Basic Design Report
on
The Construction Project
of
Food Grain Storagehouses
in
The Republic of Zambia

September, 1984

Japan International Cooperation Agency

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ABBREVIATION

CIDA;	Canadian International Development Agency
EC;	European Community
FAO;	Food and Agricultural Organization of the United Nations
MAWD;	Ministry of Agriculture and Water Development
NAMB;	National Agricultural Marketing Board
NCDP;	National Commission for Development Planning
TNDP;	Third National Development Plan
WFP;	World Food Program

PREFACE

In response to the request of the Government of the Republic of Zambia, the Government of Japan decided to conduct a basic design study on the Construction Project of Constructing Food Grain Storagehouses and entrusted the study to the Japan International Cooperation Agency. The JICA sent to Zambia a study team headed by Mr. Mitsui Matsuzu, Assistant Director, Second Economic Cooperation Division, Ministry of Foreign Affairs from May 13 to June 8, 1984.

The team had discussions with the officials concerned of the Government of Zambia and conducted a field survey. After the team 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 Zambia for their close cooperation extended to the team.

September 1984

Keisuke Arita

President

Japan International Cooperation Agency

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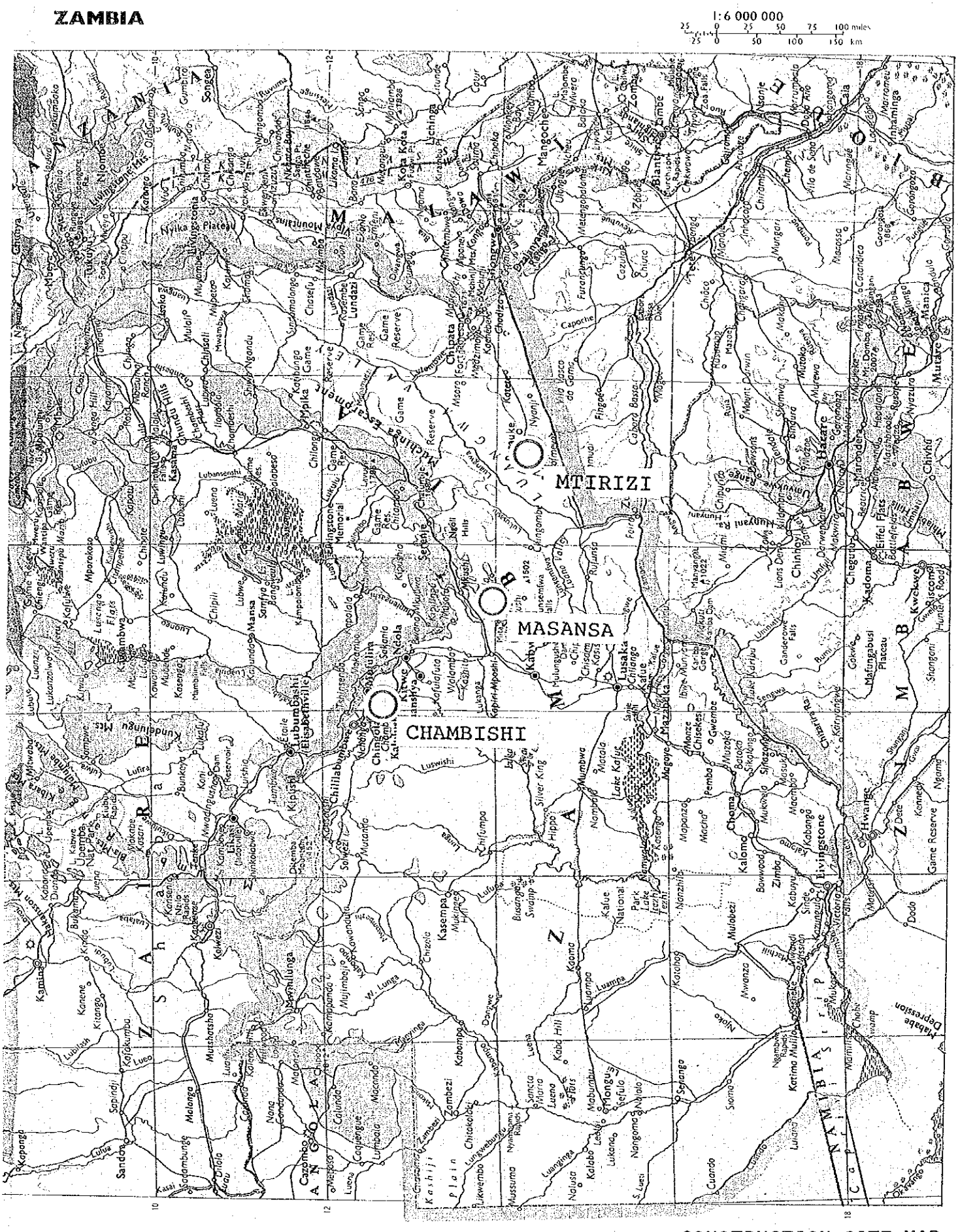
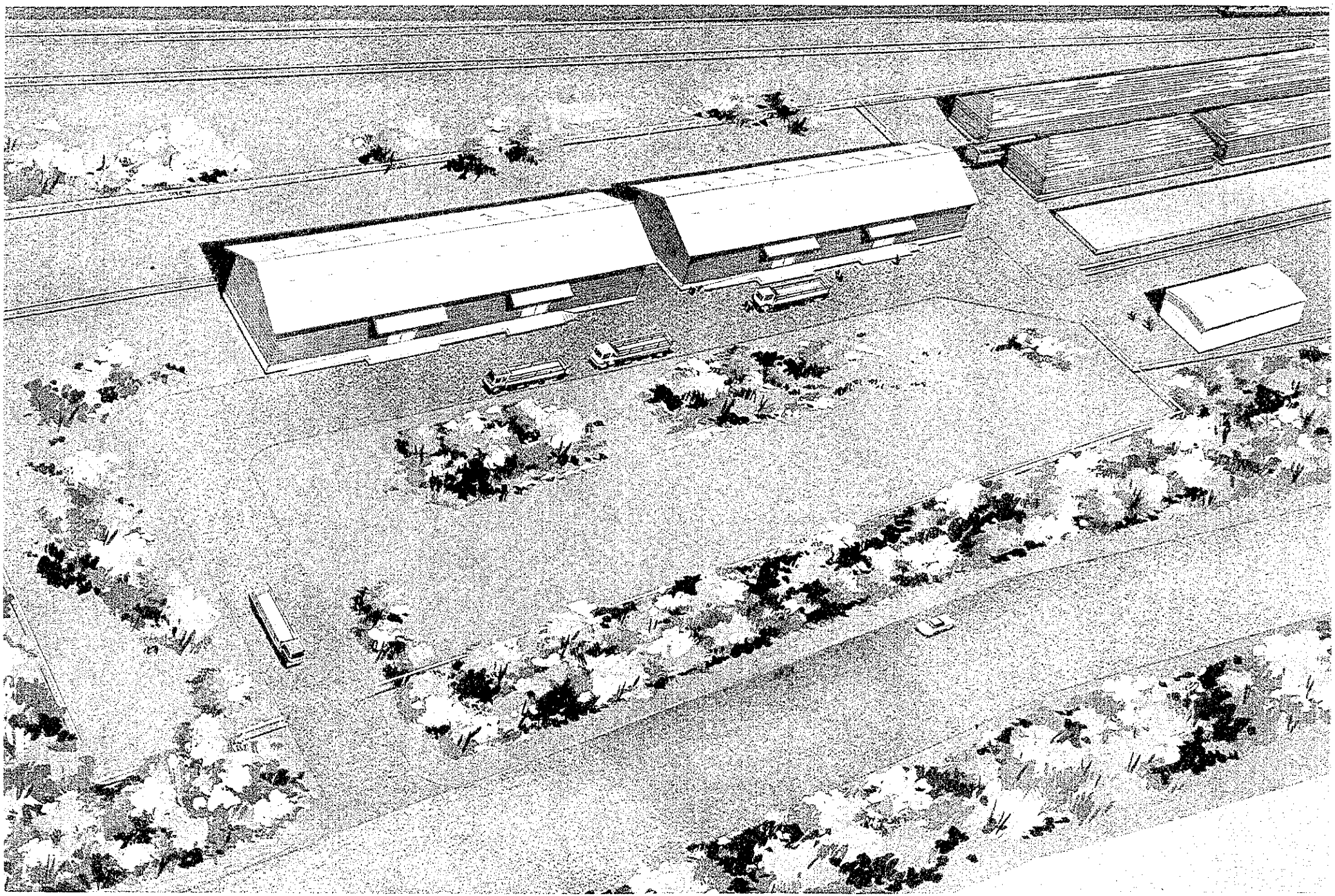


CONSTRUCTION SITE MAP



SUMMARY

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The Republic of Zambia became independent in 1964. Since then it has taken a policy to emphasize agriculture for economic as well as political independence to free itself from the mono-cultural economy which relies on the export of mineral products, mainly copper. In recent years, however, the rate of food self-sufficiency has been decreasing under such unfavorable conditions as the rapidly increasing urban population, insufficient investments in agriculture due to the lack of foreign currencies, a drought, etc. In Zambia, food grains are produced by the traditional peasant farmers who are engaged in self-sufficient agriculture, emergent farmers who raise some cash crops and commercial farms which produce farm products on a large scale. Maize which is the staple food of Zambia, accounts for about 80 % of the grain consumption in that country. While it is mainly produced in Central, Eastern and Southern Provinces, the production in Southern Province has drastically decreased due to the drought which recently hit the country.

The distribution of these food grains begins by the Cooperative Marketing Unions which buy them from farmers. To meet the demand within the province, the Cooperative Marketing Unions directly sell grains to the consumers. To meet demand from outside the province, the National Agricultural Marketing Board (NAMB) buys the grains from the Cooperative Marketing Unions, transports it outside of the province and then sells it to the millers.

During the above distribution processes involving transportation and storage, however, crops undergo large losses both in quality and quantity. This accelerates the fall of the food self-sufficiency rate. According to the report of the survey which was recently conducted by the Government of Zambia and the FAO, an amount equivalent to about one month's consumption is lost during distribution each year. The majority of these losses is reportedly attributable to inefficient storage and handling facilities.

In Zambia, the indoor storage facilities for food grains are insufficient. Although storagehouses are being constructed under the assistance of foreign countries at present, the number of storagehouses is very small. As a result, most of the grains are stored outdoors piled up in the field. These undergo big losses in quality due to direct sunlight, rain, and moisture from the ground and in quantity due to such pests as insects, rats and broken bags, etc.

Under such circumstances, the Government of Zambia has planned the construction of grain storagehouses and has requested the Government of Japan for financial cooperation, in order to decrease the losses during the distribution process and to secure a smooth distribution system.

In response to the request, the Government of Japan, through the Japan International Cooperation Agency, dispatched a basic design study team to the Republic of Zambia in May, 1984 following the preliminary survey in March, 1983. The basic design study team discussed concretely the details of the request with the officials of the Government of Zambia concerned and carried out field surveys on the proposed sites. The study team analyzed the results of its findings after returning to Japan and completed the Basic Design, whose outline appears below, for the construction of food grain storagehouses at the three sites, Chambishi in Copperbelt Province, Masansa in Central Province and Mtirizi in Eastern Province among the seven sites proposed by the Government of Zambia.

The study team has selected the above three sites for the following reasons:

1. Chambishi

Being in Copperbelt Province, which covers a large consumption area, this is an important depot of cargo collection with a large volume handled. However, it has no sheds for maize at all. All of the maize is stored outdoors on open hard-standings (concrete floors on which to stack up grains).

2. Masansa

This is an important depot in Mkushi District, a major production area of maize in Central Province. It is located almost midway between Copperbelt Province and Lusaka Province both of which are consumption areas. Therefore, its location is very advantageous for transportation. As a storage facility, however, it only has storagehouses with a capacity of 3,000 tons. Since there are no open hard-standings at all, most of the maize is stored on wooden racks laid directly on the ground.

3. Mtirizi

Among the depots in Eastern Province, this is located the nearest to Lusaka, the capital. Also it is very close to the highway. Maize production in

this area has been rapidly increasing in recent years.
Nevertheless, the storage conditions there are poor, one storagehouse (450 tons) and one open hardstanding (900 tons).

The table below shows the outline of the basic design.

	Chambishi (Consumption area)	Masansa (Production area)	Mtirizi (Production area)	Total
Storage capacity in tons	10,000	5,000	4,000	19,000
Building area in m^2	1629.25 x 2 = 3258.5	1629.25 x 1	1335.25 x 1	6,223
Structure	One-storied steel-frame structure	- do -	- do -	
Portable conveyor	8	3	3	14
Diesel generator for conveyor	-	2	2	4
Inspection apparatus for grains	1 set	1 set	1 set	3 sets

This construction project of food grain storagehouses requires 17 months including 5.5 months for detail design, preparation of tender, selection of the construction company after the exchange of notes and about 11.5 months for the construction work.

The construction of all-weather type storagehouses at the aforementioned important sites in consumption and production areas are expected to help Zambia to promote its agricultural policy by greatly contributing to reduce the losses caused during the food grain distribution processes in that country.

CHAPTER 1
INTRODUCTION

Chapter 1. INTRODUCTION

The Republic of Zambia became independent in 1964, and Dr. Kenneth Kaunda of the United National Independence Party (UNIP) was elected as Zambia's first president. Since then, the Republic of Zambia has been striving to construct a new nation proclaiming a national political philosophy based on humanism under the strong leadership of the president, who also leads the UNIP, Zambia's one and only political party.

The nation's most important policy involves economic as well as political independence. Thus the Government of Zambia is implementing its agricultural policy the most strenuously aiming at self-sufficiency in food along with the improvement of its copper industry on which the nation has traditionally depended.

In 1980, the Government of Zambia announced the Operation Food Production Program to achieve self-sufficiency in food. However, the outdoor storage of food grains which is traditional, causes significant losses in both quality and quantity during distribution. To reduce such losses during distribution, therefore, it is one of the government's most important agricultural policies to urgently construct all-weather type storagehouses.

Under the above circumstances, the Government of Zambia is currently constructing storagehouses under the financial assistance of Canada, the EC, Australia, etc. As a part of this program, it has also requested the Government of Japan for financial cooperation to construct food grain storagehouses.

In concrete terms, this request involved the following food grain storagehouses.

A. Consumption areas

Chambishi, Copperbelt Province	Capacity:	15,000 tons
Chingola, Copperbelt Province	Capacity:	5,000 tons

B. Production areas

i) Central Province

Priority	1 Masansa	Capacity:	7,500 tons
	2 Serenje	Capacity:	5,000 tons

ii) Eastern Province

Priority	1 Chadiza	Capacity:	6,000 tons
	2 Sinda	Capacity:	5,000 tons
	3 Mtirizi	Capacity:	5,000 tons

In response to Zambia's request, the Government of Japan studied the background of the project as well as ascertaining the content of the request by dispatching a preliminary study team through the Japan International Cooperation Agency (JICA) in March 1983 and has studied how cooperation should be in implementing on this project. As a result of this, the Basic Design Study Team, headed by Mr. Mitsui Matsuzu, Assistant Director, Second Economic Cooperation Division, Economic Cooperation Bureau of the Ministry of Foreign Affairs, was dispatched between May 15 and June 5, 1984.

Investigations conducted by this team included:

1) Ascertainment of the content of the request.
2) The study of the background of the project, such as the grain distribution system, etc., and the collection of the materials and information required for the project.
3) The on-site survey of the actual conditions of grain storage and of the construction conditions of the proposed sites.
4) The study of existing storagehouses and of the actual assistance by other foreign countries.
5) The study of the construction conditions and transportation conditions for materials in Zambia.

In addition to conducting the above studies, the study team held discussions with Zambian side on fundamental items of this project. It also visited the EC headquarters in Brussels and its agency in Lusaka to make adjustments with the EC, which is planning a similar assistance. The study team explained its objectives and the results of its survey and held discussions with the EC personnel.

The material in the appendix includes the minutes of the discussions, the list of the study team, the officials of the Government of Zambia concerned and the schedule of survey.

This report analyzes the contents of the discussions and of the field survey conducted, information and the collected materials, and evaluates the effect of this project on the improvement in the grain distribution system in Zambia to draw up a basic design which has the most adequate scale and content of installations.

CHAPTER 2
BACKGROUND OF PROJECT

Chapter 2. BACKGROUND OF PROJECT

2.1 General Conditions

2.1.1 Natural conditions

Landlocked Zambia, being situated in the southern part of the African continent, is surrounded by Zimbabwe and Botswana to the south, Tanzania and Zaire to the north, Malawi and Mozambique to the east, and Angola and Namibia to the west. The country lies from longitude 23°E to 34°E and from latitude 9°S to 18°S. The country's total area of 750,000 km^2 makes it about twice the size of Japan.

The land is roughly divided into the low land area 500 m or less above sea level in the basins of the Zambezi River which flows along the southern border and of its branch, the Luangwa River; the flood plain in the upper reaches of the Zambezi River in the west; the basin of the Kafue Rver; and the Plateau which occupies most of the nation's land.

Except for the low land along the Zambezi and Luangwa and for the mountains lying on the Tanzanian and Malawi borders, most of the land consists of a gently sloped plateau from 1,000 to 1,500 m above sea level. It is a savannah where high grass and bushes grow.

The country belongs to the tropical savannah climate. It is comparatively cool throughout the year except in the low land. The year there is divided into the cool dry season from May to August, the hot dry season from September to November, and the hot rainy reason from December to March. The temperature seldom exceeds 30°C. The lowest temperature in July sometimes drops to 5°C or 6°C. The northern part of the country gets more rainfall than the southern part. The rainfall, which is within the range of from 800 to 1,600 mm, supports the country's agriculture. The country is sometimes hit by droughts, however. The rain, which is indispensable for a successful crops, is brought by the northwesterly trade wind from the Zaire Basin. Meanwhile, the southeasterly trade wind prevails in the dry season.

2.1.2 Social conditions

Northern Rhodesia, a British protectorate, became independent on October 24, 1964 as the Republic of Zambia. The country is very sparsely populated with about 6 million people (5,680,000 in 1980 according to government statistics, 6,220,000 in 1983 according to a government estimation) inhabiting an area which is about twice the size of Japan. The country consists of 9 provinces: Lusaka, Cooperbelt, Central, Southern, Western, Northern, Northwestern, and Luapura Province, and 34 % of the population live in Lusaka Province where the capital is located and in Copperbelt Province where there are a cluster of copper mines. The population is increasing at the rate of 3.2 % (Government estimation for 1979 - 1984).

Since the independence, the Government of Zambia has been striving for the popularization of education by building educational facilities. As a result, percentage of school attendance is rising every year. The attendance to elementary schools exceeded one million in 1982 (government statistics). Besides regular elementary and middle schools, there are vocational training schools, while adult education is also conducted. The enrollment of the University of Zambia reached 3,600 in 1982.

2.1.3 Economic situation

The Zambian economy depends on the export of mineral products, mainly copper. The export of mineral products accounts for 96 % of total exports (1982 government statistics) and the countries, to which copper is exported, include the Communist bloc as well as such Western countries as Britain, West Germany, Japan, the U.S., South Africa, etc.

Amid the recession in world economy due to the oil crisis in 1974, however, the demand for copper decreased and its price fell. In addition, the closure of the border until the independence of Zimbabwe and the closure of the transportation routes caused by the unstable political situations in Angola and Mozambique have accelerated the significant fall of copper export. Amid the violent inflation which continues, the economic activities are rather sluggish and the price index rose 19 % in one year from 1982 to 1983. Under such circumstances, the real Gross Domestic Product (GDP) per capita has been decreasing since 1976, when

the copper production hit a peak (about 700,000 tons per annum). In 1983, it decreased to 674 Kwacha, about 78 % (actual value) of that in 1976 (about 500 dollars).

Although the agricultural population accounts for a very large part, about 75 % of the gross population, the productivity of the agricultural sector is very low, resulting in the production of only about 12 % of the GDP. This is considered to be attributable to the mono-cultural economy which involves the traditional dependence on miniming, mainly copper. A policy to emphasize agriculture which aims at the self-supply of foods and at an increase in the production of farm products for export to acquire foreign currencies, has been taken from the beginning of the First National Development Plan. Also the Second and Third National Development Plans (1979 - 1983) include as an important policy the promotion of agriculture to achieve their objectives. In 1980, furthermore, the Operation Food Production Program (1980 - 1990) which gives a longer prospect than the National Development Plans, was established.

2.1.4 Administrative organization and national plans

The administrative organization of the Republic of Zambia consists of the Office of the President, the Office of the Prime Minister and 19 ministries. Also the ministers in charge of each local province are assigned to the Office of the Prime Minister. In charge of agriculture are the Ministry of Agriculture and Water Development, and the Ministry of Land and Natural Resources. Many corporations are established in each ministry as implementing organs. The National Agricultural Marketing Board (NAMB) which deals with the distribution of food grains belongs to the Ministry of Agriculture and Water Development, while the National Milling Corporation (NMC), for processing food grains, and the Industrial Development Corporation (INDECO) belong to the Ministry of Commerce and Industry.

The government established in the Office of the President the National Commission for Development Planning(NCDP) which draws up national development plans for each year.

The Third National Development Plan (1979 - 1983) has ended and the content of the Fourth National Development Plan which is now being drawn up,

has not yet been announced. The national development plans stipulate agricultural reformation, namely the increase in food production, as one of the most important policies and in 1980, the Operation Food Production Program which aims at the self-supply of foods and at the acquisition of foreign currencies, was announced. In this connection, the NCDP controls the assistance from foreign countries.

2.2 Agricultural Conditions

2.2.1 General conditions

(1) Outline of agriculture

Zambia has arable land enough for agricultural production for both domestic consumption and export. However, only about 5 % of the arable land is cultivated. (The arable land accounts for about 40 % of the country's total area.)

Major crops are maize, groundnuts, sunflower seeds, millet, sorghum, cassava, pulse, tobacco, raw cotton, etc. Also the livestock industry is flourishing. From among the above major crops, maize is grown on more than half of the farm land and its production amount is overwhelmingly large in comparison with other cereals. Also maize is the major self-supporting crop as well as the major cash crop. As a staple food in Zambia, it accounts for about 80 % of that nation's grain consumption and it is also important feed for livestock.

There are large commercial farms along the railroad between Livingstone and Copperbelt. At locations far from major traffic routes, however, the land is only sparsely cultivated and the agricultural level is not above that of self-sufficiency there.

Agriculture has been sluggish in the past due to the low food price policy which was taken by the government as a countermeasure against the rapid increase in urban population and to insufficient investments in agricultural materials such as chemical fertilizers caused by the shortage in foreign currencies.

The maize crop has been poor since 1980 due to the drought. As a result, Zambia is importing a large amount of maize. As was mentioned earlier, however, vast areas of land remain uncultivated. It is safe to say, therefore, that there is a large latent agricultural production capacity depending on the development of the infrastructure such as transportation, irrigation, etc.

(2) Agricultural policies

Zambia's production structure has traditionally placed emphasis on the mining industry. This tendency had been prevalent since inde-

pendence up to 1974. Since 1975, when copper price slumped, however, the weight of the mining sector has considerably decreased. The weights of the agricultural and manufacturing sectors have been slowly increasing instead. The government has taken a policy to emphasize agriculture since the beginning of the First National Development Plan (1966 - 1970). This tendency has become particularly strong since the above-mentioned slump in copper prices. This policy was handed down to the Second National Development Plan which followed. Also in the Third National Development Plan (TNDP; 1979 - 1983), the promotion of agriculture is taken as an important strategy to achieve its objectives.

In implementing these national development plans, an annual plan is announced every year. Such annual plans give budgetary measures and also various objectives of the agricultural production increase in concrete terms. For maize, the objective of the production increase during the 1983/1984 crop season is put at 12,065,000 bags (1,085,850 tons) to be produced from a planted area of 571,000 ha. Of these 1,080,000 tons to be produced, 8,300,000 bags (747,000 tons) are projected to be bought by the Cooperatives Marketing Unions and the NAMB.

While the average annual growth rate of the GDP is projected to be 3.5 % for 1983, that in the agricultural sector is projected to be an amazingly high 9 %, rising from 157 million kwacha in 1982 to 171 million kwacha in 1983. (See Table 1.) Also in 1980, the Operation Food Production Program (1980 - 1990) which gives a longer prospect than the TNDP, was announced as a basic policy to achieve the self-supply of foods, to increase the food production for export, to increase the farmers incomes and to expand the employment opportunities.

As concrete measures to promote agriculture, there is the Lima Program, an agriculture promotion activity to cover the traditional self-sufficient agriculture and the development of large state farms. It is planned to open state farms, each 200 ha in area, at two locations in each province. These state farms are planned to incorporate advanced technologies in organization, schedule, cultivation, and farm machinery. This paln is also a part of the aforementioned TNDP.

Table 1 Gross Domestic Product (At Constant 1970 Prices), 1983 Projections
(K'million)

		1982		1983	
	1977	Projections	Actuals	Projections	Planned growth rate %
AGGREGATE GROSS DOMESTIC PRODUCT (GDP)	1,428	1,400	1,406	1,456	3.6
Sectoral-Breakdown:					
Agriculture	168	160	157	171	9.0
Mining and quarrying	470	376	421	434	3.0
Manufacturing	141	168	147	148	1.0
Electricity, gas and water	58	77	79	83	6.0
Construction	90	80	77	78	1.0
Wholesale and retail trade	97	105	96	97	1.0
Hotels and restaurants	17	26	23	24	4.0
Transport and communications	62	67	60	61	1.0
Financial institutions	49	43	36	40	3.0
Real estate	45	60	57	60	5.0
Business services	32	40	40	43	8.0
Community, social and other services including correction for import duties less imputed bank charges	199	209	213	217	2.0

Source : TNDP Annual Plan 1983

Table 2 Sectoral Investment 1983
(K'million)

	Planned Investment 1983	Percentage of the total
Agriculture, Lands and Natural Resources	102.6	10.5
Mining	295.1	30.2
Manufacturing	149.9	15.4
Energy	36.4	3.7
Transport and Communications (including Roads)	138.1	14.2
Social Services (Education, Health and Housing)	101.9	10.5
Other miscellaneous heads (including tourism and Government administration	150.8	15.5
TOTAL	974.8	100.0

Source : TNDP Annual Plan 1983

Table 3 Details of Aggregate Investment, 1981-83
(K' million)

	TNDP* (1980-84) (1)	1981 Actuals				1982 Planned				Preliminary 1982 Actuals				1983 Planned			
		Government (2)	Parastatal†† (3)	Private (4)**	Total (5)	Government (6)	Parastatal†† (7)	Private (8)**	Total (9)	Government (10)	Parastatal†† (11)	Private (12)**	Total (13)	Government (14)	Parastatal†† (15)	Private (16)**	Total (17)
Agriculture and Water Development ..	420.0	28.6	1.7	5.8	36.1	67.2	—	6.0	73.2	46.6	1.0	15.0	62.6	61.7	22.7	10.0	94.4
Lands and Natural Resources	85.0	6.6	..	2.2	8.8	5.7	—	1.0	6.7	18.2	0.3	1.0	19.5	7.2	—	1.0	8.2
Mining and Quarrying..	573.0	0.5	176.3	4.4	180.2	0.1	274.9	5.0	286.0	8.2	127.0	5.0	140.2	3.3	290.8	1.0	295.1
Manufacturing	460.0	4.3	29.2	0.9	53.4	30.1	55.4	10.0	95.5	50.8	92.0	15.0	157.8	2.8	127.1	20.0	149.9
Power and Energy ..	190.0	..	17.1	0.3	17.4	3.2	23.8	—	27.0	0.2	17.6	—	17.8	4.2	32.2	—	36.4
Transport and Communications ..	640.0	3.4	9.8	2.8	16.0	28.0	114.3	3.0	145.3	22.6	22.7	5.0	50.3	28.4	87.9	2.0	118.3
Commerce	68.0	—	7.6	3.0	10.6	0.2	6.5	5.0	11.7	..	5.5	1.0	6.0	0.2	2.6	10.0	19.8
Public Works (Roads only)	146.0	37.2	—	—	37.2	81.8	—	—	81.8	53.8	—	—	53.8	38.1	—	—	38.1
Housing and Real Estates	251.0	28.7	0.1	4.5	33.3	38.3	46.3	5.0	89.6	31.8	17.6	15.0	64.4	33.7	25.4	13.0	72.1
Education	106.0	4.1	—	—	4.1	14.3	—	—	14.3	18.8	—	—	18.8	11.8	3.2	2.0	16.8
Health	43.0	3.7	—	—	3.7	11.8	—	—	11.8	11.1	—	—	11.1	11.0	—	2.0	13.0
Information and Broadcasting	30.0	11.5	—	—	11.5	4.7	—	—	4.7	6.2	..	—	6.2	4.3	..	—	4.3
Financial Institutions and Insurance ..	—	—	—	—	—	—	—	—	—	—	11.3	—	11.3	—	62.4	—	62.4
Tourism	54.0	0.9	7.2	0.6	8.7	2.9	0.1	5.0	17.0	0.3	..	1.7	2.0	0.3	1.5	1.0	8.8
Youth and Sport ..	4.2	2.0	—	—	2.0	6.3	—	—	6.3	5.1	..	—	5.1	2.4	—	—	2.4
Scientific Research ..	5.0	1.2	—	—	1.2	1.0	—	—	1.0	1.0	..	—	1.0	1.0	—	—	1.0
General Administration	40.0	8.2	—	—	8.2	18.3	—	—	18.3	10.7	..	—	10.7	27.5	—	—	27.5
Provinces	150.0	17.2	—	—	17.2	11.7	—	—	11.7	11.9	—	—	11.9	12.3	—	—	12.3
GRAND TOTAL ..	1,354.0	158.1	248.0	33.6	439.6	331.6	630.3	40.0	901.9	306.3	295.0	58.7	660.0	250.0	662.8	62.0	974.8

* 1977 Prices.
†† Based on nine months.
** National Commission for Development Planning estimates.
.. Less than K100,000.
— No expenditure.

Source : TNDP Annual Plan 1983

In addition, INDP includes mechanization of agriculture, increase in producer's prices, improvement in grain storage facilities, promotion of agricultural processing, increase of investments in the infrastructure of rural areas, revision of the distribution system, improvement in the distribution facilities, etc.

Table 2 shows the planned amounts of investment and their rates for each sector in 1983. Meanwhile, Table 3 shows that the actual results of investment in the agricultural sector of the TNDP did not achieve the objective of the plan.

(3) Production of food grains

a. Production areas

Maize is produced in areas where the annual rainfall is within the range of 800 - 1,200 mm. The major producing areas lie in Central, Eastern and Northern Provinces. In particular, the areas along the main railways from Livingstone to Copperbelt via Lusaka and along the main road from Kapiri Mposhi to Mkushi, in both of which the soil is comparatively fertile and the transportation conditions are good, have well-developed commercial farms and are major production areas of maize. Also in areas along main roads in Petauke and Chipata Districts in Eastern Province where most of the farms are small, the maize production has recently been increasing in spite of the drought. Meanwhile, the maize production in Southern Province which had accounted for a large percentage up to several years ago, has greatly decreased being affected by the recent drought.

Rice is raised in northern areas where the annual rainfall is within the range of 1,200 - 1,300 mm. It is raised, if in a small quantity, also in Eastern and Western Provinces. The northern areas have such problems in distribution as the great distance from markets and the transportation of harvests which becomes impossible in the rainy season.

About 2,900 tons of rice were produced in 1982 and the production amount rose to about 5,000 tons in 1983. Such a large increase is considered to be attributable to the producer's price which almost doubled.

In areas where the amount of rainfall is small or where transporta-

tion conditions are bad, being distant from main roads, agriculture is still at the self-sufficient level. In these areas, small farms raise minor cereals, cassava, etc., and sell surplus, if any. These areas have such a latent production capacity that the production will suddenly increase, if the infrastructure such as irrigation facilities, roads, etc. is improved.

b. Production amounts

Table 4 "Planted Areas and Production for Major Agricultural Crops" and Table 5 "Planted Areas and Major Crops in Provinces" show the amounts of major crops produced.

In 1981/1982, maize as a food grain had the widest planted area with 503,000 ha, followed by 8,380 ha for soybeans, 4,873 ha for rice, and 3,650 ha for wheat. For crops other than food grains, the planted areas were 41,130 ha for sunflower, 25,758 ha for raw cotton, 20,100 ha for groundnuts and so on. The yield of maize per hectare which slightly differs from one province to another, was about 1.9 tons on the average which is quite higher than about 1 ton for neighboring African countries. This is considered to be largely attributable to the introduction of hybrids. However, this yield is far below the world's average of 2.8 tons. The yield per hectare is expected to increase depending on the future increase in agricultural inputs such as fertilizers, agricultural chemicals, etc.

In the future, Zambia must increase the production of maize to be domestically consumed to meet its increasing population and maize for export to obtain foreign currencies. There is a great possibility of increasing the maize production in the future because of the aforementioned vast uncultivated areas of land.

c. Farm management scales

Farms are classified as follows according to the management scale.

Traditional peasant farmer:	1 ha or less
Emergent farmer:	1 - 10 ha
Commercial farmer/State farm:	10 ha or more

The number of traditional peasant farmers is overwhelming (estimated at 460,000) and they are at the traditional self-sufficient agricultural level.

Table 4 Planted Area and Production for Major Agricultural Crops

CROP	DESCRIPTION	UNIT (BAGS)	1980/81	1981/82	1982/83 (ESTIMATED)
Maize	Planted Area	Ha	493783	503000	564000
	Total Production	90 Kg	11192000	6000000	12800000
Paddy Rice	Planted Area	Ha	5362	4873	6300
	Total Production	80 Kg	65770	61800	83000
Wheat	Planted Area	Ha	3600	3650	4750
	Total Production	90 Kg	131500	-	221700
Groundnuts	Planted Area	Ha	33515	20100	42800
	Total Production	80 Kg	190500	112000	253300
Sunflower	Planted Area	Ha	47156	41130	51600
	Total Production	50 kg	379300	410000	440900
Soy beans	Planted Area	Ha	4900	8380	10060
	Total Production	90 Kg	55270	45300	217380
Seed Cotton	Planted Area	Ha	36460	25758	44800
	Total Production	Kg	17176796	13169966	23000000
Tobacco	Area Planted	Ha	2845	2370	3640
	Total Production	Kg	23500 2350000	2000000	3000000

Source : Central Statistical Office 1983

Table 5 Planted Area and Major Crops in Provinces (1980/1981)

(ha)
(bag or kg)
* **

Province	Maize *	Paddy Rice *	Wheat *	Ground Nut *	Sun-flower *	Soya-beans *	Cotton **	Tobacco V. **
Central	155,600	50	460	5,082	12,200	1,220	136,000	950
	3,346,000	600	22,000	30,200	97,000	14,600	6,657,460	857,524
Copperbelt	5,322	9	250	492	390	828	175	50
	109,400	140	12,600	4,500	2,300	10,000	78,874	27,746
Easter	149,000	1,160	-	16,000	17,600	360	4,050	700
	2,651,000	13,300	-	91,000	127,000	5,000	1,855,122	489,321
Luapula	2,680	278	-	301	100	-	10	3
	40,000	3,500	-	2,000	1,200	-	2,150	1,935
Lusaka	34,500	10	1,460	1,600	2,600	950	1,360	75
	500,000	130	72,000	5,700	18,000	12,000	794,298	62,570
Northern	19,864	2,225	970	1,440	298	32	145	12
	450,000	30,000	6,500	6,500	1,900	270	30,856	10,156
North Western	3,707	106	-	200	350	250	-	25
	65,000	1,900	-	800	2,100	2,000	-	18,740
Southern	114,225	20	410	8,000	13,411	250	16,840	850
	3,930,000	200	18,000	48,000	129,000	2,000	7,709,899	765,830
Western	8,885	1,504	50	400	207	-	280	180
	100,000	16,000	400	1,800	800	-	52,137	116,473
Total	493,783	5,362	3,600	33,515	47,156	3,890	36,460	2,845
	11,192,000	65,770	131,500	190,500	379,300	45,870	17,180,796	2,350,295

Source : Economic Report 1982

Table 6 Farms Units and Farm Population by Province and by Farm Level (1980)

Level / Province	Large-Scale Commercial (>40 ha)		Medium-Scale Commercial (10 - 40 ha)		Small-Scale Commercial (1 - 10 ha)		Traditional Farming Sector		Total	
	Farms	Pop	Farms	Pop	Farms	Pop	Farms	Pop	Farms	Pop
Southern	320	16 000	8 000	76 000	49 900	374 100	7 500	33 900	65 720	500 000
Central	300	15 200	7 630	72 500	21 400	160 599	18 400	82 800	47 730	331 000
Lusaka	90	4 300	1 910	18 100	4 300	32 300	13 400	60 300	19 700	115 000
Copperbelt	-	-	490	4 700	2 000	14 900	17 900	80 400	20 390	100 000
Eastern	20	1 000	3 100	29 500	27 000	202 700	80 900	363 800	111 020	597 000
Western	-	-	-	-	5 450	40 800	85 400	384 200	90 850	425 000
N/Western	-	-	80	800	2 900	21 900	53 600	241 300	56 580	264 000
Luapula	-	-	50	500	2 050	15 300	73 600	331 200	75 700	347 000
Northern	-	-	90	800	7 400	55 500	111 900	503 700	119 390	560 000
Total	730	36 500	21 350	202 900	122 400	918 000	462 600	2 081 600	607 080	3 239 000

Source: Food Strategy Study, 1981, MAWD.

The emergent farmers, having recently emerged from traditional peasant farmers, cultivate cash crops. Ordinarily they produce maize, cassava, groundnuts, sorghum, etc.

Meanwhile, commercial farmers and state farms produce large amounts of farm products on a commercial basis. In particular the number of very large farms having 40 ha or more land, such as state farms and Zambia Anglo American Corporation (Zam-Anglo), reaches about 800. (See Table 6.) All of these state and private farms are located near railways or main roads and produce about 50 % of the total agricultural production in Zambia. Large farms carry out capital-intensive production by using modern techniques. They produce cereals, beef, pork and eggs for urban areas, and tobacco for export. Under the national development plans, the government is striving to establish state farms. The state farms thus established have achieved significant results in the development of each locality during the past several years. Furthermore, they are expected to flourish as service centers for nearby farms in the future.

d. Cultivation, harvesting and cleaning of maize

Sowing of maize begins about the middle of November in Western and Northwestern Provinces, and about the end of November in other provinces, coinciding with the start of the rainy season. Meanwhile, the farmers are encouraged to previously deeply plow the field from March to April when it still rains from time to time. As seeds, such high-yield hybrids as S.R. 52, S.R. 11, Zambia Hybrid 1, etc. are widely used. In particular, S.R. 11 is recommended for areas with a small quantity of rainfall, such as the southern part of the country. Maize ripens about March when the rainy season nears its end. It is left as it is until the cob somewhat dries. Then the cob is twisted off by hand. In some cases, the stalk is harvested and is dried as it is for about 4 weeks then the cob is twisted off. On the other hand some commercial farms use corn harvesters during harvesting.

In regard to threshing, most of the traditional peasant farmers use simple implements, while some use their hands only. Some commercial farms have powered threshers, while some others use threshing methods of laying the maize (on the cob) on the ground to dry and then to thresh by driving a tractor on it. After threshing,

foreign materials are removed by sieving or winnowing for shipment. The purity of the product is not so high, however.

Generally speaking, grains are dried naturally rather than artificially, because, in Zambia, maize is harvested in the dry season. Traditionally, farmers store maize on the cob in cribs with good ventilation. Since maize stored in this manner is prone to be affected by pests or rats, however, the agricultural extension organizations encourage the farmers to store threshed maize in brick bins with cement mortar.

(4) Loss of crops

The Zambian Government has recently taken measures to promote agriculture to meet the increase in the grain consumption due to the growing population and to increase the production of grains for export. Efforts have been made to expand the production by heightening the yield per unit area by intensive agricultural inputs, for maize in particular, by introducing hybrid maize seeds. However, the biggest defect in Zambia's agriculture involves the large losses both in quality and quantity that are caused in crops after harvesting. According to the results of the "Nation-Wide Study of Zambia's Storage Requirement for Both Produce and Input" which was conducted by the Zambian Government and the FAO, an amount which is equivalent to about one month's consumption has been lost every year during distribution. The majority of such a loss is reported to be attributable to insufficient storage and handling facilities. The possible losses in quality during storage include decay by microbes such as mold, etc., due to insufficient drying, water or moisture from the outside and losses by heat resulted from a rise in temperature by the direct sunlight. Meanwhile, the possible losses in quantity are caused by pests such as insects, rats, birds, etc. and the crop leaking through the holes in bags.

In Zambia, crops are mostly stored by being piled up outdoors, and then covered with tarpaulin sheets. As a result, they are largely affected by losses in quality due to direct sunlight, rainleaks, moisture from the ground, etc., and by losses in quantity due to the gunny bags breaking induced by the above causes, animals eating grains, etc. As was mentioned earlier, the loss caused in this manner is equivalent to about one month's consumption every year.

These losses can be largely reduced by storing crops in sheds and by appropriate control of storage. Such measures will have a significant economic effect.

(5) Supply and Demand of Foods

Table 7 shows the relationship between the production of and the demand for maize in 1982 and 1983 based on NAMB material. The demand for maize was about 1,030,000 tons (11,407,969 bags including farmers' own consumption), while the total production was about 840,000 tons (9,278,612 bags) leaving a difference of about 190,000 tons. By subtracting the imported amount of about 130,000 tons from this value, a shortage of about 60,000 tons is left. Although the distribution amount in 1983 had been projected to be about 800,000 tons, according to the study results, however, the Cooperative Marketing Unions actually bought 5,900,000 bags (531,000 tons) of maize. While the NAMB bought 3,586,000 bags (322,740 tons), including 3,550,000 bags (319,500 tons) bought from the Cooperative Marketing Unions and bought 36,000 bags (3,240 tons) directly from farmers in 1983.

Zambia had been an exporter of maize from 1973 to 1978. It became an importer in 1979, however, due to continuously poor crops caused by the drought. In 1983, it imported 950,000 bags (85,500 tons) of maize from Zimbabwe and also 450,000 bags (40,500 tons) from Malawi respectively, for a total of 1,400,000 bags (126,000 tons). Of the 1,400,000 bags, 460,000 bags were imported on a commercial basis and 940,000 bags were granted as assistance from the US, the Netherlands, EC, WFP, etc.

Maize is transferred between provinces for adjustment of surplus and shortage. Table 8 shows the actual results of such transfer in 1983.

According to the World Bank's report in 1981, the world's average of the annual food grain consumption per capita is 362.1 kg (1976 - 1979). However, the annual food grain consumption per capita of middle-income African countries, south of the Sahara (including Zambia), is 148.5 kg, or less than half this level.

According to the Food Strategy Study 1981 (Table 9), announced by the Ministry of Agriculture and Water Development, the grain

supply per capita in 1980 was 138 kg. By adding 30 kg (10 kg in grain equivalent) for cassava to this value, a value which is almost equal to the afore-mentioned level (148.5 kg) is obtained.

Table 7 Sufficiency and Deficiency for Maize in Provinces

(Unit 90 kg Bag)

Province	Estimated consumption (a)	Total production (b)	Balance (b) - (a)
Northern	608,993	864,787	255,854
Luapula	353,243	68,785	-284,458
Central	1,260,576	2,604,518	1,343,939
Eastern	1,924,918	2,784,956	860,038
Lusaka	1,739,698	335,757	-1,403,941
C. belt	2,353,907	235,157	-2,118,750
Southern	1;937,348	2,191,273	253,925
Western	888,670	115,748	-772,922
N. Western	340,676	77,634	-263,042
Total	11,407,969	9,278,612	-2,129,357

Source : NAMB

Table 8 Interprovincial Transfer of ABC Maize during 1983 in 90 kg Bags

(As reported by receiving depots)

From/To	Central	Southern	N/Western	C/Belt	Eastern	Northern	Lusaka	Total
Central						169,175		169,175
Western	80,101						130,831	210,932
N/Western	10,016			67,601				77,617
C/Belt	1,370,153	410,646	480			210,975	879,753	2,872,007
Luapula	12,610					41,749		54,359
Lusaka		67,011			690,278			757,289
Total	1,472,880	477,657	480	67,601	690,278	421,899	1,010,584	4,141,379

Source: NAMB

Table 9 Food Consumption and Food Supply per Capita per Annum, in Kg.

Food group	Consumption		Supply		
	1967	1975	1967	1975	1980
Maize flour	111	106	121	116	107
Wheat flour	9	15	9	18	24
Sorghum/Millet flour	15	13	16	13	7
Fresh Cassava	40	36	37	33	30
Vegetables	33	33	33	33	33
Fish - fresh	8.1	9.4	9.7	9.6	7.3
- dried	7.4	7.9	-	-	-
Meet - fresh beef	6.6	5.3	17	16	13
- others	7.4	7.9	-	-	-
Fruits	12	11	12	11	12
Groundnuts	3	2.7	5	7	6.7
Pulses	2.4	3	2	1.9	2.3
Sweet Potatoes	3.1	2.9	3.8	3.4	3.3
Fat	2.3	3.4	3	3.8	4.3
Sugar	7.3	8.6	9.1	16	17
Milk - fresh	4.3	8.4	8.1	7.7	6.2

Source: Food Strategy Study, Ministry of Agriculture & Water Development, 1981.

2.2.2 Distribution of food grains

(1) Grain distribution system

Major food grains distributed in Zambia include maize, wheat, sorghum, millet and rice. Maize accounts for 95 % or more (excluding imported grains) of these grains. These grains had been monopolistically handled by the NAMB under the Ministry of Agriculture and Water Development since its establishment on September 1, 1969. As a result of the revision of the NAMB's functions which was carried out to maintain close cooperation with the Cooperative Marketing Unions which had handled similar duties, the Cooperative Marketing Unions in each province took over the distributing function in each province from the NAMB in March 1982 and have been carrying

out the duties since then. Therefore, the NAMB is currently in charge of the ditribution between provinces.

(2) Distribution amounts of food grains

Table 10 shows the distribution amounts of major food grains in each year.

Table 10 Marketed Agricultural Production
(Selected Crops in Metric Tons)
1978 to 1982

CROP	1978/79	1979/80	1980/81	1981/82	1982/83
Maize	657,000	331,255	382,988	693,480	510,525
Groundnuts	6,777	2,693	2,253	2,649	628
Sunflower	11,355	12,869	28,279	18,738	20,115
Wheat	6,400	4,322	6,670	8,250	2,800
Paddy Rice	2,970	1,686	2,511	2,779	2,888
Soy Beans	2,844	1,274	3,510	1,743	3,321

Source: Nation-Wide Study of Zambia's Storage Requirements

For maize, from 60 to 70 % of the total production is expected to be on the distribution route. During the past several years, the demand for maize could not be met by the domestic production only. As a result, Zambia depends considerably on imported maize.

Table 11 includes the maize import in 1983. The actual amount of the maize export from 1971 to 1978 are as follows and no maize has been exported thereafter.

1971 (year)	8,598 (ton)
1972	1,896
1973	50,086
1974	111,212
1975	16,621
1976	8,803
1977	25,606
1978	61,284

Table 11 Total Import of Maize During 1983 as Reported by Receiving Branches

(in 90 Kg Bags)

Month	Commercial ZIMBABWE	Commercial MALAWI	WFP-AID ZIMBABWE	US-IAD ZIMBABWE	EEC-AID ZIMBABWE	ROYAL DUTCH AID ZIMBABWE	TOTAL
January	3,723					130,203	133,926
February	9,312					124,232	133,544
March			44,063			68,370	112,424
April			10,164	44,695		50,488	105,350
May				177,161			177,161
June		10,488		99,518			110,006
July		87,353		32,375	47,690**		167,418
August		119,690			41,023		160,713
September		90,873			56,970		147,843
October		31,952			7,612		39,564
November		33,090	4,500*				37,590
December		73,225	1,200*				74,425
TOTAL	13,035	446,671	59,927	353,752	153,295	373,284	1,399,964

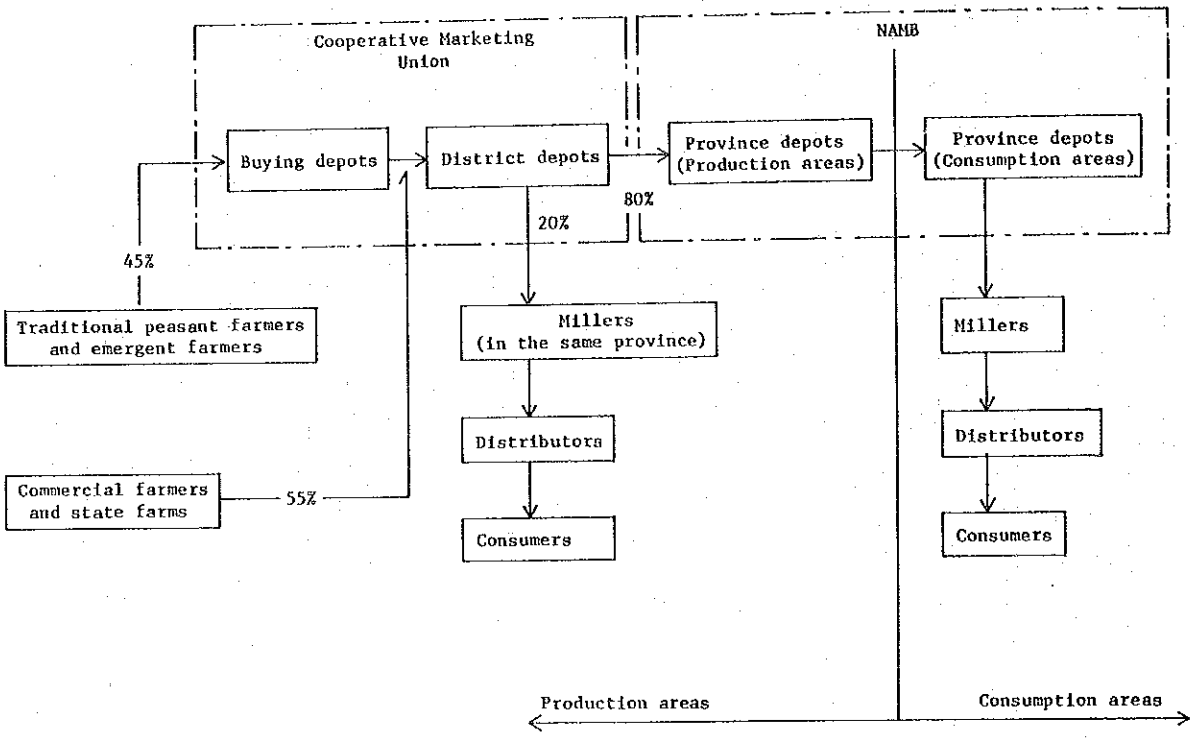
* Received by - Livingstone Branch

** Includes 240 bags D-Maize

Source : NAMB

(3) Distribution system for maize

The diagram below shows the maize distribution system from the producer to the consumer. The dotted lines indicate the duty range of each of the Cooperative Marketing Unions and the NAMB.



(4) National Agricultural Marketing Board (NAMB)

The NAMB which exclusively controls the distribution of major food grains in Zambia together with the Cooperative Marketing Unions was established on September 1, 1969. According to "NAMBOARD TODAY" published in September 1982, its functions are:

(1) Purchase, storage and sale of the farm products designated by the Ministry of Agriculture and Water Development

(2) Purchase, sale and distribution of agricultural materials and equipment

(3) Import and export of farm products, agricultural materials and equipment

(4) Provision of storage and distribution facilities for the designated farm products and agricultural materials and equipment

(5) Measures required for the adequate distribution of the designated farm products and for the adequate supply of agricultural materials and equipment in the designated areas

On March 31, 1981, the NAMB largely delegated its authorities to its branches in conformity to the policy aiming at the decentralization of power. Also the provincial duties were transferred to the Cooperative Marketing Unions in each province. The current duties of the Cooperative Marketing Unions are:

(1) Purchase of farm products from farmers and their sale within the province

(2) Sale of maize to the NAMB for transfer to the outside of the province

(3) Purchase of agricultural material and equipment from the NAMB and their distribution to farmers

The domestically produced maize which is bought by the NAMB through the Copperative Marketing Unions accounts for about 80 % of the total distribution amount. The remaining 20 % is sold within the province by the Cooperative Marketing Unions.

Table 12 shows the actual results of the sale of maize by the NAMB. The organizational chart of the NAMB headquarters is given for reference in "Appendix 5."

(5) Prices of marketed food grains

For agricultural development, the policies of the Government of Zambia are, firstly, to achieve the self-supply of major farm products and, secondly, to produce grains for export. To achieve the above goals, it has been taking for the past several years a policy to increase investments in agriculture, the production of farm products, and their distribution amount by giving the farmers incentive for production increase by raising the official purchase prices of farm products which had hitherto been maintained low.

This tendency is apparent in Table 13 which shows the fluctuations in the maize price in 1979 onwards.

Table 12 Comparative Maize Sales by Province by Namboard from 1975 to 1983 in 90 Kg Bags

PROVINCE	1975	1976	1977	1978	1979	1980	1981	1982	1983
Southern	571,900	673,425	612,211	717,886	755,395	885,421	645,487	440,108	497,209
Central	2,350,561	2,412,595	2,471,729	954,016	85,768	816,874	731,061	448,827	19,313
Lusaka	*	*	*	1,853,566	1,753,285	1,462,305	1,408,137	1,342,053	1,331,451
C/Blet	2,183,312	2,512,002	2,650,722	3,004,556	2,754,892	2,482,865	2,705,750	2,974,647	2,819,698
Eastern				88,823	120,138	189,976	103,004		
Northern				63,514	94,636	118,032	50,944		
Luapula		91,470	196,591	269,305	285,234	271,246	201,377	141,939	119,212
N/Western		19,028	90,554	91,582	143,770	123,981	146,171	105,505	82,992
Western		35,430	60,724	122,516	165,163	209,030	236,760	235,879	253,855
Others	627,983**			70,127**					
TOTAL	5,653,764	5,743,950	6,090,531	7,243,891	6,923,281	6,551,730	6,228,691	5,688,950	5,123,730

* Lusaka included in Central Province

** Brockdown unknown.

Source : NAMB

On the other hand, it is essential for public welfare to supply low-priced foods to low-income consumers in urban areas who are increasing in number. The financial burden to compensate for the margin to keep the consumer price for maize fairly low, as shown in Table 15, has become a problem.

The Ministry of Agriculture and Water Development draws up the draft for the producer's price. Then the Cabinet approves and announces it. Normally this is done in April before the harvesting year so that it is reflected on that year's crop. The Cooperative Marketing Unions buy maize from farmers at this purchase price.

(6) Purchase from farmers

The Cooperative Marketing Unions in each province collect harvested maize from the farmer except for the farmers' own consumption via buying (satellite) depots for the NAMB.

Each buyin g depot which covers about 10 farmers or about 1,000 bags, is installed at such a location that the distance from the farthest farmer does not exceed 4 miles. At the buying depot, the inspector dispatched from the Cooperative Marketing Unions inspects the quality and weight of the maize. At present, the quality is checked visually, while the weight is measured using platform scales or spring scales. If the quality turns out to be unacceptable, the inspector instructs the farmer to dry and clean the maize again. A receipt is issued when the delivery is over. Then a check is issued from the Cooperative Marketing Unions afterwards. The farmer can cash his check anytime in a city bank.

Since Zambia has no allocation system for delivery, each farmer decides by himself on the amount to be sold. The customer is limited to a branch of the Cooperative Marketing Unions, however.

(7) Quality of food grains and inspections

The National Agricultural Marketing Act stipulates the inspection standards and methods for food grains. The inspection items for maize include moisture, extraneous matters, colored grains, insect-damaged grain, diseased grain and so on. According to the inspection results, maize is ranked into 5 grades, i.e. A, B, C, D and E. Maize ranked A, B, or C is used as food, while that ranked D or E is used as brew and feed materials. There is an official purchase

Table 13 National Agricultural Marketing Board, Grains Marketing Division
Statutory Producer Prices of Maize in KW/Bag, Real Maize Prices
and Real Maize Price Index 1971=100

YEAR	A	B	C	D	E	AGRICULTURAL PRICE INDEX	REAL MAIZE PRICE	REAL MAIZE PRICE INDEX
1969	3.20	3.15	3.05					
1970	3.50	3.45	3.35					
1971	4.00	3.95	3.85			75.1	5.33	100.0
1972	4.30	4.25	4.15			78.9	5.45	102.3
1973	4.30	4.25	4.15			84.0	5.12	96.1
1974	4.30	4.25	4.15	3.50	2.80	90.8	4.74	88.9
1975	5.00	4.95	4.85	4.60	3.85	100.0	5.00	93.8
1976	6.30	6.20	6.05	2.50	2.00	118.8	5.30	99.4
1977	6.30	6.20	6.05	2.50	2.00	142.3	4.43	83.1
1978	6.80	6.75	6.70	3.00	2.75	165.6	4.11	77.1
1979	9.20	9.10	8.95			181.6	5.07	95.1
1980	11.70	11.60	11.40			202.9	5.77	108.3
1981	13.50	13.45	13.25			233.3	5.79	108.6
1982	16.00	15.90	15.85			268.3	5.96	111.8
1983	18.30	18.20	18.15					
1984	24.50*							

* Preplanning price as at 31/12/83

repurchase price from unions 1982 K17.00

1983 K20.00

Source: NAMB

Table 14 Producer Price for Crops Other Than Maize
1977-1983 and Preplanting Prices
(As at 31/12/83)

	UNIT KG	1977	1978	1979	1980	1981	1982	1983	1984*
Sunflower	50	10.00	10.00	12.50	16.40	17.60	20.75	21.50	21.50
Wheat	90	16.00	20.00	20.00	24.00	26.00	32.00	35.75	42.50
Soy beans	90	17.00	17.00	21.50	32.00	36.20	42.31	45.30	52.50
Paddy Rice	80	14.40	14.40	14.40	16.00	18.60	28.00	40.00	40.00
S/G/Nuts A	80	25.00	25.00	28.60	32.00	42.70	48.00	52.00	71.50
Sorghum	90	6.00	6.00	6.00	9.00	9.00	9.00	16.00	18.65
Sunhemp	90	5.72	5.72	5.72	5.72	5.72	6.00	6.00	6.00
Cow Peas	90	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Beans									
Canadian Wonder	90	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Harricot	90	17.00	17.00	18.00	18.50	18.50	18.50	18.50	18.50
Mixed	90	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Velvet	90	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

Average nominal price index for crops other than maize 1977=100

100	103	111	129	144	165	186	211

Source : NAMB

Table 15 Producer and Selling Prices of the Main Commodities in KW/Bag and Selling Price as % of Producer Price

Unless otherwise indicated, prices in this table were valid from the 1st of May of the year in column heading until the 30th April of the following year: example: prices under 1977 were valid from 1/5/77 until 30/4/78.

PP = Producer Price SP = Selling price % SP = Selling price as % of producer price
F: PP paid to farmers M: SP to millers U: PP or SP for Unions

COMMODITY	UNIT	1977	1978	1979	1980	1981	1982 F/M	1982 U	1983 F/M	1983 U
Maize	90 PP	6.30	6.80	9.20	11.70	12.50	16.00	17.00 (1)	18.30	20.00
	SP	4.82	6.25	10.21	12.91	13.50	17.00	16.00	22.48	21.00
	%SP	77	92	111	110	108	106	94	124	105
Sunflower	50 PP	10.00	10.00	12.50	16.40	17.60	20.75		21.50	
	SP	12.50	12.50	19.35	23.70	19.30	27.25 (2)		27.25 (3)	
	%SP	125	125	155	145	110	131		127	
Wheat	90 PP	20.00	20.00	20.00	24.00	26.00	32.00		35.75	
	SP	24.60	24.60	24.60	25.90	26.30	40.95 (2)		40.95 (3)	
	%SP	123	123	123	108	101	128		114	
Soy Beans	90 PP	17.00	17.00	21.50	32.00	36.20	42.31		45.30	
	SP	28.51	31.70	29.20	33.20	40.60	51.91 (2)		51.91 (3)	
	%SP	168	186	136	104	112	123		115	
Paddy Rice	80 PP	14.40	14.40	14.40	16.00	18.60	28.00		40.00	
	SP	19.66	25.25	22.45	24.30	24.80	36.00 (2)		36.00 (3)	
	%SP	137	175	156	152	133	129		90	
S/G/Nuts	80 PP	25.00	25.00	28.60	32.00	42.70	48.00		52.00	
	SP	30.15	32.60	38.95	43.00	43.80	57.60 (2)		57.60 (3)	
	%SP	121	130	136	134	103	120		111	

price margin, if small, between each of these grades. (See Table 13.)

The quality and weight of maize are inspected each time the Cooperative Marketing Unions buys it from the producer, the NAMB buys it from the Cooperative Marketing Unions and the Miller buys it from the Cooperative Marketing Unions or the NAMB.

For weight, sampling inspections are carried out using platform scales or truck scales installed at some of the NAMB depots.
For quality, meanwhile, the inspector decides on whether the maize is acceptable or not is most cases by his own intuition because of the lack of test apparatuses. As a result, the quality is prone to a wide dispersion. It is desirable to install more test apparatuses.

(8) Fumigation of food grains in storage

Maize which is being stored is fumigated.

Methyl bromide is used in fumigation. The pile of maize is covered with a vinyl sheet which is fixed on the floor with sand bags. Then methyl bromide gas is injected into the cover and it is tightly covered for 24 hours. The chemical is used in the following standard quantities which are stipulated by the TPI of Britain.

Temperature	Chemical quantity
10 - 20°C	54 g/ton or 36 g/m^3
20°C and over	36 g/ton or 24 g/m^3

The fumigation is implemented about twice a year for the maize which is stored for about oneyear and about three times a year when there are many insects.

To prevent insects from entering after the fumigation, the pile surfaces are sprayed with the actellic liquid agent.

The following three NAMB pest control offices implement the fumigation.

1 Pest Control Office Lusaka (Headquarter)
2 Pest Control Office Ndola
3 Pest Control Office Monze

One fumigation team is assigned to each pest control office. It implements fumigation by visiting the depots (including those of

the Cooperative Marketing Unions) in the areas under its control.

Each of the above pest control offices is in charge of the following provinces.

1) Central, Eastern and Lusaka Provinces
2) Copperbelt, Northern, Northwestern and Luapura Provinces
3) Southern and Western Provinces

It is difficult to implement fumigation sufficiently, since each team covers too large an area.

As a countermeasure against rats, the rodenticide "Finale" is used under the guidance of the pest control offices.

(9) Grain consumption

The staple food in Zambia is white maize milled and cooked into paste. The powder is called "mil meal," while the cooked dish is called 'nshima." Depending on the powder mesh, there are two kinds, i.e. breakfast (porridge) meal and roller meal. The former which is made of finer powder, is more expensive than the latter by about 20 to 30 %.

Table 16 shows the retail price being maintained fairly low in conformity to the low-price policy for major foods. The milled maize is packed into a vinyl bag with a capacity of 25 kg or 50 kg and is retailed through an official distribution organ (ex. the Consumer's Buying Cooperatives of Zambia). There are no restrictions on the purchased quantity. It sometimes happens, however, that maize temporarily disappears from shops.

Table 16 Average Urban Retail Prices of Food

	Unit	Dec 78	Dec 79	Dec 80	Dec 81	Dec 82	Dec 83
Breakfast Meal	25 kg	6.10	6.10	6.10	6.88	6.37	11.20
Breakfast Meal	50 kg	9.00	9.00	9.00	13.26	16.19	21.75
Roller Meal	25 kg	2.39	4.00	4.00	5.47	6.77	8.80
Roller Meal	50 kg	4.66	7.90	7.90	10.45	13.00	16.90
Bread	800 g	0.33	0.33	0.41	0.53	0.53	0.53
Rice	1 kg	0.46	0.55	0.55	0.70	1.69	1.71
Plain Flour	1 kg	0.26	0.26	0.37	0.56	0.56	0.66

Source: Consumer Price Statistics, September 1983

One person consumes about 110 kg each year. Recently the maize consumption per capita has been decreasing, while the consumption of wheat flour, oils and fats, sugar, etc. has been increasing. (See Table 9.)

(10) Transportation of food grains

Normally, trucks are used to transport food grains within one province (buying depot - district depot - province depot). In rural areas, the transportation is not smooth because of the bad roads in addition to the shortage in trucks. This tendency is particularly apparent in the rainy season.

For transportation between provinces, railways are used in most cases to transport grain from its production areas in Southern and Central Provinces to its consumption areas in Copperbelt Province. Trucks are used to transport grain from Eastern Province to Lusaka, because these provinces are not connected by railway.

The transportation rate using trucks is 0.12 kwacha per ton kilometer. Meanwhile, the transportation rate using railways decreases as the distance increases. Therefore, railways are used where they are available notwithstanding the cost of transhipment. It takes very long to tranship grain from one railway to another, however.

Table 17 Cost of Transporting Maize and Fertilizer by Zambia Railways after the Increase in Rate in April 1984

KILOMETERS	NEW RATE PER ton. km.		KILOMETERS	NEW PATE PER ton. km.	
	K	N		K	N
1.100	0	- 20	550.600	0	- 05
100.150	0	- 11	600.650	0	- 05
150.200	0	- 08	650.700	0	- 05
200.250	0	- 07	700.750	0	- 05
250.300	0	- 07	750.800	0	- 05
300.350	0	- 07	800.850	0	- 05
350.400	0	- 06	850.900	0	- 05
400.450	0	- 06	900.950	0	- 05
450.500	0	- 06	950.100	0	- 05
500.550	0	- 06			

Usually, maize is transported in gunny bags (net weight 90 kg; gross weight 91 kg). When a silo owned by the NAMB is used, maize which is brought in bags is injected into it in bulk. It is also transported from the silo to the mill in bulk.

In 1983, 4,140,000 bags (373,000 tons) of domestically produced maize were transported across provincial borders. In the same year, additional 1,400,000 bags (126,000 tons) were imported into Zambia. Therefore, a total of 5,540,000 bags, or about 500,000 tons, of maize were transported between provinces or from foreign countries. Table 8 shows the breakdown of the transportation between provinces.

2.3 Present Conditions of Storagehouses and Assistance Programs

2.3.1 Present conditions of existing storagehouses

(1) Food storage facilities

1) Ownership

The food storage facilities are roughly classified into those in the farmer's stage, those in the distribution stage, and those in the processing stage respectively. For storage in the distribution stage, the official organs for grain, namely the Cooperative Marketing Unions and the NAMB, own silos, storagehouses, and open hard-standings (concrete slabs on the ground) for outdoor storage to play their own roles. For storage in the processing stage, there are silos and storagehouses for storing materials and products, that are owned by mills. This basic design study covers the storage facilities in the distribution stage from among the above storage facilities.

2) Functions

The buying and district depots belong to the Cooperative Marketing Unions which buy grains from farmers, and transport and sell them within the province. A buying depot has a character of a junction to transport grains bought from farmers to a district depot. However, it sometimes stores grains for 3 to 4 months depending on the transportation condition. A district depot stores the food grains which were collected from the buying depots before they are sold within the province or are bought by the NAMB. Consequently,

the above buying and district depots are storage facilities in production areas.

The province depots, which belong to the 12 NAMB branches distributed throughout the country, are located at important points along the main roads and railways connecting production and consumption areas. Some province depots are located at the junctions between production and consumption areas, while others are located in consumption areas. The former are located in places to facilitate the transportation between provinces, such as the transhipment point from truck to freight car. The latter, the major role of which is the acceptance and storage of cargos to supply raw materials to mills, require a large amount of operating stock. Therefore, they have large storage facilities.

3) Present state of storage facilities

In Zambia, maize is mostly stored outdoors, while it is stored in silos in bulk or in sheds in bags in some parts of the country. Outdoor storage has been possible because such favorable natural conditions as the temperature which is comparatively low and the rainfall which is fairly small with about 1,000 mm a year in most of the land, though situated in the tropics, being covered with a highland savannah from 1,000 to 1,300 m above sea level. It cannot be denied, however, that this has been a major cause of losses in both quality and quantity.

1 Buying depots

In buying depots,maize bags are usually piled up on logs which are laid crisscross in two level on the ground (called a "wooden rack"), covered with sheets. The maize bags are piled up in rare cases, on a open hard-standings with a capacity within the range of from 200 to 400 tons. Generally speaking, the road conditions are bad. However, the buying depots are located in places where transportation is possible using tractors or small to medium trucks. In some of these places, transportation becomes difficult in the rainy season.

2 District depots

The state of the facility considerably differs from one depot to another. Normally, maize bags are piled on open hard-standings (concrete slabs with a ground clearance of 30 - 60 cm,

with a capacity of 2,000 - 5,000 tons), or on above-mentioned wooden racks covered with waterproof tarpaulin sheets. Maize bags are rarely stored in sheds.

The maize bags are piled up on open hard-standings or wooden racks into a shape which resembles a house with a hipped roof. The height sometimes reaches 20 bags in the vertical section and 20 to 25 bags at inclining section. In such cases, the height to the top of the stack reaches over 10 m.

The piles are covered with tarpaulin sheets to protect them from the sun and rain. When the maize bags are piled up on the wooden rack, the maize contained in the bags at the bottom is prone to be damaged by the moisture absorbed from the ground.

Even in open hard-standings, moisture sometimes rises through the cracks in the concrete slabs and damages the maize bags at the bottom in a similar manner. Most of the district depots have a capacity within the range of about 5,000 to 20,000 tons.

3 Province depots

Unlike district depots, most of the province depots use open hard-standings. Also those which are located along railways are equipped with sidetracks for freight trains for long-haul transportation. The province depots include three silos (Monze, Lusaka, Kitwe) that were constructed by Britain before the independence, and also the three silos (Ndola, Kabwe, Chisamba) that were constructed by Yugoslavia in 1973. These are not fully utilized, however, due to the aged mechanical equipment, cracking of the silos themselves, etc.

4) Capacities of storage facilities

In Zambia, the present grain storage capacities are 110,000 tons for silos, 205,000 tons for one-storied storagehouses including those being planned under CIDA's (the Canadian International Development Agency) assistance and 640,000 tons for outdoor storage facilities (open hand-standings) respectively. Thus the indoor storage facilities have a very small capacity.

When the maize bags are so many that all of a them cannot even be piled upon the open hard-standings at a buying depot or a district depot, the excess maize bags are sometimes piled up on logs. The

capacity of this method is not included in the above data.

The capacity of one-storied storagehouses of 205,000 tons include 190,000 tons for the storagehouses that are being built under the assistance of the CIDA and 15,000 tons for the storagehouses owned by the Cooperative Marketing Unions. The former include 50,000 tons in Lusaka and 10,000 tons in Mumbwa in Central Province respectively, for which the storagehouses have already been constructed and put to use. The remaining 130,000 tons are accounted for by those being constructed and by those the construction of which is planned to be started soon and completed by 1985. In addition to these 190,000 tons, the CIDA plans to construct one-storied storagehouses with a capacity of 85,000 tons as indicated below.

Phase II

Western Province:	5,000 tons
Luapura Province:	5,000 tons

Phase III

Northern Province:	25,000 tons
Eastern Province:	35,000 tons
Western Province:	15,000 tons

The 15,000 tons of the storage facilities owned by the Cooperative Marketing Unions are those in Luapura Province (180 tons), Western Province (7,965 tons) and Northwestern Province (7,110 tons).

The CIDA's storagehouses are being constructed under the authority of the NAMB. The management of those which become district depots will be transferred to the Cooperative Marketing Unions after completion.

Table 18 shows the capacities of the storage facilities now existing and under construction.

(2) Fluctuations in stock

Harvesting of maize reaches its peak in April to May in Zambia. The harvested maize is at first collected at the buying depots and then is sent to the district depots. Generally speaking, the stock at the district depots is at a minimum from the harvesting season to immediately before its collection and is at a maximum from 3 to 4

Table 18 Existing Grain Storage Facilities and Capacities Owned by Namboard and C.U.

Province		Open Hard-standing	Silo	Shed owned by C.U.	Shed by CIDA
		ton	ton	ton	ton
Southern					
	Livingstone	55,800			
	Senkobo	2,250			
	Mayoba	2,250			
	Bow-wood	2,700			
	Kalomo	14,400			
	Tara	5,400			
	Choma	45,000			40,000
	Pemba	18,000			
	Monze	32,400	14,400		20,000
	Kaleya	27,000			20,000
	Mazabuka	25,200			
	Nega-Nega	2,700			
Lusaka					
	Chipongwe	2,700			
	Lusaka	58,500	14,400		50,000
Central					
	Karubwe	27,000			
	Chisamba	45,000	22,500		
	Kawavasa	18,000			
	Mumbwa	10,800			10,000
	Natuseko	31,500	22,500		
	Chankwakwa	5,400			
	Kakulu	1,800			
	Kapiri-Mposhi	28,800			
	Mkushi	11,700			25,000
Copper Belt					
	Bwana Mkubwa	50,400	22,500		
	Kitwe		14,400		
	Chambeshi	54,000			
Wester		16,200		7,965	
Eastern		18,000			25,000
Nothern		9,000			
North Western		3,600		7,110	
Luapula		14,580		180	
Total		640,080	110,700	15,255	190,000

Source : Namboard

months after harvesting around August to September.

The stock at each province depot seems to reach its maximum and minimum at different times depending on the condition of the crops in the production areas, the transportation conditions, the operating conditions of the mills. Usually, the stock is stable, however. It seems that about 10 % of the stock is carried forward into the next season.

Table 19 shows the stocks when they are at minimum throughout a year.

2.3.2 Assistance programs of foreign countries to construct food grain storagehouses

Various foreign countries and international organizations have plans to assist Zambia in constructing storagehouses as follows.

a) Canada

The Government of Canada is assisting Zambia through the CIDA in constructing storagehouses. Its program, which is divided into Phases I, II and III, involves the construction of storagehouses for maize and fertilizers. The breakdown is as follows. (See Table 20.)

For maize, all the storagehouses in Phase I have been completed except for the one in Choma, with a capacity of 40,000 tons, which is planned to be completed before the end of 1984. The storagehouses in Phase II in Monze and Mkushi (45,000 tons in total), now under construction, are planned to be completed by the end of 1985. The construction of the one in Kaleya is planned to start soon. The above covers a total of 190,000 tons. The storagehouses in Phase II in Solwezi and Mansa (10,000 tons in total) and those in Phase III (75,000 tons in total) are planned to be completed at the end of 1985.

b) EC

The EC has constructed storagehouses for fertilizers, seeds, agricultural implements and chemicals, etc. and houses for the staff members of the depot at 11 locations (13 locations according to the initial plan). At present, it is offering to assist the Zambian Government in the field of storage. In response to this offer,

Table 19 National Agricultural Marketing Board
Grains Marketing Division

Stock Position of ABC Marize as at 25-05-84

DEPOT	INTAKE 24 W/MAIZE (1983 crops)	INTAKE 22 Y/MAIZE (IMPORTS)	INTAKE 22 W/MAIZE (IMPORTS)	TOTAL
LIVINGSTONE	18,739	-	-	18,739
MONZE MAIN	120	-	-	120
MONZE SILO	23,300	69,367	-	92,667
SUB TOTAL	42,159	69,367	-	111,526
CIDA SHEDS	13,241	-	13,461	26,702
LUSAKA MAIN	69,119	-	62,718	131,837
LUSAKA SILO	66,002	-	7,419	73,421
SUB TOTAL	148,362	-	83,598	231,960
CHISAMBA SILO	7,420	-	-	7,420
NATUSEKO SILO	608	-	-	608
KAPIRI MPOSHI	992	-	-	992
SUB TOTAL	9,020	-	-	9,020
B/MKUBWA MAIN	55,550	-	-	55,550
B/MKUBWA SILO	53,215	-	-	53,215
KITWE SILO	12,086	-	-	12,086
CHAMBESHI	105,167	-	-	105,167
SUBTOTAL	226,018	-	-	226,018
		S U M M A R Y		
SOUTHERN	42,159	69,367	-	111,526
LUSAKA	148,362	-	83,598	231,960
CENTRAL	9,020	-	-	9,020
COPPERBELT	226,018	-	-	226,018
EASTERN	-	-	-	-
LUAPULA	20,451	-	-	20,451
N/WESTERN	21,770	-	-	21,770
WESTERN	42,674	-	-	42,674
NORTHERN	-	-	-	-
TOTAL	510,454	69,367	83,598	663,419*

*Maize in Transit (between DEPOTS) is not included

Source : NAMB

Table 20 CIDA' Assistance Program

LOCATION		MAIZE CAPACITY IN TONS	FERTILIZER CAPACITY IN TONS
PHASE 1			
Lusaka	Lusaka	50,000	-
Central	Mumbwa	10,000	-
Southern	Choma	40,000	17,500
Eastern	Chipata	10,000	7,000
"	Katete	5,000	7,000
"	Lundazi	5,000	3,500
"	Petauke	5,000	3,500
PHASE 2			
Southern	Kaleya	20,000	-
"	Mazabuka	-	7,000
"	Monze	20,000	7,000
Central	Mkushi	25,000	17,500
"	Natuseko	-	7,000
"	Mpika	-	3,500
North-Western	Solwezi	5,000	3,500
Luapula	Mansa	5,000	3,500
Northern	Kasama	-	3,500
PHASE 3			
Northern	Mwenzo	10,000	3,500
"	Isoka	5,000	-
"	Kasama	10,000	-
"	Mbala	-	3,500
Eastern	Sinda	10,000	-
"	Chadiza	5,000	-
"	Lundazi	10,000	3,500
"	Chipata	10,000	-
Western	Mongu	10,000	-
"	Kalabo	5,000	-
TOTAL (IN TONS)		275,000	101,500

the work inside the Government to draft the formal request will be finalized around October this year and the government is expected to thereupon submit a formal request to the EC.

The EC, which has a considerable amount of data from past experience of assistance in constructing storagehouses in Zambia, does not consider re-study necessary. Therefore, it will decide on the construction site, scale, etc. only by perusing documents including the proposed report on storage of food crops, fertilizers and processing, expected in October 1984. If internal proceedings such as submitting of the draft assistance program to the headquarters, the acquisition of approvals from related department, etc. are successfully carried out on schedule, the construction could start sometime after June 1985.

c) Other countries

i) Australia

Australia granted construction materials for 15 prefabricated steel-frame storagehouses with a total capacity of 8,500 tons. The construction of these storagehouses were carried out by the NAMB because the assistance was limited only to construction materials.

ii) West Germany

West Germany plans to implement a study soon to rehabilitate the 6 aging silos that are located at major collecting and distributing centers.

iii) World Bank

To form a part of the Southern Province Agricultural Development Project, the World Bank is constructing 60 fertilizer storehouses with a capacity of 12,000 tons in total in rural areas in Southern Province through FAO at present.

iv) Saudi Arabia

Saudi Arabia had planned to assist Zambia in constructing 20 storagehouses with a capacity of 50,000 tons in major production and consumption areas of maize. This has not yet materialized, however, due to the restrictions on capital on the Zambian side, since Saudi Arabia will only grant required capital after Zambia constructs them.

v) Czechoslovakia

Czechoslovakia had planned to construct silos with a capacity of 11,900 tons. This plan has not yet materialized either, since the assistance system was similar to that of Saudi Arabia.

CHAPTER 3
OUTLINE OF PROJECT

Chapter 3. OUTLINE OF PROJECT

3.1 Objective of Project

Since independence, Zambia's economy had largely depended on the mining industry, mainly copper. Due to the instable fluctuations in international copper prices in recent years, however, it was unavoidable for Zambia to switch from a reliance on copper. Under such circumstances, the Government of Zambia takes an agricultural promotion policy as one of the most important items to achieve economic self-support in its Third National Development Plan (1979 -- 1983). In 1980, furthermore, it announced the Operation Food Production Program (1980 -- 1990) to achieve self-sufficiency in foods and for the agriculture to earn foreign currencies.

Nevertheless, the production amount significantly decreased being affected by the population increase in Zambia and by the drought which recently hit the whole of Africa. As a result, Zambia has to import a considerable amount of maize, which has been its major crop, to cover the insufficiency of domestic production. In addition, since most of the crops are stored outdoors in Zambia, large losses of grains have been caused both in quality and quantity, thus this has become an obstacle to the grain supply. It will be necessary to improve the grain distribution system by decreasing the losses caused during storage in order to achieve the self-supply of foods and the objectives of the agricultural policy.

This project involves the construction of all-weather type storagehouses which meet the actual situation in Zambia and which provides the equipment required for effective cargo handling and quality control to achieve the above objectives.

3.2 Project Orientation

3.2.1 Selection of project sites and setting of scales

To select the project sites requires consideration of conditions related to the food supply-demand, distribution and the construction.

Food grain storagehouses in production areas should be those that can collect grains produced in nearby areas as soon as possible after harvesting and can store them under the best storage conditions until they are shipped to the consumption areas. Therefore, the selection requirements for a project site of a storagehouse in a production area depends on the grain production, the storage capacity, the transportation conditions, etc. in each area.

Meanwhile, the objective in constructing a storagehouse in consumption area is the stable supply of foods to nearby consumption areas. For this purpose, the storagehouse should store grain as the adjustment stock which are brought in from the production areas without deteriorating their quality. Therefore, the selection requirements for the project site of a storagehouse in a consumption area depend on the storage capacity, the consumption amount in nearby areas, the transportation conditions, etc.

Regarding the setting of scales, all of the project sites planned in this project lie on the premises of existing depots. Therefore, the point is to what degree the outdoor storage facilities at these depots should be turned into indoor storage facilities in consideration of the conditions of location for these depots.

For the above reasons, the fluctuations in the estimated stock as time goes by should be observed by monitoring the state of the cargo arival and shipment each month. It would be ideal to construct a storagehouse with a capacity to meet the maximum estimated storage volume throughout the year obtained in this manner. In this case, there would scarcely be any need for outdoor storage, if the cargo is adequately handled. However, in order to efficiently utilize instrument, it would be desirable to plan for a capacity for only the rainy season in December onwards.

Discussed below are the selection of each project site and the setting of scales.

3.2.2 Current grain distribution at proposed sites

(1) Chambishi

The depot at this proposed site which is in Copperbelt Province, a large consumption area, occupies an important position as the depot in a consumption area. It has railway sidetracks and also is near the highway. Though a large amount maize arrives and is shipped in freight cars and trucks, there are no sheds for maize at all. At present, all of this maize is stored on the open hard-standings (600,000 bags; 54,000 tons).

Notwithstanding the fact that a total 258,000 tons of maize are transferred from other provinces, there are silos with a capacity of 36,900 tons, open hard-standings with a capacity of 104,400 tons only and no sheds at all in this province. Under such circumstances, the need for constructing a storagehouse seems very urgent.

To decide on the optimum scale of the storagehouse to be constructed, the amounts of arrival and shipment in each month from April 1983 to March 1984 were surveyed on the site, and the amount of stock each month was estimated as follows. The table below shows the results.

Table A

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
	ton	ton	ton	ton	ton
Jan.	11,000	6,700	7,100	10,600	
Feb.		4,100	4,900	9,800	
Mar.		8,600	8,500	9,900	
Apr.		7,200	8,000	9,100	
May		10,600	8,300	11,400	
Jun.		12,400	7,100	16,700	
Jul.		11,000	7,100	20,600	
Aug.		11,500	11,800	20,300	
Sept.		9,700	10,700	19,300	
Oct.		4,100	7,100	16,300	
Nov.		6,700	12,000	11,000	
Dec.		7,900	7,900	11,000	11,000
Total		100,500	100,500		

According to the above table, the maximum monthly stock is 20,600 tons at the end of July. In regard to the indoor storage in the rainy season in December onwards, however, the amount of stock from the end of November to the end of December is 11,000 tons. Based on the afore-mentioned concept of deciding on the scale, therefore, the optimum scale is estimated to be about 11,000 tons.

Meanwhile, the table below shows the results of the estimation of the average amounts of arrival and shipment in each month during the 5 years from 1979 to 1983. Accordingly, the amount of stock during the period from the end of November to the end of March is estimated to be within the range of 9,300 -- 11,200 tons, or almost equal to the afore-mentioned optimum scale of about 11,000 tons.

Table B

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
Jan.	10,700	6,400	6,800	10,300	
Feb.		5,600	4,700	11,200	
Mar.		6,900	8,100	10,000	
Apr.		7,200	7,600	9,600	
May		7,200	7,900	8,900	
Jun.		10,100	6,800	12,200	
Jul.		11,000	6,800	16,400	
Aug.		6,500	11,200	11,700	
Sept.		12,000	10,200	13,500	
Oct.		8,500	6,800	15,200	
Nov.		5,500	11,400	9,300	
Dec.		8,800	7,500	10,600	10,600
Total		95,700	95,800		

Table A indicates the amount of stock at the end of the rainy season (the end of March) at 9,900 tons, while Table B indicates it at 10,000 tons. In view of effectively utilizing the storagehouse, therefore, it is possible to store all the volume indoors in the rainy season in a storagehouse with a capacity of about 10,000 tons. In Copeerbelt Province, there are grain silos with a tatal

capacity of 36,900 tons which include 22,500 tons for Bwana Mkubwa and 14,400 tons for Kitwe. This accounts for 26% of the total storage capacity in Copperbelt Province. Thus the province has a much higher ratio of silos than other provinces. It is more advantageous to store grain in silos in bulk than to store it in bags with respect to cargo handling efficiency and to handling cost. Threfore, it is possible to improve the utilization factor of the storagehouse in Chambishi by adjusting the arrivals and shipments between these silos.

In consideration of the above points, the optimum scale which is the most efficient and which brings about the largest investment effects in Chambishi Depot was determined as 10,000 tons.

(2) MASANSA

The depot at this proposed site is an important base in Mkushi District which is a major production area in Central Province as well as Kabwe District. This depot is on a gravel road 70 km from the highway connecting Kapri Mposhi and the Tanzanian border. There are no obstacles to truck transportation. Its location is advantageous in that the railways can be used to transport grain to Copperbelt and Lusaka Provinces which are large consumption provinces, via Kapri Mposhi (trucks are used up to Kapri Mposhi).

Since there is not even one open hard-standing, however, the whole amount is stored on wooden racks at present. Consequently, the need for constructing a storagehouse which can prevent the grains from the losses both in quality and quantity during storage is urgent. For the optimum scale of the storagehouse to be constructed, the amounts of arrival and shipment each month in 1983 were surveyed on the site. The table below shows the smounts of arrival and shipment, and the amounts of stock at the end of each month that were estimated based on the data thus obtained.

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
	ton	ton	ton	ton	ton
Jan.	6,800		2,100	4,700	
Feb.			2,100	2,600	
Mar.			1,400	1,200	
Apr.			800	400	
May			400	0	
Jun.		4,700	1,800	2,900	
Jul.		9,400	7,200	5,100	
Aug.		11,200	5,400	10,900	
Sept.		9,300	5,400	14,800	
Oct.		1,400	3,600	12,600	
Nov.			2,900	9,700	
Dec.			2,900	6,800	6,800
Total		36,000	36,000		

According to the above table, the maximum amount of stock is estimated to be 14,800 tons at the end of September. The capacity of the storagehouse to be constructed, however, will be 9,700 tons which is equivalent to the amount at the end of November in order to store all grains indoors in the rainy season in December onwards. In consideration of the fact that Masansa Depot already has existing prefabricated storehouses with a capacity of about 3,000 tons, the most economical and optimum scale is estimated to be about 6,700 tons. Meanwhile, the total amounts of maize purchased in Mkushi District during the past 5 years (1978 -- 1983) are listed below.

1978/79	359,697 (bags)
1979/80	271,074
1980/81	691,586
1981/82	644,555
1982/83	887,000

While there is a wide dispersion between each harvest year, the amount handled in Masansa Depot accounted for about 40% of the

total amount purchased in this district, i.e. 887,000 bags (79,800 tons), in 1982/1983. Since a production increase of about 10% is projected for 1983/1984, the total amount purchased is estimated at about 980,000 bags (88,000 tons). Assuming that Masansa Depot handled 40% of this amount, it handles slightly over 35,000 tons. Therefore, the amount estimated to be collected, i.e. 36,000 tons, which was used in deciding on the scale, is judged to be appropriate. In Mkushi, storagehouses with a capacity of 25,000 tons are planned to be completed soon under the CIDA assistance. After the completion of these storagehouses, Mkushi District will have a fairly high percentage of indoor storage capability. In view of the distribution throughout Mkushi District, it is expected possible to make shipment adjustments between the depots in the district. The table below shows the stocks that are obtained by increasing the shipments from September to November in Masansa Depot by 15%.

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
	ton	ton	ton	ton	ton
Sept.	10,900	9,300	6,200	14,000	
Oct.		1,400	4,100	11,300	
Nov.			3,300	8,000	8,000

Namely, it is expected possible to reduce the stock at the end of November to about 8,000 tons. In consideration of the fact that the existing storagehouses have a capacity of about 3,000 tons, the economical and appropriate capacity is estimated to be 5,000 tons. Meanwhile, the total amount of stock in December onwards can be stored indoors in the new storagehouse.

It is expected, therefore, that the amount of the outdoor storage in the rainy season in this area can be considerably reduced, the storage condition can be largely improved and that the losses in quality and quantity can be drastically reduced, by delaying the shipment and by effectively utilizing the storagehouse.

(3) Mtirizi

The depot at this proposed site is located in an area where the maize production has been smoothly increasing in recent years. The

need for constructing a storagehouse can be seen as urgent when the fact that there are only one open hardstanding (900 tons) and one storagehouse (450tons) as the storage facilities, is considered. Presently, most of the crop is piled up outdoors on wooden racks. Furthermore, this depot has the advantage of being located the nearest to Lusaka of the depots in Eastern province, in addition to the location conditions mentioned later. For the optimum scale of the storagehouse to be constructed, the amounts of arrival and shipment in each month in 1983 and the amounts of arrival estimated for the further were surveyed on the site. The table below shows the the estimated amounts of arrival and shipment and those of stock at the end of each month that were calculated from the data thus obtained.

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
	ton	ton	ton	ton	ton
Jan.	1,800		1,800	0	
Feb.					
Mar.					
Apr.					
May					
Jun.		100		100	
Jul.		900		1,000	
Aug.		3,600	1,800	2,800	
Sept.		9,000	2,700	9,100	
Oct.		2,700	2,700	9,100	
Nov.		800	3,600	6,300	
Dec.			4,500	1,800	1,800
Total		17,100	17,100		

Nymba District in which this depot is located, is very fertile and has much rainfall. In addition, its production amount has been increasing every year affected by the poor crop in the southern part of the country due to the recent drought. The estimated production amounts of maize in the district during the past 5 years are listed below. The production is expected to further increase as the storage facilities are improved.

1978/79	7,540 (ton)
1979/80	7,060
1980/81	23,540
1981/82	30,450
1982/83	31,780

The amounts of maize brought in the depot during the past 5 years increased 2.5 times during the same period as shown in the table below. This means that the amount has increased at a rate of about 26% per annum.

1978/79	4,880 (ton)
1979/80	7,490
1980/81	8,440
1981/82	7,110
1982/83	12,260

Therefore, the afore-mentioned amount estimated to be stored, i.e. 17,100 tons, is judged as appropriate. According to the above table, the maximum amount of stock each year is estimated to be 9,100 tons from the end of September to the end of October. In consideration of the indoor storage in the rainy season in December onwards, the amount to be stored will be about 6,300 tons at the end of November. In view of the fact that the existing storagehouse has a capacity of about 500 tons, the capacity is calculated to be about 5,800 tons.

According to this estimation, however, the shipment reaches its peak in December and the estimated amount of stock drops to a trifling 1,800 tons at the end of December. Therefore, it is not efficient to construct a storagehouse with the afore-mentioned capacity of 5,800 tons. Meanwhile, the table below shows the relationship between the amount collected and the capacity of storagehouses (including those being planned) at each of the depots in Eastern Province. According to this table, the capacities of storagehouses (including those being planned) at each of the depots in Eastern Province. According to this table, the capacities of the storagehouse are

distributed comparatively uniformly.

	Amount received (1982/1983)	Capacity of shed
	ton	ton
Mtirizi	12,300	-
Petauke	16,700	5,000
Sinda	-	10,000
Katete	14,800	5,000
Sub-total	31,500	20,000
Chandiza	10,500	5,000
Chipata	43,000	20,000
Lundazi	46,600	15,000

In particular, Mtirizi Depot is the nearest to Lusaka from among the depots in Eastern Province. Also it faces a highway. Thus its location is very convenient for transportation. In consideration of the distribution throughout Eastern Province, it is expected possible to make shipment adjustments between the depots in Eastern Province. The table below shows the stocks that are obtained by increasing the shipments from September to November in Mtirizi Depot by 20%.

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
	ton	ton	ton	ton	ton
Sept.	2,800	9,000	3,200	8,600	
Oct.		2,700	3,300	8,000	
Nov.		800	4,300	4,500	4,500

Accordingly, it is expected possible to make the stock at the end of November about 4,500 tons. In consideration of the fact that the existing storagehouse has a capacity of about 500 tons, the economical and appropriate capacity is calculated to be 4,000 tons. For the stock in December onwards, meanwhile, early shipments have been made in the rainy season because of the lack of indoor storage facilities at present. After the storagehouse which can store the total amount indoors is completed, it will be possible to effectively

utilize the storagehouse by delaying the shipment. Also for the shipment, it is expected that the amount of the crop stored outdoors in the rainy season in this area can be reduced, the storage condition can be largely improved, and that the losses in quality and quantity can be drastically reduced by delaying the shipment of the stock of 4,500 tons at the end of November and by adjusting the distribution throughout Eastern Province as shown in the following table.

	Opening stock	Arrival	Shipment	Stock at end of month	Closing stock
	ton	ton	ton	ton	ton
Dec.	4,500	-	-	4,500	
Jan.			-	4,500	
Feb.			-	4,500	
Mar.			-	4,500	
Apr.			2,500	2,000	
May			2,000	0	

(4) Serenje

The depot at this proposed site is located in an area where maize production has been rapidly increasing in recent years because of having been less affected by the drought than the southern part of the country. All of the producers in this area are traditional peasant farmers. The shipment of each farmer is small and the grains are collected from a considerably wide range reaching to Makatambo which is located 173 km to the northeast. Since the grains are collected in small amounts from many farms and the transportation is difficult due to the unfavorable road conditions and to the lack of trucks, the collection is particularly difficult in the rainy season. Thus the quality of the crops is prone to be damaged by rain. This frequently occur in production areas. Although the Zambian side has requested Japan to construct a storagehouse in this proposed site and even if a storagehouse is constructed, chances are small that the crop can be smoothly stored in it before the rainy season. Threfore, it is considered necessary that the road and transportation conditions in the nearby areas should be improved

before anything else. In consideration of the above facts and the poor location for construction mentioned later, it was judged that Serenje Depot will not be appropriate for the site of this construction project of food grain storagehouses.

3.2.3 Physical and geographical condition for proposed sites

(1) Chambishi in Copperbelt Province

The Zambia Railway owns the land at this proposed site and the NAMB has obtained permission to use land from the Zambia Railway. (Appendix 8)

The site is adjacent to the existing depot and has a rectangular shape with the longer side rapallel to the highway which runs nearby from the north to the south. The existing depot has two sidetracks for freight cars of the Zambia Railway. As a result, the site is advantageous for either rail or truck transportation. At present, the site is a copse with several large trees and it is gently sloped with a level difference about 2m somewhat to the north from the existing site.

The existing depot has an office, a lavatory, etc. and also water supply and electric facilities which are available for the new storagehouses. The existing sidetracks which are currently used to bring in grains, will also be used for the new storagehouses. Judging from the lie and shape of the land, there seem to be no technical problems as to the extension of these sidetracks. However, the existing high-voltage cable which crosses the site must be relocated. Also trees must be felled, and the land leveled and prepared. The study team has requested the NAMB to complete the relocation and land preparation works before the construction work starts and the NAMB thereupon gave its approval.

Storage facilities at existing depot

9 open hard-standings:	Total 600,000 bags (54,000 tons)
One prefabricated storagehouse constructed under Australian assistance for gunny bags:	Capacity 500,000 sheets

(2) Masansa in Central Province

The site lies along a gravel road from 7 to 8m in width and about 70 km from the highway. Vehicles can pass this road even in the rainy season. Also there are no obstacles to truck transportation such as narrow bridges, paths, etc. along this road. Thus there are no particular problems in the transportation of construction materials.

The site lies along the above-mentioned gravel road and is adjacent to the existing depot. The site and the land which surrounds it are owned by the NAMB. It is reportedly possible to further expand the site, if necessary, up to the front road and on the west.

The portion in which the construction is planned is currently flat grassland with no particulary high trees. The existing depot has neither a paved portion nor a section which is specifically allocated as a road.

Storage facilities at existing depot

Three prefabricated storagehouses constructed under Australian assistance:	1,000 tons x 3
One prefabricated storagehouse for materials:	

In addition to the above, there is a vacant lot for wooden racks.

(3) Mtirizi in Eastern Province

The site, about 30 km from Petauke towards Lusaka, lies on an unpaved road about 8 m in width, 500 m north of the highway between Lusaka and Malawi. Since there are no obstacles to transportation along the road, large trucks can easily reach this site. The site and its surroundings have an unobstructed view and the grain bags piled on the open hard-standings can be seen from the highway.

The NAMB's request involved the construction of a storagehouse in the existing depot. The site, which is a pentagon, is flat. It is possible to construct the storagehouse after carrying out simple land leveling only. Since existing buildings and an open hard-standing are scattered in this depot, however, the possible location of the storagehouse to be constructed is fairly limited.

All the land is owned by the NAMB. Existing facilities include the followings in addition to an office about 55 m^2 in area.

Existing storage facilities

One brick storagehouse:	5,000 bags
One prefabricated storage yard with roof for equipment:	
One open hard-standing:	10,000 bags (900 tons)

In addition to the above, there is a vacant lot for wooden racks.

(4) Serenje in Central Province

The site lies on the northern side of a gently sloped hill which is about 6 km north of Tanzan Highway. There are two roads connecting the highway and the site. Both of them end at this site. Neither of these two roads is paved. One of them which crosses a

river, is not available in the rainy season. The other one which passes through a village, has a narrow path midway. Large trucks cannot use this road, since there is a narrow bridge about 3m in width.

The proposed site is adjacent to the existing depot. Since the proposed area is allocated in the rear of the existing facilities, the truck route for carrying grains in and out will have to be built through the existing depot. The site which slopes from the south to the north, has a level difference of about 4m. Therefore, the site has poor conditions in view of flow planning for trucks, such as the road planning within yard, etc. and of the plan involving the cargo handling work in the storagehouse.

Since the railway which passes near the site, is on the mountain-side and far above the site. It is impossible to construct a sidetrack into the site because of the large level difference.

All the land including the existing depot is owned by the NAMB.

Existing facilities include the followings in addition to an office about 75 m^2 in area.

Storage facilities at existing depot

One brick storagehouse for fertilizers, seeds and agricultural chemicals:	37,000 bags
One prefabricated storagehouse for fertilizers and equipment:	5,000 bags
One open hard-standing	40,000 bags (3,600 tons)

In addition to the above, there is a vacant lot for wooden racks.

3.2.4 Infrastructure in proposed sites

1. Electric power

The main source of power generation in Zambia is hydroelectric power generation using readily available water. As a result, Zambia has excess electric power for export. Although the main power lines which connect cities are well provided, the power distribution facilities at the ends of these lines are not sufficient. No electric power is supplied to most of the rural areas. No utility power is available at the proposed sites in this project except for Chambishi and Serenje.

Reportedly, work is not done during the night at the depots except for Chambishi. Therefore, the storagehouse interior need not be illuminated. It is enough to secure only the electric power for the construction work.

i) Chambishi

Utility power is supplied to the existing depot. In addition to indoor illumination, the cargo handling conveyors are driven by electric power. Utility power could also readily be made available at the construction site which is adjacent to the existing depot, by installing power receiving equipment.

ii) Masansa and Mtirizi

Neither of these proposed sites has a utility power supplying facility nearby. No electric power is available.

iii) Serenje

Electric power is supplied to a village which is located near this proposed site. Electric power is available by extending this power line.

2. Water supply

In Zambia, city waterworks are complete in urban areas where sanitary water is stably supplied. However, the people in most of the rural areas rely on public wells. No city water is available at the proposed sites except for Serenje.

i) Chambishi

At the existing depot, a motor-driven pump is used to pump up water from the well into an elevated water tank. This water is available for construction.

ii) Masansa and Mtirizi

Neither of these proposed sites has city waterworks. Since there is a well nearby from which water is manually drawn, ground water seems to be available at a comparatively shallow depth and is reportedly abundant even in the dry season. Therefore, water for construction could easily be obtained by sinking a well.

iii) Serenje

City waterworks reach a nearby village. These can be extended.

3. Drainage

No public drainage is available at any of the proposed sites. Therefore, water will be drained by seepage into the ground through seepage pits in the site.

3.2.5 Selection of project sites and capacity of storagehouses

As a result of the study of the current conditions of grain storage and of construction conditions at the sites obtained through the field survey, and of the other information and materials collected, the following food grain storagehouses have been planned to be constructed.