Lake Victoria Basin Region. Individual farmers and/or farmers' organisation should be involved in the system to produce quality seeds under the supervision of NIA. In this regard, the capacity development of individual farmers and/or farmers' organisation to be reliable seed multipliers as agri-business will also be required.[25]

2) Selection and Development of Rice Varieties suitable for the Lake Victoria Basin Region

In the Lake Victoria Basin Region, major rice varieties are IR-lines because those yields are higher than other high value rice such as Basmati 370. IR-lines are also tolerant of the rice blast, which is one of the common diseases in the areas. In this regard, the selection and/or development of rice varieties, which is suitable for natural conditions in the Lake Victoria Basin Region and has higher market values than IR-lines. The introduction and extension of NERICA varieties are also needed especially for areas where irrigation water is not enough for paddy rice production.

3) Clarification of Land Ownership and/or Tenant and Boundaries in Lower Kuja Irrigation Scheme

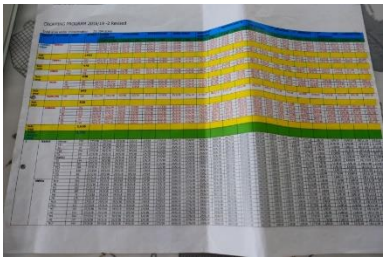
Clarification of land ownership and boundaries in Lower Kuja Irrigation Scheme by NIA is required because some areas will be newly developed, and ownerships of those farm lands are unclear. As of September 2019, NIA is demarcating the land in several plots lent to farmers for rice cultivation.

4) Upscaling of Good Cultivation Practices introduced by JICA at Ahero and Mwea Irrigation Schemes

Upscaling of the comprehensive good cultivation practices that were introduced in RiceMAPP in Mwea and transferred to the Lake Victoria Basin Region through CaDPERP is needed. A series of good cultivation techniques of rice from sowing to harvesting are really needed by farmers in the irrigation schemes in the areas especially in the Lower Kuja Irrigation Scheme. Those techniques should be modified to meet natural and social conditions in the areas and added to some additionally required techniques regarding labour saving, post-harvest, and marketing. Then, those techniques should be extended through such as demonstrations at the field and web-based information platforms for the irrigation schemes in the Lake Victoria Basin Region. To accelerate the technology dissemination, JICA's financial support is recommended.

5) Establishment of Proper Rice Production Model by Farmers' Groups

The production model by farmers groups has been functioning in the Mwea Irrigation Scheme. The production model is in line with a designated cropping programme prepared by NIA including canal cleaning, flooding, rotavation, seed distribution, transplanting, irrigation, spraying, weeding, top dressing, and harvesting for each irrigation unit. This model could be extended to the irrigation schemes in the Lake Victoria Basin Region. According to the interview with NIA Mwea, this method has been especially effective to distribute and use irrigation water properly and to increase rice productivity. The management of the activities within a block is under the responsibility of the block members and each block has a representative for the designated works on time.



Source: JICA Survey Team
Cropping Programme prepared by NIA for the Mwea Irrigation Scheme

[25] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB

6) Capacity Development of Farmers' Organisations for Group Purchasing and Selling

The rice farmers' organisations and cooperative societies in the areas are weak in all aspects. The individual farmers in the areas have limited access to market information, inadequate knowledge on post-harvest handling, and low negotiation power. Working in groups either by strengthening the existing groups or forming a new group could help the farmers undertake their business collectively to buy farm inputs such as fertilisers and agro-chemicals at lower prices and sell their product at higher prices. This is also expected to improve their productivity significantly because the collective buying of farm inputs would largely reduce costs.

7) Effective Utilising of the Kisumu Rice Stakeholder Forum

It is recommended to utilise "Kisumu Rice Stakeholder Forum" as much as possible to share information among stakeholders in the rice value chains including representatives of rice farmers in the Lake Victoria Basin Region. Kisumu Rice Stakeholder's Forum is periodically organised in and around Kisumu City and the main functions are:[26]

- Identifying the groups, institutions, and individuals who are interested in the promotion of the rice value chain and improving its profitability for the benefit of all participants;
- Facilitating information exchange on production, post-harvest, marketing, and policy issues of broad interest to the group;
- Development of mechanisms to promote greater commercial integration and the ease, or "fluidity," of commercial transactions; and
- Commitment to the county rice promotional and advocacy activities.

8) Conversion from Conventional Staple Crops to High Value Cash Crops

Depending on availability of irrigation water, farmers can also cultivate not only rice but also a wide range of diversified crops in the Lake Victoria Basin Region. It is proposed that the early rice plantings in March should involve rainfed crops such as maize, sorghum, soybeans, beans, green grams, and sunflower; these would be followed by rice from May to November. From November, vegetable production including tomatoes, cabbages, onions, kales, green peppers, chillies, and water melons would take place mainly under irrigation. This would provide fresh market vegetables, which are highly needed and imported into Kenya from the neighbouring countries during the period from November to January. With proper planning, rice farmers can also harvest more than two crops in a year. The first crop planted in May-June is harvested in September to enable a second rice crop to be planted in October-November and harvested in February-March just before the onset of the long rains.[27] Technical trainings for rice farmers to produce other high value cash crops are needed. Crop diversification could mitigate and avoid unpredictable production and marketing risks and stable farmers' income.

9) Consideration of Division of Works between Male and Female Farmers and Active Involvement of Female Farmers into Technical Trainings

To solve and mitigate constraints on gender related issues as mentioned above, making clear strategies to involve female farmers to irrigation development projects at the beginning is needed. Besides, confirmation of female farmers' needs, awareness creation campaign, confirmation of division of works between male and female farmers, and the implementation of gender consideration strategies should be also done throughout the project periods.

[26] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for Ahero and West Kano Irrigation Schemes Development Project, NIB

[27] Source: Final Detailed Design Report, Lower Kuja Irrigation Development Project, NIB, June 2011 and field survey by JICA Project Team

10) Promotion of Mechanisation of Rice Production

Mechanising rice farming by introducing appropriate machinery and equipment such as power tillers for land preparation, push weeders for weeding, small-scale combine harvesters, threshers, and winnowing machines could improve production efficiency and reduce production costs. Especially, power tillers accompanied with attachments for ploughing, rotavation, and transportation are one of the useful multipurpose machines. This could also make good business for individual entrepreneurs in the area.[28]

11) Strengthening Related Institutions for Soil Analysis and Giving Recommendations on Fertiliser Application to Farmers

Poor soil nutrition and improper application of chemical fertiliser are some of the main reasons of low productivity in the Lake Victoria Basin Region. Routine soil sampling and testing as well as giving recommendations from extension agents to farmers is needed. To do so, capacity development of related institutions on soil sampling, analysing and giving proper recommendations to improve soil nutrient management is indispensable.

12) Further and Detailed Soil Survey in Lower Kuja Irrigation Scheme

Regarding soil issues in Lower Kuja Irrigation Scheme as mentioned above, vegetation and crop cultivation such as maize and sorghum were observed in the area of PLB2 during the field visit by the JICA Survey Team in August 2019. It implies that crops may grow in the area and a further survey is needed to properly evaluate current soil situations and suitability for irrigated rice production. The areas of PLB2 were excluded from the Lower Kuja Irrigation Project in the Final Detailed Design Report prepared by NIA. If any issues will be identified as a result of the further and detailed soil survey, it could be included in the project areas.

3.2.6 Potential Cooperation Programmes for Agricultural Practice & Extension

According to the consideration and proposed approaches for countermeasures as mentioned above, the following programmes and/or components as interventions are proposed.

(1) Programmes for Agricultural Extension

Category	Components	Works/Remarks	Target Area
Extension	Capacity Development Project for Enhancement of Rice Production Techniques through Wide-range Extension in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	**Target Group:** Rice farmers in the Lake Victoria Basin Region (Note: Ahero, West Kano and South West Kano to be excluded because those areas were already covered by CaDPERP.) **Outputs:** 1) Capacity development of NIA officers for wide-range extension services to enhance rice productivity 2) Extension of rice production techniques in irrigation schemes in the Lake Victoria Basin Region including Lower Kuja Irrigation Scheme 3) Capacity development of AIRS and KALRO to solve rice farmers' issues especially in soil analysis and pest/disease control 4) Establishment of wide-range information sharing system on rice production techniques and rice market information covering the Lake Victoria Basin Region **Inputs (Donor Side):** 1. Expert dispatch (110 MM) (Team leader/agricultural extension, rice production, irrigation water management, training management) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 2 cars	All the irrigation schemes in the Lake Victoria Basin Region except for Ahero and West Kano Irrigation Schemes

[28] Source: Final Design Report, Detailed Design and Preparation of Bidding Documents for the Ahero and West Kano Irrigation Schemes Development Project, NIB

Category	Components	Works/Remarks	Target Area
		Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 2 places (Kisumu and Lower Kuja)	
	Capacity Development Project for Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	**Target Group:** Rice farmers in Lower Kuja Irrigation Scheme **Outputs:** 1) Capacity development of officers of NIA Kuja on extension services for rice production 2) Technology transfer of rice production techniques improved in Ahero and West Kano irrigation schemes to Lower Kuja irrigation scheme 3) Capacity development of officers of NIA Kuja and Migori county to solve farmers' issues on rice production **Inputs (Donor Side):** 1. Expert dispatch (70 MM) (Team leader/agricultural extension, rice production, irrigation water management, training management) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car **Inputs (Kenyan Side):** 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	Lower Kuja Irrigation Scheme
	Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	**Target group:** Rice farmers in Lower Kuja Irrigation Scheme **Outputs:** 1) Capacity development of officers of NIA Kuja on agricultural extension services for rice production 2) Technology transfer of rice production techniques improved in the Ahero and West Kano irrigation schemes to the Lower Kuja irrigation scheme 3) Capacity development of officers of NIA Kuja and Migori County to solve farmers' issues on rice production **Inputs:** 1. Expert dispatch (35 MM) (Agricultural extension) 2. Travel cost 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car 6. Participation of government officers to project activities 7. Travelling expenses of government officers 8. Office spaces: 2 places	Lower Kuja Irrigation Scheme

Source: JICA Survey Team

(2) Programmes for Rice Variety Selection, Seed Multiplication and Distribution

Category	Components	Works/Remarks	Target Area
Seed Production	Capacity Development Project for Quality Rice Seed Production and Wide-range Distribution in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	**Target group:** Rice farmers in the Lake Victoria Basin Region **Outputs:** 1) Capacity development of officers of NIA Ahero in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production 3) Installation of required equipment and machinery and establishment of distribution mechanism for certified seed in the Lake Victoria Basin Region **Inputs (Donor Side):** 1. Expert dispatch (80 MM) (Team leader, seed production, agricultural extension) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 2 cars	All the irrigation schemes in the Lake Victoria Basin Region including Ahero and West Kano Irrigation Schemes

Category	Components	Works/Remarks	Target Area
		Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	
	Capacity Development Project for Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	**Target group:** Rice farmers in Lower Kuja Irrigation Scheme **Outputs:** 1) Capacity development of officers of NIA Kuja in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production to NIA Kuja **Inputs (Donor Side):** 1. Expert dispatch (50 MM) (Team leader, seed production, and agricultural extension) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car **Inputs (Kenyan Side):** 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	Lower Kuja Irrigation Scheme
	Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	**Target group:** Rice farmers in Lower Kuja Irrigation Scheme **Outputs:** 1) Capacity development of officers of NIA Kuja in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production to NIA Kuja **Inputs:** 1. Expert dispatch (25 MM) (Seed production) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car 6. Participation of counterparts to project activities 7. Travelling expenses of counterparts 8. Office spaces: 1 place	Lower Kuja Irrigation Scheme

Source: JICA Survey Team

3.3 Rice Value Chain

3.3.1 Paddy Collection, Storage and Processing

(1) Collection of Paddy

1) Drying of Paddy

Sun-drying is a major method to dry paddy, and mechanical dryers are not so popular in Kenya. Drying of harvested paddy is not easy since there are not enough places/facilities to dry the goods. Generally, paddy grains are dried on sheets, which are unfolded on the ground/concrete drying yard, but the condition of the sheets and the ground/concrete yard is not good, and foreign matter may contaminate the drying paddy. For example, the drying yard of the Ahero Irrigation Scheme was made in 1972, whose surface has many cracks and grains of sand.

Source: JICA Survey Team

Figure A3.3.1-1 Drying Yard in Nzoia Irrigation Scheme

Preparation of the drying yards in the proposed irrigation scheme as a potential cooperation program is

one of the important components because proper drying is necessary for the storage and milling of paddy. The drying yard of Nzoia Irrigation Scheme (NIA) in Siaya County can be raised as one of the good examples of sun-drying yard. The drying yard is well separated from the surrounding fields, and the surface of concrete is kept in good condition, which can allow the workers to dry paddy without sheets.

Workers, both men and women, in a sun-drying yard usually stir paddy by their feet, but from the viewpoint of working efficiency, using stirring sticks is recommended. Also, introduction of accuracy water moisture meters is also required to prevent from too much drying, which is a major reason for broken grains.

2) Purchasing of Paddy

When rice-millers collect paddy from farmers/farmer groups, the rice producers want to receive the cash as a matter of course. But there are many cases where the payment takes a few months, especially in the western region. NIA established Western Kenya Rice Mill (WKRM) and operates it in Ahero Irrigation Scheme. However, the paddy collection is difficult because the payment for purchased paddy takes a few months.

On the other hand, Ugandan paddy collectors appeared in such a situation, who bought paddy by cash and did not care about the quality of paddy. Now, about 80-90% of paddy produced in the western region is taken to Uganda. According to the factory manager of the LBDC, Ugandan collectors pay a little bit higher price than ordinary prices; e.g., they buy paddy at Ksh.40/kg that is usually bought by LBDC at Ksh.37/kg. Also, there is no tariff among the East African countries.

In such circumstances, the operation rate of the WKRM falls off around 20%. As a countermeasure to increase the operation rate, NIA tries securing a necessary fund to the rice-mill for purchasing paddy by cash, which is considered about Ksh.700-750 per season, but the detail plan has not yet been prepared.

The rice milling factory of the Lake Basin Development Company (LBDC) is one of the large-scale rice millers in the western region. Their payment on collecting paddy took about two weeks, which cause the difficulties to collect necessary volume of paddy. Hence, they have prepared money necessary for the cash payment. Now they are ready to pay cash in exchange for paddy. LBDC recognized the importance of the cash payment, so they improved the financial transaction. Their new challenge has just started although they said that there is no problem on the cash payment for their paddy collection.

The following table shows the buying price of paddy by the WKRM and the Kisumu Station of National Cereals and Produce Board (NCPB), which is mentioned in the next section, as per variety. The table shows that the price of aromatic variety (Pishori/Basmati) is about 1.6-2.0 times higher than the price of non-aromatic/local varieties (Sindano IR, IITA). In Mwea Rice Mill (MRM), which is described later in "(3) Rice Milling," about 95% of their paddy stock is Pishori/Basmati, and the buying price is Ksh.60-85/kg. According to the Production Manager of MRM, check points of paddy are three; a) moisture content of 14.0%, confirmed using a moisture meter, b) only healthy paddy with required density is bought so as to give a high recovery, also, c) free of impurities, such as stones, insects, mud rolls, weeds, etc.

Table A3.3.1-1 Paddy Buying Price of the WKRM and the Kisumu Station of NCPB

Variety	Buying Price (Ksh/kg)	
	WKRM	Kisumu Station of NCPB
Pishori / Basmati	62.0	60.0
Sindano IR	35.0	30.0
IITA	38.0	-

Source: JICA Survey Team based on the results of interviews with staffs of the WKRM and the Kisumu Station of NCPB

Also, the relatively high cost of rice milling in the western region is one of the reasons that allowed the advance of Ugandan rice millers. Rice-mill business in the western region is required to be improved radically.

Although the demand of rice in the western region also seems to expand, prices of rice are higher than those of maize, and a huge amount of Pakistan/Thai rice is imported. It is important to increase the provision amount of rice produced in the western region through marketing activities that divide the target consumers groups.

(2) Storage of Paddy

1) General Situation of Paddy Storage Work

Warehouses for paddy storage are usually built with rice-milling facilities. In Mwea, there are many rice-mill facilities, which seem to be operated well, and warehouses of paddy along the main road. Generally, dried paddy is sacked by 50 kg and stored on pallets, but forklifts are not used in and around warehouses, and loading and unloading service is carried out by human power, whose costs are about Ksh.0.02/kg in normal and Ksh.0.03-0.05/kg by contract.

Usually dried paddy is stored and booked in the milling on first-come first-serve basis. Ideal moisture content of paddy for storage is 13.5%, which is a little bit lower than that for milling. As an example of paddy storage fee, the Lake Western Storage Station of NCPB charges Ksh.160,000/month for 50,000 bags of 50 kg, equivalent to Ksh.3.2/month/bag, and Ksh.240,000/month for 100,000 bags, equivalent to Ksh.2.4/month/bag.

The JICA Survey Team must make special mention of two issues on cereal storage in Kenya. One is "Warehouse Receipt System", which is going to be described in the sentence 3.3.3. Another one is "Strategic Food Reserve of Rice", which is going to be mentioned in the following paragraph. Both are still in the preparation stage and their full-scale operations have not yet started; however, they have high potential to lead epoch-making events on cereal marketing in Kenya.

2) Strategic Food Reserve (SFR) of Maize

Kenyan SFR has been implemented mainly by maize. Recently, it was decided to add rice as a new target commodity for the SFR, considering the increase of rice consumption these years. This amendment shows that rice is a Kenyan staple food as well as maize, wheat, legume and root crops. The NCPB is the implementing organization of SFR. They mainly store maize for the SFR, dividing the whole country into six areas; Lake Western, South Lift, North Lift, Northern, Nairobi Eastern, and Coast. Their total storage capacity is 1.8 million MT. They purchase new maize in November/December, keep them about 15 months, and sell them to private maize millers in April/May.

In the Lake Western Area, the NCPB has 23 storage stations, which are located in Kisumu, Muhoroni, Kendu Bay, Homa Bay, Kisii, Nyansiongo, Awendo, Migori, Kehancha, etc., whose total storage capacity is 323,000 MT. Also, their two silos are installed in Bungoma and Kisumu, whose storage capacities are 75 and 69,000 MT, respectively. Within the 323,000 MT storage, about 50,000 MT is used for the SFR, and other storages are used for their business. They purchase maize in Bungoma and Kakamega.

Source: JICA Survey Team

Figure A3.3.1-2 Maize Silo of the NCPB in Kisumu

The cereal silo in the Kisumu Storage Station of the NCPB is used for maize but a part of the silo is used for sorghum, which is provided to a brewery in Kisumu. The system of the silo was made in Japan and installed in 1987. Also, they use their warehouses, whose storage capacity is 14,000 MT, for maize, paddy and chemical fertilizer storage. The oldest warehouses were built before World War II. In the last year,

they bought Pure Pishori of 222 MT in Ahero and Sindano IR of 12 MT in West Kano, but the demand of paddy seems to be about 500 MT.

(3) Rice Milling

1) All scales Rice-mill Combination

In Mwea, large-, medium- and small-scale rice-millers are actively operated. This combination of different scale rice millers is one of the key points of the success of the rice-milling business in Mwea. Seeking reduction of the milling cost, the scale becomes large in getting the benefits of such a scale, but there are also needs of small amount milling.

If the JICA Survey Team considers the new introduction of a rice-milling facility, other than a lot amount of paddy per order, rice-milling quality is another indicator for the consideration on the scale of the facility. For example, almost all large-scale rice-millers have equipped colour sorters for eliminating foreign matters that are the same shape and weight as actual paddy grains. Large-scale rice-millers can install full-scale new equipment for increasing rice-milling quality, but this requires a big investment.

Middle-scale rice-millers are comparatively easy to install. These kinds of new equipment are good for quality improvement since the investment costs of the equipment are still manageable. On the other hand, small-scale rice-millers are having a difficult time in improving their existing rice-milling system for quality improvement because improvement methods of the existing system are limited and the investment fund for quality improvement is small.

In the case of the WKRM in Kisumu, their average recovery rate of rice-milling is 55% even though the general standard ratio is 60-65% in the world. The rice milling machine of the LBDC is made in Germany and is able to mill paddy at a rate of 3.5 MT per hour. They mill 1,600 MT of paddy in a year, which consists of aromatic varieties of 400 MT and non-aromatic varieties of 1,200 MT. The following table shows the paddy prices, retail prices of milled rice, and those gaps, which covers processing and distribution costs.

Table A3.3.1-2 Rice Processing and Distribution Costs of the LBDC

Variety, Grade	Paddy (Ksh/kg)	Converted Paddy (Ksh/1.82kg)	Proc. and Distribution Costs (Ksh/kg)	Retail Price of Milled Rice (Ksh/kg)
Pishori/ Basmati, Super	65.0	118.2	81.8	200.0
Non-aroma, Grade-1	37.5	68.2	31.8	100.0
Non-aroma, Grade-2	30.0	54.5	30.5	85.0

Note 1): Recovery rate of milling rice is assumed at 55%.
Note 2): Milling fee of the LBDC is Ksh.4.5/kg.
Note 3): Processing cost includes drying, storage, weighing, packing, etc.
Note 4): Broken rice ratio of "Super" is less than 5%; Grade-1 is less than 15%.
Source: JICA Survey Team based on the results of interviews with staffs of the LBDC

MRM, a large-scale public rice mill was established in 1969. Now, its milling machine is made in China, and able to mill paddy of 40 MT per day, equivalent to 5.0 MT per hour. The Production Manager told us that important points of milling are described as "3Ms"; Man (knowledge and experience), Machine (proper milling system), and Material (good paddy).

2) Open Rice Markets, Managed by Women Dealers

In a private large-scale rice-miller in Mwea, which was visited in the Survey, the milling machines were installed in a large building. There were warehouses and drying yards in the backside of the rice-milling building. When the Team entered the large warehouse, next to the rice-milling building, the Team saw an "open rice market." There were a lot of milled rice that were put in 50-kg bags and many women were standing/sitting by the side of the rice. They were rice dealers and selling rice to customers who came there by their family cars.

Those dealers buy paddy from farmers/farmer groups and bring them into the rice-milling facilities. They ask the rice-miller to mill the paddy and pay the rice-milling fee. After the milling, they sell them to customers, and recover the purchase cost and get the profit. The rice-millers provide the marketplace to dealers by free as a rice-milling business promotion. The selling scene of milled rice in the marketplace as a real open rice market can be seen.

Along the main road in Mwea, large warehouses stand in a row. There are many dealers under the eaves, who display a variety of milled rice and wait customers. Roughly speaking, 90% of those dealers are women. MRM also provides an open rice market in their compound; whose regular dealers are about 300, and 90% of them are women.

Such type of business that conducts small business transactions with money management seems to be a role of women in the area, which must contribute to increase women's power. It is considered that if rice-milling business is established in the western region, it will be able to provide the same business opportunities to the area, especially for women like in Mwea.

3) Comprehensive Rural Development through Rice Value Chain (RVC)

In Mwea, a developing rice industry can be seen through RVC; huge paddy fields expand around the town. Donkey carts loaded with paddy, milled rice, and other by-products together with rice related farming machines and cars of buying rice are coming and going in the town. The centre of the local economy is rice milling but agriculture inputs business, transportation industry, tourist industry, etc. are also leading sectors in rural economy.

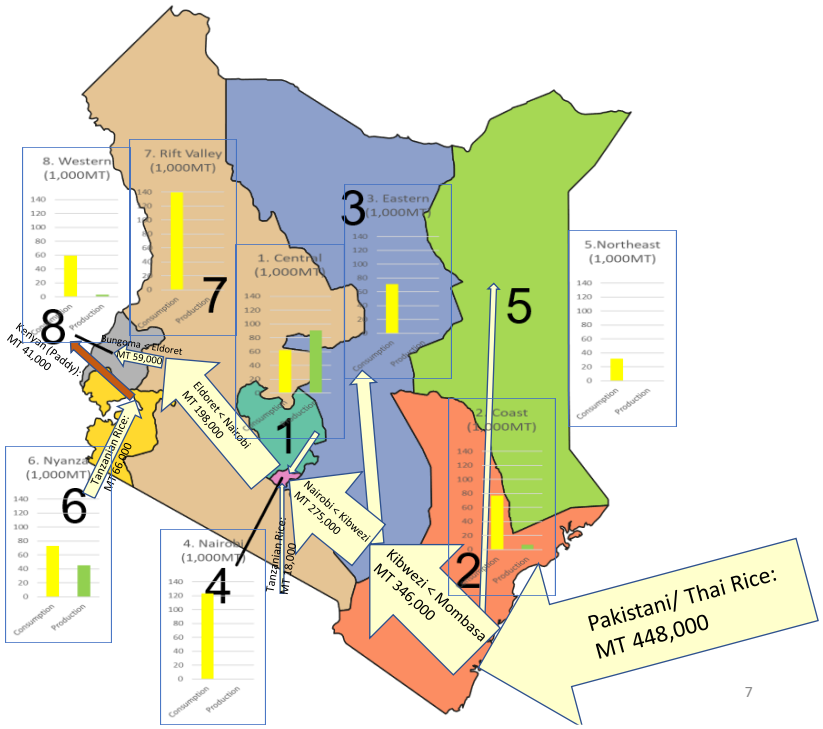
For instance, small-scale horticulture promotion, some alternatives of potential farming are considered in the western region; however, as a wide-area rural development, RVC development is the best choice, utilizing the weather conditions on rice cultivation and the expansion timing of rice consumption, including the demand in Uganda.

3.3.2 Rice Distribution/ Marketing

(1) Distribution Situation of Rice

The rice consumption amount has rapidly increased in recent times but the major rice production areas are limited in Mwea, Coast, and Western/Lake Victoria basin regions, whose total yield can cover about 23% of the total consumption. Therefore, the shortage portion of the consumption is covered by imported rice. Almost all imported rice arrived at the Port of Mombasa.

The next figure shows a rough estimation of the rice flow, whose bar graphs show the rice production in green and consumption in yellow in each former state. Although the portion of the consumption in the northern side is separated from the main flow of the imported rice, landed rice from ships is sent to the west. It will finally reach around the north-west area through Nairobi, the biggest rice consumption city, Eldoret and Kisumu, providing local consumption amounts in each state.



Source: JICA Survey Team

Figure A3.3.2-1 Rough Estimation of Rice Flow in Kenya, 2019

Table A3.3.2-1 Assumptions of Rice Import and Export

Item	Milled Rice ('000MT)	Remarks
Annual Shortage	490	Consumption - Production
Outflow to Uganda	41	85% of production in Nyanza and Western State
Import from Tanzania	- 84	66 through Isebania, 18 through Namanga
Import through Mombasa	448	Pakistan 58%, Thailand 29%, India 5%, China 5%

Note 1): Import from Tanzania; "Tanzania projects to export 84,000 tonnes of the locally produced rice to Kenya and 60,000 tonnes to Rwanda."; Tanzania's rice exports to Kenya, Rwanda to increase, Tuesday February 6, 2018; A newspaper article of The East African (Internet)

Note 2): "66 through Isebania" is the shortage amount in Nyanza.

Note 3): Rice imported quantity by country and ratio; International Trade Centre – Trade Map (Internet)

Source: JICA Survey Team based on the results of interviews with related persons

The above table shows assumptions for the "Rough Estimation of Rice Flow in Kenya, 2019". The map below shows Kenyan imported rice origin countries by imported value.

Source: JICA Survey Team; Compiled by International Trade Centre – Trade Map – International Trade Statistics (Internet)

Figure A3.3.2-2 Kenyan Imported Rice Origins by Imported Value in 2018

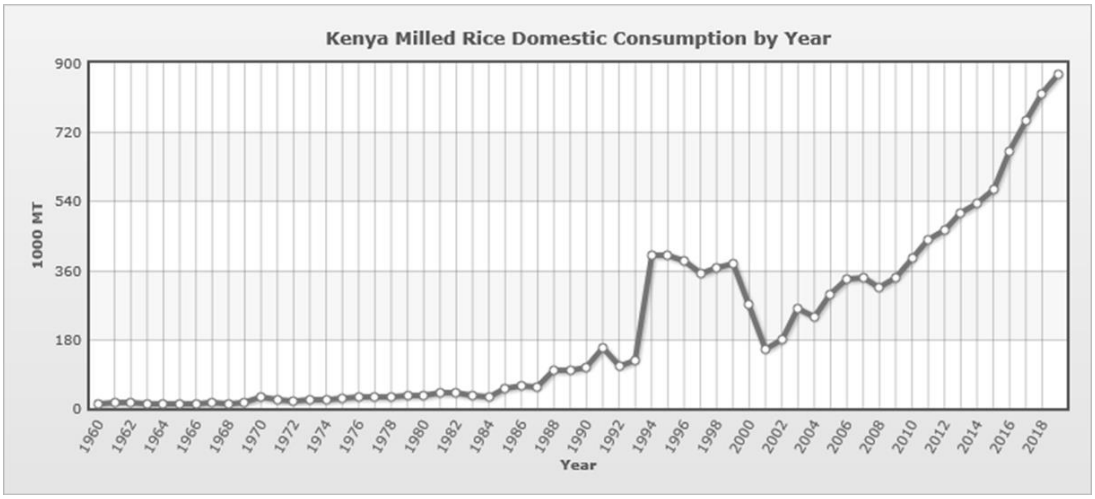
(2) Rice Marketing

1) Rice Marketing in the Western Region

The current staple food in the western region is ugali but youth and urban people prefer rice, chapatti, and pasta. Indeed, the next figure shows a rapid increase of rice consumption in these years. The growth rate in 2017 is 17.5%. While, major rice variety in Mwea is aromatic rice, whose yield is low, but price is high, and mainstream in the western region is IR of non-aromatic, whose yield is high, but price is low. Although it is said that even in the western region, consumption of aromatic rice will increase in the future. This seems to take time because rice consumption in the western region itself is not popular the central and the coastal region. Additionally, it is evident that the income level in the western region does not reach a level that allows ordinary people to buy the high price of aromatic rice.

Hence, the target of the rice industry development in the western region for the moment is set to increase the planting area and the unit yield of IR cultivation. For the next step, installation and expansion of aromatic variety cultivation can be considered, monitoring the demand in local markets. Regarding the next step in the near future, Kilimo Trust, an international NGO has a new installation idea of a "semi-aromatic variety", whose yield and price are at the middle[29]. They are seeking to apply the possibility before the installation of an aromatic variety in the western region.

[29] Mwea Irrigation Scheme tries to install new varieties for their marketing penetration. "BW196" is a newly installed variety, crossbred a local variety and a basmati variety, and shows high yield in Mwea.



Source: Department of Agriculture, United States

Figure A3.3.2-3 Rice Domestic Consumption, 1960 - 2019

2) Rice Marketing in the Irrigation Schemes around Kisumu

In the case of the WKRM, 15-20% of the total milled rice is sent toward the central region for the public rice provision of NIA, e.g., schools, institutions, universities, hospitals, prisons, etc. About 10% of the production in MRM is also sold to such institutions through the distribution network of NIA. The Kisumu Storage Station of NCPB has no rice milling machine and sells collected paddy to the LBDC. The milled rice of Pishori is packed by 1kg, 2 kg, 5 kg, and 25 kg and shipped to supermarkets. The milled Sindano IR is sacked by 50 kg and shipped to schools, universities, etc.

As it was already mentioned above, the paddy demand of Uganda is a special opportunity for the marketing in this area. It is required to increase the production amount through the increase of unit yield and planting area, giving priority to increase the quantity of paddy since Ugandan collectors of paddy do not care about the quality. Furthermore, it is expected that the milling cost of existing rice millers will decrease through the improvement of their milling efficiency so that Ugandan dealers will buy milled rice in the western region to save the transportation cost.

At least in Kenya, nobody knows how long the demand of Uganda continues. However, as long as the special demand is offered, it is necessary to install a new large-scale rice-milling facility into the north-western area of Kisumu so that rice farmers in the area will be able to avoid paying the transportation cost of rice husk between the production areas to the rice-millers in Kisumu. This is after changing the shipping destination from the border with Uganda to Kisumu Town.

If the paddy demand of Uganda is caused by the demand of South Sudan, direct export of milled rice from Kisumu to South Sudan, not through Uganda, can be considered. Now, the road improvement from Kisumu to the border with South Sudan is ongoing, which is planned to be finished in about five years. The business of the milled rice export must affect good impacts to the both countries if this idea comes true.

With regard to the paddy demand of Uganda, it is expected to utilize the northern route of Lake Victoria, connecting Kisumu and Jinja in Uganda, for the paddy transportation because the cost of shipping is lower than that of track transport though major commodities of the lake transport are fuels of petroleum products so far.

3) Rice Marketing in Lower Kuja Irrigation Scheme

The main point of the rice marketing of the irrigation scheme is clearly to secure a large-scale rice-milling facility in and around the command area. The first targets of rice marketing are local towns in Migori, Kishii, Homa Bay, Nyamira and Kisumu Counties, and Kisumu City. However, except for the two rice-millers in Kisumu County, there is no large-scale rice-miller in those counties.

Therefore, Lower Kuja Irrigation Scheme will have to transport paddy to Kisumu, whose distance is more than 150 km, if they cannot secure a large-scale rice-miller in around its beneficially area. Also, without a large-scale rice-miller, provision volume of milled rice even near around the irrigation scheme would be limited because considerable amount of milled rice is brought from Tanzania.

According to the Regional Manager in the Lake Western Area of the NCPB, their warehouses in Muhuru Bay, which are not operated now, may be re-run if the lake transportation between Kisumu and Muhuru Bay restarts since the rehabilitation of Kisumu Port is going to finish in November 2019. In former times, Tanzanian rice used to be transported from Mwanza in Tanzania to Muhuru Bay, and sorghum and millet produced around Muhuru Bay used to be transported to Mwanza.

3.3.3 Consideration to Issues and Handling Policies in the Rice Value Chain

(1) Outflow of Western Paddy to Uganda

The ratio of the paddy outflow to Uganda in the western region is estimated at about 80-90% by the related staff of NIA, Kisumu County, and MOALF. Roughly speaking, the demand of NIA distribution network is around 10%, which supplies rice to some schools, universities, military camps, prisons, etc. The local consumption, especially in towns, is another 10%. Therefore, the remaining 80-90% is estimated to be exported to Uganda.

The reasons of the paddy outflow to Uganda are arranged as stated below, comprehensively considering the observations of interviewees in the Survey.

- Western side of the western region, which is a border with Uganda, is covered by Ugandan rice-millers since there is no big-scale rice-mill facility, and the distance to a Ugandan rice-miller is shorter than that to LBDC and WKRM in Kisumu County.
- Increase of rice consumption in Uganda might cause an insufficiency of paddy in the eastern area, including the by-products, which seems to have high demand because of the increase of livestock consumption.
- The paddy outflow seems to be started around 12 years ago. Ugandan rice-millers might have got new rice needs. The outflowed rice, milled in Uganda, is estimated to be exported to South Sudan/Sudan.
- Some of the outflowed paddy seem to be returned to Kenya after the milling in Uganda. Due to the high milling cost in the western region in comparison with that in the eastern area of Uganda, Ugandan rice-millers seem to make a profit through the paddy business between Kenya and Uganda even if paying the cost of the transportation.

Table A3.3.3-1 Ugandan Rice Export, 2014 - 2017

Importers	Exported Quantity (MT)				
	2014	2015	2016	2017	% in 2017
Dem. Re. of Congo	32,900	26,814	27,085	35,867	66
South Sudan	17,371	19,622	15,009	15,866	29
Rwanda	6,629	5,053	964	1,174	2
Burundi	-	50	2	603	1
Sudan	882	186	121	422	1
Central African Repub.	-	-	48	47	0
Congo	-	-	-	30	0
Kenya	0	1,716	2,271	25	0
Canada	-	-	1	20	0
World	57,836	53,554	45,500	54,054	100

Source: International Trade Centre (Internet) based on the statistics of Uganda Bureau of Statistics (UBOS)

The above table shows rice export in Uganda from 2014 to 2017. The rice importers are top nine in 2017. About 70% of the total import is sent to Democratic Republic of Congo, and about 30% is sent to South

Sudan, which is exported about 15,000 – 20,000 MT every year. Rice export to Sudan is only about 1%. Kenyan import of rice from Uganda can be confirmed statistically as the No. 8 even though the amount is a little.

(2) Development Steps of Rice Farming in the Western Region

Is the outflow of domestic paddy a serious problem for Kenya from the viewpoint of increasing self-sufficiency of rice? If the Ugandan dealers had not come the western region to buy paddy with the good condition, could the farmers have sold their paddy with the same condition to domestic dealers? The answer is no. The sales price to domestic markets might be lower than the actual price to Ugandan markets, and the regional rice farming was not progressed as well as the current situation although it might contribute the increase of the operation rate of WKRM.

Now, Kenya imports a lot of amount of rice from Pakistan, Thai, etc., to make up for the insufficiency of the domestic demand. Those commodities are good quality and have low prices. Domestic rice in Kenya must compete with those imported commodities. In agriculture developing countries, imported produces often defeat the domestic farmers and do not allow them to grow; hence, the government in those countries protect domestic farmers through raising agricultural tariff and/or subsidy.

However, what happens in the western region is not rice import but rice export with good conditions. Rice farming in the region is still developing and the irrigated area is limited, compared with the situation of Tanzania, Uganda, or other neighbouring countries. It takes time for the rice farmers to have power to compete with rice farmers in those countries. Namely, the outflow to Uganda is considered as a good opportunity for the rice farmers to grow through increasing their knowledge and experiences.

Next table shows a step-by-step expectation of rice farming development, utilizing the good opportunity. If the paddy needs in Uganda is a transient business, such as an emergency demand due to the political unrest in South Sudan/Sudan, it may not continue so long. This is the one of the reasons that this development should be tried for rice farming in the western region.

Table A3.3.3-2 Expecting Plan of Rice Farming Development in the Western Region

Development Steps	Current Situation/ Expecting Plan	Shipping Destinations (%)		
		Uganda	Western Region	Central, Eastern
1st Step in 5 years	a) Purchase of paddy by Ugandan dealers (80-90%) b) Youth and city dwellers lead expansion of rice consumption. c) To provide rice to schools/hospitals through a network of NIA d) Low unit yield of paddy (3.0 MT/ha） e) Improvement of main shipping roads is ongoing. f) Payment of rice-millers' purchase of paddy takes time. (2 weeks – several months) g) High rice-milling and distribution cost (Ksh.50/kg)	80	15	5
2nd Step in 10 years	a) Purchase of paddy by Ugandan dealers will be reduced by half b) To keep up with expansion of rice consumption in the western region c) To expand local supply of middle-class rice d) To increase the unit yield of paddy (4.0 MT/ha) e) To improve access roads between production sites and main shipping roads f) Purchasing paddy by cash (Utilization of Warehouse Receipt System) g) To decrease rice-milling cost (Increase of rice-milling efficiency)	40	50	10
3rd Step in 15 years	a) Purchase of paddy by Ugandan dealers will be decreased b) To keep up with the nationwide changing that rice becomes a staple food c) To expand nationwide supply of middle-class rice	10	60	30

Development Steps	Current Situation/ Expecting Plan	Shipping Destinations (%)		
		Uganda	Western Region	Central, Eastern
	d) To increase the unit yield of paddy (5.0 MT/ha) e) Network roads improvement for the rice nationwide supply f) Development of rice milling business (Promotion of women's rice-milling business) g) To establish competitive rice-milling business (Utilization of by-products)			

Source: JICA Survey Team

(3) Warehouse Receipt System

In this system, when farmers bring their agriculture produces into warehouses of millers/warehouse companies, warehouse receipts are to be issued to the farmers as the evidence of stored produces. The farmers who received the receipts can borrow money from banks with them as collateral. The system aims to make farmers have a right to get loans on their receipts because the access to a loan for farmers, especially tenant farmers, is very limited in developing countries.

This system can contribute the improvement of farmers' access of loan and the increase of their bargaining power. It is necessary to prepare the following three conditions at least for smoothly making use of the system.

- Agriculture produces can be stored properly without damage caused by a leak in the roof, a harmful insect, etc.
- Warehouse companies/millers check the quality and the quantity of the stored agriculture produces properly when the produces arrive at the warehouses.
- Stored agriculture produces are dealt properly in the market and their price information is widely known by ordinary people.

Supporting programs (by grant aid) are required for the preparation of the above conditions as a supporting measure for rice farmers in the target area.

(4) Strategic Food Reserve (SFR) of Rice

Strategic Food Reserve Board (SFRB) is the planning and arranging agency for the implementation of the SFR, which consists of related ministries, agencies, NGOs, experts, etc. Now, foods targeted for the SFR include maize, dry milk powder, beans, fish, canned beef, and rice. The main reason why the SFRB newly included rice into the target foods is to address cultural needs in wide regions. Rice is an important diet choice in Kenya.

The SFRB plans to make a trial of paddy reserve in this FY. For the trial program, as the first consignment, the SFRB seeks to purchase 25,000 bags of 50 kg each. This paddy of 1,250 MT is equivalent to the milled rice of 688 MT, applying the recovery ratio of 55%. The volume of the milled rice is about 0.5% of the domestic rice production of 146,000 MT. The SFRB intends to purchase local rice as a priority but can outsource where the volumes are not met with the requirement.

Since it is a trial programme, the SFRB is making the arrangements with the NIA to handle the logistics of the purchase and also to store for them. The NIA will handle paddy quality parameters, such as moisture content, level of purity, etc., according to the East African Standards. This is so as to avoid any contamination with the rice. The NIA will also carry out preservative measures of the rice.

The trial programme will be like a learning experience for the SFRB. Diagnostic will be done to ascertain certain fundamental points to which the board may make further recommendations, depending on the performance of the pilot programme. After the first consignment, the SFRB is going to expand the volumes of paddy storage. They will double and triple the volume in the second and the third consignment, respectively.

3.3.4 Potential Cooperation Program in Rice Value Chain

(1) Promotion Program for Private Rice-millers to the Rice-Mill Complex – A TCP for the Whole Coastal Area of Lake Victoria

NIA develops the Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, there is no rice-mill factory in and around the irrigation scheme; hence, the paddy harvested in the area is transported to Kisumu and milled there. Therefore, NIA has installed a small-scale milling machine into the NIA Office in Lower Kuja, but its capacity is very limited. It is necessary to secure enough milling factories for the full-scale rice production and marketing in the area.

In terms of the promotion of rice-milling industry, considering the development history of private rice-millers in Mwea and the dullness of the public rice-miller in Ahero Irrigation Scheme, it is desirable that the industry will be developed under the initiative of the private sector. At the same time, the NIA of the public sector is required to support the business of the private sector since rice-milling business is the first challenge in the area of Lower Kuja.

Through the preparation of basic infrastructure in accordance with the needs of private rice-millers, which are small, medium and large scale, such as land, electricity, water, etc., into the irrigation area, rice-millers will be invited to the area, and local business of rice-milling will be promoted. If the developing manners of Mwea Irrigation Scheme can be applied on the rice-milling industry development, a lot of time can be saved to achieve the level of their development progress.

<table>
<tr><th>No. 1</th><th colspan="3">Promotion Program for Private Rice-millers to the Rice-Mill Complex – A TCP for the Whole Coastal Area of Lake Victoria</th></tr>
<tr><td>Implementation Period</td><td colspan="3">3 years</td></tr>
<tr><td>Target Group</td><td colspan="3">Private rice-millers who want to do rice-milling business in Lower Kuja Irrigation Scheme (small, medium, and big scale rice-millers)</td></tr>
<tr><td>Implementation Agency</td><td>Irrigation Development Project in Lower Kuja (NIA)
Western Kenya Rice Mill (NIA)</td><td>Cooperation Agencies</td><td>NCPB, MOALF, Migori County, Kisumu County</td></tr>
<tr><td colspan="4"><u>Background and Purposes</u>
− NIA develops Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, there is no rice-mill factory around the irrigation scheme, the paddy harvested in the area is transported to Kisumu and milled there.
− Hence, NIA has installed a small-scale milling machine into the NIA Office in Lower Kuja, but its capacity is limited; therefore, it is necessary to secure a milling factory for the full-scale rice production and marketing in the area.
− In terms of the promotion of rice-milling industry, consideration of the development of private rice-millers in Mwea and the dullness of the public rice-miller in Ahero, <u>it is desirable that the industry will be developed under the initiative of the private sector. It is required to support the business of the private sector since rice-milling business is the first challenge in the area of Lower Kuja.</u>
− <u>Through the preparation of the basic infrastructure in accordance with the needs of private rice-millers, which are small, medium and big scale, such as land, electricity, water, etc., into the irrigation area, rice-millers will be invited to the area, and local business of rice-milling will be promoted.</u></td></tr>
<tr><td colspan="4"><u>Program Goal</u>
To invite enough rice-millers to Lower Kuja Irrigation Area that can mill the whole amount of paddy produced in the Area</td></tr>
<tr><td colspan="4"><u>Outputs</u>
1. Inviting rice-millers is planned, based on the advance needs of private rice-millers.
2. Provision system of land, electricity, water and drainage is formulated, based on the inviting plan.
3. Publicity work of the inviting rice-millers is conducted and rice-millers that will be invited are selected.
4. Private rice-millers are invited to the irrigation area and beginning preparation of the rice-mill business is supported.</td></tr>
</table>

5. Lessons learned regarding the rice-mill operation through inviting rice-millers are arranged. 6. The lessons learned on rice-mill operation are applied to the operation improvement of the Western Kenya Rice Mill.	
Activities 1-1 Candidate rice-millers for the inviting are investigated, and supporting contents to them are decided, based on the needs of their advances. 1-2 Inviting plan is made, including candidate millers, selection ways, supporting contents and schedule. 2-1 Preparation works are conducted for land preparation and facilities installation of water and electricity provision, and sewage and garbage disposal. 2-2 Land preparation and facilities installation of water and electricity provision, and sewage and garbage disposal are implemented. 3-1 Publicity work of inviting rice-millers is carried out. 3-2 Rice-millers that will be invited are selected, and each inviting plan is made. 4-1 Private rice-millers are invited to the irrigation area in accordance with each inviting plan. 4-2 Beginning of rice-mill business is supported in conference with invited millers. 5-1 Rice-mill operation ways observed in the inviting rice-millers are analysed. 5-2 Rice-mill operation guide in Lake Victoria basin region is compiled. 6-1 Operation situation of the Western Kenya Rice Mill is investigated, and the improvement plan will be made. 6-2 Improvement methods of the Western Kenya Rice Mill are proposed, based on the operation guide.	
Inputs	
Donor Side 1. Experts dispatch (80 MM): Ksh.180 million (Team leader/Agriculture produce distribution, Rice value chain, Agriculture machines facilities/Postharvest processing/Agriculture produce processing, Agricultural credit, Facilities design, S/V, PPP) 2. Travel cost: Ksh.68 million 3. General management cost: Ksh.120 million 4. Equipment cost (PC, etc.): Ksh.4 million 5. Vehicle cost (2 cars): Ksh.8 million 6. Preparation cost for rice-mill complex: Ksh.85 million ・ Land preparation: Ksh.15 million ・ Electricity facility: Ksh.30 million ・ Water facility: Ksh.20 million ・ Sewage facility: Ksh.10 million ・ Garbage disposal facility: Ksh.10 million 7. Data collection/ Publicity work cost: Ksh.6 million ・ Holding W/S: Ksh.4 million ・ Advertise for rice-millers: Ksh.2 million Total Ksh.471 million	**Kenyan Side** 1. Government officers (C/P) activities: All 2. C/P travelling expenses: All 3. Office spaces: 2 places 4. C/P vehicle: 1 car 5. Land for rice-mill complex: All

(2) Promotion Program for Private Rice-millers to the Rice-Mill Complex – A Component of Yen Loan Project for the Irrigation Development in Lower Kuja

Main components of this program are same as the program No.1, whose target rice millers are not only the rice-mill complex in Lower Kuja but also the WKRM in Ahero and other rice millers in the western region. The program No.2 aims to reduce the project cost through focusing on the rice-mill complex in Lower Kuja only.

No. 2	**Promotion Program for Private Rice-millers to the Rice-Mill Complex – A Component of Yen Loan Project for the Irrigation Development in Lower Kuja**
Implementation Period	3 years
Target Group	Private rice-millers who want to do rice-milling business in Lower Kuja Irrigation Scheme (Small, Medium and Big scale rice-millers)

Implementation Agency	Irrigation Development Project in Lower Kuja (NIA)	Cooperation Agencies	NCPB, MOALF, Migori County

Background and Purposes

- NIA develops Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, there is no rice-mill factory around the Irrigation Scheme, the paddy harvested in the area is transported to Kisumu and milled there.
- Hence, NIA has installed a small-scale milling machine into the NIA Office in Lower Kuja, but its capacity is limited; therefore, it is necessary to secure a milling factory for the full-scale rice production and marketing in the area.
- In terms of the promotion of rice-milling industry, consideration of the development of private rice-millers in Mwea and the dullness of the public rice-miller in Ahero, **it is desirable that the industry will be developed under the initiative of the private sector. It is required to support the business of the private sector since rice-milling business is the first challenge in the area of Lower Kuja.**
- **Through the preparation of the basic infrastructure in accordance with the needs of private rice-millers, which are small, medium and big scale, such as land, electricity, water, etc. into the irrigation area, rice-millers will be invited to the area, and local business of rice-milling will be promoted.**

Program Goal

To invite enough rice-millers to Lower Kuja Irrigation Area which can mill the whole amount of paddy produced in the Area

Outputs

1. Inviting rice-millers is planned, based on the advance needs of private rice-millers.
2. Provision system of land, electricity, water and drainage is formulated, based on the inviting plan.
3. Publicity work of the inviting rice-millers is conducted and rice-millers that will be invited are selected.
4. Private rice-millers are invited to the irrigation area and beginning preparation of the rice-mill business is supported.

Activities

1-1 Candidate rice-millers for the inviting are investigated, and supporting contents to them are decided, based on the needs of their advances.
1-2 Inviting plan is made, including candidate millers, selection ways, supporting contents and schedule.
2-1 Preparation works are conducted for land preparation and facilities installation of water and electricity provision, and sewage and garbage disposal.
2-2 Land preparation and facilities installation of water and electricity provision, and sewage and garbage disposal are implemented.
3-1 Publicity work of inviting rice-millers is carried out.
3-2 Rice-millers that will be invited are selected, and each inviting plan is made.
4-1 Private rice-millers are invited to the irrigation area in accordance with each inviting plan.
4-2 Beginning of rice-mill business is supported in conference with invited millers.

Inputs

Donor Side	**Kenyan Side**
1. Experts dispatch (20 MM): Ksh.45 million (Team leader/Agriculture produce distribution, Rice value chain, Agriculture machines facilities/Postharvest processing/Agriculture produce processing, Agricultural credit, Facilities design, S/V, PPP) 2. Travel cost: Ksh.17 million 3. General management cost: Ksh.30 million 4. Equipment cost (PC, etc.): Ksh.1 million 5. Vehicle cost (2 cars): Ksh.8 million 6.Preparation cost for rice-mill complex: Ksh.85 million ・ Land preparation: Ksh.15 million ・ Electricity facility: Ksh.30 million ・ Water facility: Ksh.20 million ・ Sewage facility: Ksh.10 million ・ Garbage disposal facility: Ksh.10 million 7. Data collection/ Publicity work cost: Ksh.3 million	1. Government officers (C/P) activities: All 2. C/P travelling expenses: All 3. Office spaces: 2 places 4. C/P vehicle: 1 car 5. Land for rice-mill complex: All

・ Holding W/S: Ksh.2 million ・ Advertise for rice-millers: Ksh.1 million Total Ksh.189 million	

(3) Installation Program of Paddy Collection, Shipping and Storage Center - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja

NIA develops the Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, there is no paddy drying yard and cereal warehouse in and around the irrigation scheme. It is required that drying yards and warehouses will be installed in the irrigation area for the full-scale rice production and sales in the area.

Private rice-millers are planned to be invited to the centre of the irrigation scheme. This program aims to divide in the area about five blocks including the centre block, and to install a sun-drying yard and a serial warehouse with office into each block so that harvested paddy will be properly dried, stored and sold to the rice millers within the irrigation scheme.

No. 3	**Installation Program of Paddy Collection, Shipping and Storage Center - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja**		
Implementation Period	2 years		
Target Group	About 5 WUAs of branch canals in Lower Kuja Irrigation Scheme		
Implementation Agency	Irrigation Development Project in Lower Kuja (NIA)	Cooperation Agencies	NCPB, MOALF, Migori County

Background and Purposes

- NIA develops Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, there is no paddy drying yard and cereal warehouse around the Irrigation Scheme, it is required that drying yards and warehouses would be installed in the irrigation area for full-scale rice production and sales.
- Private rice-millers are planned to be invited to the centre of the Irrigation Scheme. This program aims to divide in the area about five blocks including the centre block, and to install a sun-drying yard and a serial warehouse with office into each block.

Program Goal

To dry, pack, storage and sell the whole amount of paddy produced in Lower Kuja Irrigation Scheme, at every block of the blanch canals, appropriately

Outputs

1. Installation of drying yards and warehouses is planned, based on the rice production plan in Lower Kuja Irrigation Scheme.
2. Sun-drying yards and warehouses with offices are constructed, based on their installation plan.
3. Each WUA of a blanch-canal block makes operation plan of the drying yard and the cereal warehouse.
4. Each WUA of a blanch-canal block dries, storages and ships paddy produced in the block.

Activities

1-1 Each block WUA plans drying, storage and shipping of paddy, based on the rice production and sales plan.
1-2 Facilities installation plan is made, based on the drying and storage plan.
2-1 A constructor is selected, based on the facilities installation plan, and the drying yards and the warehouses are installed.
2-2 The construction is supervised in accordance with the facilities installation plan.
3-1 O&M of the drying yard is planned through discussion with WUA of each blanch-canal block.
3-2 O&M of the cereal warehouse is planned through discussion with WUA of each blanch-canal block.
4-1 Each block WUA dries and stores paddy.
4-2 Each block WUA ships dried paddy.

Inputs	
Donor Side 1. Experts dispatch (10 MM): Ksh.23 million	**Kenyan Side** 1. Government officers (C/P) activities: All 2. C/P travelling expenses: All 3. Office space: 1 place

(Team leader/Postharvest processing facilities, S/V of facilities construction, Operation of postharvest processing facilities) 2. Travel cost: Ksh.9 million 3. General management cost: Ksh.15 million 4. Equipment cost (PC, etc.): Ksh.1 million 5. Vehicle cost (2 cars): Ksh.4 million 6. Installation of collection, shipping and storage facilities: Ksh.43 million ・ Sun-drying yards (5): Ksh.10 million ・ Cereal warehouses with offices (5): Ksh.25 million ・ Cereal warehouses (2): Ksh.8 million 7. Operation training program: Ksh.3 million Total Ksh.98 million	4. C/P vehicle: 1 car 5. Land for drying and storage facilities: 12 places

(4) Improvement of Rice Transportation Routes (Road and Port) - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja

NIA develops Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, because of gravel pavements in the Irrigation Scheme, the transportation efficiency is low, and there are scattered points that are difficult to pass in the rainy season. Hence, it is expected that farming roads in the area will be paved with asphalt/ concrete as commute, working and transportation roads when full-scale rice production starts in the area.

The JICA Survey Team can secure a shipping route from the production site toward Kisumu by the improvement of internal roads because rehabilitation of the main road between Migori and Kisumu is ongoing in earnest, and the connection road between the irrigation area and the main road has paved already with asphalt. Private rice-millers are planned to be invited to the centre of the irrigation scheme. Drying yards and serial warehouses are also planned to be installed, dividing the area into about five blocks. Therefore, connection roads among those installed facilities have high priority to be improved.

A jetty of the lake port in Muhuru Bay, next to the irrigation scheme, will be improved as well as the roads improvement because the ship transportation on the lake, using the port, may be resumed after the completion of the rehabilitation of Kisumu Port, which is planned to be finished in November 2019.

No. 4	**Improvement of Rice Transportation Routes (Road and Port) - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja**		
Implementation Period	2 years		
Target Group	Rice farmers in Lower Kuja Irrigation Scheme		
Implementation Agency	Irrigation Development Project in Lower Kuja (NIA)	Cooperation Agencies	NCPB, MOALF, Migori County
Background and Purposes − NIA develops Lower Kuja Irrigation Scheme, whose rice cultivation trial was started in 2019. However, because of gravel pavements in the irrigation scheme, the transportation efficiency is low, and there are scattered points that are difficult to pass in rainy season. Hence, it is expected that roads in the area will be paved with asphalt/ concrete as commute, working and transportation roads in case full-scale rice production starts. − The JICA Survey Team can secure a shipping road from the production site toward Kisumu through the improvement of internal roads because full-scale rehabilitation of the main road between Kisumu and Migori is ongoing, and the connection road between the irrigation area and the main road has already paved with asphalt. − Private rice-millers are planned to be invited to the centre of the Irrigation Scheme. Drying yards and serial warehouses are planned to be installed as well, dividing the area into about five blocks. Therefore, connection roads among those installed facilities have high priority to be improved. − Also, a jetty of the lake port, next to the irrigation area, will be improved as well as the roads improvement because the water transportation using the port may be resumed after the completion of the rehabilitation of Kisumu Port.			
Program Goal			

To increase activity efficiency of the agriculture production and produce sales in Lower Kuja Irrigation Scheme through paving roads with asphalt/ concrete in the irrigation area, and improving the jetty of the lake port, next to the area, as well
Outputs 1. Improvement of roads in the irrigation area and a jetty of the adjoining port is planned, based on the rice production plan in Lower Kuja Irrigation Scheme. 2. Those roads and the jetty are improved, based on their improvement plan. 3. WUA makes the maintenance plan of the improved roads. 4. WUA maintains the improved roads.
Activities 1-1 Improvement of roads in the irrigation area is planned, based on the rice production and shipping plan. 1-2 Improvement of the jetty of the adjoining port is planned, based on the rice shipping plan. 2-1 Constructors are selected, based on the facilities improvement plan, and the pavement and the improvement constructions are implemented. 2-2 The constructions are supervised in accordance with the facilities improvement plan. 3-1 Maintenance of the paved roads in the area is planned through discussion with WUA. 3-2 Repair of paved roads is planned through discussion with Migori County. 4-1 WUA conducts maintenance activities of the paved roads. 4-2 Migori County conducts repair works of the paved roads.

Inputs	
Donor Side 1. Experts dispatch (10 MM): Ksh.23 million (Team leader/Improvement of transportation route, S/V of facilities construction) 2. Travel cost: Ksh.9 million 3. General management cost: Ksh.15 million 4. Equipment cost (PC, etc.): Ksh.1 million 5. Vehicle cost (2 cars): Ksh.4 million 6. Road pavement (10 km): Ksh.500 million 7. Jetty improvement (1 place): Ksh.10 million Total Ksh.562 million	**Kenyan Side** 1. Government officers (C/P) activities: All 2. C/P travelling expenses: All 3. Office space: 1 place 4. C/P vehicle: 1 car

(5) Operation Improvement of the Existing Public Rice-mill – A TCP for the Whole Coastal Area of Lake Victoria

The NIA has installed a rice-milling facility and operated it in Ahero Irrigation Scheme. However, the paddy collection from farmers are difficult because the payment for purchasing paddy take a few months. On the other hand, Ugandan paddy collectors appeared in such a situation, who buy paddy by cash and do not care the quality of paddy. Now, about 80-90% of paddy produced in the western region is taken to Uganda. In the circumstances, the operation rate of the WKRM falls off around 20%.

Therefore, the NIA tries securing a necessary fund for purchasing paddy of the WKRM to pay by cash, but the detail plan has not yet prepared. Also, comparatively high cost of rice milling in the western region is one of the backgrounds of the paddy outflow, which allowed to the advance of Ugandan rice millers. Rice-mill business in the western region is required to be improved radically.

Though the demand of rice in the western region is also expanding, prices of rice are higher than those of maize, and a huge amount of Pakistani/Thai rice is distributed. The price of aromatic rice is still expensive for the ordinary people in the area, which is one reason the majority people prefer non-aromatic rice. It is important to increase the provision amount of rice produced in the western region through marketing activities that divide the target consumers groups.

No. 5	**Operation Improvement of the Existing Public Rice Mill – A TCP for the Whole Coastal Area of Lake Victoria**
Implementation Period	2 years
Target Group	Staffs of Western Kenya Rice Mill (NIA)

Implementation Agency	Western Kenya Rice Mill (NIA)	Cooperation Agencies	NCPB, MOALF, Kisumu County

Background and Purposes

- NIA has installed a rice-mill facility and operated it in Ahero Irrigation Scheme. However, the paddy collection from farmers was difficult because the payment for purchased paddy took a few months. Ugandan paddy collectors appeared in the situation, who bought paddy by cash and did not care the quality of paddy. Now, about 80-90% of paddy produced in the western region is taken to Uganda. In the circumstances, the operation rate of the rice-mill of NIA falls off around 20%.
- Therefore, NIA tries securing a necessary fund for purchasing paddy to Western Kenya Rice Mill to pay by cash, but the detail plan has not yet prepared. Also, comparatively high cost of rice milling in the western region is one of the backgrounds, which allowed to the advance of Ugandan rice millers. Rice-mill business in the western region is required to be improved radically.
- Though the demand of rice in the western region also seems to expand, prices of rice are higher than those of maize, and a huge amount of Pakistan/Thai rice is imported. It is important to increase the provision amount of rice produced in the western region through marketing activities that divide the target consumers groups.

Program Goal

To contribute to expand rice demand in the western region through the improvement of the operation of Western Kenya Rice Mill (NIA) to increase milling/sales amount

Outputs

1. Local situation of rice demand, production, milling and distribution is grasped.
2. Operation improvement plan is formulated through arranging the current situation and problems of the operation.
3. Methods of the current business operation are improved in accordance with the operation improvement plan.
4. Dealings with new customers/dealers are begun in accordance with the operation improvement plan.

Activities

1-1 Local information on rice demand and production is collected, and problems are arranged.
1-2 Local information on rice milling and distribution is collected, and problems are arranged.
2-1 Current operation situation is arranged in accordance with rice flow, its problems are extracted, and the solution is considered.
2-2 Current operation situation is arranged in accordance with money flow, its problems are extracted, and the solution is considered.
3-1 Existing business methods are improved in accordance with the operation improvement plan.
3-2 Improved existing business methods are monitored, and effects of the improvement are confirmed.
4-1 New customers/dealers are developed in accordance with the operation improvement plan.
4-2 Dealings with new customers/dealers are monitored, and effects of the new business are confirmed.

Inputs	
Donor Side	**Kenyan Side**
1. Experts dispatch (20 MM): Ksh.45 million (Team leader/Rice-milling business operation, Rice VC, Rice-milling facilities)	1. Government officers (C/P) activities: All
2. Travel cost: Ksh.17 million	2. C/P travelling expenses: All
3. General management cost: Ksh.30 million	3. Office space: 1 place
4. Equipment cost (PC, etc.): Ksh.1 million	4. C/P vehicle: 1 car
5. Vehicle cost (2 cars): Ksh.8 million	
6. Holding workshops: Ksh.2 million	
Total Ksh.103 million	

3.4 Environmental Impact Assessment

3.4.1 Environmental Impact Assessment System in Kenya

In Kenya, projects classified as “High Risk” must undergo an EIA study following the Environmental Management and Coordination Act (ECMA) 1999 and EIA license must be acquired. The procedures of the EIA study are stipulated in the Environmental (Impact Assessment and Audit) Regulations 2003. The National Environment Management Authority (NEMA) is the authority for EIA, which is responsible for evaluation, publication, issuing of license. The following figure shows the general procedures of EIA in Kenya.

Table A3.4.1-1 General Procedure for Issuance of EIA License in Kenya

Procedure	Notice
1. Scoping and preparation of TOR of EIA	-
2. Evaluation of TOR of EIA by NEMA	-
3. Preparation and submission of EIA to NEMA	Including three times of public hearing
4. Evaluation of EIA by NEMA (within three months)	Invitation of comments from lead agencies and public hearing, if necessary
5. Issuance of EIA licence by NEMA	-

Source: Environmental (Impact Assessment and Audit) Regulations 2003

Except for the EIA license, NIA must follow other related laws and regulations in Kenya. Environment-related laws and regulations relevant to irrigation development projects in Kenya are as shown in the table below.

Table A3.4.1-2 Environment-related Laws and Regulations relevant to the Irrigation Projects in Kenya

Category	Law and regulation	Relevance to the proposed project
Natural environment	Environmental Management and Coordination (Wetlands, Riverbanks, Lake Shores and Sea Shore Management) Regulation 2009	Regulates wetland conservation and management. Requires permission in case of extraction of resources from wetlands around the Lake Victoria.
	Wildlife Conservation and Management Act 2013	Prescribes protected areas and wildlife flora/fauna.
	Forest Conservation and Management Act 2016	Regulates forest conservation and management. Requires permission in case of cutting of forests.
	Water Act 2002	Regulates water resource conservation and usages. Requires permission in case of water extraction of from water resources
Social environment	Land Act 2012	Regulates land acquisition process and compensation.
	Occupational Safety and Health Act 2007	Regulates occupational safety and registration for construction premises.
Environmental management	Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009	Prescribes standards for ambient air, industrial emissions, vehicle emission and requirement for emission license.
	Environmental Management and Coordination (Water Quality) Regulations 2006	Prescribes standards for effluent water, domestic water use and requirement for effluent license.
	Environmental Management and Coordination (Waste Management) Regulations 2006	Regulates waste transportation, treatment/disposal.

Source: JICA Survey Team

3.4.2 EIA License for Lower Kuja Irrigation Project

NIA acquired the EIA license from NEMA in November 2012 for Lower Kuja Irrigation Project. But the license has been already expired because its validity was only for two years after issuance. Therefore, NIA must renew the license or acquire a new license before the commencement of the project. In the license, the following conditions were mentioned, and similar conditions would be implied for the proposed project.

Table 3.4.2-1 Conditions mentioned in the EIA License for Lower Kuja Irrigation Project

Category	Condition
General Conditions	1.1 This approval is for the proposed Irrigation of Lower Kuja Basin, at a cost of Ksh. 3,982,468,311.00. 1.2 The license shall be valid for 24 months from the date of issue. 1.3 Without prejudice to the other conditions of this license, the proponent shall implement and maintain and environmental management system, organizational structure and allocate resources that are sufficient to achieve compliance with the requirements and conditions of this license. 1.4 The Authority shall take appropriate actions against the proponents in the event of breach of any of the conditions stated herein of any contravention to the Environmental Management and Coordination Act, 1999 and regulations therein. 1.5 This license shall not be taken as statutory defense against charges of environmental degradation or pollution in respect of any manner of degradation/pollution not specified herein. 1.6 The proponent shall ensure that record on conditions of license/approval and project monitoring and evaluation shall be kept on the project site for inspection by NEMA's Environmental

Category	Condition
	Management Plan. 1.7 The proponent shall submit an Environmental Audit report in the first year of occupation/operations/commissioning to confirm the efficacy and adequacy of the Environmental Management Plan. 1.8 The proponent shall provide the final project account (final project costs) on completion of construction phase. This should be done prior to project commissioning/operation/occupation.
Construction Conditions	2.1 The proponent shall put up project signboard as per the Ministry of Public Works standards showing the NEMA EIA license number among other details. 2.2 The proponent shall ensure that adequate and appropriate sanitary facilities are provided for the workers during construction phase and that proper decommissioning of the facilities is carried out once construction is complete. 2.3 The proponent shall implement a Resettlement Action Plan as per the relevant legislations and to the satisfaction of the affected persons. 2.4 The proponent shall ensure that the irrigation layout plan is approved by the relevant authorities before commencement of works. 2.5 The proponent shall ensure that the community is engaged fully in the implementation of the irrigation plan and that full support is rendered before commencement. 2.6 The proponent shall ensure that all excavated material and debris is collected, re-used and where need be, disposed off as per the Environmental Management and Coordination (Riverbanks, Lakeshores and Seashores) Regulations of 2009. 2.7 The proponents shall ensure strict adherence to the provisions of Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control.) Regulations of 2009. 2.8 The proponents shall ensure strict adherence to the Occupational Safety and Health Act (OSHA), 2007. 2.9 The proponent shall ensure that workers are provided with adequate personal protection equipment (PPE), sanitary facilities as well as adequate training. 2.10 The proponent shall ensure strict adherence to the Environmental Management Plan developed throughout the project cycle. 2.11 The proponent shall ensure that the development adheres to zoning specifications issued for development of such a project within the jurisdiction of the Municipal Council of Kisumu, with emphasis on approved land use for the area.
Operational Conditions	3.1 The proponent shall ensure that farmers are trained on appropriate methods and management systems of application and disposal of agro-chemicals. 3.2 The proponent shall obtain a water use abstraction permit from Water Resources Management Authority (WRMA) and shall adhere to the conditions issued. 3.3 The proponent shall ensure that latrines are constructed at suitable places so as to avoid contamination of water bodies and the subsequent outbreak of water-borne diseases. 3.4 The proponent shall ensure usage of agro-chemicals which are approved by KEPHIS and that appropriate measures are put in place to ensure no ground water pollution takes place. 3.5 The proponent shall ensure that all waste water is disposed as per the standards set out in the Environmental Management and coordination (Water Quality) Regulations of 2006. 3.6 The proponent shall ensure that rain water harvesting facilities are provided to supplement surface and ground water. 3.7 The proponent shall ensure that all drainage facilities are fitted with adequate functional oil water separators and slit traps. 3.8 The proponent shall ensure that appropriate and functional efficient air pollution control mechanisms are installed in the facility to control all air emissions. 3.9 The proponent shall ensure that all equipment used are well maintained in accordance with the Environmental management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations of 2009. 3.10 The proponent shall ensure that all solid waste is handled in accordance with the Environmental Management and Coordination (Waste Management) Regulations of 2006. 3.11 The proponent shall ensure that all workers are well protected and trained as per the Occupational Safety and Health Act (OSHA) of 2007. 3.12 The proponent shall comply with the relevant principal laws, by-laws and guidelines issue for development of such a project within the jurisdiction of the Ministry of Agriculture, Ministry of Water and Irrigation, Water Resources Management Authority, Ministry of Lands and Physical Planning, Ministry of Livestock, Ministry of Public Health and Sanitation, Directorate of Occupational Health and Sanitation and other relevant Authorities. 3.13 The proponent shall ensure that environmental protection facilities or measures to prevent pollution and ecological deterioration such as dykes, river bank stabilization and other necessary structures to protect life and property, soil erosion prevention, tree planting mechanisms are designed, constructed and employed simultaneously with the proposed project.
Notification Conditions	4.1 The proponent shall seek written approval from the Authority for any operational changes under this license. 4.2 The proponent shall ensure that the Authority is notified of any malfunction of any system within

Category	Condition
	12 hours on the NEMA hotline No. 020 6006041 and mitigation measure put in place. 4.3 The proponent shall keep records of all pollution incidences and notify the Authority within 24 hours. 4.4 The proponent shall notify the Authority in writing of its intent to decommission the facility three (3) months in advance.
Decommissioning Conditions	5.1 The proponent shall ensure that all pollutions and polluted material is contained and adequate mitigation measures during the project phases

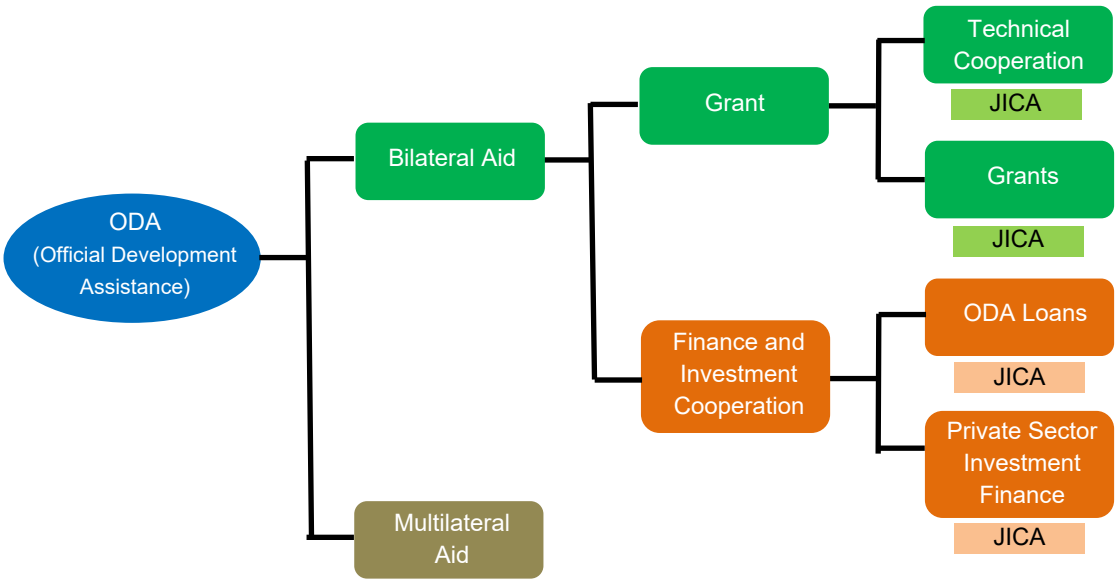
Source: EIA License for Lower Kuja Irrigation Project issued in November 2012

CHAPTER 4 PROJECT COST ESTIMATION

Through the aforementioned discussions in Chapter 3, the three project categories, namely: 1) infrastructure improvement, 2) agriculture practice and extension, and 3) rice value chain improvement, have been identified as potential loan or grant aid-assisted categories together with sub-categories. This chapter discusses the project cost by each sub-category and component.

4.1 Types of ODA Project

Official development assistance (ODA) is broadly divided into bilateral aid and multilateral aid. Bilateral aid consists of finance and investment cooperation (ODA loans and private sector investment finance) and grants (grant aid and technical cooperation).



Source: HP of JICA

Figure A4.1-1 Types of ODA

This Survey would consider the following financial assistance for the development of the targeted four irrigation schemes.

(1) ODA Loans (Yen Loan Project)

Considering the scale of all four project areas (four irrigation schemes), it appears that a yen loan project is suitable for this irrigation development project. In case of the independent project for Lower Kuja Irrigation Scheme, a yen loan project is also suitable due to its scale. ODA loans support developing countries by providing low-interest, long-term, and concessional funds to finance their development efforts. The yen loan project would consist of the hard component (infrastructure improvement) and the soft component (agriculture practice and rice value chain improvement) in this project. Moreover, the international co-financing project shall be considered, according to the amount of project cost.

(2) Grants (Grant Aid Project)

Based on the previous result on the grant aid projects which were provided by JICA, the range of development in the project area would be limited due to the budget limitation. In case only the grant aid project will be adopted, the Lower Kuja Irrigation Scheme would be excluded from the candidate development project because the area is too large to be covered by the grant aid project.

(3) Technical Cooperation (Technical Cooperation Project)

The yen loan projects and grant aid projects usually include the technical cooperation project. It is expected that the multiplier effects will be demonstrated by the cooperation with the Capacity Development Project for Enhancement of Rice Production in Irrigation Schemes (CaDPERP) which is provided by JICA.

4.2 Contents of Potential Cooperation Program

(1) Types of Financial Assistance

There are three potential cooperation programs in this project and these programs are divided into hard component and soft component. Table A4.2-1 shows each cooperation program and type of financial assistance which shall be provided by JICA and/or other international organization. These three cooperation programs should be conducted in close cooperation and they could have some options for financial assistance as shown below.

Table A4.2-1 Cooperation Program and Types of Financial Assistance

No.	Cooperation Program	Types of Financial Assistance		Donors
1	Infrastructure Improvement (Hard Component)	Yen Loan Project		JICA
		International Co-financing Project		JICA and Other International Organization
		Grant Aid Project		JICA
2	Agriculture Practice (Soft Component)	Technical Cooperation Project	with Yen Loan Project	JICA
			with International Co-financing Project	JICA and Other International Organization
			with Grant Aid Project	JICA
3	Rice Value Chain Improvement (Soft Component)	Technical Cooperation Project	with Yen Loan Project	JICA
			with International Co-financing Project	JICA and Other International Organization
			with Grant Aid Project	JICA

Source: JICA Survey Team

(2) Contents of Cooperation Program

Table A4.2-2~4 summarizes the "Sub-categories" and "Components" for each "Category". Based on the data collection, data analysis, and field investigation, the hard component (Infrastructure Improvement) is planned for each scheme. Meanwhile, the soft components (Agriculture Practice and Extension and Rice Value Chain Improvement) are comprehensively considered as the entire plan in the Lake Victoria Basin Region.

Table A4.2-2 Contents of Infrastructure Improvement

1) Ahero Irrigation Scheme

Category	Component
1. Intake by Pump	1-1. Rehabilitation of pump system
	1-2. Rehabilitation/upgrading of pump system with new technology (e.g., solar system)
2. Intake by Gravity	2-1. Introduction of the gravity system without dam (no expansion＝Ahero 867 ha)
	2-2. Introduction of the gravity system with the Koru Dam (Extension: 3,360 ha, including the existing Ahero (867 ha) and West Kano (892 ha): 5,119 ha in total)
3. Canals	3-1. Rehabilitation of the existing canal system (no expansion: 867 ha)
	3-2. Rehabilitation of the existing canal system (expansion: 451 ha)

Category	Component
	3-3. Introduction of the new canal system in expansion area and W. Kano (3,360+892 ha)
4. Flood Dyke	4-1. Improvement of the flood protection dyke

Source: JICA Survey Team

2) West Kano Irrigation Scheme

Category	Component
1. Intake by Pump	1-1. Rehabilitation of the pump system (ordinary repair)
	1-2. Rehabilitation/upgrading of the pump system with new technology (e.g., solar system)
2. Canals	2-1. Rehabilitation of the canal system
3. Flood Dyke	3-1. Improvement of the flood protection dyke

Source: JICA Survey Team

3) South West Kano Irrigation Scheme

Category	Component
1. Intake by Gravity	1-1. Improvement of the intake structure
2. Canals	2-1. Rehabilitation of the canal system
3. Flood Dyke	3-1. Improvement of the flood protection dyke

Source: JICA Survey Team

4) Lower Kuja Irrigation Scheme

Category	Component
1. Dam	1-1. Dam development
2. Intake by Gravity	2-1. Rehabilitation of the headworks
3. Canal Plan 1-A (Paddy 2,375 ha + Upland 5,342 ha = 7,717 ha)	3-1. Rehabilitation of the existing canal system (Block M: paddy + upland crop= 82 ha)
	3-2. Development of a new canal system up to 7,717 ha (Cost: without Block M)
	3-3. Land consolidation (paddy + upland crop)
4. Canal Plan 1-B (Paddy 4,610 ha + Upland 3,107 ha = 7,717 ha)	4-1. Rehabilitation of the existing canal system (Block M: paddy + upland crop= 82 ha)
	4-2. Development of a new canal system up to 7,717 ha (Cost: without Block M)
	4-3. Land consolidation (paddy + upland crop)
5. Canal Plan 1-C (Paddy 7,717 ha + Upland 0 ha = 7,717 ha)	5-1. Rehabilitation of the existing canal system (Block M: paddy=60 ha)
	5-2. Development of a new canal system up to 7,717 ha (Cost: without Block M)
	5-3. Land consolidation (paddy)
6. Canal Plan 2 (Paddy 5,047 ha + Upland 11,353 ha 16,400 ha)	6-1. Rehabilitation of the existing canal system (Block M: paddy + upland crop= 82 ha)
	6-2. Development of a new canal system up to 16,400 ha (Cost: without Block M)
	6-3. Land consolidation (paddy + upland crop)
7. Flood Dyke	7-1. Development of a new flood dyke

Source: JICA Survey Team

Table A4.2-3 Contents of Agriculture Practice and Extension

Category	Component
1. Extension	1-1. Capacity development project for the enhancement of rice production techniques and wide-range extension in the Lake Victoria Basin Region (JICA technical cooperation project)
	1-2. Capacity development project for enhancement of rice production techniques and extension in Lower Kuja Irrigation Scheme (JICA technical cooperation project)
	1-3. Enhancement of rice production techniques and extension in Lower Kuja Irrigation Scheme (A component of JICA yen loan project)
2. Seed Production	2-1. Capacity development project for rice seed production and wide-range distribution in the Lake Victoria Basin Region (JICA technical cooperation project)
	2-2. Capacity development project for rice seed production and distribution in Lower Kuja Irrigation Scheme (JICA technical cooperation project)
	2-3. Rice seed production and distribution in Lower Kuja Irrigation Scheme (A component of JICA yen loan project)

Source: JICA Survey Team

Table A4.2-4 Contents of Rice Value Chain Improvement

Category	Component
1. Rice Mill (Lower Kuja)	1-1. Promotion program for private rice millers to the rice mill complex – A technical cooperation project for the whole coastal area of Lake Victoria
	1-2. Promotion program for private rice millers to the rice mill complex – A component of yen loan project for the irrigation development in Lower Kuja
2. Postharvest Processing	2-1. Installation program of paddy collection, shipping, and storage center - A component of yen loan project for the irrigation development in Lower Kuja
3. Transportation	3-1. Improvement of rice transportation routes (road and port) – A component of yen loan project for the irrigation development in Lower Kuja
4. Rice Mill (Kisumu)	4-1. Operation improvement of the existing public rice mill – A technical cooperation project for the whole coastal area of Lake Victoria

Source: JICA Survey Team

4.3 Policy of Cost Estimation

(1) Policy of Cost Estimation

The project cost shall be estimated under the following policies:

- The unit procurement/construction cost of infrastructure improvement, such as the pump system, main canal, secondary canal, flood protection dyke, and farm road, is referred to the following design reports which were published by NIA (former NIB) and JIID (Japan Institute of Irrigation and Drainage).

    1) *"Detailed design and Preparation of Bidding Documents of Ahero and West Kano Irrigation Schemes Development Project (2009, NIB)"*

    2) *"Lower Kuja Irrigation Development Project Final Detailed Design Report (June 2011, NIB)"*

    3) *"Consultancy Services for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Schemes Development Project (May 2013, MWI & NIB)"*

4) *"Lower Kuja Final Design Review Report Lot 2 & 3 (May 2014, NIB)"*

5) *"Agricultural Development Plan on the Lake Victoria Basin Region (March 2017, JIID)"*

6) *"The Study on Integrated Flood Management for Nyando River Basin in the Republic of Kenya Final Report (March 2009, Nippon Koei Co., Ltd.)"*

7) *"Building Construction Costs Handbook 2018/2019 (2018, Institute of Quantity Surveyors of Kenya (IQSK))"*

In addition, the unit construction cost in the above design reports is decided by taking account of the price escalation rate as of 2018 (There is no appropriate data to set the price escalation rate for the fiscal year of 2019). The following section, "(2) Price Escalation of Construction Cost", shows the calculation for the price escalation rate.

- The operation and maintenance cost (O&M cost) of the infrastructure is estimated based on the past experience in the Japanese ODA loan project.
- The unit procurement/implementation costs of soft component, such as the seed center, rice mill, and training fee, are also estimated based on the past experience in the Japanese ODA loan project.
- The project cost consists of the abovementioned procurement/construction/implementation cost and other costs. In case of the yen loan project, the following costs should be considered as the other costs (see Table A4.3-1). The eligible portion (JICA portion) is covered by the financial assistance and the non-eligible portion should be borne by the developing country (borrower).

Table A4.3-1 Classification of Cost Items in Yen Loan Project

Classification		Cost Items
Eligible Portion (JICA Portion)	Direct Cost	Procurement/Construction/Implementation Cost (Construction, Equipment and Training)
		Consulting Services
	In-direct Cost	Price Escalation
		Physical Contingency
Non-eligible Portion		Land Acquisition
		Administration Cost
		VAT
		Import Tax
		Interest during Construction

Source: JICA Survey Team

- Meanwhile, the grant aid project is roughly classified into 1) civil work, 2) construction (architecture) work, and 3) procurement of equipment, and these assistances are planned individually or collectively in accordance with the requirements of the developing countries. The project cost of grant aid is estimated by referring to the Japanese standard and the various kinds of administration fee and extra fee are added to the project cost; therefore, the project cost of grant aid is more expensive than that of the loan project.
- The foreign exchange ratios are set at JPY 1.050790 against Ksh. 1 and JPY 107.990 against USD 1, which were announced by JICA ("Monthly Exchange Rate" in October 2019).

(2) Escalation of Construction Cost

In the JIID's report, the price escalation rate was calculated based on the unit construction cost in the *"Building Construction Costs Handbook"* which were published by IQSK in the fiscal years of 2011, 2015, and 2017. Since the unit construction cost of three major work items in the irrigation development project, i.e., 1) Excavation (Manual), 2) Excavation (Machine), and 3) Concrete 1:2:4 (Class 20/20), were

used for the calculation in the JIID's report, this Survey also used the abovementioned unit construction costs for the calculation of the price escalation (see Table A4.3-2).

Table A4.3-2 Price Escalation Rate of Construction Cost

Work Item and Unit Cost		Fiscal Year			
		2011	2015	2017	2018
		(a)	(b)	(c)	(d)
1. Earth Work					
Excavation (Manual)	Unit Cost * (Escalation Rate)	Ksh. 238/m^3 (1.00000)	Ksh. 250/m^3 (b/a = 1.05042)	Ksh. 250/m^3 (c/a = 1.05042)	Ksh. 267/m^3 (d/a = 1.12185)
Excavation (Machine)	Unit Cost (Escalation Rate)	Ksh. 552/m^3 (1.00000)	Ksh. 580/m^3 (b/a = 1.05072)	Ksh. 615/m^3 (c/a = 1.11413)	Ksh. 622/m^3 (d/a = 1.12681)
2. Concrete Work					
Concrete 1:2:4 (Class 20/20)	Unit Cost * (Escalation Rate)	Ksh. 12,352/m^3 (1.00000)	Ksh. 12,980/m^3 (b/a = 1.05084)	Ksh. 13,500/m^3 (c/a = 1.09294)	Ksh. 13,167/m^3 (d/a = 1.06598)
Average of Price Escalation Rate		**1.00000**	**1.05066**	**1.08583**	**1.10488**

Source: "Building Construction Costs Handbook (IQSK)"

Based on Table A4.3-2, the price escalation rates of every fiscal year are estimated, as shown in Table A4.3-3. The unit construction costs, quoted from the abovementioned reference materials, are multiplied by these price escalation rates and converted into the amount of fiscal year 2018.

Table A4.3-3 Price Escalation Rate of Each Fiscal Year

Fiscal Year	2009	2010	2011	2012	2013
Price Escalation Rate	0.97467	0.98734	1.00000	1.01267	1.02533
Fiscal Year	2014	2015	2016	2017	2018
Price Escalation Rate	1.03800	1.05066	1.06825	1.08583	1.10488

Source: JICA Survey Team

4.4 Project Cost

(1) Infrastructure Improvement

The direct construction and maintenance cost of each category or component is shown in Table A4.4-1.

Table A4.4-1 Project Cost of Infrastructure Improvement

1) Ahero Irrigation Scheme

Category	Component	Direct Cost		Maintenance Cost	
		million Ksh.	million JPY*	million Ksh.	million JPY*
1. Intake by Pump	1-1. Pump system (ordinary repair)	100	105	640	673
	1-2. Pump system with new technology	140	147	140	147
2. Intake by Gravity	2-1. Gravity system without dam (no expansion)	994	1,044	298	313
	2-2. Gravity system with Koru Dam (extension)	21,355	22,440	6,407	6,732
3. Canals	3-1. Existing canal system	709	745	213	223
	3-2. Rehabilitation of existing canal system (expansion: 451 ha)	126	133	38	40
	3-3. New canal system in expansion area and West Kano	1,204	1,265	361	380
4. Flood Dyke	4-1. Flood protection dyke	419	440	126	132

* Ksh. 1 = JPY 1.050790 (“Monthly Exchange Rate” in October 2019, JICA)

Source: JICA Survey Team

2) West Kano Irrigation Scheme

Category	Component	Direct Cost		Maintenance Cost	
		million Ksh.	million JPY*	million Ksh.	million JPY*
1. Intake by Pump	1-1. Pump system (ordinary repair)	116	122	742	780
	1-2. Pump system with new technology	166	174	166	174
2. Canals	2-1. Canal system	486	510	146	153
3. Flood Dyke	3-1. Flood protection dyke	216	227	65	68

* Ksh. 1 = JPY 1.050790 (“Monthly Exchange Rate” in October 2019, JICA)

Source: JICA Survey Team

3) Southwest Kano Irrigation Scheme

Category	Component	Direct Cost		Maintenance Cost	
		million Ksh.	million JPY*	million Ksh.	million JPY*
1. Intake by Gravity	1-1. Intake structure	90	95	27	28
2. Canals	2-1. Canal system	180	189	54	57
3. Flood Dyke	3-1. Flood protection dyke	194	204	58	61

* Ksh. 1 = JPY 1.050790 (“Monthly Exchange Rate” in October 2019, JICA)

Source: JICA Survey Team

4) Lower Kuja Irrigation Scheme

Category	Component	Direct Cost		Maintenance Cost	
		million Ksh.	million JPY*	million Ksh.	million JPY*
1. Dam	1-1. Dam development	7,603	7,989	2,281	2,397
2. Intake by Gravity	2-1. Rehabilitation of headworks	130	137	39	41
3. Canal Plan 1-A (Paddy 2,375 ha + Upland 5,342 ha = 7,717 ha)	3-1. Rehabilitation of existing canal system	78	82	23	24
	3-2. New development of canal system	3,884	4,082	1,165	1,224
	3-3. Land consolidation	2,904	3,051	0	0
4. Canal Plan 1-B (Paddy 4,610 ha + Upland 3,107 ha = 7,717 ha)	4-1. Rehabilitation of existing canal system	78	82	23	24
	4-2. New development of canal system	3,884	4,082	1,165	1,224
	4-3. Land consolidation	4,712	4,952	0	0
5. Canal Plan 1-C (Paddy 7,717 ha + Upland 0 ha = 7,717 ha)	5-1. Rehabilitation of existing canal system	107	112	32	34
	5-2. New development of canal system	4,213	4,427	1,264	1,328
	5-3. Land consolidation (paddy)	9,233	9,702	0	0
6. Canal Plan 2 (Paddy 5,047 ha + Upland 11,353 ha 16,400 ha)	6-1. Rehabilitation of existing canal system	12,070	12,683	3,621	3,805
	6-2. New development of canal system				
	6-3. Land consolidation				
7. Flood Dyke	7-1. New development of flood dyke	680	714	204	214

* Ksh. 1 = JPY 1.050790 ("Monthly Exchange Rate" in October 2019, JICA)

Source: JICA Survey Team

(2) Agriculture Practice and Extension

The direct implementation cost of each component is shown in Table A4.4-2.

Table A4.4-2 Project Cost of Agriculture Practice and Extension

Category	Component	Direct Cost	
		million Ksh.	million JPY*
1. Extension	1-1. Capacity development project for the enhancement of rice production techniques and wide-range extension in the Lake Victoria Basin Region	570	599
	1-2. Capacity development project for the enhancement of rice production techniques and extension in the Lower Kuja Irrigation Scheme	476	500
	1-3. Enhancement of rice production techniques and extension in the Lower Kuja Irrigation Scheme	274	288
2. Seed	2-1. Capacity development project for rice seed production and	312	328

Category	Component	Direct Cost	
		million Ksh.	million JPY*
Production	wide-range distribution in the Lake Victoria Basin Region		
	2-2. Capacity development project for rice seed production and distribution in the Lower Kuja Irrigation Scheme	230	242
	2-3. Rice seed production and distribution in the Lower Kuja Irrigation Scheme	194	204

* Ksh. 1 = JPY 1.050790 ("Monthly Exchange Rate" in October 2019, JICA)
Source: JICA Survey Team

(3) Rice Value Chain Improvement

The direct implementation cost of each component is shown in Table A4.4-3.

Table A4.4-3 Project Cost of Rice Value Chain Improvement

Category	Component	Direct Cost	
		million Ksh.	million JPY*
1. Rice Mill (Lower Kuja)	1-1. Promotion program for private rice millers to the rice mill complex – A technical cooperation project for the whole coastal area of Lake Victoria	471	495
	1-2. Promotion program for private rice millers to the rice mill complex – A component of yen loan project for the irrigation development in Lower Kuja	189	199
2. Postharvest Processing	2-1. Installation program of paddy collection, shipping, and storage center - A component of yen loan project for the irrigation development in Lower Kuja	98	103
3.Transportation	3-1. Improvement of rice transportation routes (road and port) – A component of yen loan project for the irrigation development in Lower Kuja	287	302
4. Rice Mill (Kisumu)	4-1. Operation improvement of the existing public rice mill – A technical cooperation project for the whole coastal area of Lake Victoria	103	108

* Ksh. 1 = JPY 1.050790 ("Monthly Exchange Rate" in October 2019, JICA)
Source: JICA Survey Team

4.5 Subject of Project Cost Estimation

(1) Confirmation of Distribution Infrastructure Improvement

KeNHA, KURA, and KeRRA are the state corporations which were established under the Kenya Roads Act 2007 and each authority is responsible for the management, development, rehabilitation, and maintenance of the entire road of Kenya. Table A4.5-1 shows the classification of the roads which are administered by the abovementioned authorities. These three authorities shall conduct the monitoring and evaluation of the use of each classified road and make the construction and maintenance plan for the roads.

Table A4.5-1 Road Authority and Road Classification

Road Authority in Kenya	Classification of Road (Administered by Each Authority)
KeNHA (Kenya National Highways Authority)	National road (International trunk roads linking centers of international importance and crossing international)
KURA (Kenya Urban Roads Authority)	Urban road (All public roads in cities and municipalities except where the roads are categorized as national roads)
KeRRA (Kenya Rural Roads Authority)	Rural road network for sustainable socio-economic development

Source: JICA Survey Team

The strengthening of the distribution infrastructure would significantly contribute to agricultural improvement as well as to the local economy. Since marine transportation does not flourish in the Lake Victoria Basin Region, the improvement of road network would play an important part in the agricultural improvement. Therefore, the latest construction and maintenance plans should be closely examined during the feasibility/preparatory study of the ODA project. If there are promising roads such as farm to market roads, the construction cost can be covered by the ODA project.

4.6 Basic Study of Project Benefit

(1) Basic Approaches

Project benefit of each irrigation scheme is considered based on the manuals as shown in Table A4.6-1.

Table A4.6 -1 List of Manuals

No.	Manuals	Outline
1	New Land Improvement Benefit Calculation Manual (September 2007, Supervised: Agriculture, Forestry and Fisheries, Rural Development Bureau Development Department)	This manual describes crop production benefit and maintenance cost reduction benefit regarding agriculture and irrigation development projects. In 2007 this manual was significantly revised to support rehabilitation projects. After that, the latest version is revised in September 2014.
2	Flood Control Economic Research Manual (Draft) (April 2005) (Ministry of land, Infrastructure, Transport and Tourism, River Bureau)	This manual describes methods to calculate flood damage. This manual is one of reference documents for above manual.
3	The Study on Integrated Flood Management for Nyando River Basin in The Republic of Kenya (March 2009, JICA)	Features of flood of Nyando river are as below. a. Large amount and intense rainfall b. Flood flow with high velocity c. Short travel time of flood flow after rainfalls. d. Overflowing water forma Nyand river etc. e. Overflowing water form Nyand river influences riparian area of tMiriu river etc.

Source :JICA Survey Team

(2) Main Benefit Items

1) General Benefit Items for Agriculture Development

According to "New Land Improvement Benefit Calculation Manual", benefit items shown in Table A4.6-2 are appeared by implementing agriculture and irrigation development projects.

Table A4.6-2 Benefit System and Items

Benefit System	Benefit Items
Benefit on ensuring stable food supply	Crop production benefit, quality improvement benefit, farming cost reduction benefit, maintenance cost reduction benefit, travel cost reduction benefit (agriculture)
Benefit on sustainable development of agriculture	Benefit for prevention of cultivation abandonment land, disaster damage reduction benefit (agriculture), agriculture labour environment improvement benefit
Benefit on rural area promotion	Disaster damage reduction benefit (property), rural water benefit, travel cost reduction benefit (general), land registration benefit, land creation benefit, non-agriculture land creation benefit
Benefit on multifaceted functions	Disaster damage reduction benefit (public), water resource cultivation benefit, landscape and environment preservation benefit, urban and rural area interaction promotion benefit
Others	Benefit on survey of cultural properties, safety improvement benefit, large scale earthquake measurement benefit, benefit on stable supply of domestic agricultural products

Source: JICA Survey Team based on New Land Improvement Benefit Calculation Manual

2) Project Types of Each Irrigation Scheme

Benefit calculation methods depend on project types (rehabilitation/ new construction). The project types are shown in Table A4.6-3 regarding irrigation and flood protection.

Table A4.6-3 Project Types of Each Irrigation Scheme

Irrigation Scheme	Irrigation	Flood
3 schemes in Nyando river	Rehabilitation of existing facilities	New construction of dykes
Lower Kuja	New construction of facilities	

Source: JICA Survey Team

3) Expected Main Benefit Items and Methods

Expected main benefit items are crop production benefit, maintenance cost reduction benefit, and disaster damage reduction benefit. Concept of each benefit is shown in Table A4.6-3.

Table A4.6-3 Main benefit and Concept

Items	Concept	Conditions	3 Schemes in Nyando river	Lower Kuja Irrigation Scheme
Crop production benefit	Conditions of farmland and irrigation system is improved by implementing projects. Crop production changes before and after projects. This different is benefit.	With project	Existing crop production	Plan crop production
		Without project	Crop production with no function of facilities	Existing crop production

Maintenance cost reduction benefit	Irrigation facilities need maintenance and operation cost. This cost changes before and after projects. This difference is benefit.	With project	Plan maintenance and operation cost	Plan maintenance and operation cost
		Without project	Maintenance and operation cost with no function of facilities	Existing maintenance and operation cost
Disaster damage reduction benefit	Damage of crop, agriculture facilities, properties is reduced by implementing projects. The damage changes before and after projects. This different is benefit.	With project	Damage with projects	
		Without project	Existing damage	

Source: JICA Survey Team

(3) Basic Information

Collected basic information regarding the crop production benefit, the maintenance cost reduction benefit, and the disaster damage reduction benefit is shown in Table A4.6-4.

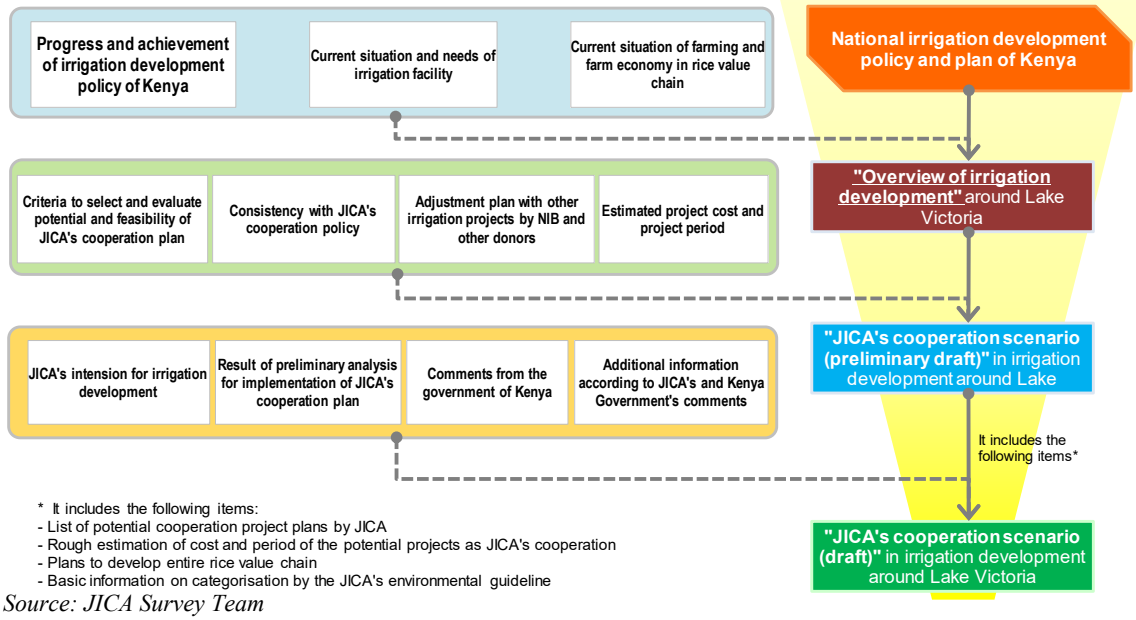
Table A4.6-4 Main information and Collection

Items	Main Information	Collection (mentioned chapter)	
		3 schemes in Nyando river	Lower Kuja Irrigation Scheme
Crop production benefit	Cropping area	3.1.1(1)	3.1.5(2)
	Unit yield	3.1.2(2)、3.1.3(2)、3.1.4(2)	-
	Unit price	3.2.1(1)	
Maintenance cost reduction benefit	Maintenance cost	3.1.2(1)、3.1.3(1)、3.1.4(1)	-
	Pump operation cost	3.1.2(1)、3.1.3(1)	Not applicable
Disaster damage reduction benefit	Flood damage	-	-

Source: JICA Survey Team

CHAPTER 5. OVERALL DEVELOPMENT CONCEPT

As mentioned in the Inception Report, the JICA Survey Team conducted analysis and develop the cooperation scenarios based on the following procedure illustrated in Figure A5-1.



Source: JICA Survey Team

Figure A5-1 General Flow of the Survey and Procedure

Procedure

- The survey started with the confirmation of progress and achievement of national irrigation development policy of the Republic of Kenya, which was described in Chapter 2.
- After, the overview of irrigation development and development concepts around the Lake Victoria Basin Region was developed (refer to Section 5.2).
- Furthermore, the JICA Survey Team selected and prioritized "potential cooperation project plans by JICA" which can also be used as model cases in Kenya. Finally, the JICA Survey Team prepared the "JICA's cooperation scenario" including potential and feasible project plans.

5.1 Rationale of Development Project in the Target Area

The JICA Survey Team considered that it is about time that new irrigation projects were implemented based on the JICA Survey Team's recommended concepts in the target area due to the following reasons:

(1) JICA's History of Assistance for Rice Production in the Target Area

The JICA's history of rice cultivation support in western Kenya started in the 1980s and has a very long history, contributing to the future increase in rice production in Kenya while effectively utilizing this accumulation is considered to be very meaningful from the continuity of business.

The history of JICA in the coastal area of Lake Victoria is as follows:

- In the 1980s, JICA dispatched rice cultivation experts to Ahero State Farm to instruct the establishment and popularization of paddy rice cultivation technology;
- JICA conducted a Comprehensive Regional Development Master Plan Survey for Lake Victoria (about 50,000 km, 15 counties) in the 1980s, and the Sondu River Multipurpose Development in the 1990s;

- In 2009, JICA conducted a Flood Management Plan Survey for the Nyando River, which flows through the center of the Kano-Plains; and
- A Technical Cooperation Project, so-called CaDPERP, started in 2019 and fully support rice cultivation.

(2) Appropriate Timing of Introduction of Solar Power Electricity Generating System for Irrigation Pump System

The JICA Survey Team found the following facts and trends regarding the solar power generation business circumstance and utilization.

(a) Reduction of Initial Investment Cost for Solar Power Systems

According to a provider of a solar power generating system, the unit price of solar power modules, i.e., solar panels, is continuously decreasing from the unit cost of USD 5.50/W in 2001 to USD 0.30-0.47/W in 2018, which is around more than 90% reduction in 17 years. Consequently, its initial installation cost decreases drastically and becomes more affordable in comparison with electricity powered pumping systems provided by the Kenyan Power and Lightening Company (KPLC). This is shown in Section 3.1.2 (2), considering the operation cost during long term operation.

(b) Favourable Environment of Renewable Energy Generation with the Feed-in-System

Kenya has pledged to cut greenhouse gas emissions of 30% below their "business as usual levels" by 2030. The government plans on meeting this target by expanding the use of solar, wind, and geothermal generation, and bringing forest cover up while reducing reliance on wood fuel (Bounagui 2015).

The Energy Act, 2019 came into force on March 28, 2019. The act seeks to consolidate the laws relating to energy; promote renewable energy (solar, wind, biomass, hydro, and geothermal); promote exploration, recovery and commercial utilization of geothermal energy; regulate midstream and downstream petroleum and coal activities; and regulate the production, supply and use of electricity, among others. The legislation is expected to create an enabling environment for the government's Big Four Agenda.

The Energy Act, 2019 provides for a Feed-in Tariff (FiT) System aimed at the following:

- Catalysing the generation of electricity through renewable energy sources
- Encouraging local distributed generation thereby reducing demand on the network and technical losses associated with transmission and distribution of electricity over long distances
- Encouraging uptake of, and stimulating innovation in, renewable energy technology
- Reducing greenhouse gas emissions.

Since an irrigation scheme with the solar power system has not been implemented so far in Kenya, it is a good time to implement it for the government aiming for an exhibition effect and promotion of such renewable energy for the agriculture sector.

(3) Necessity of Large-scale Irrigation Scheme in Flood Plane Areas and Support by Japan

There are three major potential areas for large-scale rice production in Kenya such as (i) Mwea Irrigation Scheme area, (ii) Lake Victoria Region, and (iii) lower reach area of the Tana River.

Table A5.1-1 Comparison of Major Irrigation Potential Areas for Rice Production in Kenya

	(i) Mwea Irrigation Scheme area,	(ii) Lake Victoria Region	(iii) Lower reach area of the Tana River.
Geographical condition	A basin around 20,000 ha El.1,100 m – 1.200 m	Kano Plane: Alluvial plane around 40,000 ha El.1,200 m - 1,300 m	Tana Delta Plane: 200,0000 ha El. 0-20 m
Annual rainfall	1,120 mm at Embu	1,320 mm at Kisumu	720 mm at Garsen
River Gradient	Steep - moderate	Moderate	Moderate
Flood frequency	Not so high	High	High
Current rice production	The most famous rice production area in Kenya	The 2nd largest rice production area	Less rice production
Status of Irrigation Development	Developing by JICA assistance widely	Partially developed by World Bank (WB) and the government	Partially developed by WB and the government
Remarks	Planning of the project is relatively easy. The riverbed slope is relatively steeper than those in the other two areas. Consequently, severe flood damage may not occur. Generally, it is not required to consider countermeasures against flood damage in the irrigation plan. On the other hand, it is very difficult to expand rice irrigation development in the same region due to the limitation of water resources, and it is necessary to develop new rice cultivation regions.	The areas are flat and flooding occurs frequently. Currently, irrigation development projects are being promoted slightly with the support of the World Bank and other donors (see Section 2.1.3 (2)). It is difficult to say that Kenya is still mainstream because of the increased costs.	

Source: JICA Survey Team

The government of Kenya has planned a policy to increase rice irrigation area in the future, but when looking over the whole of Kenya, all of the good rice irrigation potential areas except for the Mwea area are areas where flood damage occurs. In that sense, in the future rice irrigation development in Kenya, it is inevitable to implement the "type of irrigation project that simultaneously performs flood protection and irrigation development" as proposed in this study. On the other hand, Kenya has little experience in implementing such projects, and it is very significant to use irrigation technology cultivated in flood-prone countries like Japan.

It is time that the irrigation development project was implemented in such difficult areas in order to build the Kenyan engineers' capacity on irrigation development in flood-prone area.

(4) Upgrading for Irrigation Development and Support by the New Organization (National Irrigation Authority)

In August 2019, the parliament of the Republic of Kenya passed the "Irrigation Act 2019" in order to support the sustainable food production by outlining the roles of national and county governments in facilitating irrigation activities in the country. Then National Irrigation Board (NIB) has been transformed into National Irrigation Authority (NIA). In this act, the roles and responsibilities of NIA

are expanded, and NIA covers not only national irrigation schemes but also medium or smallholder irrigation schemes and private schemes.

Originally in Kenya, the State Department of Irrigation under the Ministry of Agriculture, Livestock, Fisheries and Irrigation managed small and medium-sized irrigation schemes (mainly developed by local governments), and the National Irrigation Board supported the large-scale irrigation scheme at the national level. Thus the mandates and boundaries of roles was clear for those 2 organization. On the other hand, the above-mentioned "Irrigation Act 2019" disrupts this system, greatly reducing the impact of the State Department of Irrigation significantly. Consequently the scope of responsibility of National Irrigation Authority has been increased. Therefore, all newly formed irrigation projects will be implemented under the National Irrigation Authority.

Among the four target irrigation schemes in the Survey, the Southwest Kano Irrigation Scheme is a communal irrigation scheme. So, if the rehabilitation and upgrading of the Southwest Kano Irrigation Scheme was included in the JICA's Irrigation Development Project and supported by the Japanese consulting firm technically, its approach and methodology in this scheme could be a very good example for NIA's further activities specially when working in communal irrigation schemes with county government and community people.

A summary of the Irrigation Act 2019 is given in Table B5.1-1 and the original document can be obtained at the following site:

(http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/2019/IrrigationAct_No.14of2019.pdf)

(5) Favourable Environment for Acceleration of Rice Production

Currently, the following two favourable institutional environments are emerged for acceleration of rice production in Kenya, such as (i) Warehouse Receipt System, and (ii) Strategic Food Reserve (SFR) of Rice.

With the Warehouse Receipt System, small-scale farmers can be facilitated to:

- have easier access to fund for next production, and
- have better farm gate prices of their products.

In addition, if JICA could support to introduce a modern warehouse facility which can fully comply with the requirements of the system of a grant-aid project as a demonstration facility, and to strengthen implementation capability of the government officers for this system with a technical cooperation project, it could greatly accelerate farmers' agriculture activities.

According to a news source[1], a large amount of rice equivalent to one billion Kenyan Shilling will be purchased by the government as the strategic food reserve. Strategic Food Reserve (SFR) of rice can, therefore, provide more opportunities for farmers to sell rice and it could introduce the increase of demand of rice which in turn will push up its farm gate price.

The details of the above two topics are described in Section 3.3.3 (3) and (4).

In addition, as a matter that should not be forgotten, the survey team notes "the outflow of rice to Uganda" and "the rice production development steps in the western region" as described in section 3.3.3 (1) and (2). This is because "the outflow of rice to Uganda" can be understood as a "good opportunity" of demand for increasing rice production in the western region, and it is not known how long this situation will continue. The idea is that rice production should be promoted in the western region while the

[1] Source: Standard Digital on Jan. 30, 2019
(https://www.standardmedia.co.ke/article/2001308152/rice-now-categorised-under-strategic-food-reserve)

tailwind is blowing. This is one of the important reasons why it is necessary to realize increased rice production in the western region as soon as possible.

(6) Necessity of farming support such as rice cultivation in the coastal area of Lake Victoria including Lower Kuja irrigation scheme

The necessity of conducting agricultural management technical guidance and extension activities in the Lake Victoria region is described below:

- **High cultivation potential of farmland:** First of all, the climate and soil conditions in the Lake Victoria region are very suitable for rice farming and it has high agricultural potential. For example, Table A3.2.1-6 in Section 3.2.1 details the yield data in the Lower Kuja irrigation area. Despite the very first rice cultivation, the unit yield in this area was much higher than the average rice yield of farmland (4.0 tons / ha), indicating the high agricultural potential in this region. Therefore, it is considered it is possible to increase rice production more efficiently than in other regions by expanding cultivating area in the target area with providing more advanced guidance of agricultural practice.
- **Presence of rice cultivation instructors who have been trained so far and the necessity of increasing the number of extension officers:** As stated in (1) above, JICA has been providing capacity development for rice cultivation for many years since the 1980s. The effort has paid off, and the target irrigation scheme has core human resources for technical guidance and dissemination of rice cultivation in new projects. For example, in the Lower Kuja irrigation scheme, which recorded a high unit yield despite the first rice cultivation mentioned above, an NIA agronomist who have been trained for rice cultivation techniques for one year in Japan are providing farming guidance. This is largely due to his contribution. On the other hand, in the target area, because the fishing industry is thriving, it is expected that there will be many “amateurs” farmers when they start new irrigation projects. Therefore, in order to provide detailed support for such people, increasing the number of extension workers is absolutely required. Since there are well-trained core agronomists in the target area, it is possible to establish a farming extension system more quickly and more efficiently than in other areas. This is a big advantage for the target area.
- **Necessity of comprehensive agricultural support:** Considering the current status of rice cultivation in the Lake Victoria region, the establishment and dissemination of a series of useful technologies covering from sowing to harvesting is indispensable for rice farming in the region.
  In agriculture support through JICA's RiceMAPP at the Mwea area, the rice cultivation technology has been established and introduced in the Mwea irrigation area. Then it is expected that such technologies will be transferred to the Lake Victoria region through its successor project, CaDPERP. Those technical systems, however, need to be modified to suit the natural and social environment of the Lake Victoria region, and the research for that purpose should be sufficiently conducted. In addition, post-harvest processing and marketing techniques that cannot be covered by CaDPERP need to be put into practice and disseminated in the Lake Victoria region.

As mentioned above, although there are various challenges in terms of farming support in the target area, it can be said that the potential for rice farming development in the target area is much greater than in other areas, and support for the extension of farming technology is essential for that. It is thought that.

5.2 Basic Concept of Formulation of Development Scenarios

In order to formulate a realistic development plan in the Survey, the following basic concepts for the formulation of development scenarios were set up based on the observation of current status in the region.

- Promotion of Rice Production with Irrigation
- Promotion of Disaster Resilience Improvement with Irrigation
- Reduction of Operation and Maintenance Cost with New Technologies

- Concept for Regional Development by Irrigation Development Project
- Holistic Approach for Agriculture Support

The detailed explanation is given in the following sections:

5.2.1 Promotion of Rice Production with Irrigation

Rice production should be treated as a main crop in the irrigation project for as much as the situation allows based on the following background and reasons:

(1) Demand/Supply Balance of Rice

As explained in Chapters 3.2 and 3.3, imported volume of rice is currently growing rapidly in Kenya at 448,000 ton per annum as described, while the production of rice is only 91,600 ton per annum.

High pressure on rice demand is expected to last for a long time, and will be further accelerated with the increasing consumption trend by the young generation and urban dwellers who prefer to have rice.

(2) Food Security: Rice as Strategic Food Reserve

The importance of agriculture in line with the food security issue has been emphasized in Kenya through Vision 2030, the Medium-Term Plan III, and the President's Big Four Priority Agenda for 2017-2022.

The Legal Notice No.15: Public Finance Management (Strategic Food Reserve Trust fund) Regulation 2015 (Kenya Gazette Supplement No. 14, Feb. 12, 2015) stipulated in the *"Strategic Food Reserve" includes maize, beans, rice, fish, powdered milk, and canned beef"*, that rice is currently the third important staple crop in Kenya. Consequently, the increase of rice production, can contribute greatly to the food security issue as an alternative cereal.

5.2.2 Promotion of Disaster Resilience Improvement with Irrigation

The climate change, known as a current prominent worldwide issue, affects all the African lands severely, and Kenya is no exception. Therefore, the Project's facilities in the Lake Victoria Region should be taken into consideration in order to contribute to the alleviation of damage caused by floods and droughts based on the following grounds:

(1) Prominent Magnitudes in Floods and Droughts in the Southwestern Region

Although most of the lands in Kenya is being affected by recurrent disasters, the Southwestern region of Kenya, including the Lake Victoria Region, has recently had a larger magnitude of disasters in both floods and droughts among all the other regions in Kenya. It could be explained in Table A5.2.2-1 .

Table A5.2.2-1 Comparison of Frequency of Severe Disasters* in Kenya

(Unit: times)

Period	Southwest region (Kakamega)		Northwest region (Turkana)		Northeast region (Garissa)		Southeast region (Makueni)	
	Floods	Droughts	Floods	Droughts	Floods	Droughts	Floods	Droughts
1981-1990	2	2	3	0	3	0	4	0
1991-2000	2	1	7	0	7	1	2	1
2006-2015	**7 ↑**	**4 ↑**	**0 ↓**	**0**	**3**	**4 ↑**	**1 ↓**	**4 ↑**
Analisys	Both floods and droughts increased recently		Floods decreased recently		Only droughts increased recently		Floods dicreased and droughts increased recently	

Note: "Severe disaster" means Standardized Precipitation Index (SPI) >2 for floods and SPI<-2 for droughts.

Source: Derived from "KIPPRA Policy Brief No.11-2017/18: Drought and Flood Vulnerability in Kenya: What Needs to be Done?" (https://kippraconference.org/wp-content/uploads/2018/06/PB-11-2017.pdf), and analysed by the JICA Survey Team

Explanation

The table above shows the comparison of frequencies of severe floods and droughts by the regions and through three decades, i.e., 1981-1990, 1991-2000, and 2006-2015. In this table, only "extreme floods"

and "extreme droughts" were counted and listed based on the classification of Standardized Precipitation Index (SPI) below, using a report published by the Kenya Institute for Public Policy Research and Analysis (KIPPRA).

"Extreme floods": SPI > 2.0

"Extreme droughts": SPI < -2.0

It is observed that the numbers of both floods and droughts in the Southwestern Region in the recent decade, i.e., Y2006-Y2015, including the Project area, increased significantly due to climate change.

In order to improve resilience against disasters caused by such climate change, it is necessary to construct (i) flood dykes as a flood protection measure, and (ii) irrigation facilities in order to realize a stable water supply even in drought. The Project proposes the introduction of "disaster-resilient irrigation facilities" with flood protection functions in this region as well.

(2) Vulnerable Agriculture in Kenya

As shown in Section 2.1.2 (5) on the "Kenya Climate Smart Agriculture Implementation Framework 2018-2027" (KCSAIF 2018-2027), Figure A 2.1.2-1 describes the growth rate in the agriculture sector. It is observed that once a drought happened, the current year's growth rate drops down drastically. It proves that agriculture in Kenya is very vulnerable against droughts.

In combating droughts, KCSAIF 2018-2027 clearly declared the importance of irrigation development as it was set as such as a target in the "Sub-component 2.2 increase area under sufficient irrigation" in "Component 2: Agricultural productivity and integration of value chain approach".

5.2.3 Reduction of Operation and Maintenance Cost with New Technologies

Currently, some of target irrigation schemes employ pumping irrigation systems by electricity. It was discovered through the survey that payments for electricity charges in those pumping systems were fully shouldered by the National Irrigation Board, then such expenses become NIB's financial burden and poses as an obstacle against further development of different irrigation schemes.

Thus, in the Project, facilities with less operation and maintenance cost in the future should be considered in various means, such as changing the irrigation system from pumping up system to gravity system, employment of solar energy, and so on, as much as possible.

5.2.4 Concept for Regional Development by Irrigation Development: Replication of Good Practice in Mwea Development

Since the Mwea Irrigation Project is known for its good practice of agriculture development in rice in Kenya, the JICA Survey Team visited the Mwea area to learn the key factors for success for the replication of the Project area.

Then it was observed that it is a fact that the wealth in the Mwea area was derived originally from and actually triggered by the irrigation project. However, current vigorous activities in the Mwea area are not coming only from the rice production by farmers, but also from the results of mutual linkage between agriculture production and other relevant private sectors such as rice mills, storage business, retail trading, transportation, by-product business, and so on.

Based on such observation, the JICA Survey Team considers that the Project to be formulated in the Lake Victoria Region should focus on promoting other relevant private sectors as well as ordinary irrigation facility construction component. It means that the Project should be formulated in aiming to promote a regional development project triggered by the irrigation development in the region. In order to realize such concept, the following points should be taken in consideration:

- Collaboration of the public sector and private sector in the irrigation development, including various facilitations for attracting private businessmen to start-up rice businesses in the region.
- Development of flood protection not only for irrigation farms but also for business properties, private houses, and so on to alleviate the fear of flood damage,

- Development or improvement of physical access to the region in inland and water transportation system, and
- Establishment of regional agriculture supporting system (see in next Section).

5.2.5 Holistic Approach for Agriculture Support

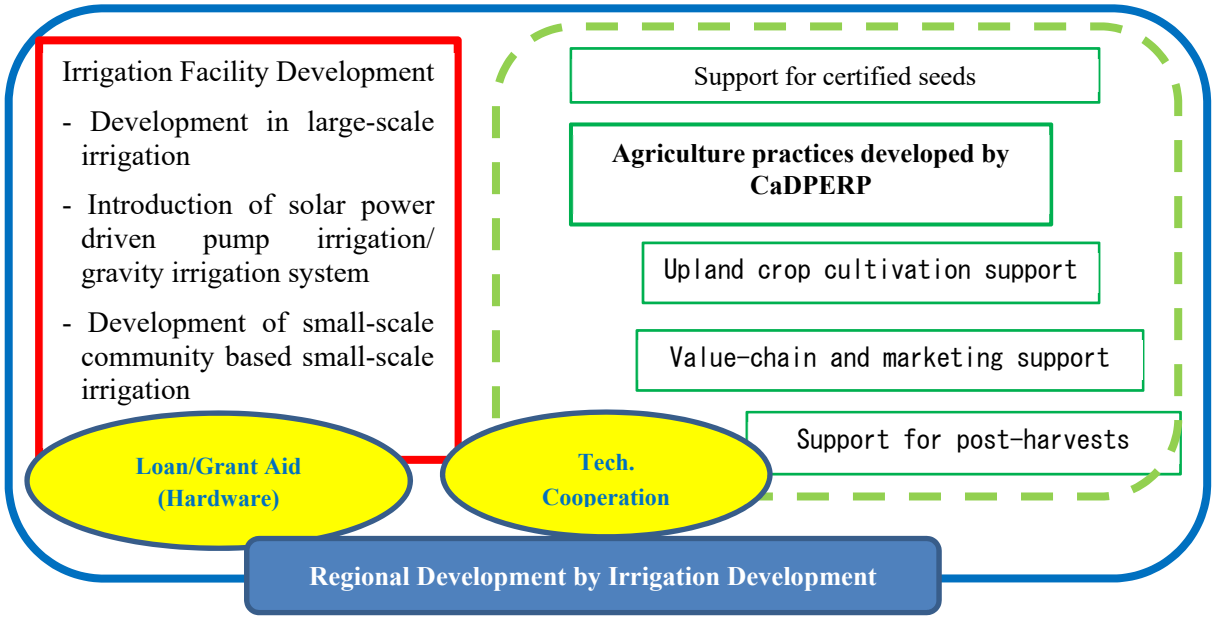
In the Lake Victoria Region, there are several irrigation schemes in various scales that are supported by the national and county governments.

Currently, JICA is implementing technical cooperation projects such as the "Capacity Development for Enhancement of Rice Production in Irrigation Schemes in Kenya" (CaDPERP) at the Ahero Irrigation Scheme from 2019 to 2024. It is highly expected that the outcome of CaDPERP could be a good model for agriculture practice for the rice production all over the region.

Considering the results of the CaDPERP activities, the JICA Survey Team plans to utilize the results in the agriculture support aspect. Then, the Project should be formulated by developing and spreading the CaDPERP outcome on technical depth and on spatial area.

In addition, some technical areas that are not covered by CaDPERP should be included in the Project plan such as:

- Post-harvest facilities and technical support,
- Value chain development and marketing support,
- Support of agricultural practices for upland crop cultivation, and
- Certified seeds development.



Source: JICA Survey Team

Figure A5.2.5-1 Holistic Approach for Agriculture Support

Source: JICA Survey Team

Figure A5.2.5-2 Spatial Agricultural Support for the Lake Victoria Region

CHAPTER 6. DEVELOPMENT SCENARIOS

6.1 Potential Cooperation Project Plans (Infrastructures)

6.1.1 Potential Cooperation Project Plans in Ahero Irrigation Scheme

The following options for the formulation of Ahero Irrigation Scheme development plans have been examined and explained in Chapter 3.

The advantages and disadvantages are summarized in the tables below for further comparison and decisions:

(1) Intake System by Pump

Question: If pumping intake system is applied, which type of pumping system do you select?

(a) Rehabilitation of pump system, or

(b) Rehabilitation of pump system with new technology (e.g., solar system)

Table A6.1.1-1 Comparison for Intake System by Pump

Options	Advantage	Disadvantage
(a) Rehabilitation of pump system (normal)	- Initial investment cost is low. - Special knowledge is not required for maintenance and repair.	- More operation cost is required.
(b) Rehabilitation of pump system with new technology (e.g., solar system)	- Less operation cost is required. - It could be a model for other schemes.	- Initial investment cost is high. - Special knowledge is required for maintenance and repair.

Source: JICA Survey Team

(2) Intake System by Gravity

Question: If the gravity intake system is applied, which will you select?

(a) Introduction of the gravity system without Koru Dam (no expansion, Ahero: 867 ha),

(b) Introduction of a new canal system in the extension area (a part of extension area: 451 ha), or

(c) Introduction of the gravity system with Koru Dam up to 5,173 ha in total (Ahero (867 ha)) and West Kano (892 ha) + Extension: 3,414 ha)

Table A6.1.1-2 Comparison for Intake System by Gravity

Options	Advantage	Disadvantage
(a) Introduction of the gravity system without dam (no expansion, Ahero: 867 ha) at the same intake discharge as before (1.76 m^3/s), and Rehabilitation of existing canal system (no expansion)	- Total amount of initial investment is less than option (c). - The previous water management can be accepted with rough water measurement.	- Its investment efficiency is lower than the others. - No increase of irrigation area
(b) Introduction of new canal system in extension area (a part of extension area: 451 ha) at the same intake discharge as before (1.76 m^3/s), and Rehabilitation of existing canal system and construction of new canal system in the extension area for 451 ha	- Irrigation area of 451 ha can be increased with the same discharge as before.	- Precise water management is required by WUA.

(c) Introduction of the gravity system with Koru dam up to 5,173 ha in total, and Rehabilitation of Ahero canal system and introduction of new canal system for the extension area (3,414 ha)	- Irrigation area of 3,414ha can be increased drastically. - River flow can be stabilized by the dam. - Flood will be alleviated by the dam.	- Huge investment is required for development of the dam and irrigation system in the extension area (3,414 ha). - Negative environmental impact is high because of the construction of the dam

Source: JICA Survey Team

(3) Potential Cooperation Project Plan for Ahero Irrigation Scheme

In consideration of the conditions mentioned above, the potential cooperation project plans were examined with the following evaluation aspect, such as model potential, economic efficiency, technical soundness, sustainability, and environmental aspect.

The results are given in the following table and details are shown in Table B6.1.1-1.

Table A.6.1.1-3 Potential Cooperation Project Plan in Ahero Irrigation Scheme

		Potential Cooperation Project Plans				
		A1	A2	A3	A4	**A5**
Intake by pump	(a) Rehabilitation of pump system (normal)	○				
	(b) Rehabilitation of pump with solar system		○			○
Intake by gravity	(a) Without dam (no expansion area)				○	
	(b) With Koru Dam and extension area (3,414 ha)			○		
Canal	(a) Rehabilitation (no expansion)	○	○	○	○	○
	(b) Introduction of new canal system in the extension area					○
	(c) Introduction of new canals in the extension area			○		
Flood dyke	Improvement of flood protection dyke	○	○	○	○	○
Total Direct Cost (Ksh. 1 billion)		*2.21*	***2.10***	*30.79*	*2.76*	***2.19***
Benefit (Ksh. 1 billion)*		*2.19*	***2.19***	*21.64*	*2.19*	***4.46***
B/C		*0.99*	***1.04***	*0.70*	*0.79*	***2.04***
Total Evaluation Score		*12*	***19***	*11*	*15*	***20***

Note Benefit = Benefit from flood protection is not included.*

Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that the potential cooperation project plans A2 and A5 have high priority among the five plans.

6.1.2 Potential Cooperation Project Plans in West Kano Irrigation Scheme

For the formulation of the West Kano Irrigation Scheme development plans, there are several options, all of which have been examined and explained in Chapter 3.

The advantages and disadvantages are summarized in Table A6.1.2-1 below for further comparison and decision:

(1) Intake System by Pump

Question: If the pumping intake system is applied, which type of pumping system will you select?

(a) Rehabilitation of pump system, or
(b) Rehabilitation of pump system with new technology (e.g., solar system)

Table A6.1.2-1 Comparison for Intake System by Pump

Options	Advantage	Disadvantage
(a) Rehabilitation of pump system (normal)	- Initial investment cost is low. - No any special knowledge is required for maintenance and repairing.	- More operation cost is required.
(b) Rehabilitation of pump system with new technology (e.g. solar system)	- Less operation cost is required. - It could be a model for other schemes.	- Initial investment cost is high. - Special knowledge is required for maintenance and repair.

Source: JICA Survey Team

(2) Potential Cooperation Project Plan for West Kano Irrigation Scheme

In consideration of the conditions mentioned above, the potential cooperation project plans were examined with the following evaluation aspect, such as model potential, economic efficiency, technical soundness, sustainability, and environmental aspect.

The results are given in the following table and details are shown in Table B6.1.2-1.

Table A6.1.2-2 Potential Cooperation Project Plan in West Kano Irrigation Scheme

		Potential Cooperation Project Plans			
		B1	B2	**B3**	B4
Intake by pump	(a) Rehabilitation of pump system (normal)	○	○		
	(b) Rehabilitation of pump with solar system			○	○
Canal	Rehabilitation (no expansion)	○		○	
Flood dyke	Improvement of flood protection dyke	○	○	○	○
Total Cost (Ksh. 1 billion)		*1.77*	*1.14*	***1.57***	*0.94*
Benefit (Ksh. 1 billion)*		*2.25*	*1.80*	***2.25***	*1.80*
B/C		*1.27*	*1.58*	***1.43***	*1.92*
Total Evaluation Score		*11*	*13*	***20***	*18*

Note Benefit = Benefit from flood protection is not included.*

Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that the potential cooperation project plan B3 has the highest priority among the four plans.

6.1.3 Potential Cooperation Project Plans in Southwest Kano Irrigation Scheme

For the formulation of the Southwest Kano Irrigation Scheme development plans, there are several options, all of which have been examined and explained in Chapter 3.

The advantages and disadvantages are summarized in Table A6.1.3-1 below for further comparison and decisions:

(1) Improvement of the Intake Structure

Question: Is the improvement of intake structure necessary?

(a) Yes, it is necessary, or
(b) No, it is not necessary.

Table A6.1.3-1 Comparison for the Improvement of Intake Structure

Options	Advantage	Disadvantage
(a) Yes, necessary	- Sedimentation problem can be solved with the improvements. Consequently, the efficiency of water delivery can be improved as well. - Operation and maintenance cost, especially desilting work, can be reduced.	- Improvement cost is required.
(b) No, not necessary	- Construction cost can be reduced.	- Sedimentation problem will remain. The required amount of water cannot be delivered. - Operation and maintenance cost, especially desilting work, is continuously required.

Source: JICA Survey Team

(2) Canal Rehabilitation

Question: Is the rehabilitation of the existing canal system necessary?

(a) Yes, it is necessary, or
(b) No, it is not necessary.

Table A6.1.3-2 Comparison for the Improvement of Canal

Options	Advantage	Disadvantage
(a) Yes, necessary	- Efficiency of water delivery can be improved. - -Renovate facilities that have been damaged by long-term use, making the facilities easier to use	- Rehabilitation cost is required.
(b) No, not necessary	- Construction cost can be reduced.	- In some cases, the required amount of water cannot be delivered. - -Eventually, it will be necessary to renovate the facility, so the burden

		will not change if you look at the long-term

Source: JICA Survey Team

(3) Improvement Flood Dyke

Question: Is the improvement of the flood dyke necessary?

(a) Yes, it is necessary, or
(b) No, it is not necessary.

Table A6.1.3-3 Comparison for the Improvement of Flood Dyke

Options	Advantage	Disadvantage
(a) Yes, necessary	- Flood damage can be reduced. - -By reducing flood damage, farmers can invest in cultivation with confidence.	- Improvement cost is required.
(b) No, not necessary	- Construction cost can be reduced.	- There will always be risk of flood damage. - Farmers fear flood damage too much to make bold investments on agriculture

Source: JICA Survey Team

(4) Potential Cooperation Project Plan for Southwest Kano Irrigation Scheme

In consideration of the conditions mentioned above, the potential cooperation project plans were examined with the following evaluation aspects, such as model potential, economic efficiency, technical soundness, sustainability, and environmental aspect.

The results are given in the following table and details are shown in Table B6.1.3-1.

Table A6.1.3-4 Potential Cooperation Project Plan in Southwest Kano Irrigation Scheme

		Potential Cooperation Project Plans				
		C1	**C2**	**C3**	**C4**	**C5**
Intake by gravity	Improvement of intake structure	○	○	○	○	
Canal	Rehabilitation (no expansion)	○		○		
Flood dyke	Improvement of flood protection dyke	○	○			○
Total Cost (Ksh. 1 billion)*		*0.35*	*0.12*	*0.35*	*0.12*	*0*
Benefit (Ksh. 1 billion)*		*1.68*	*0.45*	*1.68*	*0.45*	*0*
B/C		*4.78*	*3.88*	*4.78*	*3.88*	-
Total Evaluation Score		*20*	*16*	*19*	*15*	*14*

Note Cost = Cost of flood protection is not included. Benefit* = Benefit from flood protection is not included.*

Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that the potential cooperation project plan C1 has high priority among the five plans.

6.1.4 Potential Cooperation Project Plans in Lower Kuja Irrigation Scheme

For the formulation of the Lower Kuja Irrigation Scheme development plans, there are several options, all of which have been examined and explained in Chapter 3.

The advantages and disadvantages are summarized in Table A6.1.4-1 below for further comparison and decision:

(1) Dam Development

Question: Is the development of the dam and expansion of the irrigation area up to 16,400 ha at the upstream reach necessary?
(a) Yes, it is necessary, or
(b) No, it is not necessary.

Table A6.1.4-1 Comparison for the Improvement of Dam Development

Options	Advantage	Disadvantage
(a) Yes, necessary	- Irrigation area of 16,400 ha can be increased drastically. - River flow can be stabilized by the dam. - Flood will be alleviated by the dam.	- Huge investment is required for the development of the dam and the irrigation system in the extension area (16,400 ha). - Negative environmental impact is high because of the construction of the dam
(b) No, not necessary	- Huge investment is not required	- River flow is not stable

Source: JICA Survey Team

(2) Canal Rehabilitation

Question: What kind of work is necessary for the rehabilitation of the existing canal system and the new construction of irrigation system in new area?
(a) The works for 2,375 ha for paddy and 5,342 ha for upland crop is necessary,
(b) The works for 4,670 ha for paddy and 3,47 ha for upland crop is necessary, or
(c) The works for 7,717 ha for paddy and 0 ha for upland crop is necessary.

Table A6.1.4-2 Comparison for the Improvement of Canal Rehabilitation

Options	Advantage	Disadvantage
(a) 2,375 ha for paddy and 5,342 ha for upland crop	- This is the original plan. No design change is required.	- Paddy cultivation is not maximized in the scheme.
(b) 4,670 ha for paddy and 3,047 ha for upland crop	- Available water can effectively be utilized for paddy cultivation. - Land consolidation cost is not so high in comparison with that of case (c), since land slope is moderate in the paddy area.	- In addition to land consolidation cost of the case (a), another consolidation cost is required.
(c) 7,717 ha for paddy	- All of the plots can be utilized for rice cultivation.	- Large additional land consolidation cost is required due to levelling works in the steeper land slope area.

Source: JICA Survey Team

(3) Potential Cooperation Project Plan for Southwest Kano Irrigation Scheme

In consideration of the conditions mentioned above, the potential cooperation project plans were examined with the following evaluation aspects, such as model potential, economic efficiency, technical soundness, sustainability, and environmental aspect.

The results are given in the following table and details are shown in Table B6.1.4-1.

Table A6.1.4-3 Potential Cooperation Project Plan in Lower Kuja Irrigation Scheme

		Potential Cooperation Project Plans			
		D1	D2	D3	D4
Dam	Dam development	○			
Intake	Rehabilitation of the headworks	○	○	○	○
Canal plans without dam	(a) 2,375 ha for paddy and 5,342 ha for upland crop		○		
	(b) 4,670 ha for paddy and 3,047 ha for upland crop			○	
	(c) 7,717 ha for paddy				○
Canal plan with dam	Rehabilitation and new development work for 16,400 ha (paddy: 5,047 and upland:11,353 ha)	○			
Flood dyke		○	○	○	○
Total Cost (Ksh. 1 billion		*26.63*	*9.98*	*12.33*	*18.67*
Benefit (Ksh. 1 billion)*		*56.56*	*26.49*	*33.33*	*42.27*
B/C		*2.12*	*2.66*	*2.70*	*2.26*
Total Evaluation Score		*12*	*16*	*17*	*14*

Note Benefit = Benefit from flood protection is not included.*

Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that the potential cooperation project plan D3 has the highest priority among the four plans.

6.2 Potential Cooperation Project Plans (Agriculture Support)

6.2.1 Agriculture Support Component

There are two sub-sectors of the agriculture support component in the Project, such as (i) agricultural practices and extension, and (ii) value chain improvement. For each component, the following concrete supports were considered, as explained in Section 3.2, for agricultural practices and extension, and Section 3.3 for value chain improvement.

Agricultural Practices and Extension

Extension: Capacity Development Project for Enhancement of Rice Production Techniques and Extension

Seed Production Capacity Development Project for Rice Seed Production and Distribution

Value Chain Improvement:

Rice Mill: - Promotion Program of Private Rice-millers Participation in the Rice-Mill Complex

- Operation Improvement of the Existing Public Rice-mill

Postharvest Processing: Installation Program of Paddy Collection, Shipping and Storage Centre

Transportation: Improvement of Rice Transportation Routes (Road and Port)

6.2.2 Type of JICA's Cooperation Schemes for Agriculture Support

There are three types of JICA cooperation schemes, such as (i) Yen Loan Project, (ii) Grant Aid Project, and (iii) Technical Cooperation Project. The agriculture supporting activities, however, can only be supported by (i) a part of Yen Loan Project, and (iii) Technical Cooperation Project.

Since each of JICA's cooperation scheme for agriculture development has different characteristics and budget limitations, as shown in Table A6.2.2-1, the project components may drastically vary depending on what type of scheme JICA applies.

The JICA Survey Team had selected and considered the following three types of cooperation schemes before consideration of the concrete components of the agriculture supports.

Table A6.2.2-1 JICA's Cooperation Scheme for Agriculture Support in the Project

JICA's Support Schemes	Target Area	Input	Period
(1) JICA's Technical Cooperation Project	Large: (Whole coastal area of Lake Victoria) It can not be applied to the construction program	Large (by grant)	Long, normally five years
(2) JICA's Technical Cooperation Project in joint operation with Yen Loan Project	Medium: (covering specific irrigation scheme, like Lower Kuja area only)	Medium (by grant)	Before/during/after implementation period of Yen Loan Project
(3) Agriculture Support as Soft Component in the Yen Loan Project	Small: (within the limits of the Yen Loan Project's scope and budget)	Small (by loan)	During implementation period of the Yen Loan Project only

Source: JICA Survey Team

(1) JICA's Technical Cooperation Project

This is an independent technical cooperation project, such as CaDPERP, etc., which are being implemented by JICA in Kenya normally. This type of support will allow considerable amount of input, such as various experts, equipment, small facilities, and so on.

Thus, the JICA Survey Team proposes to apply it to a large-scale support covering the whole costal area of the Lake Victoria Region including not only Kisumu and Migori counties but also Busia, Siaya, and Homa Bay counties.

(2) JICA's Technical Cooperation Project in joint operation with Yen Loan Project

The supporting scheme is applied when a Yen Loan Project will be implemented and some technical support are required by grand aid. Due to the limited scale of target area and scope, the input and scale of support may be smaller than the normal JICA's Technical Cooperation Project.

(3) Agriculture Support in Yen Loan Project

The agriculture support is executed within the scope of the Yen Loan Project. Consequently, the size of input and scale of activities may be limited due to the budget ceiling of Yen Loan Project.

6.2.3 Matrix of Potential Cooperation Project Plans for Agriculture Support

The JICA Survey Team formulated the following matrix in combination with the Agriculture Support Component mentioned in Section 6.2.1 and JICA's supporting schemes explained in Section 6.2.2.

Table A6.2.3-1 Matrix for Agriculture Support Component

	(1) JICA's Technical Cooperation Project	(2) JICA's Technical Cooperation Project in joint operation with Yen Loan Project	(3) Agriculture Support as soft component in Yen Loan Project
Extension: Capacity Development Project for Enhancement of Rice Production Techniques and Extension	○	○	○
Seed Production: Capacity Development Project for Rice Seed Production and Distribution	○	○	○
Rice Mill: Promotion Program of Private Rice-millers Participation in the Rice-Mill Complex	○	-	○
Rice Mill: Operation Improvement of the Existing Public Rice-mill	○	-	-
Postharvest Processing: Installation Program of Paddy Collection, Shipping and Storage Centre	-	-	○
Transportation: Improvement of Rice Transportation Routes	-	-	○

Source: JICA Survey Team

6.2.4 Proposed Potential Cooperation Project Plans for Agriculture Support

In consideration of the conditions mentioned above, the potential cooperation project plans were examined using the following evaluation aspect, such as model potential, economic efficiency, technical soundness, sustainability, and environmental aspect.

The results are given in the following table and details are shown in Table B6.2.4-1.

Table A6.2.4-1 Potential Cooperation Project Plan for Agricultural Support

(a) Agricultural Practice and Extension

		Potential Cooperation Project Plans						
		E1	E2	E3	E4	E5	E6	E7
Extension	Capacity Development Project for Enhancement of Rice Production Techniques and Wide-range Extension in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	○	○	○				
	Capacity Development Project for Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)				○	○		
	Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)						○	○
Seed Production	Capacity Development Project for Rice Seed Production and Wide-range Distribution in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	○						
	Capacity Development Project for Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)		○		○			
	Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)						○	
*Total Cost (Ksh. 1 billion)**		*0.66*	*0.80*	*0.57*	*0.53*	*0.48*	*0.35*	*0.27*
Total Evaluation Score		*21*	*18*	*18*	*17*	*17*	*15*	*15*

Note: If several components can be combined to one project, 75% of summed amounts are accounted.

Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that the potential cooperation project plans E1, E3, and E6 have high priority among the seven plans.

(b) Value Chain Improvement

		Potential Cooperation Project Plans						
		F1	F2	F3	F4	F5	F6	F7
Rice mill (Lower Kuja)	Promotion Program for Private Rice-millers to the Rice-Mill Complex – A TCP for the Whole Coastal Area of Lake Victoria	○		○				
	Promotion Program for Private Rice-millers to the Rice-Mill Complex – A Component of Yen Loan Project for the Irrigation Development in Lower Kuja				○	○	○	○
Postharvest processing	Installation Program of Paddy Collection, Shipping and Storage Center - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja				○		○	
Transportation	Improvement of Rice Transportation Routes (Road and Port) - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja				○	○		
Rice mill (Kisumu)	Operation Improvement of the Existing Public Rice-mill – A TCP for the Whole Coastal Area of Lake Victoria	○	○					
Total Cost (Ksh. 1 billion)		*0.57*	*0.10*	*0.47*	*0.57*	*0.47*	*0.28*	*0.19*
Total Evaluation Score		*21*	*21*	*20*	*18*	*16*	*17*	*15*

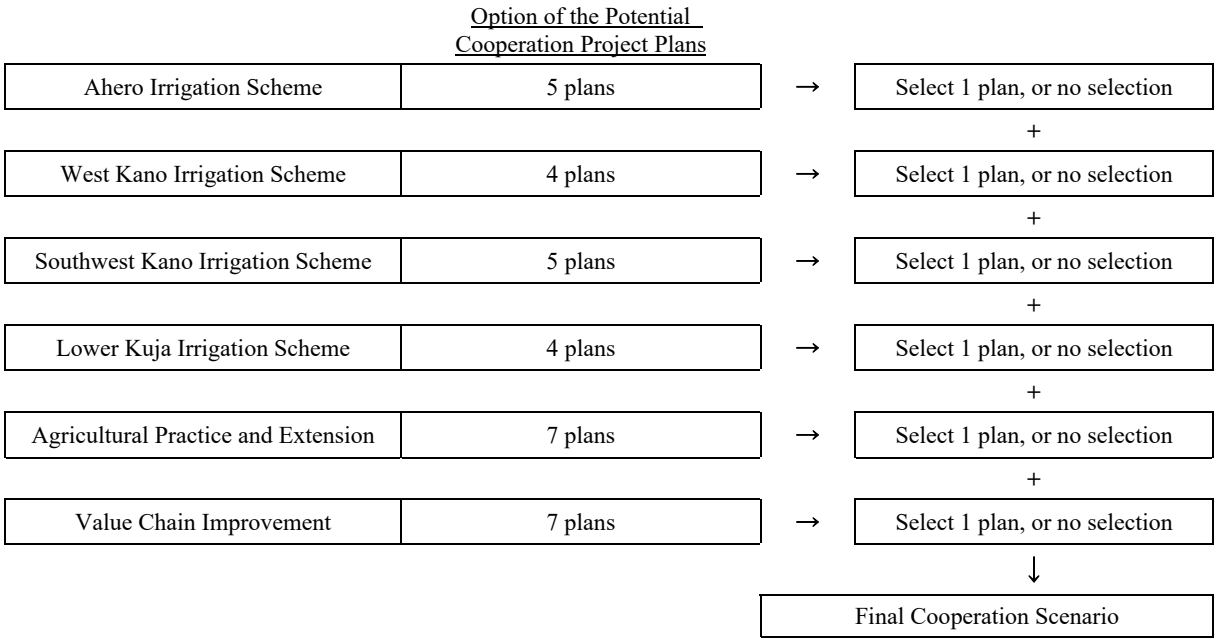
Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that the potential cooperation project plans F1, F2, F3, and F4 have high priority among the seven plans.

6.3 Comparison of JICA's Cooperation Scenarios

6.3.1 Cooperation Scenarios

As explained in Section 6.1 for infrastructure and Section 6.2 for agriculture support, there are several options of the potential cooperation project plans. Theoretically, one can select a final scenario out of the 19,600 scenarios (= 5 x 4 x 5 x 4 x 7 x 7) in total.



Source: JICA Survey Team

Figure A 6.3.1-1 Selection of Scenarios

6.3.2 Available Cooperation Scheme by JICA

For reference, the JICA Survey Team herewith tentatively selected several major cooperation scenarios based on the experiences of site observation and analysis.

There are three types of JICA's cooperation schemes, such as (i) Yen Loan Project, (ii) Grant Aid Project, and (iii) Technical Cooperation Project. For infrastructure, (i) Yen Loan Project and (ii) Grant Aid Project were considered, and the three cooperation schemes which were explained in Section 5.3.2 were considered for agriculture support.

6.3.3 Scenario-I: Yen Loan Project

A case of Yen Loan Project was considered in this section. Thereafter, the following scenarios were considered based on the prioritized cooperation project plans in each evaluation in Section 6.1 and Section 6.2.

Table A6.3.3-1 Prioritized Cooperation Project Plans for Yen Loan Project

	Prioritized Cooperation Project Plans
(A) Ahero Irrigation Scheme	A5 (see Table A5.2.1-3)
(B) West Kano Irrigation Scheme	B3 (see Table A5.2.2-2)
(C) Southwest Kano Irrigation Scheme	C1 (see Table A5.2.3-4)
(D) Lower Kuja Irrigation Scheme	D3 (see Table A5.2.4-3)
(E) Agriculture	E6 (see Table A5.3.4-1)
(F) Value Chain Improvement	F4 (see Table A5.3.4-1)

Source: JICA Survey Team

After the combination of the above prioritized cooperation project plans was made, the evaluation of scenarios was summarized in the following table and the detailed information is shown in Table B6.3.3-1.

Table A6.3.3-2 Major Cooperation Scenarios for Yen Loan Project

	Cooperation Scenarios					
	Case-1-1	Case-1-2	Case-1-3	Case-1-4	Case-1-5	Case-1-6
(A) Ahero	A5	-	A5	-	A5	A5
(B) West Kano I	B3	-	-	-	B3	B3
(C) Southwest Kano	C1	-	C1	C1	C1	C1
(D) Lower Kuja	D3	D3	D3	D3		
(E) Agriculture	E6	E6	E6	E6	E6	E6
(F) Value Chain	F4	F4	F4	F4	F4	F4
(1) Total Cost* **(*Ksh. 1 billion*)**	19.2	15.1	17.9	15.8	5.0	6.1
(2) Total Cost* + OM Cost (*Ksh. 1 billion*)	**23.7**	**18.00**	**21.7**	**18.8**	**6.6**	**7.6**
(3) Benefit =(3)/(2) (*Ksh. 1 billion*)	**41.7**	**33.3**	**35.6**	**35.0**	**6.7**	**4.4**
B/C	**1.76**	**1.85**	**1.64**	**1.86**	**1.01**	**0.59**

Note: Total cost = initial cost + administrative cost
Source: JICA Survey Team

As shown in the table above, the JICA Survey Team judged that Case-1-4 is the most appropriate scenario in terms of budget size, project benefit and investment efficiency. However, if there is no limitation in budget size, Case-1-1 and Case-1 3 could be second option when considering area of influences of the additional schemes. On the other hand, even if Case-4 is not accepted due to budget limitation, you can select Case-1-2. Case-1-5 and Case-1-6 are not recommended because those cases do not produce new irrigation land.

6.3.4 Scenario-II: Grant Aid Project

A case of Grant Aid Project was considered in this section. Thereafter, the following scenarios were considered based on the prioritized cooperation project plans in each evaluation in Section 6.1 and Section 6.2.

Table A6.3.4-1 Prioritized Cooperation Project Plans for Grant Aid Project

	Prioritized Cooperation Project Plans
(A) Ahero Irrigation Scheme	A2 or A5 (see Table A6.1.1-3)
(B) West Kano Irrigation Scheme	B3 (see Table A6.1.2-2)
(C) Southwest Kano Irrigation Scheme	C1 (see Table A6.1.3-4)
(D) Lower Kuja Irrigation Scheme	- (not selected in consideration of budget limits for the grant aid project)

Source: JICA Survey Team

Combination of the above prioritized cooperation project plans was made, then evaluation of scenarios was summarized in the following table and the detailed information is shown in Table B6.3.4-1.

Table A6.3.4-2 Major Cooperation Scenarios for Grant Aid Project

	Cooperation Scenarios					
	Case-2-1	Case-2-2	Case-2-3	Case-2-4	Case-2-5	Case-2-6
(A) Ahero Irrigation Scheme	A4	A5	-	-	-	A5a**
(B) West Kano Irrigation Scheme	-	-	B3	-	B3	-
(C) Southwest Kano Irrigation Scheme	-	-	C1	C1	-	-
(D) Lower Kuja Irrigation Scheme	-	-	-	-	-	-
Total Construction Cost* **(*KSH 1 billion*)**	**2.85**	**3.14**	**3.00**	**1.04**	**1.95**	**2.34**
O & M Cost (*KSH 1 billion*)	**0.83**	**0.80**	**0.84**	**0.14**	**0.70**	**0.69**

Note: Total cost = initial cost + O& M cost + administrative cost + others*

***A5a in Case-2-6 has only 50% of A5 (rehabilitation cost of canal) is included.*

Source: JICA Survey Team

Since the grant aid project has a certain ceiling with regard to project budget, an appropriate case should be selected based on the total construction cost. If the project budget does not allow more than *Ksh.* 3 billion.

6.3.5 Scenario-III: Technical Cooperation Project

A case of the Technical Cooperation Project was considered in this section. Thereafter, the following scenarios were considered based on the prioritized cooperation project plans in each evaluation in Section 6.2.

Table A6.3.5-1 Prioritized Cooperation Project Plans for Technical Cooperation Project

	Prioritized Cooperation Project Plans
(E) Agriculture	E1 or E3 (see Table A6.2.4-1)
(F) Value Chain Improvement	F1, F2, or F3 (see Table A6.2.4-1)

Source: JICA Survey Team

A combination of the above prioritized cooperation project plans was made. Afterwards, the evaluation of scenarios was summarized in the following table and the detailed information is shown in Table B6.3.4-1.

Table A6.3.5-2 Major Cooperation Scenarios for Technical Cooperation Project

		Potential Cooperation Project Plans			
		Case-3-1	Case-3-2	Case-3-3	Case-3-4
		E1	E3	E3	E1
Extension	Capacity Development Project for Enhancement of Rice Production Techniques and Wide-range Extension in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	○	○	○	○
	Capacity Development Project for Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)				
	Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)				
Seed Production	Capacity Development Project for Rice Seed Production and Wide-range Distribution in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	○			○
	Capacity Development Project for Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)				
	Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)				
		F1	F2	F1	F3
Rice mill (Lower Kuja)	Promotion Program for Private Rice-millers to the Rice-Mill Complex – A TCP for the Whole Coastal Area of Lake Victoria	○		○	○
	Promotion Program for Private Rice-millers to the Rice-Mill Complex – A Component of Yen Loan Project for the Irrigation Development in Lower Kuja				
Postharvest processing	Installation Program of Paddy Collection, Shipping and Storage Center - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja				
Transportation	Improvement of Rice Transportation Routes (Road and Port) - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja				
Rice mill (Kisumu)	Operation Improvement of the Existing Public Rice-mill – A TCP for the Whole Coastal Area of Lake Victoria	○	○	○	
	Total Cost (Ksh. 1 billion)	*1.31*	*0.61*	*1.03*	*1.22*

Note: Total cost = initial cost + O& M cost + administrative cost + others
Source: JICA Survey Team

The JICA Survey Team considered that the cooperation scenario Case-3-1 and Case-3-2 had high priority in terms of size of project budget, impact of the project, and other several aspects.

6.4 Risks and Points for Project Formation and Project Implementation

It is necessary to pay attention to the following risks when implementing the various development scenarios and cooperation projects proposed above. In future project formation, further investigation, examination, and consideration of these points are considered necessary:

- **Climate change:** As shown in Section 5.2.2, it can be said that the frequency and scale of drought and flooding in the target area are expanding. In particular, with regard to the expansion of the scale of floods, it is not only the impact on permanent structures, but also the scale of temporary facilities during construction, which is directly linked to safety issues in construction work.
  On the other hand, since the investigation of flood and rainfall in this study is based on past

phenomena, it is necessary to examine whether these past meteorological data can be applied to future irrigation plans. If necessary, it is necessary to review the flow rate of each river (review of dikes) and the amount of intake water discharge (Q80) in consideration of not only past data but also recent trends in climate change. If these data are misunderstood, it will directly link to the direct flood damage to the irrigation facilities themselves.

Drought carries the risk of severe water shortage. In a normal irrigation plan, it is considered that a drought once every five years is unavoidable and will be accepted, but if it is hit by extreme drought, it can be damaged to the extent that it cannot be planted in the next year. Therefore, it is considered necessary to establish safety net that accepts drought once every five years but does not suffer damage that cannot be recovered. For example, in drought years, measures such as rotation irrigation and incorporating a system will be effective, in which all the beneficiaries divide the damage equally into pain while preventing serious damage from being concentrated on a part of members.

- **Natural and social environment:** The negative impact on the natural and social environment of the new irrigation system in the Lower Kuja irrigation scheme is a concern. As shown in Section 3.1.5 (2), paragraph 7), there is an undeniable risk of negative impacts on nature due to newly opened paddy fields, especially at wetland development in the Lower Kuja Irrigation scheme. In addition, when constructing a new irrigation scheme, land acquisition such as waterways will occur, which will have an impact on the social environment. As detailed in section 2.2.3 (2), there is a case in which the Dominion company farm of the United States around the Lake Victoria has failed, and this case should be examined carefully as a reference of social trouble in irrigation development project.

  On the other hand, we recognize that the Kenya government is keen on environmental impacts. According to interviews with the National Irrigation Authority about land acquisition by the government, the land acquisition work such as waterways in the Lower Kuja Irrigation scheme is almost completed and the land has already been acquired by the government. However obvious data of the land acquisition could not be confirmed in the survey. It need to be confirm with an evidence at project formulation stage. In addition, as detailed in Chapter 3.4, it is good news that the National Irrigation Authority has already undergone the EIA on the Lower Kuja irrigation scheme and has received development permission.

- **Progress of dam development plan:** Currently, some dam constructions (including irrigation) are planned on Nyando River and Kuja River. The Soin-Koru dam on the Nyando River may affect the expansion of the Ahero irrigation scheme, and the Gogo falla dam on the Kuja River may affect the development of the Lower Kuja Irrigation scheme. These changes have significant impacts on the amount of the irrigation schemes, so even if it is a plan change that is good for the beneficiaries, in some cases the irrigation plan itself have to be changed drastically which causes delay of the works. It is necessary, therefore, to advance the plan while paying close attention to the progress of the dam plans and constantly updating the latest information.

- **Trends of other donors:** In the Zoia River basin, the World Bank is implementing an irrigation development project. At present, there is no information on the deployment of other donors to the Nyando River and Kuja River, but the possibility of advancing into the future cannot be denied. If supports are provided twice in the same area, the project effect may be halved. To avoid such risks, it is necessary to always share information with other donors. Accordingly, it is important to segregate and coordinate with other donors.

CHAPTER 7 CONCLUSION

As explained in Chapter 6, there are several scenarios depending on its circumstances. The final scenario should be selected in consideration of the actual limitation of budget size, timing of implementation, investment efficiency, impact of the Project, and so on.

For reader's references, the following are presented as conclusions of the Survey results as the JICA Survey Team's recommendations depend on each condition.

7.1 Condition-1: Implementation by Yen Loan, Grant-Aid, and Technical Cooperation

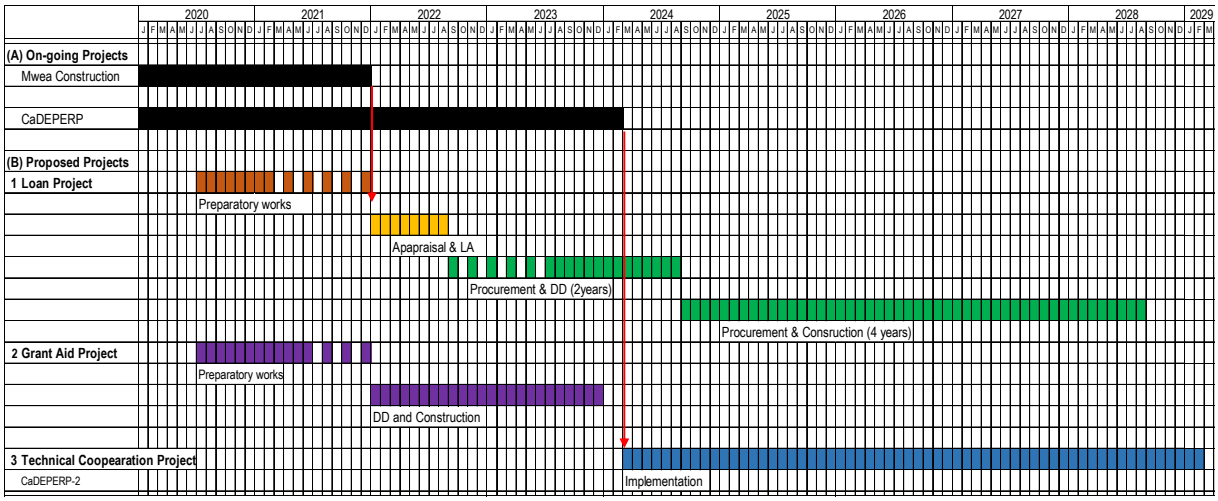
If all the three JICA cooperation schemes are available, it is recommended that the following could be recommended.

The time schedule is shown in Figure A7.1-1.

Table A7.1-1 Preferable Combination for Irrigation Development (Condition-1)

	(1) By Yen Loan	(2) By Grand Aid	(3) By Technical Cooperation
	Case-1-4	Case-2-2	Case-3-1
(A) Ahero	-	A5	-
(B) West Kano	-	-	-
(C) Southwest Kano	C1	-	-
(D) Lower Kuja	D3	-	-
(E) Agriculture & Extension	E6	-	E1
(F) Value Chain	F4	-	F1
Total Cost* (Ksh. 1 billion)	**15.8**	**3.14**	**1.31**
	Refer to Table A6.3.3-2	Refer to Table A6.3.4-2	Refer to Table A6.3.5-2

Source: JICA Survey Team



Source: JICA Survey Team

Figure A7.1-1 Overall Project Implementation Schedule (Condition-1)

7.2 Condition-2: Implementation by Yen Loan and Technical Cooperation

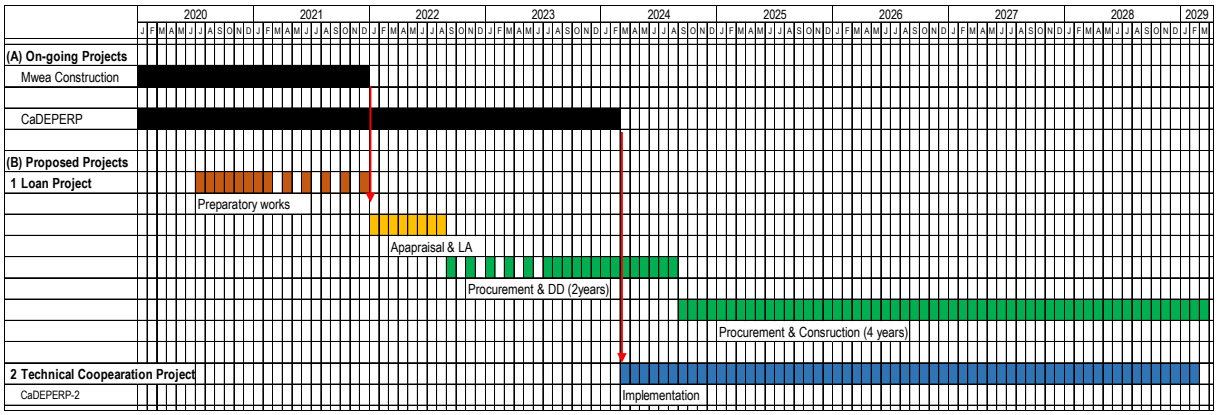
If the grant-aid cooperation scheme is not available and the budget allows it, the following combination could be recommended to be implemented.

Its time schedule could be shown in Figure A7.2-1.

Table A7.2-1 Preferable Combination for Irrigation Development (Condition-2: without Grant Aid)

	(1) By Yen Loan	(2) By Technical Cooperation
	Case-1-3	Case-3-1
(A) Ahero	A5	-
(B) West Kano	-	-
(C) Southwest Kano	C1	-
(D) Lower Kuja	D3	-
(E) Agriculture & Extension	E6	E1
(F) Value Chain	F4	F1
Total Cost* (Ksh. 1 billion)	**17.9**	**1.31**
	Refer to Table A6.3.3-2	Refer to Table A6.3.5-2

Source: JICA Survey Team



Source: JICA Survey Team

Figure A7.2-1 Overall Project Implementation Schedule (Condition-2)

7.3 Items to be Examined in Detail

The site conditions and circumstances around agriculture and irrigation in the target area could be drastically changed from time to time. The following factors, therefore, should be examined in the next step of the study for the concrete formulation of the Project. The risks and points to be considered for project implementation are described in detail in Chapter 6.4. Please refer to that as well.

Table A7.3-1 Items to be Examined in Detail

Category	Items	Reference
Infrastructure	Environmental impact, especially about the development of virgin land in Lower Kuja Irrigation Scheme	Section 3.1.5 (2)
	Progress of project formulation and budgeting for the Soin-Koru Dam	Section 3.1.2 (2)
	Construction progress made by NIA's fund	-
	Road improvement condition and county action plan for road improvement	-
	Feed-in-Tariff system of electricity at solar power generation facility	Section 5.1 (2)
	Irrigation water management status in the irrigation schemes around the target area	-
Agriculture Practices and Extension	Soil classification and suitability at Block 5 in Lower Kuja Irrigation Scheme.	Section 3.2.3 (16)
	Selection of suitable rice variety in Lower Kuja Irrigation Scheme	Section 3.2.5 (2)
Value Chain Improvement	Condition of the Warehouse Receipt System in Kenya	Section 3.3.1 (2)
	Food reserve activity for rice in Kenya	Section 3.3.1 (2)

Source: JICA Survey Team

Tables

Table B2.1.2-1 Priority Objectives and Approaches of NRDS-II

Strategic/ Specific Objective	Major Expectations	Targets (by 2030)	Approaches
1. Expansion of area under rice cultivation	Irrigation infrastructures (Rehabilitation of existing and development of new schemes)	Irrigated: Expansion from 20,000 ha to 90,000 ha	• Irrigation schemes will be expanded and/or newly developed in areas where the soil and other agro-climatic conditions favor rice production – • Potential areas for expansion are as follows in the following (counties); - Mwea (Kirinyaga) - 5,500 ha - Lower Nzoia (Busia)- 9,687 ha - Sio (Busia)- 6,600 ha - Yala (Siaya)- 4,600 ha - Anyiko(Siaya) 150ha150 ha - Kano plains (Kisumu)-12,000 ha - Nyando (Kisumu)- 6,361 ha - Muhoroni (Kisumu)- 690 ha - Kuja (Migori)- 32,700 ha - Lower Kuja (Migori)- 7,678 ha - OluchKimira (Homa Bay)- 200 ha - Maugo (Homa Bay)- 300 ha - Perkerra (Baringo)- 1,338 ha - Tana delta (Tana River)- 2,955 ha - Bura (Tana River)- 3,441 ha - Kimorigo 500ha(TaitaTavet a)-? ha - Buluma 400ha (TaitaTaveta)- ? ha **Total = 94,950 ha**
	Rain-fed areas	Rain fed (lowland and upland Expansion from 9,000 to 42,000 ha	• Potential areas for expansion are as follows in the following counties; - Bungoma - Busia (Teso North, Teso South and Nambale) - Kakamega - Kilifi (Kaloleni and Malindi - Kwale (Matuga, Msambweni and Lungalunga) Meru (Tigania West and Tigania East) - Isiolo - Migori (Uriri and Awendo) - Homabay - Siaya - Embu - Elgeyo-Marakwet (East and West Marakwet) - Lamu - West pokot (Sigor and Ortum) - TharakaNithi - Murang'a (Kiharu) - Community based water storage/supplementary irrigation
2. Increasing on-farm productivity	Raise on-farm productivity	Irrigated From 4.0 to 7.5 t/ha; RF Lowland From 2.0 to 3.5 t/ha; Upland From 1.5 to 2.5 t/ha	• Double cropping and ratooning • Capacity building of extension agents on rice production, processing and marketing
	Inputs, technologies		• Introduction of high-yielding, stress tolerant, market-oriented varieties • Increase the 'uptake' of certified seeds and hybrids, fertilizers and agro-chemicals in irrigated and rain-fed • Facilitation of private investments in production and agro-dealerships (SMEs)
	Appropriate mechanization		• Appropriation of cost-efficient machineries for sowing, transplanting, harvesting, drying and milling • Promote private investments and participation of youth in provision of hiring services, sales and after-sales services (SMEs)
	Minimizing		• Promotion of the use of efficient machineries

Strategic/ Specific Objective	Major Expectations	Targets (by 2030)	Approaches
	harvest and postharvest losses		• Increase adoption of improved harvest and postharvest handling practices • Training on postharvest handling technologies such as parboiling (SMEs)
	Soil and water management		• Organize soil testing in rice growing areas for appropriation of fertilizer usage • Upscale adoption of proven water saving technologies
3. Increase the competitiveness of locally produced rice	Reducing the cost of production	Reduce from Kshs. 56,585 to 40,000 per acre	• Increase on-farm mechanization • Optimization of application of farm-inputs • Organization of Agribusiness Development Groups for bulk procurements (SMEs) • Promote local sourcing/manufacturing of inputs such as fertilizers, machineries, other resources/utilities
	Improving the quality of locally produced rice		• Promotion of good harvesting and postharvest handling practices (harvesting, drying, cleaning, milling, grading and packaging) [SMEs] • Increased and organized private investments in trading, processing and marketing of paddy and milled rice (SMEs)
	Promote efficient marketing/trading		• Increase the accessibility and availability of rice to consumers • Promoting linkages between farmers, farmer-based organizations, millers and markets • Facilitation of procurement towards National Strategic Food Reserve
4. Promoting private sector participation in agribusinesses	Agribusiness promotion along rice value chain	At least 100 new enterprises in rice value chain, At least 3 new value-added rice products and At least 3 new producer-marketing organizations	• Provide an enabling environment for private sector investment along the rice value chain • Capacity build farmer organizations in rice value addition
	Input supply		• Creating more demand for inputs through demonstrations and other extension services • Capacity building (training and trade fairs) for farmers, agro-dealers • Create an enabling environment (standards, regulations, infrastructure (roads, electricity)
	Hiring/Service provision (machineries), Support services		• Promotion of setting up of 'machinery hiring hubs' in rice growing areas • Facilitating finance (low interest schemes) for investments, especially by youth • Promotion of rice crop insurance • Increased technical back-stopping • Capacity building for operators, artisans and technicians
	Value Addition (packaging, branding, by-products)		• Capacity building of stakeholders • Promote entrepreneurships (especially youth, women) e.g. baling of straws for animal feeds • Technology support towards innovative products • Improve rural infrastructure such as electricity and roads
	Farmer based organizations		• Strengthen existing cooperatives and creation of Agribusiness Development Groups • Mobilize farmers and rural leadership committees • Facilitate linkages (including contractual agreements) with input suppliers, service providers (machineries, millers) • Capacity building (training workshops) on business and organizational skills
	Large scale (>1,000 ha) private rice farms		• Provide enabling environment (guarantee/protected land ownership) • Provide amenities (road, power, water)

Source: National Rice Development Strategy - II (2019 - 2030) (NRDS-II) (Draft)

Table B2.1.3-1 Irrigation Develop3ment Projects supported by JICA

1. Tana Delta Irrigation Project

1.1 Project Description

The Tana River Delta and flood plain is estimated to comprise 200,000 Ha of land. Out of the 200,000 ha available, 100,000 Ha is considered suitable for commercial exploitation while the local communities reserve the remainder for conservation and use.
The project is planned and dovetailed towards achieving the national development goals and in particular with respect to food security.
The Tana Delta Irrigation Project (TDIP) is located in Garsen Division, 110 km north of Malindi, Tana Delta District, and Coast Province. The project area lies on the left bank of the river Tana from Sailoni in the north, where the TDIP intake is constructed. This is a rice scheme of 1800 Ha expandable to 4000 Ha.

1.2 Project Goal or Objectives

- Food security
- Create employment and generate incomes for the local communities.
- To generate revenue from sale of the produce in the local and export market.
- Reduce the rice import gap thereby saving on foreign exchange.
-

1.3 Project Purpose

- The major objective of the project was to open up the delta area to farming.

1.4 Project Benefits

- Provision of employment opportunities
- Efficient utilization of land and water resources.
- Food reliance

2. Mwea Irrigation Project

2.1 Original Project

Project Description and background
The scheme was started as a detention camp for Mau Mau detainees during the height of the state of emergency. In order to establish whether rice crop could be cultivated, the colonial government carried out the first rice trials (research) in 1953.
This was mainly because the whole scheme area was then used as a common grazing ground and hence there was need to set up trials in order to determine the viability of rice crop production in the area. The scheme is currently run under the participatory irrigation management approach with NIB being responsible for the primary and secondary infrastructure while the farmers are responsible for the tertiary infrastructure. Other key roles played by NIB in the scheme include land administration, capacity building, irrigation expansion and rehabilitation of the irrigation infrastructure.

Location/County: Kirinyaga County, Mwea East and West Sub-counties
Year of establishment: 1954
Gazetted Area: 30, 350 acre (12,140ha)
Main Crop: Basmati 370 Rice

2.2 Current Expansion Project

In a bid to improve the reliability of irrigation water and increase area under irrigation in Mwea Irrigation scheme, NIB is constructing the Thiba dam and infrastructure for irrigation area financed by Japan International Cooperation Agency (JICA) and Government of Kenya (GoK) under the Mwea Irrigation Development Project.

The component of the project includes: -

- Construction of the Thiba dam
- Construction works for irrigation and Drainage facilities in the expansion area Mutithi section covering 10,000 acres.
- Procurement works of Operation and Maintenance equipment
- Resettlement of Project affected Persons (PAP) from the Dam area through community site development.
- Compensation for the canal way leave and livelihoods restoration

Source: NIA

Table B3.1.2-1 Water Requirement Calculation: Ahero Irrigation Scheme (Pattern 1: 867ha, 200% crop intensity)

Condition: Planting period-3months, Qmax = 1.56m3/s only

Crop: Paddy only		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1	Unit	31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc				1.10	1.10	1.15	0.95			1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	5.58	5.50	5.68	4.63	0.00	0.00	5.42	5.52	5.72	4.71
	mm/month	0.00	0.00	172.89	165.00	176.11	138.80	0.00	0.00	162.69	171.18	171.47	146.07
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment requirement	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	0.00	93.60	283.09	128.80	183.91	177.20	0.00	88.00	305.89	202.38	204.07	194.67
Irrigation water Need IN	mm/day	0.00	3.34	9.13	4.29	5.93	5.91	0.00	2.84	10.20	6.53	6.80	6.28
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	6.69	18.26	8.59	11.87	11.81	0.00	5.68	20.39	13.06	13.60	12.56
Unit water requirement	l/s/ha	0.00	0.77	2.11	0.99	1.37	1.37	0.00	0.66	2.36	1.51	1.57	1.45
Area	ha	0	289	289	289	289	289	0	289	289	289	289	289
Flow in Canal	m3/s	0.00	0.22	0.61	0.29	0.40	0.40	0.00	0.19	0.68	0.44	0.46	0.42
PADDY Area2		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		0.95			1.10	1.10	1.15	0.95			1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.73	0.00	0.00	5.50	5.43	5.60	4.60	0.00	0.00	5.52	5.47	5.70
	mm/month	146.66	0.00	0.00	165.00	168.45	168.02	142.54	0.00	0.00	171.18	164.01	176.82
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment requirement	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	177.06	0.00	70.20	228.80	176.25	206.42	186.54	0.00	103.20	302.38	196.61	225.42
Irrigation water Need IN	mm/day	5.71	0.00	2.26	7.63	5.69	6.88	6.02	0.00	3.44	9.75	6.55	7.27
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	11.42	0.00	4.53	15.25	11.37	13.76	12.03	0.00	6.88	19.51	13.11	14.54
Unit water requirement	l/s/ha	1.32	0.00	0.52	1.77	1.32	1.59	1.39	0.00	0.80	2.26	1.52	1.68
Area	ha	289	0	289	289	289	289	289	0	289	289	289	289
Flow in Canal	m3/s	0.38	0.00	0.15	0.51	0.38	0.46	0.40	0.00	0.23	0.65	0.44	0.49
PADDY Area3		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		1.15	0.95			1.10	1.10	1.15	0.95			1.10	1.10
Crop water need (Eto*Kc)	mm/day	5.73	4.77	0.00	0.00	5.43	5.36	5.57	4.64	0.00	0.00	5.47	5.46
	mm/month	177.54	133.53	0.00	0.00	168.45	160.71	172.55	143.72	0.00	0.00	164.01	169.14
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	150	0	0
Percolation	mm/month	90	90	0	0	90	90	90	90	0	0	90	90
WL establishment requirement	mm	0	0	0	0	100	0	0	0	0	0	100	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	207.94	167.13	0.00	23.80	276.25	199.11	216.55	171.72	0.00	91.20	296.61	217.74
Irrigation water Need IN	mm/day	6.71	5.97	0.00	0.79	8.91	6.64	6.99	5.54	0.00	2.94	9.89	7.02
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	13.42	11.94	0.00	1.59	17.82	13.27	13.97	11.08	0.00	5.88	19.77	14.05
Unit water requirement	l/s/ha	1.55	1.38	0.00	0.18	2.06	1.54	1.62	1.28	0.00	0.68	2.29	1.63
Area	ha	289	289	0	289	289	289	289	289	0	289	289	289
Flow in Canal	m3/s	0.45	0.40	0.00	0.05	0.60	0.44	0.47	0.37	0.00	0.20	0.66	0.47
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal Paddy only	m3/s	0.83	0.62	0.76	0.85	1.37	1.30	0.87	0.56	0.91	1.29	1.56	1.38
	rank	9	11	10	8	3	4	7	12	6	5	1	2
Total Area - Paddy	ha	578	578	578	867	867	867	578	578	578	867	867	867
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	2.82	1.64	2.02	5.66	7.58	3.8	3.66	4.74	4.1	2.36	2.56	2.36
Canal design discharge	m3/s	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76

Source: JICA Survey Team

Table B 3.1.2-2 Water Requirement Calculation: Ahero Irrigation Scheme (Pattern 2: 1,318ha, 175% crop intensity)

Condition: Planting period-3months, Qmax = 1.76m3/s

Crop: Paddy only		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1	Unit	31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc			1.10	1.10	1.15	0.95			1.10	1.10	1.15	0.95	
Crop water need (Eto*Kc)	mm/day	0.00	5.52	5.58	5.75	4.69	0.00	0.00	5.37	5.42	5.77	4.72	0.00
	mm/month	0.00	154.62	172.89	172.50	145.48	0.00	0.00	166.41	162.69	178.96	141.65	0.00
SAT (land preparation)	mm	150	0	0	0	0	0	150	0	0	0	0	0
Percolation	mm/month	0	90	90	90	90	0	0	90	90	90	90	0
WL establishment requirement	mm	0	100	0	0	0	0	0	100	0	0	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	90.40	288.22	183.09	136.30	153.28	0.00	104.00	294.41	205.89	210.16	174.25	0.00
Irrigation water Need IN	mm/day	2.92	10.29	5.91	4.54	4.94	0.00	3.35	9.50	6.86	6.78	5.81	0.00
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	5.83	20.59	11.81	9.09	9.89	0.00	6.71	18.99	13.73	13.56	11.62	0.00
Unit water requirement	l/s/ha	0.68	2.38	1.37	1.05	1.14	0.00	0.78	2.20	1.59	1.57	1.34	0.00
Area	ha	439	439	439	439	439	0	330	330	330	330	330	0
Flow in Canal	m3/s	0.30	1.05	0.60	0.46	0.50	0.00	0.26	0.72	0.52	0.52	0.44	0.00
PADDY Area2		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc				1.10	1.10	1.15	0.95			1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	5.58	5.50	5.68	4.63	0.00	0.00	5.42	5.52	5.72	4.71
	mm/month	0.00	0.00	172.89	165.00	176.11	138.80	0.00	0.00	162.69	171.18	171.47	146.07
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment requirement	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	0.00	93.60	283.09	128.80	183.91	177.20	0.00	88.00	305.89	202.38	204.07	194.67
Irrigation water Need IN	mm/day	0.00	3.34	9.13	4.29	5.93	5.91	0.00	2.84	10.20	6.53	6.80	6.28
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	6.69	18.26	8.59	11.87	11.81	0.00	5.68	20.39	13.06	13.60	12.56
Unit water requirement	l/s/ha	0.00	0.77	2.11	0.99	1.37	1.37	0.00	0.66	2.36	1.51	1.57	1.45
Area	ha	0	439	439	439	439	439	0	330	330	330	330	330
Flow in Canal	m3/s	0.00	0.34	0.93	0.44	0.60	0.60	0.00	0.22	0.78	0.50	0.52	0.48
PADDY Area3		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		0.95			1.10	1.10	1.15	0.95			1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.73	0.00	0.00	5.50	5.43	5.60	4.60	0.00	0.00	5.52	5.47	5.70
	mm/month	146.66	0.00	0.00	165.00	168.45	168.02	142.54	0.00	0.00	171.18	164.01	176.82
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment requirement	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	177.06	0.00	70.20	228.80	176.25	206.42	186.54	0.00	103.20	302.38	196.61	225.42
Irrigation water Need IN	mm/day	5.71	0.00	2.26	7.63	5.69	6.88	6.02	0.00	3.44	9.75	6.55	7.27
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	11.42	0.00	4.53	15.25	11.37	13.76	12.03	0.00	6.88	19.51	13.11	14.54
Unit water requirement	l/s/ha	1.32	0.00	0.52	1.77	1.32	1.59	1.39	0.00	0.80	2.26	1.52	1.68
Area	ha	330	0	439	439	439	439	439	0	330	330	330	330
Flow in Canal	m3/s	0.44	0.00	0.23	0.78	0.58	0.70	0.61	0.00	0.26	0.74	0.50	0.55
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal	m3/s	0.73	1.39	1.76	1.67	1.68	1.30	0.87	0.94	1.56	1.76	1.46	1.03
Total Area	ha	769	879	1,318	1,318	1,318	879	769	659	989	989	989	659
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	2.82	1.64	2.02	5.66	7.58	3.8	3.66	4.74	4.1	2.36	2.56	2.36
Canal design discharge	m3/s	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76

Source: JICA Survey Team

Table B3.1.2-3 Summary of Comparison of Irrigation System (Existing Scheme) in Ahero Irrigation Scheme

Unit (million Ksh)

Option	Option 1-1	Option 1-2	Option 2-1	Option 2-2
Initial cost	200	280	996	1,208
O&M cost	540	279	300	363
Total	740	559	1,296	1,571

Unit (million Ksh)

Option	Option 1-1	Option 1-2	Option 2-1	Option 2-2
Rehabilitation	200	240	-	-
New construction	-	40	996	1,208
Maintenance	150	150	300	363
Operation	390	129	-	-
Total	740	559	1,296	1,571

Source: JICA Survey Team

Table B3.1.2-4 Breakdown of Comparison of Irrigation System (Existing Scheme) in Ahero Irrigation Scheme

Life cycle evaluation for 30 year

Option 1-1 (Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	Pump Rehabititaion	Pump Maintenance	Pump Operation	Total	Remarks
1	100.0	5.0	13.0	119.0	Project completion
2		5.0	13.0	20.0	
3		5.0	13.0	21.0	
4		5.0	13.0	22.0	
5		5.0	13.0	23.0	
6		5.0	13.0	24.0	
7		5.0	13.0	25.0	
8		5.0	13.0	26.0	
9		5.0	13.0	27.0	
10		5.0	13.0	28.0	
11		5.0	13.0	29.0	
12		5.0	13.0	30.0	
13		5.0	13.0	31.0	
14		5.0	13.0	32.0	
15		5.0	13.0	33.0	
16	100.0	5.0	13.0	134.0	Rehabilitation
17		5.0	13.0	35.0	
18		5.0	13.0	36.0	
19		5.0	13.0	37.0	
20		5.0	13.0	38.0	
21		5.0	13.0	39.0	
22		5.0	13.0	40.0	
23		5.0	13.0	41.0	
24		5.0	13.0	42.0	
25		5.0	13.0	43.0	
26		5.0	13.0	44.0	
27		5.0	13.0	45.0	
28		5.0	13.0	46.0	
29		5.0	13.0	47.0	
30		5.0	13.0	48.0	
Total	200.0	150.0	390.0	740.0	

Summary

Rehabilitation	200.0	(Ksh million)
New construction		(Ksh million)
Maintenance	150.0	(Ksh million)
Operation	390.0	(Ksh million)
Total	740.0	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-5 Breakdown of Comparison of Irrigation System (Existing Scheme) in Ahero Irrigation Scheme

Option 1-2(Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	Pump Rehabititaion	Solar New construction	Solar Rehabititaion	Pump+solar Maintenance	Pump Operation	Total	Remarks
1	100.0	40.0		5.0	4.3	149.3	Project completion
2				5.0	4.3	9.3	
3				5.0	4.3	9.3	
4				5.0	4.3	9.3	
5				5.0	4.3	9.3	
6				5.0	4.3	9.3	
7				5.0	4.3	9.3	
8				5.0	4.3	9.3	
9				5.0	4.3	9.3	
10				5.0	4.3	9.3	
11				5.0	4.3	9.3	
12				5.0	4.3	9.3	
13				5.0	4.3	9.3	
14				5.0	4.3	9.3	
15				5.0	4.3	9.3	
16	100.0		40.0	5.0	4.3	149.3	Rehabilitation
17				5.0	4.3	9.3	
18				5.0	4.3	9.3	
19				5.0	4.3	9.3	
20				5.0	4.3	9.3	
21				5.0	4.3	9.3	
22				5.0	4.3	9.3	
23				5.0	4.3	9.3	
24				5.0	4.3	9.3	
25				5.0	4.3	9.3	
26				5.0	4.3	9.3	
27				5.0	4.3	9.3	
28				5.0	4.3	9.3	
29				5.0	4.3	9.3	
30				5.0	4.3	9.3	
Total	200.0	40.0	40.0	150.0	129.0	559.0	

Summary

Rehabilitation	240.0	(Ksh million)
New construction	40.0	(Ksh million)
Maintenance	150.0	(Ksh million)
Operation	129.0	(Ksh million)
Total	559.0	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-6 Breakdown of Comparison of Irrigation System (Existing Scheme) in Ahero Irrigation Scheme

Option 2-1 (Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	New construction		Maintenance		Total	Remarks
	Weir	Link canal	Weir	Conveyance canal		
1	500.0	496.0	5.0	5.0	1006.0	Project completion
2			5.0	5.0	10.0	
3			5.0	5.0	10.0	
4			5.0	5.0	10.0	
5			5.0	5.0	10.0	
6			5.0	5.0	10.0	
7			5.0	5.0	10.0	
8			5.0	5.0	10.0	
9			5.0	5.0	10.0	
10			5.0	5.0	10.0	
11			5.0	5.0	10.0	
12			5.0	5.0	10.0	
13			5.0	5.0	10.0	
14			5.0	5.0	10.0	
15			5.0	5.0	10.0	
16			5.0	5.0	10.0	
17			5.0	5.0	10.0	
18			5.0	5.0	10.0	
19			5.0	5.0	10.0	
20			5.0	5.0	10.0	
21			5.0	5.0	10.0	
22			5.0	5.0	10.0	
23			5.0	5.0	10.0	
24			5.0	5.0	10.0	
25			5.0	5.0	10.0	
26			5.0	5.0	10.0	
27			5.0	5.0	10.0	
28			5.0	5.0	10.0	
29			5.0	5.0	10.0	
30			5.0	5.0	10.0	
Total	500.0	496.0	150.0	150.0	1296.0	

Summary		
Rehabilitation		(Ksh million)
New construction	996.0	(Ksh million)
Maintenance	300.0	(Ksh million)
Operation		(Ksh million)
Total	1296.0	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-7 Breakdown of Comparison of Irrigation System (Existing Scheme) in Ahero Irrigation Scheme

Option 2-2 (Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	New construction		Maintenance		Total	Remarks
	Weir	Link canal	Weir	Conveyance canal		
1	990.0	218.2	9.9	2.2	1220.3	Project completion
2			9.9	2.2	12.1	
3			9.9	2.2	12.1	
4			9.9	2.2	12.1	
5			9.9	2.2	12.1	
6			9.9	2.2	12.1	
7			9.9	2.2	12.1	
8			9.9	2.2	12.1	
9			9.9	2.2	12.1	
10			9.9	2.2	12.1	
11			9.9	2.2	12.1	
12			9.9	2.2	12.1	
13			9.9	2.2	12.1	
14			9.9	2.2	12.1	
15			9.9	2.2	12.1	
16			9.9	2.2	12.1	
17			9.9	2.2	12.1	
18			9.9	2.2	12.1	
19			9.9	2.2	12.1	
20			9.9	2.2	12.1	
21			9.9	2.2	12.1	
22			9.9	2.2	12.1	
23			9.9	2.2	12.1	
24			9.9	2.2	12.1	
25			9.9	2.2	12.1	
26			9.9	2.2	12.1	
27			9.9	2.2	12.1	
28			9.9	2.2	12.1	
29			9.9	2.2	12.1	
30			9.9	2.2	12.1	
Total	990.0	218.2	297.0	66.0	1571.2	

Summary		
Rehabilitation		(Ksh million)
New construction	1208.2	(Ksh million)
Maintenance	363.0	(Ksh million)
Operation		(Ksh million)
Total	1571.2	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-8 Breakdown of Comparison of Irrigation System (Existing Scheme) in Ahero Irrigation Scheme

Basic estimation

Option 1-1 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
Rehabilitation	Pump	Q=1.1 m^3/s	2	nos.	30,000,000	Ksh/nos.	60.0	Life time: 15 years*
		Q=0.66 m^3/s	2	nos.	20,000,000	Ksh/nos.	40.0	Life time: 15 years*
	Sub-total						100.0	
Maintenance	Pump repair		1	set	5,000,000	Ksh/set/year	5.0	5% of rehabilitation*
Operation	Pump electricity		1	set	13,040,608	Ksh/set/year	13.0	Dec-16 to Nov-17

*: Base on "Water Design Manual - Kenya 2005"

Option 1-2 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
Rehabilitation	Pump	Q=1.1 m^3/s	2	nos.	30,000,000	Ksh/nos.	60.0	Life time: 15 years*
		Q=0.66 m^3/s	2	nos.	20,000,000	Ksh/nos.	40.0	Life time: 15 years*
	Sub-total						100.0	
New construction	Solar system	Q=1.1 m^3/s	1	set	25,000,000	Ksh/nos.	25.0	H=15m
		Q=0.66 m^3/s	1	set	15,000,000	Ksh/nos.	15.0	H=15m
	Sub-total				40,000,000	Ksh/set	40.0	Life time: 10 years*
Maintenance	Pump repair		1	set	5,000,000	Ksh/set/year	5.0	5% of rehabilitation and new construction*
	Solar repair		1	set	0	Ksh/set/year	0.0	0% of rehabilitation and new construction***
Operation	Pump electricity		1	set	4,303,401	Ksh/set/year	4.3	33% of Option 1**

*: Base on "Water Design Manual - Kenya 2005"
**: 8 hours (9AM to 4 PM) out of 10 to 14 hour pump operation per day
***: Based on track record of other projects

Option 2 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
New construction	Weir	L=58.5m, H=5.5m	1	nos.	500,000,000	Ksh/nos.	500.0	Life time: 40 years*
	Conveyance canal	L=10.0km, Q=2.2m^3/s**, Open channel	1	nos.	496,000,000	Ksh/nos.	496.0	Life time: 30 years*
	Sub-total						996.0	
Maintenance	Weir		1	set	5,000,000	Ksh/set/year	5.0	1% of rnew construction*
	Conveyance canal		1	set	4,960,000	Ksh/set/year	5.0	1% of rnew construction*
	Sub-total						10.0	

*: Base on "Water Design Manual - Kenya 2005"
**: Q=1.76/0.8=2.2 (m^3/s)

Source: JICA Survey Team

Table B3.1.2-9 Summary of Comparison of Irrigation System (Extension Scheme) in Ahero Irrigation Scheme

Unit (million Ksh)

Option	Option 1-1	Option 1-2	Option 2-1	Option 2-2
Initial cost	800	1,120	1,988	1,645
O&M cost	2,166	1,116	597	492
Total	2,966	2,236	2,585	2,137

Unit (million Ksh)

Option	Option 1-1	Option 1-2	Option 2-1	Option 2-2
Rehabilitation	800	960	-	-
New construction	-	160	1,988	1,645
Maintenance	600	600	597	492
Operation	1,566	516	-	-
Total	2,966	2,236	2,585	2,137

Source: JICA Survey Team

Table B3.1.10 Breakdown of Comparison of Irrigation System (Extension Scheme) in Ahero Irrigation Scheme

Life cycle evaluation for 30 year

Option 1-1 (Extension plan, Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	Pump Rehabititaion	Pump Maintenance	Pump Operation	Total	Remarks
1	400.0	20.0	52.2	473.2	Project completion
2		20.0	52.2	74.2	
3		20.0	52.2	75.2	
4		20.0	52.2	76.2	
5		20.0	52.2	77.2	
6		20.0	52.2	78.2	
7		20.0	52.2	79.2	
8		20.0	52.2	80.2	
9		20.0	52.2	81.2	
10		20.0	52.2	82.2	
11		20.0	52.2	83.2	
12		20.0	52.2	84.2	
13		20.0	52.2	85.2	
14		20.0	52.2	86.2	
15		20.0	52.2	87.2	
16	400.0	20.0	52.2	488.2	Rehabilitation
17		20.0	52.2	89.2	
18		20.0	52.2	90.2	
19		20.0	52.2	91.2	
20		20.0	52.2	92.2	
21		20.0	52.2	93.2	
22		20.0	52.2	94.2	
23		20.0	52.2	95.2	
24		20.0	52.2	96.2	
25		20.0	52.2	97.2	
26		20.0	52.2	98.2	
27		20.0	52.2	99.2	
28		20.0	52.2	100.2	
29		20.0	52.2	101.2	
30		20.0	52.2	102.2	
Total	800.0	600.0	1566.0	2966.0	

Summary		
Rehabilitation	800.0	(Ksh million)
New construction		(Ksh million)
Maintenance	600.0	(Ksh million)
Operation	1566.0	(Ksh million)
Total	2966.0	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-11 Breakdown of Comparison of Irrigation System (Extension Scheme) in Ahero Irrigation Scheme

Option 1-2 (Extension plan, Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	Pump	Solar		Pump+solar	Pump	Total	Remarks
	Rehabititaion	New construction	Rehabititaion	Maintenance	Operation		
1	400.0	160.0		20.0	17.2	597.2	Project completion
2				20.0	17.2	37.2	
3				20.0	17.2	37.2	
4				20.0	17.2	37.2	
5				20.0	17.2	37.2	
6				20.0	17.2	37.2	
7				20.0	17.2	37.2	
8				20.0	17.2	37.2	
9				20.0	17.2	37.2	
10				20.0	17.2	37.2	
11				20.0	17.2	37.2	
12				20.0	17.2	37.2	
13				20.0	17.2	37.2	
14				20.0	17.2	37.2	
15				20.0	17.2	37.2	
16	400.0		160.0	20.0	17.2	597.2	Rehabilitation
17				20.0	17.2	37.2	
18				20.0	17.2	37.2	
19				20.0	17.2	37.2	
20				20.0	17.2	37.2	
21				20.0	17.2	37.2	
22				20.0	17.2	37.2	
23				20.0	17.2	37.2	
24				20.0	17.2	37.2	
25				20.0	17.2	37.2	
26				20.0	17.2	37.2	
27				20.0	17.2	37.2	
28				20.0	17.2	37.2	
29				20.0	17.2	37.2	
30				20.0	17.2	37.2	
Total	800.0	160.0	160.0	600.0	516.0	2236.0	

Summary		
Rehabilitation	960.0	(Ksh million)
New construction	160.0	(Ksh million)
Maintenance	600.0	(Ksh million)
Operation	516.0	(Ksh million)
Total	2236.0	(Ksh million)

Option 2-1 (Extension plan, Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	New construction		Maintenance		Total	Remarks
	Weir	Link canal	Weir	Conveyance canal		
1	500.0	1488.0	5.0	14.9	2007.9	Project completion
2			5.0	14.9	19.9	
3			5.0	14.9	19.9	
4			5.0	14.9	19.9	
5			5.0	14.9	19.9	
6			5.0	14.9	19.9	
7			5.0	14.9	19.9	
8			5.0	14.9	19.9	
9			5.0	14.9	19.9	
10			5.0	14.9	19.9	
11			5.0	14.9	19.9	
12			5.0	14.9	19.9	
13			5.0	14.9	19.9	
14			5.0	14.9	19.9	
15			5.0	14.9	19.9	
16			5.0	14.9	19.9	
17			5.0	14.9	19.9	
18			5.0	14.9	19.9	
19			5.0	14.9	19.9	
20			5.0	14.9	19.9	
21			5.0	14.9	19.9	
22			5.0	14.9	19.9	
23			5.0	14.9	19.9	
24			5.0	14.9	19.9	
25			5.0	14.9	19.9	
26			5.0	14.9	19.9	
27			5.0	14.9	19.9	
28			5.0	14.9	19.9	
29			5.0	14.9	19.9	
30			5.0	14.9	19.9	
Total	500.0	1488.0	150.0	447.0	2585.0	

Summary		
Rehabilitation		(Ksh million)
New construction	1988.0	(Ksh million)
Maintenance	597.0	(Ksh million)
Operation		(Ksh million)
Total	2585.0	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-12 Breakdown of Comparison of Irrigation System (Extension Scheme) in Ahero Irrigation Scheme

Option 2-2 (Extension plan, Life cycle evaluation for 30 years)

Unit (Ksh million)

Year	New construction		Maintenance		Total	Remarks
	Weir	Link canal	Weir	Conveyance canal		
1	990.0	654.7	9.9	6.5	1661.1	Project completion
2			9.9	6.5	16.4	
3			9.9	6.5	16.4	
4			9.9	6.5	16.4	
5			9.9	6.5	16.4	
6			9.9	6.5	16.4	
7			9.9	6.5	16.4	
8			9.9	6.5	16.4	
9			9.9	6.5	16.4	
10			9.9	6.5	16.4	
11			9.9	6.5	16.4	
12			9.9	6.5	16.4	
13			9.9	6.5	16.4	
14			9.9	6.5	16.4	
15			9.9	6.5	16.4	
16			9.9	6.5	16.4	
17			9.9	6.5	16.4	
18			9.9	6.5	16.4	
19			9.9	6.5	16.4	
20			9.9	6.5	16.4	
21			9.9	6.5	16.4	
22			9.9	6.5	16.4	
23			9.9	6.5	16.4	
24			9.9	6.5	16.4	
25			9.9	6.5	16.4	
26			9.9	6.5	16.4	
27			9.9	6.5	16.4	
28			9.9	6.5	16.4	
29			9.9	6.5	16.4	
30			9.9	6.5	16.4	
Total	990.0	654.7	297.0	195.0	2136.7	

Summary		
Rehabilitation		(Ksh million)
New construction	1644.7	(Ksh million)
Maintenance	492.0	(Ksh million)
Operation		(Ksh million)
Total	2136.7	(Ksh million)

Source: JICA Survey Team

Table B3.1.2-13 Breakdown of Comparison of Irrigation System (Extension Scheme) in Ahero Irrigation Scheme

Basic estimation for extension plan

Option 1-1 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
Rehabilitation	Pump	Q=1.1 m^3/s	8	nos.	30,000,000	Ksh/nos.	240.0	Life time: 15 years*
		Q=0.66 m^3/s	8	nos.	20,000,000	Ksh/nos.	160.0	Life time: 15 years*
	Sub-total						400.0	
Maintenance	Pump repair		1	set	20,000,000	Ksh/set/year	20.0	5% of rehabilitation*
Operation	Pump electricity		4	set	13,040,608	Ksh/set/year	52.2	Dec-16 to Nov-17

*: Base on "Water Design Manual - Kenya 2005"

Option 1-2 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
Rehabilitation	Pump	Q=1.1 m^3/s	8	nos.	30,000,000	Ksh/nos.	240.0	Life time: 15 years*
		Q=0.66 m^3/s	8	nos.	20,000,000	Ksh/nos.	160.0	Life time: 15 years*
	Sub-total						400.0	
New construction	Solar system	Q=1.1 m^3/s	4	set	25,000,000	Ksh/nos.	100.0	H=15m
		Q=0.66 m^3/s	4	set	15,000,000	Ksh/nos.	60.0	H=15m
	Sub-total				40,000,000	Ksh/set	160.0	Life time: 10 years*
Maintenance	Pump repair		1	set	20,000,000	Ksh/set/year	20.0	5% of rehabilitation and new construction*
	Solar repair		1	set	0	Ksh/set/year	0.0	0% of rehabilitation and new construction***
Operation	Pump electricity		4	set	4,303,401	Ksh/set/year	17.2	33% of Option 1**

*: Base on "Water Design Manual - Kenya 2005"

**: 8 hours (9AM to 4 PM) out of 10 to 14 hour pump operation per day

***: Based on track record of other projects

Option 2-1 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
New construction	Weir	L=58.5m, H=5.5m	1	nos.	500,000,000	Ksh/nos.	500.0	Life time: 40 years*
	Conveyance canal	L=10.0km, Q=6.6m^3/s**, Open channel	1	nos.	1,488,000,000	Ksh/nos.	1,488.0	Life time: 30 years*
	Sub-total						1,988.0	
Maintenance	Weir		1	set	5,000,000	Ksh/set/year	5.0	1% of rnew construction*
	Conveyance canal		1	set	14,880,000	Ksh/set/year	14.9	1% of rnew construction*
	Sub-total						19.9	

*: Base on "Water Design Manual - Kenya 2005"

**: Based on "Detailed design and preparation on bidding documents for Ahero and West Kano irrigation schemens development project, final design report

Option 2-2 (basic estimation)

Items			Qty	Unit	Unit cost	Unit	Cost (Million Ksh)	Remarks
New construction	Weir	L=58.5m, H=10.8m	1	nos.	990,000,000	Ksh/nos.	990.0	Life time: 40 years*
	Conveyance canal	L=4.4km, Q=6.6 m^3/s**, Open channel	1	nos.	654,720,000	Ksh/nos.	654.7	Life time: 30 years*
	Sub-total						1,644.7	
Maintenance	Weir		1	set	9,900,000	Ksh/set/year	9.9	1% of rnew construction*
	Conveyance canal		1	set	6,547,000	Ksh/set/year	6.5	1% of rnew construction*
	Sub-total						16.4	

*: Base on "Water Design Manual - Kenya 2005"

**: Based on "Detailed design and preparation on bidding documents for Ahero and West Kano irrigation schemens development project, final design report

Source: JICA Survey Team

Table B3.1.3-1 Water Requirement Calculation: West Kano Irrigation Scheme (892ha, 200% crop intensity)

Condition: Planting period-2months, Qmax = 1.50m3/s

Crop: Paddy only		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1	Unit	31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc				1.10	1.10	1.15	0.95			1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	5.58	5.50	5.68	4.63	0.00	0.00	5.42	5.52	5.72	4.71
	mm/month	0.00	0.00	172.89	165.00	176.11	138.80	0.00	0.00	162.69	171.18	171.47	146.07
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment requirement	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	0.00	93.60	283.09	128.80	183.91	177.20	0.00	88.00	305.89	202.38	204.07	194.67
Irrigation water Need IN	mm/day	0.00	3.34	9.13	4.29	5.93	5.91	0.00	2.84	10.20	6.53	6.80	6.28
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	6.69	18.26	8.59	11.87	11.81	0.00	5.68	20.39	13.06	13.60	12.56
Unit water requirement	l/s/ha	0.00	0.77	2.11	0.99	1.37	1.37	0.00	0.66	2.36	1.51	1.57	1.45
Area	ha	0	297	297	297	297	297	0	361	361	361	361	361
Flow in Canal	m3/s	0.00	0.23	0.63	0.30	0.41	0.41	0.00	0.24	0.85	0.55	0.57	0.52
PADDY Area2		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		0.95			1.10	1.10	1.15	0.95			1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.73	0.00	0.00	5.50	5.43	5.60	4.60	0.00	0.00	5.52	5.47	5.70
	mm/month	146.66	0.00	0.00	165.00	168.45	168.02	142.54	0.00	0.00	171.18	164.01	176.82
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment requirement	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	177.06	0.00	70.20	228.80	176.25	206.42	186.54	0.00	103.20	302.38	196.61	225.42
Irrigation water Need IN	mm/day	5.71	0.00	2.26	7.63	5.69	6.88	6.02	0.00	3.44	9.75	6.55	7.27
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	11.42	0.00	4.53	15.25	11.37	13.76	12.03	0.00	6.88	19.51	13.11	14.54
Unit water requirement	l/s/ha	1.32	0.00	0.52	1.77	1.32	1.59	1.39	0.00	0.80	2.26	1.52	1.68
Area	ha	361	0	297	297	297	297	297	0	361	361	361	361
Flow in Canal	m3/s	0.48	0.00	0.16	0.52	0.39	0.47	0.41	0.00	0.29	0.82	0.55	0.61
PADDY Area3		31	28	31	30	31	30	31	31	30	31	30	31
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		1.15	0.95			1.10	1.10	1.15	0.95			1.10	1.10
Crop water need (Eto*Kc)	mm/day	5.73	4.77	0.00	0.00	5.43	5.36	5.57	4.64	0.00	0.00	5.47	5.46
	mm/month	177.54	133.53	0.00	0.00	168.45	160.71	172.55	143.72	0.00	0.00	164.01	169.14
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	150	0	0
Percolation	mm/month	90	90	0	0	90	90	90	90	0	0	90	90
WL establishment requirement	mm	0	0	0	0	100	0	0	0	0	0	100	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	207.94	167.13	0.00	23.80	276.25	199.11	216.55	171.72	0.00	91.20	296.61	217.74
Irrigation water Need IN	mm/day	6.71	5.97	0.00	0.79	8.91	6.64	6.99	5.54	0.00	2.94	9.89	7.02
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	13.42	11.94	0.00	1.59	17.82	13.27	13.97	11.08	0.00	5.88	19.77	14.05
Unit water requirement	l/s/ha	1.55	1.38	0.00	0.18	2.06	1.54	1.62	1.28	0.00	0.68	2.29	1.63
Area	ha	170	170	0	297	297	297	297	297	0	170	170	170
Flow in Canal	m3/s	0.26	0.23	0.00	0.05	0.61	0.46	0.48	0.38	0.00	0.12	0.39	0.28
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal Paddy only	m3/s	0.74	0.46	0.78	0.88	1.41	1.34	0.89	0.62	1.14	1.48	1.50	1.41
Total Area - Paddy	ha	531	467	595	892	892	892	595	658	722	892	892	892
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s												
Canal design discharge	m3/s	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

Source: JICA Survey Team

Table B3.1.4-1 Water Requirement Calculation: West Kano Irrigation Scheme (1,800ha, 141% crop intensity)

Condition: Planting period-4months, Qmax = 2.14m3/s only

Crop: Paddy only		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc				1.10	1.10	1.15	0.95			1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	5.58	5.50	5.68	4.63	0.00	0.00	5.42	5.52	5.72	4.71
	mm/month	0.00	0.00	172.89	165.00	176.11	138.80	0.00	0.00	162.69	171.18	171.47	146.07
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment requirement	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	0.00	93.60	283.09	128.80	183.91	177.20	0.00	88.00	305.89	202.38	204.07	194.67
Irrigation water Need IN	mm/day	0.00	3.34	9.13	4.29	5.93	5.91	0.00	2.84	10.20	6.53	6.80	6.28
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	6.69	18.26	8.59	11.87	11.81	0.00	5.68	20.39	13.06	13.60	12.56
Unit water requirement	l/s/ha	0.00	0.77	2.11	0.99	1.37	1.37	0.00	0.66	2.36	1.51	1.57	1.45
Area	ha	0	450	450	450	450	450	0	185	185	185	185	185
Flow in Canal	m3/s	0.00	0.35	0.95	0.45	0.62	0.62	0.00	0.12	0.44	0.28	0.29	0.27
PADDY Area2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		0.95			1.10	1.10	1.15	0.95			1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.73	0.00	0.00	5.50	5.43	5.60	4.60	0.00	0.00	5.52	5.47	5.70
	mm/month	146.66	0.00	0.00	165.00	168.45	168.02	142.54	0.00	0.00	171.18	164.01	176.82
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment requirement	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	177.06	0.00	70.20	228.80	176.25	206.42	186.54	0.00	103.20	302.38	196.61	225.42
Irrigation water Need IN	mm/day	5.71	0.00	2.26	7.63	5.69	6.88	6.02	0.00	3.44	9.75	6.55	7.27
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	11.42	0.00	4.53	15.25	11.37	13.76	12.03	0.00	6.88	19.51	13.11	14.54
Unit water requirement	l/s/ha	1.32	0.00	0.52	1.77	1.32	1.59	1.39	0.00	0.80	2.26	1.52	1.68
Area	ha	185	0	450	450	450	450	450	0	185	185	185	185
Flow in Canal	m3/s	0.24	0.00	0.24	0.79	0.59	0.72	0.63	0.00	0.15	0.42	0.28	0.31
PADDY Area3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		1.15	0.95			1.10	1.10	1.15	0.95			1.10	1.10
Crop water need (Eto*Kc)	mm/day	5.73	4.77	0.00	0.00	5.43	5.36	5.57	4.64	0.00	0.00	5.47	5.46
	mm/month	177.54	133.53	0.00	0.00	168.45	160.71	172.55	143.72	0.00	0.00	164.01	169.14
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	150	0	0
Percolation	mm/month	90	90	0	0	90	90	90	90	0	0	90	90
WL establishment requirement	mm	0	0	0	0	100	0	0	0	0	0	100	0
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	207.94	167.13	0.00	23.80	276.25	199.11	216.55	171.72	0.00	91.20	296.61	217.74
Irrigation water Need IN	mm/day	6.71	5.97	0.00	0.79	8.91	6.64	6.99	5.54	0.00	2.94	9.89	7.02
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	13.42	11.94	0.00	1.59	17.82	13.27	13.97	11.08	0.00	5.88	19.77	14.05
Unit water requirement	l/s/ha	1.55	1.38	0.00	0.18	2.06	1.54	1.62	1.28	0.00	0.68	2.29	1.63
Area	ha	185	185	0	450	450	450	450	450	0	185	185	185
Flow in Canal	m3/s	0.29	0.25	0.00	0.08	0.93	0.69	0.73	0.58	0.00	0.13	0.42	0.30
PADDY Area4		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		4.98	5.02	5.07	5.00	4.94	4.87	4.84	4.88	4.93	5.02	4.97	4.96
Kc		1.10	1.15	0.95			1.10	1.10	1.15	0.95			1.10
Crop water need (Eto*Kc)	mm/day	5.48	5.77	4.82	0.00	0.00	5.36	5.32	5.61	4.68	0.00	0.00	5.46
	mm/month	169.82	161.64	149.31	0.00	0.00	160.71	165.04	173.97	140.51	0.00	0.00	169.14
SAT (land preparation)	mm	0	0	0	0	150	0	0	0	0	0	150	0
Percolation	mm/month	90	90	90	0	0	90	90	90	90	0	0	90
WL establishment requirement	mm	0	0	0	0	0	100	0	0	0	0	0	100
Rainfall	mm/month	87.0	83.0	131.0	189.0	134.0	77.0	70.0	90.0	71.0	86.0	103.0	83.0
Effective Rain	mm/month	59.6	56.4	79.8	126.2	82.2	51.6	46	62	46.8	58.8	57.4	41.4
Irrigation water Need IN	mm/month	200.22	195.24	159.51	0.00	67.80	299.11	209.04	201.97	183.71	0.00	92.60	317.74
Irrigation water Need IN	mm/day	6.46	6.97	5.15	0.00	2.19	9.97	6.74	6.52	6.12	0.00	3.09	10.25
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	12.92	13.95	10.29	0.00	4.37	19.94	13.49	13.03	12.25	0.00	6.17	20.50
Unit water requirement	l/s/ha	1.50	1.61	1.19	0.00	0.51	2.31	1.56	1.51	1.42	0.00	0.71	2.37
Area	ha	185	185	185	0	450	450	450	450	450	0	185	185
Flow in Canal	m3/s	0.28	0.30	0.22	0.00	0.23	1.04	0.70	0.68	0.64	0.00	0.13	0.44
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal	m3/s	0.53	0.60	1.19	1.32	2.14	2.02	1.35	0.70	0.58	0.82	0.99	0.88
Total Area	ha	554	819	1,085	1,350	1,800	1,800	1,350	1,085	819	554	738	738
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	1.99	1.02	1.26	4.81	6.21	2.50	2.79	4.18	3.19	1.07	1.00	0.98
Actual canal discharge	m3/s	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80

Source: JICA Survey Team

Table B3.1.5-1 Water Requirement Calculation: Lower Kuja Irrigation Scheme (200% crop intensity)

Condition: Planting period-1&3months, Qmax = 7.41m3/s only (Pattern 1)

Crop: Paddy & Vegetables		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.00	0.00	1.10	1.10	1.15	0.95			1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	6.26	5.40	5.24	4.21						
	mm/month	0.00	0.00	194.03	162.03	162.56	126.26						
SAT (land preparation)	mm	0	150	0	0	0	0		150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90			90	90	90	90
WL establishment requirement	mm	0	0	100	0	0	0			100	100	0	0
Rainfall	mm/month	47.5	63.7	110.0	160.0	126.6	40.2	26.9	30.9	38.7	64.7	107.7	75.8
Effective Rain	mm/month	18.5	28.2	63.5	103.5	76.3	14.1	6.1	8.5	13.2	28.8	61.2	35.6
Irrigation water Need IN	mm/month	0.00	121.78	320.55	148.55	176.28	202.14	0.00	141.46	176.78	161.18	28.84	54.36
Irrigation water Need IN	mm/day	0.00	4.35	10.34	4.95	5.69	6.74	0.00	4.56	5.89	5.20	0.96	1.75
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	0.00	8.70	20.68	9.90	11.37	13.48	0.00	9.13	11.79	10.40	1.92	3.51
Unit water requirement	l/s/ha	0.00	1.01	2.39	1.15	1.32	1.56	0.00	1.06	1.36	1.20	0.22	0.41
Area	ha	0	2,375	2,375	2,375	2,375	2,375	0	2,375	2,375	2,375	2,375	2,375
Flow in Canal	m3/s	0.00	2.39	5.68	2.72	3.13	3.70	0.00	2.51	3.24	2.86	0.53	0.96
PADDY TOTAL													
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal Paddy only	m3/s	0.00	2.39	5.68	2.72	3.13	3.70	0.00	2.51	3.24	2.86	0.53	0.96
Total Area for Paddy	ha	0	2,375	2,375	2,375	2,375	2,375	0	2,375	2,375	2,375	2,375	2,375

		0.45	0.75	1.15	0.80	<=Kc (vege.)							
Vegetable Area1		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto	mm/day	5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.80	0.00	0.00	0.45	0.75	1.15	0.80	0.00	0.00	0.45	0.75	1.15
Crop water need (Eto*Kc)	mm/day	4.07	0.00	0.00	2.21	3.42	5.09	3.69	0.00	0.00	2.47	3.68	5.60
	mm/month	126.23	0.00	0.00	66.29	106.02	152.84	114.33	0.00	0.00	76.59	110.48	173.62
Rainfall	mm/month	47.5	63.7	110.0	160.0	126.6	40.2	26.9	30.9	38.7	64.7	107.7	75.8
Effective Rain	mm/month	18.5	28.2	63.5	103.5	76.3	14.1	6.1	8.5	13.2	28.8	61.2	35.6
Irrigation water Need IN	mm/month	107.73	0.00	0.00	0.00	29.74	138.72	108.19	0.00	0.00	47.77	49.32	137.98
Irrigation water Need IN	mm/day	3.48	0.00	0.00	0.00	0.96	4.62	3.49	0.00	0.00	1.54	1.64	4.45
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	6.95	0.00	0.00	0.00	1.92	9.25	6.98	0.00	0.00	3.08	3.29	8.90
Unit water requirement	l/s/ha	0.80	0.00	0.00	0.00	0.22	1.07	0.81	0.00	0.00	0.36	0.38	1.03
Area	ha	1,781	0	0	1,781	1,781	1,781	1,781	0	0	1,781	1,781	1,781
Flow in Canal	m3/s	1.43	0.00	0.00	0.00	0.40	1.91	1.44	0.00	0.00	0.64	0.68	1.83
Vegetable Area2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto	mm/day	5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		1.15	0.80	0.00	0.00	0.45	0.75	1.15	0.80	0.00	0.00	0.45	0.75
Crop water need (Eto*Kc)	mm/day	5.85	4.35	0.00	0.00	2.05	3.32	5.30	3.87	0.00	0.00	2.21	3.65
	mm/month	181.46	121.86	0.00	0.00	63.61	99.68	164.35	120.03	0.00	0.00	66.29	113.23
Rainfall	mm/month	47.5	63.7	110.0	160.0	126.6	40.2	26.9	30.9	38.7	64.7	107.7	75.8
Effective Rain	mm/month	18.5	28.2	63.5	103.5	76.3	14.1	6.1	8.5	13.2	28.8	61.2	35.6
Irrigation water Need IN	mm/month	162.96	93.64	0.00	0.00	0.00	85.56	158.21	111.49	0.00	0.00	5.13	77.59
Irrigation water Need IN	mm/day	5.26	3.34	0.00	0.00	0.00	2.85	5.10	3.60	0.00	0.00	0.17	2.50
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	10.51	6.69	0.00	0.00	0.00	5.70	10.21	7.19	0.00	0.00	0.34	5.01
Unit water requirement	l/s/ha	1.22	0.77	0.00	0.00	0.00	0.66	1.18	0.83	0.00	0.00	0.04	0.58
Area	ha	1,781	1,781	0	0	1,781	1,781	1,781	1,781	0	0	1,781	1,781
Flow in Canal	m3/s	2.17	1.38	0.00	0.00	0.00	1.18	2.10	1.48	0.00	0.00	0.07	1.03
Vegetable Area3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto	mm/day	5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.75	1.15	0.80	0.00	0.00	0.45	0.75	1.15	0.80	0.00	0.00	0.45
Crop water need (Eto*Kc)	mm/day	3.82	6.26	4.55	0.00	0.00	1.99	3.46	5.57	4.15	0.00	0.00	2.19
	mm/month	118.34	175.17	141.11	0.00	0.00	59.81	107.18	172.55	124.56	0.00	0.00	67.94
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	99.84	146.95	77.63	0.00	0.00	45.69	101.04	164.01	111.34	0.00	0.00	32.30
Irrigation water Need IN	mm/day	3.22	5.25	2.50	0.00	0.00	1.52	3.26	5.29	3.71	0.00	0.00	1.04
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	6.44	10.50	5.01	0.00	0.00	3.05	6.52	10.58	7.42	0.00	0.00	2.08
Unit water requirement	l/s/ha	0.75	1.21	0.58	0.00	0.00	0.35	0.75	1.22	0.86	0.00	0.00	0.24
Area	ha	1,781	1,781	1,781	0	0	1,781	1,781	1,781	1,781	0	0	1,781
Flow in Canal	l/s	1,328	2,163	1,032	0	0	628	1,344	2,181	1,530	0	0	429
Flow in Canal	m3/s	1.33	2.16	1.03	0.00	0.00	0.63	1.34	2.18	1.53	0.00	0.00	0.43
Total		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Required Flow in Canal	m3/s	4.93	5.93	6.72	2.72	3.52	7.41	4.89	6.17	4.77	3.49	1.28	4.26
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Canal design discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	ha	0	2,375	2,375	2,375	2,375	2,375	0	2,375	2,375	2,375	2,375	2,375
Area-Vege	ha	5,342	3,561	1,781	1,781	3,561	5,342	5,342	3,561	1,781	1,781	3,561	5,342
Area-Total	ha	5,342	5,936	4,156	4,156	5,936	7,717	5,342	5,936	4,156	4,156	5,936	7,717

Source: JICA Survey Team

Table B3.1.5-2 Water Requirement Calculation: Lower Kuja Irrigation Scheme (paddy200%+vege110% crop intensity)

Condition: Planting period-3&1months, Qmax = 8.55m3/s (Pattern 2-1)

Crop: Paddy & Vegetables		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	6.26	5.40	5.24	4.21	0.00	0.00	5.71	6.04	5.65	4.63
	mm/month	0.00	0.00	194.03	162.03	162.56	126.26	0.00	0.00	171.27	187.21	169.40	143.42
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment req.	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	0.00	121.78	320.55	148.55	176.28	202.14	0.00	141.46	348.05	248.39	198.24	197.78
Irrigation water Need IN	mm/day	0.00	4.35	10.34	4.95	5.69	6.74	0.00	4.56	11.60	8.01	6.61	6.38
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	0.00	8.70	20.68	9.90	11.37	13.48	0.00	9.13	23.20	16.03	13.22	12.76
Unit water requirement	l/s/ha	0.00	1.01	2.39	1.15	1.32	1.56	0.00	1.06	2.69	1.85	1.53	1.48
Area	ha	0	1,557	1,557	1,557	1,557	1,557	0	1,557	1,557	1,557	1,557	1,557
Flow in Canal	m3/s	0.00	1.57	3.73	1.78	2.05	2.43	0.00	1.64	4.18	2.89	2.38	2.30
PADDY Area2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.84	0.00	0.00	5.40	5.02	5.09	4.38	0.00	0.00	6.04	5.40	5.60
	mm/month	149.90	0.00	0.00	162.03	155.50	152.84	135.76	0.00	0.00	187.21	162.03	173.62
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment req.	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	221.40	0.00	86.52	248.55	169.22	228.72	219.62	0.00	136.78	348.39	190.87	227.98
Irrigation water Need IN	mm/day	7.14	0.00	2.79	8.29	5.46	7.62	7.08	0.00	4.56	11.24	6.36	7.35
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	14.28	0.00	5.58	16.57	10.92	15.25	14.17	0.00	9.12	22.48	12.72	14.71
Unit water requirement	l/s/ha	1.65	0.00	0.65	1.92	1.26	1.76	1.64	0.00	1.06	2.60	1.47	1.70
Area	ha	1,557	0	1,557	1,557	1,557	1,557	1,557	0	1,557	1,557	1,557	1,557
Flow in Canal	m3/s	2.57	0.00	1.01	2.99	1.97	2.75	2.55	0.00	1.64	4.05	2.29	2.65
PADDY Area3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10
Crop water need (Eto*Kc)	mm/day	5.85	5.17	0.00	0.00	5.02	4.87	5.30	4.60	0.00	0.00	5.40	5.36
	mm/month	181.46	144.70	0.00	0.00	155.50	146.19	164.35	142.54	0.00	0.00	162.03	166.07
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	150	0	0
Percolation	mm/month	90	90	0	0	90	90	90	90	0	0	90	90
WL establishment req.	mm	0	0	0	0	100	0	0	0	0	0	100	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	252.96	206.48	0.00	46.52	269.22	222.07	248.21	224.00	0.00	121.18	290.87	220.43
Irrigation water Need IN	mm/day	8.16	7.37	0.00	1.55	8.68	7.40	8.01	7.23	0.00	3.91	9.70	7.11
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	16.32	14.75	0.00	3.10	17.37	14.80	16.01	14.45	0.00	7.82	19.39	14.22
Unit water requirement	l/s/ha	1.89	1.71	0.00	0.36	2.01	1.71	1.85	1.67	0.00	0.90	2.24	1.65
Area	ha	1,557	1,557	0	1,557	1,557	1,557	1,557	1,557	0	1,557	1,557	1,557
Flow in Canal	m3/s	2.94	2.66	0.00	0.56	3.13	2.67	2.89	2.60	0.00	1.41	3.49	2.56
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal-paddy	m3/s	5.51	4.22	4.73	5.33	7.15	7.84	5.44	4.25	5.82	8.35	8.17	7.51
	rank	7	12	10	9	5	3	8	11	6	1	2	4
Total Area for Paddy	ha	3,113	3,113	3,113	4,670	4,670	4,670	3,113	3,113	3,113	4,670	4,670	4,670
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Canal design discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
		0.45	0.75	1.15	0.80	<=Kc (vege.)							
Vegetables		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto	mm/day	5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.00	0.45	0.75	1.15	0.80	0.00	0.00	0.45	0.75	1.15	0.80	0.00
Crop water need (Eto*Kc)	mm/day	0.00	2.45	4.27	5.65	3.65	0.00	0.00	2.18	3.89	6.31	3.93	0.00
	mm/month	0.00	68.54	132.29	169.40	113.09	0.00	0.00	67.52	116.78	195.72	117.84	0.00
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	0.00	40.32	68.81	65.92	36.81	0.00	0.00	58.98	103.56	166.90	56.68	0.00
Irrigation water Need IN	mm/day	0.00	1.44	2.22	2.20	1.19	0.00	0.00	1.90	3.45	5.38	1.89	0.00
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	0.00	2.88	4.44	4.39	2.37	0.00	0.00	3.81	6.90	10.77	3.78	0.00
Flow (unit water req)	l/s/ha	0.00	0.33	0.51	0.51	0.27	0.00	0.00	0.44	0.80	1.25	0.44	0.00
Area	ha	0	3,047	3,047	3,047	3,047	0	0	164	164	164	164	164
Flow in Canal	m3/s	0.00	1.02	1.57	1.55	0.84	0.00	0.00	0.07	0.13	0.20	0.07	0.00
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal for Paddy	m3/s	5.51	5.24	6.30	6.88	7.98	7.84	5.44	4.32	5.95	8.55	8.24	7.51
Mean river flow	m3/s	16.10	13.80	26.50	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Canal design discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	ha	3,113	3,113	3,113	4,670	4,670	4,670	3,113	3,113	3,113	4,670	4,670	4,670
Area-Vege	ha	0	3,047	3,047	3,047	3,047	0	0	164	164	164	164	164
Area-Total	ha	3,113	6,160	6,160	7,717	7,717	4,670	3,113	3,277	3,277	4,834	4,834	4,834

Source: JICA Survey Team

Table B3.1.5-3 Water Requirement Calculation: Lower Kuja Irrigation Scheme (180% crop intensity)

Condition: Planting period-3&1months, Qmax = 8.55m3/s (Pattern 2-2)

Crop: Paddy & Vegetables		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	6.26	5.40	5.24	4.21	0.00	0.00	5.71	6.04	5.65	4.63
	mm/month	0.00	0.00	194.03	162.03	162.56	126.26	0.00	0.00	171.27	187.21	169.40	143.42
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment req.	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	0.00	121.78	320.55	148.55	176.28	202.14	0.00	141.46	348.05	248.39	198.24	197.78
Irrigation water Need IN	mm/day	0.00	4.35	10.34	4.95	5.69	6.74	0.00	4.56	11.60	8.01	6.61	6.38
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	0.00	8.70	20.68	9.90	11.37	13.48	0.00	9.13	23.20	16.03	13.22	12.76
Unit water requirement	l/s/ha	0.00	1.01	2.39	1.15	1.32	1.56	0.00	1.06	2.69	1.85	1.53	1.48
Area	ha	0	1,557	1,557	1,557	1,557	1,557	0	1,242	1,242	1,242	1,242	1,242
Flow in Canal	l/s	0	1,567	3,726	1,784	2,049	2,428	0	1,312	3,337	2,304	1,900	1,835
Flow in Canal	m3/s	0.00	1.57	3.73	1.78	2.05	2.43	0.00	1.31	3.34	2.30	1.90	1.83
PADDY Area2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.84	0.00	0.00	5.40	5.02	5.09	4.38	0.00	0.00	6.04	5.40	5.60
	mm/month	149.90	0.00	0.00	162.03	155.50	152.84	135.76	0.00	0.00	187.21	162.03	173.62
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment req.	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	221.40	0.00	86.52	248.55	169.22	228.72	219.62	0.00	136.78	348.39	190.87	227.98
Irrigation water Need IN	mm/day	7.14	0.00	2.79	8.29	5.46	7.62	7.08	0.00	4.56	11.24	6.36	7.35
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	14.28	0.00	5.58	16.57	10.92	15.25	14.17	0.00	9.12	22.48	12.72	14.71
Unit water requirement	l/s/ha	1.65	0.00	0.65	1.92	1.26	1.76	1.64	0.00	1.06	2.60	1.47	1.70
Area	ha	1,557	0	1,557	1,557	1,557	1,557	1,557	0	1,242	1,242	1,242	1,242
Flow in Canal	m3/s	2.57	0.00	1.01	2.99	1.97	2.75	2.55	0.00	1.31	3.23	1.83	2.12
PADDY Area3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10
Crop water need (Eto*Kc)	mm/day	5.85	5.17	0.00	0.00	5.02	4.87	5.30	4.60	0.00	0.00	5.40	5.36
	mm/month	181.46	144.70	0.00	0.00	155.50	146.19	164.35	142.54	0.00	0.00	162.03	166.07
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	150	0	0
Percolation	mm/month	90	90	0	0	90	90	90	90	0	0	90	90
WL establishment req.	mm	0	0	0	0	100	0	0	0	0	0	100	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	252.96	206.48	0.00	46.52	269.22	222.07	248.21	224.00	0.00	121.18	290.87	220.43
Irrigation water Need IN	mm/day	8.16	7.37	0.00	1.55	8.68	7.40	8.01	7.23	0.00	3.91	9.70	7.11
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	16.32	14.75	0.00	3.10	17.37	14.80	16.01	14.45	0.00	7.82	19.39	14.22
Unit water requirement	l/s/ha	1.89	1.71	0.00	0.36	2.01	1.71	1.85	1.67	0.00	0.90	2.24	1.65
Area	ha	1,242	1,242	0	1,557	1,557	1,557	1,557	1,557	0	1,242	1,242	1,242
Flow in Canal	m3/s	2.35	2.12	0.00	0.56	3.13	2.67	2.89	2.60	0.00	1.12	2.79	2.05
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal-paddy	m3/s	4.92	3.69	4.73	5.33	7.15	7.84	5.44	3.92	4.65	6.66	6.52	6.00
	rank	8	12	9	7	2	1	6	11	10	3	4	5
Total Area for Paddy	ha	2,799	2,799	3,113	4,670	4,670	4,670	3,113	2,799	2,485	3,727	3,727	3,727
Mean river flow	m3/s	16.1	13.8	26.5	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Canal design discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55

		0.45	0.75	1.15	0.80	<=Kc (vege.)							
Vegetables		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto	mm/day	5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.00	0.45	0.75	1.15	0.80	0.00	0.00	0.00	0.45	0.75	1.15	0.80
Crop water need (Eto*Kc)	mm/day	0.00	2.45	4.27	5.65	3.65	0.00	0.00	0.00	2.34	4.12	5.65	3.90
	mm/month	0.00	68.54	132.29	169.40	113.09	0.00	0.00	0.00	70.07	127.64	169.40	120.78
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	0.00	40.32	68.81	65.92	36.81	0.00	0.00	0.00	56.85	98.82	108.24	85.14
Irrigation water Need IN	mm/day	0.00	1.44	2.22	2.20	1.19	0.00	0.00	0.00	1.89	3.19	3.61	2.75
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr Water Req	mm/day	0.00	2.88	4.44	4.39	2.37	0.00	0.00	0.00	3.79	6.38	7.22	5.49
Flow (unit water req)	l/s/ha	0.00	0.33	0.51	0.51	0.27	0.00	0.00	0.00	0.44	0.74	0.84	0.64
Area	ha	0	3,047	3,047	3,047	3,047	0	0	0	2,432	2,432	2,432	2,432
Flow in Canal-vege	m3/s	0.00	1.02	1.57	1.55	0.84	0.00	0.00	0.00	1.07	1.79	2.03	1.55
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal	m3/s	4.92	4.70	6.30	6.88	7.98	7.84	5.44	3.92	5.71	8.46	8.55	7.54
Mean river flow	m3/s	16.10	13.80	26.50	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Canal design discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55
Area-Paddy	Area-paddy	2,799	2,799	3,113	4,670	4,670	4,670	3,113	2,799	2,485	3,727	3,727	3,727
Area-Vege	Area-Vege	0	3,047	3,047	3,047	3,047	0	0	0	2,432	2,432	2,432	2,432
Area-Total	Area-Total	2,799	5,846	6,160	7,717	7,717	4,670	3,113	2,799	4,917	6,159	6,159	6,159

Source: JICA Survey Team

Table B3.1.5-4 Water Requirement Calculation: Lower Kuja Irrigation Scheme (177% crop intensity)

Condition: Planting period-3&1months, Qmax = 8.55m3/s (Pattern 3)

Crop: Paddy only		1.10	1.10	1.15	0.95	<= Kc (paddy)							
PADDY Area1	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95
Crop water need (Eto*Kc)	mm/day	0.00	0.00	6.26	5.40	5.24	4.21	0.00	0.00	5.71	6.04	5.65	4.63
	mm/month	0.00	0.00	194.03	162.03	162.56	126.26	0.00	0.00	171.27	187.21	169.40	143.42
SAT (land preparation)	mm	0	150	0	0	0	0	0	150	0	0	0	0
Percolation	mm/month	0	0	90	90	90	90	0	0	90	90	90	90
WL establishment req.	mm	0	0	100	0	0	0	0	0	100	0	0	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	0.00	121.78	320.55	148.55	176.28	202.14	0.00	141.46	348.05	248.39	198.24	197.78
Irrigation water Need IN	mm/day	0.00	4.35	10.34	4.95	5.69	6.74	0.00	4.56	11.60	8.01	6.61	6.38
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	0.00	8.70	20.68	9.90	11.37	13.48	0.00	9.13	23.20	16.03	13.22	12.76
Unit water requirement	l/s/ha	0.00	1.01	2.39	1.15	1.32	1.56	0.00	1.06	2.69	1.85	1.53	1.48
Area	ha	0	1,929	1,929	1,929	1,929	1,929	0	1,486	1,486	1,486	1,486	1,486
Flow in Canal	m3/s	0.00	1.94	4.62	2.21	2.54	3.01	0.00	1.57	3.99	2.76	2.27	2.19
PADDY Area2		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15
Crop water need (Eto*Kc)	mm/day	4.84	0.00	0.00	5.40	5.02	5.09	4.38	0.00	0.00	6.04	5.40	5.60
	mm/month	149.90	0.00	0.00	162.03	155.50	152.84	135.76	0.00	0.00	187.21	162.03	173.62
SAT (land preparation)	mm	0	0	150	0	0	0	0	0	150	0	0	0
Percolation	mm/month	90	0	0	90	90	90	90	0	0	90	90	90
WL establishment req.	mm	0	0	0	100	0	0	0	0	0	100	0	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	221.40	0.00	86.52	248.55	169.22	228.72	219.62	0.00	136.78	348.39	190.87	227.98
Irrigation water Need IN	mm/day	7.14	0.00	2.79	8.29	5.46	7.62	7.08	0.00	4.56	11.24	6.36	7.35
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	14.28	0.00	5.58	16.57	10.92	15.25	14.17	0.00	9.12	22.48	12.72	14.71
Unit water requirement	l/s/ha	1.65	0.00	0.65	1.92	1.26	1.76	1.64	0.00	1.06	2.60	1.47	1.70
Area	ha	1,486	0	1,267	1,267	1,267	1,267	1,267	0	975	975	975	975
Flow in Canal	m3/s	2.46	0.00	0.82	2.43	1.60	2.24	2.08	0.00	1.03	2.54	1.44	1.66
PADDY Area3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10	1.10
Crop water need (Eto*Kc)	mm/day	5.85	5.17	0.00	0.00	5.02	4.87	5.30	4.60	0.00	0.00	5.40	5.36
	mm/month	181.46	144.70	0.00	0.00	155.50	146.19	164.35	142.54	0.00	0.00	162.03	166.07
SAT (land preparation)	mm	0	0	0	150	0	0	0	0	0	150	0	0
Percolation	mm/month	90	90	0	0	90	90	90	90	0	0	90	90
WL establishment req.	mm	0	0	0	0	100	0	0	0	0	0	100	0
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	252.96	206.48	0.00	46.52	269.22	222.07	248.21	224.00	0.00	121.18	290.87	220.43
Irrigation water Need IN	mm/day	8.16	7.37	0.00	1.55	8.68	7.40	8.01	7.23	0.00	3.91	9.70	7.11
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	16.32	14.75	0.00	3.10	17.37	14.80	16.01	14.45	0.00	7.82	19.39	14.22
Unit water requirement	l/s/ha	1.89	1.71	0.00	0.36	2.01	1.71	1.85	1.67	0.00	0.90	2.24	1.65
Area	ha	1,486	1,486	0	1,929	1,929	1,929	1,929	1,929	0	1,486	1,486	1,486
Flow in Canal	m3/s	2.81	2.54	0.00	0.69	3.88	3.31	3.58	3.23	0.00	1.34	3.33	2.45
PADDY Area4		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto		5.09	5.44	5.69	4.91	4.56	4.43	4.61	4.84	5.19	5.49	4.91	4.87
Kc		1.10	1.15	0.95	0.00	0.00	1.10	1.10	1.15	0.95	0.00	0.00	1.10
Crop water need (Eto*Kc)	mm/day	5.60	6.26	5.41	0.00	0.00	4.87	5.07	5.57	4.93	0.00	0.00	5.36
	mm/month	173.57	175.17	167.57	0.00	0.00	146.19	157.20	172.55	147.92	0.00	0.00	166.07
SAT (land preparation)	mm	0	0	0	0	150	0	0	0	0	0	150	0
Percolation	mm/month	90	90	90	0	0	90	90	90	90	0	0	90
WL establishment req.	mm	0	0	0	0	0	100	0	0	0	0	0	100
Rainfall	mm/month	47.5	63.7	110	160.00	126.60	40.20	26.90	30.90	38.70	64.70	107.70	75.8
Effective Rain	mm/month	18.5	28.22	63.48	103.48	76.28	14.12	6.14	8.54	13.22	28.82	61.16	35.64
Irrigation water Need IN	mm/month	245.07	236.95	194.09	0.00	73.72	322.07	241.06	254.01	224.70	0.00	88.84	320.43
Irrigation water Need IN	mm/day	7.91	8.46	6.26	0.00	2.38	10.74	7.78	8.19	7.49	0.00	2.96	10.34
Overall scheme effciency		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Gross Irr water req	mm/day	15.81	16.92	12.52	0.00	4.76	21.47	15.55	16.39	14.98	0.00	5.92	20.67
Unit water requirement	l/s/ha	1.83	1.96	1.45	0.00	0.55	2.49	1.80	1.90	1.73	0.00	0.69	2.39
Area	ha	1,996	1,996	1,996	0	2,592	2,592	2,592	2,592	2,592	0	1,996	1,996
Flow in Canal	m3/s	3.65	3.91	2.89	0.00	1.43	6.44	4.67	4.92	4.49	0.00	1.37	4.78
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Flow in Canal	m3/s	5.26	4.48	5.44	5.33	8.02	8.55	5.65	4.80	5.02	6.64	7.04	6.30
Total Area	ha	4,967	5,411	5,192	5,125	7,717	7,717	5,788	6,007	5,053	3,946	5,942	5,942
Mean river flow	m3/s	16.10	13.80	26.50	67.50	107.20	47.30	22.59	17.22	39.60	26.83	45.25	45.25
River flow Q80	m3/s	5.40	4.50	5.60	17.80	58.00	24.10	10.10	8.10	9.20	10.80	10.53	7.80
Canal design discharge	m3/s	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55	8.55

Source: JICA Survey Team

Table B6.1.1-1 Construction Cost and Analysis (Ahero Irrigation Scheme)

Category	Components	No.				Initial Cost (10^9 Ksh)	Selection A1	A2	A3	A4	A5
I-1. Intake by Pump	Rehabilitation of pump system	1	Rehabilitation	Simple replacement. Low initial cost. High operation cost (17 million Ksh in 2018).	Q=1.1 m3/s; 2 nos. Q=0.66 m3/s; 2 nos.	0.10	○				
	Rehabilitation/upgrading of pump system with new technology (e.g. solar system)	2	Upgrading	Upgrading with solar system. High initial cost, low operation cost (Estimation: 5.7 million Ksh/ year, 33% of normal pump).	Q=1.1 m3/s; 2 nos. Q=0.66 m3/s; 2 nos. Solar system; 1 set	0.14		○			○
I-2. Intake by Gravity	Introduction of the gravity system without dam (no expansion = Ahero 867ha)	3	New construction	Conveyance of irrigation water for Ahero (867ha) by new canal (10 km) from new intake	Intake: H=5.5m, L=58.5m Canal: Q=6.6m3/s, L=10 km	0.99				○	
	Introduction of the gravity system with Koru dam up to (Extension: 3,360 ha, including existing Ahero (867ha) and West Kano (892ha) : 5,119 ha in total)	4	New construction	Conveyance of irrigation water for Ahero (867ha), West Kano (892ha), Extesion area (3,414ha) in total 5,173ha by new canal (10 km) from new intake	Dam: V=71.7 MCM Intake: H=5.5m, L=58.5m Canal: Q=6.6m3/s, L=10 km	21.36			○		
I-3 .Canals	Rehabilitation of existing canal system (no expansion: 867ha)	5	Rehabilitation	Simple rehabilitation for Ahero (867ha)	Main canal: Q=1.8m3/s, L=9.7km Secondary canal: L=85.4km Tertiary drain: L=93.5km Farm road: L=70km	0.71	○	○	○	○	○
	Rehabilitation of existing canal system (expansion: 451ha)	6	New construction	New development of irrigation area (451ha) as the most optimum water use.	Main canal: Q=1.8m3/s, L=0.8km Secondary canal: L=8.4km Tertiary canal: L=9.1km Secondary drain: L=6.5km Tertiary drain: L=9.3km	0.13					○
	Introduction of new canal system in expansion area and W.Kano(3,360+892 ha)	7	New construction	New development of irrigation area (4,306ha=Extension; 3,414ha+West Kano;892ha)	Main canal: Q=3.2m3/s, L=7.8km Secondary canal: L=83.9km Tertiary canal: L=90.6km Secondary drain: L=65.2km Tertiary drain: L=93.3km	1.20			○		
I-4. Flood Dyke	Improvement of flood protection dyke	8	Upgrading, New construction	Prevention of flood damage. New construction of upper area. Upgrading of existing dyke along Nyado river.	Upper area: L=13.7km, H=2m, W=4.5m Nyando river: L=8.0km, H=3m, W=4.5m	0.42	○	○	○	○	○
	Cost & Benefit					Initial Cost (10^9 Ksh)	1.23	1.27	23.69	2.12	1.39
						OM const (10^9 Ksh)	0.98	0.83	7.11	0.64	0.80
						Cost Total (10^9 Ksh)	**2.21**	**2.10**	**30.79**	**2.76**	**2.19**
						Benefit Total (10^9 Ksh, dyke benefit is not included)	**2.18**	**2.18**	**21.64**	**2.18**	**4.46**
						B/C	**0.99**	**1.04**	**0.70**	**0.79**	**2.04**
						Rehabili & extention Area (ha)	867	867	5,173	867	1,318
						Beneficiries-Irrigation only (HH)	570	570	3,359	570	867
						Beneficiries-Irrigation only (10^3 preson) direct	20	2	12	2	3
						Beneficiries-Irrigation only (10^3 preson) Indirect	30	30	179	30	46
						Beneficiries- flood only (10^3 preson)	15	15	15	15	15
						Beneficiries total (10^3 preson)	65	47	206	47	64
	Evaluation 1:bad for formulation 5:good for formulation					Model potential	3	5	3	3	5
						Economic efficiency	2	3	3	1	4
						Technical soundness	3	3	1	3	3
						Sustainability	1	5	3	5	5
						Environmental aspect	3	3	1	3	3
							12	**19**	11	15	20

Source: JICA Survey Team

Table B6.1.2-1 Construction Cost and Analysis (West Kano Irrigation Scheme)

Category	Components	No.				Initial Cost (10^9 Ksh)	Selection B1	B2	B3	B4
I.-1 Intake by Pump	Rehabilitation of pump system (ordinary repair)	1	Rehabilitation	Simple replacement. Low initial cost. High operation cost (7.2 million Ksh in 2017).	Irrigation: Q=0.75 m3/s; 3 nos. Drain: Q=0.13 m3/s; 2 nos. Q=0.5 m3/s; 2 nos.	0.12	○	○		
	Rehabilitation/upgrading of pump system with new technology (e.g. solar system)	2	Upgrading	Upgrading with solar system. High initial cost, low operation cost (Estimation: 2,4 million Ksh/ year, 33% of normal pump).	Irrigation: Q=0.75 m3/s; 3 nos. Drain: Q=0.13 m3/s; 2 nos. Q=0.5 m3/s; 2 nos. Solar system; 1 set	0.17			○	○
I-2. Canals	Rehabilitation of canal system	3	Rehabilitation	Simple rehabilitation for West Kano (892ha)	Approach canal: L=2.2km Main canal: L=8.7km Tertiary canal: L=55.5km Main drain: L=9.1km Tertiary drain: L=102.5km Farm road: L=2km	0.49	○		○	
I-3. Flood Dyke	Improvement of flood protection dyke	4	Upgrading,	Prevention of flood damage from surrounding area and the Lake Victoria. Upgrading of existing dyke.	Upper area: L=15km H=2m, W=4.5m	0.22	○	○	○	○
	Cost & Benefit					Initial Cost (10^9 Ksh)	0.82	0.33	0.87	0.38
						OM const (10^9 Ksh)	0.95	0.81	0.70	0.55
						Cost Total (10^9 Ksh)	**1.77**	**1.14**	**1.57**	**0.94**
						Benefit Total (10^9 Ksh, dyke benefit is not included)	**2.25**	**1.80**	**2.25**	**1.80**
						B/C	**1.27**	**1.58**	**1.43**	**1.92**
						Rehabili & extention Area (ha)	892	892	892	892
						Beneficiries-Irrigation only (HH)	780	780	780	780
						Beneficiries-Irrigation only (10^3 preson) direct	2	2	2	2
						Beneficiries-Irrigation only (10^3 preson) Indirect	20	20	20	20
						Beneficiries- flood only (10^3 preson)	8	8	8	8
						Beneficiries total (persons)	30	30	30	30
	Evaluation 1:bad for formulation 5:good for formulation					Model potential	1	1	5	5
						Economic efficiency	1	2	2	3
						Technical soundness	3	3	3	3
						Sustainability	1	2	5	2
						Environmental aspect	5	5	5	5
							11	13	**20**	18

Source: JICA Survey Team

Table B6.1.3-1 Construction Cost and Analysis (Southwest Kano Irrigation Scheme)

Category	Components	No.				Initial Cost (10^9 Ksh)	Selection				
							C1	C2	C3	C4	C5
I-1. Intake by Gravity	Improvement of intake structure	1	Upgrading	Upgrading with structures (flush gate etc.) to prevent silting.	H=1.3m, L=44m	0.09	○	○	○	○	
I-2. Canals	Rehabilitation of canal system	2	Rehabilitation	Simple rehabilitation of existing irrigation and drain canals.	By pass canal: L=500m By pass canal (dredging): V=20,000m3 Main canal: H=2m, L=2.4km Tertiary canal: L=4km Main drain: L=13.4km Tertiary drain: L4km Farm road: L=40km	0.18	○		○		
I-3. Flood Dyke	Improvement of flood protection dyke	3	Upgrading	Prevention of flood damage from Nyando river. Upgrading of existing dyke of right bank.	Dyke: L=7km, H=3m, W=4.5m	0.19	○	○			○
Cost & Benefit						Initial Cost (10^9 Ksh)	0.46	0.28	0.27	0.09	0.19
						OM const (10^9 Ksh)	0.14	0.09	0.08	0.03	0.06
						Cost Total (10^9 Ksh)	**0.60**	**0.37**	**0.35**	**0.12**	**0.25**
						Benefit Total (10^9 Ksh, dyke benefit is not included)	**1.68**	**0.45**	**1.68**	**0.45**	**0.00**
						B/C	**2.78**	**1.23**	**4.78**	**3.88**	**0.00**
						Rehabili & extention Area (ha)	1,800	1,800	1,800	1,800	1,800
						Beneficiries-Irrigation only (HH)	3,900	3,900	3,900	3,900	3,900
						Beneficiries-Irrigation only (10^3 preson) direct	4	4	4	4	4
						Beneficiries-Irrigation only (10^3 preson) Indirect	40	40	40	40	40
						Beneficiries- flood only (10^3 preson)	7	7	0	0	7
						Beneficiries total (persons)	51	51	44	44	51
Evaluation 1:bad for formulation 5:good for formulation						Model potential	4	1	4	1	1
						Economic efficiency	3	3	3	3	1
						Technical soundness	5	5	5	5	5
						Sustainability	3	2	2	1	2
						Environmental aspect	5	5	5	5	5
							20	16	19	15	14

Source: JICA Survey Team

Table B6.1.4-1 Construction Cost and Analysis (Lower Kuja Irrigation Scheme)

Category	Components	No.				Initial Cost (10^9 Ksh)	Selection			
							D1	D2	D3	D4
I-1. Dam	Dam development	1	New construction	New dam at upper side of the Gogofalls dam. Implementation is not clear.	Dam height= 36m Total storage= 155Mm3	7.60	○			
I-2. Intake by Gravity	Rehabilitation of headworks	2	Rehabilitation	Rehabilitation of damaged weir.	H=4m, L=60m	0.13	○	○	○	○
I-3. Canal Plan 1-A (7,717 ha)	Rehabilitation of existing canal system (Block M: paddy+upland crop= 82 ha)	3	Rehabilitation	Rehabilitation of existing canal (Block M: paddy(60ha)+upland(22ha) =82ha).	Irrigation canal: L=13.2km Drainage canal: L= 6.3km	0.08		○		
Paddy 2,375 ha	New development of canal system up to 7,717ha (Cost: without Block M)	4	New construction	New development of canal system up to 7,717ha (without Block M)	Irrigation canal: L=519.1km Drainage canal: L=430.6km Access road: L=212km	3.88		○		
Upland crop 5,342 ha	Land consolidation (paddy+upland crop)	5	Rehabil & New construction	Land consolidation (paddy+ upland crop)	Rehabilitation: 82ha New (paddy): 2,315ha New (upland): 5,320ha	2.90		○		
I-4. Canal Plan 1-B (7,717 ha)	Rehabilitation of existing canal system (Block M: paddy+upland crop= 82 ha)	6	Rehabilitation	Rehabilitation of existing canal system (Block M: paddy+ upland crop=82ha).	Irrigation canal: L=13.2km Drainage canal: L= 6.3km	0.08			○	
Paddy 4,610 ha	New development of canal system up to 7,717ha (Cost: wiyhout Block M)	7	New construction	New development of canal system up to 7,717ha (without Block M)	Irrigation canal: L=519.1km Drainage canal: L=430.6km Access road: L=212km	3.88			○	
Upland crop 3,107 ha	Land consolidation (paddy+upland crop)	8	Rehabil & New construction	Land consolidation (paddy+ upland crop)	Rehabilitation: 82ha New (paddy): 4,610ha New (upland): 3,025ha	4.71			○	
I-5. Canal Plan 1-C (7,717 ha)	Rehabilitation of existing canal system (Block M: paddy=60 ha)	9	Rehabilitation	Rehabilitation of existing canal system (Block M: paddy+ upland crop=82ha).	Irrigation canal: L=13.2km Drainage canal: L= 6.3km	0.11				○
Paddy 7,717 ha	New development of canal system up to 7,717ha (Cost: without Block M)	10	New construction	New development of canal system up to 7,717ha (without Block M)	Irrigation canal: L=519.1km Drainage canal: L=430.6km Access road: L=212km	4.21				○
Upland crop 0 ha	Land consolidation (paddy)	11	Rehabil & New construction	Land consolidation (paddy+ upland crop)	Rehabilitation: 60ha New (paddy): 7,657ha	9.23				○
I-6. Canal Plan 2 (16,400 ha)	Rehabilitation of existing canal system (Block M: paddy+upland crop= 82 ha)	12	Rehabilitation	Rehabilitation of existing canal system (Block M: paddy+ upland crop=82ha).	Irrigation canal: L=13.2km Drainage canal: L= 6.3km	12.07	○			
Paddy 5,047 ha	New development of canal system up to 16,400ha (Cost: without Block M)		New construction	New development of canal system up to 16,400ha (without Block M)	Rehabilitation (paddy): 60ha Rehabilitation (upland): 22 ha		○			
Upland crop 11,353 ha	Land consolidation (paddy+upland crop)		Rehabil & New construction	Land consolidation (paddy+ upland crop)	New (paddy):4,987 ha New (upland): 11,331ha		○			
I-7. Flood Dyke	New development of flood dyke	13	New construction Upgrading,	Prevention of flood damage from Kuja-Migori river. New construction and upgrading of the Lake Victoria and existing dyke of both banks.	Kujya-Migori river; H=3m, W=4.5m, L=15km Lake Victoria: H=3m, W=4.5m, L=6km	0.68	○	○	○	○
	Cost & Benefit					Initial Cost (10^9 Ksh)	20.48	7.68	9.48	14.36
						OM const (10^9 Ksh)	6.14	2.30	2.85	4.31
						Cost Total (10^9 Ksh)	**26.63**	**9.98**	**12.33**	**18.67**
						Benefit Total (10^9 Ksh, dyke benefit is not included)	**56.56**	**26.49**	**33.33**	**42.27**
						B/C	**2.12**	**2.66**	**2.70**	**2.26**
						Rehabili & extention Area (ha)	16,500	7,717	7,717	7,717
						Beneficiries-Irrigation only (HH)	5,980	2,797	2,797	2,797
						Beneficiries- flood only (10^3 persons)	5	5	5	5
	Evaluation 1:bad for formulation 5:good for formulation					Model potential	4	2	3	3
						Economic efficiency	2	3	3	2
						Technical soundness	2	3	3	1
						Sustainability	3	3	3	3
						Environmental aspect	1	5	5	5
							12	16	**17**	14

Source: JICA Survey Team

Table B6.2.4-1 Project Cost for Soft Component : Consideration of Data Collection Survey on Irrigation Development Plan in the Lake Victoria (1/2)

(E) Agricultural Practice & Extension

Category	Components	Works/Remarks	Initial Cost (10^6 Ksh)	No.	Selection						
					E1	E2	E3	E4	E5	E6	E7
Extension	Capacity Development Project for Enhancement of Rice Production Techniques and Wide-range Extension in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	Target Group: Rice farmers in the Lake Victoria Basin Region (Note: Ahero, West Kano and South West Kano to be excluded because those areas are already covered by CaDPERP.) Outputs: 1) Capacity development of NIB officers for wide-range extension services to enhance rice productivity 2) Extension of rice production techniques in irrigation schemes in the Lake Victoria Basin Region including Lower Kuja Irrigation Scheme 3) Capacity development of AIRS and KALRO to solve rice farmers' issues especially in soil analysis and pest/disease control 4) Establishment of wide-range information sharing system on rice production techniques and rice market information covering the Lake Victoria Basin Region Inputs (Donor Side): 1. Expert dispatch (110MM)(Team leader/agricultural extension, rice production, irrigation water management, training management) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 2 cars Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 2 places	570	1	○	○	○				
	Capacity Development Project for Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	Target Group: Rice farmers in Lower Kuja Irrigation Scheme Outputs: 1) Capacity development of officers of NIB Kuja on extension services for rice production 2) Technology transfer of rice production techniques improved in Ahero and West Kano irrigation schemes to Lower Kuja irrigation scheme 3) Capacity development of officers of NIB Kuja and Migori county to solve farmers' issues on rice production Inputs (Donor Side): 1. Expert dispatch (70MM) (Team leader/agricultural extension, rice production, irrigation water management, training management) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 places	476	2				○	○		
	Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	Target group: Rice farmers in Lower Kuja Irrigation Scheme Output: 1) Capacity development of officers of NIB Kuja on agricultural extension services for rice production 2) Technology transfer of rice production techniques improved in Ahero and West Kano irrigation schemes to Lower Kuja irrigation scheme 3) Capacity development of officers of NIB Kuja and Migori county to solve farmers' issues on rice production Input: 1. Expert dispatch (35MM)(Agricultural extension) 2. Travel cost 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car 6. Participation of government officers to project activities 7. Travelling expenses of government officers 8. Office spaces: 2 places	274	3						○	○
Seed production	Capacity Development Project for Rice Seed Production and Wide-range Distribution in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	Target group: Rice farmers in the Lake Victoria Basin Region Outputs: 1) Capacity development of officers of NIB Ahero in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production 3) Installation of required equipment and machinery and establishment of distribution mechanism for certified seed in the Lake Victoria Basin Region Inputs (Donor Side): 1. Expert dispatch (80MM)(Team leader, seed production, agricultural extension) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 2 cars Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	312	4	○						
	Capacity Development Project for Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	Target group: Rice farmers in Lower Kuja Irrigation Scheme Outputs: 1) Capacity development of officers of NIB Kuja in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production to NIB Kuja Inputs (Donor Side): 1. Expert dispatch (50MM) (Team leader, seed production, agricultural extension) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 cars Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	230	5		○		○			
	Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	Target group: Rice farmers in Lower Kuja Irrigation Scheme Outputs: 1) Capacity development of officers of NIB Kuja in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production to NIB Kuja Inputs: 1. Expert dispatch (25MM)(Seed production) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 cars 6. Participation of counterparts to project activities 7. Travelling expenses of counterparts 8. Office spaces: 1 place	194	6						○	
		Cost (million Ksh.)			882	800	570	706	476	468	274
		Cost (million Ksh) (If several components can be combined to one project, 75% of summed amounts are accounted.)			662	800	570	530	476	351	274
		Evaluation (1:bad for formulation / 5:good for formulation)									
		Model potential			5	3	3	2	2	2	2
		Economic efficiency			5	4	4	2	2	2	2
		Technical soundness			3	3	3	4	4	2	2
		Sustainability			3	3	3	4	4	4	4
		Environmental aspect			5	5	5	5	5	5	5
		Total Evaluation Score			21	18	18	17	17	15	15

Source: JICA Survey Team

Table B6.2.4-1 Project Cost for Soft Component : Consideration of Data Collection Survey on Irrigation Development Plan in the Lake Victoria (2/2)

(E) Agricultural Practice & Extension

Category	Components	Works/Remarks	Initial Cost (10^6 Ksh)	No.	Selection						
					E1	E2	E3	E4	E5	E6	E7
Extension	Capacity Development Project for Enhancement of Rice Production Techniques and Wide-range Extension in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	Target Group: Rice farmers in the Lake Victoria Basin Region (Note: Ahero, West Kano and South West Kano to be excluded because those areas are already covered by CaDPERP.) Outputs: 1) Capacity development of NIB officers for wide-range extension services to enhance rice productivity 2) Extension of rice production techniques in irrigation schemes in the Lake Victoria Basin Region including Lower Kuja Irrigation Scheme 3) Capacity development of AIRS and KALRO to solve rice farmers' issues especially in soil analysis and pest/disease control 4) Establishment of wide-range information sharing system on rice production techniques and rice market information covering the Lake Victoria Basin Region Inputs (Donor Side): 1. Expert dispatch (110MM)(Team leader/agricultural extension, rice production, irrigation water management, training management) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 2 cars Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 2 places	570	1	○	○	○				
	Capacity Development Project for Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	Target Group: Rice farmers in Lower Kuja Irrigation Scheme Outputs: 1) Capacity development of officers of NIB Kuja on extension services for rice production 2) Technology transfer of rice production techniques improved in Ahero and West Kano irrigation schemes to Lower Kuja irrigation scheme 3) Capacity development of officers of NIB Kuja and Migori county to solve farmers' issues on rice production Inputs (Donor Side): 1. Expert dispatch (70MM) (Team leader/agricultural extension, rice production, irrigation water management, training management) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 places	476	2				○	○		
	Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	Target group: Rice farmers in Lower Kuja Irrigation Scheme Output: 1) Capacity development of officers of NIB Kuja on agricultural extension services for rice production 2) Technology transfer of rice production techniques improved in Ahero and West Kano irrigation schemes to Lower Kuja irrigation scheme 3) Capacity development of officers of NIB Kuja and Migori county to solve farmers' issues on rice production Input: 1. Expert dispatch (35MM)(Agricultural extension) 2. Travel cost 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 car 6. Participation of government officers to project activities 7. Travelling expenses of government officers 8. Office spaces: 2 places	274	3						○	○
Seed production	Capacity Development Project for Rice Seed Production and Wide-range Distribution in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	Target group: Rice farmers in the Lake Victoria Basin Region Outputs: 1) Capacity development of officers of NIB Ahero in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production 3) Installation of required equipment and machinery and establishment of distribution mechanism for certified seed in the Lake Victoria Basin Region Inputs (Donor Side): 1. Expert dispatch (80MM)(Team leader, seed production, agricultural extension) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 2 cars Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	312	4	○						
	Capacity Development Project for Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	Target group: Rice farmers in Lower Kuja Irrigation Scheme Outputs: 1) Capacity development of officers of NIB Kuja in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production to NIB Kuja Inputs (Donor Side): 1. Expert dispatch (50MM) (Team leader, seed production, agricultural extension) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 cars Inputs (Kenyan Side): 1. Participation of counterparts to project activities 2. Travelling expenses of counterparts 3. Office spaces: 1 place	230	5		○		○			
	Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	Target group: Rice farmers in Lower Kuja Irrigation Scheme Outputs: 1) Capacity development of officers of NIB Kuja in certified seed production and distribution 2) Installation of required equipment and machinery for certified seed production to NIB Kuja Inputs: 1. Expert dispatch (25MM)(Seed production) 2. Travel cost for experts 3. General operation cost 4. Equipment cost (computer, copy machine, projector, etc.) 5. Vehicle cost: 1 cars 6. Participation of counterparts to project activities 7. Travelling expenses of counterparts 8. Office spaces: 1 place	194	6						○	
		Cost (million Ksh.)			882	800	570	706	476	468	274
		Cost (million Ksh) (If several components can be combined to one project, 75% of summed amounts are accounted.)			662	800	570	530	476	351	274
		Evaluation (1:bad for formulation / 5:good for formulation)									
		Model potential			5	3	3	2	2	2	2
		Economic efficiency			5	4	4	2	2	2	2
		Technical soundness			3	3	3	4	4	2	2
		Sustainability			3	3	3	4	4	4	4
		Environmental aspect			5	5	5	5	5	5	5
		Total Evaluation Score			21	18	18	17	17	15	15

Source: JICA Survey Team

Table B6.3.3-1 Major Cooperation Scenarios for Yen Loan Project

(1.1) Cost Summary

		Case-1-1		Case-1-2		Case-1-3		Case-1-4		Case-1-5		Case-1-6	
		Selection	Cost	Selection	Cost	Selection	Cost	Selection	Cost	Selection	Cost	Selection	Cost
Direct Cost	(A) Ahero Irrigation Scheme	A5	1,394	-	-	A5	1,394			A5	1,394	A4	2,122
	(B) West Kano Irrigation Scheme	B3	867	-	-					B3	867	B3	867
	(C) SW Kano Irrigation Scheme	C1	464	-	-	C1	464	C1	464	C1	464	C1	464
	(D) Lower Kuja Irrigation Scheme	D3	9,484	D3	9,484	D3	9,484	D3	9,484				
	(E) Agriculture	E6	351	E6	351	E6	351	E6	351	E6	351	E6	351
	(F) Value Chain Improvement	F4	574	F4	574	F4	574	F4	574	F4	574	F4	574
	Total Direct Cost (before adjustment)		13,134		10,409		12,267		10,873		3,650		4,378
	Total Construction Cost (Civil x 1.5) million Ksh.		**19,238**		**15,151**		**17,938**		**15,847**		**5,012**		**6,104**

Note: Total Cost for Yen Loan Project = 1.5 x Direct Costs

(1.2) Analysis

		Case-1-1	Case-1-2	Case-1-3	Case-1-4	Case-1-5	Case-1-6
Cost	Initial Cost	**19,238**	**15,151**	**17,938**	**15,847**	**5,012**	**6,104**
(Ksh 10^6)	OM const	4,479	2,845	3,780	2,984	1,634	1,475
	Total Project Cost	**23,717**	**17,996**	**21,717**	**18,832**	**6,646**	**7,579**
	Total Area(ha)	9,932	7,717	9,040	7,722	2,215	1,764
	Rehabili Area (ha)	1,824	60	932	65	1,764	1,764
	Paddy Extension Area (ha)	5,061	4,610	5,061	4,610	451	0
	Upland Extension Area (ha)	3,047	3,047	3,047	3,047	0	0
	Beneficiries-Irrigation only (HH)	6,244	2,797	5,464	4,597	3,447	3,150
	Beneficiries- flood only (persons)	68,003	5,020	60,184	45,020	62,983	62,983
Benefit	Rehabili Area	6,276	165	2,348	1,844	4,445	4,445
(Ksh 10^6)	Paddy Extension Area	27,657	25,384	25,507	25,384	2,273	0
	Upland Extension Area	7,781	7,781	7,781	7,781	0	0
	total	41,714	33,330	35,636	35,008	6,718	4,445
	B/C	**1.76**	**1.85**	**1.64**	**1.86**	**1.01**	**0.59**

Note: Benefit calculation. Period 30years, Rehabili=+2ton/ha (Paddy), Paddy Extension=+4ton/ha, Upland Extension=+2ton/ha(maiz), Basmati rice=Ksh65/kg, IR Rice=Ksh40/kg, Upland (Maise)=Ksh30/kg

Source: JICA Survey Team

Table B6.3.4-1 Major Cooperation Scenarios for Grant Aid Project and Technical Cooperation Project

(a) Grant Aid Project

		Case-2-1		Case-2-2		Case-2-3		Case-2-4		Case-2-5		Case-2-6**	
		Selection	Cost	Selection	Cost	Selection	Cost	Selection	Cost	Selection	Cost	Selection	Cost
Direct Cost	(A) Ahero Irrigation Scheme	A2	1,268	A5	1,394							A5a	1,039
	(B) West Kano Irrigation Scheme	-	-			B3	867			B3	867		
	(C) Southwest Kano Irrigation Scheme					C1	464	C1	464				
	(D) Lower Kuja Irrigation Scheme	-	-	-	-	-	-	-	-	-	-	-	-
	Total before adjustment		1,268		1,394		1,331		464		867		1,039
	Total Construction Cost* (Civil x 2.25) million Ksh.		2,852		3,136		2,995		1,044		1,951		2,339
	O&M Cost million Ksh.		829		795		839		139		700		689

Note: * Total Cost for Grant Aid Project = 2.25 x Direct Costs.

**A5a in Case-2-6 has only 50% of A5 (rehabilitation cost of canal) is included.

Canal rehabilitation : 50%

(b) Technical Cooperation Project

			Case-3-1	Case-3-2	Case-3-3	Case-3-4	
			E1	E3	E3	E1	
Extension	Capacity Development Project for Enhancement of Rice Production Techniques and Wide-range Extension in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	570	○	○	○	○	
	Capacity Development Project for Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (JICA Technical Cooperation Project)	476					
	Enhancement of Rice Production Techniques and Extension in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	274					
Seed production	Capacity Development Project for Rice Seed Production and Wide-range Distribution in the Lake Victoria Basin Region (JICA Technical Cooperation Project)	312	○			○	
	Capacity Development Project for Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (Technical Cooperation Project)	230					
	Rice Seed Production and Distribution in Lower Kuja Irrigation Scheme (A Component of JICA's Yen Loan Project)	194					
	Sub-total Cost (million Ksh)		882	570	570	882	
			F1	F2	F1	F3	
Rice mill	Promotion Program for Private Rice-millers to the Rice-Mill Complex – A TCP for the Whole Coastal Area of Lake Victoria	471	○		○	○	
	Promotion Program for Private Rice-millers to the Rice-Mill Complex – A Component of Yen Loan Project for the Irrigation Development in Lower Kuja	189					
Postharvest processing	Installation Program of Paddy Collection, Shipping and Storage Centre - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja	98					
Transportation	Improvement of Rice Transportation Routes (Road and Port) - A Component of Yen Loan Project for the Irrigation Development in Lower Kuja	287					
Rice mill	Operation Improvement of the Existing Public Rice-mill – A TCP for the Whole Coastal Area of Lake Victoria	103	○	○	○		
	Sub-total Cost (million Ksh)		574	103	574	471	
	Total Cost (million Ksh) before adjustment		1,456	673	1,144	1,353	
	Total Cost (million Ksh) after adjustment (x 90%)		**1,310**	**606**	**1,030**	**1,218**	

Source: JICA Survey Team

Annex

Annex 2.1.3-1 THE CASE OF DOMINION FARM

Reclamation of Yala swamp

In 1954, Kenyan colonial government assigned Sir Alexander Gibb and partners to investigate potential of wetland reclamation in the Kenyan portion. The study recognized high productive potential and recommendations implemented 8 years later. This happened when Kenya government requested the UN to assist in execution of recommendations. The recommendation aimed at reclaiming Yala swamp as a realization for the development of the area. Request was granted under the UN special fund where FAO/UNDP implemented land reclamation Area 1 (2300ha) in 1965-1970. The works carried out include the following:

a. Construction of diversion canal ,
b. Construction of protection dyke on R.Yala

   Both a. and b. were 7.25km long.
c. Construction of feeder canal to L. Kanyaboli, 8.8km long
d. Construction of retention dyke at L. Kanyaboli, 2.5km on Area II an Area III left under water after reclamation of Area I. Reclaimed area remained idle for some years despite structural works partly done. This land developed into good grazing land for local community (Abila 2005).

In 1972, Ministry of Agriculture commissioned a Dutch Consulting firm (Indian Life assurance Company ILACO) to investigate possible development options of Yala swamp. ILACO recommended a further 9200ha (Area II), leaving 6900ha (Area III) to act as a buffer zone. Due to rapid population increase and need to increase food production for self-sufficiency, in 1979 and 1982, Kenya government re-visited Yala swamp reclamation to agric. Activities and contracted Mehta Group International that revealed more potential for Area II. However, due to resource and management constraints, Area II was not implemented.

Therefore already reclaimed Area I was put under agriculture by Lake Basin Development Authority, for integrated utilization and development firstly on pilot basis. They did intensive crop husbandry for production of cereals, pulses, horticulture crops, seed bulking and upgrading local agric. Production techniques. Other programs included community based rehabilitation and conservation of degraded areas (SIDA 2002).

Dominion farms

In 2003, regional government authority granted a 25 year lease for Rice cultivation to Dominion Farms, an American based company. The agreement was approved by local authorities in Bondo and Siaya County council that Dominion would do rice production in part of Area I. this portion of area I was the land was previously used by LBDA for agricultural activity. Dominion got license in 2004, for rice irrigation.

However, instead of the originally intended rice cultivation in Area I previously owned by LBDA, Dominion embarked on other additional agricultural and development activities in the swamp that went beyond rice cultivation. These were:

a. construction of irrigation dykes

b. construction of weirs
c. water-drilling
d. an airstrip
e. a road

Also Dominion farms engaged in major aquaculture ventures such as:

a. fish farms
b. fish processing
c. fish mill factories

Reaction by locals

These new activities elicited mixed reactions within stakeholders ranging from issues such as economic empowerment, food security, and environmental conservation.

The locals voiced a number of complains including the following

1. non-inclusion in the negotiations
2. compulsory acquisition of land
3. inadequate compensation
4. threat of environmental degradation (Okemwa and Ochieng 2006)

Yala swamp wetland had been a sole source of livelihood for the riparian community of South Central Alego for generations. The arable land, rivers, lakes, forest, papyrus roofing grass, wood, green pastures ensured sustainable household livelihoods for residents. However this was disrupted when local leaders leased Area I to Dominion farms for large scale rice production. This meant loss of territorial space and loss of sole source of livelihoods.

Households realized they could not meet their basic needs since they no longer owned arable swamp-land for cottage industries and their economic power started to diminish. Rivers and lakes cold no longer produce enough fish for commercial purposes, forests were cleared so herbal medicines, roofing grass, edible birds, wild vegetables, honey and fruits disappeared. Hunting and logging stopped. This led to residents of Kadenge and Obambo to demonstrate and have open confrontations with management of Dominion farms.

Studies reveal that about 28% of locals, or their relatives were employees of Dominion farms, as security guards, farm laborers, messengers, clerks, drivers, section supervisors and factory workers. 6.8% were in cottage industries, 15% subsistence farmers, 16% in individual fish businesses, 10.6% in NGOs and 20.6% depended on relatives in urban rea to send them money. Hence, majority of residents did not draw their livelihoods from the project, hence the outcry.

In some studies, locals revealed that Before Dominion, they harvested enough products from wetland, giving them higher returns, compared to when Dominion farms took over. The fish and livestock trade coupled with cottage industry ensured sustainability.

Studies show that locals decried use of chemicals to kill weeds in rice fields rather than engaging more workers in the fields was a disadvantage to them as few laborers were employed. The locals cited chemical use polluted the environment. Locals complained of planes spraying chemicals which fell on farm laborers, and Lake Kanyaboli which made people, domestic animals sick, and killed fish. Moreover, crops, fruit trees, and vegetable drying up, The laborers in the farms cited low wages(60% of workers

eared less than Kshs.10,000,)with long working hours (5am to 5pm), and no provision of gumboots and overalls in rice fields and fish ponds.

Majority of locals believe land taken over by LBDA given to Dominion farms by Siaya County officials, belonged to their ancestors hence have a right to the lands.

Locals revealed the "Prime Harvest Rice" from Dominion was not affordable, but lower qualities-brokens were quite affordable. The locals also complained that Dominion ought to provide seeds at affordable rates and train them in irrigating their small farms to tap knowledge on modern farming methods.

COURT TUSSLES

Referring to Civil Case 8 of 2018, Kenyalaw.org

On 6th April 2018, Juanco SPS Ltd. Sued Dominion Ltd, at Kajiado High Court of Kenya. Juanco SPS seeked a Kshs 16,009,280 plus Interest accrued from Dominion Ltd.

From 16 March 2016 to 4th Nov 2017, Dominion Ltd ordered for Agrochemicals valued at Kshs 20,619,400. The consignment was delivered, invoices issued and Dominion was to pay 120 days later. Upon expiry, a demand notice was issued to Dominion where it paid Kshs 4,610,120. On Oct 2016, Dominion requested a credit extension of 150 day up to 21 March 2017. It is after this extension, that Juanco SPS learnt that Dominion Co. assets had been put under auction by Nyluoyo auctioneers, advertised in December 13, 2013.

NYALUOYO AUCTIONEERS

Official Court Brokers, Bailiffs, Valuers, Repossessors & Auctioneers.
P.O. Box 648-40100, Kisumu, Tel: 020 2161934 /0722329463 Indusi Road, Tom Mboya Estate. Nairobi Office, Pop Man House, 3rd Floor, Room 311, P.O Box 17752-00100, Nairobi. Email: nyaauction@yahoo.com

PUBLIC AUCTION

Pursuant to a court order In SIAYA PRINCIPAL MAGISTRATES CIVIL SUIT NO – 96B of 2017

We shall sell by public auction *'in situ'* at Dominion Farms Ltd, Siaya Farm, Godown and offices in Siaya County the following proclaimed machinery and Motor Vehicles on Wednesday 13th December 2017.

1. KCG 743Q MAHINDRA BOLERO
2. KBP 713Q SUZUKI
3. KCE 028S SUZUKI
4. KCE 030S MARUTI
5. KAZ 086R TATA LORRY
6. 1 JOHN DEERE 9520 TRACTOR NO REGISTRATION NUMBER
7. 1 JOHN DEERE 9420 TRACTOR NO REGISTRATION NUMBER
8. 1 CASE COMBINE HARVESTER 2388 AXIAL FLOW NO REGISTRATION NUMBER
9. KCG 395L ERRA 5 EICHER
10. KCG 658Q MAHINDRA BOLERO
11. KAX 969K DOUBLE CABIN TOYOTA HILUX P/UP
12. KBY 346V TATA BUS
13. 4 24 DISC HARROWS
14. 1 HYSTER FORK LIFT
15. KAU 381Y JEEP
16. KAR 686H LAND CRUISER
17. KAU 382Y JEEP
18. KCG 764Q MAHINDRA BOLERO

TERMS OF SALE

1. A refundable deposit of Kshs. 100,000/= to enable you to bid.
2. Cash at the fall of the hammer.

www.nyaluoyoauctioneers.com

TO DOMINION FARMS LTD (DIRECTORS, AGENTS, SERVANTS AND OR EMPLOYEES HOWSOEVER)

NOTICE

SIAYA PMCC NO 96B OF 2017

Take notice that any person who removes, alters, damages, substitutes or alienates any goods comprised in the proclamation before they are redeemed by payment in full of the amount in the court warrant, or letter of instruction, or in such lesser amount as the creditor or his advocates may agree in writing, commits an offence, and is liable to prosecution under rule 14 together with rule 54 of the Auctioneers rules.

For the avoidance of any doubt all the proclaimed machinery and motor vehicles shall remain where they were proclaimed and be sold on the scheduled date at the said Dominion Farms Ltd, Siaya Farm, Godowns and offices.

J.O. JOSIAH
NYALUOYO AUCTIONEERS.

Immediately after learning this Juanco served Dominion with notice of motion, but failed to pay. It seemed Dominion had filed an interlocutory injunction on a past instance, an exercise making Dominion property unavailable to satisfy collateral for debt in a court of law.

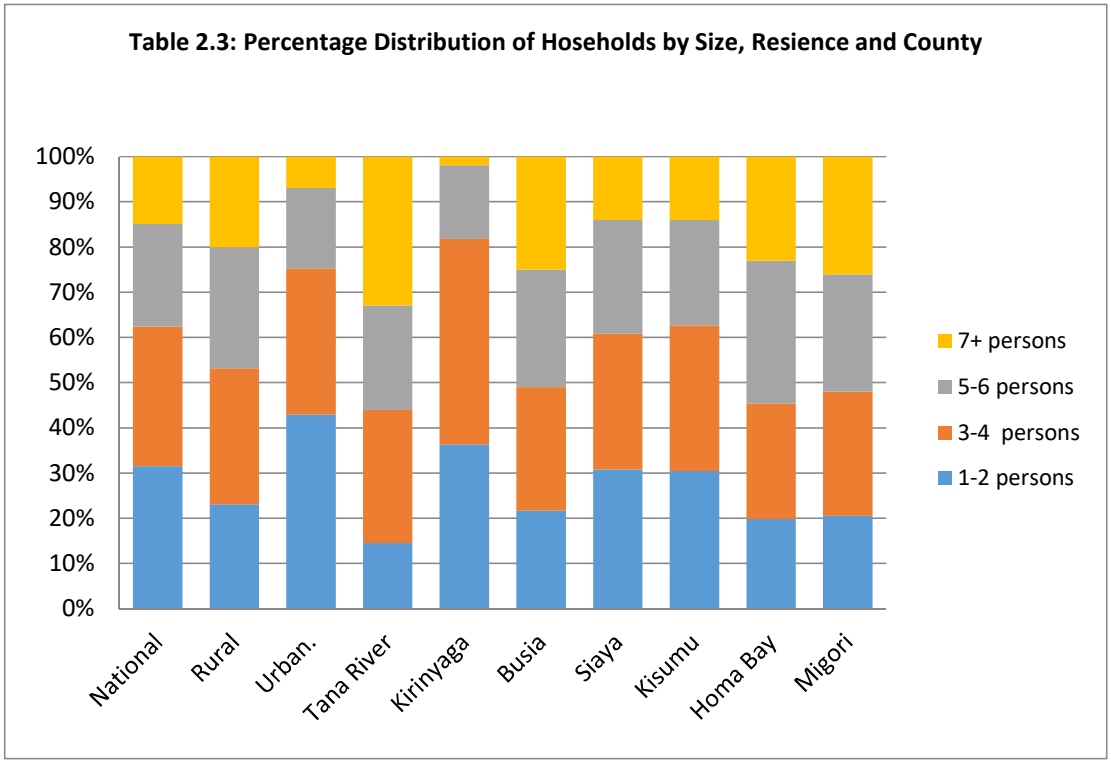
Affidavit evidence presented at the hearing indicated Dominion was about to close operations. This blocked execution of decrees to any suits.

The court ordered Juanco to serve Dominion a Demand & Enforcement order to deposit security equivalent to Kshs.16, 009,280 plus interest owed. This was to be done in 30 days failure to which Juanco was granted to attach movable assets or restrict immovable assets for repossession at land registry.

REFERENCES

1. Assessment of effect of irrigation projects on wetlands: Yala swamp, Siaya" by Lydia Kemuto, 2018
2. Civil appeal 40 of 2012, kenyalaw.org
3. Civil case 8 of 2018, kenyalaw.org
4. Daily Nation, February 26 2017 – Rumours, truths and lies on Dominion fam

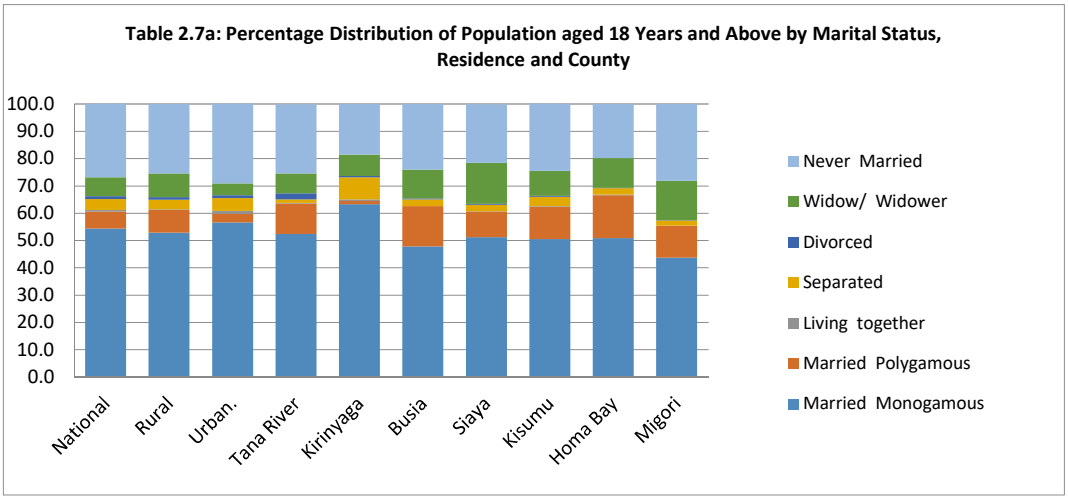
Table 2.3: Percentage Distribution of Hoseholds by Size, Resience and County						
Residence/ County	1-2 persons	3-4 persons	5-6 persons	7+ persons	Number of Households ('000)	Mean Household size
National	31.6	30.9	22.8	15.0	11,415	4.0
Rural	23.0	30.0	26.7	20.0	6,442	4.5
Urban.	42.7	32.2	17.7	7.0	4,972	3.3
Tana River	14.5	29.5	23.1	33.0	56	5.4
Kirinyaga	36.4	45.6	16.3	2.0	198	3.1
Busia	21.6	27.2	25.9	25.0	177	4.7
Siaya	30.7	29.9	25.1	14.0	246	4.0
Kisumu	30.3	32.1	23.2	14.0	284	4.0
Homa Bay	19.7	25.5	31.4	23.0	224	4.8
Migori	20.4	27.4	25.8	26.0	233	4.8



- Homabay and Migori had similar 1-2 persons household units percentages
- Kisumu, Homabay and Migori had similar 3-4 persons household units percentages
- Homabay had slightly more 5-6 persons households than Migori or Kisumu
- Migori had slightly more 7+ persons households than Kisumu or Homabay

Table 2.7a: Percentage Distribution of Population aged 18 Years and Above by Marital Status, Residence and County

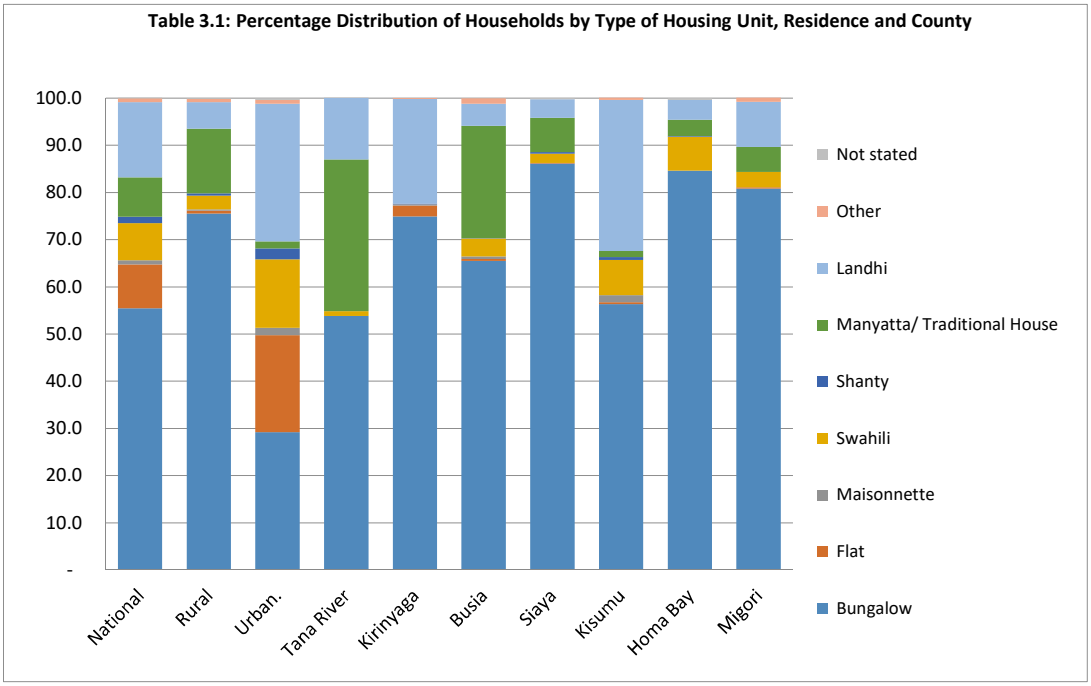
Residence/ County	Married Monogamous	Married Polygamous	Living together	Separated	Divorced	Widow/ Widower	Never Married	Number individuals ('000)
National	54.4	6.2	0.6	4.0	1.0	6.9	27.0	23,462
Rural	52.8	8.4	0.2	3.5	0.9	8.7	25.5	13,878
Urban.	56.6	3.1	1.1	4.7	1.1	4.3	29.2	9,584
Tana River	52.4	11.1	0.2	1.3	2.3	7.2	25.4	135
Kirinyaga	63.3	1.2	0.5	8.1	0.5	7.8	18.6	365
Busia	47.8	14.8	0.0	2.4	0.4	10.5	24.1	384
Siaya	51.2	9.4	0.1	2.3	0.4	15.0	21.5	467
Kisumu	50.5	11.8	0.3	3.4	0.3	9.2	24.6	576
Homa Bay	50.9	15.7	0.2	2.3	0.2	10.9	19.8	447
Migori	43.7	11.7	0.0	1.9	0.1	14.4	28.2	487



- Kisumu, Migori, Homabay mostly Married Monogamous with significantly similar levels to National, Rural and Urban
- Kisumu, Homabay and Migori married polygamous significantly higher than National, Rural and Urban levels.
- Kisumu, Homabay and Migori Divorced and Separated significantly lower than National, Rural and Urban

Table 3.1: Percentage Distribution of Households by Type of Housing Unit, Residence and County

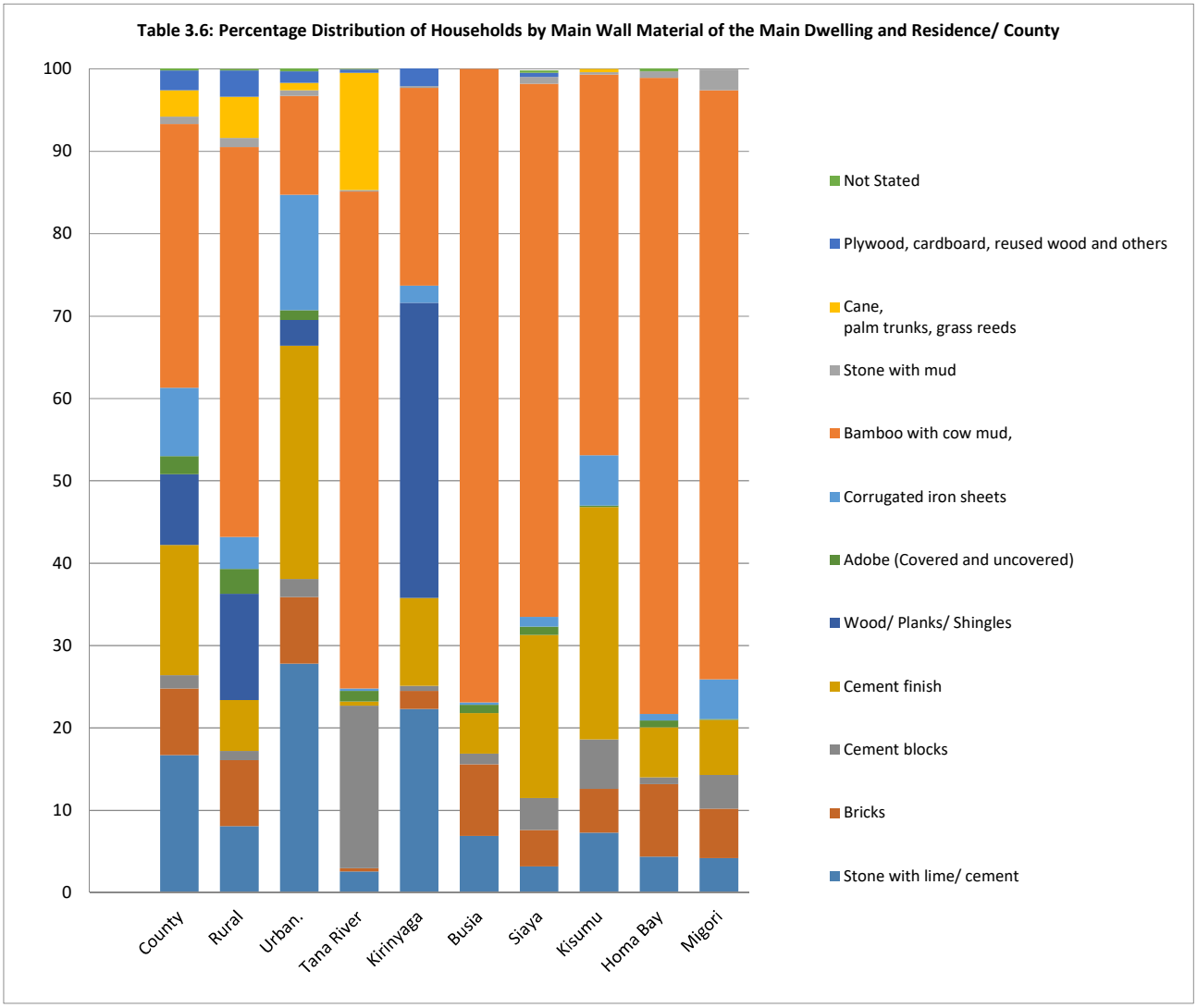
Residence/ County	Bungalow	Flat	Maisonnette	Swahili	Shanty	Manyatta/ Traditional House	Landhi	Other	Not stated	Number Households ('000)
National	55.4	9.3	0.9	7.9	1.3	8.4	15.9	0.8	0.2	11,415
Rural	75.5	0.6	0.3	2.9	0.5	13.7	5.6	0.7	0.1	6,442
Urban.	29.2	20.5	1.6	14.5	2.3	1.5	29.2	0.8	0.3	4,972
Tana River	53.8	-	-	1.0	-	32.2	13.0	-	0.1	56
Kirinyaga	74.9	2.3	0.3	-	0.1	-	22.2	0.2	-	198
Busia	65.5	0.4	0.5	3.8	0.1	23.8	4.7	1.1	-	177
Siaya	86.1	0.1	-	2.0	0.3	7.3	3.9	-	0.3	246
Kisumu	56.3	0.4	1.5	7.5	0.6	1.3	32.0	0.5	-	284
Homa Bay	84.6	-	-	7.2	0.1	3.5	4.2	-	0.4	224
Migori	80.8	0.3	-	3.2	-	5.3	9.6	0.9	-	233



- Kisumu, Homabay and Migori housing unit mostly Bungalow similar significance to Rural.
- Kisumu has less Bungalows than Migori or Homabay
- Migori Swahili housing less than in Kisumu and Homabay
- Migori and Homabay has no significcant mansionette, or Shanty
- Kisumu more Lanhi in comparison to Homabay or Migori which is similar case in Urban
- Migori and Homabay has more Manyatta/Traditional House than Kisumu, significant to Rural

Table 3.6: Percentage Distribution of Households by Main Wall Material of the Main Dwelling and Residence/ County

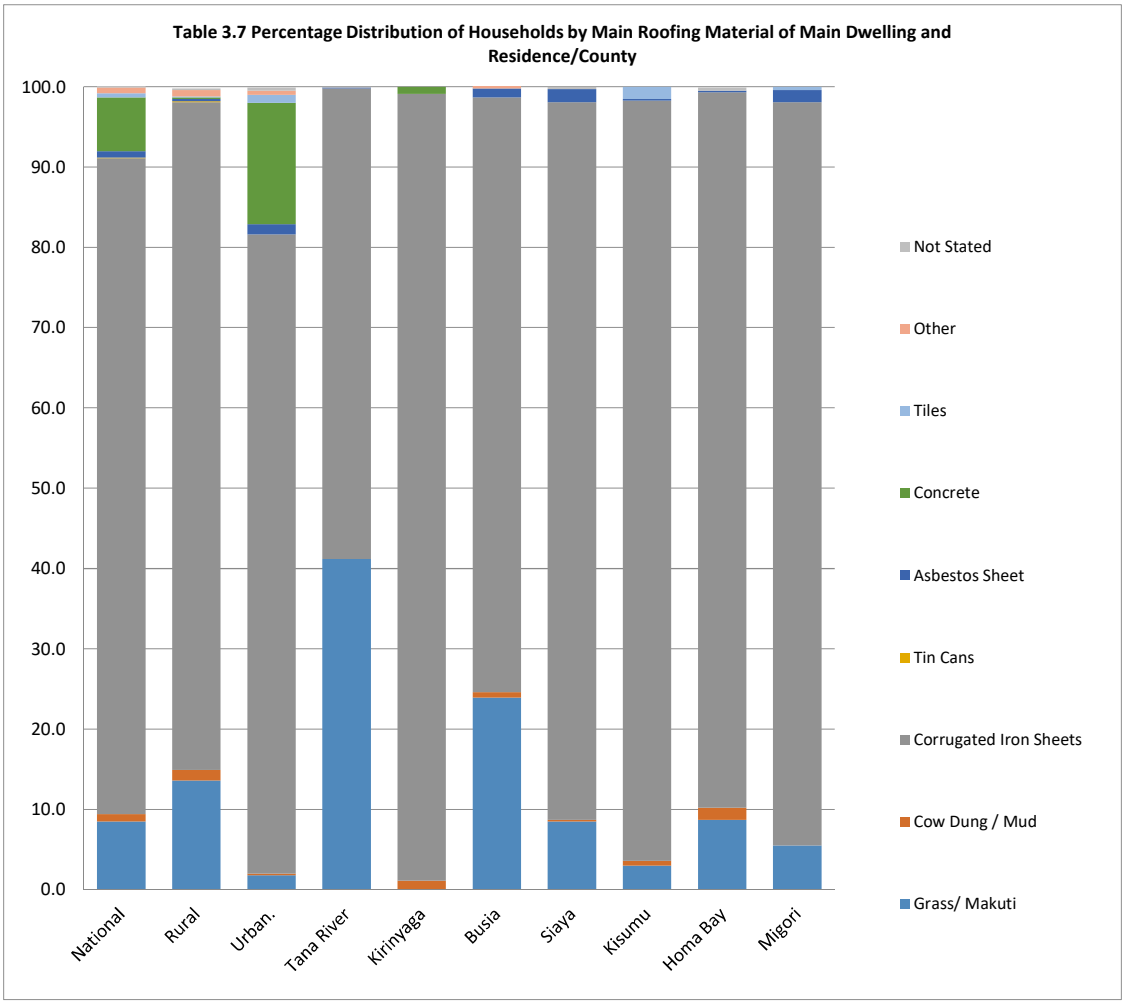
Residence/ County	Stone with lime/ cement	Bricks	Cement blocks	Cement finish	Wood/ Planks/ Shingles	Adobe (Covered and uncovered)	Corrugated iron sheets	Bamboo with cow mud,	Stone with mud	Cane, palm trunks, grass reeds	Plywood, cardboard, reused wood and others	Not Stated	Number of Households ('000)
County	16.7	8.1	1.6	15.8	8.6	2.2	8.3	32.0	0.9	3.2	2.4	0.3	11,415
Rural	8.1	8.0	1.1	6.2	12.9	3.0	3.9	47.3	1.1	5.0	3.2	0.2	6,442
Urban.	27.8	8.1	2.2	28.3	3.1	1.2	14.0	12.0	0.7	0.9	1.4	0.4	4,972
Tana River	2.6	0.4	19.7	0.5	0.0	1.3	0.3	60.3	0.2	14.2	0.4	0.1	56
Kirinyaga	22.3	2.2	0.6	10.7	35.8	0.0	2.1	24.0	0.2	0.0	2.2	0.0	198
Busia	6.9	8.7	1.3	4.9	0.0	1.0	0.3	76.9	0.0	0.0	0.0	0.0	177
Siaya	3.2	4.4	3.9	19.8	0.0	1.0	1.2	64.7	0.8	0.0	0.5	0.3	246
Kisumu	7.3	5.3	6.0	28.2	0.0	0.2	6.1	46.2	0.3	0.4	0.0	0.0	284
Homa Bay	4.4	8.8	0.8	6.1	0.0	0.8	0.8	77.2	0.8	0.0	0.0	0.4	224
Migori	4.2	6.0	4.1	6.7	0.0	0.1	4.8	71.5	2.5	0.0	0.0	0.0	233



- Homabay and Migori have more Bamboo with cow mud walls than Kisumu,
- Homabay and Migori bamboo with cow mud significantly similar to Rural
- Kisumu, Homabay and Migori has significantly similar stone with lime/cement to Rural
- Kisumu and Migori similar Cement blocks wall than in Homabay
- Kisumu and Migori have sigificant similar corrugated iron sheet wall
- Kisumu cement finish wall significantly higher than Homabay and Migori, similar to Urban
- Migori has more stone with mud wall than Kisumu or Homabay

Table 3.7 Percentage Distribution of Households by Main Roofing Material of Main Dwelling and Residence/County

Residence/ County	Grass/ Makuti	Cow Dung / Mud	Corrugated Iron Sheets	Tin Cans	Asbestos Sheet	Concrete	Tiles	Other	Not Stated	Number of Households('000)
National	8.5	0.9	81.7	0.1	0.8	6.7	0.5	0.7	0.3	11,415
Rural	13.6	1.3	83.2	0.1	0.3	0.2	0.1	0.8	0.2	6,442
Urban.	1.8	0.2	79.6	0.0	1.3	15.1	1.0	0.5	0.4	4,972
Tana River	41.2	0.0	58.6	0.0	0.1	0.0	0.0	0.0	0.1	56
Kirinyaga	0.0	1.1	98.0	0.0	0.0	0.9	0.0	0.0	0.0	198
Busia	23.9	0.7	74.1	0.0	1.1	0.0	0.0	0.3	0.0	177
Siaya	8.5	0.2	89.4	0.0	1.6	0.0	0.0	0.0	0.3	246
Kisumu	3.0	0.6	94.7	0.0	0.2	0.0	1.5	0.0	0.0	284
Homa Bay	8.7	1.5	89.1	0.0	0.2	0.0	0.0	0.0	0.4	224
Migori	5.5	0.0	92.6	0.0	1.5	0.0	0.4	0.0	0.0	233



- Migori and Kisumu has similar Corrugated iron sheet roof than Homabay
- Homabay has more makuti than Migori
- Migori has Asbestos sheet at levels significantly similar to National and Urban, no significant Asbestos in Kisumu and Homabay
- Kisumu has tiled roof significant to Urban, whearas Homabay and Migori significantly no tiled roof

Table 3.9: Percentage Distribution of Households by Main Source of Drinking Water and Residence/County

	Improved Water Sources	Unimproved Water Sources	Other
National	73	26	1
Rural	62	37	2
Urban.	87	12	1
Tana River	67	29	4
Kirinyaga	64	28	8
Busia	75	25	0
Siaya	57	42	1
Kisumu	80	20	0
Homa Bay	34	64	3
Migori	61	39	0

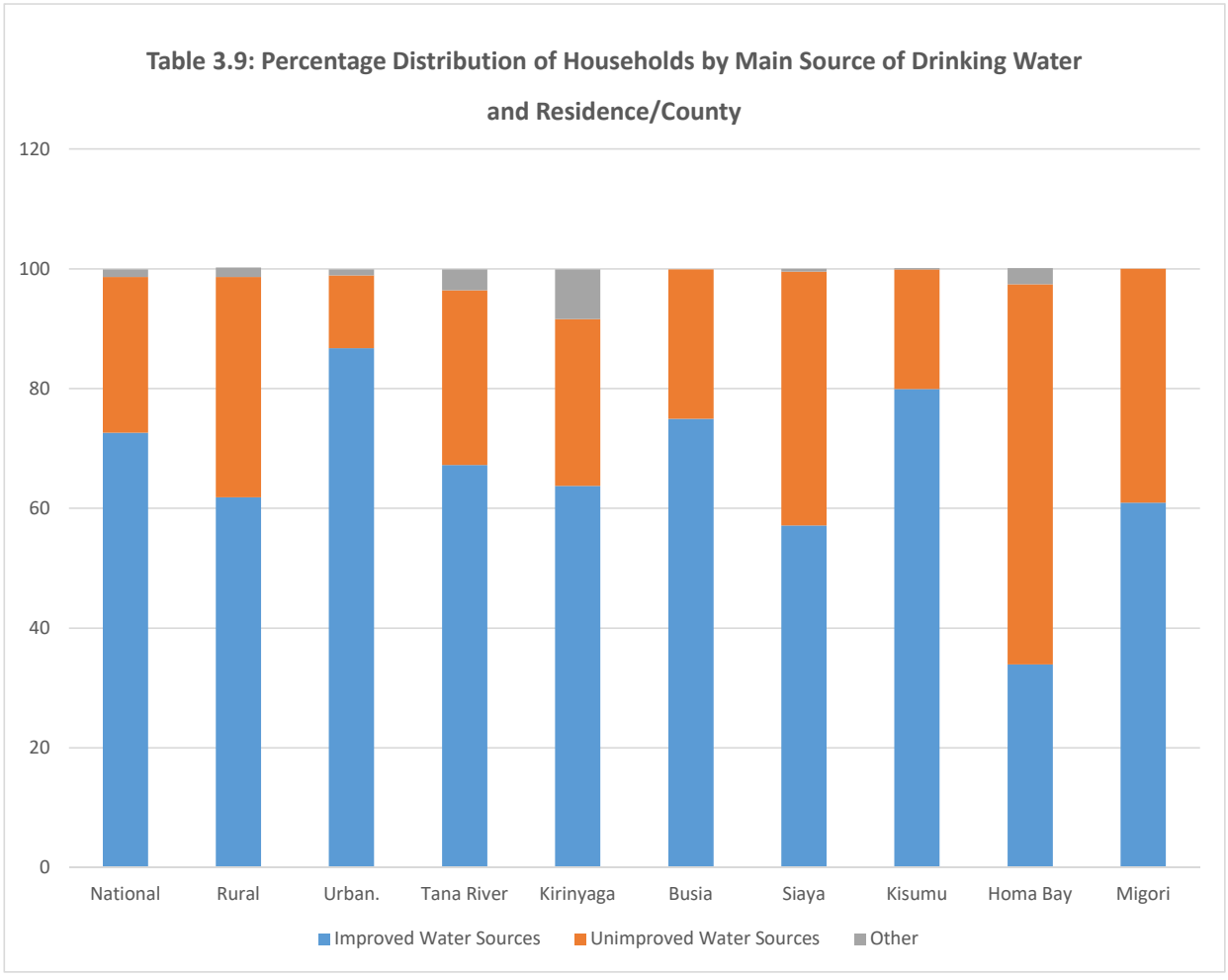
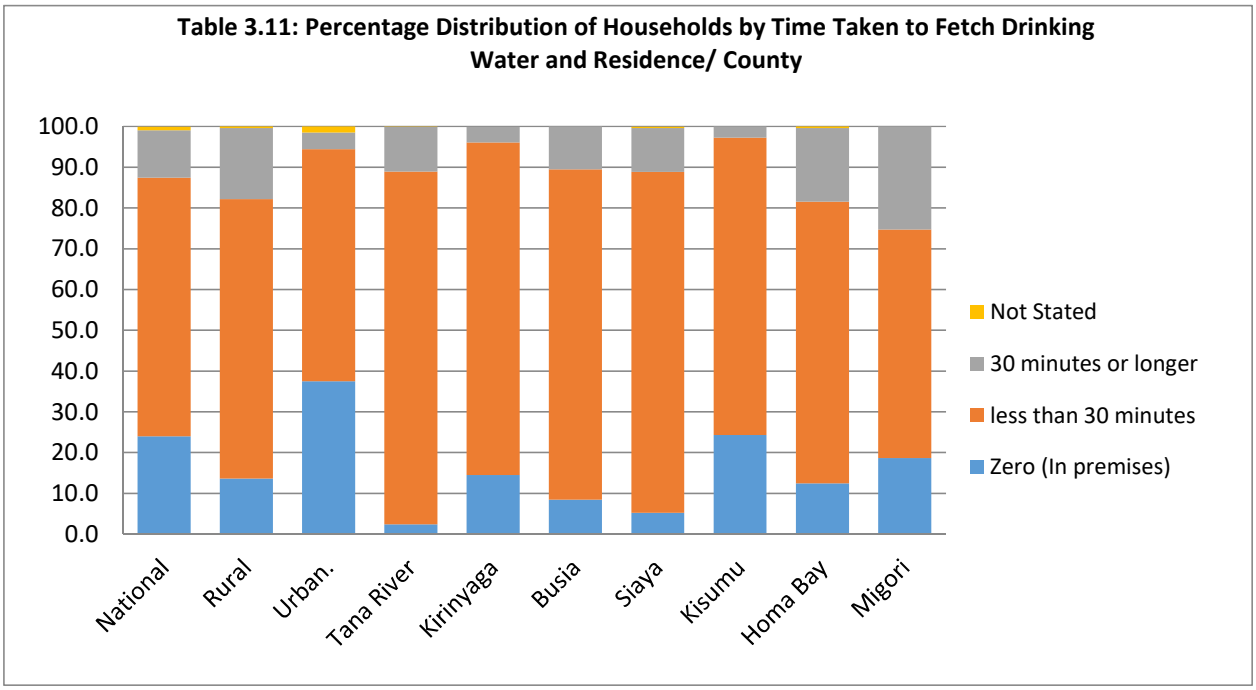


Table 3.11: Percentage Distribution of Households by Time Taken to Fetch Drinking Water and Residence/ County

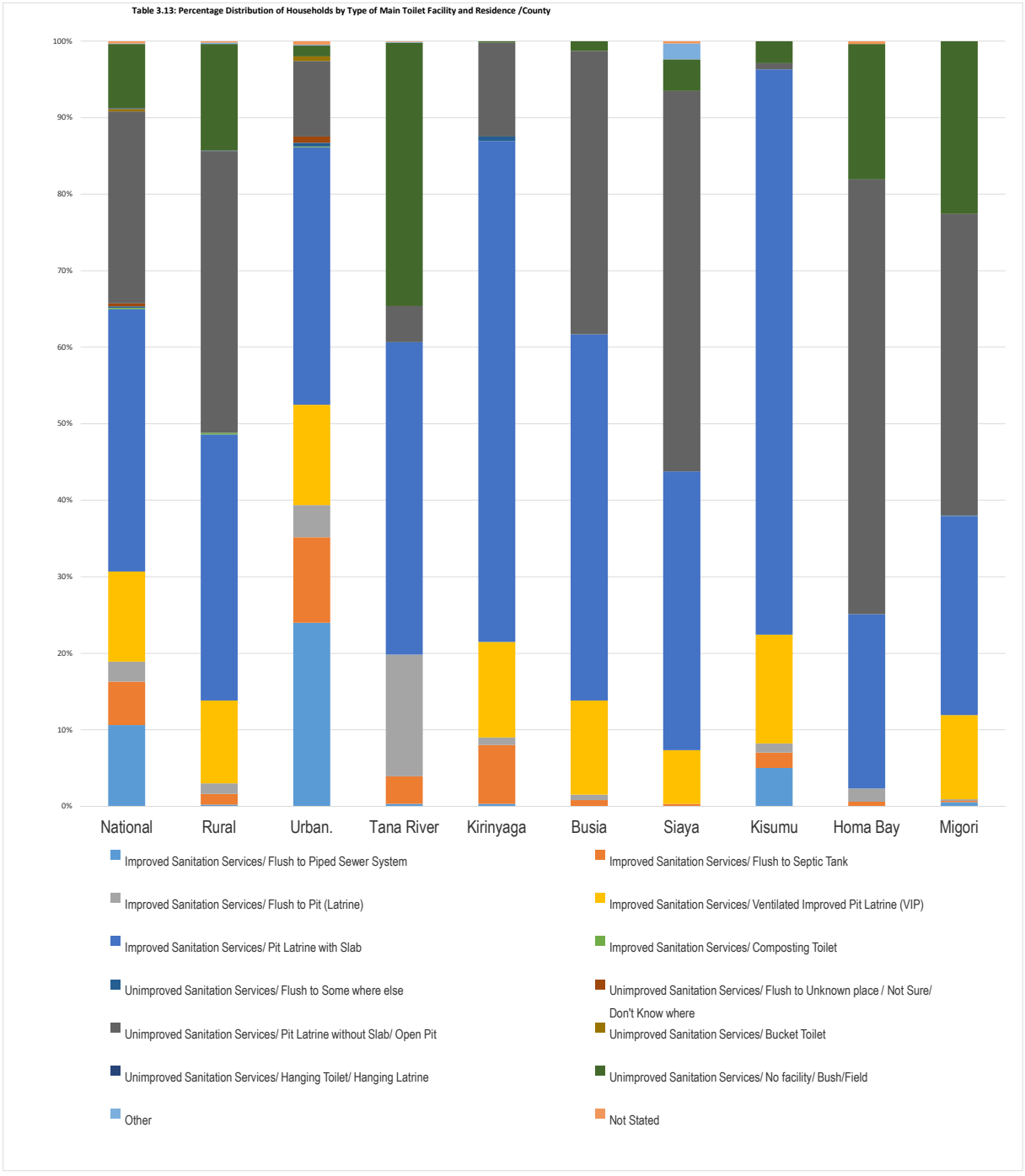
Residence/ County	Zero (In premises)	less than 30 minutes	30 minutes or longer	Not Stated	Number of Households ('000)
National	24.0	63.4	11.6	0.9	11415.0
Rural	13.6	68.5	17.5	0.4	6442.0
Urban.	37.5	56.9	4.1	1.5	4972.0
Tana River	2.4	86.5	11.0	0.1	56.0
Kirinyaga	14.5	81.5	3.9	0.0	198.0
Busia	8.4	81.0	10.6	0.0	177.0
Siaya	5.2	83.6	10.8	0.3	246.0
Kisumu	24.3	72.9	2.8	0.0	284.0
Homa Bay	12.4	69.1	18.1	0.4	224.0
Migori	18.6	56.1	25.3	0.0	233.0



- Kisumu, Migori, Homabay mostly take less than 30 minutes to fetch drinking water signioficant similar to Rural, National and Urban
- Migori and Homabay hiouseholds taking more than 30 minutes to fetch water significantly huigher than in Kisumu
- Kisumu households fetching water in premises in higher comparison to Homabay or Migori.

Table 3.13: Percentage Distribution of Households by Type of Main Toilet Facility and Residence /County

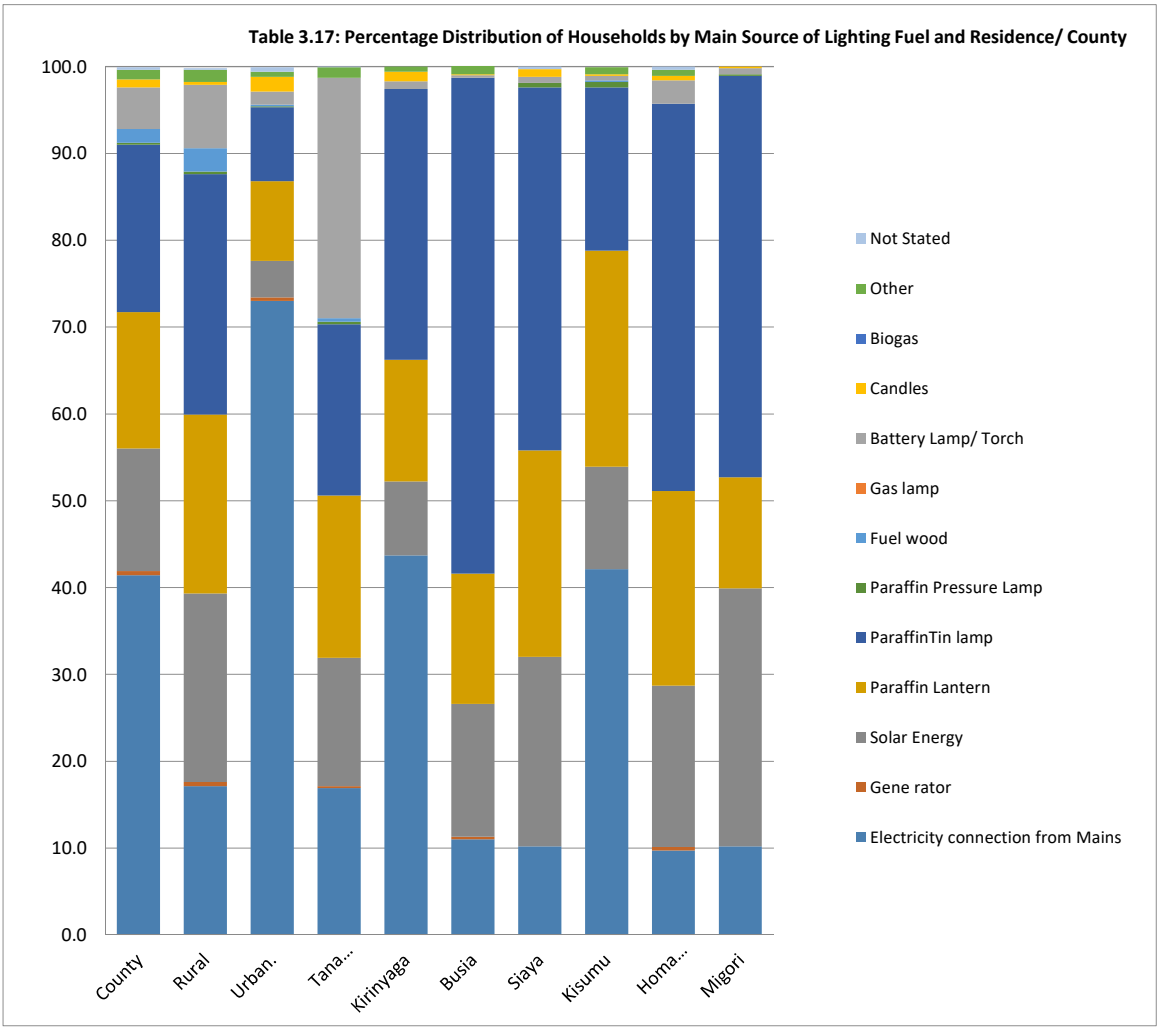
	Improved Sanitation Services/						Unimproved Sanitation Services/								
Residence/ County	Flush to Piped Sewer System	Flush to Septic Tank	Flush to Pit (Latrine)	Ventilated Improved Pit Latrine (VIP)	Pit Latrine with Slab	Composting Toilet	Flush to Some where else	Flush to Unknown place / Not Sure/ Don't Know where	Pit Latrine without Slab/ Open Pit	Bucket Toilet	Hanging Toilet/ Hanging Latrine	No facility/ Bush/Field	Other	Not Stated	Number of Households ('000)
National	10.6	5.7	2.6	11.8	34.3	0.2	0.2	0.4	25.1	0.3	0.1	8.4	0.1	0.3	11,415
Rural	0.2	1.4	1.4	10.8	34.8	0.2	0.0	0.0	36.8	0.0	0.1	13.9	0.2	0.2	6,442
Urban.	24.0	11.2	4.2	13.1	33.7	0.1	0.5	0.8	9.9	0.6	0.0	1.4	0.1	0.5	4,972
Tana River	0.3	3.6	15.9	0.0	40.8	0.0	0.0	0.0	4.7	0.0	0.0	34.4	0.1	0.1	56
Kirinyaga	0.3	7.7	1.0	12.5	65.5	0.0	0.6	0.0	12.3	0.0	0.0	0.2	0.0	0.0	198
Busia	0.0	0.8	0.7	12.3	47.8	0.0	0.0	0.0	37.0	0.0	0.0	1.3	0.0	0.0	177
Siaya	0.0	0.3	0.0	7.0	36.4	0.0	0.0	0.0	49.7	0.0	0.0	4.1	2.1	0.3	246
Kisumu	5.0	2.0	1.2	14.2	73.9	0.0	0.0	0.0	0.8	0.0	0.0	2.9	0.0	0.0	284
Homa Bay	0.0	0.6	1.7	0.0	22.8	0.0	0.0	0.0	56.8	0.0	0.0	17.7	0.0	0.4	224
Migori	0.5	0.2	0.2	11.0	26.0	0.0	0.1	0.0	39.4	0.0	0.0	22.6	0.0	0.0	233



- Homabay and Migori have unimproved sanitation services similar to Rural whearas in Kisumu is non significant
- Homabay and Migori have more unimproved sanitation services open pit / flush to somewhere else in Bush/Field compared to Kisumu similar to Rural
- Kisumu has more improved sanitation services pit latrine with slab in comparison to Homabay and Migori

Table 3.17: Percentage Distribution of Households by Main Source of Lighting Fuel and Residence/ County

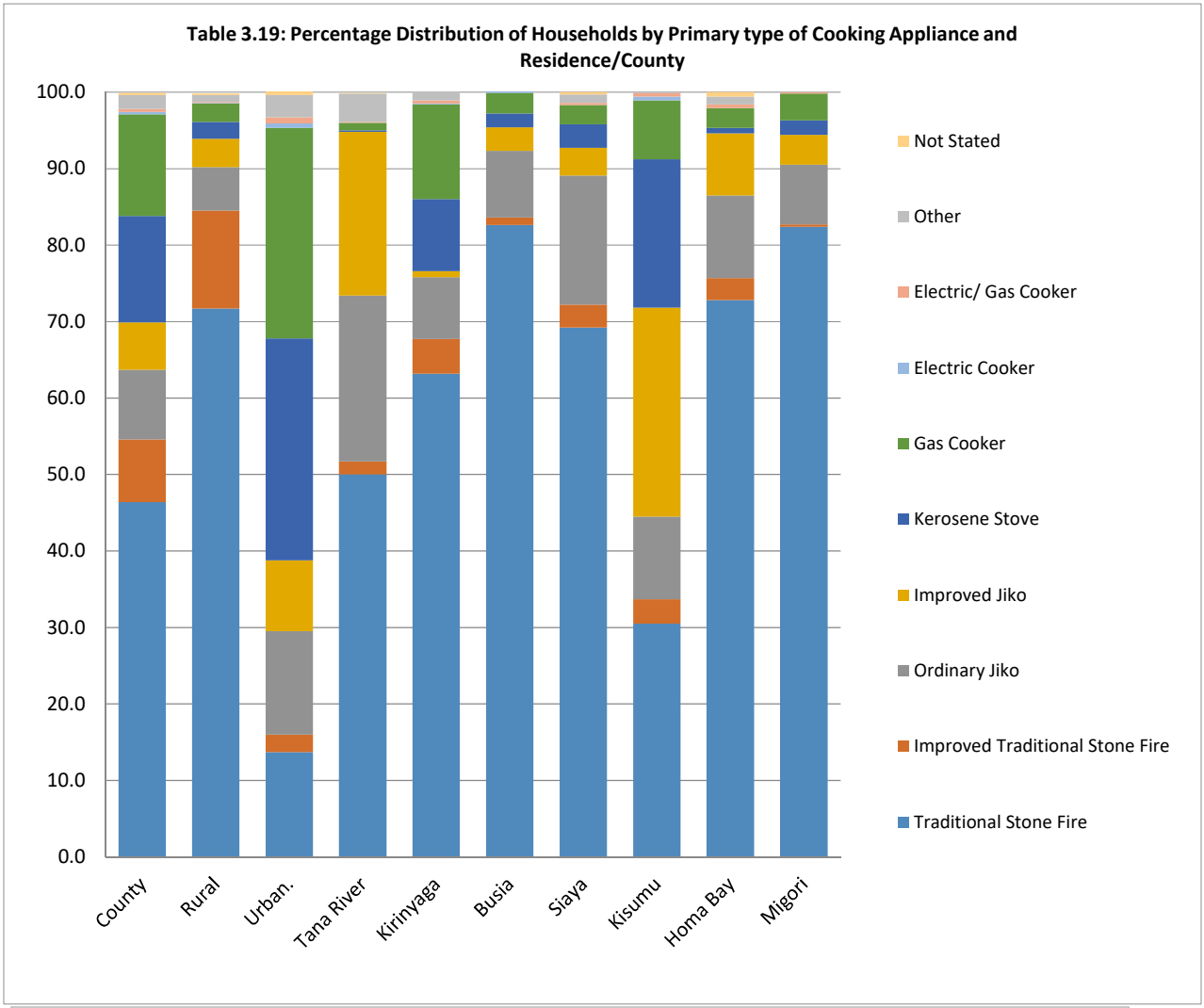
Residence/ County	Electricity connection from Mains	Gene rator	Solar Energy	Paraffin Lantern	ParaffinTin lamp	Paraffin Pressure Lamp	Fuel wood	Gas lamp	Battery Lamp/ Torch	Candles	Biogas	Other	Not Stated	Number of Households ('000)
County	41.4	0.5	14.1	15.7	19.3	0.2	1.6	0.0	4.8	0.9	0.0	1.1	0.3	11,415
Rural	17.1	0.5	21.7	20.6	27.7	0.3	2.7	0.0	7.3	0.3	0.0	1.4	0.2	6,442
Urban.	73.0	0.4	4.2	9.2	8.5	0.1	0.2	0.0	1.5	1.7	0.0	0.6	0.5	4,972
Tana Rive	16.9	0.2	14.8	18.7	19.7	0.3	0.4	0.0	27.7	0.0	0.0	1.2	0.1	56
Kirinyaga	43.7	0.0	8.5	14.0	31.2	0.0	0.0	0.0	0.9	1.1	0.0	0.6	0.0	198
Busia	11.0	0.3	15.3	15.0	57.1	0.0	0.0	0.0	0.3	0.1	0.0	1.0	0.0	177
Siaya	10.2	0.0	21.8	23.8	41.8	0.5	0.0	0.0	0.7	0.9	0.0	0.0	0.3	246
Kisumu	42.1	0.0	11.8	24.9	18.8	0.6	0.2	0.0	0.5	0.2	0.0	0.8	0.0	284
Homa Bay	9.7	0.4	18.6	22.4	44.6	0.0	0.0	0.0	2.7	0.5	0.0	0.7	0.4	224
Migori	10.2	0.0	29.7	12.8	46.2	0.2	0.0	0.0	0.7	0.2	0.0	0.0	0.0	233



Migori and Homabay has Paraffin tin lamp as lighting in more than in Kisumu,
Migori has more Battery Lamp/Torch compared to Kisumu
Homabay has more battery lamp toch than Kisumu
Kisumu has more fuel wood fuel in comparison to Homabay and Migori
Significantly similar Paraffin Lanterns across Kisumu, Hjomabay and Migori salso similar to Urban
Homabay has gas lamps for lighting
Homabay and Migori have more biogas fuel in comparison to Kisumu

Table 3.19: Percentage Distribution of Households by Primary type of Cooking Appliance and Residence/County

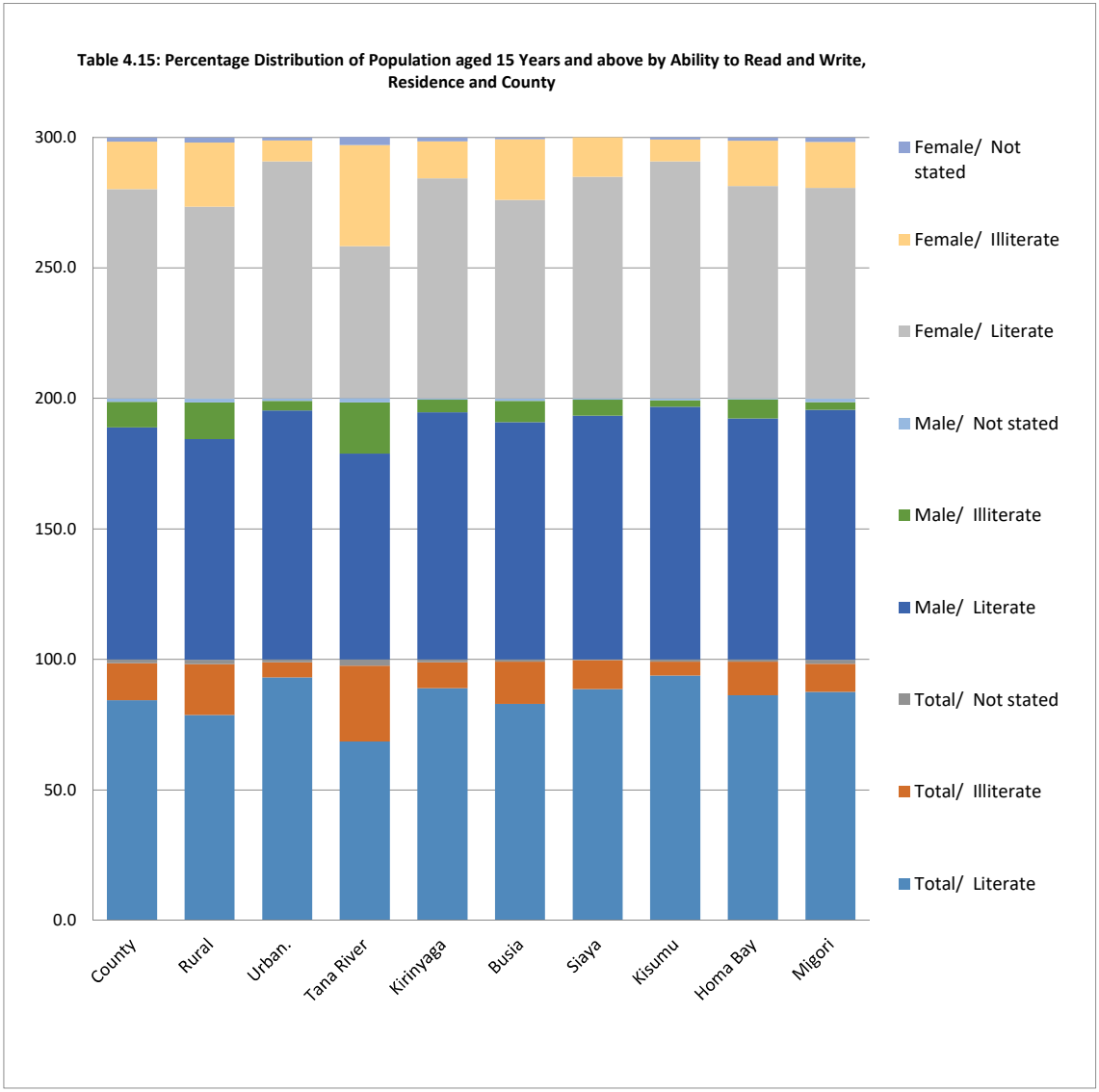
County/ Residence	Traditional Stone Fire	Improved Traditional Stone Fire	Ordinary Jiko	Improved Jiko	Kerosene Stove	Gas Cooker	Electric Cooker	Electric/ Gas Cooker	Other	Not Stated	Number of Households ('000)
County	46.4	8.2	9.1	6.2	13.9	13.3	0.3	0.4	1.8	0.3	11,415
Rural	71.7	12.8	5.7	3.7	2.2	2.4	0.1	0.1	0.9	0.2	6,442
Urban.	13.7	2.3	13.5	9.3	29.0	27.5	0.6	0.8	2.9	0.5	4,972
Tana River	50.0	1.7	21.7	21.4	0.2	1.0	0.0	0.1	3.7	0.1	56
Kirinyaga	63.2	4.5	8.1	0.8	9.4	12.4	0.1	0.4	1.2	0.0	198
Busia	82.6	1.0	8.7	3.1	1.8	2.7	0.2	0.0	0.0	0.0	177
Siaya	69.2	3.0	16.9	3.6	3.1	2.5	0.0	0.3	1.1	0.3	246
Kisumu	30.5	3.2	10.8	27.3	19.4	7.7	0.5	0.5	0.1	0.0	284
Homa Bay	72.8	2.9	10.8	8.1	0.7	2.6	0.0	0.5	1.0	0.6	224
Migori	82.4	0.3	7.8	3.9	1.9	3.5	0.0	0.2	0.1	0.0	233



- Homabay and Migori have more Traditional Stone Fire than Kisumu
- Migori does not have significant improved traditional stone fire
- kisumu and Homabay have improved Traditional Stone Fire similar to Urban
- Kisumu, Migori and Homabay have significant similar Ordinary Jiko
- Kisumu has more Improved jiko than Homabay and Migori
- Kisumu has more kerosene stove than Migori or Homabay
- Kisumu has more gas cookers than Homabay or Migori

Table 4.15: Percentage Distribution of Population aged 15 Years and above by Ability to Read and Write, Residence and County

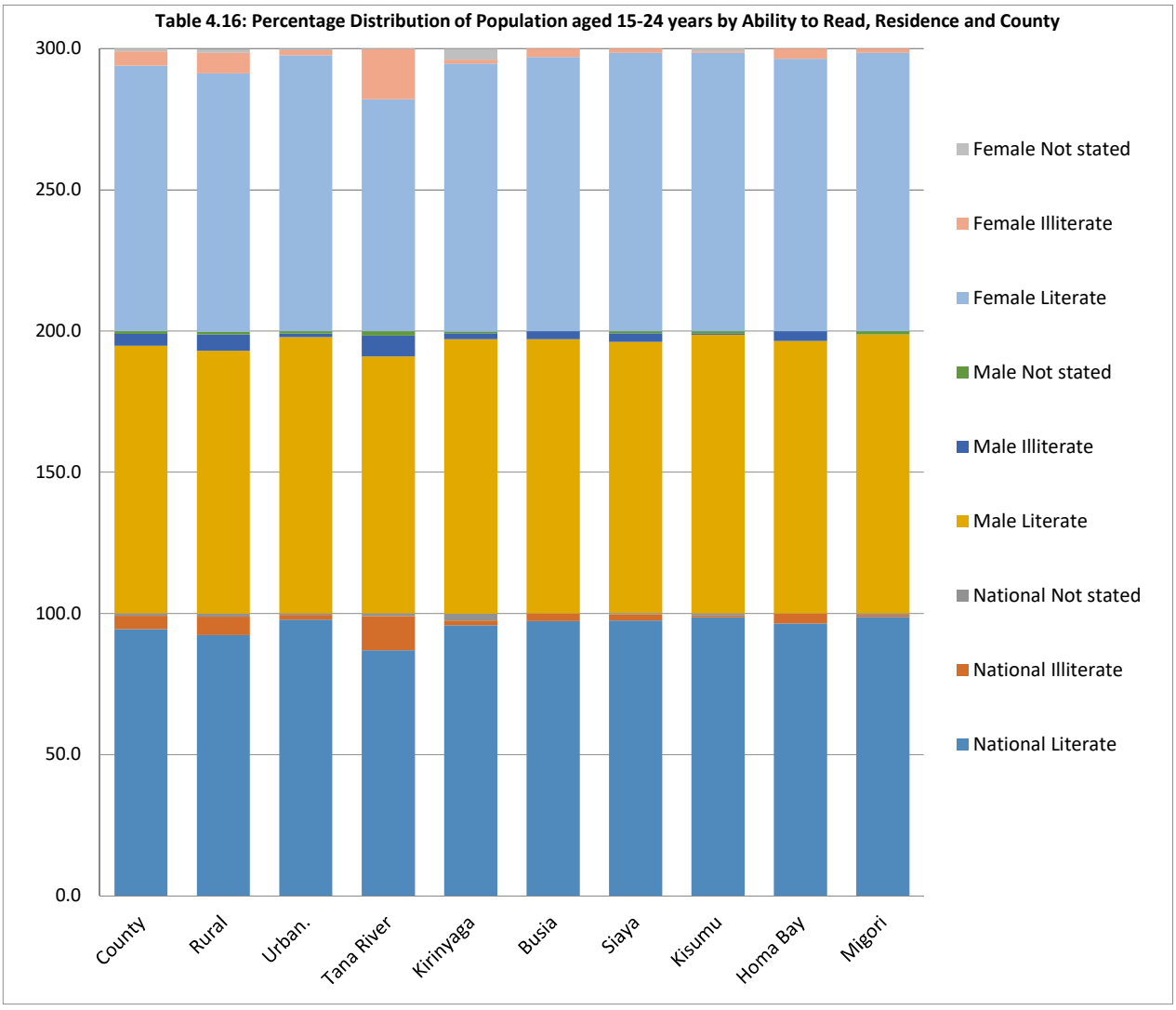
Residence / County	Total/				Male/				Female/			
	Literate	Illiterate	Not stated	Number of Individuals ('000)	Literate	Illiterate	Not stated	Number of Individuals ('000)	Literate	Illiterate	Not stated	Number of Individuals ('000)
County	84.5	14.1	1.4	26693.0	89.0	9.8	1.2	13016.0	80.2	18.2	1.6	13,677
Rural	78.8	19.5	1.6	16173.0	84.6	14.0	1.4	7710.0	73.6	24.5	1.9	8,463
Urban.	93.2	5.8	1.0	10520.0	95.4	3.7	0.9	5306.0	90.9	8.0	1.1	5,214
Tana River	68.6	29.1	2.4	160.0	78.8	19.6	1.7	81.0	58.2	38.7	3.1	80
Kirinyaga	89.1	9.9	1.0	405.0	94.8	4.8	0.4	182.0	84.4	14.1	1.5	222
Busia	83.0	16.2	0.8	456.0	91.0	8.1	0.9	210.0	76.1	23.2	0.7	246
Siaya	88.7	11.1	0.2	555.0	93.5	6.1	0.4	249.0	84.9	15.1	0.0	306
Kisumu	93.9	5.3	0.8	653.0	96.9	2.5	0.7	333.0	90.8	8.3	0.9	319
Homa Bay	86.4	12.8	0.8	538.0	92.4	7.3	0.3	244.0	81.4	17.4	1.2	294
Migori	87.6	10.8	1.5	602.0	95.8	2.9	1.3	275.0	80.8	17.6	1.7	327



Kisumu, Migori and Homabay have significantly similar literate levels for female, Male and National
Homabay has slightly nmore male illeterate compared to Kisumu and Migori
Migori, Kisumu and Homabay have significantly similar Male Literate and Female Literate
Migori and Homabay have more Female illeterate than Kisumu
Migori have similar Male literate to Kisumu

Table 4.16: Percentage Distribution of Population aged 15-24 years by Ability to Read, Residence and County

Residence/ County	National			Male			Female		
	Literate	Illiterate	Not stated	Literate	Illiterate	Not stated	Literate	Illiterate	Not stated
County	94.4	4.7	0.9	94.8	4.2	1.0	94.0	5.1	0.9
Rural	92.3	6.5	1.1	93.1	5.8	1.0	91.5	7.3	1.2
Urban.	97.8	1.6	0.6	97.9	1.3	0.8	97.7	1.8	0.4
Tana River	86.9	12.1	1.0	91.0	7.4	1.6	82.1	17.7	0.2
Kirinyaga	95.8	1.6	2.5	97.3	2.1	0.6	94.9	1.3	3.8
Busia	97.2	2.8	0.0	97.2	2.8	0.0	97.1	2.9	0.0
Siaya	97.4	2.3	0.4	96.1	3.1	0.7	98.5	1.5	0.0
Kisumu	98.6	0.6	0.8	98.7	0.6	0.7	98.5	0.6	0.9
Homa Bay	96.4	3.6	0.0	96.5	3.5	0.0	96.4	3.6	0.0
Migori	98.7	0.7	0.6	98.8	0.0	1.2	98.6	1.4	0.0

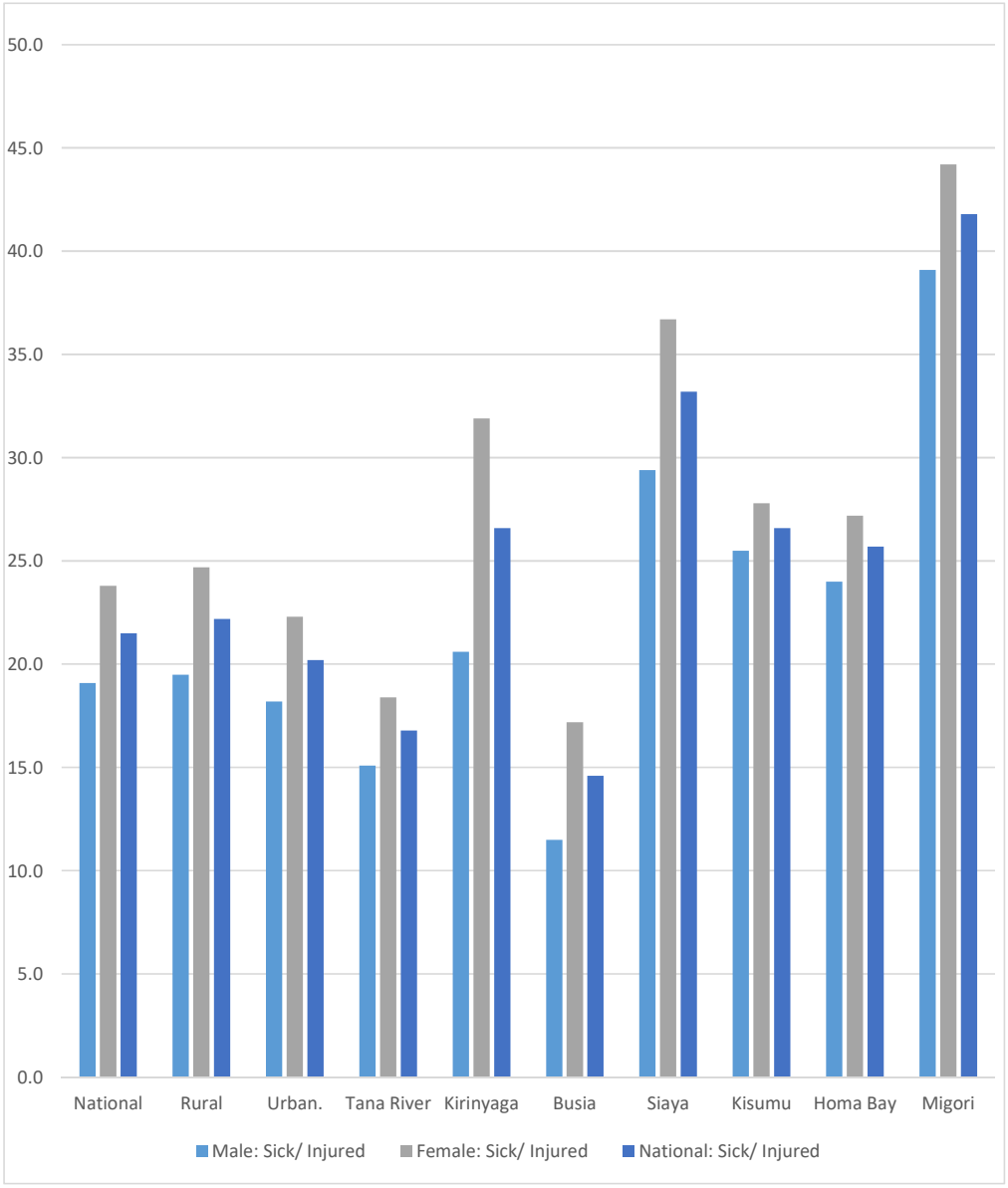


Kisumu, Migori and Homabay had similar Male Literate and Female Literate

Homabay had low National illeterate and Male illeterate compared to Kisumu or Migori

Table 5.1: Percentage Distribution of the Population by Incidence of Sickness/Injury by Sex, Residence and County

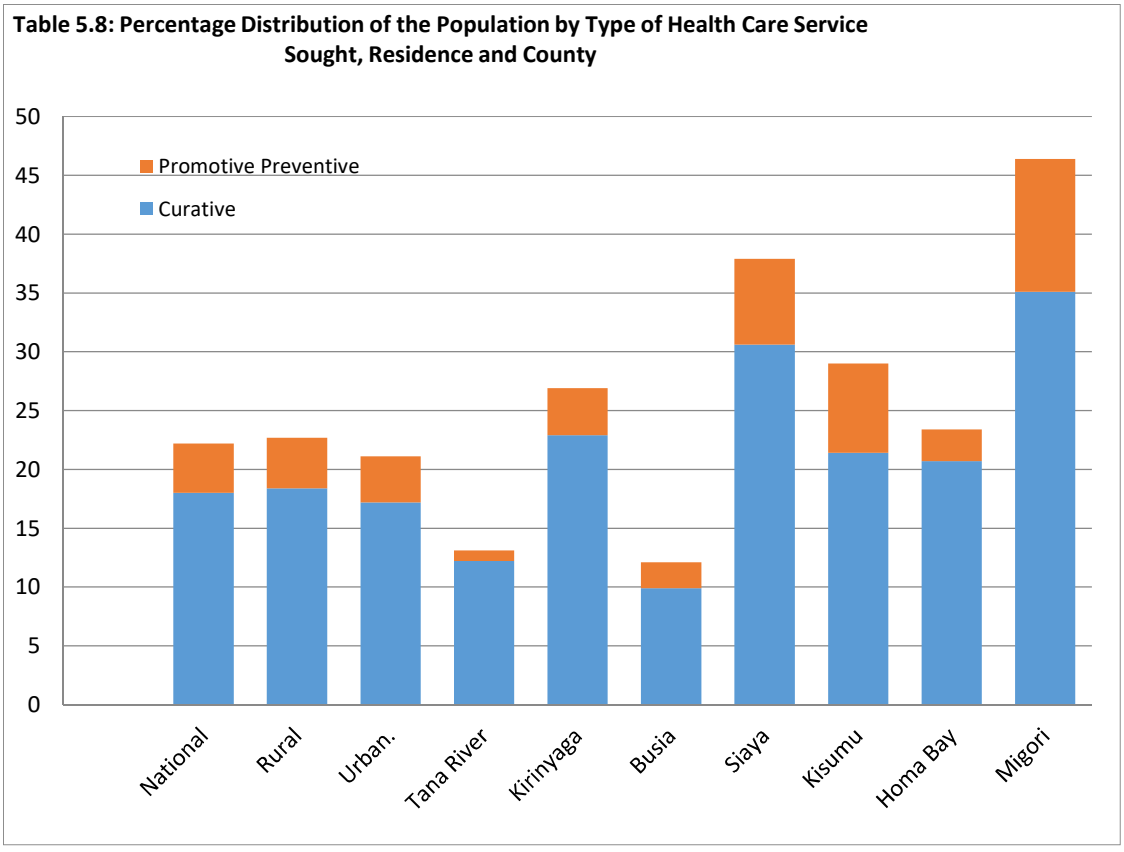
Residence/ County	Male:		Female:		National:	
	Sick/ Injured	Number of Individuals ('000)	Sick/ Injured	Number of Individuals ('000)	Sick/ Injured	Number of Individuals ('000)
National	19.1	22393.0	23.8	22978.0	21.5	45,371
Rural	19.5	14212.0	24.7	14915.0	22.2	29,127
Urban.	18.2	8181.0	22.3	8064.0	20.2	16,245
Tana River	15.1	150.0	18.4	153.0	16.8	304
Kirinyaga	20.6	284.0	31.9	324.0	26.6	608
Busia	11.5	379.0	17.2	462.0	14.6	840
Siaya	29.4	466.0	36.7	519.0	33.2	985
Kisumu	25.5	593.0	27.8	539.0	26.6	1,132
Homa Bay	24.0	512.0	27.2	560.0	25.7	1,072
Migori	39.1	533.0	44.2	593.0	41.8	1,126



Kisumu Homabay and National have significantly similar Male sick/Injured and Female/Sick distribution
Migori male and Female injured/sick significantly more than in Kisumu ,Homabay or National

Table 5.8: Percentage Distribution of the Population by Type of Health Care Service Sought, Residence and County

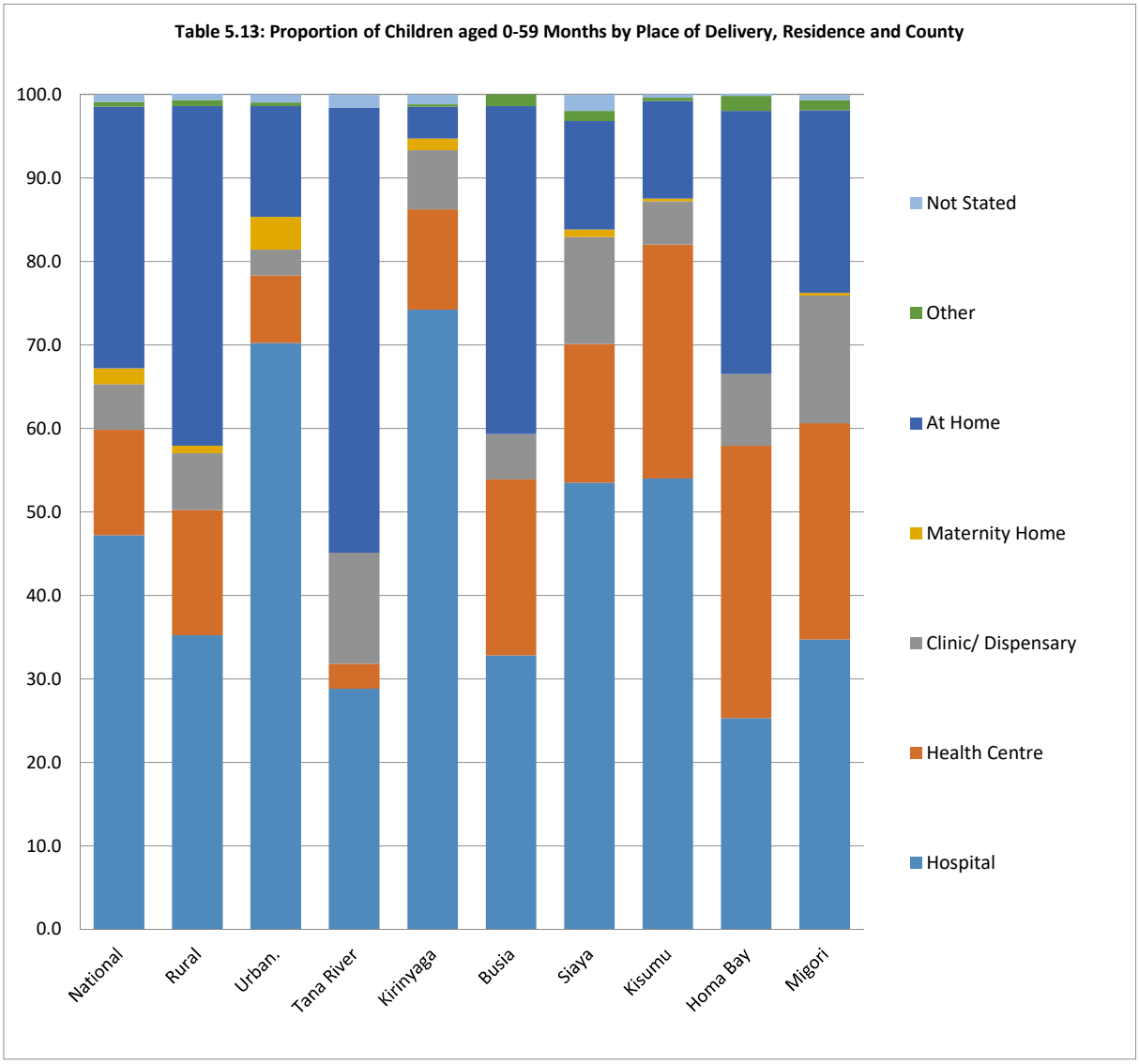
Residence/ County	Curative	Promotive Preventive	Number of Individuals ('000)
National	18.0	4.2	45,371
Rural	18.4	4.3	29,127
Urban.	17.2	3.9	16,245
Tana River	12.2	0.9	304
Kirinyaga	22.9	4.0	608
Busia	9.9	2.2	840
Siaya	30.6	7.3	985
Kisumu	21.4	7.6	1,132
Homa Bay	20.7	2.7	1,072
Migori	35.1	11.3	1,126



Migori seek more Curative healthcare services than Homabay , Kisumu, National, Urban or Rural
Migori seek more Promotive Preventive services than Kisumu or Homabay
National, Rural and Urban significantly similar
Homabay seek least Promotive/Preventive services compared to Kisumu or Migori

Table 5.13: Proportion of Children aged 0-59 Months by Place of Delivery, Residence and County

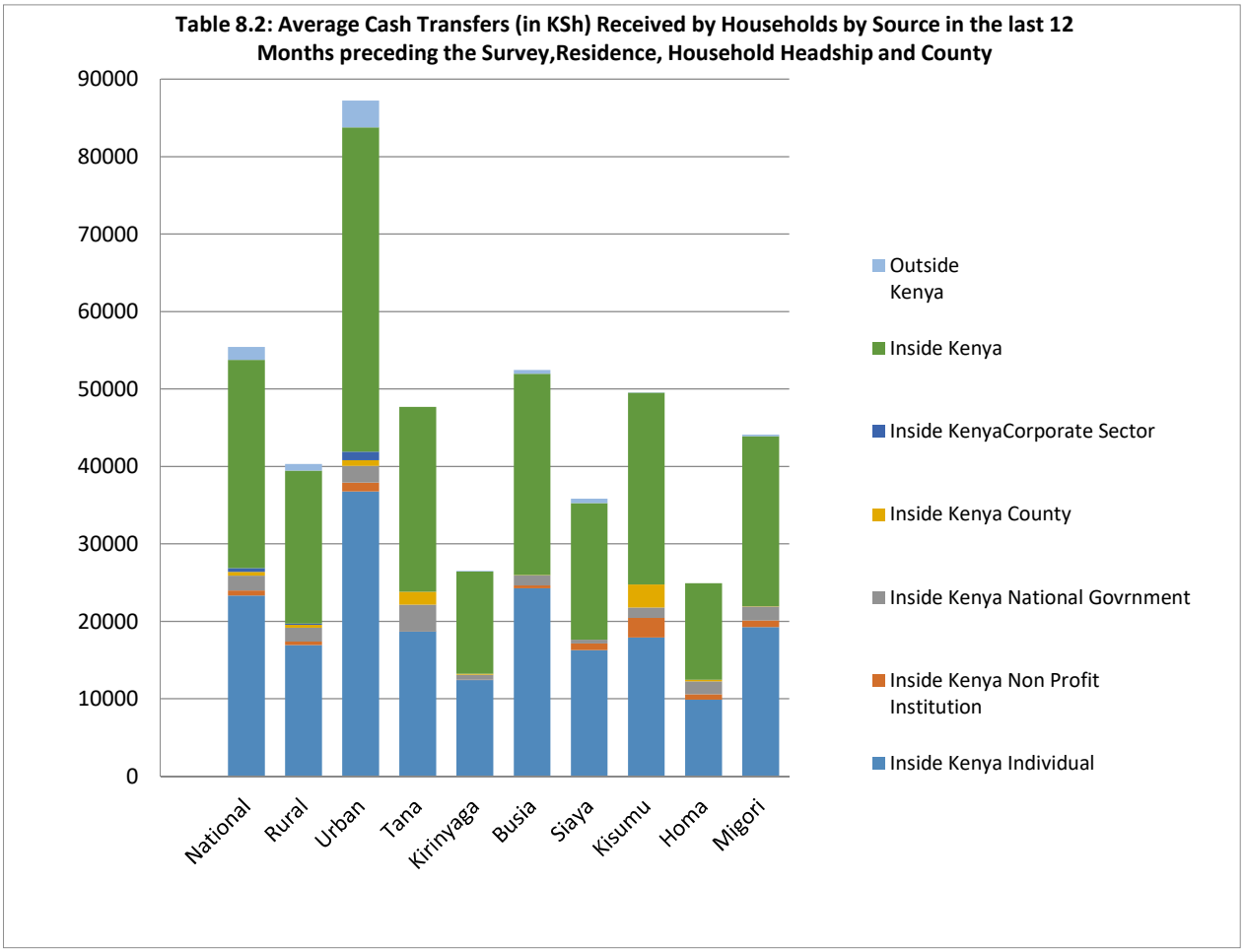
Residence/ County	Hospital	Health Centre	Clinic/ Dispensary	Maternity Home	At Home	Other	Not Stated	Number of Individuals ('000)
National	47.2	12.6	5.5	1.9	31.3	0.6	0.9	6,081
Rural	35.2	15.0	6.8	0.9	40.7	0.7	0.8	3,991
Urban.	70.2	8.1	3.1	3.9	13.3	0.4	1.0	2,090
Tana River	28.8	3.0	13.3	0.0	53.3	0.0	1.5	48
Kirinyaga	74.2	12.0	7.1	1.4	3.8	0.3	1.1	56
Busia	32.8	21.1	5.4	0.0	39.3	1.4	0.0	110
Siaya	53.5	16.6	12.8	0.9	13.0	1.2	1.9	133
Kisumu	54.0	28.0	5.2	0.3	11.7	0.4	0.4	152
Homa Bay	25.3	32.6	8.6	0.0	31.5	1.8	0.3	177
Migori	34.7	25.9	15.3	0.3	21.9	1.2	0.6	154



Kisumu has significantly more Hospital children deliveries than Migori or Homabay
Migori and Homabay have Hospital deliveries significantly similar to Rural
Kisumu, Migori and Homabay have similar Health Centre deliveries
Migori has significantly more Clinic/Dispensary deliveries than Kisumu or Homabay
Homabay and Migori have significantly similar Home deliveries
Migori has some siginficantly small maternity home deliveries compared to Kisumu or Homabay

Table 8.2: Average Cash Transfers (in KSh) Received by Households by Source in the last 12 Months preceding the Survey, Residence, Household Headship and County

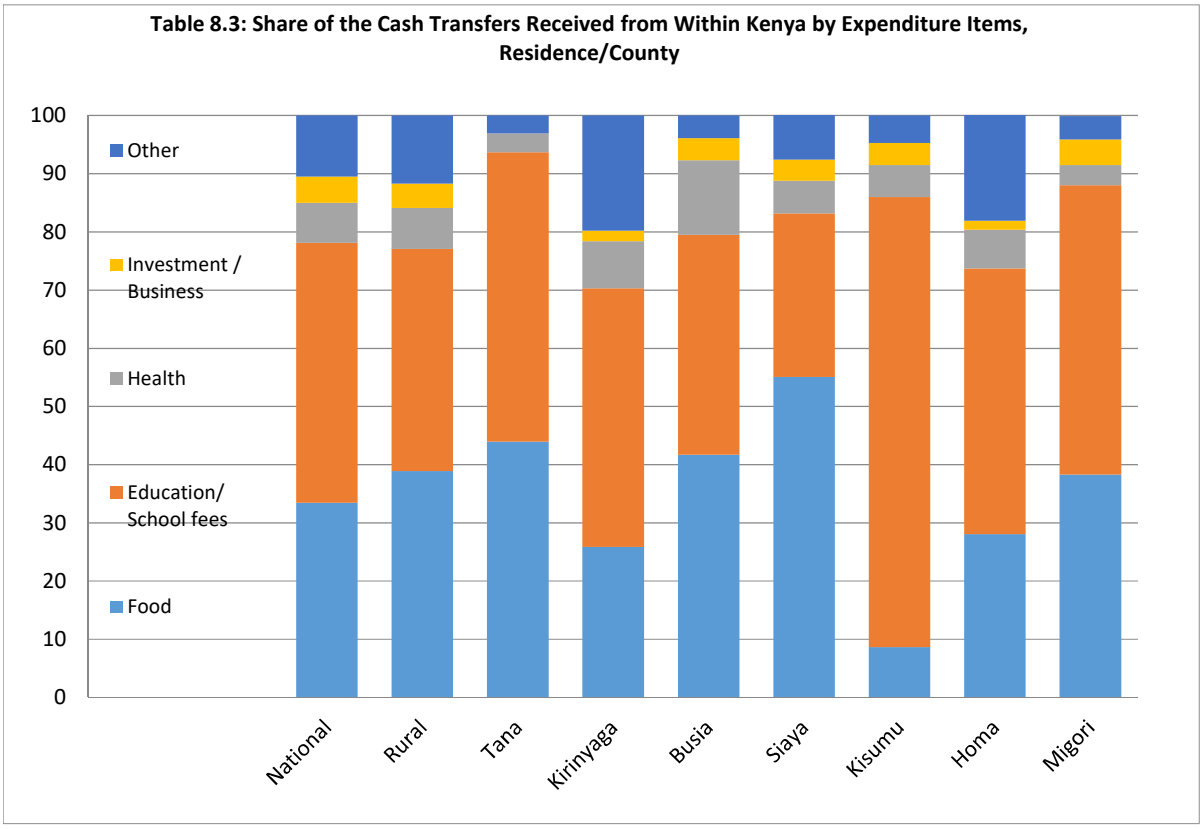
Residence / County	Inside Kenya Individual	Inside Kenya Non Profit Institution	Inside Kenya National Govrnment	Inside Kenya County	Inside KenyaCorporate Sector	Inside Kenya	Outside Kenya	Total
National	23,327	668	1,922	473	482	26,871	1,706	55,449
Rural	16,927	439	1,819	338	203	19,725	865	40,316
Urban	36,780	1,148	2,140	756	1,067	41,891	3,472	87,254
Tana	18,680	12	3,455	1,693	-	23,840	-	47,680
Kirinyaga	12,424	46	635	112	-	13,217	56	26,490
Busia	24,273	370	1,293	49	-	25,986	498	52,469
Siaya	16,294	856	487	-	-	17,636	571	35,844
Kisumu	17,899	2,539	1,342	2,989	-	24,769	34	49,572
Homa	9,884	697	1,653	229	-	12,462	-	24,925
Migori	19,261	843	1,797	59	-	21,960	177	44,097



Kisumu and Migori has similar Inside Kenya Individual cash transfers
Kisumu has more Inside Kenya non-profit and Inside Kenya County Cash transfers than Migori or Homabay
Homabay haad generally least average cash transfers compared to Kisumu or Migori
Kisumu and Migori had similar Inside Kenya cash transfers

Table 8.3: Share of the Cash Transfers Received from Within Kenya by Expenditure Items, Residence/County

Residence/ Household headship / County	Food	Education/ School fees	Health	Investment / Business	Other	Total cash transfers received (KSh million)
National	33.5	44.6	6.9	4.5	10.5	97,768
Rural	38.9	38.2	7.0	4.2	11.7	49,726
Tana	44.0	49.7	3.2	0.0	3.1	467
Kirinyaga	25.9	44.4	8.1	1.8	19.8	1,196
Busia	41.7	37.8	12.8	3.8	3.9	1,445
Siaya	55.1	28.1	5.6	3.6	7.7	2,155
Kisumu	8.7	77.3	5.5	3.8	4.7	1,815
Homa	28.1	45.6	6.7	1.5	18.2	1,156
Migori	38.3	49.7	3.5	4.4	4.0	2,465



Kisumu has the least cash transfer expenditure on food compared to Migori or Homabay

Migori has more cash transfer expenditure on food compared to Homabay

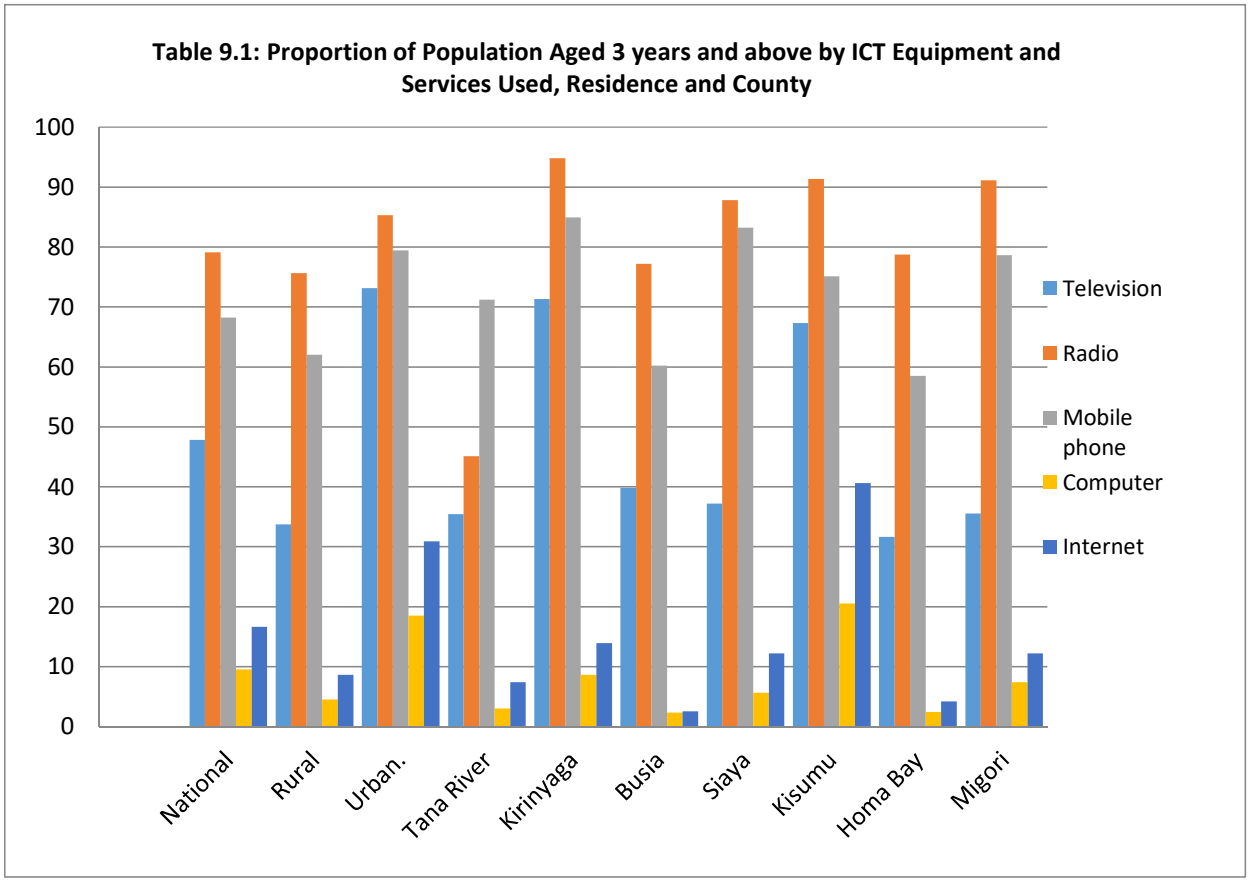
Kisumu has more cash transfer expenditure on Education/school fee compared to Migori or Homabay

Kisumu and Migori had similar cash transfer expenditure on business

Migori has least cash transfer expenditure on health compared to Kisumu or Homabay

Table 9.1: Proportion of Population Aged 3 years and above by ICT Equipment and Services Used, Residence and County

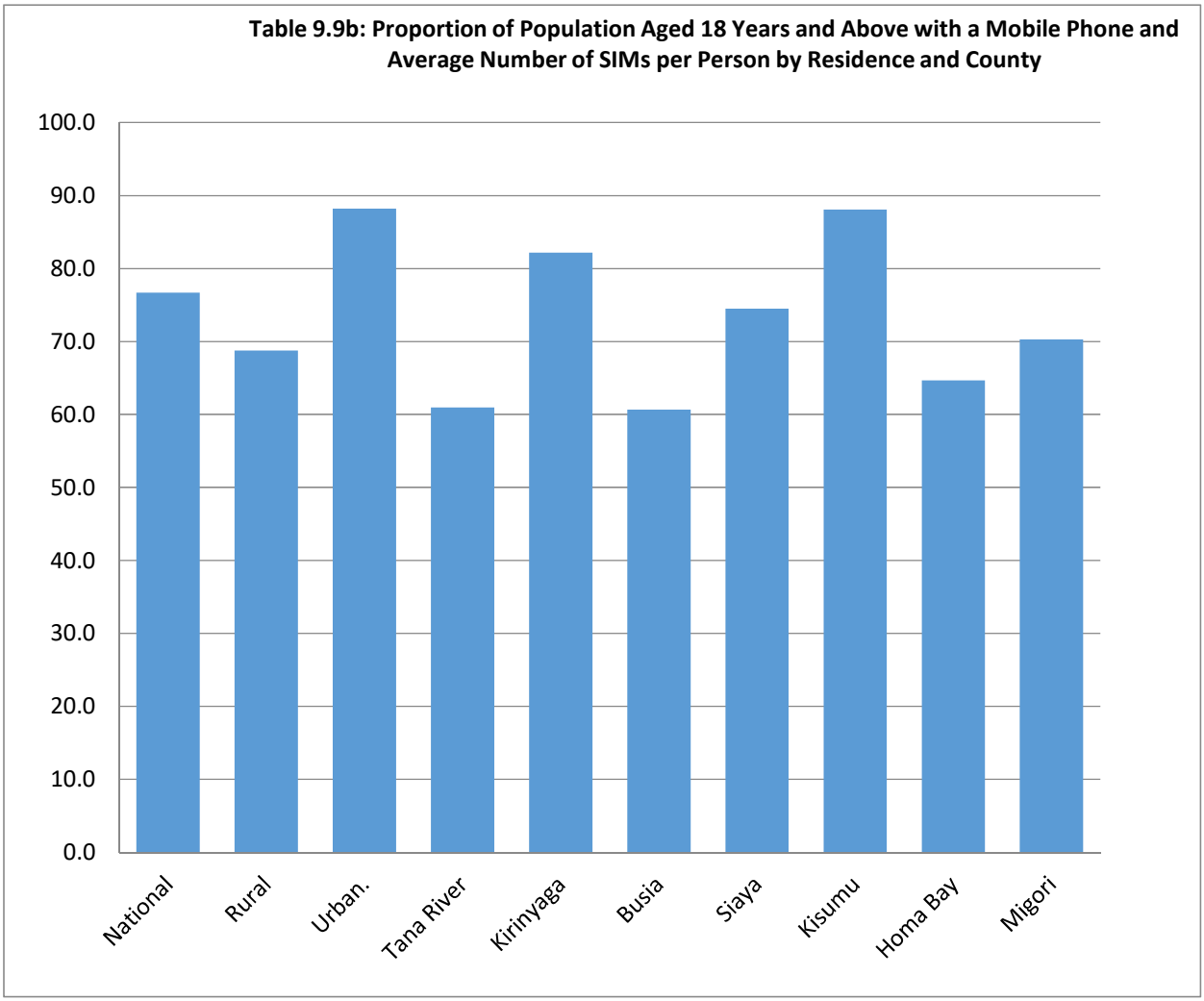
Residence/ County	Television	Radio	Mobile phone	Computer	Internet	Population aged 3 years and above ('000)
National	47.8	79.1	68.2	9.5	16.6	41,751
Rural	33.7	75.6	62.0	4.5	8.6	26,795
Urban.	73.1	85.3	79.4	18.5	30.9	14,956
Tana River	35.4	45.1	71.2	3.0	7.4	276
Kirinyaga	71.3	94.8	84.9	8.6	13.9	571
Busia	39.8	77.2	60.2	2.3	2.5	774
Siaya	37.2	87.8	83.2	5.6	12.2	907
Kisumu	67.3	91.3	75.1	20.5	40.6	1,049
Homa Bay	31.6	78.7	58.5	2.4	4.2	970
Migori	35.5	91.1	78.6	7.4	12.2	1,037



- Kisumu has more proportion on Television compared to Migori or Homabay
- Kisumu, Migori and Homabay have similar proportions on Radio and mobile phone number
- kisumu had more proportions for Internet compared to Homabay or Migori
- Homabay has least proportions for computer compared to Migori or Kisumu
- Migori had similar proportions to Rural

Table 9.9b: Proportion of Population Aged 18 Years and Above with a Mobile Phone and Average Number of SIMs per Person by Residence and County

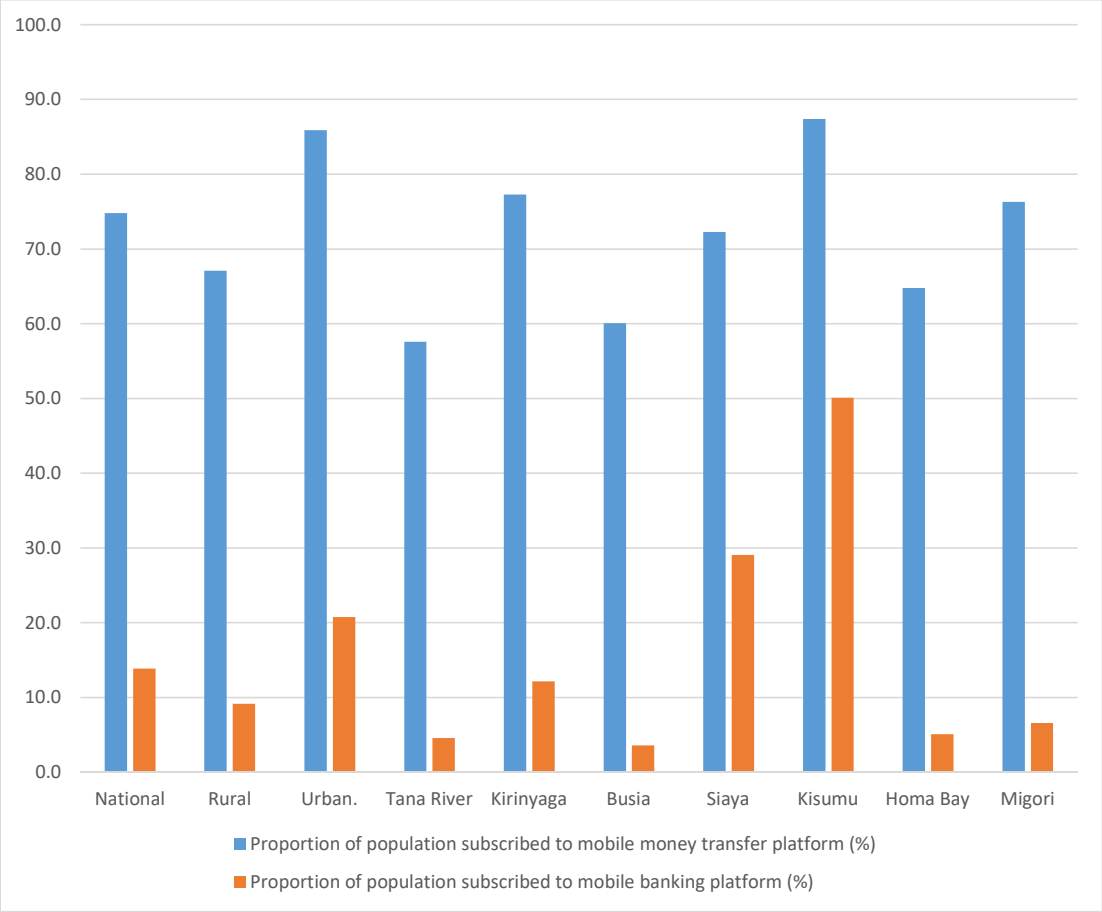
Residence/ County	Proportion of population that have a mobile phone (%)	Population 18+ years ('000)	Average SIM cards per person (Number)	Population 18+ years having SIM Cards ('000)
National	76.7	23,462	1.3	18,002
Rural	68.8	13,878	1.3	9,553
Urban.	88.2	9,584	1.4	8,449
Tana River	61.0	135	1.4	82
Kirinyaga	82.2	365	1.3	300
Busia	60.7	384	1.2	233
Siaya	74.5	467	1.3	347
Kisumu	88.1	576	1.4	508
Homa Bay	64.7	447	1.3	289
Migori	70.3	487	1.2	343



Kisumu, Homabay and Migori had significantly similar low proportions compared to Rural Urban or National

Table 9.13: Proportion of Population Aged 18 Years and Above that Subscribed to Mobile Money Transfer and Mobile Banking Platforms by Residence and County

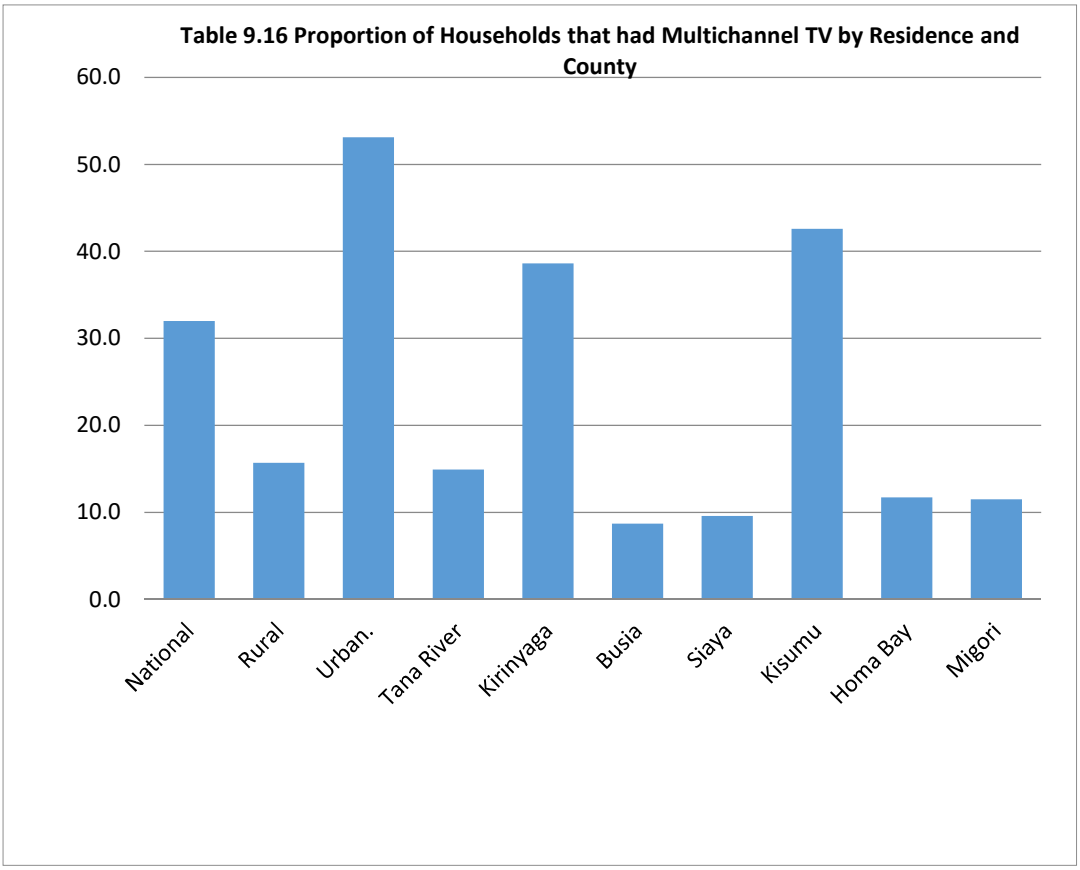
Residence/ County	Proportion of population subscribed to mobile money transfer platform (%)	Proportion of population subscribed to mobile banking platform (%)	Population aged 18 years and above ('000)
National	74.8	13.9	23,462
Rural	67.1	9.2	13,878
Urban.	85.9	20.8	9,584
Tana River	57.6	4.6	135
Kirinyaga	77.3	12.2	365
Busia	60.1	3.6	384
Siaya	72.3	29.1	467
Kisumu	87.4	50.1	576
Homa Bay	64.8	5.1	447
Migori	76.3	6.6	487



Kisumu, Migori and Homabay had similarly low proportion of subscribers to mobile money compared
to those of National, Rural or Urban
Kisumu had more subscribers to mobile money comparesd to Migori or Homabay

Table 9.16 Proportion of Households that had Multichannel TV or Decoders by Residence and County

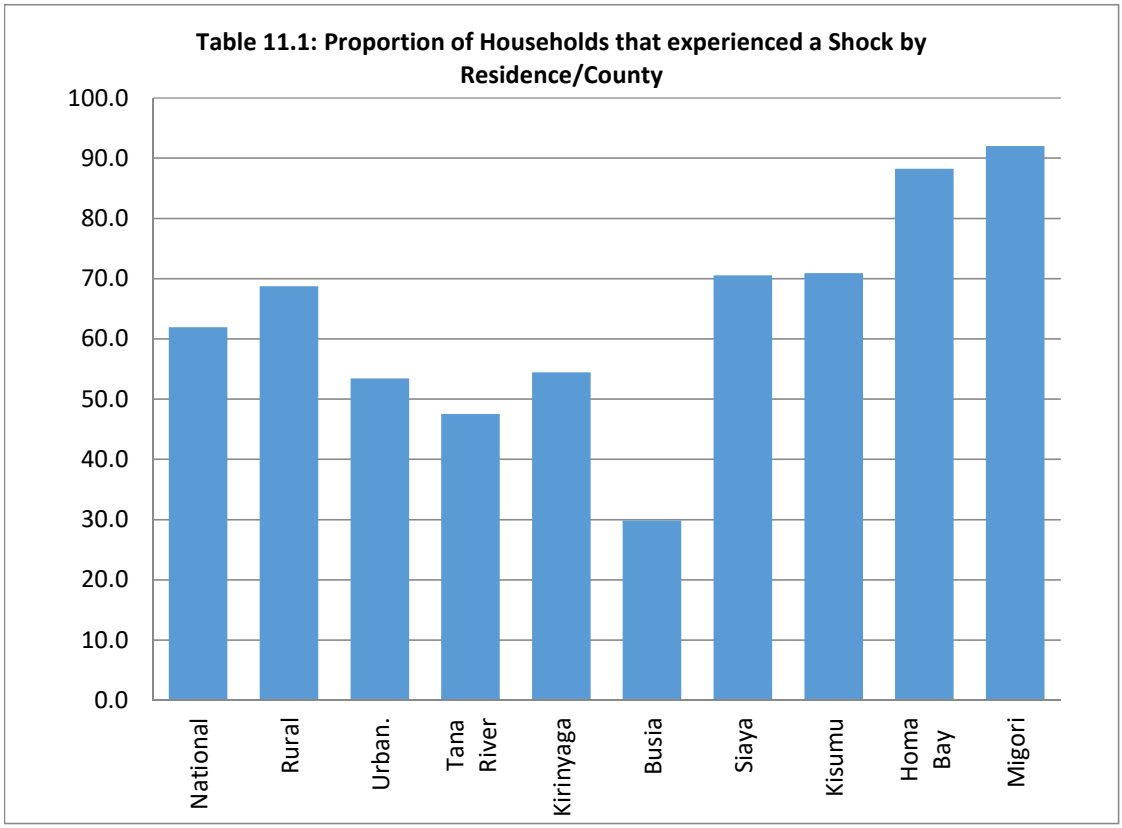
Residence / County	Proportion of Households with TV	Number of Households ('000)	Households with TV					
			Built-in Digital TV	Pay TV Dercorder	Free to air set box	Internet protocal TV	None	Number of Households with TV
National	32.0	11,415	4.8	57.3	25.5	0.4	13.5	3,649
Rural	15.7	6,442	4.4	47.1	29.2	0.1	19.7	1,009
Urban.	53.1	4,972	4.9	61.2	24.1	0.5	11.1	2,640
Tana River	14.9	56	11.3	53.9	7.8	0.0	31.7	8
Kirinyaga	38.6	198	1.5	43.4	40.4	0.0	15.5	77
Busia	8.7	177	21.8	66.2	1.2	0.0	16.1	15
Siaya	9.6	246	6.1	76.3	3.3	4.7	11.0	24
Kisumu	42.6	284	6.9	77.4	10.0	0.0	7.4	121
Homa Bay	11.7	224	5.2	63.1	0.0	0.0	31.6	26
Migori	11.5	233	4.1	49.2	25.2	0.0	22.4	27



Kisumu Homabay and Migori had similar low household proportions with decoders or Multichannel TV
Migori had households proportions with build in Digital TV compared to Homabay

Table 11.1: Proportion of Households that experienced a Shock by Residence/County

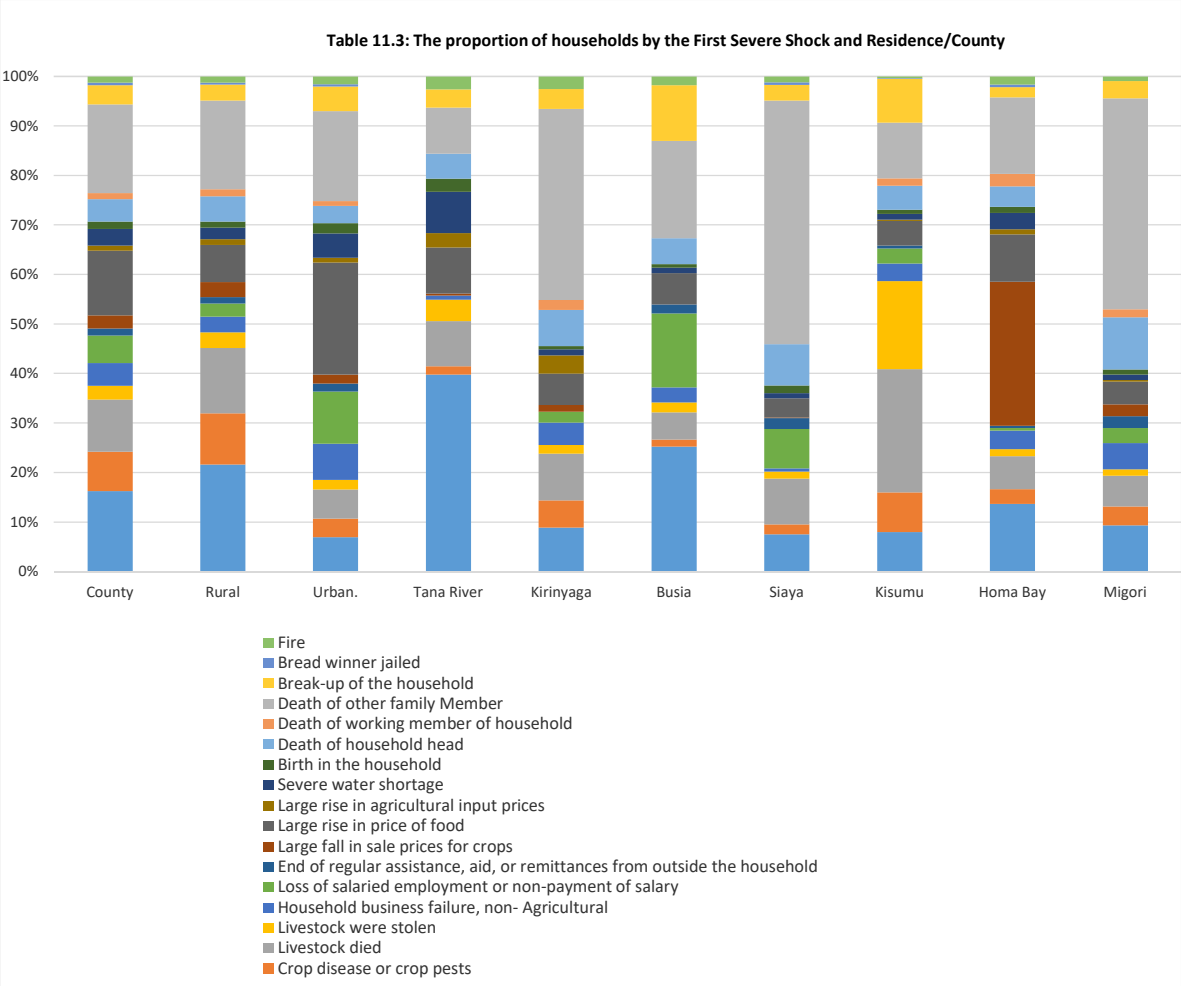
Residence/ County	Percentage of Households reporting any shock	Number of households ('000)
National	61.9	11,415
Rural	68.7	6,431
Urban.	53.4	4,963
Tana River	47.5	56
Kirinyaga	54.4	198
Busia	29.8	177
Siaya	70.5	246
Kisumu	70.9	284
Homa Bay	88.2	224
Migori	92.0	233



Homabay and Migori had similar percentage reporting any shock
Kisumu, Migori and Homabay had least proportion of households experiencing shock compared to National, Rural and Urban

Table 11.3: The proportion of households by the First Severe Shock and Residence/County

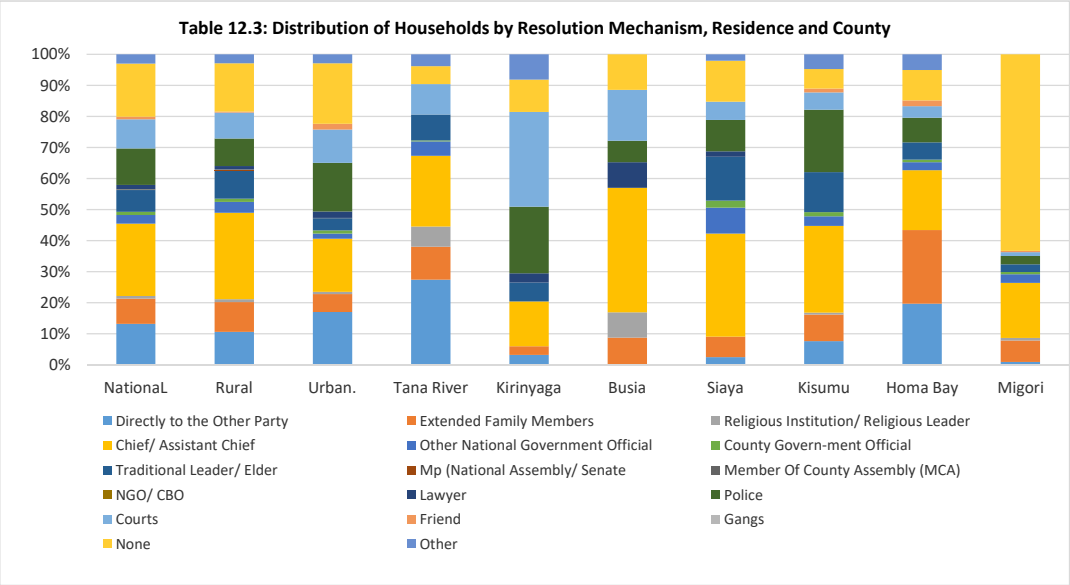
Residence/ County	Droughts or Floods	Crop disease or crop pests	Livestock died	Livestock were stolen	Household business failure, non-Agricultural	Loss of salaried employment or non-payment of salary	End of regular assistance, aid, or remittances from outside the household	Large fall in sale prices for crops	Large rise in price of food	Large rise in agricultural input prices	Severe water shortage	Birth in the household	Death of household head	Death of working member of household	Death of other family Member	Break-up of the household	Bread winner jailed	Fire
County	13.7	6.7	8.9	2.3	3.9	4.7	1.2	2.2	11.0	0.9	2.8	1.3	3.8	1	15.1	3.3	0.4	1.1
Rural	18.5	8.8	11.3	2.7	2.7	2.3	1.1	2.6	6.4	1	2	1	4.4	1.2	15.3	2.8	0.3	1.1
Urban.	5.7	3.1	4.8	1.6	6.0	8.7	1.3	1.5	18.6	0.8	4	1.7	2.9	0.8	14.9	4.1	0.4	1.3
Tana Ri	32.9	1.4	7.5	3.6	0.7	0.0	0.0	0.3	7.7	2.4	6.9	2.2	4.2	0	7.7	3	0	2.2
Kirinyag	6.5	4.0	6.9	1.3	3.3	1.6	0.0	1.0	4.6	2.7	0.9	0.5	5.3	1.5	28.2	2.9	0	1.9
Busia	13.9	0.8	3.0	1.1	1.7	8.2	1.0	0.0	3.5	0	0.6	0.4	2.9	0	10.8	6.2	0	1
Siaya	5.7	1.5	7.0	1.1	0.5	6.0	1.7	0.1	2.9	0	0.8	1.2	6.3	0	37.3	2.4	0.4	0.9
Kisumu	6.6	6.6	20.5	14.7	2.9	2.5	0.5	0.0	4.1	0.2	1	0.7	4	1.2	9.3	7.3	0.1	0.3
Homa B	12.5	2.7	6.1	1.3	3.4	0.5	0.4	26.6	8.7	1	3	1.1	3.8	2.3	14.1	1.9	0.5	1.5
Migori	8.6	3.5	5.7	1.2	4.9	2.8	2.2	2.2	4.2	0.3	1	1	9.7	1.5	39.2	3.2	0	0.9



Migorihad more Drought or Flood related first severe shock than Kisumu or Homabay
Kisumu had more crop disease and pest first severe shock compared to Homabay or Migori
Kisumu had more dead livestock first severe shock compared to Migori or Homabay
Homabay had more Large fall in sale price for crops as first severe shock, compared to Kisumu or Migori
Homabay and Migori had sightly more severe water shortage compared to Kisumu
Homabay, Migori and Kisumu had similar proportiopn to Large rise in price of food as first severe shock
Migori had more Birth in the household severe shock compared to Kisumu or Migori
Migori, Kisumu and Homabay had similar end of asssistance aid as first severe shock

Table 12.3: Distribution of Households by Resolution Mechanism, Residence and County

Residence/ County	Directly to the Other Party	Extended Family Members	Religious Institution/ Religious Leader	Chief/ Assistant Chief	Other National Government Official	County Govern-ment Official	Traditional Leader/ Elder	Mp (National Assembly/ Senate	Member Of County Assembly (MCA)	NGO/ CBO	Lawyer	Police	Courts	Friend	Gangs	None	Other	Number of Households with Grievance ('000
National	13.2	8.1	0.8	23.3	2.8	1.0	7.0	0.0	0.1	0.1	1.5	11.7	9.3	0.9	0	17.1	2.9	1,832
Rural	10.6	9.7	0.9	27.8	3.6	1.0	9.2	0.1	0.0	0.1	1.1	8.9	8.4	0.3	0	15.5	2.9	1,076
Urban.	17.0	5.8	0.7	17.1	1.7	1.0	3.9	0.0	0.1	0	2.1	15.7	10.7	1.9	0	19.4	2.9	756
Tana Ri	27.4	10.7	6.5	22.7	4.7	0.3	8.3	0.0	0.0	0	0	0	9.8	0	0	5.8	3.8	6
Kirinyag	3.2	2.8	0.0	14.4	0.0	0.0	6.1	0.0	0.0	0	3	21.4	30.5	0	0	10.4	8.1	29
Busia	0.0	8.8	8.1	40.1	0.0	0.0	0.0	0.0	0.0	0	8.3	6.9	16.4	0	0	11.4	0	5
Siaya	2.5	6.6	0.0	33.2	8.3	2.3	14.1	0.0	0.0	0	1.8	10.1	5.9	0	0	13.2	2	37
Kisumu	7.7	8.5	0.6	28.0	3.1	1.3	12.9	0.0	0.0	0	0	20.1	5.6	1.2	0	6.3	4.7	80
Homa B	19.7	23.8	0.0	19.3	2.6	0.8	5.5	0.0	0.0	0	0	8	3.7	1.9	0	9.8	5	47
Migori	0.9	7.0	0.8	17.7	2.8	0.7	2.5	0.0	0.0	0	0	2.7	1.3	0.4	0	63.3	0	66



- Migori had least direct to other party resolution mechanism compared to Kisumu or Migori
- Homabay had more Extended family members resolution compared to Kisumu or Migori
- Migori had most none resolution compared to Kisumu or Homabay
- Kisumu had more lawyer resolution compared to Migori or Homabay
- Kisumu, Migori and Homabay had similar chief resolution
- Migori had more Religious institution resolution compared to Homabay or Kisumu
- Kisumu had more police resolution compared to Migori or Homabay
- Migori had least courts resolution compared to Homabay or Kisumu

Annex 4 Project Cost Estimation

1. Breakdown of each Category / Component

1-1. Infrastructure Improvement

1-1-1. Ahero Irrigation Scheme

(1) Category : Intake by Pump

a) Component: Rehabilitation of Pump System (Normal)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Irrigation Pump	Q = 1.10 m3/s	2 nos.	30,000,000 Ksh./nos.	Ksh. 60,000,000	Unit cost is referred to the previous ODA projects etc.
Irrigation Pump	Q = 0.66 m3/s	2 nos.	20,000,000 Ksh./nos.	Ksh. 40,000,000	
			Total	Ksh. 100,000,000	

b) Component: Rehabilitation/Upgrading of Pump System with New Technology (e.g. Solar System)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Irrigation Pump	Q = 1.10 m3/s	2 nos.	30,000,000 Ksh./nos.	Ksh. 60,000,000	Unit cost is referred to the previous ODA projects etc.
Irrigation Pump	Q = 0.66 m3/s	2 nos.	20,000,000 Ksh./nos.	Ksh. 40,000,000	
Solar System	Q = 1.10 m3/s	1 set	25,000,000 Ksh./set	Ksh. 25,000,000	
Solar System	Q = 0.66 m3/s	1 set	15,000,000 Ksh./set	Ksh. 15,000,000	
			Total	Ksh. 140,000,000	

(2) Category : Intake by Gravity

a) Introduction of the Gravity System without Dam (No Expansion, Ahero; 867 ha)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Headworks	L=58.5 m, H=5.5m	1 set	500,000,000 Ksh./set	Ksh. 500,000,000	Unit cost is referred to the previous ODA projects etc.
Conveyance Canal	Q = 2.2 m3/s, Open Cannel	10.0 km	49,400 Ksh./m	Ksh. 494,000,000	Unit Construction Cost No.14
			Total	Ksh. 994,000,000	

b) Introduction of the Gravity System with Koru Dam up to (Extension: 3,414 ha, including Existing Ahero (867 ha) and West Kano (892 ha) : 5,713 ha in Total)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Dam	Live storage = 71.7m3	1 set	20,000,000,000 Ksh./set	Ksh. 20,000,000,000	Unit cost is referred to the previous ODA projects etc.
Headworks	L=58.5m, H=5.5m	1 set	500,000,000 Ksh./set	Ksh. 500,000,000	
Conveyance Canal	Q = 6.6 m3/s, Open Cannel	10.0 km	85,500 Ksh./m	Ksh. 855,000,000	Unit Construction Cost No.13
			Total	Ksh. 21,355,000,000	

(3) Category : Canals

a) Rehabilitation of Existing Canal System (No Expansion)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal	Q = 1.76 m3/s	9.7 km	8,000 Ksh./m	Ksh. 77,600,000	Unit Construction Cost No.8
Secondary Canal	Q = ** m3/s	85.4 km	4,100 Ksh./m	Ksh. 350,140,000	Unit Construction Cost No.10
Tertiary Drain		93.5 km	1,400 Ksh./m	Ksh. 130,900,000	Unit Construction Cost No.23
Farm Road	W=5m, Soil Pavement	65.0 km	1,200 Ksh./m	Ksh. 78,000,000	Unit Construction Cost No.27
Farm Road (Evacuation Road)	Height: Half of Dyke	5.0 km	14,400 Ksh./m	Ksh. 72,000,000	Unit Construction Cost No.28
			Total	Ksh. 708,640,000	

b) Introduction of New Canal System in Extension Area (a part of Extension Area: 451 ha)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Canal System		451 ha	280,000 Ksh./ha	Ksh. 126,280,000	Unit Cost = (1,204,140,000 Ksh.) / (4,306 ha)
			Total	Ksh. 126,280,000	

c) Introduction of New Canal System in Extension Area (Extension: 3,414 ha+W Kano: 892ha=4,306 ha)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal (Expanded)	Q=3.2 m3/s	4.9 km	11,500 Ksh./m	Ksh.56,350,000	Unit Construction Cost No.1
New Main Canal 1	Q=0.89 m3/s	1.3 km	7,400 Ksh./m	Ksh.9,620,000	Unit Construction Cost No.3
New Main Canal 2	Q=2.2 m3/s	1.6 km	9,500 Ksh./m	Ksh.15,200,000	Unit Construction Cost No.2
Secondary Canal (Area 1)	B=1.2m	37.9 km	5,800 Ksh./m	Ksh.219,820,000	Unit Construction Cost No.4
Secondary Canal (Area 2)	B=1.2m	30.1 km	5,800 Ksh./m	Ksh.174,580,000	Unit Construction Cost No.4
Secondary Canal (Area 3)	B=1.2m	7.6 km	5,800 Ksh./m	Ksh.44,080,000	Unit Construction Cost No.4
Secondary Canal (Area 4)	B=1.2m	8.3 km	5,800 Ksh./m	Ksh.48,140,000	Unit Construction Cost No.4
Secondary Drain (Area 1)	B=1.0m	35.8 km	2,300 Ksh./m	Ksh.82,340,000	Unit Construction Cost No.20
Secondary Drain (Area 2)	B=1.0m	20.9 km	2,300 Ksh./m	Ksh.48,070,000	Unit Construction Cost No.20
Secondary Drain (Area 3)	B=1.0m	5.1 km	2,300 Ksh./m	Ksh.11,730,000	Unit Construction Cost No.20
Secondary Drain (Area 4)	B=1.0m	3.4 km	2,300 Ksh./m	Ksh.7,820,000	Unit Construction Cost No.20
Tertiary Canal		90.6 km	3,000 Ksh./m	Ksh.271,800,000	Unit Construction Cost No.5
Tertiary Drains		93.3 km	2,300 Ksh./m	Ksh.214,590,000	Unit Construction Cost No.20
			Total	Ksh. 1,204,140,000	

(4) Category : Flood Dyke

a) Improvement of Flood Protection Dyke

Item	Specification	Quantity	Unit Cost	Cost	Remark
Dyke (Protection from Flood Caused by Upper Area of Ahero Area)	Height: Half of Nyando River Dyke	13.7 km	14,400 Ksh./m	Ksh. 197,280,000	Unit Construction Cost No.28
Dyke (Protection from Flood Caused by Nyando River)	Size: Nyando River Dyke	8.0 km	27,700 Ksh./m	Ksh. 221,600,000	Unit Construction Cost No.29
			Total	Ksh. 418,880,000	

1-1-2. West Kano Irrigation Scheme

(1) Category: Intake by Pump

a) Component: Rehabilitation of Pump System (Ordinary Repair)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Pump Type 1 (Irrigation)	Q = 0.75 m3/s	3 nos.	25,000,000 Ksh./nos.	Ksh. 75,000,000	Unit cost is referred to the previous ODA projects etc.
Pump Type 2 (Drain)	Q = 0.13 m3/s	2 nos.	5,000,000 Ksh./nos.	Ksh. 10,000,000	
Pump Type 3 (Drain)	Q = 0.5 m3/s	2 nos.	15,000,000 Ksh./nos.	Ksh. 30,000,000	
Flap Gate	H: 1.5m, W= 1.5m	2 nos.	500,000 Ksh./nos.	Ksh. 1,000,000	
			Total	Ksh. 116,000,000	

b) Rehabilitation/Upgrading of Pump System

Item	Specification	Quantity	Unit Cost	Cost	Remark
Pump Type 1 (Irrigation)	Q = 0.75 m3/s	3 nos.	25,000,000 Ksh./nos.	Ksh. 75,000,000	Unit cost is referred to the previous ODA projects etc.
Pump Type 2 (Drain)	Q = 0.13 m3/s	2 nos.	5,000,000 Ksh./nos.	Ksh. 10,000,000	
Pump Type 3 (Drain)	Q = 0.5 m3/s	2 nos.	15,000,000 Ksh./nos.	Ksh. 30,000,000	
Solar System 1 (Irrigation)	Q = 0.75 m3/s	2 nos.	17,000,000 Ksh./nos.	Ksh. 34,000,000	
Solar System 2 (Drain)	Q = 0.13 m3/s	1 nos.	3,500,000 Ksh./nos.	Ksh. 3,500,000	
Solar System 3 (Drain)	Q = 0.5 m3/s	1 nos.	12,000,000 Ksh./nos.	Ksh. 12,000,000	
Flap Gate	H: 1.5m, W= 1.5m	2 nos.	500,000 Ksh./nos.	Ksh. 1,000,000	
			Total	Ksh. 165,500,000	

(2) Category: Canals

a) Rehabilitation of Canal System

Item	Specification	Quantity	Unit Cost	Cost	Remark
Approach Canal		2.2 km	8,000 Ksh./m	Ksh.17,600,000	Unit Construction Cost No.8
Main Canal	Earth	8.7 km	8,000 Ksh./m	Ksh.69,600,000	Unit Construction Cost No.8
Tertiary Canal	Earth	55.5 km	2,100 Ksh./m	Ksh.116,550,000	Unit Construction Cost No.11

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Drain	Earth	9.1 km	2,800 Ksh./m	Ksh.25,480,000	Unit Construction Cost No.22
Tertiary Drain	Earth	102.5 km	1,400 Ksh./m	Ksh.143,500,000	Unit Construction Cost No.23
Farm Road	W=5m, Soil pavement	70.0 km	1,200 Ksh./m	Ksh.84,000,000	Unit Construction Cost No.27
Farm Road } (Evacuation Road)	Height: Half of Nyando River Dyke	2.0 km	14,400 Ksh./m	Ksh.28,800,000	Unit Construction Cost No.30
			Total	Ksh. 485,530,000	

(3) Category: Flood Dyke

a) Improvement of Flood Protection Dyke

Item	Specification	Quantity	Unit Cost	Cost	Remark
Flood Protection Dyke	Height: Half of Nyando River Dyke	15.0 km	14,400 Ksh./m	Ksh.216,000,000	Unit Construction Cost No.30
			Total	Ksh. 216,000,000	

1-1-3. South West Kano Irrigation Scheme

(1) Category: Intake by Gravity

a) Component: Improvement of Intake Structure

Item	Specification	Quantity	Unit Cost	Cost	Remark
Improvement of intake structure	H=1.3m, Concrete	1 set	90,000,000 Ksh./set	Ksh. 90,000,000	Unit cost is referred to the previous ODA projects etc.
			Total	Ksh. 90,000,000	

(2) Category: Canals

a) Rehabilitation of Canal System

Item	Specification	Quantity	Unit Cost	Cost	Remark
By Pass Canal	Earth Lining	500 m	8,000 Ksh./m	Ksh.4,000,000	Unit Construction Cost No.8
	By Pass Canal, Dredging	20,000 m3	622 Ksh./m3	Ksh.12,440,000	Unit Construction Cost No.24
Pipeline	Concrete, D=1500mm	750 m	30,000 Ksh./m	Ksh.22,500,000	Unit cost is referred to the previous ODA projects etc.
	Concrete, D=1500mm	750 m	30,000 Ksh./m	Ksh.22,500,000	
Main Canal, Open Cannel	W=12.25m, B=3.25m, H=2.0m	2,400 m	8,000 Ksh./m	Ksh.19,200,000	Unit Construction Cost No.8
Main Drain		13,400 m	2,800 Ksh./m	Ksh.37,520,000	Unit Construction Cost No.22
Tertiary Canal		4,000 m	2,100 Ksh./m	Ksh.8,400,000	Unit Construction Cost No.11
Tertiary Drain		4,000 m	1,400 Ksh./m	Ksh.5,600,000	Unit Construction Cost No.23
Road		40,000 m	1,200 Ksh./m	Ksh.48,000,000	Unit Construction Cost No.27
			Total	Ksh. 180,160,000	

(3) Category: Flood Dyke

a) Improvement of Flood Protection Dyke

Item	Specification	Quantity	Unit Cost	Cost	Remark
Flood Protection Dyke	Size: Nyando River Dyke	7.0 km	27,700 Ksh./m	Ksh.193,900,000	Unit Construction Cost No.31
			Total	Ksh.193,900,000	

1-1-4. Lower Kuja Irrigation Scheme

(1) Category: Dam

a) Dam Development

Item	Specification	Quantity	Unit Cost	Cost	Remark
Dam	Live Storage = 15.5 M m3	1 set	7,603,000,000 Ksh./set	Ksh.7,603,000,000	Unit Construction Cost No.33
			Total	Ksh.7,603,000,000	

(2) Category: Intake by Gravity

a) Rehabilitation of Headworks

Item	Specification	Quantity	Unit Cost	Cost	Remark
Headworks	L=60 m, H=4 m	1 set	130,000,000 Ksh./set	Ksh.130,000,000	Unit cost is referred to the previous ODA projects etc.
			Total	Ksh.130,000,000	

(3) Category: Canal Plan 1-A (Paddy 2,375 ha + Upland Crop 5,342 ha = 7,717 ha)

a) Rehabilitation of Existing Canal System (Block M: Paddy + Upland Crop = 82 ha)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal		7.3 km	8,000 Ksh./m	Ksh.58,400,000	Unit Construction Cost No.8
Branch Canal		0.0 km	8,000 Ksh./m	Ksh.0	Unit Construction Cost No.8
Sub-branch Canal		0.0 km	5,200 Ksh./m	Ksh.0	Unit Construction Cost No.9
Sango Pipeline		0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
SBC 2-3 Pipeline		0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
Tertiary Canal		1.1 km	2,100 Ksh./m	Ksh.2,310,000	Unit Construction Cost No.11
Tertiary Pipeline	Q=0.18 – 0.92 m3/s (GI)	0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
Feeder Canal		4.8 km	2,100 Ksh./m	Ksh.10,080,000	Unit Construction Cost No.11
Main Drain		0.0 km	2,800 Ksh./m	Ksh.0	Unit Construction Cost No.22
Field Drain		4.7 km	1,400 Ksh./m	Ksh.6,580,000	Unit Construction Cost No.23
Collector Drain		1.6 km	200 Ksh./m	Ksh.320,000	Unit Construction Cost No.25
Access Road		0.0 km	1,200 Ksh./m	Ksh.0	Unit Construction Cost No.27
			Total	Ksh. 77,690,000	

b) New Development of Canal System up to 7,717 ha (Cost: without Block M)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal		0.0 km	11,500 Ksh./m	Ksh.0	Unit Construction Cost No.1
Branch Canal		21.4 km	11,500 Ksh./m	Ksh.246,100,000	Unit Construction Cost No.1
Sub-branch Canal		55.7 km	7,400 Ksh./m	Ksh.412,180,000	Unit Construction Cost No.3
Sango Pipeline		3.9 km	31,900 Ksh./m	Ksh.124,410,000	Unit Construction Cost No.15
SBC 2-3 Pipeline		1.4 km	31,900 Ksh./m	Ksh.44,660,000	Unit Construction Cost No.15
Tertiary Canal		121.8 km	3,000 Ksh./m	Ksh.365,400,000	Unit Construction Cost No.5
Tertiary Pipeline	Q=0.18 – 0.92 m3/s (GI)	15.5 km	31,900 Ksh./m	Ksh.494,450,000	Unit Construction Cost No.15
Feeder Canal		299.4 km	3,000 Ksh./m	Ksh.898,200,000	Unit Construction Cost No.5
Main Drain		90.9 km	4,700 Ksh./m	Ksh.427,230,000	Unit Construction Cost No.19
Field Drain		225.9 km	2,300 Ksh./m	Ksh.519,570,000	Unit Construction Cost No.20
Collector Drain		113.8 km	300 Ksh./m	Ksh.34,140,000	Unit Construction Cost No.21
Access Road		212.0 km	1,500 Ksh./m	Ksh.318,000,000	Unit Construction Cost No.26
			Total	Ksh.3,884,340,000	

c) Land Consolidation (Paddy + Upland Crop)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Land Consolidation (Paddy Field)	Rehabilitation	60 ha	278,000 Ksh./ha	Ksh.16,680,000	Unit Construction Cost No.36
	New Construction	2,315 ha	927,000 Ksh./ha	Ksh.2,146,005,000	Unit Construction Cost No.34
Land Consolidation (Upland Crop)	Rehabilitation	22 ha	70,000 Ksh./ha	Ksh.1,540,000	Unit Construction Cost No.38
	New Construction	5,320 ha	139,000 Ksh./ha	Ksh.739,480,000	Unit Construction Cost No.37
			Total	Ksh.2,903,705,000	

(4) Category: Canal Plan 1-B (Paddy 4,610 ha + Upland Crop 3,107ha = 7,717 ha)

a) Rehabilitation of Existing Canal System (Block M: Paddy + Upland Crop = 82 ha)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal		7.3 km	8,000 Ksh./m	Ksh.58,400,000	Unit Construction Cost No.8
Branch Canal		0.0 km	8,000 Ksh./m	Ksh.0	Unit Construction Cost No.8
Sub-branch Canal		0.0 km	5,200 Ksh./m	Ksh.0	Unit Construction Cost No.9

Item	Specification	Quantity	Unit Cost	Cost	Remark
Sango Pipeline		0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
SBC 2-3 Pipeline		0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
Tertiary Canal		1.1 km	2,100 Ksh./m	Ksh.2,310,000	Unit Construction Cost No.11
Tertiary Pipeline	Q=0.18 – 0.92 m3/s (GI)	0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
Feeder Canal		4.8 km	2,100 Ksh./m	Ksh.10,080,000	Unit Construction Cost No.11
Main Drain		0.0 km	2,800 Ksh./m	Ksh.0	Unit Construction Cost No.22
Field Drain		4.7 km	1,400 Ksh./m	Ksh.6,580,000	Unit Construction Cost No.23
Collector Drain		1.6 km	200 Ksh./m	Ksh.320,000	Unit Construction Cost No.25
Access Road		0.0 km	1,200 Ksh./m	Ksh.0	Unit Construction Cost No.27
			Total	Ksh.77,690,000	

b) New Development of Canal System up to 7,717 ha (Cost: without Block M)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal		0.0 km	11,500 Ksh./m	Ksh.0	Unit Construction Cost No.1
Branch Canal		21.4 km	11,500 Ksh./m	Ksh.246,100,000	Unit Construction Cost No.1
Sub-branch Canal		55.7 km	7,400 Ksh./m	Ksh.412,180,000	Unit Construction Cost No.3
Sango Pipeline		3.9 km	31,900 Ksh./m	Ksh.124,410,000	Unit Construction Cost No.15
SBC 2-3 Pipeline		1.4 km	31,900 Ksh./m	Ksh.44,660,000	Unit Construction Cost No.15
Tertiary Canal		121.8 km	3,000 Ksh./m	Ksh.365,400,000	Unit Construction Cost No.5
Tertiary Pipeline	Q=0.18 – 0.92 m3/s (GI)	15.5 km	31,900 Ksh./m	Ksh.494,450,000	Unit Construction Cost No.15
Feeder Canal		299.4 km	3,000 Ksh./m	Ksh.898,200,000	Unit Construction Cost No.5
Main Drain		90.9 km	4,700 Ksh./m	Ksh.427,230,000	Unit Construction Cost No.19
Field Drain		225.9 km	2,300 Ksh./m	Ksh.519,570,000	Unit Construction Cost No.20
Collector Drain		113.8 km	300 Ksh./m	Ksh.34,140,000	Unit Construction Cost No.21
Access Road		212.0 km	1,500 Ksh./m	Ksh.318,000,000	Unit Construction Cost No.26
			Total	Ksh.3,884,340,000	

c) Land Consolidation (Paddy + Upland Crop)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Land Consolidation (Paddy Field)	Rehabilitation	60 ha	278,000 Ksh./ha	Ksh.16,680,000	Unit Construction Cost No.36
	New Construction	4,610 ha	927,000 Ksh./ha	Ksh.4,273,470,000	Unit Construction Cost No.34
Land Consolidation (Upland Crop)	Rehabilitation	22 ha	70,000 Ksh./ha	Ksh.1,540,000	Unit Construction Cost No.38
	New Construction	3,025 ha	139,000 Ksh./ha	Ksh.420,475,000	Unit Construction Cost No.37
			Total	Ksh.4,712,165,000	

(5) Category: Canal Plan 1-C (Paddy 7,717 ha + Upland Crop 0 ha = 7,717 ha)

a) Rehabilitation of Existing Canal System (Block M: Paddy = 60 ha)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal		7.3 km	12,000 Ksh./m	Ksh.87,600,000	Unit Construction Cost No.8*1.5
Branch Canal		0.0 km	12,000 Ksh./m	Ksh.0	Unit Construction Cost No.8*1.5
Sub-branch Canal		0.0 km	7,800 Ksh./m	Ksh.0	Unit Construction Cost No.9*1.5
Sango Pipeline		0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
SBC 2-3 Pipeline		0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
Tertiary Canal		1.1 km	2,100 Ksh./m	Ksh.2,310,000	Unit Construction Cost No.11
Tertiary Pipeline	Q=0.18 – 0.92 m3/s (GI)	0.0 km	15,900 Ksh./m	Ksh.0	Unit Construction Cost No.16
Feeder Canal		4.8 km	2,100 Ksh./m	Ksh.10,080,000	Unit Construction Cost No.11
Main Drain		0.0 km	2,800 Ksh./m	Ksh.0	Unit Construction Cost No.22
Field Drain		4.7 km	1,400 Ksh./m	Ksh.6,580,000	Unit Construction Cost No.23
Collector Drain		1.6 km	200 Ksh./m	Ksh.320,000	Unit Construction Cost No.25
Access Road		0.0 km	1,200 Ksh./m	Ksh.0	Unit Construction Cost No.27
			Total	Ksh.106,890,000	

b) New Development of Canal System up to 7,717 ha (Cost: without Block M)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Main Canal		0.0 km	17,250 Ksh./m	Ksh.0	Unit Construction Cost No.1*1.5
Branch Canal		21.4 km	17,250 Ksh./m	Ksh.369,150,000	Unit Construction Cost No.1*1.5
Sub-branch Canal		55.7 km	11,100 Ksh./m	Ksh.618,270,000	Unit Construction Cost No.3*1.5
Sango Pipeline		3.9 km	31,900 Ksh./m	Ksh.124,410,000	Unit Construction Cost No.15
SBC 2-3 Pipeline		1.4 km	31,900 Ksh./m	Ksh.44,660,000	Unit Construction Cost No.15
Tertiary Canal		121.8 km	3,000 Ksh./m	Ksh.365,400,000	Unit Construction Cost No.5
Tertiary Pipeline	Q=0.18 – 0.92 m3/s (GI)	15.5 km	31,900 Ksh./m	Ksh.494,450,000	Unit Construction Cost No.15
Feeder Canal		299.4 km	3,000 Ksh./m	Ksh.898,200,000	Unit Construction Cost No.5
Main Drain		90.9 km	4,700 Ksh./m	Ksh.427,230,000	Unit Construction Cost No.19
Field Drain		225.9 km	2,300 Ksh./m	Ksh.519,570,000	Unit Construction Cost No.20
Collector Drain		113.8 km	300 Ksh./m	Ksh.34,140,000	Unit Construction Cost No.21
Access Road		212.0 km	1,500 Ksh./m	Ksh.318,000,000	Unit Construction Cost No.26
			Total	Ksh.4,213,480,000	

c) Land Consolidation (Paddy)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Land Consolidation (Paddy Field)	Rehabilitation	60 ha	278,000 Ksh./ha	Ksh.16,680,000	Unit Construction Cost No.36
	New Construction	4,610 ha	927,000 Ksh./ha	Ksh.4,273,470,000	Unit Construction Cost No.34
	New Construction	3,047 ha	1,622,250 Ksh./ha	Ksh.4,942,995,750	Unit Construction Cost No.35
Land Consolidation (Upland Crop)	Rehabilitation	0 ha	70,000 Ksh./ha	Ksh.0	Unit Construction Cost No.38
	New Construction	0 ha	139,000 Ksh./ha	Ksh.0	Unit Construction Cost No.37
			Total	Ksh.9,233,145,750	

(6) Category: Canal Plan 2 (Paddy 5,047 ha + Upland Crop 11,353 ha = 16,400 ha)

a) Rehabilitation of Existing Canal System (Block M: Paddy + Upland Crop = 82 ha)

b) New Development of Canal System up to 7,717 ha (Cost: without Block M)

c) Land Consolidation (Paddy + Upland Crop)

Item	Specification	Quantity	Unit Cost	Cost	Remark
Canal System	Rehabilitation	82 ha	248,300 Ksh./ha	Ksh.20,360,600	Unit Construction Cost No.18
	New Construction	16,318 ha	355,000 Ksh./ha	Ksh.5,792,890,000	Unit Construction Cost No.17
Land Consolidation (Paddy)	New Construction	5,047 ha	927,000 Ksh./ha	Ksh.4,678,569,000	Unit Construction Cost No.34
Land Consolidation (Upland)	New Construction	11,353 ha	139,000 Ksh./ha	Ksh.1,578,067,000	Unit Construction Cost No.37
			Total	Ksh.12,069,886,600	

(7) Category: Flood Dyke

a) New Development of Flood Dyke

Item	Specification	Quantity	Unit Cost	Cost	Remark
Flood protection (Dyke)	Kuja River	15.0 km	30,800 Ksh./m	Ksh.462,000,000	Unit Construction Cost No.32
	Lake Victoria	6.0 km	30,800 Ksh./m	Ksh.184,800,000	Unit Construction Cost No.32
Drain Pump Station	(if necessary)	1 nos.	30,000,000 Ksh./nos.	Ksh.30,000,000	Unit cost is referred to the previous ODA projects etc.
Flap Valve	H:1.5m, W:1.5m	6 nos.	500,000 Ksh./nos.	Ksh.3,000,000	
			Total	Ksh.679,800,000	

2. Estimation of Unit Cost

2-1. Price Escalation Rate of Construction Cost

Fiscal Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Price Escalation Rate	0.97467	0.98734	1.00000	1.01267	1.02533	1.03800	1.05066	1.06825	1.08583	1.10488

2-2. Estimation of Unit Cost

(1) Unit Construction Cost of Canal, Drain and Road

Item No.	Work Item	Specification	Cost and Quantity in Original Report			Inflation Rate	Converted Unit Cost	Source*	Remark
			Cost	Quantity	Unit Cost (a)	(b)	(c) = (a) x (b)	(Original Report)	
001	New Construction of Irrigation Canal (Earth Lining)	Q > 3.0 m3/s (including the Canal Structures)	Ksh.89,553,862	28,190 m	3,177 Ksh./m	1.13359 (2018/2009)	3,601 Ksh./m	NIB (2009)	Ahero & West Kano
			Ksh.62,966,440	3,600 m	17,491 Ksh./m	1.10488 (2018/2011)	19,325 Ksh./m	NIB (2011)	Lower Kuja (Lot 1)
						Average	**11,500 Ksh./m**		
002	New Construction of Irrigation Canal (Earth Lining)	Q = 1.5 – 2.5 m3/s (including the Canal Structures)				Q > 3.0 m3/s (including the Canal Structures)	11,500 Ksh./m	Item No. 001	
						Q = 0.5 – 1.5 m3/s (including the Canal Structures)	7,400 Ksh./m	Item No. 003	
						Average of Item No. 001 & 003	**9,500 Ksh./m**		
003	New Construction of Irrigation Canal (Earth Lining)	Q = 0.5 – 1.5 m3/s (including the Canal Structures)	Ksh.44,983,584	9,869 m	4,558 Ksh./m	1.10488 (2018/2011)	5,036 Ksh./m	NIB (2011)	Lower Kuja (Lot 4)
			Ksh.45,147,551	5,908 m	7,642 Ksh./m	1.10488 (2018/2011)	8,443 Ksh./m	NIB (2011)	Lower Kuja (Lot 5)
			Ksh.19,706,739	2,519 m	7,823 ksh./m	1.10488 (2018/2011)	8,643 Ksh./m	NIB (2011)	Lower Kuja (Lot 6)
						Average	**7,400 Ksh./m**		
004	New Construction of Irrigation Canal (Earth Lining)	Q < 0.5 m3/s (including the Canal Structures)	Ksh.18,103,904	3,856 m	4,695 Ksh./m	1.10488 (2018/2011)	5,187 Ksh./m	NIB (2011)	Lower Kuja (Lot 4)
			Ksh.5,199,215	856 m	6,074 Ksh./m	1.06443 (2018/2014)	6,465 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
						Average	**5,800 Ksh./m**		
005	New Construction of Irrigation Canal (Earth Lining)	Tertiary Canal, In-field Canal	Ksh.125,724,424	174,288 m	721 Ksh./m	1.13359 (2018/2009)	817 Ksh./m	NIB (2009)	Ahero & West Kano
			Ksh.412,742,765	130,300 m	3,168 Ksh./m	1.10488 (2018/2011)	3,500 Ksh./m	NIB (2011)	Lower Kuja (Lot 1 - 6)
			Ksh.134,647,867	40,539 m	3,321 Ksh./m	1.06443 (2018/2014)	3,535 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
			Ksh.95,325,050	25,093 m	3,799 Ksh./m	1.06443 (2018/2014)	4,044 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**3,000 Ksh./m**		
006	New Construction of Irrigation Canal (Concrete Lining)	B > 3.0 m (including the Canal Structures)	Ksh.402,187,831	7,200 m	NIB (2014)	1.10488 (2018/2011)	61,717 Ksh./m	NIB (2011)	Lower Kuja (Lot 1)
			Ksh.190,632,761	9,250 m	20 609 Ksh./m	1.10488 (2018/2011)	22,770 Ksh./m	NIB (2011)	Lower Kuja (Lot 4)
			Ksh.243,839,440	8,045 m	30,309 Ksh./m	1.06443 (2018/2014)	32,262 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
						Average	**38,900 Ksh./m**		
007	Rehabilitation of Irrigation Canal (Concrete Lining)	B > 3.0 m (including the Canal Structures)	50 % of Construction Cost		27,930 Ksh./m	1.10488 (2018/2011)	30,859 Ksh./m	NIB (2011)	Lower Kuja (Lot 1)
					10,305 Ksh./m	1.10488 (2018/2011)	11,386 Ksh./m	NIB (2011)	Lower Kuja (Lot 4)
					15,155 Ksh./m	1.06443 (2018/2014)	16,131 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
						Average	**19,500 Ksh./m**		

Item No.	Work Item	Specification	Cost and Quantity in Original Report			Inflation Rate (b)	Converted Unit Cost (c) = (a) x (b)	Source* (Original Report)	Remark
			Cost	Quantity	Unit Cost (a)				
008	Rehabilitation of Irrigation Canal (Earth Lining)	Q > 3.0 m3/s (including the Canal Structures)	70 % of Construction Cost		2,224 Ksh./m	1.13359 (2018/2009)	2,521 Ksh./m	NIB (2009)	Ahero & West Kano
					12,244 Ksh./m	1.10488 (2018/2011)	13,528 Ksh./m	NIB (2011)	Lower Kuja (Lot 1)
						Average	**8,000 Ksh./m**		
009	Rehabilitation of Irrigation Canal (Earth Lining)	Q= 0.5 – 1.5 m3/s (including the Canal Structures)	70 % of Construction Cost		3,191 Ksh./m	1.10488 (2018/2011)	3,526 Ksh./m	NIB (2011)	Lower Kuja (Lot 4)
					5,349 Ksh./m	1.10488 (2018/2011)	5,910 Ksh./m	NIB (2011)	Lower Kuja (Lot 5)
					5,476 Ksh./m	1.10488 (2018/2011)	6,050 Ksh./m	NIB (2011)	Lower Kuja (Lot 6)
						Average	**5,200 Ksh./m**		
010	Rehabilitation of Irrigation Canal (Earth Lining)	Q < 0.5 m3/s (including the Canal Structures)	70 % of Construction Cost		3,287 Ksh./m	1.10488 (2018/2011)	3,632 Ksh./m	NIB (2011)	Lower Kuja (Lot 4)
					4,252 Ksh./m	1.06443 (2018/2014)	4,526 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
						Average	**4,100 Ksh./m**		
011	Rehabilitation of Irrigation Canal (Earth Lining)	Tertiary Canal, In-field Canal	70 % of Construction Cost		505 Ksh./m	1.13359 (2018/2009)	572 Ksh./m	NIB (2009)	Ahero & West Kano
					2,218 Ksh./m	1.10488 (2018/2011)	2,451 Ksh./m	NIB (2011)	Lower Kuja (Lot 1 - 6)
					2,325 Ksh./m	1.06443 (2018/2014)	2,475 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
					2,659 Ksh./m	1.06443 (2018/2014)	2,830 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**2,100 Ksh./m**		
012	New Construction of Conveyance Canal	Q = 3.49 m3/s	Ksh. 576,461,992	9,992 m	57,692 Ksh./m	1.07758 (2018/2013)	62,168 Ksh./m	MIWI & NIB (2013)	Ahero
						Average	**62,200 Ksh./m**		
013	New Construction of Conveyance Canal	Q = 6.6 m3/s	Ksh. 792,738,467	9,992 m	79,337 Ksh./m	1.07758 (2018/2013)	85,492 Ksh./m	MIWI & NIB (2013)	Ahero
						Average	**85,500 Ksh./m**		
014	New Construction of Conveyance Canal	Q = 2.2 m3/s	Ksh. 457,687,767	9,992 m	45,805 Ksh./m	1.07758 (2018/2013)	49,359 Ksh./m	MIWI & NIB (2013)	Ahero
						Average	**49,400 Ksh./m**		
015	New Construction of Sango Pipeline and Concrete Lining Canal		Ksh. 266,234,340	9,222 m	28,869 Ksh./m	1.10488 (2018/2011)	31,897 Ksh./m	NIB (2011)	Lower Kuja
						Average	**31,900 Ksh./m**		
016	New Construction of Sango Pipeline and Concrete Lining Canal		50 % of Construction Cost		14,435 Ksh./m	1.10488 (2018/2011)	15,949 Ksh./m		
						Average	**15,900 Ksh./m**		
017	Canal Systems in Lower Kuja (New Development)	Min Canal	Ksh. 402,187,831	7,717 ha	321,094,Ksh./ha	1.10488 (2018/2011)	**355,000 Ksh./ha**	NIB (2011)	Lower Kuja
		Branch Canal 1	Ksh. 113,800,179						
		Branch Canal 2	Ksh. 264,157,279						
		Sub-branch Canals/Pipelines	Ksh. 612,240,874						
		In-field Canal Systems	Ksh. 412,761,534						
		Access Roads	Ksh. 365,605,520						
		Drainage Systems	Ksh. 307,132,206						
		Total	**Ksh. 2,477,885,423**						

Item No.	Work Item	Specification	Cost and Quantity in Original Report			Inflation Rate (b)	Converted Unit Cost (c) = (a) x (b)	Source* (Original Report)	Remark
			Cost	Quantity	Unit Cost (a)				
018	Canal Systems in Lower Kuja (Rehabilitation)		70 % of Construction Cost		224,766 Ksh./ha	1.10488 (2018/2011)	248,339 Ksh./ha		
						Average	**248,300 Ksh./ha**		
019	New Construction of Drain	Main Drain	Ksh. 276,413,534	90,885 m	3,041 Ksh./m	1.10488 (2018/2011)	3,360 Ksh./m	NIB (2011)	Lower Kuja (Lot 1 - 6)
			Ksh. 151,333,595	37,347 m	4,052 Ksh./m	1.06443 (2018/2014)	4,313 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
			Ksh. 67,163,783	11,152 m	6,023 Ksh./m	1.06443 (2018/2014)	6,411 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**4,700 Ksh./m**		
020	New Construction of Drain	Secondary Drain, Tertiary Drain	Ksh. 171,551,651	65,112 m	2,635 Ksh./m	1.13359 (2018/2009)	2,987 Ksh./m	NIB (2009)	Ahero & West Kano
			Ksh. 140,360,441	93,257 m	1,505 Ksh./m	1.13359 (2018/2009)	1,706 Ksh./m	NIB (2009)	Ahero & West Kano
						Average	**2,300 Ksh./m**		
021	New Construction of Drain	Field and Collector Drain	30,712,615 Ksh.	128,258 m	239 Ksh./m	1.10488 (2018/2011)	264 Ksh./m	NIB (2011)	Lower Kuja (Lot 1 - 6)
			37,833,399 Ksh.	121,769 m	311 Ksh./m	1.06443 (2018/2014)	331 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
			28,784,479 Ksh.	68,289 m	422 Ksh./m	1.06443 (2018/2014)	449 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**300 Ksh./m**		
022	Rehabilitation of Drain	Main Drain	60 % of Construction Cost		1,825 Ksh./m	1.10488 (2018/2011)	2,016 Ksh./m	NIB (2011)	Lower Kuja (Lot 1 - 6)
					2,431 Ksh./m	1.06443 (2018/2014)	2,588 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
					3,614 Ksh./m	1.06443 (2018/2014)	3,847 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**2,800 Ksh./m**		
023	Rehabilitation of Drain	Secondary Drain, Tertiary Drain	60 % of Construction Cost		1,581 Ksh./m	1.13359 (2018/2009)	1,792 Ksh./m	NIB (2009)	Ahero & West Kano
					903 Ksh./m	1.13359 (2018/2009)	1,024 Ksh./m	NIB (2009)	Ahero & West Kano
						Average	**1,400 Ksh./m**		
024	By Pass Canal Dredging	Excavation (by Machine)				1.00000 (2018/2018)	**622 Ksh./m3**	IQSK (2018)	
025	Rehabilitation of Drain	Field and Collector Drain	60 % of Construction Cost		143 Ksh./m	1.10488 (2018/2011)	158 Ksh./m	NIB (2011)	Lower Kuja (Lot 1 - 6)
					187 Ksh./m	1.06443 (2018/2014)	199 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
					253 Ksh./m	1.06443 (2018/2014)	269 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**200 Ksh./m**		
026	New Construction of Access & Farm	Gravel Pavement (Access Roads: B=6.00m, Farm Roads: B=5.00m)	Ksh. 365,605,520	254,943 m	1,434 Ksh./m	1.10488 (2018/2011)	1,584 Ksh./m	NIB (2011)	Lower Kuja (Lot 2 - 6)
			Ksh. 112,216,146	75,388 m	1,489 Ksh./m	1.06443 (2018/2014)	1,585 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
			Ksh. 57,546,705	42,253 m	1,362 Ksh./m	1.06443 (2018/2014)	1,450 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**1,500 Ksh./m**		
027	Rehabilitation of Access & Farm Roads	Gravel Pavement (Access Roads: B=6.00m, Farm Roads: B=5.00m)	75 % of Construction Cost		1,076 Ksh./m	1.10488 (2018/2011)	1,189 Ksh./m	NIB (2011)	Lower Kuja (Lot 2 - 6)
					1,117 Ksh./m	1.06443 (2018/2014)	1,189 Ksh./m	NIB (2014)	Lower Kuja (Lot 2)
					1,022 Ksh./m	1.06443 (2018/2014)	1,088 Ksh./m	NIB (2014)	Lower Kuja (Lot 3)
						Average	**1,200 Ksh./m**		

**** NIB (2009)**: "Detail design and Preparation of Bidding Documents of Ahero and West Kano Irrigation Schemes Development Project (2009, NIB)"*

**** NIB (2011)**: "Lower Kuja Irrigation Development Project Final Detailed Design Report (June 2011, NIB)"*

**** MWI & NIB (2013)**: "Consultancy survives for Review of Detailed Design and Tender Documents and Supervision of Construction Works of Ahero and West Kano Irrigation Schemes Development Project (May 2013, MWI & NIB)"*

**** NIB (2014)**: "Lower Kuja Final Design Review Report Lot 2 & 3 (May 2014, NIB)"*

**** IQSK (2018)**: "Building Construction Costs Handbook (IQSK, 2018/2019)"*

(2) Unit Construction Cost of Flood Protection Dyke

a) Unit Cost of Earth Work (including related facilities)

Work Item	Cost *	Remark *
Earth Work	Ksh. 356,520,000	**Earth Work Volume = 488,000 m3**
Stone Work	Ksh. 218,000	
Concrete Work	Ksh. 11,359,000	
Total	**Ksh. 368,097,000**	

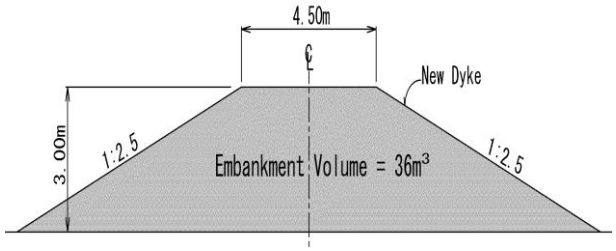
* "The Study on Integrated Flood Management for Nyando River Basein in the Republic of Kenya Final Report (March 2009, Nippon Koei Co., LTD.)

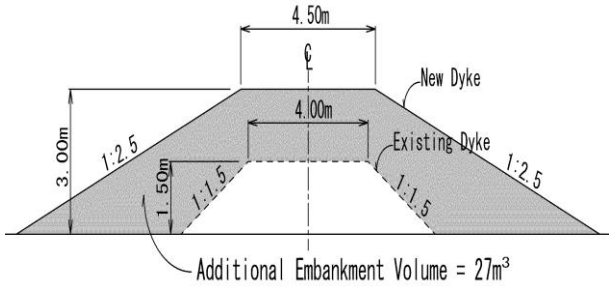
Unit Cost of Earth Work (New Construction) = Ksh. 368,097,000 / 488,000 m3 = **754 Ksh./m3**

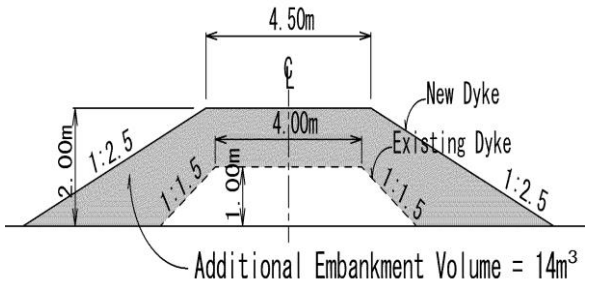
Unit Cost of Earth Cost (Rehabilitation) = 754 Ksh./m3 x 1.2 = **905 Ksh./m3** : Rehabilitation needs additional works (Bench Cut etc.)

b) Typical Cross Section of Dyke

Type-A	Type-B	Type-C
Work Item : New Construction	Work Item : Rehabilitation	Work Item : Rehabilitation
Width of Dyke Crest : 4.5 m	Width of Dyke Crest : 4.5 m	Width of Dyke Crest : 4.5 m
Height of Dyke : 3.0 m	Height of Dyke : 3.0 m	Height of Dyke : 2.0 m
Embankment Volume : 36 m3/m	Embankment Volume : 27 m3/m	Embankment Volume : 14 m3/m
Unit Cost : 754 Ksh./m3 (Earth Work)	Unit Cost : 905 Ksh./m3 (Earth Work)	Unit Cost : 905 Ksh./m3 (Earth Work)
Typical Cross Section of Dyke	Typical Cross Section of Dyke	Typical Cross Section of Dyke



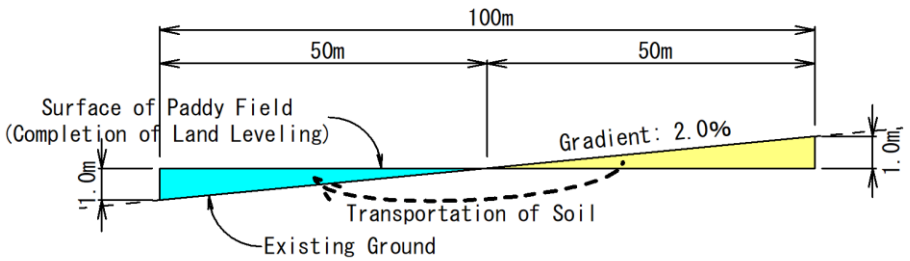




Item No.	Work Item	Specification	Cost and Quantity in Original Report			Inflation Rate *(b)*	Converted Unit Cost *(c) = (a) x (b)*	Source * (Original Report)
			Embankment Volume	Unit Cost	Construction Cost *(a)*			
Ahero Irrigation Scheme								
028	Dyke (Protection form flood caused by upper area of Ahero area)	Type-C	14 m3/m	905 Ksh./m3	12,670 Ksh./m	1.13359 (2018/2009)	14,400 Ksh./m	NK (2009)
029	Dyke (protection from flood caused by Nyando River)	Type-B	27 m3/m	905 Ksh./m3	24,435 Ksh./m	1.13359 (2018/2009)	27,700 Ksh./m	NK (2009)
West Kano Irrigation Scheme								
030	Flood Protection Dyke	Type-C	14 m3/m	905 Ksh./m3	12,670 Ksh./m	1.13359 (2018/2009)	14,400 Ksh./m	NK (2009)

Section A-A (Type-A)

(Gradient of Existing Ground = 2.0%)



Earth Work Volume per ha

Excavation

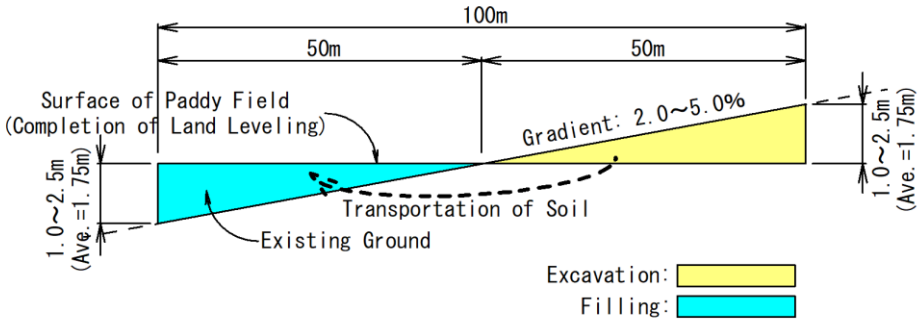
Length	Depth	Width	Earth Work Volume	Remark
(a)	(b)	(c)	(d)	
50 m	1.00 m	100 m	2,500 m3/ha	(d) = ((a) * (b))/2 * (c)

Filling

Length	Depth	Width	Earth Work Volume	Remark
(a)	(b)	(c)	(d)	
50 m	1.75 m	100 m	2,500 m3/ha	(d) = ((a) * (b))/2 * (c)

Section A-A (Type-B)

(Gradient of Existing Ground = 2.0~5.0%)



Earth Work Volume per ha

Excavation

Length	Depth	Width	Earth Work Volume	Remark
(a)	(b)	(c)	(d)	
50 m	1.00 m	100 m	4,375 m3/ha	(d) = ((a) * (b))/2 * (c)

Filling

Length	Depth	Width	Earth Work Volume	Remark
(a)	(b)	(c)	(d)	
50 m	1.75 m	100 m	4,375 m3/ha	(d) = ((a) * (b))/2 * (c)

Item No.	Work Item	Specification	Cost and Quantity in Original Report			Inflation Rate *(b)*	Converted Unit Cost *(c) = (a) x (b)*	Source * (Original Report)
			Embankment Volume	Unit Cost	Construction Cost *(a)*			
South West Kano Irrigation Scheme								
031	Flood Protection Dyke	Type-B	27 m3/m	905 Ksh./m3	24,435 Ksh./m	1.13359 (2018/2009)	27,700 Ksh./m	NK (2009)
Lower Kuja Irrigation Scheme								
032	Flood Protection Dyke (Kuja River & Lake Victoria)	Type-A	36 m3/m	754 Ksh./m3	27,144 Ksh./m	1.13359 (2018/2009)	30,800 Ksh./m	NK (2009)

* ***NK (2009)***: *"The Study on Integrated Flood Management for Nyando River Basin in the Republic of Kenya Final Report (March 2990, Nippon Koei Co., LTD.)"*

(3) Unit Construction Cost of Gogo Fall Dam

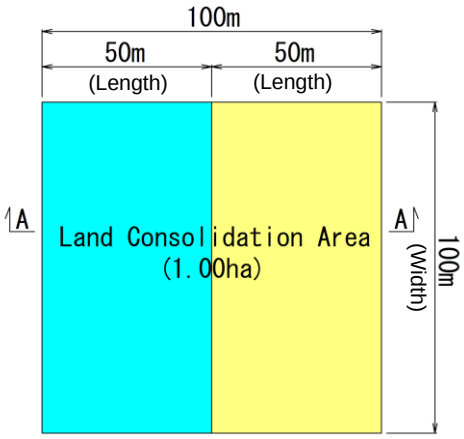
Item No.	Work Item	Specification	Construction Cost			Inflation Rate *(b)*	Converted Unit Cost *(c) = (a) x (b)*	Source * (Original Report)	Remark
			Construction Cost in Original Report	JICA Exchange Rate (Dec. 2010)	Converted Construction Cost *(a)*				
033	Gogo Fall Dam	RCC Type (H = 36m) Storage Volume = 155 million m3	79,300,000 USD	85.675 Ksh./USD	Ksh. 6,794,027,500	1.11905 (2018/2010)	Ksh. 7,603,000,000	NIB – GG (2010)	

* ***N IB-GG (2010)***: *"Gogo Falls Dam Feasibility Report (December 2010, NIB)"*

(4) Unit Construction Cost of Land Consolidation

Item No.	Type and Content		Work Item of Land Consolidation		Unit Cost	Quantity	Cost
034	Type-A	Paddy Field (Gradient of Existing Ground = 2.0%)	New Construction	Excavation (by Machine)	159 Ksh./m3	2,500 m3	Ksh. 397,500
				Filling (by Machine)	150 Ksh./m3	2,500 m3	Ksh.375,000
			Sub-total				Ksh.772,500
			Field Canal, Drain, Farm Road etc. (20% of Earth Work)				Ksh.154,500
			Total				**Ksh.927,000**
035	Type-B	Paddy Field (Gradient of Existing Ground = 2.0 – 5.0%)	New Construction	Excavation (by Machine)	159 Ksh./m3	4.375 m3	Ksh.695,625
				Filling (by Machine)	150 Ksh./m3	4.375 m3	Ksh.656,250
			Sub-total				**Ksh.1,351,875**
			Field Canal, Drain, Farm Road etc. (20% of Earth Work)				**Ksh.270,375**
			Total				**Ksh.1,622,250**
036	Type-C	Paddy Field (Gradient of Existing Ground = 2.0 – 5.0%)	Rehabilitation of Existing Paddy		30% of Type-A		**Ksh.278,000**
037	Type-D	Upland Crop	New Construction of Upland Crop		15% of Type-A		**Ksh.139,000**
038	Type-E	Upland Crop	Rehabilitation of Existing Upland Crop		50% of Type-D		**Ksh.70,000**

Plane of Land Consolidation
(Paddy Field)



Annex 5-1 IRRIGATION ACT 2019

The Irrigation Bill of 2019 is intended to support sustainable food production by outlining the roles of national and county governments in facilitating irrigation activities in the country.

The Act sees NIB transit into an Authority and redefine its roles and responsibilities. The coming into force of the Act, tasks NIA with more responsibilities some of which are:

1. Developing and improving irrigation infrastructure for national or public schemes;
2. Providing irrigation support services to private medium and smallholder schemes, in consultation and cooperation with county governments and other stakeholders;
3. Facilitating formation and strengthening of scheme management committees at scheme level for management of the schemes in consultation with the county governments and other stakeholders
4. Ensuring that irrigation research, innovation and training functions are carried out and appropriately coordinated.
5. Overseeing management of existing and new national or public schemes, except those under county governments, and particularly storage dams, intakes, main and secondary systems as necessary

Previously, the NIB focused mainly on the national irrigation schemes and carried out the following responsibilities:

- Promoting and improving national irrigation schemes in the country
- Conducting research and investigation into the establishment of national schemes
- Designing, constructing, supervising and administering irrigation schemes
- Coordinating and planning settlement on national irrigation schemes
- Determining the number of settlers to be accommodated in national irrigation schemes
- Promoting marketing of crops and produce in national irrigation schemes in liaison with organizations responsible for marketing of agricultural produce
- Formulating and executing policy regarding national irrigation schemes in conjunction with the Water Resource Authority

- Coordination of construction and rehabilitation of major irrigation and drainage infrastructure.
- Operation and maintenance of major irrigation and drainage infrastructure
- Administering land in the public schemes and providing technical advice to farmers