



FEASIBILITY REPORT
ON
CONSTRUCTION OF GRAIN SILOS PROJECT
IN
THE REPUBLIC OF KENYA

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OCTOBER 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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81-35

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PREFACE

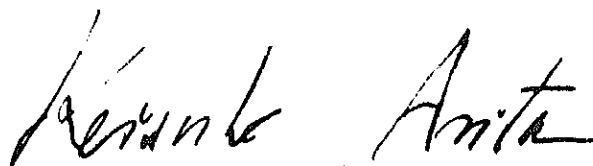
In response to the request of the Government of the Republic of Kenya, the Japanese Government decided to conduct a survey on the Construction of Grain Silo Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Kenya survey teams headed by Mr. Shigeru Matsushashi of Ministry of Agriculture, Forestry & Fisheries and by Mr. Kazunori Tamaki of Sanyu Consultants Inc. from July 20 to August 9, 1981.

The team exchanged views with the officials concerned of the Government of Kenya and conducted a field survey in Nakuru, Bungoma and Kisumu areas, in Kenya. After the teams returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Kenya for their close cooperation extended to the team.

October, 1981



KEISUKE ARITA
President
Japan International Cooperation Agency

Mr. Keisuke Arita
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir;

We have the honor to submit herewith our report on the feasibility study for the Construction of Grain Silo Project, the Republic of Kenya. The field survey was conducted for 21 days from July 21 to August 9, 1981. This report has been prepared on the basis of various discussions held between the Kenyan Government agencies concerned and the team.

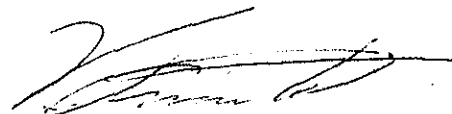
The Project aims at increasing in the marketing volume of grains and establishing stable food supply through construction of the grain silos, total capacity by 110,000 ton, at Bungoma, Nakuru and Kisumu.

We sincerely hope that the Project will greatly contribute to stabilization of grain prices as well as social security of the nation.

Finally, we take this opportunity to express our deep gratitude to the Ministry of Agriculture, National Cereals and Produce Board, Ministry of Finance, Ministry of Foreign Affairs (Japan), Embassy of Japan in the Kenya, Ministry of Agriculture, Forestry and Fisherys, Overseas Economic Cooperation Fund (Japan) and Japan International Cooperation Agency for their valuable assistance and cooperation extended to us throughout the survey period and compilation of this report.

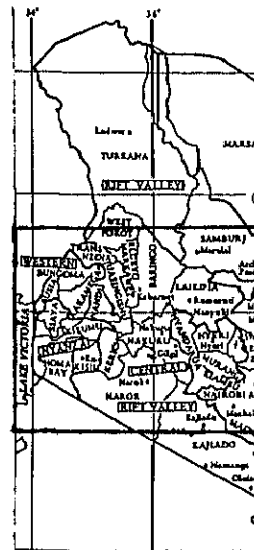
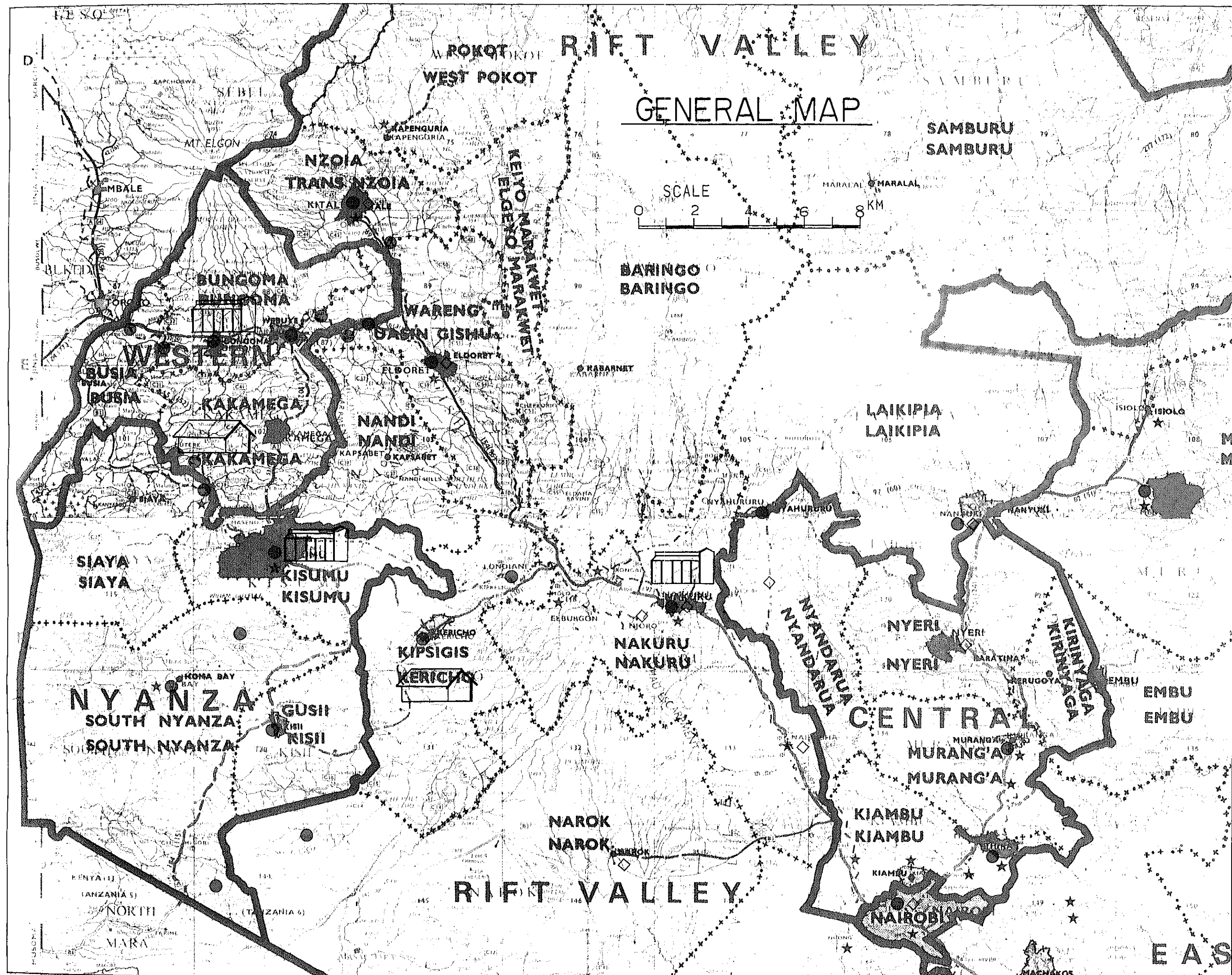
Respectfully yours,

October, 1981



Kazunori Tamaki
Team Leader for Feasibility Study
the Construction of Grain Silo Project

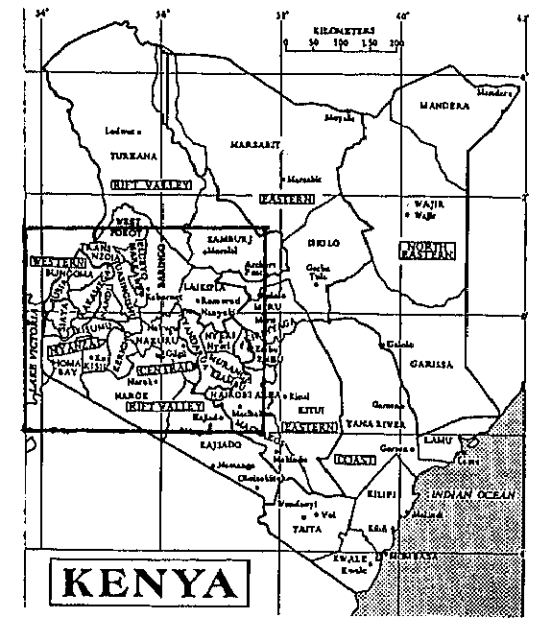
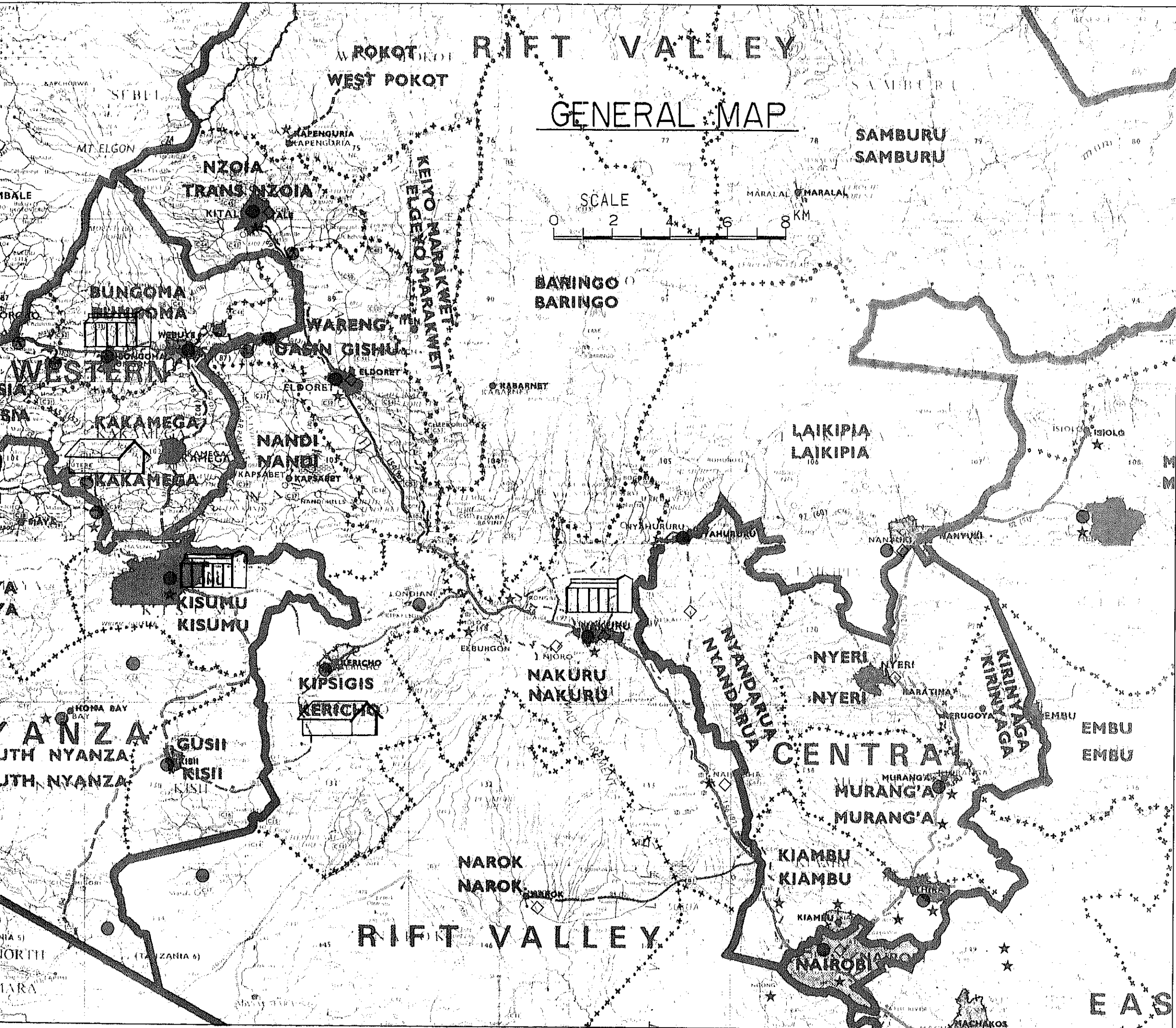
RIFT VALLEY GENERAL MAP



KENYA

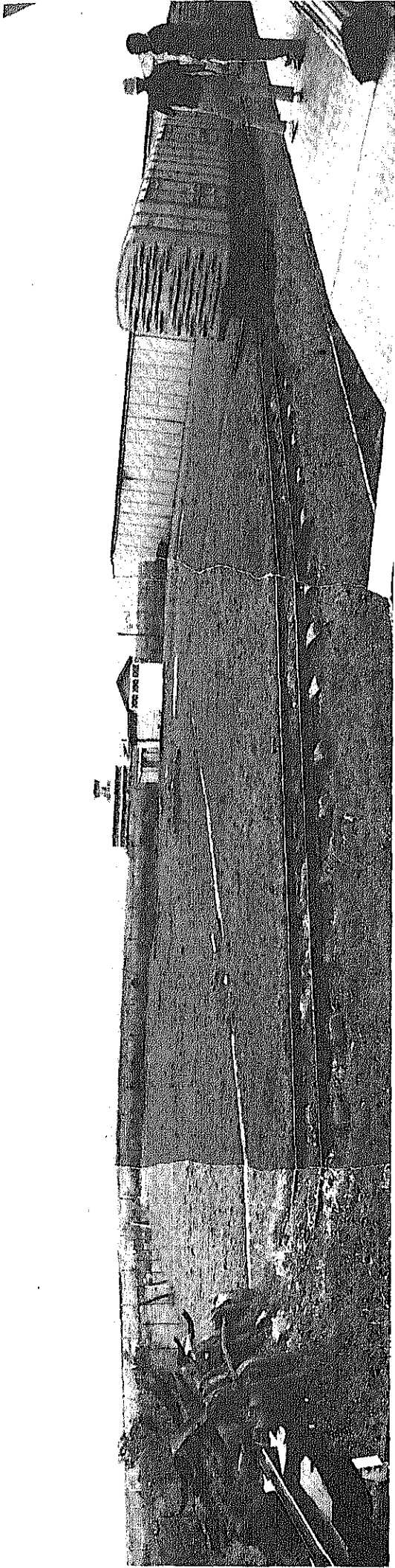
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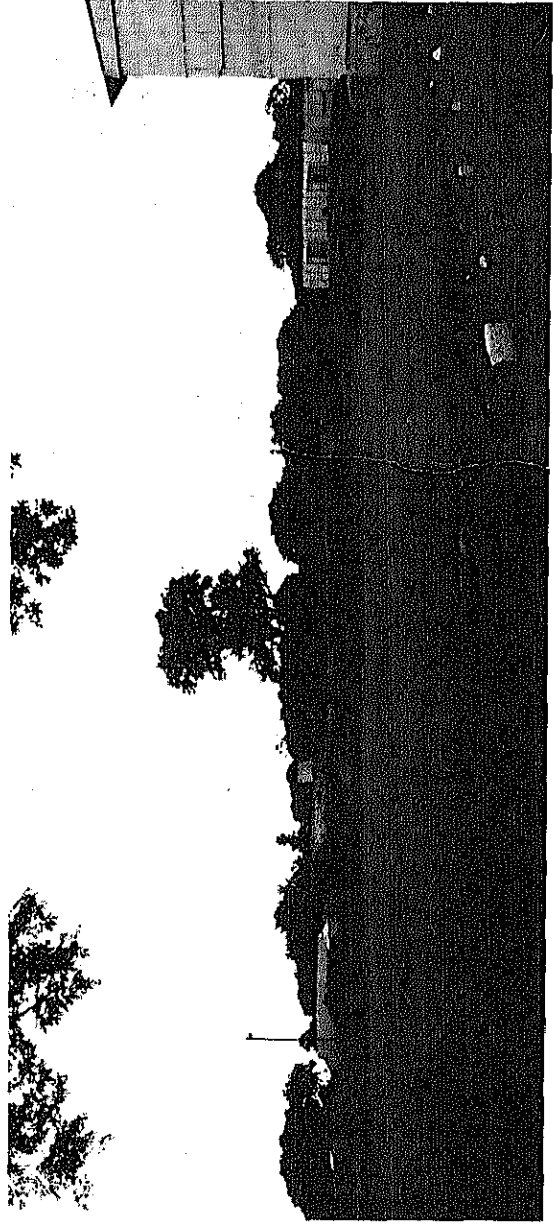


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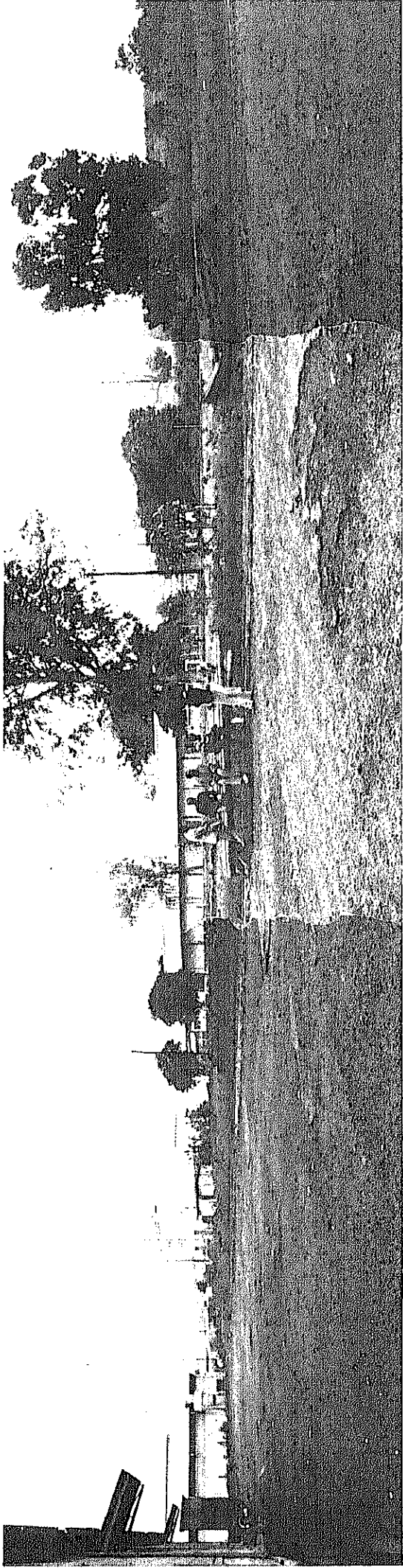
	MAIZE & WHEAT PRODUCTION AREA
	MAIZE PRODUCTION AREA
	WHEAT PRODUCTION AREA
	CONVENTIONAL STORAGE
	SILO
	EXISTING MAIZE DEPOTS
	EXISTING WHEAT DEPOTS
	EXISTING MAIZE MILLS



Proposed Construction Site of Kisumu Silo



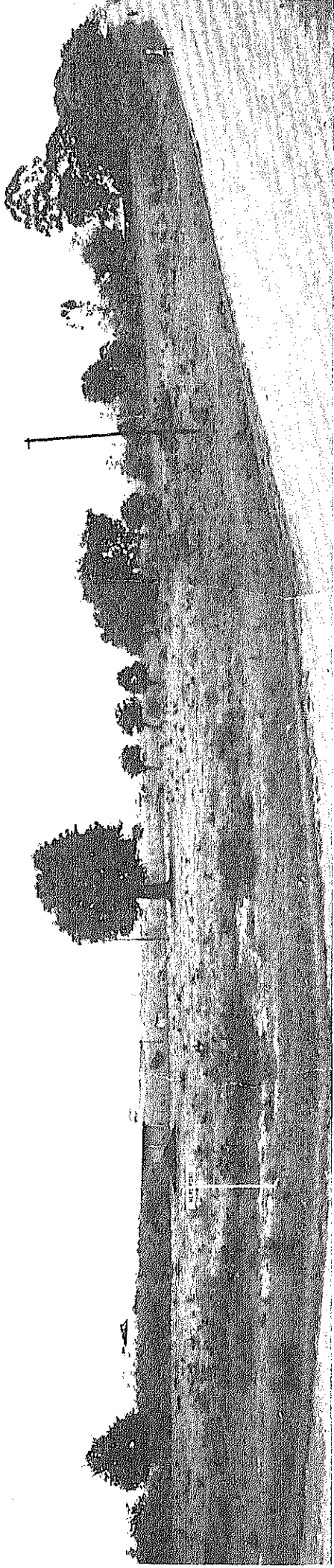
Proposed Construction Site of Burgoma Silo



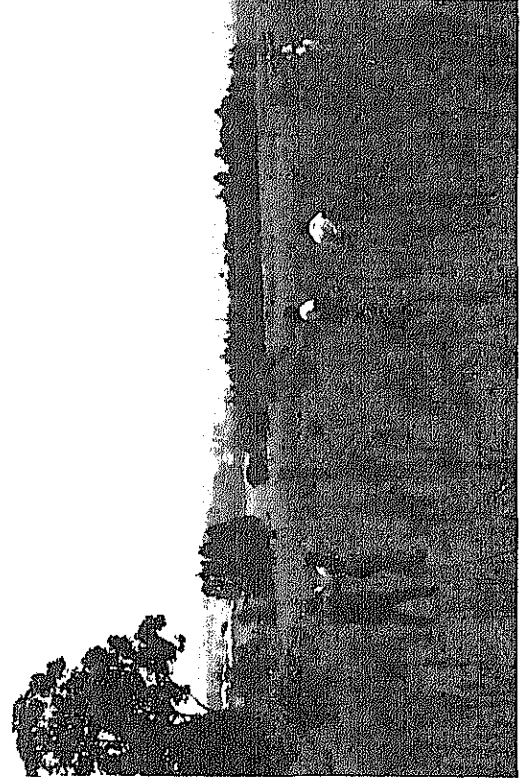
Proposed Construction Site of Nakuru Silo



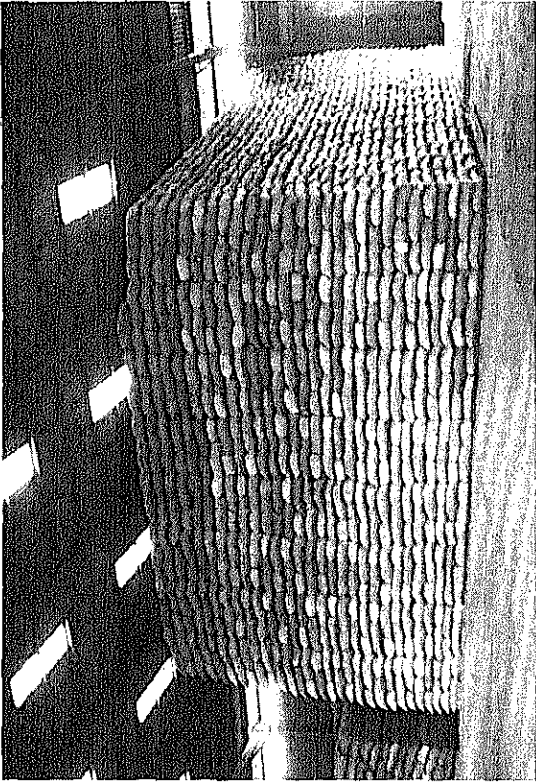
Existing Nakuru Silo



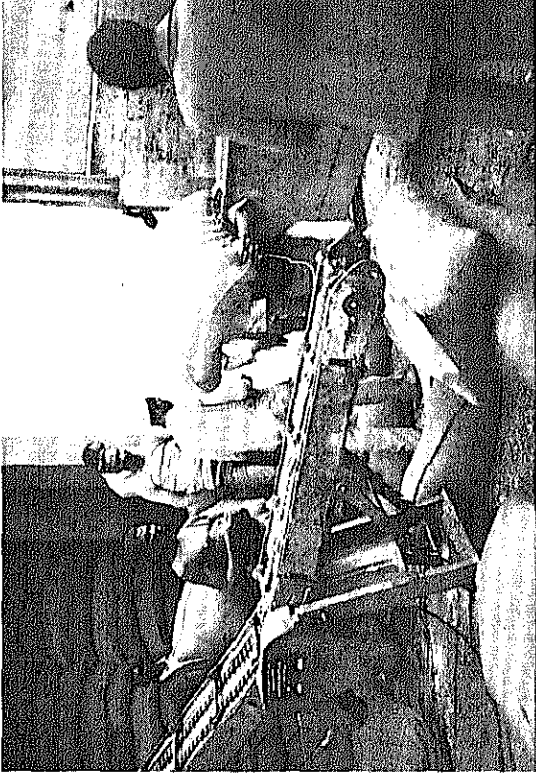
Proposed Construction Site of Kakamega



Proposed Construction Site of Kericho



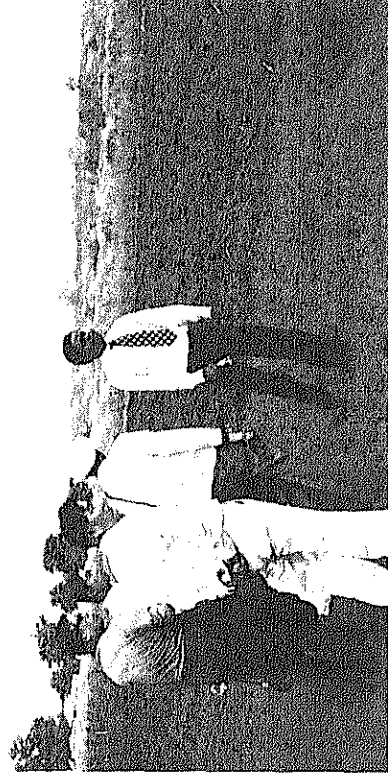
Storage Condition



Receiving of Maize



Farm Road & Maize Field



Maize Field

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Abbreviations and Achronyms

Agencies

ADC:	Agriculture Development Corporation
IADP:	Integrated Agriculture Development Programme
KFA:	Kenya Farmers' Association
KSC:	Kenya Seed Company
JICA:	Japan International Cooperation Agency
MOA:	Ministry of Agriculture
MOF:	Ministry of Finance
NCPB:	National Cereals and Produce Board
OECF:	Overseas Economic Cooperation Fund (Japan)

Unit

mm:	millimeter
cm:	centimeter
m:	meter
km:	kilometer
sq.cm, cm ² :	square centimeter
sq.m, m ² :	square meter
sq.km, km ² :	square kilometer
MSM, 10 ⁶ m ² :	million square meter
ℓ, lit:	liter
cu.m, m ³ :	cubic meter
MCM, 10 ⁶ m ³ :	million cubic meter
lit/sec:	liter per second
m/sec:	meter per second
PPM:	part per million
g:	gram
kg:	kilogram
ton, m.t.:	metric ton
bag:	90 kg
EL:	elevation above mean sea level
MSL:	mean sea level
FWL:	full water level
HWL:	high water level
LWL:	low water level

sec:	second
minu:	minute
hr:	hour
min:	minimum
max:	maximum
%:	percent
No.:	number
°C:	degree centigrade
°F:	degree fahrenheit
Cl:	chlorine
HP:	horse power
GWH:	gigawatt hour
ET:	evapotranspiration
N:	nitrogen
P:	phosphorous
K:	potassium
HYV:	high yielding variety
O & M:	operation and maintenance
IRR:	internal rate of return
B/C:	benefit cost ratio
FY:	fiscal year

Conversion Rates of Measurements

<u>Unit</u>	<u>Comparison</u>	<u>English Equivalents</u>
<u>Units of Length</u>		
Millimeter (mm)	0.001 meter	0.0394 inch
Centimeter (cm)	0.01 meter	0.3937 inch
Meter (m)		3.2800 feet
Kilometer	1,000 meters	0.6213 mile
<u>Units of Area</u>		
Square centimeter (cm ²)	0.0001 m ²	0.155 square inch
Square meter (m ²)		10.764 square feet
Hectare (ha)	10,000 m ²	2.471 acres
Square kilometer (km ²)	1,000,000 m ²	0.3861 square mile
<u>Units of Volume</u>		
Cubic centimeter (cm ³)		0.061 cubic inch
Liter (1,000 cm ³)	0.001 m ³	1.0567 quarts (liquid)
Cubic meter (cu.m)	1,000 liters	35.3145 cubic feet

Units of Weight

Gram (g)		0.0353 ounce
Kilogram (kg)	1,000 grams	2.2046 pounds
Metric Ton (mt)	1,000 kg	2,204.6 pounds

Conversion Rates of Currency

¥ 100 Japanese Yen = 3.7777 Kenyan shillings (K.sh)

\$ 1.0 US Dollar = 8.9891 Kenyan shillings (K.sh)

(as of July 31, 1981)

K.sh 1.0 = ¥ 26.47

K.sh 1.0 = \$ 0.1111

Note: The computation for foreign currency position was carried out based on the conversion rate of currency as of July 31, 1981. However, Kenya has declared the devaluation of Kenya shilling, and the above matters should be noted in the financial considerations.

Background of the Project

The Government of the Republic of Kenya requested the Government of Japan, through the Japanese Embassy in Kenya, to extend the technical and financial cooperation for the Construction of Grain Silos for agricultural production increase which plays a vitally important role in the growth of the Gross National Product as a mainstay of the fourth five-year development plan. Thereby, the Japan International Cooperation Agency (JICA), dispatched to the field the first party of the survey and planning mission for the Construction of Grain Silos, headed by Mr. Shigeru Matsuhashi (Deputy Director at Osaka Food Agency Office, Ministry of Agriculture, Forestry and Fisheries, Japan), in the assignment of 15-day field investigation from July 20, 1981. In parallel with this Matsuhashi mission, the second party of the feasibility study, headed by Mr. Kazunori Tamaki, was sent to the field so as to carry out investigations and studies in the sites. The Matsuhashi mission, under cooperation of the second party, worked positively in holding frequent consultative meetings with the Kenyan Authorities concerned to define the scope of works of the study team and other matters for smooth promotion of the Project. The relevant scope of works is described as follows;

1. Study on the necessity of the storage facilities at Bungoma, Kakamega, Kericho, Kisumu and Nakuru, and
2. Feasibility study, in terms of engineering and economy, for the construction of the silos at proposed Bungoma, Nakuru and Kisumu.

Summary of the Project and Recommendations

A. Summary of the Project

1. The republic of Kenya holds a fertile land suitable to agriculture by 18 percent of the total national land area in the western highland which is blessed with adequate rainfall and temperate climate. Approximately 80 percent of maize and wheat, the staple food of the nation, is produced in this area, and on top of the above, coffees, teas and paddy rice as cash crops are also grown.

2. Maize is the essential ingredient of "Ugali" - the main food of the people, - and thereby almost of all farmers grow maize in Kenya for their own consumption. Maize in the market is the surplus after the farmers reserve for their own consumption. The marketed maize occupies about 20 to 25 percent of the total maize production. Some of the surplus maize after the Kenyan reserve had been exported to Uganda, Tanzania and other neighbouring countries until around 1977. Since 1976, drought and unfavourable weather condition have driven the production into the remarkable decrease to result in making Kenya a maize importing country in 1980.

3. Since a greater part of the wheat production, on the other hand, has been made by the larger farmers and commercialize, no heavy fluctuation has observed on the marketed amount. The demand increase due to population growth in the country, however, has recently tended to result in short supply. But there has been no serious shortage problem raised because wheat is a staple of a limited urban people.

4. The flow system of the grain is that the National Cereals and Produce Board (NCPB) procures grain from the farmers and sells to the millers after processing and shorting. When the grain cropping is bumper, however, the surplus products caused from shortage in the NCPB's storing capacity have been left intact on the fields and given damages to the farmers. This is one of the reasons that the grain production dropped in the latter 1970s. As the population is expected to grow by 3.9 percent per annum and to concentrate to the urban area in future, the shortage in storage capacity will be a bottle-neck for the increasing handling amount by the NCPB to cope with the situation.

5. The NCPB provides 46 storage facilities with total capacity of about 6.8 million bags in maize/wheat (about 610,000 tons equivalent) throughout the country. The population growth and the urban concentration, however, will force the NCPB to handle the grains of about 11.2 million bags (about 1.0 million tons equivalent) to be required in 1985.

6. In order to cope such situation, the NCPB has made the three-staged development plan to secure the additional storage capacity of 4.2 million bags by 1985. The first stage aims at constructing the silos and the conventional storage with the total capacity of 660,000 bags (about 60,000 tons equivalent) at Eldoret and others, which will be completed around the first quarter of 1982, (the Eldoret silo is provided by Danish financial aid).

The second stage plans to provide the storage facilities with capacity of about 1.6 million bags (about 146,000 tons equivalent) in total and the details are shown as follows;

Bungoma	330,000 bags (30,000 tons)	silo
Nakuru	550,000 bags (50,000 tons)	silo
Kisumu	330,000 bags (30,000 tons)	silo
Kakamega	200,000 bags (18,000 tons)	conventional storage
Kericho	200,000 bags (18,000 tons)	conventional storage

The Kenyan Government has request the Japanese Government for technical and financial cooperation for construction of the silos at Bungoma, Nakuru and Kisumu.

7. The silos at Bungoma, Nakuru and Kisumu will have a structure of the aggregate of the reinforced concrete circular-bins, and the space to be created by such aggregation will also be used for storage purpose. The dimensions of the respective silos are as follows;

<u>Location</u>	<u>Total Capacity</u> ton	<u>Total Volume</u> cu.m	<u>One Main Bin Diameter</u> m	<u>Height</u> m	<u>Circuare Bin</u>	
					<u>No.</u>	<u>Row</u>
Bungoma	30,000	46,500	12.0	40	10	2
Nakuru	50,000	77,300	12.0	41	16	2
Kisumu	30,000	46,500	12.0	40	10	2

8. The foundation piles to be used for the Bungoma and the Nakuru silos are to be the cast-in place reinforced concrete piles with 800 mm across and 10 m long, while those for the Kisumu silo are to be steel pipe piles with 800 mm across and 25 m long.

9. The actual receiving service of grains at each silo will last about 150 days per year, and the drying capacity per day and dryer capacity for each silo are as follows:

Bungoma and Kisumu silo (for each silo)

dryer capacity	30 tons/hr
drying capacity per day . .	300 tons/day (ordinary)
drying capacity per day . .	600 tons/day (maximum)

Nakuru silo

dryer capacity	50 tons/hr
drying capacity per day . .	500 tons/day (ordinary)
drying capacity per day . .	1,000 ton/day (maximum)

Note: Operation hours for each silo is considered at 10 hours for ordinary but 20 hours for maximum.

10. The forwarding capacity of each silo is as follows:

Bungoma and Kisumu silos

capacity per hour	30 tons/hr
capacity per day	180 tons/hr (ordinary)
capacity per day	360 tons/hr (maximum)

Nakuru silo

capacity per hour	50 tons/hr
capacity per day	300 tons/hr (ordinary)
capacity per day	600 tons/hr (maximum)

11. The methyl bromide fumigation is adopted.

12. The total project cost for the three silos was estimated at K.sh 433.3 million (¥ 11,469 million equivalent) excepting the interests during the construction period, of which the foreign currency portion covers K.sh 324.9 million (¥ 8,600 million equivalent) and the local currency portion K.sh 108.4 million (¥ 2,869 million equivalent).

13. The construction period was estimated at four years from July, 1982 to June, 1985, including six-month detailed design period, and the consultants services for detailed design, tendering, construction supervision and guidance of operation and management of the facilities will be from July, 1982 to June, 1986.

14. The economic benefit of the Project implies the tangible and the intangible one, and this report describes the economic benefit estimated on the basis of the tangible benefits only, while the intangible benefit was evaluated in terms of their economical and social effects.

15. The economic benefit taken up in the Project is summarized as the benefit to be expected to accrue from the marketed grains, which would have been lost on the farms or in the course of distribution without the proposed silos. And such target benefit will be realized at the fiscal 1985 and was estimated at K.sh 53.4 million per annum by reducing the damages and losses of the grains.

16. The internal rate of return (IRR) for the Project as a whole was computed by 16.8 percent.

B. Recommendations

The Project of urgently constructing the proposed silos has been understood as the prerequisites for national self-sufficiency and stable supply of the staple food of maize and wheat, and the NCPB should make the necessary arrangements as follows for execution of the Project.

- 1) Aquisition of storage development site for the Bungoma and the Kisumu.
- 2) Geological survey by boring and bearability study on the respective sites.
- 3) Topographycal survey and mapping of the sites (topo-maps and plane maps),
- 4) Confirmation for the cooperation of the Kenya National Railway and the truckers,
- 5) Guidance to the millers in Kisumu area for them to receive maize in bulk,

6) Provision of the field offices as well as the foreign consultants' residences in Bungoma, Nakuru and Kisumu, and

7) Training the NCPB's staffs on the site and in Japan.

The Ministry of Agriculture should give guidance to the farmers and farmers' organization for securing the growing acreages of maize and wheat at least at the level in 1975.

CHAPTER 1. INTRODUCTION

The Government of the Republic of Kenya has requested the Government of Japan to render the technical and financial assistances for the fourth five-year development plan (1979 – 1983), in particular, for the grains storage projects which have been considered vitally important for the development of the nation. In reply to the request, the Japan International Cooperation Agency, the executing body of the overseas technical cooperation programme of the Japanese Government, sent a Feasibility study team for basic plan formulation to the field on July 20, 1981, through field investigation, data collection and consultative meeting with the Kenyan Authorities concerned.

The Feasibility study team included two parties: the one, composed of the staff of the Ministry of Agriculture, Forestry and Fisheries, Japan and the Japan International Cooperation Agency (JICA), was engaged in consultation on the Project formulation with the Kenyan Authorities concerned and investigation on the national need for the Project for 15 days from July 20, 1981, and the other, composed of the staff of Sanyu Consultants Inc. which was entrusted the study works by the JICA, was engaged in the field investigation and basic plan formulation for three weeks from July 21, 1981. The report was prepared based on the results of the study and consultative meetings held during the field works.

The grains storage facilities that were proposed by the Government of Kenya were to be provided at Nakuru, Kakamega, and Kericho. The consultative meetings held in Kenya, however, have resulted in the agreement of the Government for the silos at Nakuru, Bungoma and Kisumu with higher priority than those other two sites because the higher benefit is expected to accrue from these three silos. Hence, the study team has concentrated the energy to make the basic plans for these three silos and made only the rough plan for the facilities at Kakamega and Kericho.

The following is the list of the Japanese members engaged in the study and the Kenyan Government officials and counterparts personnel.

Team Members

First Party

Leader

Mr. Shigeru Matsushashi

Deputy Director at Osaka Food Agency Office,
Ministry of Agriculture, Forestry and Fisheries
(MAFF)

Structural Engineer	Mr. Kiyoshi Kikuchi Assistant Director at Food Agency, MAFF
Planner	Mr. Fumio Yamamoto Assistant Manager at Import Section, Food Agency, MAFF
Coordinator	Mr. Yoshihiko Nishimura Japan International Cooperation Agency

Second Party

Leader	Mr. Kazunori Tamaki Director of Sanyu Consultants Inc. (SCI) Consulting Engineer Registered
Marketing/ Grain Storage Expert	Mr. Shizuo Tsuaki Technical Advisor (SCI)
Mechanical Engineer	Mr. Yuzo Miura Section Chief Plant Department (SCI)
Foundation/ Structural Engineer	Mr. Hiroshi Kondo Section Chief Engineering Department (SCI)
Economist	Mr. Masanobu Yamashita Technical Advisor Engineering Department (SCI)

The Kenyan Government Officials Contacted

Ministry of Agriculture

Mr. Shikwe	Under Secretary
Mr. Muthama	Director of Agriculture
Mr. Kimani	Deputy Director of Agriculture
Mr. Kabuga	Manager of Crop Production
Mr. Waiithaka	Agronomist
Mr. Riungu	Chief Economist of Planning

Ministry of Finance

Mr. Wangai	Manager in Charge of Asian Region
------------	-----------------------------------

Counterparts Personnel of NCPB

Mr. Kikwai	Managing Director
Mr. Karanja	Financing Manager
Mr. Shimala	Storage Manager
Mr. Bogecho	Technical Manager
Mr. Migunda	Operation Manager
Mr. Kariungi	Field Service Manager
Mr. Muchuma	Maintenance Officer

CHAPTER 2. ECONOMIC BACKGROUND

2.1. Five-year Plan of Kenya

Since independence in 1963, Kenya has been making substantial progress along the long-term development programme adopted by the Government and the people. The programme includes political equality, religious freedom, social justice, freedom from want, ignorance and disease, human dignity and high growth of per capita income by equitable distribution.

The guide-line of the Government for national economy has been indicated in every five-year plans definitely as follows:

(1) The first five-year plan (from 1966 to 1970) aimed at changing the national economy which has devoted to colonial industrial structure into the new industrial structure for Kenyan people the so-called Kenyanization of the economy. However, agricultural sector has stagnated due to decline estate farming managed by English farmers during the period.

(2) Despite the Government effort to promote traditional industries and devotion to provide a resumption of growth between 1964 and 1972, it was disrupted in the years between 1972 and 1976 when international economical instability and uncertainty together with several years of bad weather which hampered the growth and forced hardship on many people, especially in the agricultural sector.

Gross Domestic Products grew by only 4.0 percent (6.5% in 1964 - 1972) per annum, the monetary sector by only 4.8 percent (7.4% in 1964 - 1972) and in particular monetary agriculture by only 1.5 percent.

(3) In light of the past economical situation, the third five-year plan (from 1974 to 1978) provided enabled to increase the agricultural production, and allowed market-ing effort to accelerate employment opportunities through rural development and in-come equitable distribution. Unfortunately, however, the target of the plan could not be attained and the growth rate of GDP during the period had fallen to 1.9 percent per annum due to the long-lasting economic instability and unfavourable weather condition.

(4) The fourth national development plan which has been undertaken since 1979, provides restoration of economic development disturbance as ever, recognizing the initial nation's target and has adopted the following four principles.

- i. Nationwide participation
- ii. Diversity of organization, and provision of incentives
- iii. Government participation
- iv. Mutual social responsibility

The growth target has been set by 6.3 percent on an average in GDP. By 1983 the total output per capita should be 21.3 percent higher in real terms than it was in 1976.

The economic performance of the plan was adversely affected in 1979 by low price of coffee and tea in the world market, drought, increased crude petroleum prices and credit squeeze on imports. The situation, however, is turning to prosperity with the recovery of agricultural production in 1980 and 1981.

2.2. Present Agriculture and Food Problem

Kenya has the total area of 582,600 sq.km, of which 26,340 sq.km are under water and forest. Topographically, the country is divided into two, the west and the east, by the Rift Valley, and on the west lands slope to Lake Victoria, located at EL 1,100 m above the sea.

Of total land, 18 percent is considered to be of high or medium potential for cultivation, nine percent is marginal agricultural land, 52 percent is pasture for grazing and the remainder - 21 percent is desert or semi-desert.

As Kenya is characterized by varied climate, topography and soil, good potential area for cultivation spread over the western highland, around Lake Victoria, the Mount Kenya where adequate rainfall, warm climate and fertile soils are available. While the vast arid or semi-arid areas are utilized for pasture or nomadism.

(1) Agricultural production

To identify the present Kenyan agricultural production is difficult because of lack of the production statistics.

The following table shows the marketed agricultural outputs handled by marketing board only and not the total production, but can outline the Kenyan agriculture. Crop production has a share of 80 percent of the total, of which the perenial crops including coffee and tea around 70 percent.

Marketed Agricultural Products at Current Price
1975 – 1979

(Unit: 1,000 K£)

	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>
Cereals	28,923	39,333	35,527	27,477	30,479
Annual Industrial Crops	15,822	17,377	22,466	29,439	37,227
Other Annual Crops	7,123	8,626	6,604	6,640	7,196
Perennial Crops	68,571	141,487	293,393	200,199	183,458
(Coffee)	(35,345)	(101,333)	(192,919)	(118,822)	(106,426)
(Tea)	(22,914)	(32,757)	(92,729)	(73,914)	(67,343)
Total Crops	120,439	206,823	357,991	263,755	258,360
Livestock	36,123	37,109	49,104	62,102	54,720
Unrecorded Marketed Products	5,404	6,115	7,489	7,532	7,160
Grand Total	161,966	250,047	414,584	333,339	320,240

The table indicates, on the other hand, that the share of cereals included in staple food for Kenyan people fell to 8 - 9 percent in 1978/79 from 18 percent of 1975. The fall has resulted mainly from large reduction of maize production.

The maize production decreased to 240 thousand tons in 1977/78 from 550 thousand tons in 1976/77. The production of wheat also stagnated in 1977 and 1978. However, it seems to be recovering the following year, as learnt from the table below.

Production of Maize and Wheat

(Unit: ton)

	<u>1974/75</u>	<u>1975/76</u>	<u>1976/77</u>	<u>1977/78</u>	<u>1978/79</u>	<u>1979/80</u>	
Maize	450,704	555,667	542,822	244,205	236,610	222,693	
	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
Wheat	157,916	161,912	180,716	165,966	154,612	155,186	189,949

(2) Food problem and food policy

Since independence Kenyan Government has made an effort to promote agricultural development in order to achieve the self-sufficiency of staple food and to increase the exporting crops through every five-year plan. In the long run, however, it does not to have been successful.

Maize and wheat are staple food for Kenyan people. Specially, maize is a ingredient for "Ugali" - - - daily food for local people. The most farmers produce maize as a self-sufficiency and sell the surplus to the markets. Though the planted areas of maize are not identified, it is considered that the small holders have a large share of the total area comparing with large holders. And throughout the late 1960's until 1976, Kenya has had enough volume of maize for self-sufficiency. However, purchased amount of maize by the NCPB has reduced since 1977 and it became 240 thousand tons in 1979, as can be seen the in above table. But this does not mean potential marketing amount is reduced.

The substantial amount of surplus of maize was carried to the buying center where the NCPB purchases the surplus in the bumper crops of 1976 or 77. The NCPB could not follow all of the farmers' selling because the grain storage and handling facilities of the NCPB have not been adequate to store the purchased in addition to the shortage in purchase funds. As a result, maize producers lose huge amount of money. During the following season, large farmers grew less maize and the NCPB could not purchase adequate amount of maize for the national supply. Finally, the Government had to import maize for emergency supplies. (See Appendix A, Table A-5)

On the other hand, wheat in Kenya has been produced by mainly large farmers and a greater part of it used to be sold to the surplus to the NCPB, which has exported until 1960's. But the grown area had become reduced and the surplus for marketing has begun to decrease since 1970's, whereas the demand for the wheat flour has been increased. Consequently, the Government has currently had to import a large amount of wheat. In the light of the above food situation, the Government has come to take a new food policy in the first priority. The new food policy is stated clearly in Sessional Paper No.4 of 1981.

2.3. Marketing System of Agricultural Products and Grain Storage

The marketing system of agricultural commodities in Kenya consists of traditional, local free marketing and centralized marketing controlled by the Board.

Since pre-independence the special board has been established to control the marketing and prices for main foods. The Wheat and Produce Board was established in 1930's and Maize and Produce Board in 1950's. They were merged into the National Cereals and Produce Board in 1980.

An extension programme has been introduced by the Government to give the farmers the knowledge and technique of construction of farm stores. But very few of

commercialized large farmers have any grain storage and none of small holders have the store facilities due to lack of capital fund. Then, the surplus of maize/wheat has to be supplied to buying center of the NCPB after harvested.

When the grain storages handled by the NCPB are limited to store the surplus in the capacity, the farmers are forced to keep them on their farm. The estimation was made that approximately 30 percent of grain stored by small farmers and 16 percent by large farmers are damaged by rodents, insects and moisture, etc.

In the new food policy, the Ministry of Agriculture has a responsibility to prepare national grain storage plan.

CHAPTER 3. THE PROJECT AREAS

3-1. The Project Areas and the Natural Conditions

3-1-1. Location

Kenya borders on Sudan and Ethiopia at the north, on Somalia and the Indian Ocean at the east, on Tanzania at the south, and on Uganda at the west, and the land area is about 582,600 sq.km, which can be classified into three in view of natural conditions, the borderland in the north east, the coastal area facing the Indian Ocean, and the highlands in the west of the Mount Kenya. The highlands are further divided into two by the Rift Valley.

All the proposed five sites for constructing the grain storage facilities, Bungoma, Nakuru, Kisumu, Kakamega and Kericho, are located northwest of Nairobi, in the highlands of the west of the Rift Valley.

3-1-2. Population

The total population is about 16.6 million (as of 1980), about 10 percent of which concentrates to live in the national capital of Nairobi and its environs. Recently the population influx into Nairobi has become remarkable and its population concentration has been accelerated at some 10 percent per annum. The populations of the respective districts involving the proposed facilities sites are as follows;

<u>Proposed Site</u>	<u>District</u>	<u>Population</u>
Bungoma	Bungoma	547,000
Kakamega	Kakamega	1,161,000
Kisumu	Kisumu	579,000
Kericho	Kericho	886,000
Nakuru	Nakuru	491,000

The national total population is tabulated in Table B-1 in Appendix B, together with the population forecast.

3-1-3. Meteorology

The meteorological conditions prevailing in Kenya can be roughly specified into two by areas; i) semi-arid areas in the northern and the eastern parts of the country and ii) the remaining pluvius highlands and mountain areas.

The semi-arid areas have recorded the annual rainfalls of 200 - 1,200 mm, although decreasing in deepening into the inland area, and a greater part of the rainfalls takes place in concentration in the period from March to May and from November to

December. The rainfalls, however, do not rarely take place in other months than the above. The annual mean evaporation ranges from 2,000 to 3,500 mm. Except for the coastal area on the Indian Ocean, the monthly mean evaporation exceeds the monthly mean rainfall.

The highlands and the mountain areas, although divided into two by the Rift Valley, are exposed under the same meteorological conditions.

The meteorological records at the proposed sites are described in the following paragraphs, although the records at Bungoma and Kakamega have been represented by those of Busia which provide the similar meteorological conditions to these two sites, where there are no records available. The meteorological records of four (4) stations have been observed for the following period:

Busia	1957 -- 1970
Kericho	1964 -- 1970
Kisumu	1938 -- 1970
Nakuru	1956 -- 1970

The detailed observation values (on the monthly basis) at the respective site, Nairobi and Mombasa are arranged in the figures - Table C-1 to 12 in the Appendix C attached hereto.

Rainfalls

More than 50 mm of rainfalls on the monthly average basis have been recorded at most of the sites excepting for Nakuru. Especially there has been relatively much rainfall observed in March, April, May, November and December. The annual mean rainfalls and maximum daily rainfalls at the sites are shown as follows.

	<u>Annual Mean Rainfall</u> (mm)	<u>Maximum Daily Rainfall</u> (mm)
Busia	1,775	112 (April)
Kericho	2,081	79.3 (April)
Kisumu	1,306	154.9 (April)
Nakuru	956	67.8 (April)

Temperature and humidity

Every meteorological station, despite being located in comparatively high altitude in the highlands, has never recorded the temperature below zero since being directly on the equator. And the related humidity observed at three o'clock in the afternoon by Kenyan Standard Time has been about 55 percent.

The mean emperature, maximum temperature, minimum temperature and related humidity at the respective sites are shown in the following table.

	Mean	Maximum	Minimum	Humidity	
	Temperature (°C)	Temperature (°C)	Temperature (°C)	9:00 AM (%)	3:00 PM (%)
Busia	28.0	37.8	9.0	77	55
Kericho	22.2	29.0	2.5	71	63
Kisumu	29.4	36.9	11.0	68	47
Nakuru	25.3	31.5	1.5	77	46

Wind

Almost of all the winds prevailing in the country, excepting for the trade wind blowing in the coastal areas, result from the topographic conditions and the wind forces are not so strong.

Evaporation

The evaporation has been observed by the Pan-A (120.7 cm dia. and 25 cm water depth) which is recommended by the World Meteorological Organization. The annual mean evaporation ranges from 1,400 mm to 2,100 mm. The annual mean evaporations recorded at the respective sites are illustrated in the following table. Most of the sites, have recorded the annual mean rainfall over 1,000 mm and no sites have recorded the annual mean evaporation over 2,500 mm (around 2,000 mm). And yet, there are few sites found which have recorded the evaporation twice as much as the rainfall on the annual average basis.

Annual Mean Evaporation

Busia	2,097 (mm)
Kericho	1,396
Kisumu	2,421
Nakuru	1,791

3-2. Infrastructures

3-2-1. Railways

The trunk line of the Kenya National Railway runs from Mombasa, the international open port of the country, to Kampala of the capital of Uganda via Nairobi, Nakuru and Bungoma. There are several other branch lines available in running between Voi near Mombasa and Dar Es Salaam, the capital of Tanzania, and between Nakuru and Butere via Kisumu on the shore of Lake Victoria, and so forth. The Kenya National Railway has been operated mostly in the single tracked system, extending about 2,000 km, and has rendered the both passenger and cargo services. There is no railway service, however, connecting Kakamega and Kericho nor between Bungoma and Kisumu.

3-2-2. Road Networks

Kenya has developed its road networks rather well, and the roads are roughly classified into two types, the all-weather roads (asphalt paved roads) and the non-paved roads. The trunk roads connecting major municipalities in the highlands and port city of Mombasa or connecting major municipalities in the adjacent country of Tanzania are all asphalt-paved for the whole courses, although required to be repaired partly.

The road networks linking the proposed five sites each other are shown as follows together with their extension.

	<u>Distance</u> km
Nakuru - Bungoma	244
Nakuru - Kakamega	237
Nakuru - Kericho	107
Nakuru - Kisumu	187
Bungoma - Kakamega	74
Bungoma - Kisumu	124
Bungoma - Kericho	204
Kisumu - Kakamega	50
Kisumu - Kericho	80
Nakuru - Nairobi	157

The above roads are all asphalt-paved. A very few roads in the rural area, however, have been asphalt-paved, although the pavement works have recently been progressed even for these rural roads.

3-3. General Description of Agriculture

The agricultural production in Kenya has still occupied about 30 percent of the Gross National Product (GNP), although showing a slightly declining tendency resulted from the growth of the other sectors, and the export of the farm products has also a share of more than 50 percent in the total export. Hence, agriculture has been playing the vitally important role as the mainstay in the national economy. The farm products in the country cover a wide range of crops such as maize as staple food, wheats, pulses, potatoes, sugar canes, coffees, teas, animal husbandry, and so forth. Kenya has a prospect of food self-sufficiency with vast fertile lands and a variety of crops.

In these few years, inability of staple food self-sufficiency has driven the nation into a food import-country with part of grain consumption, and the population explosion has raised its growth rate to about 3.9 percent per annum. The agricultural policy