

**HORTICULTURAL DEVELOPMENT PROJECT
IN
THE REPUBLIC OF KENYA**

**DETAILED DESIGN REPORT
ON
MODEL INFRASTRUCTURE IMPROVEMENT WORKS**

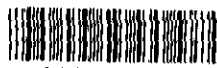
MAY 1988

**JAPAN INTERNATIONAL COOPERATION AGENCY
(J I C A)**

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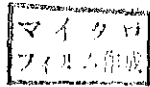
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PREFACE

This Project has started after the pursuance of the Record of Discussions signed on December 4, 1985. The aim of the Project is mainly to establish growing technology of Macadamia and specific fruits, and to train local extension personnel.

The Project facilities were established by grant aid cooperation from Japan (1,150 million Japanese Yen). However, the facilities of research field, gates and fences, farm road, etc., to carry out the study of breeding, pomology, crop protection, etc., have not been prepared sufficiently. In this connection, a study team headed by Mr. Kazuo Nagai, Deputy Head, Technical Cooperation Division, Agricultural Development Department, Japan International Cooperation Agency (JICA), was dispatched to the Republic of Kenya in order to carry out the detailed design for those infrastructure improvement works.

The team conducted a field survey in the Project area. After the team returned to Japan, further studies were made. As a result, the present report has been prepared.

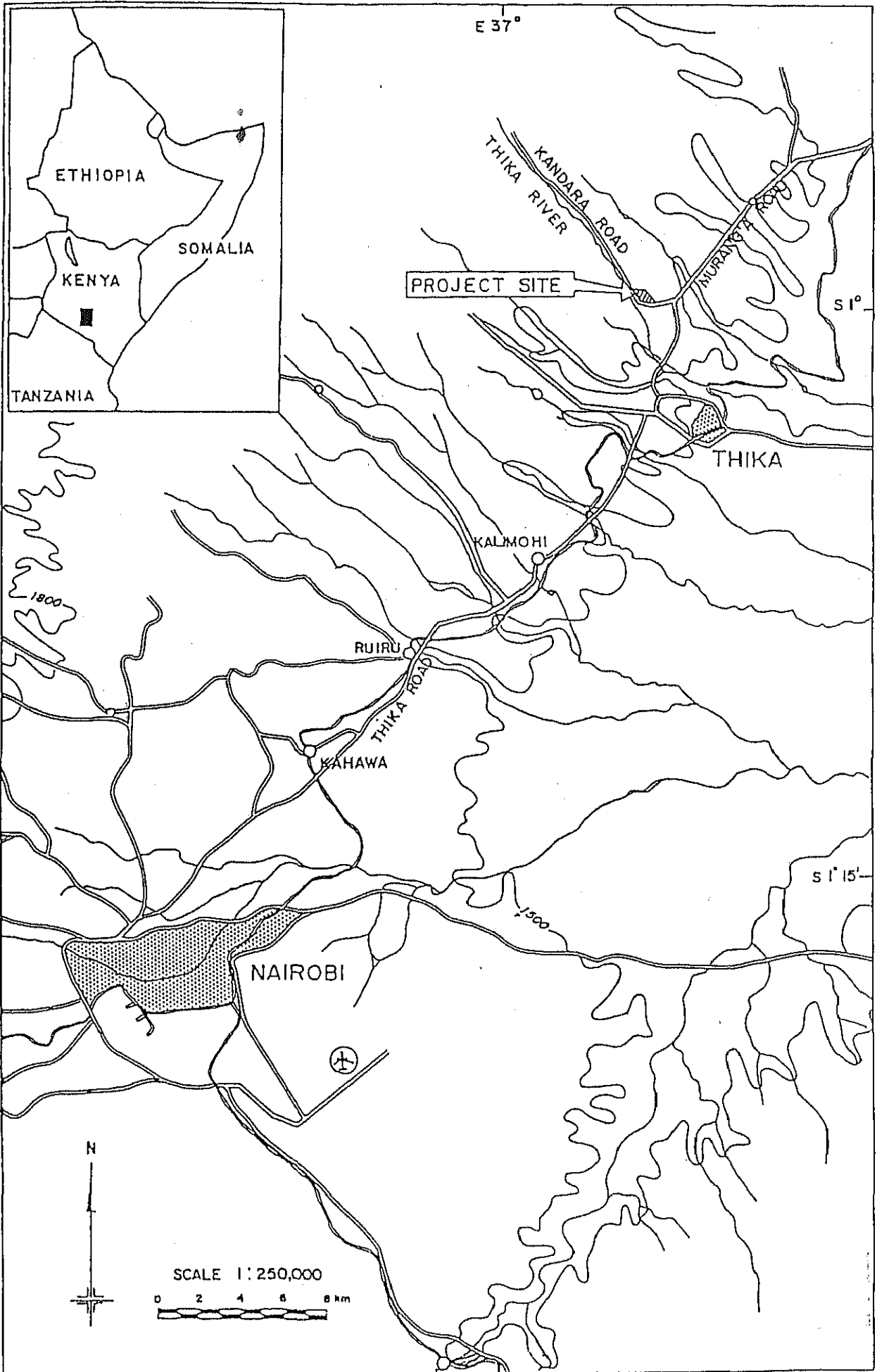
I hope that this report will serve for the enforcement of the Model Infrastructure Works scheduled.

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.

May, 1988

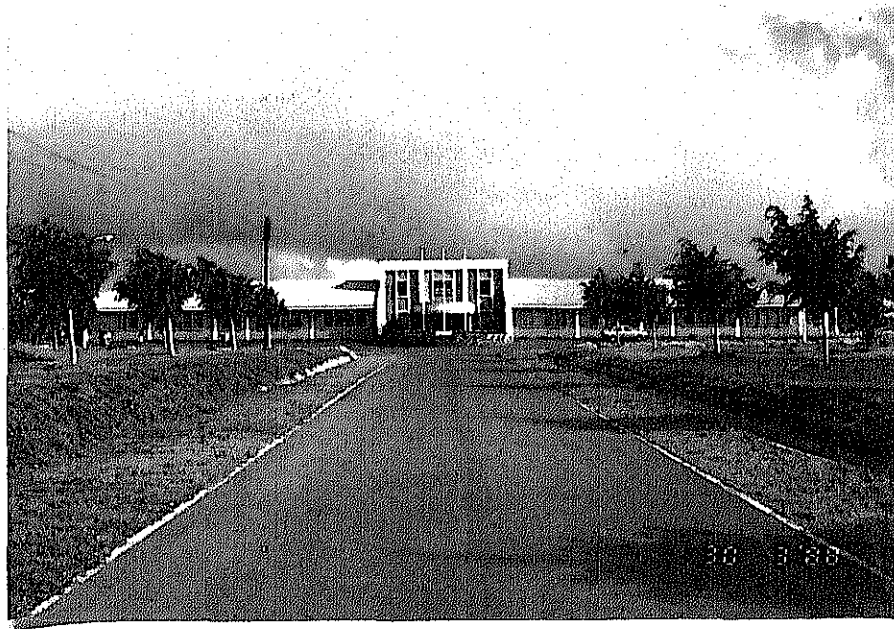
Kazumi Miyamoto
Director
Agricultural Development Cooperation Dept.
Japan International Cooperation Agency

LOCATION OF SURVEY AREA



No.1

View of the
Horticultural
Development
Project

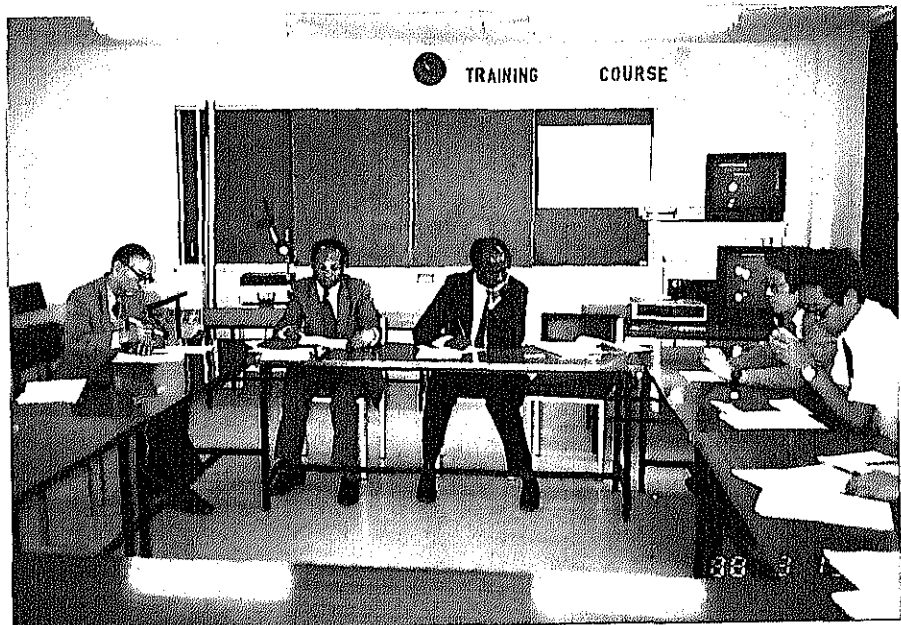


No.2

Front View of
Main Building

No.3

Meeting with
Kenyan Government
Officials concerned
and Japanese
Experts at NHRS



No.4
Existing Main
Farm Road



No.5
Existing Secondary
Farm Road

No.6
Soil Exploration

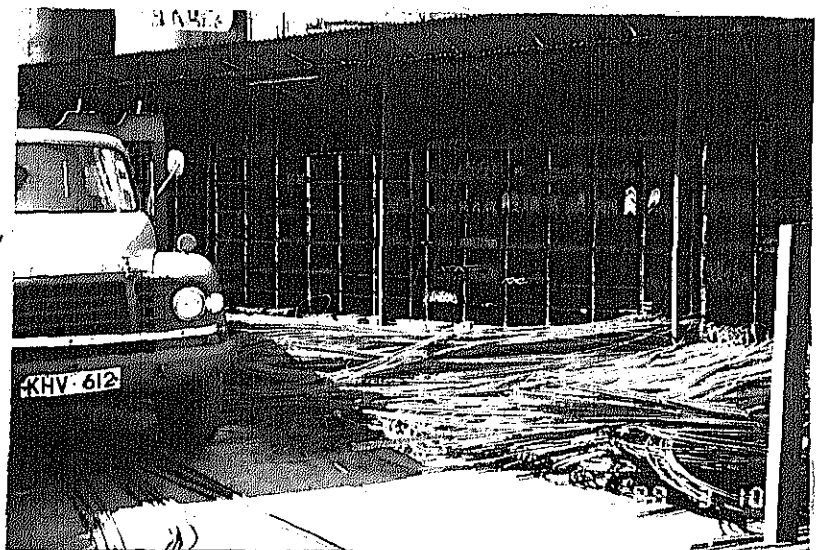


No.7
Existing Windbreak



No.8
Existing Fence

No.9
Construction
Material Survey



DETAILED DESIGN REPORT
 ON
 MODEL INFRASTRUCTURE IMPROVEMENT WORKS
 FOR
 HORTICULTURAL DEVELOPMENT PROJECT IN THE REPUBLIC OF KENYA

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CHAPTER 1 PRESENT CONDITION OF THE REPUBLIC KENYA

CHAPTER 1 PRESENT CONDITION OF THE REPUBLIC OF KENYA

1.1 General Conditions

The Republic of Kenya is located in the eastern part of the African Continent. Kenya is situated between latitude 4° N and 4° S and between longitudes 34° and 42° E, and covers an area of $582,646 \text{ km}^2$ (1.5 times the total area of Japan). The eastern part faces the Indian Ocean and the northern part touches the border of Somali, Ethiopia and Sudan. The western part borders with Uganda and the southern part with Tanzania. Extreme difference in the weather greatly influences agriculture production.

The Rift Valley divides Kenya geographically into west and east regions. The width of the Rift Valley varies from 50 to 80 km and the height of its cliff varies from 600 to 1,500 m. There are 9 lakes between the Ethiopian and Tanzanian borders along the Rift Valley.

Lake Turkana located in the north part of Kenya and Lake Victoria located on the Ugandan border are the centres of fresh water fisheries. The highland in the central part of the country ranges from 1,000 m to 2,000 m above sea level. Mt. Kenya rises to a height of over 5,200 m in the central part of Kenya right on the equator.

The climate of this country is divided into three zones as follows:

Dry climate zone - Northeastern border area
Tropical climate zone - Indian Ocean area
Semi-tropical climate zone - Western highland area

The average annual maximum temperature on the coast of the Indian Ocean is 32.7°C and the average annual minimum temperature is 20.0°C . The climate in the highland area is relatively mild.

Rainfall in many regions averages 800 mm per year. In the northeastern semi-dry zone, there is less than 250 mm of rainfall per year. In the western part, such as the coastal region of Lake Victoria and the

southern slope of Mt. Kenya, there is rainfall of approximately 2,000 mm per year. Thus, since there are great differences in the amount of rainfall by region, this causes a difference in agricultural productivity. When dividing the country into regions according to rainfall, the following four can be seen:

- (1) the region from Kitale to Nairobi with approximately 1,300 mm of rainfall per year.
- (2) the coastal area of Lake Victoria with approximately 2,000 mm of rainfall per year.
- (3) the region from Nairobi to the Tanzanian border with approximately 600 mm of rainfall per year.
- (4) the coastal area of the Indian Ocean around Mombasa with approximately 800 mm of rainfall per year.

Differences of the weather cycle length between the rainy and dry seasons in each region regulate the cultivation of crops - from planting to harvesting. Although rain falls throughout the year in Kenya, there are two rainy seasons (April - June, October - November). The time for planting seeds and harvesting are coordinated with these seasons.

These climate features as well as location, altitude and rainfall greatly affect the productivity of the land.

Table 1-1 Temperature and Rainfall in Major Cities

Station		J	F	M	A	M	J	J	A	S	O	N	D	Year
Lodwar	Deg C	28.9	29.7	30.3	29.9	29.7	29.1	28.4	28.7	29.6	30.1	29.2	28.7	29.3
506m	mm	9	8	21	49	25	9	20	10	4	10	17	11	193
Mombasa Airport	Deg C	27.6	28.0	28.4	27.6	26.0	24.9	24.1	24.2	24.9	25.9	26.9	27.5	26.3
57m	mm	38	16	55	161	236	76	67	65	74	96	95	70	1049
Nairobi	Deg C	18.0	18.6	19.4	19.1	17.9	16.3	15.4	15.8	17.1	18.6	18.1	18.0	17.7
1798m	mm	73	60	93	211	195	37	19	25	35	52	157	92	1049
Nakuru	Deg C	17.6	18.3	18.7	18.5	17.9	17.1	16.8	16.8	16.9	17.0	17.1	17.1	17.5
1872m	mm	33	51	76	135	130	75	95	117	95	66	68	40	981
Kisumu	Deg C	23.8	24.1	24.1	23.4	22.8	22.2	21.9	22.2	22.8	23.8	23.7	23.5	23.15
1149m	mm	62	88	158	216	173	88	66	98	79	75	120	100	1323

Source: KENYA 1987-1988 FACTBOOK UHURU 24

According to the population census of 1979, the total population and population density of Kenya was 15,330,000 and 26.31 people/km², respectively. The annual population growth rate was 3.7%. According to this growth rate, the total population in 1987 is estimated to be 21,700,000.

In the whole continent of Africa, many different tribes live together in a country. Kenya is also included in one of those countries. The living style of each tribe varies depending upon the natural conditions of the regions where they live. The following is a list of major tribes in Kenya.

<u>Language</u>	<u>Tribe</u>
Bantu	Kikuyu, Luhya, Kamba
Hamitic	Somali
Nilotic	Luo
Nilo-Hamitic	Turkana, Masai

<u>Basic Data of the Republic of Kenya</u>	
Head of State	: HE President Daniel T Arap Moi
Capital	: Nairobi
Area	: 582,646 km ²
Population	: 21,700,000 (projected in 1987)
GDP per capita	: 3,152 Kshs for 1985 at constant 1982 prices
Currency	: Kenya shilling
National Languages	: Swahili, English
Religion	: Chistianity, Islam, etc.

1.2 National Economy

In 1963, the Republic of Kenya achieved independence from the British rule.

The economic development concept of the Government can be summarized into the following three items; i.e. increase of per capita income, Kenyaization of the economy and fair distribution of wealth.

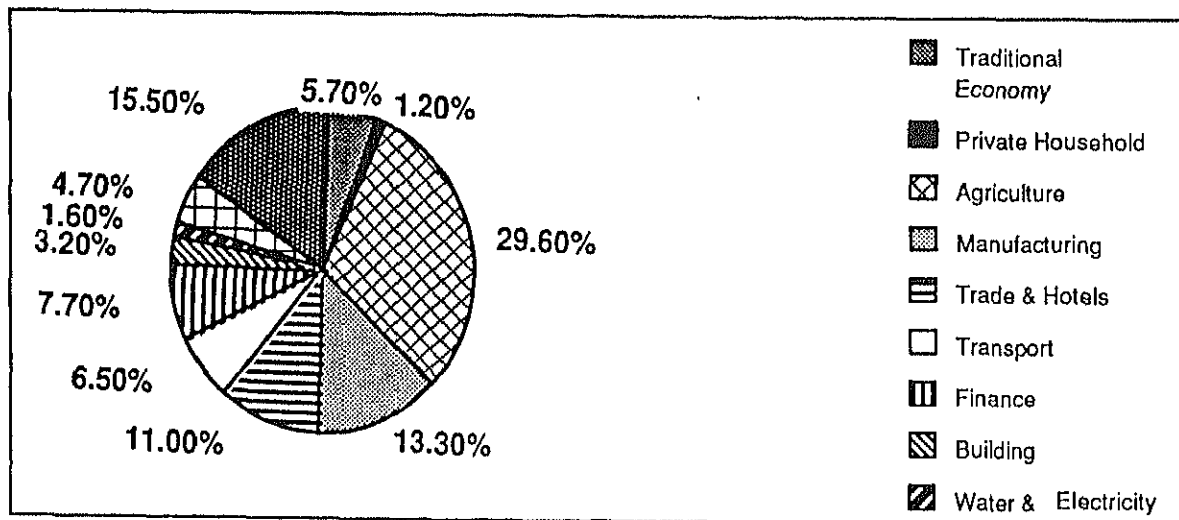
The fair distribution of wealth under the free market economy is planned through the development of various corporations and cooperatives.

The Government of Kenya has decided to spur an industrial growth since its independence in order to emerge from the economic system in the time of colony which gave priority to agriculture. As a result, Kenya has succeeded in an industrialization. However, the key industry of Kenya is still agriculture. Agriculture sector accounts for almost 30% of the national economy and for almost 67.5% of the national exports, and is an important sector for obtaining foreign currency.

The major exports items in agriculture sector are coffee, tea, pineapple, sisal and pyrethrum. In industry sector, they are petroleum products, cement and soda ash. The major imports items are crude petroleum, industrial machinery, iron and steel and vehicles.

After the worst drought in half a century in 1984, Kenyan economy has made a rapid recovery and the GDP growth rate in 1986 was 5.7 per cent. High coffee prices and low fuel prices have helped the economic recovery. Table 1-2 and 1-3 show the GDP growth rate after 1983.

Fig. 1-1 GDP Sector Analysis



Source: KENYA 1987-1988 FACTBOOK UHURU 24

A deficit of 351 million Kenyan pounds (Kshs. 7 billion) was recorded in 1986 in terms of external trade, and it becomes the biggest object of public concern. The widening trade gap is partly offset by the income from the tourists from abroad. The import control and export promotion have also helped in reducing it.

After touching a peak of 20 per-cent in 1982, Kenya's rate of inflation has declined in the following years. However, about 10 per-cent of inflation rate are in prospect in the future.

Table 1-2 Gross Domestic Product, 1983 - 1986 K£million

	CURRENT PRICES					CONSTANT (1982) PRICES						
	1983	1984	1985	1986*	1983	1984	1985	1986*	1983	1984	1985	1986*
A. NON-MONETARY ECONOMY												
Forestry	24-95	28-97	32-93	34-37	22-48	23-21	23-89	24-88	23-89	23-21	23-89	24-88
Fishing	1-11	1-25	1-56	1-84	1-32	1-29	1-41	1-59	1-41	1-29	1-41	1-59
Building and Construction	58-99	68-41	95-44	103-33	50-58	52-02	60-70	62-29	60-70	52-02	60-70	62-29
Water Collection	21-77	24-89	28-04	29-74	20-90	22-00	22-62	22-93	22-62	22-00	22-62	22-93
Ownership of Dwellings	90-01	103-96	135-44	148-65	76-52	79-55	82-65	86-09	82-65	79-55	82-65	86-09
TOTAL NON-MONETARY ECONOMY	196-83	227-48	293-41	317-93	171-80	178-07	191-27	197-78	171-80	178-07	191-27	197-78
B. MONETARY ECONOMY												
1. Enterprises and Non-Profit Institutions												
Agriculture	1,030-61	1,083-89	1,198-98	1,352-13	945-65	910-77	943-02	988-28	943-02	910-77	943-02	988-28
Forestry	26-84	27-89	28-72	32-33	23-74	24-48	25-27	25-53	25-27	24-48	25-27	25-53
Fishing	9-02	10-34	13-06	15-50	11-04	10-94	11-82	13-37	11-82	10-94	11-82	13-37
Mining and Quarrying	7-37	8-51	10-00	11-45	6-69	7-41	7-56	7-80	7-56	7-41	7-56	7-80
Manufacturing	408-26	460-96	518-40	576-37	389-07	405-84	424-07	449-08	424-07	405-84	424-07	449-08
Building and Construction	138-08	131-89	162-03	186-92	109-96	102-48	103-57	107-30	103-57	102-48	103-57	107-30
Electricity and Water	47-03	51-91	57-15	63-59	49-45	50-55	53-82	57-88	53-82	50-55	53-82	57-88
Trade, Restaurants and Hotels	381-89	422-56	502-85	633-59	307-78	324-83	350-17	379-58	350-17	324-83	350-17	379-58
Transport, Storage and Communications**	195-26	235-86	267-26	305-30	201-51	202-29	206-54	215-42	206-54	202-29	206-54	215-42
Finance, Insurance, Real Estate and Business Services	248-84	269-15	315-02	349-58	223-58	234-04	246-28	260-81	246-28	234-04	246-28	260-81
Ownership of Dwellings	154-24	168-19	181-69	207-25	135-18	134-77	130-01	133-35	130-01	134-77	130-01	133-35
Other Services***	70-17	81-93	98-73	116-98	68-46	72-02	78-23	85-50	78-23	72-02	78-23	85-50
Less: Imputed Bank Service Charges	-114-51	-120-18	-130-64	-156-44	-102-88	-104-50	-108-21	-109-29	-102-88	-104-50	-108-21	-109-29
TOTAL	2,603-10	2,832-90	3,223-25	3,694-55	2,369-23	2,375-92	2,472-15	2,614-62	2,369-23	2,375-92	2,472-15	2,614-62
2. PRIVATE HOUSEHOLDS (DOMESTIC SERVICES)	35-71	44-88	51-78	62-94	34-88	37-16	39-74	43-92	34-88	37-16	39-74	43-92
3. PRODUCERS OF GOVERNMENT SERVICES												
Public Administration	95-34	103-01	118-77	145-30	..	..	..	..	..	..	..	..
Defence	18-28	17-42	16-36	18-35	..	..	..	..	..	..	..	..
Education	212-56	240-12	293-23	372-86	..	..	..	..	..	..	..	..
Health	52-30	56-57	65-40	79-05	..	..	..	..	..	..	..	..
Agricultural Services	34-62	37-29	41-90	40-50	..	..	..	..	..	..	..	..
Other Services	62-15	67-81	83-08	101-33	..	..	..	..	..	..	..	..
TOTAL	475-25	522-22	618-75	757-39	459-89	473-13	497-26	528-09	459-89	473-13	497-26	528-09
TOTAL MONETARY ECONOMY	3,114-06	3,400-00	3,893-78	4,514-88	2,864-00	2,886-21	3,009-15	3,186-63	2,864-00	2,886-21	3,009-15	3,186-63
TOTAL NON-MONETARY AND MONETARY ECONOMY	3,310-89	3,627-48	4,187-19	4,832-81	3,035-80	3,064-28	3,200-42	3,384-41	3,035-80	3,064-28	3,200-42	3,384-41
GROSS DOMESTIC PRODUCT PER CAPITA K£	176-59	186-19	206-87	229-90	161-93	157-29	158-12	161-00	161-93	157-29	158-12	161-00

*Provisional.

**Estimates have been revised upwards to include "mini buses from 1981. These revisions, however, have had very little impact on the annual growth rates".

***Later data and observations indicate that these estimates will be revised upwards.

Source: Economic Survey 1987, Central Bureau of Statistics

Table 1-3 Gross Domestic Product; Percentage Rates of Growth, 1983 - 1986 Percentage

	CURRENT PRICES					CONSTANT (1982) PRICES					
	1983-84	1984-85	1985-86*	1982-86**	1983-84	1984-85	1985-86*	1982-86**	1983-84	1985-86*	1982-86**
A. NON-MONETARY ECONOMY											
Forestry	16-1	13-7	4-4	12-1	3-3	2-9	4-2	3-6			
Fishing	12-6	24-8	18-0	15-7	-2-3	9-3	12-8	11-4			
Building and Construction	16-0	39-5	8-3	20-5	2-8	16-7	2-6	6-2			
Water Collection	14-3	12-7	6-1	11-4	5-2	2-8	1-4	2-6			
Ownership of Dwellings	15-5	30-3	9-8	19-2	4-0	3-9	4-2	4-0			
TOTAL NON-MONETARY ECONOMY	15-6	29-0	8-4	17-9	3-5	7-3	4-5	4-4			
B. MONETARY ECONOMY											
1. Enterprises and Non-Profit Institutions											
Agriculture	5-2	10-6	12-8	10-4	-3-7	3-5	4-8	2-2			
Forestry	3-9	3-0	12-6	9-4	4-3	3-2	1-0	3-1			
Fishing	14-6	26-3	18-7	16-8	-0-9	8-1	13-1	12-6			
Mining and Quarrying	15-5	17-5	14-5	14-7	10-8	2-0	3-2	4-2			
Manufacturing	12-9	12-5	11-2	11-6	4-3	4-5	5-9	4-9			
Building and Construction	-4-5	22-8	15-4	11-6	-6-8	1-1	3-7	-2-9			
Electricity and Water	10-4	10-1	11-3	8-0	2-2	6-5	7-5	5-1			
Trade, Restaurants and Hotels	16-8	19-0	26-1	20-5	5-5	7-8	8-4	6-6			
Transport, Storage and Communications	20-8	13-3	14-2	14-7	8-4	2-1	4-3	6-0			
Finance, Insurance, Real Estate and Business Services	8-2	17-0	10-9	14-0	4-7	5-2	5-9	6-0			
Ownership of Dwellings	9-1	8-0	14-1	10-1	-0-3	-3-1	2-1	-1-2			
Other Services	15-8	20-5	18-5	16-4	5-2	8-6	9-3	8-0			
Total (Excluding imputed bank service charges)	8-8	13-8	14-6	12-8	0-3	4-1	5-8	3-6			
2. Private Households (Domestic Services)	25-7	15-4	21-6	17-7	6-5	7-0	10-5	7-6			
3. Producers of Government Services											
Public Administration	8-0	15-3	22-3	12-5	..	..	..	..
Defence	-4-7	-6-1	12-2	0-7	..	..	..	..
Education	13-0	22-1	27-1	16-8	..	..	..	..
Health	8-2	15-6	20-9	13-2	..	..	..	..
Agricultural Services	7-7	12-4	-3-3	6-4	..	..	..	..
Other Services	9-1	22-5	22-0	17-7	..	..	..	..
TOTAL	9-9	18-5	22-4	14-5	2-9	5-1	6-2	4-7			
TOTAL MONETARY ECONOMY	9-2	14-5	16-0	13-2	0-8	4-3	5-9	3-8			
TOTAL NON-MONETARY AND MONETARY ECONOMY	9-6	15-4	15-4	13-3	0-9	4-4	5-7	3-8			
GROSS DOMESTIC PRODUCT PER CAPITA	5-4	11-1	11-1	9-2	-2-9	0-5	1-8	-0-3			

*Provisional.
**Cumulative.

Source: Economic Survey 1987, Central Bureau of Statistics

Table 1-4 Balance of Trade, 1982-1986

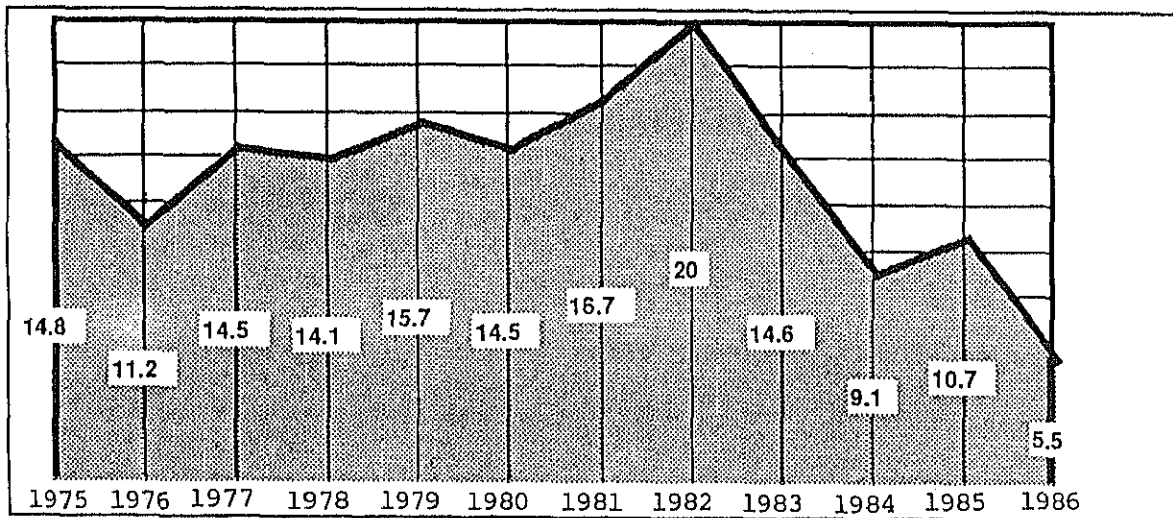
K£million

	1982	1983	1984	1985	1986*
EXPORTS—					
Domestic Exports ..	545.74	633.08	754.81	785.10	957.97
Re-exports	22.91	19.10	22.09	26.33	28.88
Total	568.64	652.18	776.91	811.43	986.85
IMPORTS—					
Commercial	843.35	852.56	1,050.22	1,153.98	1,275.41
Government	56.96	53.06	46.99	42.02	62.48
TOTAL	900.30	905.62	1,097.21	1,196.00	1,337.89
BALANCE OF TRADE ..	-331.66	-253.44	-320.30	-384.57	-351.04

*Provisional.

Source: Economic Survey 1987, Central Bureau of Statistics

Fig.1-2 Inflation Rates



Source: KENYA 1987-1988 FACTBOOK UHURU 24

1.3 Agriculture

The total area of the Republic of Kenya is 582,646 km². Although the area is comparatively large, a land suitable for agriculture is limited. The reasons are the variation of climatic features as well as location, rainfall and the variation of ecology. There are 5,300,000 ha of woodland and 80,000 ha. of high or mountainous regions which have no vegetation. The total cultivatable agricultural land is 10,600,000 ha. The land which is suitable for livestock (30,000,000 ha) have the largest part. Out of the total area available, about 18% is suitable for agriculture with another 9% being marginally suitable. Grassy plain suitable for livestock covers 52% of the land and the remaining 21% is wasteland.

From the climatic point of view, the most suitable agricultural land spreads in the western highland the altitude of which varies from 1,000 m to 2,000 m above sea level. Due to its mild climate and abundant fertile soil available, it has been developed from early days. The northern and northeastern regions, which occupies 60% of the total land, are semi-desert dry zones and not suitable for agriculture.

A large estate has been distributed to a private sector after its independence, which has produced two groups, large-scale farmers and small-scale farmers. The farm structure in Kenya still has two aspects. The structure of large-scale farmers is quite different from that of small-scale farmers.

The total area of large-scale farmers is 1,600,000 ha (26%) out of agricultural area including livestock area of 6,200,000 ha. The total area of small-scale farmers holding less than 20 ha is 3,500,000 ha (56%) and that of livestock area is 1,100,000 ha (18%).

The small-scale farming plays an important role in Kenyan agriculture. It produces 75% of the total agricultural products and occupies 85% of the total farm workers. But the average area hold by a small-scale farmer is

less than 2.3 ha. These small-scale farmers consume their farm products as their own food. On the other hand, they play an important role in agricultural economy by cultivating export and cash crops as well as producing crops for domestic consumption.

Major crops in Kenya are maize, wheat, barley, beans, sorghum, sugar-cane, coffee, tea, sisal and cotton. An irrigated area is only 0.4% of the total cultivated area. Since major crops are cultivated by a traditional farming method, the agricultural productivity is very low comparing with the world average productivity except wheat, rice, sugar-cane, tea and sisal.

Between 1964 and 1972 the small-scale farmer promptly started the cultivation of cash crops (coffee, tea, etc.) which had been prohibited before. The cultivated area of small-scale farmers was increased because of the distribution of farm land from large-scale farmers and increase of cultivation of highbred maize. Therefore, the agriculture sector's contribution to GNP grew by 4.6% per year. The agricultural sector's growth in 1986 was the biggest for the last five years. This sector's contribution to GDP grew by 4.8 per-cent following an increase of 3.5 per-cent in 1985. Table 1-5 shows the agricultural output and input from 1982 to 1986.

Table 1-5 Agricultural Output and Input, 1982 - 1986 K£million

Item	1982	1983	1984	1985	1986*
AT CURRENT PRICES—					
Total Output	1,048.82	1,182.01	1,253.13	1,431.95	1,628.31
Less Inputs	141.66	151.40	169.24	232.97	276.18
Value Added	907.16	1,030.61	1,083.89	1,198.98	1,352.13
AT CONSTANT (1982) PRICES—					
Total Output	1,048.82	1,088.82	1,056.60	1,101.50	1,173.70
Less Inputs	141.66	142.53	145.90	158.48	185.42
Value Added	907.16	946.29	910.70	943.02	988.28

*Provisional.

Source: Economic Survey 1987, Central Bureau of Statistics

Kenya is one of the few countries being almost self-sufficient in producing its food requirements.

In the fifth five-year plan (1984 - 1988), one of the policies for the agricultural sector is to keep the situation of self-sufficiency in food. It is also expected to increase the trade earnings by promoting the

exports of the fruit, livestock, and horticultural products and increasing the production of coffee and tea and improving their quality.

According to the fifth five-year plan (1984 - 1988), the targeted growth rate is 4.5 per-cent in the first four years, and 5.0 per cent in 1988. In other words, the targeted average growth rate for five years is 4.6 per cent per year.

1.4 Agricultural Production

As the agricultural census for the large-scale farmers has been carried out since 1954, its scale and aspect can be clarified. However, a statistic survey for traditional small-scale farmers has not been carried out and the circumstances of them can not be made clear.

The cultivated area for some major crops are shown in Table 1-6. Maize, beans and potatoes which are the staple foods for Kenyan are cultivated mainly in the area. The cultivation of coffee, tea, cotton and sugar-cane (cash crops) is also imcreasing. However, the cultivation of their cash consentrated in some specific provinces.

As to horticultural production, some fruits and vegetables are cultivated in Kenya and almost all of them are exported to Western Europe. Major horticultural products for exports are French bean and pineapple, etc., and the main export country is the United Kingdom. Although the scale and amount of earnings on the horticultural products are small compared with those of tea or coffee, they play an important role as the side business of large-scale farmers and as the source of earnings for small-scale farmers, and they can get a lot of foreign currency.

The production of passion fruit which has high demand in Europe is recommended by the Government of Kenya, the canned passion fruit and juice are on sale.

Major fruits produced in Kenya are pineapple, banana, orange, etc. However, due to insufficient statistics for the traditional products, it is quite difficult to grasp their amount.

Earnings of pineapple was 2,144 million Kenyan pounds in 1981. The study on production of grapes, apples, passion fruit and avocado has been carried out in National Horticultural Research Station (NHRS), and they are expected to become important agricultural products in the further.

Various vegetables are cultivated under the natural conditions of climate and soil in Kenya. Most of agricultural products are for self-consumption. However, the vegetable cultivation in the Central Province targets the big market of city; particularly Nairobi. In the market, various vegetables of temperate zone to tropical zone are sold. The vegetable which is called Sukuma in Kenya is favorite one in Africa. Table 1-10 shows the output of major vegetable products.

Table 1-6 Place of Production by Major Crops

Crops	Cultivated Area	Place of Production and its Percentage (Province)
Maize	1,194.6 ha	Easter (36.6), Nyanza (24.3)
Maize (highbred)	500.8	Western (35.8), Rift Valley (20.2), Central (20.2)
Sorghum	205.4	Nyanza (85.5)
Beans	763.5	Eastern (37.3), Central (30.4)
Potato	261.2	Eastern (53.4), Central (45.8)
Cassava	69.9	Western (49.6), Nyanza (38.5)
Banana	130.4	Central (46.2), Eastern (34.7)
Vegetables	56.0	Central (70.5)
Sugar-cane	63.7	Nyanza (75.3)
Pyrethrum	27.1	Central (46.9), Nyanza (36.5)
Cotton	70.1	Nyanza (35.9), Eastern (31.7)
Coffee	111.3	Eastern (54.3), Central (31.9)
Tea	64.8	Central (66.0)
Coconuts	51.3	Coast (96.3)
Cashew nuts	53.5	Coast (100.0)

Source: Agriculture in KENYA, AICAF

Table 1-7 Exports of Fresh Horticultural Produce, 1982 - 1986

YEAR	VOLUME '000 TONNES	VALUE K£MILLION
1982	24.6	13.63
1983	28.9	17.52
1984	31.3	20.79
1985	30.0	23.46
1986*	36.2	31.52

*Provisional.

Source: Economic Survey 1987, Central Bureau of Statistics

Table 1-8 Gross Farm Revenue

	K£'000					
	1976	1977	1978	1979	1980	1981*
CEREALS—						
Wheat	12,047	11,877	11,675	14,886	17,670	17,869
Maize	21,628	18,843	10,501	9,363	10,390	23,645
Barley	2,625	1,955	2,662	3,354	4,279	3,903
Rice	2,690	2,816	2,594	2,826	2,843	3,235
Other Cereals	343	36	45	91	70	75
Total	39,333	35,527	27,477	30,520	35,252	48,727
TEMPORARY INDUSTRIAL CROPS—						
Pineapples	1,317	2,135	2,211	2,043	2,002	2,144
Castor and other oil seeds	466	360	585	803	252	252
Pyrethrum	4,089	3,662	4,106	5,721	9,735	13,969
Sugar cane	9,618	13,364	17,392	23,302	29,520	30,877
Cotton	1,648	2,343	4,287	4,528	6,315	4,344
Tobacco	239	602	858	1,381	1,397	2,037
Total	17,377	22,466	29,439	37,778	49,221	53,623
OTHER TEMPORARY CROPS—						
Pulses	2,127	318	284	2,116	2,091	3,091
Potatoes	3,128	3,031	3,059	3,050	2,874	3,449
Other temporary crops*	3,371	3,255	3,297	3,300	3,110	3,297
Total	8,626	6,604	6,640	8,466	8,075	9,837
PERMANENT CROPS—						
Coffee	101,333	192,919	118,822	105,684	118,856	102,471
Sisal	3,920	4,800	4,278	6,577	9,714	8,512
Tea	32,757	92,729	73,914	67,343	71,515	80,590
Coconuts and Products	489	526	530	484	530	530
Wattle	422	471	419	351	563	639
Cashew nuts	1,175	667	1,006	1,146	2,062	1,643
Fruit** and Other Permanent Crops	1,391	1,281	1,230	1,124	1,267	1,245
Total	141,487	293,393	200,199	182,709	204,507	195,630
TOTAL CROPS	206,823	357,991	263,755	259,473	297,055	307,817
LIVESTOCK AND PRODUCTS						
Cattle and Calves for Slaughter	19,056	23,437	34,941	29,091	33,909	47,945
Sheep, Goats and Lambs for Slaughter	1,021	1,131	1,737	2,158	1,645	1,445
Pigs for Slaughter	994	1,042	1,207	1,087	916	1,037
Poultry and Eggs	2,142	2,522	1,578	1,856	1,606	1,354
Wool	370	321	346	370	529	449
Hides and Skins	1,476	1,815	2,706	2,253	2,642	3,699
Dairy Products	12,050	18,836	19,587	17,465	15,007	22,802
Total	37,109	49,104	62,102	54,280	56,254	78,751
UNRECORDED MARKETED PRODUCTION	6,115	7,489	7,532	7,247	7,768	8,722
GROSS FARM REVENUE	250,047	414,584	333,389	321,000	361,077	395,290

Source: Central Bureau of Statistics.

*Provisional.

**Fruit from other than permanent plants is included in "other temporary crops"

Table 1-9 Estimated Production of Selected Agricultural Commodities
in Agricultural Years, 1982/83 - 1986/87
(Based on Crop Forecast Surveys)

				<i>million bags</i>				
CROP				1982/83	1983/84	1984/85	1985/86	1986/87*
Maize	..	..	..	26.10	24.20	15.80	27.00	32.20
Beans	..	..	..	3.20	3.00	0.76	1.97	3.60
Potatoes	..	..	..	6.10	5.10	2.59	5.90	6.11

*Provisional.

Source: Economic Survey 1987, Central Bureau of Statistics

Table 1-10 Output of Major Vegetable Products (1974 - 1975)

Province	Vegetable (1,000 ha)	
	Single Cultivation	Mixed Cultivation
Central	2.1	37.4
Coast	0.1	1.6
Eastern	0.1	7.3
Nyanza	0.1	1.1
Rift Valley	0.2	1.1
Western	1.5	3.5
Total	4.1	52.0

Source: Agriculture in KENYA, AICAF

CHAPTER 2 OUTLINE OF THE PROJECT

CHAPTER 2 OUTLINE OF THE PROJECT

2.1 Horticultural Development Project

2.1.1 Present Condition of the Project Area

The National Horticultural Research Station (NHRS) is located 42 km northeast from Nairobi and belongs to Muranga District. It takes about 50 minutes by vehicle from Nairobi to the site. The site is connected to Nairobi with an asphalt-paved road.

The Jomo Kenyatta College of Agriculture and Technology, which is built by the Japanese Grant Aid, is situated 14 km south from the Project site.

Thika town is located 4 km south from the Project site. There are twenty-two factories in the Town such as an automobile manufacturing plant, textile mills, leather industrial plants, a pineapple canning plant, and paper mills. There are also a municipal office, public markets, a stadium, a hospital, banks and schools in Thika. The Project site belongs to Thika town from the social and economic points of view.

The total area of the Macadamian Unit of the NHRS is about 30 ha and its elevation is about 1,500 m above sea level. An asphalt-paved National Highway is continued from Thika town to the site and the asphalt-paved access road from the National Highway to the main building was constructed by the Japanese Grant Aid. Other facilities such as an electric installation, a telephone system within the building, a gas supply, a water supply and drainage system were completed by the Project. The climate data at the NHRS for the last eight years are shown in Fig.2-1.

2.1.2 Establishment of the Research Station for Macadamia and Specific Fruit

In 1957, the Government of Kenya decided to establish the horticultural research station for the study of pineapple cultivation in Thika, since the canning plant had been situated there. The research activity in the

research station covered all the fruits and vegetables as well as pineapple in the first half of 1960s. The research station was named the National Horticultural Research Station (NHRS) in 1974, and the research facilities were moved from the old station to the present site in 1975. All research activities for horticulture are carried out at the NHRS and some sub-stations are distributed throughout Kenya.

The study of various fruits, vegetables, crop protection, cereals and beans are carried out in the NHRS. The results of the study in the NHRS are contributing to Kenya's horticultural development plan. The NHRS requested are receiving the financial and technical assistance from other countries. The first Macadamia trees were planted near the Thika town in 1946 and were spread to the coffee plantations. Although the Macadamia cultivation as a cash crop for small-scale farmers started in 1964, it was found out that these young trees were not suitable for breeding. However, Macadamia nuts have a bright future and Macadamia processing plant had been established already at the time. Therefore, the Government of Kenya decided to improve the existing Macadamian products by selecting the suitable variety and improving grafting technology. Two Japanese experts were dispatched to the NHRS in order to assist this plan.

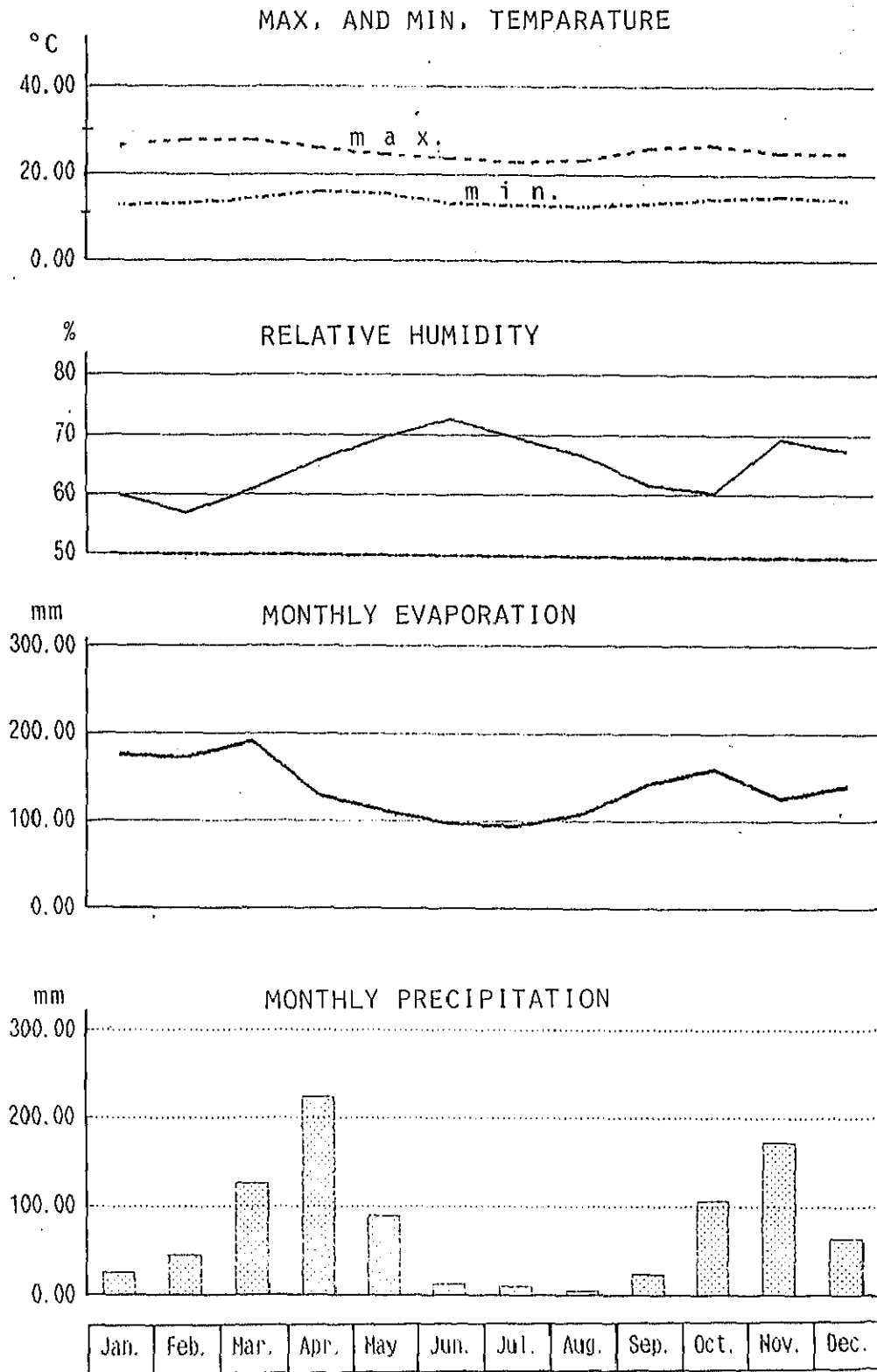
Since then, the research activity started with the technical cooperation between the Government of Kenya and Government of Japan. The good results in the selection of good variety and the improvement of grafting technology were obtained gradually.

As a result of these researches, the Horticultural Development Project was required to establish Macadamia growing technology, train the extension personnel and increase the income of small-scale farmers.

The Government of Kenya requested the grant aid cooperation to the Government of Japan in 1982, and the Project facilities were completed in 1986 in the NHRS by Grant Aid of Japan.

The Horticultural Development Project for five years has started in accordance with the Record of Discussions issued in December, 1985.

Fig.2-1 Climatic Data at NHRS (Thika) by month



2.1.3 Operation of the Project

The objectives of the Project are to establish Macadamia and specific fruit growing technology and to train the extension personnel.

Macadamia nuts have a bright future as an export crop in addition to coffee and tea. Therefore, the extension of the results of this Project to the small-scale farmers will make a good contribution to the increase of small-scale farmers' income through diversified farming.

The additional necessary equipment will be granted by Japan in accordance with the Record of Discussions. Three Kenya counterparts will be invited annually to Japan to study in maximum.

Long-term experts and short-term experts are being dispatched from Japan. As to April 1988, there are four long-term experts from Japan. Short-term experts will be called from Japan from time to time with the request of the Government of Kenya. These experts are working in conjunction with local researchers to promote the Project.

The activities in the Project are as follows.

(a) Breeding

The breeding section deals with selection of mother trees which are planted in the experimental field and carrying out a variety comparison experiments in order to get new clones. At the same time, they are tested for their suitability and adaptability to certain agrieological zones.

(b) Pomology

The pomology section conducts research on agronomy of Macadamias and carries out experiments on fructification management. This section also carries out observation of flowering, fruitset time, premature fruit drop and testing of nut quality.

The research work includes the study of tree growth, bearing habits and also training and pruning of the Macadamia tree. The inter-cropping test is also carried out in consideration of the effective utilization of land and soil conservation.

(c) Propagation

The propagation section deals with the raising of seedlings in the nursery for the further multiplication of selected varieties. Study of scion material from selected mother trees, analysis of various characteristics, storage conditions, grafting and after-care are carried out in this section. This section also works on selection of good quality nuts for raising of desirable rootstocks and includes the study on other characteristics like germination, growth rate and grafting compatibility. About 10,000 seedlings are produced per year in this section. Most of these are used of research purposes of the Project.

(d) Crop Protection

The crop protection section deals with research of various pests and diseases of the Macadamia tree. The main pests are stink bug and nut borer. The main diseases observed upto now are Root rot and Anthracnose.

(e) Training

The training section deals with training and practice of various specialists from each District; e.g. D.A.O., D.C.O., D.H.O., etc. It also trains extension workers from various divisions and locations. A hostel with dining room for the trainees which accommodates 20 people has been built at the Project site.

Extension workers who is trained here will in turn train others to facilitate the extension of research results to the farmers. The training section will train about 200 people per year.

A display room has been established in the main building in order to obtain the effective training. The display shows various Macadamia products, technology etc. in the form of show-cases and wall frames.

The display room is open to the public for viewing. At the same time, a lot of teaching materials are being prepared for the fast and effective training.

Table 2-1 Project Facilities

1. Main building	1,408 m ²
including Administration, Laboratory and Classrooms	
2. Nursery	
Grafting Workshop	1,000 m ²
Green house	200 m ²
Shade house	1,850 m ²
3. Experiment Farm	6.9 ha
Research field	0.65 ha
Scion Orchard	
4. Training Unit	396 m ²
including Hostel and Office	
Kitchen/Dining	108 m ²

2.1.4 Problems on the Project Operation

(a) Delay of the Construction Works by Kenya

The facilities constructed by the Japanese Grant Aid Cooperation were handed over to the Government of Kenya on March 26, 1986. However, the procurement of furniture, the establishment of border fences and gate, and the construction of the watching house near the gate were not yet completed as of April 1988. The completion of these works is under the responsibility of the Government of Kenya. Early action by the Government of Kenya is expected.

(b) Specific fruit tree

One of the main purposes of the Project is to study the specific fruits on their crop protection and soil science. In this connection, some nursery trees such as apple and pear were sent from Japan. However, these trees could not be reached to the NHRS because of quarantine problems in Kenya. Some measures should be taken in order to solve the quarantine problems in the future. Since the facilities for the research of the specific fruits are not enough, the sufficient study on this item can not be carried out. It is desirable that the facilities are prepared completely as soon as possible.

(c) Counterparts

At present, four long-term experts are dispatched from Japan. Their specialties are as follows: A team leader/breeding expert, a pomology expert, a coordinator/crop protection expert and a training expert. While it was agreed that the Government of Kenya would assign two Kenyan counterparts to each Japanese expert for effective training in accordance with the Minutes signed on August 29, 1986, Kenyan counterparts have not yet been assigned. Immediate measures should be taken for effective training of counterpart staff by the Government of Kenya.

2.2 Necessity of the Infrastructure Improvement Works

This Project has started after the pursuance of the Record of Discussions signed on December 4, 1985. The aim of the Project is mainly to establish Macadamia and specific fruits growing technology and train the local extension personnel.

The Project facilities were established in the NHRS by the Japanese Grant Aid Cooperation. However, the facilities of research field to carry out the study of breeding, pomology, crop protection, etc. has not been prepared sufficiently. Therefore, the following conditions shall be satisfied:

(a) Farm road

At present, the asphalt-paved road constructed around the main building by the Japanese Grant Aid, the existing east-west and north-south roads (gravel paved), and the small-scale farm roads which are covered with gravel by Japanese experts as needed are used in the NHRS. However, these roads are interrupted sometimes by excess water during the rainy season. Therefore, a main farm road to travel around the Project site and a secondary farm road to access to the each field are necessary to be improved for the smooth Project operation and training.

(b) Gates and Fences

The NHRS was partly surrounded with fences at the time when the start of the Japanese Grant Aid Cooperation, and it was mutually agreed that the fences would be constructed for the remaining sections by the Government of Kenya. However, due to the serious damages of the existing fences, the Macadamia trees and the specific fruit trees are attacked and damaged by wild animals. Therefore, the complete repair of the damaged existing fences and construction of new fences for the remaining sections should be made by the Government of Kenya in order to prevent wild animals from entering the Unit.

(c) Windbreak

The wind direction in the site is mainly from north-east. The root of the Macadamia trees planted in the experimental farm is very short and shallow, and these trees have a number of leaves. Under these conditions, the Macadamia trees planted are apt to be damaged by the wind seriously.

Accordingly, the windbreak forest was planted by the Government of Kenya in order to prevent the planted trees from being damaged by the strong wind. However, the windbreak forest is too young to reduce the wind power and many Macadamia trees are still damaged by the wind.

Therefore, the net-fence-type windbreak should be installed in substitution for the windbreak forest until the young windbreak forest grows to the one with enough height to reduce the wind power.

(d) Trellis

Although the breeding section deals with breeding of the Macadamia trees planted in the experimental field, the study on Macadamia and specific fruits and the research for their suitability and adaptability to the certain agroecological zones are not carried out smoothly for lack of facilities.

Therefore, the trellis covered with net and isolated from wild animals, birds, wind and sunbeams should be installed in order to overcome the above situations and promote the technical cooperation to Kenyan side further more.

CHAPTER 3 MODEL INFRASTRUCTURE IMPROVEMENT WORKS

CHAPTER 3 MODEL INFRASTRUCTURE IMPROVEMENT WORKS

3.1 General Description

The Model Infrastructure Improvement Works aims to improve infrastructures in the Macadamian Unit of the NHRS for the smooth experimental activities in the Project.

Main items of the Works are as follows:

- Gate and fence works;
- Farm road improvement works;
- Windbreak net fence works; and
- Trellies works

The detailed descriptions of each works are as follows:

(1) Gate and Fence Works

Kenyan Government installed the cedar-posted chain link fence around the Macadamian Unit before the construction of the Project facilities by Japanese Grant Aid. They are partially broken or rotted in the foundation, and small animals or unauthorized persons can easily enter the experimental farm. Therefore, it is required to make it permanent one by reinstalling the new fence with two gates. The fence on the east boundary, previously not installed, is now under construction by the Kenyan Government. Therefore, the construction of the fence in this section is omitted from the Works.

- Type of fence to be installed is of standard type of MOW (Ministry of Works, Housing and Physical Planning), chain link fence with concrete posts and 1.8 m high.
- Existing fence shall be demolished and the new fence shall be installed on the same line. Total fence length is 1,970 m.
- New two sets of steel gates, same type as the one installed in nursery facility area, 3.5 m wide.

(2) Farm Road Improvement Works

Farm road improvement works is divided into categories;

1) improvement of existing graveled farm road and 2) new construction of farm road in the experimental plots. They are also divided into two categories from their function; 1) main farm road which runs round the experimental unit and 2) branch farm roads which run from main or branch road to each experimental plot. Total length of these roads is 2,906 m.

- All the farm roads to be constructed/improved are of 3 m wide and gravel-paved (thickness 10 cm) ones and 50 cm wide shoulders are installed both sides of the pavement. Side ditch and field drain are constructed along the farm roads, if it is required.
- Eight (8) road crossing drain culverts are required to construct from the field drainage view point.

(3) Windbreak Net Fence Works

Windbreak trees were planted by the Government of Kenya, but they have not yet been grown up enough to protect the Macadamian trees from the wind. In order to protect young Macadamian trees temporarily until the windbreak trees grow up and to strengthen these windbreak trees, the installation of net-fence-type windbreak is required in the southern and northeastern boundary of the experimental fields of the unit. The total length becomes 1,200 m.

- Material of windowbreak net fence is tycon mesh net, which is available in Kenya, originally used for mosquito net of camping tents,
- Posts are made of precast concrete with maximum interval of 3 m and height of 3 m.

(4) Trellis Works

At the southern edge of the northeastern experimental plots, a trellis of 0.2 ha for the experimental breeding is planned to be constructed.

Steel pipe posts of 4.5 m high are installed with 5 m interval and they are anchored to the ground by wires. Fish net of 10 mm mesh covers the frame on the side and top.

3.2 Basic Design Conditions

3.2.1 Design Standard/Material Standard

The construction of the Works will be executed by a local contractor with use of the materials available in Kenya. Therefore, British Standard (BS) which is used locally is adopted for designing and selection of construction materials. Japanese Standard (JIS) is adopted only in case of no specific standard in BS.

3.2.2 Design Conditions

(1) Loads

- No earthquake load is considered.
- Design wind velocity as wind load is 28 m/sec.
- Bearing capacity of foundation is 20 ton/m² at 1.0 m below ground surface.

(2) Standard and Allowable Stress

- Reinforced Concrete
 - Class 20 of MOW ($\sigma_{28} = 205 \text{ kg/cm}^2$)
 - Allowable compressive stress: $\sigma_{ca} = 70 \text{ kg/cm}^2$
- Reinforcing Bar
 - BS 4461 $f_y = 425 \text{ N/mm}^2$ or 460 N/mm^2 , or SD30 of JIS
 - G3112 $f_t = 2,000 \text{ kg/cm}^2$
 - Allowable tensile stress: $\sigma_{sa} = 1,600 \text{ kg/cm}^2$
- Cement
 - BS12 Normal Portland Cement
- Galvanized Steel Pipes
 - BS 1387
 - Allowable tensile stress: $\sigma_{sa} = 1,600 \text{ kg/cm}^2$

- Galvanized wire, barbed wire, chain link
BS 4102

- Galvanized wire staples
BS 1494

3.3 Detailed Design

3.3.1 Gate and Fence Works

(1) Gates (2 sites)

a. Structure

Gate leaf is manufactured using 2.3 x 75 x 75 mm square hollow sections with a door of folding type, 3.5 m opening.

The gate leaf is connected to 250 x 250 mm precast concrete gate posts by three hinges on its side and an anchor bar at its top.

b. Gate Leaf

Gate leaf is manufactured in the factory using electric welding and painted with an anti-collision priming coat and three coats of enamel. Total weight of each leaf is 70 kg.

c. Precast Concrete Posts

Stability of gate posts against their turning over, sliding and bearing capacity of foundation against self weight and wind load of the gate leaf and posts are confirmed.

As a results of structural stability analysis, precast concrete post is of 250 x 250 mm with 2.80 m high and footing is of 1,000 x 1,000 x 300 mm and footing slab is set at 50 cm below the ground level.

(2) Fence Works

MOW's standard precast concrete post of 125 x 125 mm with center length 2.25 m (straight portion: 1.0 m and cranked top: 0.45 m), is installed with max. interval of 3.0 m in the excavated holes and fixed in the holes with concrete.

On the straight portion of the post, galvanized chain link of 6 inch wide reinforced by three galvanized wires is installed.

On the cranked portion of the post, three galvanized barbed wires are stretched.

a. Precast concrete posts

Standard section of a post is confirmed against wind loads on the post itself and chain link

b. Required depth of embedment of fence post

Applying the cason stability check method, the required depth of embedment of fence post is estimated. As a result of the calculation, in the case of the surrounding concrete diameter being 50 cm, the embedment depth is 60 cm below the ground level.

3.3.2 Farm Road Improvement Works

(1) Road width

- Design vehicle is ordinary car (L x W = 12.0 x 2.5 m), minimum turning curve is 12.0 m.
- Considering purpose of the farm road, traffic lane is set at one and road pavement width is 3.0 m.
- 0.5 m wide Shoulders of 0.5 m wide are provided on both sides of the pavement, and a side ditch is provided outside the shoulder if it is required.
- Cross grade of 3 % from the road center is provided for road surface drain.

(2) Alignment

- Alignments of new roads follows those of the existing farm roads as much as possible and they are confirmed in the field during the field survey in March 1988.
- Design driving speed at curvature is set at 30 km/hr. and minimum radius of curvature is set at 30 m, no widening of road section at curvature portion is considered.
- Maximum longitudinal slope is set at 9% (design driving speed is 30 km/hr.).
- Transit section of minimum vertical curve of 100 m with minimum 25 m long is provided at the turning point of longitudinal slope.
- At the crossing with farm roads, corner cutting with minimum 2.0 m is provided.

(3) Road crossing drainage culverts

- As farm roads interrupt the natural drain at many points, road crossing drainage culverts with precast concrete pipe are installed at these points.
- As catchment area of each drainage culvert is less than 1.0 ha, precast concrete pipe of 300 mm diameter can drain the excess water from higher field to lower field.
- Minimum clearance between road surface and top of pipe is 0.5 m and pipe foundation is sand bed.

3.3.3 Windbreak Net Fence Works

(1) Necessity of windbreak facilities

The Government of Kenya planted windbreak trees in the experimental field. They are still young and 1 to 2 meter high, and some part of them has already withered because of poor selection of young trees and insufficient breeding care. Young Macadamian trees have been transplanted before these windbreak trees grown up and function as windbreak. Therefore, Macadamian trees are damaged and inclined because they suffer the strong wind constantly, and it affects the research work.

As a counter measure of the problem, temporarily and supplementarily till planted windbreaks grow up, some windbreak facilities shall be provided.

(2) Selection of windbreak facilities

There are three types of windbreak facilities;

- windbreak trees,
- windbreak fence, and
- windbreak net fence.

Considering the following four (4) points, the windbreak net fence is selected for the Works;

- No obstruction to the growth of planted Macadamian trees and continuous research work;
- Instant effect as windbreak;
- Easiness of operation of the experimental field work; and
- No obstruction for research work under sun shade and other micro climate conditions

(3) Critical wind speed

The critical wind speed is the maximum wind speed which does not cause damages for the respective plant. As far as fruit trees are concerned, the bearing capacity of them against wind varies from "very weak" to "strong" as shown in Fig. 3-1. In consideration of the purpose of windbreak facilities being to protect young trees from strong wind, the bearing capacity against wind is set at medium. In this case, the critical wind speed is 9.0 m/sec.

(4) Design wind velocity-A

The design wind velocity-A is the wind speed which is used for designing the facilities to reduce the wind speed to critical wind speed. It is determined to be a daily maximum wind speed which occurs with ten-year probability. No data of maximum daily wind speed at the NHRS can be obtained. Mean daily wind speed data only are available at the NHRS. According to previous 8 years record at the NHRS, the mean daily wind speed is 134 km/day (equivalent to 1.55 m/sec). It is strong during in the rainy season and weak during the dry season. The day time wind speed is stronger than that at night.

In the design, the design wind velocity-A is set at 12 m/sec which corresponds to class 6 of the Bufford's wind velocity classification (10.8 - 13.8 m/sec). In the class 6 condition, big branches may sway and it may be difficult to walk with an umbrella (at the site, usually class 5 wind of Bufford's classification 9.8 - 10.8 m/sec) is observed).

(5) Design wind velocity-B

The design wind velocity-B is the design wind velocity to be used for the structural stability analysis. In this design, it is determined to be 28 m/sec., that is the same one as adopted in the building design of the Project.

(6) Height of windbreak net fence

Usually, the height of windbreak net fence is determined to be 1.0 - 2.0 m higher than the fruit trees to be protected. Macadamian trees grow up more than 10 m high. However, in the design, young Macadamian trees of 2 m high are considered. Consequently, the height of windbreak net fence is set at 3 m.

(7) Materials and structure

The windbreak net is spread between the precast concrete posts and reinforced by galvanized wire (8G).

Tygan mesh net, which is used for mosquito net of camping tents, is selected as a windbreak net among net materials available in Kenya. The characteristics of the net is as follows:

Diameter of thread: about 0.3 mm
Mesh interval : about 1.8 mm
Closing degree : 40%

(8) Interval of windbreak net fence

The effective length of the windbreak net fence can be estimated using Fig. 3-2.

The wind velocity reduction ratio is estimated as follows;

$$R = (U_a - U_b) / U_a$$

where; R = wind break reduction ratio

U_a = Design wind velocity-A (= 12 m/sec)

U_b = Critical wind speed (= 9 m/sec)

$$R = (12 - 9) / 12 = 0.25 \text{ (25\%)}$$

In this case, the effective length of windbreak net fence is 10 times the fence height (H). When H is 3.0 m, the interval of windbreak net fence becomes 30 m.

Considering the reduction of ground slope factor, the maximum interval of the windbreak net fence is set as follows:

Flat area: 30 m

Sloped area: 25 m

(9) Stability of windbreak net fence

- The design of section and depth of embedment of the the precast concrete posts of 150 x 150 mm are determined at their interval of 3.0 m and height of 3.0 m above ground level.
- The wind load on the windbreak net and post is 28 m/sec and coefficient of air resistivity of the net is 0.7.
- Required embedment depth becomes 1.50 m against wind load.

3.3.4 Trellis Works

In order to protect the Macadamia and specific fruits from the damages by binds and insect, the trellis which can cover the trees by net is provided.

(1) Structure

Trellis is composed of pipes and wire-reinforced frames structure. Pipes of 4.5 m high with interval of 5.0 m are installed in the field and they are reinforced by galvanized wires and anchored to the ground.

Outside the pipes and frames are covered with fish net of nylon with mesh interval of 10 mm.

(2) Structural stability

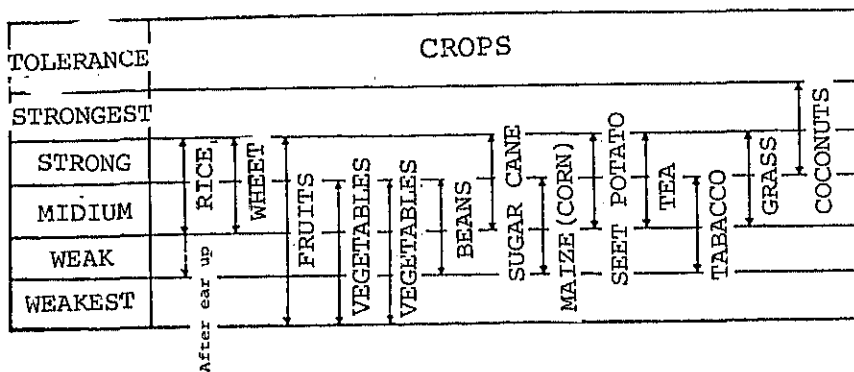
The stability and embedment requirement of pipes and wires are calculated against wind load on the net and post-pipes. The results are as follows:

- Outer main pipe posts are of galvanized steel pipe, class B of BS1387/67, with diameter 75 mm. The embedment length of the post is 1.5 m below ground level with 50 cm wide concrete foundation.

- Intermediate and anchor pipe posts are of galvanized steel pipes of class B "medium" BS1387/67, with diameter 40 mm. The embedment length is 1.5 m with 50 cm wide concrete foundation.

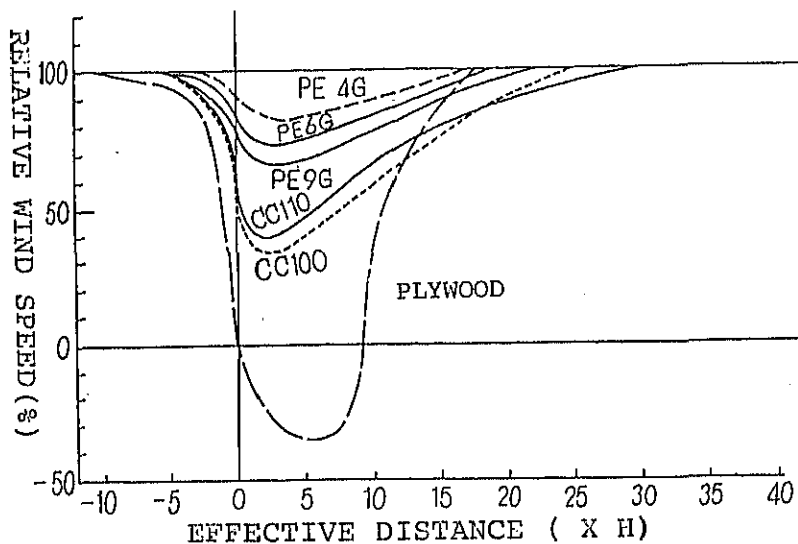
- Reinforcing wire between pipe posts is of galvanized wire 8G (9.80 m/kg). The wire which reinforces the outer main pipe posts is of 2 lines of 8G wire.

Fig.3-1 Wind Tolerance of Crops



Source: Ministry of Agriculture, Forestry and Fishery of Japan, "Design Guideline for Windbreak Facilities"

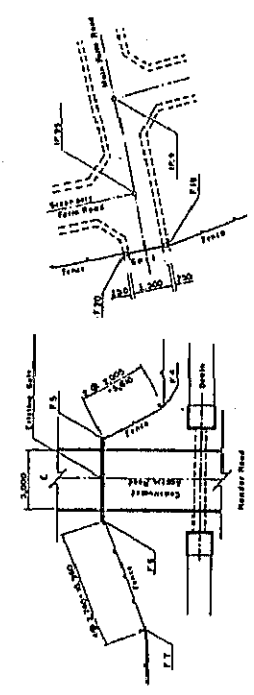
Fig.3-2 Effective Distance of Net Fence



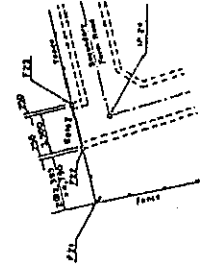
Source: Ministry of Agriculture, Forestry and Fishery of Japan, "Design Guideline for Windbreak Facilities"

FENCE LENGTH

IP	COORDINATES	DISTANCE M
F1	211.27	245.82
F2	71.05	249.30
F3	-93.01	251.39
F4	-93.40	96.11
F5	-88.31	95.37
F6	-88.48	48.33
F7	-93.40	96.11
F8	-93.95	12.39
F9	-90.72	52.89
F10	-81.11	106.30
F11	-81.05	187.47
F12	58.29	278.42
F13	78.04	286.81
F14	97.83	293.31
F15	264.63	333.87
F16	272.09	337.70
F17	275.78	339.81
F18	400.53	472.39
F19	407.32	480.14
F20	431.48	490.85
F21	437.82	496.87
F22	474.78	490.32
F23	473.73	448.33
F24	603.30	351.47
F25	642.85	356.28
F26	642.18	237.03
F27	620.10	233.37
F28	632.25	157.84
TOTAL		1291.18



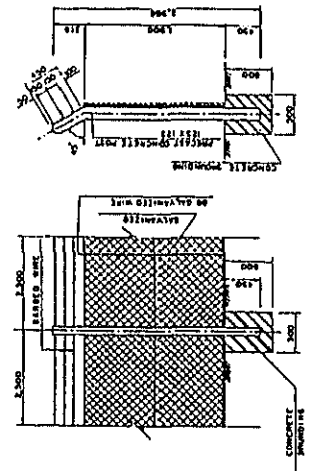
DETAIL A 15-1/2000



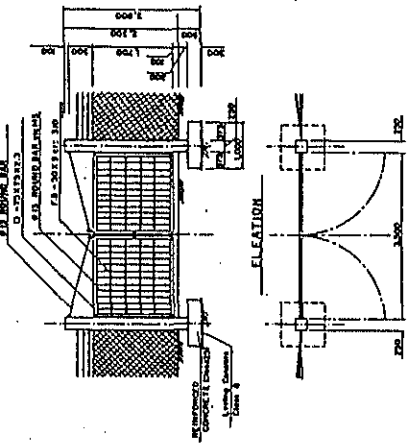
DETAIL B 15-1/2000

DETAIL C 15-1/2000

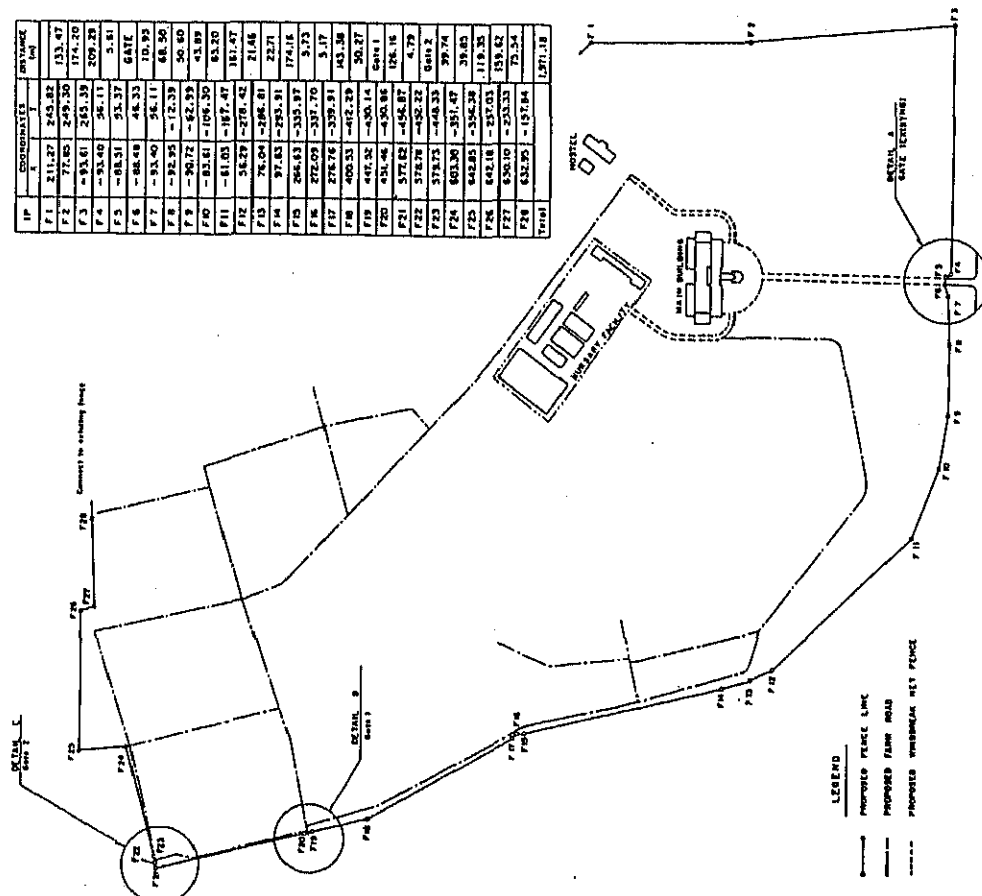
STANDARD SECTION OF FENCE 15-1/2000



GATES 15-1/2000



PLAN

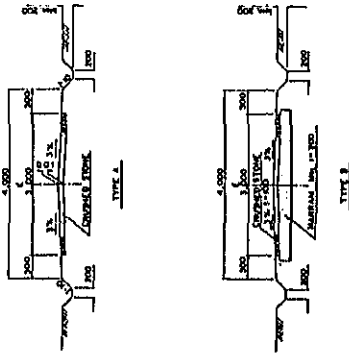


GENERAL LAYOUT OF FENCE/GATE WORKS 15-1/2000

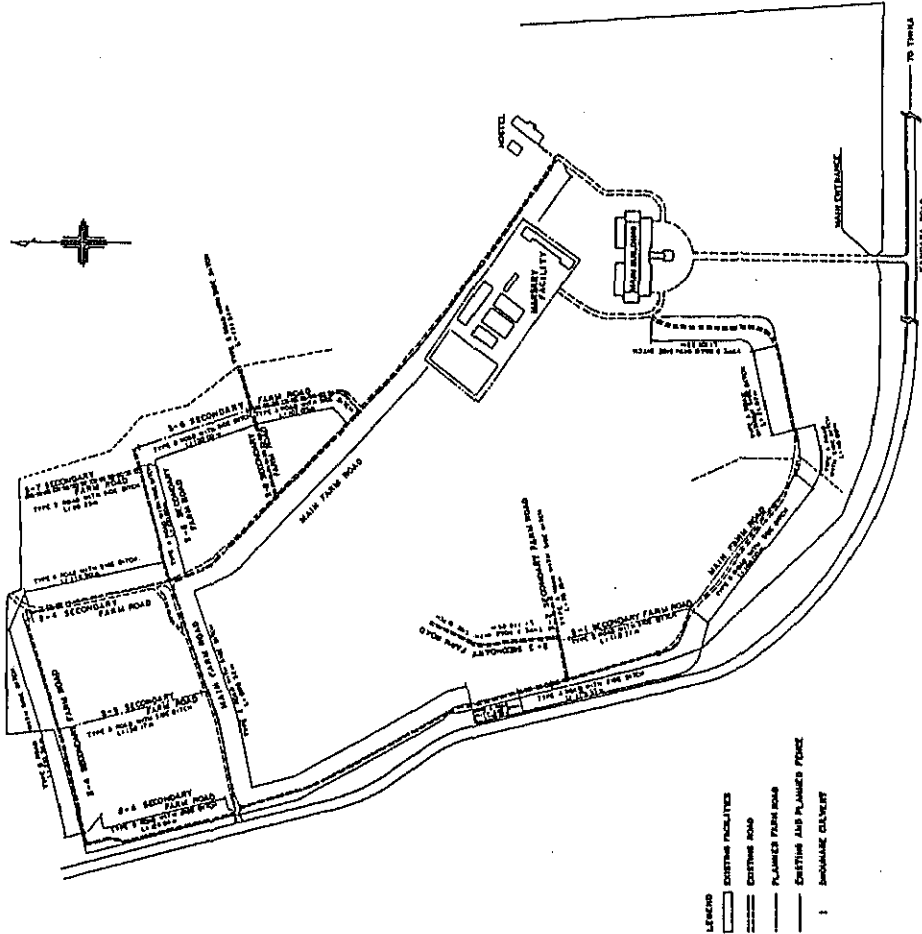
- NOTES**
- 1 Existing Fence / Gate shall be demolished completely for return reason of material.
 - 2 Fence to be installed ready shall be on the same line of existing fence line.
 - 3 Over excavation for Gate / Fence shall must filled by concrete column. For more specifications.
 - 4 Length and height of works are subject to change by the Engineer.

REPUBLIC OF MALTA
 MINISTRY OF AGRICULTURE
 AND RURAL DEVELOPMENT
 THE AGRICULTURAL DEVELOPMENT PROJECT
 GATES AND FENCING WORKS
 GENERAL LAYOUT AND GATES/FENCE
 DATE: 07.12.2011 DRAWING NO: F-01
 JAMES INTERNATIONAL CONSULTING AGENCY
 (J. J. C. A.)

STANDARD CROSS SECTION OF FARM ROAD IS-17/509



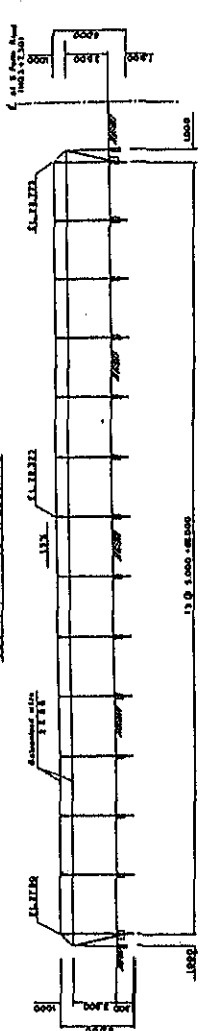
IP	ELEVATION	COORDINATES OF IP
IP0	+123.61	0.00
IP1	0.00	0.00
IP2	-26.04	-182.74
IP3	+67.23	-283.83
IP4	+77.74	-278.83
IP5	+187.75	-311.89
IP6	+227.15	-330.00
IP7	+253.89	-339.84
IP8	+364.04	-388.29
IP9	+432.21	-417.69
IP10	+463.75	-346.17
IP11	+500.72	-274.53
IP12	+472.86	-212.17
IP13	+293.73	-25.32
EP	+178.34	-133.77
IP17	+176.46	-273.40
M70A	+487.30	-505.83
IP18	+177.33	-288.50
IP19	+164.46	-337.44
IP20	+246.89	-271.25
IP21	+288.21	-238.31
IP22	+548.37	-417.05
IP23	+508.53	-433.72
IP24	+376.93	-448.43
IP25	+400.84	-391.24
IP26A	+478.99	-316.29
IP26	+489.77	-232.20
IP27	+537.32	-114.12
IP28	+532.76	-131.42
IP29	+428.15	-153.47
IP30	+436.18	-79.18
IP31	+417.20	-46.40
IP32	+417.41	-83.58
IP33	+362.23	-83.20
IP34	+346.39	-80.84



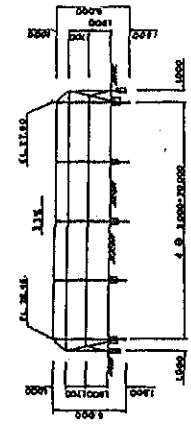
GENERAL LAYOUT (S-17/2,000)

REPUBLIC OF INDIA
 MINISTRY OF AGRICULTURE
 MODEL INFRASTRUCTURAL IMPROVEMENT
 FOR
 THE HORTICULTURAL DEVELOPMENT PROJECT
 FARM ROAD IMPROVEMENT WORKS
 LAYOUT AND STANDARD SECTION
 DATE: 27.1.1966 DRAWING NO: R-1
 JAPAN INTERNATIONAL COOPERATION AGENCY
 (J I C A)

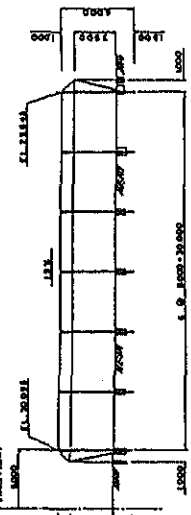
SECTION A-A (1:200)



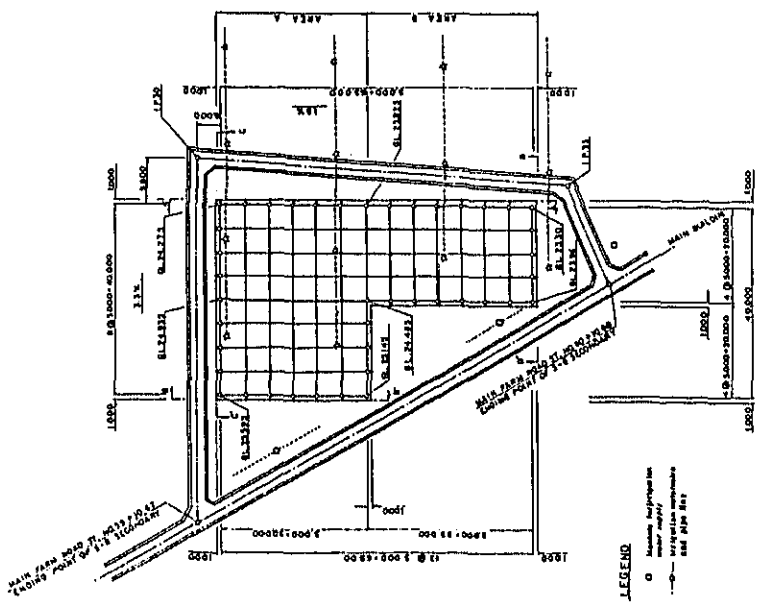
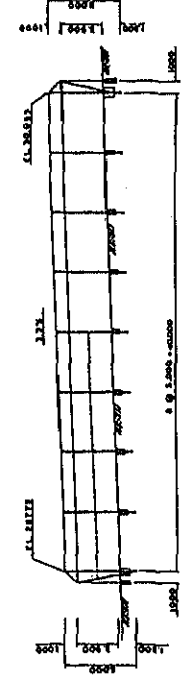
SECTION B-B (1:200)



SECTION C-C (1:200)



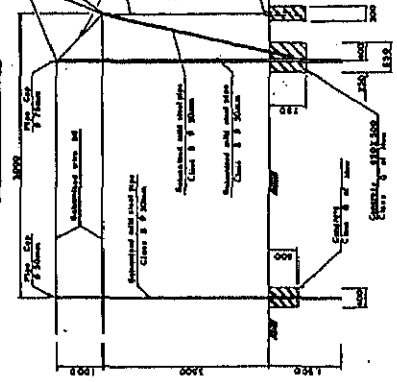
SECTION D-D (1:200)



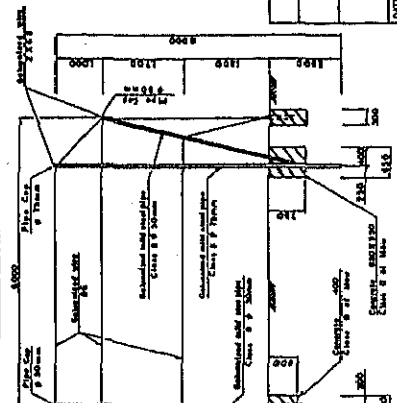
LEGEND

- Column and/or beam center mark
- Structural member
- Main axis

AREA A (1:250)



AREA B (1:250)



PLAN (1:250)

INSTITUTION OF CIVIL ENGINEERS GENERAL PLAN AND SECTIONS DATE: 1951 DRAWING NO: T-01 JOHN BENTON CORPORATION PROJECT
--

3.4 Cost Estimate

3.4.1 Component of Project Cost

The Project cost of the Model Infrastructural Improvement Works is composed of the following three (3) items:

- (1) Construction cost equivalent to the contract amount of the Works
- (2) Contingency for the Construction works
- (3) Miscellaneous cost in connection with the construction supervision

The cost necessary for assigning the JICA's Expert to supervise the construction works is not counted in the Project cost.

- (1) Construction cost

The construction cost is equal to the contract amount of the Works which includes taxes, other legal expenses (sales tax, enterprise tax, etc.) and other indirect costs.

- (2) Contingency for the construction works

About ten (10) % of the construction cost is estimated as contingency for the construction works.

- (3) Miscellaneous cost

The miscellaneous cost in connection with the construction supervision is estimated as about five (5) % of the total of items (1) and (2).

3.4.2 Basic Concept for the Cost Estimate

- (1) Cost estimate method

The construction cost is estimated with the Bill of Quantities method using unit cost and quantity of each work item based on the detailed drawings.

(2) Basic unit cost

- The Current Construction Costs of MOW, Jan. 1987, are used as basic unit costs of the works.

Unit costs in MOW's list are "all-in-rates", and one year has already passed after issuing the list. Therefore, unit costs of the Project are obtained by multiplying the unit costs in MOW's list by 1.35 with considering 10% of inflation ratio of one year and 25% of transportation Thika from Nairobi to Thika.

- In the case of unit costs which are not included in MOW's list or far from market prices, the market prices are adopted.
- Rental system is adopted for construction equipment, which is usually practiced in Kenya.
- Exchange rate for the estimate is as follows:

US\$1.00 = ¥125.00 = ksh 17.03
(ksh 1.00 = ¥7.34)

3.4.3 Project Cost

The project cost is summarized in Table 3-3.

Table 3-1 List of Construction Unit Rate by MOW (JAN.1987)

ITEM	DESCRIPTION	UNIT	UNIT RATE	
EXCAVATION	Exc. top soil ave. 150mm,dp &cp	m ²	5	
	Exc. reduce levels	m ³	25	
	Exc. surf.trench or column base ne.1.5m	m ³	25	
	ditto 1.50 - 3.00 m	m ³	30	
	R. F. & c	m ³	17	
	Cart away	m ³	20	
	Extra for rock (class 1)	m ³	400	
	Extra for rock (class 3)	m ³	200	
	Murram blinding	m ²	6	
	CONCRETE	Cement Poltoland normal	50kg	81.35
Sand		m ³	169.93	
Ballast		m ³	120.46	
16mm ϕ MS reinforcement		kg	6.89	
Blinding conc. (1:4:5)		m ³	800	
Mass conc (1:3:5)		m ³	1,000	
R. C. conc 20/20		m ³	1,270	
R. C. conc 25/20		m ³	1,370	
R. C. conc 30/20		m ³	1,450	
Formwork to soffites/walls ne. 3.50m high		m ²	70	
Formwork to soffites over 3.50m high		m ²	90	
Formwork to columns/beams		m ²	70	
6-8mm ϕ ms bars		kg	15	
10-12mm ϕ ms bars		kg	15	
16mm ϕ over ms bars		kg	14	
6-8mm ϕ ms bars		kg	15	
10-12mm ϕ ms bars		kg	15	
16mm ϕ over ms bars		kg	14	
METAL WORK		Structural steel universal beams or columns	kg	25
		ditto but R. H. S.	kg	25
	Small bars and flats in balustrades and railings including welded joints	kg	40	
	Galvanized MS pipes class B ϕ 40	m	60.37	
	Galvanized MS pipes class B ϕ 50	m	87.15	
	Galvanized MS pipes class B ϕ 75	m	146.45	
	Barbed wire 12 1/2X20kgX150m	roll	228	
	Barbed wire 12 1/2X25kgX210m	roll	279	
	Galv. fencing wire 8G&10G(9.8&15.34m/kg)	kg	20	
	Galv. fencing wire 12G&14G(26.44&39.26m/kg)	kg	20	
	Chain link fencing(12 1/2GX18m) H=5ft	roll	375	
	Chain link fencing(12 1/2GX18m) H=6ft	roll	450	
	PAINTING	Prime & paint three coats enamel on metal	m ²	27
		Red oxide or lead priming coat	m ²	12
	EXTERNAL WORKS	Chainlink fencing 3.0m high with 150x100 mm conc. posts in conc. surrounding	m	300
P. C. fence post 100X125mm		ft	23.40	
P. C. fence post 125X125mm		ft	28.08	
P. C. fence post 125X150mm		ft	32.18	
P. C. fence post 150X150mm		ft	33.93	
P. C. struts 90X90mm		ft	16.97	
P. C. struts 100X100mm		ft	19.89	
P. C. gate post 230X230mm		ft	62.01	
Grade formation		m ²	8	
150mm Murram or ston sub-base blinded		m ²	16	
100mm Water-bound macadam		m ²	20	
25mm Bitumen double seal		m ²	65	
40mm Premix bituminous surfacing		m ²	120	
70mm Premix bituminous surfacing		m ²	150	
Kerb on conc. foundation (HOW type A)		m	90	
305mm dia. conc. drain pipe ridge joint		m	80	
450mm ditto		m	370	
535mm ditto		m	480	
610mm ditto		m	660	
915mm ditto		m	1,400	

WORKS	ITEM	UNIT	UNIT RATE
HIRE CHARGES	incl. operator &/or attendant, maintenance costs, over heads, fuel and profit		
	CAT D6C Bulldozer with Ripper	hr.	600
	60 HP Tractor shovel	hr	350
	130 HP FWD Tractor	hr	400
	130 HP FWD Tractor with 4-5 cu.yd scraper	hr	500
	140 HP Wheel dozer with angle blade	hr	600
	125 HP Grader	hr	500
	Brayt Excavator 2/4 cu.yd bucket	hr	550
	Vibrating plate compactor	hr	250
	Compressor CP 260 cfm with 2 jacks	hr	200
	Concrete mixer 10/7 type	hr	250
	Concrete mixer 14/10 type	hr	200
	50mm Concrete vibrator	hr	120
	Dumper truck 15CWTs	hr	150
	5 ton lorry, ordinary	hr	170
	7 ton lorry, ordinary	hr	200
	5 ton lorry, Trippery	hr	190
	7 ton lorry, Trippery	hr	210
	10-12 ton roller	hr	2,210
	3 ton vibrating roller	hr	130
	Hard propelled vibrating roller	hr	60
	Soft propelled water tanker 4500 lit. min. capacity with pick-up pump	hr	120
	ST Mobile crane	hr	500

Table 3-2 Foreign Currency Exchange Rates

年	US\$ 1.00	¥ 100 (Ksh 1.00=)
1981 Dec.	10.28	4.68 (21.37)
1982 Dec.	12.72	5.44 (18.38)
1983 Dec.	13.80	5.96 (16.78)
1984 Dec.	15.78	6.31 (15.85)
1985 Dec.	16.34	8.12 (12.32)
1986 Dec.	16.03	10.06 (9.94)
1988 Mar.	17.03	13.65 (7.32)

Table 3-3 Project Cost

I T E M S	C O S T	
	Kshs	Japanese Yen
Construction cost	2,794,000	20,508,000
Contingency	279,000	2,048,000
Sub-total	3,073,000	22,556,000
Administration Cost	153,000	1,123,000
T o t a l	3,226,000	23,679,000

Abbreviation for unit

L.S. : Lump sum
 li .m : Linear meter
 sq.m : Square meter
 cu.m : Cubic meter
 kg : kilogram
 pc : piece
 set : set

Table 3-4 Summary of Construction Cost

BILL NO.	T I T L E	B/D AMOUNT(Kshs)
1.	Gate and Fence Works	658,000
2.	Farm Road Improvement Works	582,000
3.	Windbreak Net Fence Works	1,150,000
4.	Trellis Works	404,000
T o t a l		2,794,000

Table 3-5-1 Project Cost(1/2)

BILL NO.	PAY ITEM	UNIT	QUANTITY	UNIT COST	COST
1.	GATE AND FENCE WORKS				
1.1	Site clearing	sq.m	1 970	8.25	16,252
1.2	Manufacturing and installation of gates	set	2	11,000	22,000
1.3	Gate posts installation including manufacturing posts excavation, foundation concrete	pc.	4	2,186	8,744
1.4	Fence post installation including manufacturing posts, excavation, foundation concrete	pc	680	719.31	489,130
1.5	Wiring galvanized wire for chain link installation	kg	605	31.75	19,208
1.6	Chain link installation	ln.m	1,970	43.28	85,261
1.7	Barbed wire installation	li.m	5,910	2.40	14,184
1.8	Demolishing the existing fence	li.m	1,970	2.00	3,940
Total of Bill No. 1 carry to SUMMARY					658,719
2.	FARM ROAD WORKS L = 2,906.61 m				
2.1	Site clearing stripping and spoiling	sq.m	17,440	8.25	143,880
2.2	Excavation by bulldozer incl. spoiling	cu.m	2,250	52.92	119,070
2.3	Murrun backfill(t=100mm)incl. spreading, and compaction	sq.m	5,090	29.33	149,289
2.4	Embankment, manual	cu.m	260	11.16	2,901
2.5	Compaction of subbase course	sq.m	3,630	1.51	5,481
2.6	Gravel pavement t=100mm	sq.m	8,720	14.66	127,835
2.7	Installation of road crossing drain	set	8	3,630	29,040
2.8	Shifting fence, including demolishing and installation	li.m	103	50	5,150
Total of Bill No. 2 carry to SUMMARY					582,646

Table 3-5-2 Project Cost(2/2)

BILL NO.	PAY ITEM	UNIT	QUANTITY	UNIT COST	COST
3.	FENCE NET WINDBREAK WORKS L = 1,200 m				
3.1	Site clearing	sq.m	1,200	8.25	9,900
3.2	Fence posts installation including manufacturing posts excavation, foundation concrete	pc.	420	1,454	610,680
3.3	Wiring galvanized wire for windbreak net installation	kg.	858	31.75	27,241
3.4	Windbreak net installation	sq.m	3,240	151.47	490,762
3.5	Chain link installation	ln.m	264	43.28	11,425
Total of Bill No.3 carry to SUMMARY					1,150,306
4.	TRELLIES WORKS				
4.1	Main post installation, (galvanized mild steel pipe 75) including manufacturing, excavation and foundation concrete	pc	42	2,427	101,957
4.2	Intermediate post installation, (galvanized mild steel pipe 40) including manufacturing, excavation and foundation concrete	pc	56	795.90	44,570
4.3	Wiring for reinforcement of posts including anchoring	kg	263	100.42	26,410
4.4	Manufacturing and installation of fishnet	sq.m	2,845	81.25	231,156
Total of Bill No. 4 carry to SUMMARY					404,093

Table 3-6-1 Unit Cost Analysis (1/5)

1.1 Site clearing (excavation top soil average 150mm of cec)

Kshs. 8.25 / m³

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Excavation top soil	ave. 150 mm	m ³	1.00	8.25	8.25	c, 6.00 X 1.1 X 1.25
Total					8.25	

1.2 Gate manufacturing 1.70 X 1.50 m X 2 leaves

Kshs. 11,000,000 / set

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Structural steel	70kgX2leavesX1.05	kg	1.05	22.00	3,234.00	c, 16 X 1.1 X 1.25
Manufacturing and installation		LS			6,468.00	200 % of material
Painting	prime + 3 coating enamel	m ²	6.4	37.12	237.56	c, 27.00 X 1.1 X 1.25
Accessories		LS			1,060.44	
TOTAL					11,000.00	

1.3 Gate posts installation L = 2.80 m

Kshs. 2,186.74 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Precast gate post manufacturing	250X250mm	ft	9.33	85.26	795.51	c, 62.01 X 1.1 X 1.25
ditto installation		LS			159.10	20 % of material
Footing reinforced concrete	1.00X1.00X0.30m	m ³	0.30	3,671.25	1,101.37	c, (1270+14X100)x1.1X1.25
ditto installation		LS			110.13	10 % of material
Excavation for footing		m ³	0.60	34.37	20.62	c, 25.00 X 1.1 X 1.25
Total					2,186.74	

1.4 Fence post installation h = 1.80 m 125X125mm

Kshs. 719.31 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Precast concrete fence post	125X125mm L=2.70m	ft	9	38.61	347.49	c, 28.08 X 1.1 X 1.25
ditto installation		LS			104.24	30% of manufacturing
Struts (1 pc every 30m)	100X100X3,000 mm	ft	1	27.35	27.35	c, 19.90 X 1.1 X 1.25
ditto installation		LS			8.20	30% of manufacturing
Foundation trench excavation	0.5X0.5X0.6m	m ³	0.15	34.38	5.16	c, 25 X 1.1 X 1.25
Foundation concrete	mass conc	m ³	0.15	1,512.50	226.87	c, 1000X1.1X1.25X1.1
Total					719.31	

Note : "c," in Remarks shows unit costs shown in "Building Materials Cost Handbook Aug. 1987"; Ministry of Works,

Table 3-6-2 Unit Cost Analysis (2/5)

1.5. Wiring galvanized wire for fence

Kshs. 31.75 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Galvanized wire	10G	kg	1.05	27.50	28.87	c, 20X1.1.X1.25
ditto Instalation		LS			2.88	10 % of material
Total					31.75	

1.6 Chain link installation for fence h = 1.80 m

Kshs. 43.28 / m

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Chain link	B=1.8m, 12½ G X 18m	m	1.05	34.37	36.08	c, 450/18X1.1.X1.25
Installation of chain link		LS			3.60	10 % of material
Acceaaries		LS			3.60	10 % of material
Total					43.28	

1.7 Wiring barbed wire for fence

Kshs. 2.40 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Barbed wire	12½ GX20kgX150m	m	1.05	2.09	2.19	c, 1.52X1.1.X1.25
ditto Instalation		LS			0.21	10 % of material
Total					2.40	

1.8 Dimolition o f existing fence

Kshs. 2.00 / m

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Labour unskilled		m/d	2.00	50.00	100.00	c, 450/18X1.1.X1.25
Skilled labour		m/d	1.00	100.00	100.00	
Total					200.00	

Note : "c," in Remarks shows unit costs shown in "Building Materials Cost Handbook Aug. 1987"; Ministry of Works,

Table 3-6-3 Unit Cost Analysis (3/5)

2.2 Excavation by bulldozer for base course

Bulldozer 11ton class, 20m dozing 45m³/hr(60*0.75)
spoiling bank distance 2km

Kshs. 52.92 / m³

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Bulldozer operation	D60(11ton class)	hr	0.0222	825.00	18.31	c, 600X1.1X1.25
Tractor shovel loading	60 hp, 0.6m ³ (78.3*0.75)	hr	0.0175	481.25	8.42	c, 350X1.1X1.25
Duap truck transportation	15cwt 8ton(10.5*0.75)	hr	0.1270	206.25	26.19	c, 150X1.1X1.25
Total					52.92	

2.3 Murrum back fill, including spreading and compaction

Kshs. 29.33 / m²

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Murrum or stone sub-base	t-200mm	m ²	1.00	29.33	29.33	c, 16X(20/15)X1.1X1.25
Total					29.33	

2.4 manual embankment by tamper

spreading and compaction with tamper

Kshs. 11.16 / m³

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Unskilled labour	spreading	m.d	0.097	50.00	4.85	0.63m.d/10m ³ /0.7=0.097
Skilled labour	tamper operation	m.d	0.404	100.00	4.00	0.28m.d/10m ³ /0.7=0.024
Tamper operation	rental base	hr	0.028	82.5	2.31	c, 60X1.1X1.25
Total					11.16	

2.5 Compaction of sub-base course before gravel paving

200m²/hr, 0.005hr/m²

Kshs. 1.51 / m²

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Macadam roller operation	w-10-12 ton	hr	0.005	302.50	1.51	c, 220X1.1X1.25
Total					1.51	

2.6. Gravel pavement t-100mm

Kshs. 35.00 / m²

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
100 mm stone sub-base blinded		m ²	1.00	14.66	14.66	c, 16X10/15X1.1X1.25
Total					14.66	

Note : "c," in Remarks shows unit costs shown in "Building Materials Cost Handbook Aug. 1987"; Ministry of Works.

Table 3-6-4 Unit Cost Analysis (4/5)

2.7 Installation of road crossing drainage culvert.

Kshs. 3, 630. 00 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
PC Reinforced concrete pipe	φ300mm L=4.30m w/sand bed	m	4.00	522.50	2,090.00	c. 380X1.1X1.25
PC Reinforced concrete pipe	φ500mm L=1.00mX2pcs	m	2.00	660.00	1,320.00	c. 480X1.1X1.25
Lean concrete for pipe bottom	Class 0	m ³	0.16	1,375.00	220.00	c. 1000X1.1X1.25
Total					3,630.00	

3.2 Windbreak fence post installation

Kshs. 1, 454. 71 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Precast concrete post	150X150X4,500mm	ft	15	46.65	699.75	c. 33.93X1.1X1.25
ditto installation		LS			174.93	25 % of material
Foundation concrete	class 0, 0.5X0.5X1.50m	m ³	0.375	1,512.50	567.18	c. 1000X1.1X1.25X1.1
Excavation of foundation		m ³	0.375	34.37	12.88	c. 25.00X1.1X1.25
Total					1,454.71	

3.4 Windbreak net installation (Tygan meshing net)

Kshs. 151. 47 / m²

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Windbreak net	Tygan net B = 1.00m	m ²	1.00	137.70	137.70	otation by KENYA TENT
ditto instalation		LS			13.77	10 % of material
Total					151.47	

Note : "c," in Remarks shows unit costs shown in "Building Materials Cost Handbook Aug. 1987"; Ministry of Works,

Table 3-6-5 Unit Cost Analysis (5/5)

4.1 Trellis main post and anchor post installation

Kshs. 2,427.55 / set

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Main post ;galvanized steel pipe	φ75mm, L=6.00m, class B	m	6.00	201.36	1,208.16	c, 148.45X1.1X1.25
ditto installation	w/ manufacturing	LS			362.44	30 % of material
Anchor post; galvanized steel pipe	φ40mm, L=4.1m, class B	m	4.10	83.00	340.30	c, 60.37X1.1X1.25
ditto installation	w/ manufacturing	LS			102.09	30 % of material
Foundation concrete	class Q, 0.85X0.55X0.75m	m ³	0.268	1,512.50	405.35	c, 1000X1.1X1.25X1.1
Excavation of foundation		m ³	0.268	34.37	9.21	c, 25X1.1X1.25
Total					2,427.55	

4.2 Trellis intermediate post installation

Kshs. 795.90 / pc

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Intermediate post, galv. s.p	φ40mm, L=6.0m, class B	m	6.00	83.00	498.00	c, 60.37X1.1X1.25
ditto installation	w/ manufacturing	LS			149.40	30 % of material
Foundation concrete	class Q, 0.4X0.4X0.4m	m ³	0.096	1,512.50	145.20	c, 1000X1.1X1.25X1.1
Excavation of foundation		m ³	0.096	34.38	3.30	c, 25X1.1X1.25
Total					795.90	

4.3 Wiring reinforcing wire and anchoring

Kshs. 100.42 / kg

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Wire, galvanized	8G X-2, 49.83m, 5.1kg	-kg-	5.81	27.50	154.27	c, 20X1.1X1.25
ditto installation	w/ manufacturing	LS			15.42	10 % of material
Anchor concrete	class Q, 0.3X0.3X0.75mX2	m ³	0.135	1,512.50	204.18	c, 1000X1.1X1.25X1.1
Excavation of foundation	0.3X0.3X0.75mX2	m ³	0.135	34.38	4.64	c, 25X1.1X1.25
Anchor bar	φ16mm, 1.573kg/mX2.0mX2	kg	6.312	21.17	133.65	c, 14X1.1X1.25X1.1
Total					512.16	
	512.16/5.10kg = 100.42					

4.4 Fish net installation

Kshs. 81.25 / #2

ITEMS	SPECIFICATION	Unit	QUANTITY	Unit Cost	Cost	Remarks
Fish net	210/4 play, 10mm mesh	#2	1.00	65.00	65.00	quotation by KENYA FISHPNT
ditto installation		LS			16.25	25 % of material
Total					81.25	

Note : "c," in Remarks shows unit costs shown in "Building Materials Cost Handbook Aug. 1987"; Ministry of Works,

3.5 Implementation Plan

3.5.1 Tendering

The client of the Works is Mr. Kumagishi: representative of JICA Kenya office, and the Contractor is selected among the local contractors. All construction materials and equipment are procured in Kenya, and no exemption of taxes is applied.

The tendering will be made with selective tendering method inviting about 5 contractors without P/Q.

After the mobilization of JICA's Expert to Kenya, the tender will be made with the following procedures:

1. Issuance of the "Invitation for Tendering" to the selected tenderers
2. Tendering
3. Examination of submitted tenders and determination of the first negotiator
4. Negotiation with the first negotiator
5. Signing of the contract between the client and the contractor

The following five contractors are proposed as the tenderers:

M/S Dien builders Limited	P.O Box 11366, Nairobi
M/S Sumitomo Construction Co. Ltd.	P.O Box 60487, Nairobi
M/S Karuri Civil Engineering Co. Ltd.	P.O Box 32126, Nairobi
M/S Miharati Investments Co. Ltd.	P.O Box 59018, Nairobi
M/S Njama Construction Limited	P.O Box 52399, Nairobi

3.5.2 Construction Plan

(1) Mobilization and preparatory works

Mobilization of the contractor to the site is expected to be made within one week after signing the Contract.

(2) Gate and fence works

Detailed shop drawing of the gate shall be prepared by the contractor for the approval of the JICA's Experts. After the approval of the drawing, the manufacturing of gates in the workshop shall be started.

20 sets of precast concrete fence post form shall be prepared at the site by the contractor.

After the installation of precast concrete posts at the site, foundation concrete shall be poured and it shall be cured for min. 7 days before installation of wire and chain link.

For other detailed construction methods, MOW's "General Specification" shall be applied.

(3) Farm road improvement works

The farm road improvement works is divided into two categories;

- 1) Improvement of existing gravel-paved road
- 2) New road construction in the experimental farm

1) Existing road improvement

Existing road improvement works shall be prepared with the following procedures:

- Leveling and stripping by motor grader, 3.1 m wide class.
- Compaction by macadam roller, 10 - 12 ton class.

- Spreading gravel/crushed stone by motor grader, 3.1 m wide class.
- Compaction of gravel/crushed stone by macadam roller, 10 - 12 ton class.
- Compaction/excavation of shoulders and side ditches by manual, if any.

2) New road construction

- Excavation of subbase coarse to be replaced by bulldozer, 13 ton class.
- Spreading and compaction of Murram (subbase coarse material) by bulldozer, 13 ton class.
- Compaction of subbase coarse by macadam roller, 10 - 12 ton class.
- Spreading of gravel/crushed stone by motor grader, 3.1 m class
- Compaction of gravel/crushed stone by macadam roller, 10 - 12 ton class.
- Shoulders and side ditches shall be constructed by manual.

(4) Windbreak net fence works

- Ordering the windbreak net (Tygan net)
- Preparation of 20 sets of precast concrete post form at the site and manufacturing of concrete posts..
- For other procedures of the construction, the same instruction as for fence works shall be applied.

(5) Trellis works

- Ordering fish net, steel pipes and accessories for manufacturing
- Steel pipe posts shall be installed at the site and they shall be reinforced by wires 7 days after the pipe posts installation.

3.5.3 Construction Schedule

Distribution of monthly rainfall at the NHRS is shown in Table 2.1.1. The main rainy season is March to May and the secondary rainy season is October to November. Expected construction period is July to September (dry season).

The farm road improvement works main work item of which is earth works shall be started immediately after the contractor's mobilization to the site to avoid the interruption of the works by rain. Other construction items of the works can be continued even it is rain, except for some small-scale concrete works.

Required months for individual work item are estimated as shown in the following table. The total construction period becomes 4 months as shown in Fig. 3-3.

Items	Work Volume	Daily Production	Required Days	Required Month
1) Gate & Fence Works	1,970 m/2 sets			
Fence post	680 pcs	10 pcs	61	*2.0
Fencing	1,970 m	200 m	9	0.5
Demolition of existing fence	1,970 m	100 m	18	1.0
2) Farm Road Improvement Works	Gravel pavement 90 a	3.0 a	30	1.5
3) Windbread net fence Works				
Fence post	850 pcs	15 pcs	57	*2.0
Net installation	2,310 m	50 m	40	2.0
4) Trellis Works	0.2 ha	-	10	0.5

Note * can be done before post installation.

3.5.4 Construction Materials

All construction materials shall be purchased locally. Most of the construction materials for the Works can be easily purchased in Kenya, and the costs of some of them are controlled by the Government.

Special materials for the Works are the windbreak net and the trellis net. According the market research, they can also be purchased in Kenya at the following shops:

Windbreak net

Tygan mesh net, which is usually used as a mosquito net for camping tent, is available at

Kenya Tents Limited, P.O Box 4128, Nairobi.

Trellis

Fish net which is used by ICIPE (International Center of Insect Physiology and Ecology) can be used for the trellis net.

It is available at Kenya Fishers Industries Limited, P.O Box 1878, Kisumu.

3.5.5 Proposed Candidates for Tendering

As described before, the client of the Works is JICA Kenya Office, and the contractor will be selected locally and all construction materials will be procured at the local market. Local contractors which worked previously for the Project and/or are recommended by MOW are surveyed during the field survey of JICA mission in March, 1988.

They are as follows:

- (1) M/S Dien Builders Limited: who constructed the soil research laboratory of the Project, and he is evaluated to be good for his operation and workmanship by the Project staff.
- (2) M/S Sumitomo Construction Co. Ltd.: who constructed the main facilities of the Project which was financially supported by Japanese Grant Aid. He has also experience for similar projects such as the Forestry Development Project.
- (3) M/S Karuri Civil Engineering Co. Ltd.: who is one of the biggest Kenyan contractors, and many construction works amounting more than K shs.10,000,000 per contract are performed well. He has now the contract for the Nairobi City Bus Terminal Construction.

(4) M/S Miharati Investments Co. Ltd.

(5) M/S Njama Construction Limited

Fig.3-3 Tentative Implementation Schedule of Works

I T E M S	1 9 8 8												REMARKS	
	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC				
1. Field survey	■													
- Basic design	■													
- Field report	○													
2. Preparation of detailed design	■	■												
- Detailed design	■	■												
- Final report	○													
3. Official request of construction by the Government of Kenya		○												
4. Consultation with Ministry of Foreign Affairs of Japan		○												
5. Submission of FORM AI by GOK for request of JICA expert				○										
6. Exchange of Verbal Note				○										
7. Assignment of JICA expert														
8. Construction of the Works														

Fig.3-4 Construction Schedule

W O R K I T E M S	1 9 8 8					R E M A R K S
	JUL	AUG	SEP	OCT	NOV		DEC
1. Mobilization and preparatory works						
2. Gate and fence works						
2.1 Gate manufacturaing						
2.2 Gate post and gate installation						
2.3 Fence posts manufacturing						
2.4 Fence posts and chain link installation						
3. Farm road improvement works						
3.1 Main farm road						
3.2 Secondary farm roads						
4. Windbreak net fence works						
4.1 Procurment of net						
4.2 Fence posts manufacturing						
4.3 Fence posts and net inatallation						
5. Trellis works						
6. Demobilization						

CHAPTER 4 CONSTRUCTION PLAN

CHAPTER 4 CONSTRUCTION PLAN

4.1 Contract Documents (Draft)

Referring to the similar project in Kenya, the draft contract documents for the Works is prepared as shown in APPENDIX. The main contains are as follows:

- Preface, name of Project, client and contractor
- Purpose of the Works and contract amount
- Scope of Works
- Payment
- Construction Period
- Compensation
- JICA's right for default
- Inspection and delivery of the Works
- Rectification of the detective construction
- Discrepancies among the contract documents
- Project manager
- Replacement of labour, engineer and foreman
- Sub-contractor
- Notices correspondents
- Settlement of dispute

4.1 General Conditions (Draft)

General conditions of the contract follows the "General Specification for Building Works", Ministry of Works, Housing and Physical Planning.

4.2 Technical Specifications (Draft)

Detailed specifications which shall be restrictively followed for the construction of the Works by the contractor are described item by item of the Works.

4.3 Tender Drawings (See APPENDIX A.2.4)

Tender drawings for the Works are tabulated as follows:

DRAWING LIST

WORK ITEM	DRAWING NO.	D R A W I N G T I T L E
GENERAL	G - 1	LOCATION MAP AND GENERAL LAYOUT OF THE WORKS
GATE & FENCE	F - 1	GENERAL LAYOUT AND STANDARD SECTION
FARM ROAD IMPROVEMENT	R - 1	GENERAL LAYOUT AND STANDARD SECTIONS
	R - 2 - 8	MAIN FARM ROAD PLAN AND PROFILE (1/6 - 6/6)
	R - 8 - 13	SECONDARY FARM ROAD PLAN AND PROFILE
	R - 14 - 21	CROSS SECTION OF FARM ROAD
WINDBREK	W - 1	GENERAL LAYOUT AND STANDARD SECTION
TRELLIS	T - 1	PLAN AND SECTIONS

APPENDIXES

A.1 Detailed Design Survey

A.1.1 Background of the Survey

The Republic of Kenya is an agricultural nation based on two farmer's structure which are small-scale farmers and large-scale farmers. Farm products such as coffee and tea make up 67.5 per cent of Kenya's exports in term of value, and it is an important measure for acquisition of foreign currency.

So the Government of Kenya put emphasis on agricultural sector, and worked out the following three policies in order to get out of deficit financing.

- (1) To increase the income of small-scale farmers
- (2) To increase the yield of farm products corresponding to the population growth
- (3) To improve the external trade by means of increasing the replaceable products of the imported farm products and increasing the exported farm products

The aim is to increase improve the exported products, to try to introduce new varieties of useful farm crops, and to improve the external trade.

According to this situation the Government of Kenya put emphasis on the improvement of the nuts as cash crops for small-scale farmers, and decided to introduce Macadamia nuts to the farmers as new cash crops. After that the Government of Kenya planned to research and extend Macadamia growing technology at the NHRS to be the base of research activities. However, it was confirmed that the Macadamia trees planted previously in Kenya was not suitable for growing and breeding. Accordingly the Government of Kenya requested grant aid cooperation to the Government of Japan in June, 1982, because Macadamia growing technology has been studied sufficiently in Japan and the project facilities were completed in March, 1986.

The Horticultural Development Project in Kenya has started with cooperation between Japan and Kenya in accordance with the Record of Discussions signed on December 4th, 1985. Five long-term Japanese experts were dispatched to Kenya and two Kenyan counterparts came to Japan for the study in March, 1986. At present the research activities for Macadamia and specific fruits, and training for extension personal are carrying out.

A.1.2 Purposes of the Survey

The Horticultural Development Project in Kenya is established in the NHRS which is located in Kandara Division, Muranga District. The facilities for Macadamia and specific fruits growing technology is installed on the site, and the research activities of crop protection, breeding, pomology etc., have been carrying out. However the facilities for these activities are not sufficient, so the infrastructure improvement works on experimental farm is required to complete the research activities. Therefore, the purpose of this survey is to prepare the detailed design in order to improve the infrastructure in the Project site.

A.1.3 Detailed Design Survey Team Member

<u>Name</u>	<u>Task</u>	<u>Affiliation</u>
Mr. Kazuo NAGAI	Team Leader/Coordinator	Dupty Head, Technical Cooperation Division, Agricultural Development Dept., Japan International Cooperation Agency (JICA)
Mr. Keiji MATSUMOTO	Drainage/Facilities	Senior Engineer, Agriculture and Rural Development Dept., Pacific Consultants International
Mr. Shouji HASEGAWA	Farm Road	Engineer, Agriculture and Rural Development Dept., Pacific Consultants International

A.1.4 Main Officials Concerned

1) Kenyan Side:

Director of Research,
Ministry of Agriculture

Mr. William W. WAPAKALA

Deputy Director of Agriculture,
Ministry of Agriculture

Mr. Moses M. MUKOLWE

Head of H & Crops,
Ministry of Agriculture

Mr. F. P. MUEMA

Director of NHRS,
Ministry of Agriculture

Mr. S. K. NJUGUNA

Co-Manager of Horticultural
Development Project,
Ministry of Agriculture

Mr. N. ONDABU

2) Japanese Side:

First Secretary,
Embassy of Japan

Mr. Nobuyuki HORIE

Resident Representative,
JICA Kenya Office

Mr. Kenji KUMAGISHI

Deputy Secretary,
JICA Kenya Office

Mr. Seiji KAIHO

Team Leader/Breeding Expert
Horticultural Development Project

Mr. Shoji HIRAMA

Training Expert
Horticultural Development Project

Mr. Asao TANAKA

Pomology Expert
Horticultural Development Project

Mr. Yoshio KODERA

Entomology Expert/Coordinator
Horticultural Development Project

Mr. Takashi NAKAGAWA

Breeding Expert
Horticultural Development Project

Mr. Yoshihiko SATO

Chief Adviser
Kenya/Japan: Social Forestry Training
Project

Mr. Katsura WATANABE

