No. 3

# BASIC DESIGN STUDY REPORT
# ON
# THE PROJECT FOR
# THE MULTI-PURPOSE AGRICULTURAL WAREHOUSE CONSTRUCTION
# IN
# THE REPUBLIC OF MALAWI

AUGUST 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Malawi, the Government of Japan has decided to conduct a Basic Design Study on the Project for the Multipurpose Agricultural Warehouse Construction and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Malawi a study team headed by Mr. Seigoh Ishida, Deputy Director of Inspection Department, Food Agency, Ministry of Agriculture, Forestry and Fisheries, from February 28 to April 2, 1988.

The team had discussions on the Project with the officials concerned of the Government of Malawi and conducted a field survey in the Project area. After the team returned to Japan, further studies were made, a draft report was prepared, and for the explanation and discussion of it, a mission was sent to Malawi. As a result, the present report has been prepared.

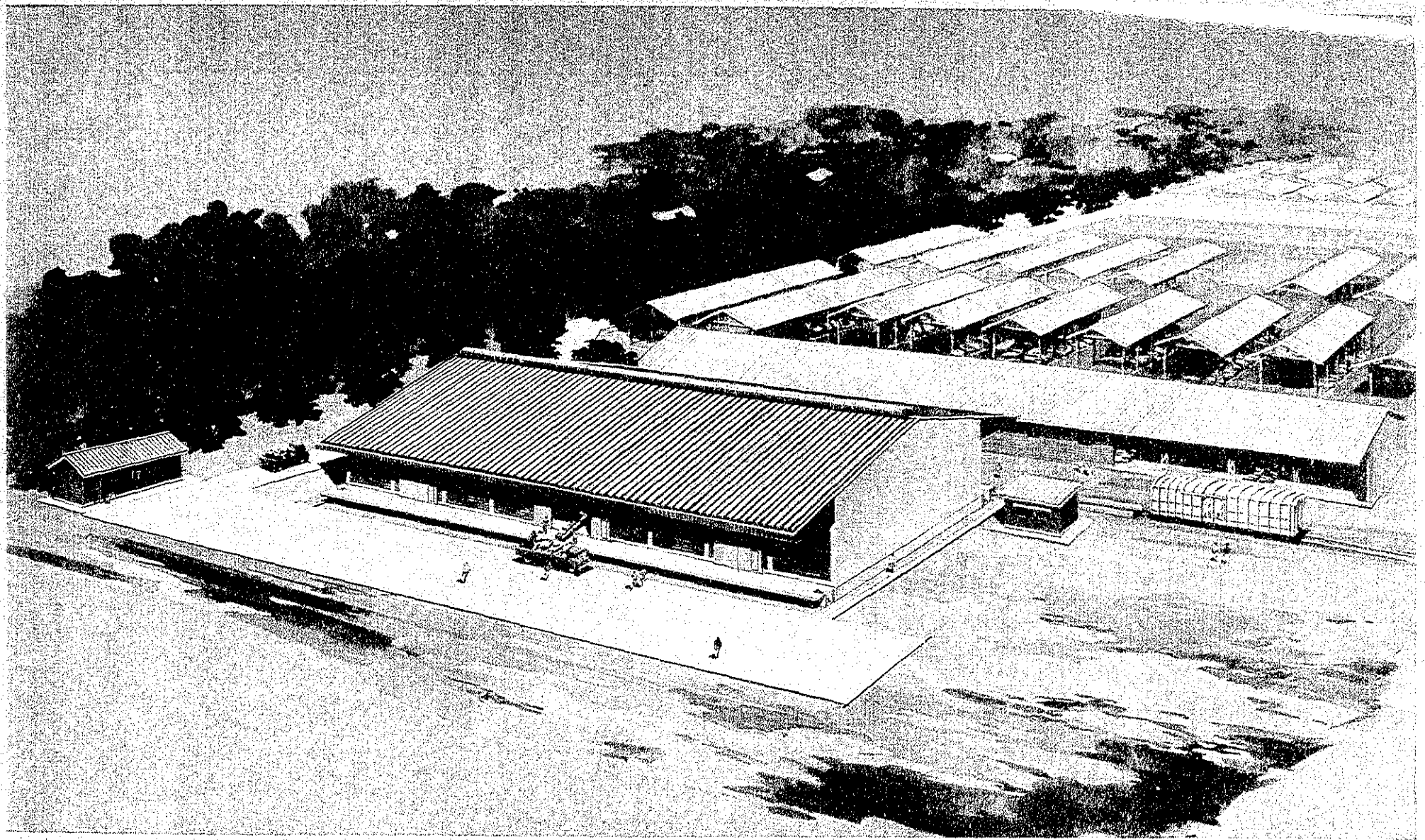
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between the two countries.

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

August, 1988

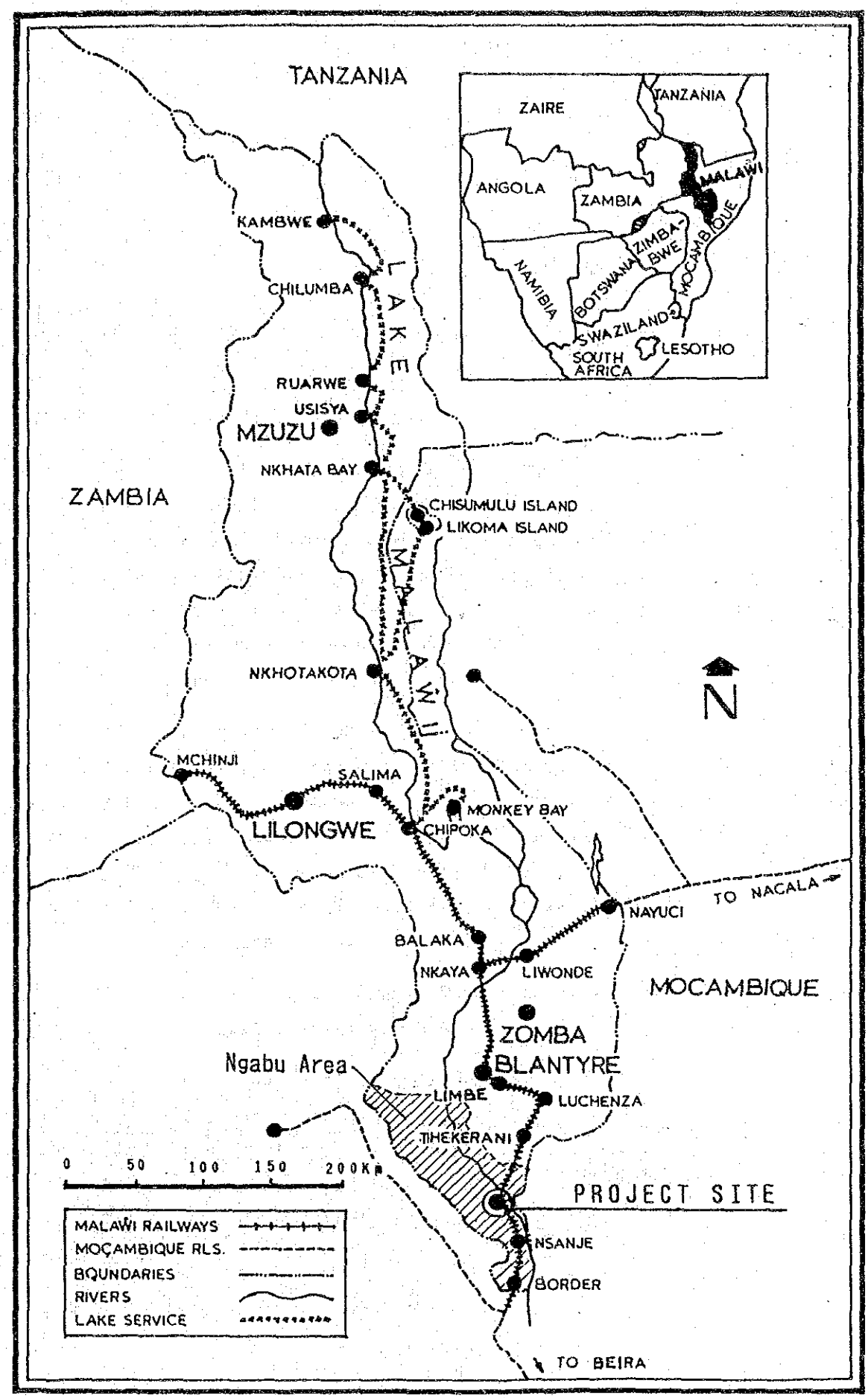
Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency



AGRICULTURAL WAREHOUSE AT BANGULA

# MAP OF MALAWI



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Summary

The Republic of Malawi has promoted the nation building centering on expansion of the agricultural sector since its independence in 1964. This is because Malawi is not blessed with mineral resources and the means of obtaining foreign currency is limited only to the agricultural products such as tobacco, tea and sugar, and there was the necessity of securing the self-supply of food.

The Government has put the importance of development on small holder farming, which is the mainstay of the country's economy, and applied the development plan with its main framework on enhancement of the productivity and reinforcement of the distribution system. Within the scope of the development, ADMARC (Agricultural Development and Marketing Corporation) under the supervision of the Ministry of Agriculture takes part of purchasing, selling and exporting the agricultural products produced by small holder farmers and supplying seeds, fertilizers and other materials, thus playing the core role of the nation's agricultural policies. While the ADMARC's purchase volume is increasing year by year, the shortage of storage facilities was raised as a big problem of which an early solution is urgently required.

ADMARC has 38 Depots (large-capacity storing facilities) to store and to circulate agricultural products, but their role is not altogether the same. Bangula Depot, the subject of this project, is located in the southern part of Malawi on the downstream side of Shire River running from Lake Malawi. The area plays an important part in transportation with the country's main road and railway running right through to Mozambique. Ngabu Agricultural District (covering the whole lower reaches of Shire River), one of the main cotton growing areas, sends its products to Bangula Depot. It also has guar beans (raw material for industrial oil and feedstuffs), produced only in this area. Few edible crops are produced owing to climatic conditions. In fact, only 40% of the necessary quantity of food is self-supplied within the area, causing severe shortages.

Bangula Depot has a cotton ginnery and a guar beans processing plant. Most of the cotton produced in this country and all of the guar beans are collected here. This depot not only handles these products but also functions as a circulation center of maize sent from the northern and central granary district of this country for aid in the period of food shortage. Under the judgment that the storage facilities in that depot are insufficient in terms of both quality and quantity, an expansion plan was established under which the Malawi Government issued a project proposal to the Japanese Government to implement by the grant aid system. The proposal contained the construction of a warehouse of 10,000 tons for maize as the first phase, those existing facilities which are not functioning properly due to their structure or deterioration to be sequentially rebuilt making an ultimate capacity 30,000 tons in total. The proposal also included annex buildings for a control office, a fumigation material storage room, etc., and providing the equipment and material necessary for goods handling and storage.

Upon receipt of this proposal the Japanese Government decided to conduct a basic design study under which the Japan International Cooperation Agency sent a study team to Malawi in February 1988, made a survey on the present status of storage and distribution facilities of agricultural products in the project area and held discussions and consultations with the authorities concerned on appropriateness of the proposal contents and matters to be granted. As a result, it was made known that the significance and importance of the distribution center for the food shortage areas are obvious and that implementation of the project under the grant aid is quite appropriate.

However, upon planning the scale of the project, consideration should be given to the climate in Bangula which is hot and humid, unfavorable for the storage of agricultural products. Therefore this depot should be regarded as a circulation store or consuming goods' store and not as a reservoir store for large amounts of collected products. Thus the depot is to be considered as helping to reduce the storing quantity and period of the products. Using the ADMARC data, the proper storage amount for this depot as a maize warehouse was calculated to be 3,700 tons.

Other products besides maize for Bangula Depot are mainly seed cotton (as picked), lint (raw cotton, or cotton fiber) which is gathered from seed cotton by machines, cottonseed (seed of cotton), guar beans, fertilizers and agricultural chemicals. Cotton is usually stored outside during the dry season. So the space for cotton storage is to be planned by considering of the amount during the rainy season. After studying the data, it was found out that the amount of the seed cotton can be reduced to zero during the rainy season by planning properly the process of the cotton ginnery and shipping of processed cotton to the next-stage factory. The present space turned out to be enough for lint and cottonseed. As for guar beans, the market is quite limited and stored beans are increasing. To cope with this, measures should be taken to reduce production or the amount of inventory. As the warehouse for the guar beans plant has a capacity to store the product for two years or more, the project excluded guar beans as a storing item of the new warehouse. Fertilizers and agricultural chemicals are small in amount and can be stored within the present warehouse.

The total study indicates that the additional space for 3,700 tons of maize is needed. The present facilities need no change as long as the present condition continues. The project for the new facilities and equipment include a warehouse of 1,475 $m^2$ and two attached buildings of 105 $m^2$ in total, a rail weighbridge, conveyors and stackers. Sidetracks from trunk railroad and driveways within the site should be included in the project.

The implementation of this project will require about five months from deciding the contractor after detailed design and the conclusion of the Exchange of Notes, and about 11 months for the construction — a total of about 16 months.

The project involves building an agricultural warehouse in order to establish a stable supply system in the above area where food is constantly short and is expected to improve the methods of goods handling and operation.

It was observed during the site survey that a large amount of cotton-seeds was open-air stored in the Bangula Depot premises. The seeds were degrated and had lost their commercial value. The next destination of the products after the ginning process is the spinning factory and the oil factory, both located in Blantyre. Blantyre being more suitable in climate for storage of agricultural products, the products should be transported to Blantyre as soon as possible after processing. It is considered desirable from the national economy viewpoint that the ginnery be transferred to Blantyre in the future.

# CHAPTER 1: Introduction

Because Malawi is not blessed with national resources, it has directed its economic development efforts to the expansion of its agricultural sector since its independence in 1964. The one potential foreign currency source is the agricultural produce, such as tobacco, tea and sugar; achieving food self-sufficiency is necessary for the increasing population. The Malawi Government is promoting the local development projects purposed for productivity enhancement as well as strengthening the sales and export structures, putting importance of the development on the small holder farmers, the mainstay of the national economy. These efforts have resulted in nearly achieving the self-sufficiency of the staple food.

In this regard, ADMARC (Agricultural Development and Marketing Corporation) takes part of the purchase and sale of the products by small holder farmers and supply of seeds and fertilizers, playing the core role of the Government's agricultural policies. As the ADMARC purchase of agricultural products increases year by year, the shortage of storage facilities raised a problem of which solution should be implemented first.

Under such circumstances, the Malawi Government proposed a plan to the Japanese Government to construct a warehouse under the Japanese Grant Aid System at ADMARC Bangula Depot in the southern part of the country.

At the request of the Government of Malawi, the Japanese Government dispatched to Malawi a basic design study team headed by Mr. Seigoh Ishida, assistant director of the Inspection Division, the Food Agency, the Ministry of Agriculture, Forestry and Fisheries, from February 28th to April 2nd, 1988.

The basic design study team consulted with its Malawian counterparts on confirmation of the contents of the proposal, carried out a survey on the background of the project, the construction conditions and the

project site. The team also confirmed the project execution structures, the scope of responsibility of both governments when this project is put into implementation, after explaining to the Malawi side the system and procedure of Japanese grant aid.

Based on the results of the survey, Japan International Cooperation Agency discussed in Japan the scope and scale of the project, construction period, project cost and appropriateness, of which results were compiled into the draft final report, and sent a draft report explanation team headed by Mr. Seigoh Ishida to Malawi from July 10th to July 23rd, 1988. The team submitted the draft final report to the Malawi Government, reached the principal agreement with the Malawi side and compiled the results in this report.

# CHAPTER 2: Background of the Project

## 2-1 Outline of the Republic of Malawi

### 2-1-1 General

The Republic of Malawi is an inland country located south of the great East African trough, its east-west span spreading from the east longitude of 32°40' to 35°55', the north-south span spreading from the south latitude of 9°22' to 17°8'. The total area is 118,000 $km^2$, with about one-fifth being Lake Malawi. The southern half of Malawi is surrounded by Mozambique, and it borders Tanzania to the north and Zambia to the west.

The topography of Malawi is divided into the lowland areas, a central plain, plateaus and isolated mountain districts. The Shire River starts flowing from the south tip of Lake Malawi and the area along the river 300 km down to the Mozambique border forms the lowland area.

The weather is of the tropical savanna type and varies considerably because the country is long in north and southwardly and has much undulation. In general the lowland areas have less rain and higher temperatures, while the highland areas have more rain and lower temperatures. The season is divided into the dry season from April to October and the rainy season with more than 90% of the annual rainfall concentrated from November to March. Annual rainfall in the northern half part is 1,500 - 2,000 mm around the coast of Lake Malawi, decreasing to less than 900 mm going inland. In the southern half part it is 800 - 900 mm in the lowland areas, 900 - 1,300 mm in the plateaus and more than 2,000 mm in the mountain districts. The warmest period is October to November, the coolest period June to July, with an annual temperature differ-ence at 7 - 8°C. The annual mean temperature is 24 - 26°C in the low areas, 19 - 22°C in the plateaus and 13 - 17°C in the mountain districts.

Malawi has a relatively high population density for its small land area. Mineral resources are not plentiful and what can be called the natural resources for Malawi are the weather, land suitable for cultivation and water resources represented by Lake Malawi. Therefore, the economic growth after independence has been centered around the projects and measures aimed at the expansion of the agricultural sector.

The agricultural sector accounts for 38% (1984) of the gross national product (GNP); more than 90% of the population, works. About 80% of exports is occupied by agricultural products such as tobacco, tea and sugar. The per capita GNP is $210 (1983).

Malawi has a republic system of government (by the 1969 Constitution); the president is sovereign for life. The organization of the central government consists of the Presidential Office and 14 ministries; the agricultural sector is controlled by the Ministry of Agriculture.

The local administration is divided into 24 districts, each having a district governor.

### 2-1-2 Second National Development Policies

Among the Statement of Development Policies of Malawi for 1987 - 1996, the items that relate to this project are as follows:

(1) The security in food supply is brought about by the self-supply and self-sufficiency of the staple food of maize, and it steers the people's livelihood to a stable one. This security is achieved by the establishment of a proper maize purchase price and the food reserve. The early forecast system for production advocated by the Ministry of Agriculture attempts to make possible the calculation of maize reserve required and to effectively carry out the trade with SADCC countries.

(2) The agricultural production policy is to be emphasized on the increased production of maize, for which comprehensive improvement is envisioned in terms of research, propagation, finance for agricultural materials, distribution and processing.

(3) As one means of production increase, the producer's guaranteed price system for small holder farmers should continue. Under the current situation in which the food is not sufficient by the nation's self-supply, the producer's price is balanced with the import price, whereas the maize price will be established taking account of the domestic supply and demand situation and the reserve volume. This will mean that it is possible that the import and export price for maize may differ from the domestic price. The food reserve provides for a short crop year and stabilizes the market price.

(4) In the distribution area, the private sector vigor will be introduced with the purpose of coexisting with ADMARC. In order to realize the above for the small farmers' product other than cotton and tobacco, some of the ADMARC markets will be closed, so that private merchants may become able to purchase the products at higher prices. Thus, the ADMARC activities will be transferred to the private sector in some areas, and results will be monitored to confirm if there were any diversions from the intentions envisaged in the policies. The transactions of products by the estate plantations will continue to be vested to the commercial markets. However, for new products whose production costs are too high or which have insufficient export competitiveness, governmental assistance will be applied.

(5) The agricultural warehouses that store and control the products and fertilizers must have expanded storage capacity, especially in those areas where the food is insufficient. This plan is being put into action.

(6) Cotton has become a small farmers' product since 1983 in spite of its estate cultivation not being prohibited. Its annual production shows large variations, at 13,000 tons to 35,000 tons, depending on the purchase price. Since the potential productivity is fairly large, its production increase is possible by means of introducing machines to the salt-clay land areas. Furthermore, the research on the pest problems and on improvements of plant breeding and grinding must be strengthened.

(7) For the wider propagation of good maize, cotton and other seeds, the seed production is to be carried out by means of consignment cultivation to the National Seed Company of Malawi and general small farmers.

(8) In order to highten the technical level and efficiency of processing cotton, rice and livestock feed, a survey is to be commenced immediately. Flour milling methods and storage methods are to be studied to develop maize of high yield. Furthermore, the processing capacity of, for example, guar beans must be enhanced to meet future requirements.

(9) To solve transportation problems, the land transporation route to the Indian Ocean coast via Tanzania, the north corridor, is to be developed under a five-year plan.

Item (5) reflects urgency of this project.

2-1-3 Agricultural Situation

The Malawi Government has put the National Rural Development Programme (NRDP) under way since 1976 for the purpose of increasing the production of foodstuffs and agricultural products for export through land productivity enhancement and for increasing the farmers' income in the small farming sector as well as for solving the problems in the domestic food situation and the international trade balance. As the organization to

execute this program, the Agricultural Development Divisions (ADD) were established in 8 locations as a substructure of the Ministry of Agriculture to work on development guidance, operation accounting, infrastructure improvement and project evaluation.

An area of 7.15 million ha., corresponding to 76% of the Malawi's land area, can be utilized as agricultural land, of which 2.25 milliion ha. still remains unused. The cultivated area by region is 11% in the north, 51% in the central area and 38% in the south, indicating that the central and the southern regions are the center of agricultural industry.

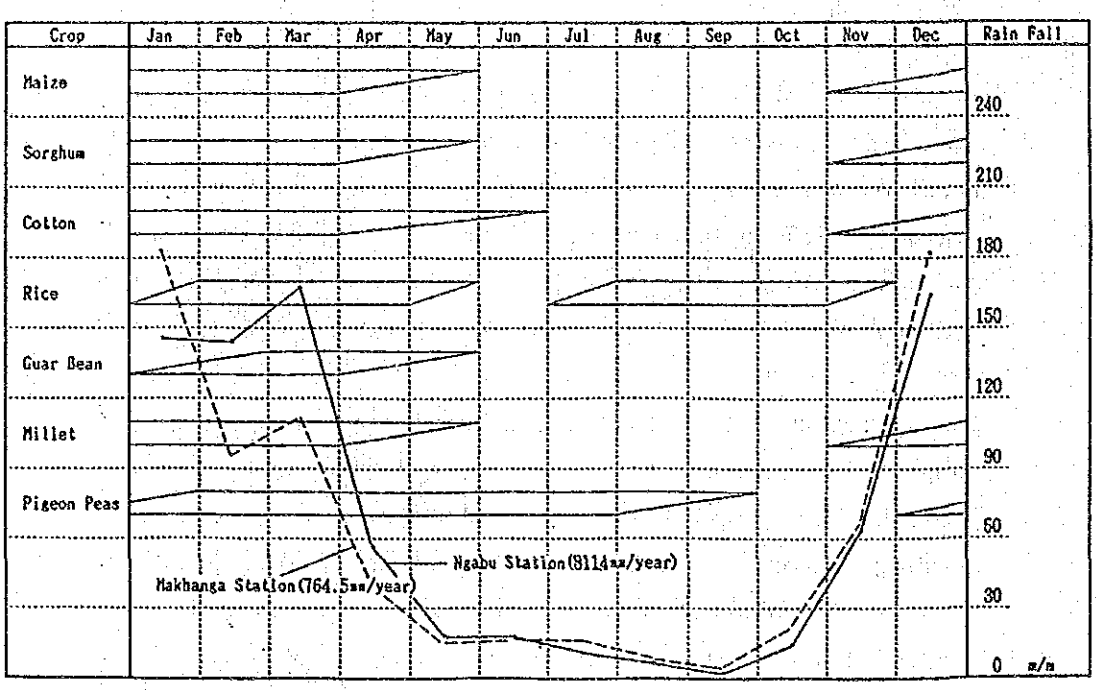
The agriculture in Malawi consists of the small farming sector composed of numerous small farmers and the estate sector composed of commercial large scale plantations. In the small farming sector, the main cultivations are cotton and tobacco, as well as foodstuff products as maize, rice, bean, cassaba, potato, peanut and sorghum, with the majority under small-scale business of below 1 ha. The estate sector produces such exporting agricultural products as tobacco, sugar, tea, coffee and macademian nuts. However, when there are viewed from the size of cultivation area, the small farming sector occupies 2.86 million ha. and the estate sector 490 thousand ha., indicating how high the ratio of small farming is. In the small farming sector, which is the object of ADMARC activities, 73% of total its crop area is maize, by well explaining the importance of maize as the staple food in Malawi. Next is peanut at 10%, followed by minor cereals, cassaba, potato and rice.

The Ngabu area under this project is the down-stream area of Shire River where temperature is very high and rainfall, sparse, thus unsuitable for maize cultivation, but it produces the minor cereals such as sorghum and millet, and about 50% of the total cotton national production.

A special product produced only in Nsanje District in the whole country is guar bean. The cropping pattern and rainfall in this area are shown in the figure below.

Cropping Pattern and Rain Fall

District: Chikwawa · Nsanje
Region : South




Source : ADMARC Ngabu Divisional Office
Climatological Tables for Malawi

2-1-4 Food Supply Condition

Malawi is basically in near equilibrium in food supply. The production of esculent cereals (maize, rice, sorghum and millet) in 1987/1988 fiscal year, a normal crop year, 1,424,326 tons (Appendix VII-1), which is 178 kg/year per capita as raw cereal (or 142 kg. as edible portion when yield is taken at 80%). According to WFP criteria, the per capita average requirement of cereals is 400 g. per day, or 146 kg. per year, which is approximately equivalent to the above figures. In other words, food self-supply is nearly achieved for the nation as a whole. However, there is a territorial variation, with the central and the northern regions having surpluses while the Lake Malawi coastal area and the southern region have shortages.

In the Ngabu area, the subject of this project, the cereal production in 1987/1988 fiscal year was 40,279 tons, which turns out per capita crop of 77 kg. (60 kg. edible) for the population of 521,092, signifying the self-supply of only a little above 40% of the human requirement, an extremely food shortage area. In addition, Nsanje District, surrounded by Mozambique, has as many as 190,000 refugees almost the same number as its 200,000 population, making the situation very serious.

2-1-5 Distribution of Agricultural Products

The Distribution of Agricultural products in Malawi differs according to the producing condition. Products of small holder farmers are sold to ADMARC in principle. ADMARC used to deal with all those goods. After the recommendation of the World Bank, some private merchants were allowed to join this market. Products of estate farmers are distributed by private merchants. The main maize processing company is Grain and Milling Company (GRAMIL). Tobacco is sold by auction at the tobacco market in Limbe and Lilongwe. Tea and cofee are produced, distributed and exported by trading companies. Sugar is also controlled in the same way by Sugar Corporation of Malawi Ltd. (SUCOMA).

Transportation means in Malawi are mainly trains and lorries. According to the information of Malawi Railroad Company, the total length of the operating line is about 800 km. Freighter cars in possession are about 1,000, but most of the cars are halted in Mozambique owing to the disturbances in Mozambique. Only about 300 of them are running in the country which supply the necessary capacity of transportation for the present amount of products. Lorries numbered about 12,600 at the end of 1987. A lot of money has been invested in road construction prior to other things since independence, so at least the main roads are in a pretty good condition.

The most serious problem in transportation is that the usual Mozambique route running from this inland country to Port Beira

and Nacala leading to the Indian Ocean is not in the condition to be used at all. Port Durban in South Africa is used instead, but this extra transportation causes a drastic hike in costs. The reopening of the Mozambique route cannot be expected for the time being. Another route to Dar es Salaam in Tanzania by road and boat using Lake Malawi is being improved.

## 2-2 Contents of ADMARC Business

### 2-2-1 Business Purpose and Major Businesses

ADMARC is an organization established to contribute to the economic growth of Malawi through the development of agriculture by small holder farmers. Reorganized from the Farmers' Marketing Board, it is a public corporation established in 1971 for the purpose of achieving income enhancement for the small farmers through the productivity improvement as well as to rationalize the distribution of agricultural products produced by the small farmers. The organization is under the supervision of the Ministry of Agriculture. While it is operated under the government policies, it takes an autonomous accounting system. The products it mainly handles are maize, tobacco, raw cotton, cassaba and rice. It also distributes to the farmers agricultural additives such as fertilizers, agricultural chemicals and seeds. In addition, it participates through affiliated companies in the agricultural product processing (flour milling, canning, cotton ginning, oil pressing and rice refining).

### 2-2-2 Organization and Personnel

The management of ADMARC is vested to the chairman appointed by the Minister of Agriculture and the board of directors consisting of eight members. In accordance with the basic policy decided in conformity with the government policy at the board meeting, the general manager takes responsibility for management. There is one assistant general manager each to take care of purchase and sales operations, under whom nine responsible staff members

are assigned for development, cultivation control, transporation and storage, general affairs, finance, accounting, business administration, personnel and training.

The outline of the ADMARC local organization is shown below. The headquarters are located in Limbe, under which three regional offices are arranged to govern the northern, central and southern regions and eleven divisional offices over the whole Malawi.

For outdoor operation, there are large storage facilities (Depots), in 38 locations all over the country and facilities for collecting and temporarily storing agricultural products and for selling agricultural materials, (Markets), at more than 1,200 locations. There are two kinds of market by organization type: the parent (or area) markets and the unit (or scheme) markets in 5 to 15 locations surrounding the former. The unit markets are divided into two categories of permanent and temporary facility opened only at the product collection period after harvest.

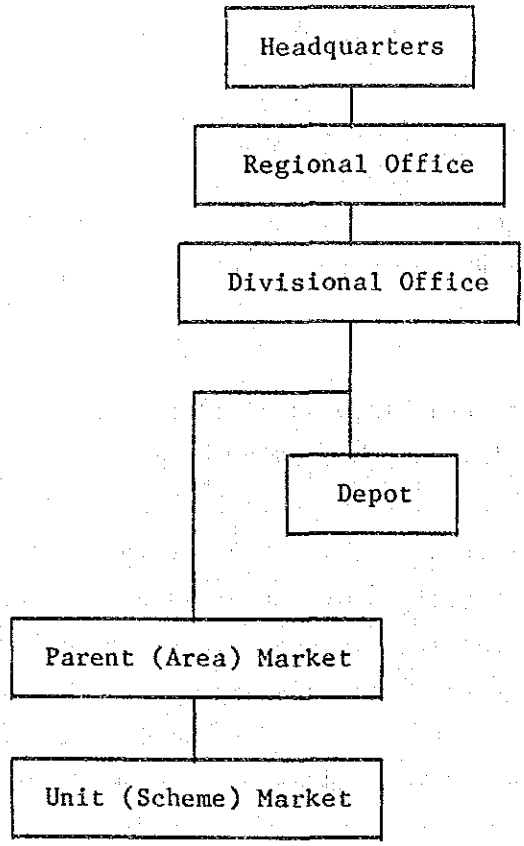
Appendix Table VII-2 shows the markets under the control of the Ngabu Divisional Office which falls under this project. Parent markets are located in six locations and unit markets in 63 locations, of which 38 markets are permanent facilities.

ADMARC has 22,277 employees in total as of September 1987, as the largest business entity in Malawi.

The personnel arrangement at Bangula Depot in the project area is as shown in Appendix Table VII-3, consisting of 65 full-time personnel, 20 temporary staff and about 500 temporary workers.

The Makhanga Parent Market, for example, has 17 full time personnel, and in the unit market 6 full time personnel and 6-8 temporary workers.

ADMARC Local Organization




Limbe

North (Mzuzu), Central (Lilongwe), South (Limbe)

11 locations over the country

Large-size storage facilities in 38 locations over the country

Total number of parent markets and unit markets in the whole country is about 1,200.

Permanent and temporary facilities.

2-2-3 Activities

The main activity of ADMARC is to purchase from the farmers the products at the guaranteed price and to sell them.

The total annual purchase by ADMARC in the past five years, as shown in Appendix Table VII-4, amounts to 242,988 (1986) - 376,253 (1984) tons and in terms of monetary amount 41,698 (1982) - 90,048 (1986) thousand MK. For maize as the main handling product, it has increased several fold in quantity in recent years compared to the late 1970's. In the past several years the maize purchase has reached 10-20% of production. The maize purchased by ADMARC is sold at the specified price (27MK/90 kg. as of March 21, 1988) in urban areas and food shortage areas.

ADMARC also handles 70-80% of cotton production and other items of small quantity production like sun flower and cassaba.

In addition ADMARC sells to the small farmers agricultural materials (fertilizers, agricultural chemicals, seeds and agricultural appliances). For fertilizers, ADMARC undertakes the business as the sales agent of the Smallholder Fertilizer Revolving Fund established in 1983 by the funds from the Malawi Government, IDA and IFAD, for which ADMARC handled 23,978 tons in 1987/1988. For seeds, cottonseeds are produced by ADMARC, whereas other seeds including maize are purchased for sale from Malawi National Seed Company.

Although ADMARC adopts the autonomous accounting system, it is largely affected by the pricing policies taken by the government from time to time, which is inevitable because the organization is an executing body of the government's agricultural and food supply policies. However, ADMARC has attained a profit of 4.3 million MK in 1984 and is continuing sound management.

In the Ngabu area, ADMARC has handled annual average of about 30,000 tons in the purchase and sales amount combined, as shown below.

ADMARC's Record in Ngabu Area

(Unit: metric ton)

| Year | Purchase of products | Sales of maize and agricultural materials | | | | |
|---|---|---|---|---|---|---|
| | | Maize | Seeds | Fertilizer | Chemicals | Total |
| 1982/83 | 8,284 | 6,670 | 14 | 899 | - | 7,583 |
| 1983/84 | 8,579 | 35,719 | 24 | 338 | - | 36,081 |
| 1984/85 | 19,561 | 6,614 | 114 | 208 | - | 6,936 |
| 1985/86 | 16,422 | 17,178 | 38 | 130 | - | 17,346 |
| 1986/87 | 14,529 | 24,386 | 110 | 218 | - | 24,714 |
| 1987/88 | 13,838 | 8,726 | 95 | 191 | - | 9,012 |

Note:
- Cottonseeds are not included in the seed sales because ADMARC distributes the seeds free of charge to the registered farmers.
- ADMARC's sale of chemicals being small in quantity is excluded from the table.

## 2-2-4 Present Status of Storage Facilities

### (1) Depot Warehouse

The total storage capacity of ADMARC Depots in 38 locations in terms of maize is about 470,000 tons as shown in Appendix Table VII-5. Against this capacity, the ADMARC's annual purchase is 240,000 - 380,000 tons which includes such bulky product as cotton, thereby making the storage volume about twice the figure when converted to maize. Whether the warehousing capacity is sufficient can not be determined simply by comparing the figures because it depends on the storage rotation (annual handling volume divided by the storage capacity) and how many steps of warehousing the products go through. As far as judged from the present status, there appears no problem in the storage capacity for the country as a whole, although there are overs and shorts by districts.

There is no standard specification for the depot warehouse construction. Storage capacity of one building is generally 5,000 - 10,000 tons (in terms of maize). Those built in the recent years call for a trend of larger buildings.

The warehouses are divided in two types, one which allows lorries enter the building (low floor design) and another which does not (high floor design). Columns are of reinforced concrete, but steel pillars are used in some cases. Walls are mostly made of bricks.

Roofs are of the gable type with steel sheets, many using top light covering 3-5% of the roof area (using light permeating material as roofing). Ventilation is mainly by natural ventilation through the openings on the upper part of the wall (at a height of 1-1.5m) provided with a bird-proof net. Monitor roofs or roofs with a ventilating fan on the ridge are also used.

Ancillary facilities for a depot warehouse include an office, a material storage room, a chemicals storage room, a workers room (with toilet and shower) and a canteen (with kitchen).

Equipment used includes a weighbridge for freight cars or lorries, platform scales, stackers, two-wheel carts, forklifts and fumigation equipment.

ADMARC depot warehouses perform functions of not only storage inherent to a warehouse, but also desk work, sale of maize to consumers, repair and sorting of empty bags.

(2) Market Warehouse

Market warehouses are generally small in size for product collection and temporary storage.

There are two standard types in ADMARC warehouse. One is MK-V type with a floor area of 208 $m^2$ and a stacking effective height of 3.0 m and another is MK-VIIIA type with a floor area of 570 $m^2$ and an effective height of 3.9 m. The lower half of the wall is constructed of bricks and the upper half and roof of galvanized steel sheets. The ancillary facilities include an office and a storage room, and are equipped with platform scales, hanging scales and sack barrows.

2-2-5 Actual Storage Condition of Agricultural Products

The agricultural products that ADMARC handles and stores are maize, peanut, cotton, rice, fertilizer, etc.

(1) Storability of Maize

Since maize is of single annual crop, it must be stored for one year at the maximum. Small farmers store their own supplies in a thatched hut of semi-high floor and cylindrical shape (2-3 m both in diameter and height) called "Nkhokwe" made of junk wood, twigs and clay, in which maize

is stored in the state of cob (kernel unremoved but pod peeled). The maize collected by ADMARC is removed from the kernels and placed in a jute bag (90 kg.). Malawi maize has three kinds, namely the conventional, composit and hybrid types. The first two are of flint species, which are hard but strong against disease and vermin attack during cultivation and storage. The hybrid allows high yield when fertilizer is used, but is soft and difficult to store, and its flavor is not welcomed by farmers, hence mostly sold to ADMARC. Therefore, the ADMARC storage facilities are required to be of higher grade than those used by farmers.

Peanuts without shell are packed in linen bags and stacked like maize in the warehouse. Sometimes they produce poisonous Afratoxin during the storage but any problem of this kind has not been reported yet in Malawi.

Cotton (seed cotton) are packed 70 kg each in linen bags at collecting points to be sent to the cotton ginnery. Cotton harvest, collection and ginning are proceeded during the dry season so that seed cotton is kept outside like in other countries. Lint (cotton fiber) after being ginned is stored in the warehouse attached to the factory. Cotton seeds are kept outside or in an open shed (hut without walls) after being packed in bags made of synthetic fiber. Since seed cotton contains a lot of oil, their quality is likely to change and they are not suitable for long-term storage.

Guar beans and split (processed guar beans) are stored in the warehouse. Meal (bran) is stored in the open shed or outside.

(2) Stacking and Floor Laying Materials

The stacking method (Note 1) is divided into flat stacking (Note 2) and 3-bag stacking (Note 3): flat stacking is employed in most cases whereas 3-bag stacking is used in

parts of large-size depots. Flat stacking makes inaccurate the number of bags as well as counting, but the entire stack becomes strong and difficult to break. Three-bag stacking makes the number of bags accurately stacked, but requires certain skill in stacking. The number of stack layers is restricted by the height of eaves of the building and the effective height of stacker and is limited to 25 stacks (about 5.2 m high) in 90 kg. maize bags (imported maize generally in 70 kg. bags) based on the available stacking technique.

While the 45 kg. cotton seed bag, 50 kg. guar bean bag and 50 kg. fertilizer bag are smaller than the maize bag, the stacking method is identical. Seed cotton is filled at 70 kg. in a jute bag of 50 x 50 x 100 cm, but its shape becomes irregular and stackable up to four stacks at the maximum (about 2.5 m high).

A lint bale weighs about 180 kg., being stackable to 2-3 stacks by manual stacking but up to eight stacks is possible if a forklift is used.

With respect to floor laying material, no pallet is used excepting a special case (10 kg. maize seed bags). Dunnage (Note 4) such as of eucalyptus trees (blue gum) or gmelina arborea are used. One deficiency is the difficulty of laying the first stack because of unevenness in length (4-8 m) and diameter (10-20 cm), but if laid in parallel crosses (done mainly outdoors), the ventilation effect is acceptable. While no ant-proof treatment is usually given, no noticeable damage appears to occur.

The following table shows the result of actual measurement by the study team on the standard stackings of the major products handled by ADMARC and calculation of the storage capacity (tons) per sq.m of floor area.

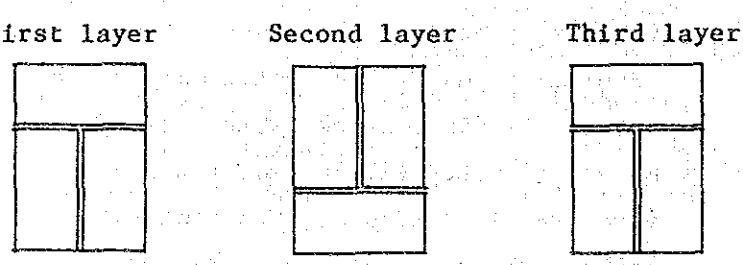
Storage capacity per sq.m by items to be stored

| Product name | kg/bag (bale) | No.of bag x layer | Stack size (m) | | | Floor occupation(%) | Storage capacity (ton/m2) |
|---|---|---|---|---|---|---|---|
| | | | Long side | Short side | Height | | |
| Maize (local) | 90 | 165x23 | 12.1 | 7.9 | 4.8 | 72.5 | 2.6 |
| Maize (import) | 70 | 324x24 | 12.9 | 12.3 | 4.8 | 72.5 | 3.2 |
| Cotton | 70 | 8 x 4 | 2.8 | 2.6 | 1.7 | 65.0 | 0.2 |
| Lint bale | 180 | 35 x 4 | 6.2 | 6.0 | 3.4 | 65.0 | 0.5 |
| Cottonseed | 45 | 150x29 | 8.0 | 7.4 | 4.8 | 72.5 | 2.4 |
| Guar bean (material) | 90 | 50x24 | 5.8 | 5.2 | 4.6 | 72.5 | 2.6 |
| Guar bean (split) | 50 | 120x23 | 6.8 | 6.5 | 4.8 | 75.0 | 2.3 |
| Guar bean (meal) | 50 | 72x25 | 5.4 | 4.8 | 4.6 | 75.0 | 2.6 |
| Fertilizer | 50 | 54x30 | 4.5 | 4.3 | 4.2 | 75.0 | 3.2 |

Note 1: Stacking is the way of piling up bagged cereals to store in accordance with a certain arrangement.

Note 2: Flat stacking is such a way as the lowermost bags are laid in alignment with a certain direction upon which bags are stacked in the right angle to the former.

Note 3: 3-bag stacking is as shown below.




Note 4: Square or round logs laid on the floor for moisture prevention and ventilation.

(3) Handling

The transportation means is by lorry and railway freight car and the major depots mostly have railroad sidetracks.

Long-distance transfer inside the depot is by tractor trailer, and short distance shifting inside the warehouse and the freight car is generally by sack barrow. Stackers are widely used in stacking. The main specifications for a stacker: an overall length of 7-10 m, motor driven, provided with a slant angle adjuster (manual, hydraulic or power driven), mostly made in South Africa or England. Cotton bales (180 kg) and jute bales (about 350 kg) are usually handled by small fork-lifts.

(4) Pest Control

Insects and vermin subjected to pest control are tribolium, sitophilux, lasioderma serricorn, sitotroga moths, cadre centellic, rats and ants. To exterminate these creatures, ADMARC possesses a pest control department consisting of 153 persons. Pest control supervisors are stationed in the northern, central and southern regions and the pest control assistants are in charge at each depot site.

The pest control department also carries out quality inspections at each stage of product purchase, storage and sale. When fumigation or sterilization is required at a warehouse, a pick-up truck, mounted with necessary devices and material such as fumigation sheets, fumigating agents (methyl bromide, phostoxyn, actellic, malathion or pyrethrum) and a sprayer, drives down to the location immediately. Average fumigating frequency is once every three months.

(5) Inventory Control System

General method of filling in the stacking form and ledger control is carried out according to rules.

The inventory from each ADMARC depot is reported weekly, not monthly. A warehouse in-and-out report each week is submitted to the divisional office by Tuesday of the following week and the divisional office submits it to the regional office by Tuesday of the following week. The regional office submits it by Tuesday of the subsequent week to the ADMARC headquarters where national calculations are carried out.

Since this method is thought to create errors when transfers are recorded at each stage of reporting, and for the purpose of contributing to the management enhancement for ADMARC, the computer entry was begun.

## 2-3 Assistance by Foreign Countries Relating to Agricultural Warehouses

### (1) Silo in Lilongwe

A cereal silo was built in 1983 in the suburb of the capital city of Lilongwe under assistance from South Africa, with a storage capacity of 180,000 tons (main silo: 5,000 tons x 36 and fumigating silo: 1,250 tons x 12). The main function of this facility is to store the food reserve on national scale. While the stored maize is replaced with the new harvest every year, the silo's inherent characteristic of improving the distribution efficiency by means of rotation enhancement is not being achieved. The site people claim that more funds, for electricity costs, etc. are required for maintenance and control, than ordinary warehouses. In addition to the incapability of accurately calculating the inventory at the quantity inspection, the work requires the bagged maize to be opened, put into the silo and re-weighed and re-bagged at shipment, which does not fit the actualities of storage, control and distribution.

(2) Warehouse in Mzuzu

The project by ADMARC of new depot construction in Katoto, 6 km. away from Mzuzu in the northern region under the assistance from the Dutch Government was commenced with the first phase in September 1987 with the schedule of completion in January 1989. Being a multi-purpose warehouse, it has a floor area of 6,120 $m^2$ (102 x 60 m) and a storage capacity of about 20,000 tons. The construction is of reinforced concrete pillars (6 m span) with brick walls, permitting lorry entrance. The ancillary facilities include an office, a canteen, a workers' room (with toilet and shower), a truck weighbridge (30 ton load-cell type) and a fumigating chemical storage room. The work supervision and the construction are carried out by local contractors respectively. The warehouse management after completion is scheduled to be performed by 12 office staff and 68 workers.

A second phase is under discussion to build a warehouse of the same size as the first one, adjoining the latter.

(3) Supply of Mini Silo

The West German Government has committed to ADMARC the supply of materials and parts for 181 mini silos of a site assembly type (diameter of 15 m, height of 7 m and storage of 500 tons), some of which have already arrived. This silo consists of steel frames, sheet side walls provided with heat insulating material, a tarpaulin sheet roof and a corrugated steel sheet for rat repelling. ADMARC plans to distribute these mini silos mainly to the northern region of which Karonga District has already installed 12 silos and Mzimba 20 silos. Four of them were installed and are in use at the flour milling plant of GRAMIL, Limbe. With these 181 mini silos for a total storage capacity of 90,500 tons, the claimed warehouse shortage in the northern area will be largely improved for the time being together with the 20,000 tons warehouse now under construction in Mzuzu.

This facility, being a silo designed for bulk storage of cereals, is difficult to be used for distribution of bagged products, hence not suitable for multi-purpose utilization. Also its service life is estimated three to five years under the tropical climate.

(4) UNDP/FAO Technical Cooperation Project

A technical cooperation project for agricultural distribution has begun for ADMARC in February 1987 by funds provided from UNDP and professional experts dispatched from FAO. The purpose of this project is to enhance the knowledge about quality in agricultural products and to improve the management and control capabilities. The area of the technical cooperation covers the distribution of agricultural products, export markets, operation administration, transportation, internal accounting procedures, control of quality and storage and a computer system.

The project fund amounts to $1,129,799 and a separate fund for material and equipment purchase of $125,000 is provided.

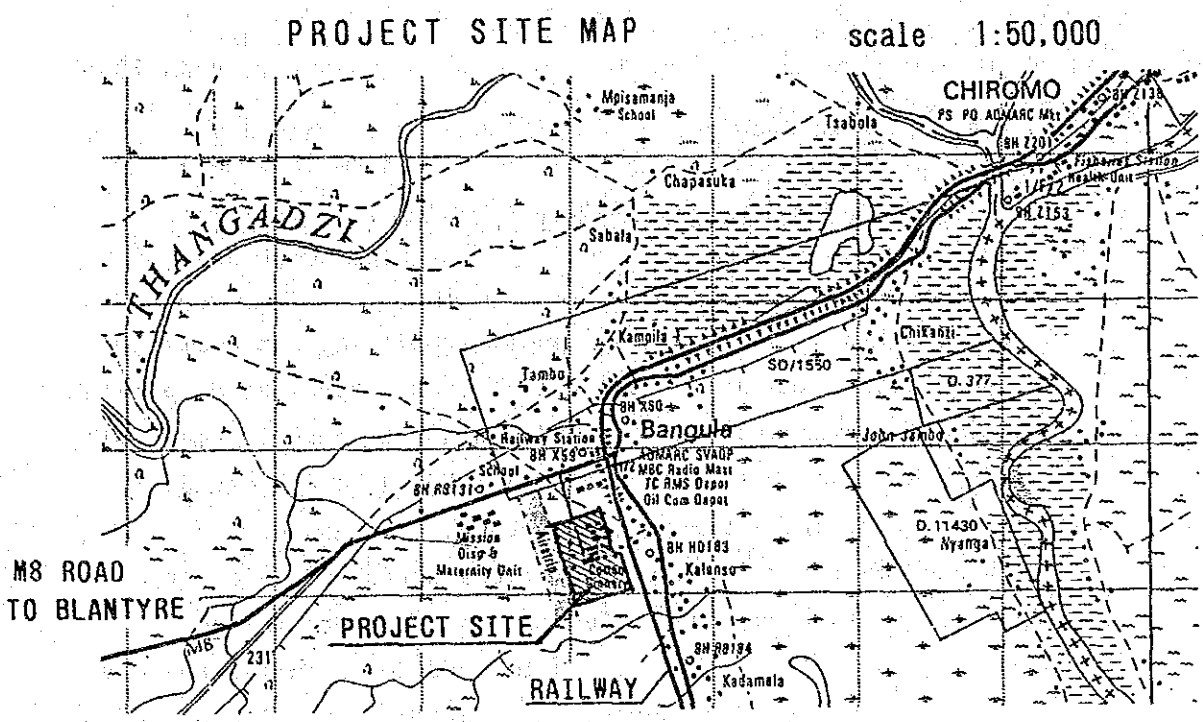
## 2-4 Existing Facilities at Project Site and Project Proposal

### 2-4-1 Project Site

Bangula Depot, the project site, is located about 130 km. south of Blantyre, which can be reached by paved trunk road (No. M8) or railway.

Bangula Depot is positioned about 300 m off to the south from the M8 road which runs east-westwardly in this area, bounded by an airstrip on the west and by Bangula Station on the east with the railroad running along the site boundary. Further east to the railroad there are private houses scattered, beyond which is a marsh with Shire River meandering in a distance of about 3 km. forming the border with Mozambique.

The entire area of the Depot site is about 23 ha with the sidetrack railroad branched from Bangula Station. To the north of the sidetrack is the cotton ginnery, to the south the ADMARC warehouse, guar bean plant and outdoor storage yard. The site is nearly flat slightly slanting to the east (about 1/100) at an altitude of 52 - 56 m. One-third of the west and part of the east side of the site are the employees' houses scattered among trees, and the southwest corner is used as a soccer ground.




2-4-2 Function and Facilities of Bangula Depot

The Ngabu area, covered by Bangula Depot, is the main cotton growing area producing 50% of the whole amount of the country. Bangula Depot has a cotton ginnery (owned by the British Cotton Growing Association Cotton Ginnery Ltd.; see following table) with the largest capacity in Malawi, a total of 60% to 80% of

the whole product of the country is gathered and processed in this factory including cotton from other areas. The average amount processed is 19,900 tons a year, and around 10,000 tons of cotton are stacked up in the depot during the peak collecting period.

Cotton Ginneries in Malawi

| Place | Owner | Capacity of Lint Production |
|---|---|---|
| Bangula, Nsanje (southern) | BCGA/CGL | 350 bale/day |
| Mitole, Chikwawa (southern) | ADMARC | 50 bale/day (constructed in 1935) |
| Balaka, Machinga (southern) | BCGA/CGL | 50 bale/day (out of order) |
| Ngara, Karonga (northern) | Private | 50 bale/day (presumption) |

ADMARC commissions the cotton ginnery to process the collected cotton. After ginning, it sells lint (raw cotton) to a spinning mill (David Whitehead and Sons Ltd.) and cotton seeds to an oil factory (National Oil Industries Ltd.: NOIL) both located at Blantyre. The operating period of the cotton ginnery is influenced by the growing period of the cotton shown in the figure on page 12 and the collecting period shown in the Appendix Table VII-6. The collecting period is during the dry season from June to December so that cotton is usually placed outside. The cotton ginnery has a capacity of storing 10,000 bales (1,800 tons) of lint.

Guar beans are the other speciality in the Ngabu area. This is a special plant only grown in Nsanje District promoted by the government as an exporting item and ADMARC started purchasing it from 1975. The average amount purchased during these six years is 2,176 tons a year (see Appendix Table VII-7). First beans were exported unprocessed, but a splitting plant was constructed at Bangula Depot to collect and process all the beans. Guar beans are processed to split and meal half the amount each.

Split is exported to South Africa and other countries as raw material for industrial oil, and meal becomes feedstuffs by roasting process. The domestic market, however, has not been developed yet for this product. The splitting plant was constructed by the aid of Steinhall Company of South Africa, and its processing capacity is 10 to 20 tons a day. This plant is placed in a warehouse (no wall) of 90 m long and 18 m wide so that the remaining open space has a capacity to store 4,000 tons of products.

Ngabu is a food shortage area as mentioned in 2-1-4. The foods in need are made up by the maize sent from northern and central granary districts. Bangula Depot functions as the distribution center of maize for the area. A part of maize arrived at Bangula Depot by train is sold there directly to consumers, but most of them are sent to the six Parent Markets in the area followed by Unit Markets which usually sell the maize to consumers. Bangula Depot handles about 17,000 tons of maize a year.

The existing facilities in the Bangula Depot premises are summarized as follows:

1) Cotton ginnery (with storage of 10,000 lint bales)
2) Guar bean splitting plant (with storage of 4,000 tons)
3) Warehouse (110 m x 18 m)
   5,200 tons x 2 buildings = 10,400 tons
4) Open shed, A type (large)
   580 tons x 9 buildings = 5,220 tons
5) Open shed, B type (small)
   370 tons x 7 buildings = 2,590 tons

   } 18,210 tons

6) Outdoor storage area: about 25,000 $m^2$
   (equivalent to 25,000 tons)
7) Annex buildings and staff's living houses

Among them, the total capacity of 3), 4) and 5) is 18,210 tons. However, warehouses 3) are older than 20 years since constructed with noticeable deterioration and damages in various parts,

allowing easy entry by rats through crevices; in addition, no air exhaust and ventilation devices are installed, hence it is judged unsuitable for food storage. They have no eaves over the entrance making the work difficult during the rainy season.

Sheds 4) and 5) have only roofs but no eaves and walls, which can serve only for temporary storage.

The existing equipment and devices in Bangula Depot are as shown in the table below, other than those in the ginnery and the guar bean splitting plant. Railway siding is available but no weighbridge is installed. Seen here and there are damaged and unrepairable vehicles, tractor trailers, forklifts and stackers. No forklifts are in operating condition.

Existing Equipment and Devices in Bangula Depot

As of March 1988

| Equipment and Devices | Quantity | | |
|---|---|---|---|
| | Usable | Unusable | Total |
| Truck weighbridge 35 tons, 9x3m, mechanical type | 1 | - | 1 |
| Platform scale, weigh 124 kg., 63x56cm, dial indicator type | 2 | 1 | 3 |
| Platform scale, weigh 200 kg. | 2 | 1 | 3 |
| Fire extinguisher, powder type | 8 | - | 8 |
| Sack barrow | 6 | 17 | 23 |
| Four-wheel tractor | 1 | 2 (under repair) | 3 |
| Trailer for tractor | 3 | 2 | 5 |
| Stacker, engine driven 1<br>motor driven 2 | 1 | 2 | 3 |
| Moisture meter | 1 | - | 1 |
| Fumigation sheet | 3 | 2 | 5 |
| Tarpaulin sheet | 76 | 27 | 103 |

Source: ADMARC Bangula Depot

## 2-4-3 Contents of Project Proposal by Malawi Side

The purchase volume of agricultural products by ADMARC and its capacity of storage facility may be said sufficient for the country as a whole, as described in 2-2-3 and 2-2-4, but for the necessity of solving the capacity shortage in the Bangula Depot warehouse in the southern part of the country, the Malawi Government proposed to build an agricultural multi-purpose warehouse in that location under the Japanese grant aid system. The contents of the project proposal are as follows:

1. Warehouse

   A warehouse capable of storing every kind of agricultural products handled at Bangula Depot, seeds, fertilizers and chemicals with a capacity of 10,000 tons in terms of maize shall be constructed as the first phase, to be expanded ultimately to a total capacity of 30,000 tons.

   A control room, a fumigating material storage room, a canteen and a wash room shall be accompanied.

2. Goods handling and other ancillary machines

   Tractor trailer: 1; conveyors and stackers: 8 in total; fumigation sheets: 12; truck and rail weighbridge: 1 each; platform scale: 4; sack barrow: 40; moisture meter: 1; stitching machine: 4; fire extinguisher: 10; ladder: 1; sprayer: 2; gas mask: 20; and fog machine: 1

   According to the Malawi side explanations, the calculation basis for the above warehouse capacity is as follows:

| | |
|---|---|
| Cottonseed (average annual handling quantity) | 19,900 tons (1) |
| Maize (two-month requirement plus reserve) | 6,800 tons (2) |
| Fertilizer and chemicals (average annual handling quantity plus reserve) | 400 tons (3) |
| Total (ultimately required capacity) | 27,100 tons - 30,000 tons |
| Existing capacity | -) 18,200 tons (4) |
| Capacity shortage (first phase construction capacity) | 8,900 tons - 10,000 tons |

where, (1): Average value of annual handling quantity between 1981 and 1987. (Appendix Table VII-8)

(2): Maximum value for two-month inventory calculated from the average value of monthly average handling quantity between 1982 and 1987 (December + January worth), added with 20% as a variation factor and further multiplied by 1.2 for population growth consideration. (Appendix Table VII-9)

(3): Average value of annual handling quantity between 1981 and 1987, added with 20% as a variation factor.

(4): Total capacity of existing two warehouse buildings and 16 open sheds. (Refer to 2-4-2.)

The plan was to construct a warehouse of 10,000 tons capacity corresponding to the present shortage as the first phase and then re-construct sequentially those existing facilities of which function is insufficient because of their construction or deterioration.

The project shall be executed by ADMARC headquarters (in Limbe) and the facilities after completion shall be operated by the organization of its Bangula Depot.

# CHAPTER 3: Contents of the Project

## 3-1 Purpose of the Project

The function of Bangula Depot is not only collecting seed cotton at 60-80% of the total Malawi production because it has a ginnery in its premises but also supplying maize to the food shorted Ngabu area. Guar beans, produced only in this area, are all collected at this depot and processed at the splitting plant. The depot also handles the supply of fertilizers and chemicals. Therefore, various products of different distribution patterns come in and go out, but the facility is low in quality and short in quantity. It is an urgent problem to improve such condition to reduce the loss of agricultural products during storage and secure the supply of foods. It is the purpose of the project to build under Japanese grant aid an all-weather and multi-purpose warehouse which corresponds to the conditions of Malawi and is equipped with equipment necessary for handling and quality control of goods.

## 3-2 Project Scale Planning

### 3-2-1 Condition of Calculation

As the weather in Bangula is not suitable for storage of agricultural products (see Appendix VII-10), it is desirable that the project building be looked as a distribution warehouse or a consumption area warehouse, so that the quantity of products to be stored will be as small and the storing duration be as short as possible. A concept of reserve type storage warehouse of keeping a large volume of harvested or collected products in stock is not adequate. The storage capacity of the warehouse shall be calculated on the maize removed of kernel and filled in bag.

There is an anticipation of irrigation development in Lower Shire Valley over a long-period basis and re-opening of the

Mozambique Beira route, which may cause changes in agricultural production and its distribution condition, but this project will be based only on the data of past several years, and the future conditional changes will not be taken into account. Also, the great number of refugees from Mozambique, reportedly about 19,000 in Nsanje District are supplied with food from other organizations such as WFP, not depended on ADMARC, hence it will not be considered in this project either.

### 3-2-2 Necessary Storage Capacity

The contents of the project proposal as described in 2-4-2 are hereinafter discussed to establish the proper capacity of the warehouse. The products that are shipped in and out of Bangula Depot are mainly [a] seed cotton (cotton as it is picked), [a-1] lint (cotton fiber), [a-2] cottonseed, [b] maize, [c] guar beans, [d] fertilizers and chemicals. Lints and cottonseeds are the products separated from seed cotton by a ginning machine. The cottonseeds are devided to [a-2a] seeds for next planting and [a-2b] oil pressing seeds.

The inventory volume is more rationally calculated from the difference between the collected volume and the processed or distributed volume, rather than from the annual handling volume as explained in the proposal.

ESTIMATION ON MONTHLY INVENTORY AT BANGULA DEPOT (unit: ton)

| | month | (a) seed cotton | (a-1) lint | (a-2a) seed for next planting | (a-2b) seed for oil | (b) maize monthly data | (b) maize adjusted value | (c) guar beans | (d) fertilizer & chemical |
|---|---|---|---|---|---|---|---|---|---|
| dry | ↑ APR | 20 | 531 | 0 | 0 | 458 | | 0 | |
| | MAY | 2,931 | 0 | 0 | 0 | 695 | | 0 | |
| | JUN | 6,189 | 836 | 0 | 914 | 746 | | 0 | |
| | JUL | 8,470 | 1,672 | 780 | 1,048 | 1,458 | | 510 | annual |
| | AUG | 6,962 | 2,508 | 780 | 402 | 1,131 | | 872 | total |
| | SEP | 3,141 | 3,344 | 780 | 0 | 1,569 | maximum | 460 | 330 |
| | ↓ OCT | 0 | 3,831 | 0 | 0 | 1,800 | 3,695 | 0 | |
| rainy | ↑ NOV | 0 | 3,281 | 0 | 0 | 2,271 | | 0 | |
| | DEC | 0 | 2,731 | 0 | 0 | 2,475 | | 0 | |
| | JAN | 0 | 2,181 | 0 | 0 | 1,850 | | 0 | |
| | FEB | 0 | 1,631 | 0 | 0 | 1,958 | | 0 | |
| | ↓ MAR | 0 | 1,081 | 0 | 0 | 290 | | 0 | |

[a] Seed cotton is usually stored outdoors during the dry season. From April to September ADMARC purchases seed cotton, of which ginning starts from June.

As the exact data of outgoing and incoming amounts were not available at ADMARC, the purchase amount rate of each month by ADMARC is assumed as monthly collecting rate to estimate the incoming amount. The incoming amount subtracted by monthly processing amount shows the inventory stock. The capacity of cotton ginnery producing lint is 350 bales a day (1 bale weighs 180 kg). Lint weighs 33% of seed cotton so that the calculation to get the monthly inventory of unprocessed seed cotton is as folllows.

$$350 \times 180 \text{ kg}/0.33 \times 22 \text{ days} = 4{,}200 \text{ ton/month}$$

This leads to the fact that the inventory in the rainy season will be zero as shown in Appendix Table VII-11. Seed cotton is usually kept outside and since there will be no stocks during the rainy season, no warehouse will be needed.

[a-1] If lint is sent to a spinnery and other places in regular amount throughout the year, the inventory of a month will be the sum of the previous stock and the remaining amount which was not sent out in the month. The largest monthly inventory in the year is 3,831 ton of October (see Appendix Table VII-11). This can be stored in the warehouse of the cotton ginnery (store capacity 1,800 tons) and that of the Blantyre spinnery (store capacity 2,880 tons). So no extra facility is in need.

[a-2] Cottonseed is produced in accordance with the production of lint. It weighs 67% of seed cotton. Seeds for next planting (a-2a) are saved from them according to the distribution pattern to the farmers. The stock of these seeds sums up to be 780 tons each month from July to

September. The markets all over the country in the cotton growing districts are in charge of the seed distribution and they have enough space in their warehouse to store them.

If the cottonseeds are to be sent out to the oil factory at Blantyre according to its capacity (1,900 ton/month), the depot only keeps the stock from June to August, resulting the maximum amount of 1,048 tons in July (see Appendix Table VII-11). This amount can be stored at the warehouse (3,000 tons for the material) of the oil factory. It is observed that a large amount of deteriorating cottonseed (about 3,000 tons) for oil pressing is stacked at the outdoor storage area of the depot, sending forth bad smells. The hot weather of Bangula does not fit the storage of oil materials, so that it is better to send cottonseed to the next processing factory at cool Blantyre as soon as possible.

Under discussion is a new plan to shift the cotton to the selling off system to the ginnery from the present process commissioning system, making the above idea more appropriate.

[b] Maize monthly data of the above table have been attained from Appendix Table VII-8 on the assumption of storing one month, i.e. the instant monthly inventory corresponds to the delivering amount for the next month.
It is requested in the proposal that maize be stored in amounts of two months. It means to keep the necessary delivering amount, for instance, for December and January at the end of November in the Bangula warehouse. This condition seems to be over guaranteeing the shipment.

Generally speaking, a warehouse at the consuming area tries to keep the level over the minimum amount (running stock for supply) so that stocks will not be sent out completely. Staple foods are usually consumed in a constant amount each

month, and this running stock suffices the demand at the real consuming areas such as urban districts. The Ngabu area however, has its own production of food to some extent and the maize are to make up for the shortage, so that the required amount of maize differs drastically by the time of the year. The warehouse has to take this seasonal variable factor into consideration to plan the scale.

Minimum stock for supply : 12% of yearly sales amount
(by FAO : Food and Agricultural Organization)
Seasonal variable factor : The difference between the maximum monthly sales amount and the monthly average sales amount

The sum of the two values above makes 2,400 + 1,083 = 3,087 tons. Putting population growth into consideration, duration of five years from the central time of data to the warehouse construction, and 3.66% annual increase (1977 - 1987) have to be put in the calculation as follows.

$$3,087 \times (1 + 0.0366)^5 = 3,695 \text{ tons}$$

As mentioned in 2-4-1, the present warehouses are not suitable for storing foods. Therfore, it is necessary to build a new warehouse to store this amount.

[c] Guar beans unprocessed stocks is the difference of monthly collected amount and the processing capacity of the plant (480 ton/month). The maximum will be 872 tons of August (see Appendix Table VII-11). However, about 5,000 tons of guar beans and about 2,500 tons of meal which correspond to three to four years production are stockpiled at present. Reduction of inventory and production for guar beans have to be considered, and as the plant has already the storing capacity of 4,000 tons (about two years production amount), the project will not include any new facilities for guar beans.

[d] Fertilizer and agricultural chemicals collected in this depot is 330 tons a year and much less a month. Therefore the present warehouse can spare some space for them.

According to the above discussion, a new warehouse of 3,700 tons storage capacity is to be planned for maize in the project. This warehouse will be a one-storied building, allowing multi-purpose use if needed. The present warehouses will almost be a spare space according to the above calculation, and need not be rebuilt if the condition does not change.

## 3-3 Outline of the Project

### 3-3-1 Facility Planning

The contents of the facility plan will be a warehouse of 3,700 tons capacity purposed mainly for maize storage and associated necessary facilities in accordance with the concept described in 3-2-2. In the vicinity of the new warehouse, an annex building will be planned which will include an office for a tally clerk and a chemical storage room and a workers' shower room which are not provided in the existing buildings. No new canteen for workers will be planned because the existing facility can be utilized.

Since the railway fare is generally smaller than road transportation charges in Malawi, the maize that arrives from the central and northern areas to Bangula Depot are transported on rail. Although it is desirable to make a layout plan of the new warehouse by extending the existing siding, there exist employees' houses built on the extension line. Therefore, the new warehouse will use part of the vacant 40,000 $m^2$ space in the southeast part of the site, laying one new siding from the trunk line running in the east side of the site.

When a maize shipment arrives, it will be weighed inclusive of the freight car and the supply weight is calculated as the

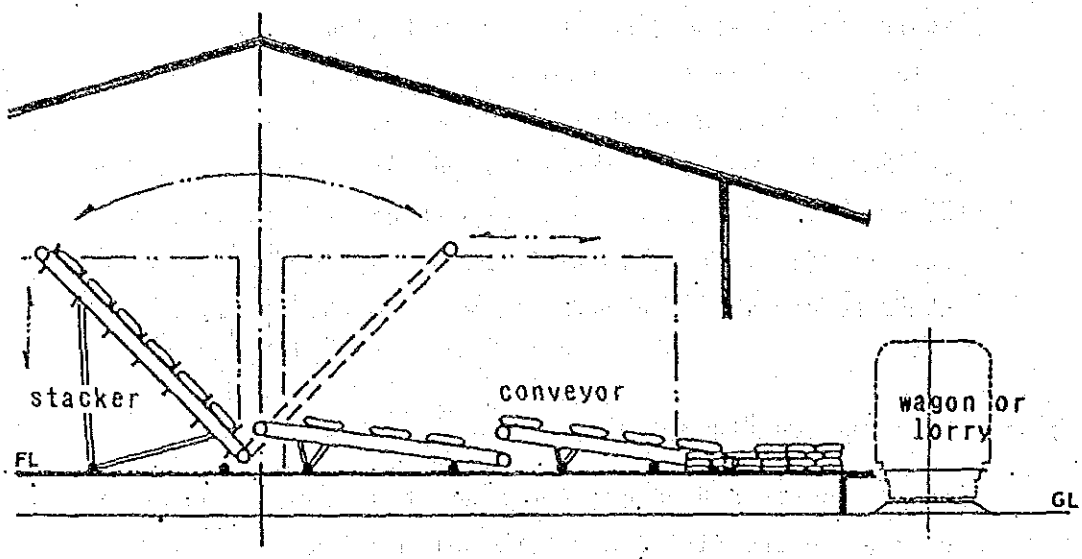
difference from an empty car weight, which is a most accurate and efficient method. (Currently in depot warehouses where no scales are provided, sampling or all quantity weighing is done using a platform scale.) For this purpose, a rail weighbridge will be installed on the sidetrack (annexed with a small house to accommodate the weighing instrument). No truck weighbridge will be included in the project because the existing one can be utilized (35 tons, 9 x 3m). The project will include paving of the driveway from the existing gate to the new warehouse.

3-3-2 Handling and Storage plan of goods

As previously described, there are two types in ADMARC warehouse, one the flat floor type which allows a lorry to enter the warehouse and another the raised floor type which does not. In a design allowing lorry entry, a wide passage will be required inside the warehouse, resulting in not only reducing the storage capacity but also bringing in dirt and dust deposited on the lorry, hence the project will adopt the system not allowing a lorry to enter. Especially in the case of Bangula, the raised floor will work so effectively to avoid the high temperature and humidity along the ground surface. At a raised floor warehouse, loading and unloading will be carried out under the eaves of the warehouse from either freight cars or lorries. Conventionally in such a case, the supplies are transferred between unloading and stacking point using sack barrows. In this project, conveyors will be mainly used in order to prevent the supplies from being damaged and to improve the work efficiency. Stacking will be carried out using the existing type stackers. The figure on the next page shows the concept of handling by conveyors.

Although the storage period of maize in the project warehouse is assumed to be short, there is a high risk that arriving maize may have been attacked by insects already somewhere else as well as that eggs may hatch during storage, thereby making fumigation necessary. Since fumigating a warehouse in sealed condition as being done in Japan is practically impossible, sheet fumigation

CONCEPT OF HANOLING GOODS BY CONVEYORS




as is done locally will be adopted. The fumigation will use hydrogen phosphate ($PH_3$) or methyl bromide which are widely used in Malawi. Equipment necessary for fumigation will be included in the project.

The existing ADMARC warehouses give practically no considerations against attacks by vermin. In the project, the doors will be provided with rat repellers and the high windows (for ventilation and lighting) with bird nets for loss prevention.

3-3-3 Implementing Body and Operation System

This project will be executed by the Agricultural Development and Marketing Corporation (ADMARC) and operated by the Bangula Depot organization (2-2-2).

The increase of the staff required for the new warehouse will be one operator and one recorder for the rail weighbridge, and the other categories will be covered by the present staff. No special training will be necessary for operation of the equipment.

# CHAPTER 4: Basic Design

## 4-1 Basic Design Policy

The basic design policy for the warehouse is set out as follows after due consideration of the products distribution system, transportation methods, handling of goods, environmental condition of the site and construction condition in Malawi.

1) Considering the climatic condition of the area, the basic performance of storing and preserving the products has to be the main point.

2) Considering the present status of foods warehouse in Malawi, the design has to be clear and simple.

3) Considering the construction condition in Malawi, the building materials which are locally available will be used as far as possible, for easy maintenance and repairing.

4) Considering the condition of the site, the layout, floor and section plan will be focussed on easy handling of goods. The design of the building will reflect the raised floor system with conveyor handling.

## 4-2 Discussion on Design Conditions

Bangula is located in the southern downstream of Shire River, lower in altitude by 1,000 m than Blantyre and it belongs to the area of high temperature and high humidity, a poor environment for an agricultural warehouse. The ambient temperature is 25.5°C in annual average of the past ten years, with the maximum average of 33 - 36°C and the single highest of 44.4°C recorded in November 1982. The insolation time is 7.5 - 9.5 hours a day throughout the year, which is one of the longest insolation time areas in Malawi. While the rainfall is 735.7 mm in the ten year average with the record of 1,168 mm annual rainfall in 1984 - 1985, the humidity is somewhere around 50 - 80% with the average of 68%.

Therefore, what is meant by observing the warehouse function as described in the basic design policy is specifically speaking to highten resistance of building for heat, weather, water, moisture and dust. This warehouse should be designed with more emphasis on these functions than its economy, considering the site conditions mentioned above.

## 4-3 Basic Design

### 4-3-1 Site and Layout Plan

#### (1) Layout Plan

In consideration of the effectiveness of the work in Bangula Depot, the new warehouse will be built adjacent to the south side of the existing guar bean plant. As it is not desirable to lay the long side of the building in the southnorth direction because of being open to the westering sunshine, the warehouse will be designed in the east-west direction as in the guar bean plant.

The railway siding will be drawn between the guar bean plant and the new warehouse. This makes also possible to use it from the guar bean side. Installed on this siding will be a rail weighbridge as well as its instrument house. The driveway will be extended to the southern side platform for lorry access. An office and a chemical storage room will be arranged at the west edge of the south side road, from which the warehouse can be overlooked.

#### (2) External Work Plan

##### 1) Railroad Siding

A siding will be constructed shunting from the trunk line according to the specification of the Malawi Railways. A gate will be provided where the railroad crosses the existing site border fence. Enough space for loading and unloading will be secured on the guar bean plant side.

2) Driveway

There is an unpaved road of about 310 m long running from the gate to the depot office in the premises. The new building is to be constructed in the farther direction of the road in the open area now used as an outside storage. The ground surface at and around the new building seems to be tight, but the area including the road tends to be muddy in the rainy season. As the products will be transported from the new warehouse to each Parent Market by lorries, the road within the premises needs to be paved. This is an area of the hottest climate in the country and the traffic will be rather small as 40 times a day by 20 tons lorries, judging from the capacity of the warehouse. The asphalted road will not be kept in good condition under such circumstance. It has to be a concrete road like those of the ADMARC Depots at Limbe and Lilongwe and the new warehouse built at Mzuzu. The road will be planned according to the standard for paved road set by the Building and Repairs Division of the Ministry of Construction of Japan. It will be a concrete road of 15 cm thick with welded wire mesh reinforcing (Roads of ADMARC's Depots mentioned above are built in the same way). The width of the road will be 6 m corresponding to the opening of the gate. Curb stone or road gutters will not be made for the road drainage.

3) Rainwater Drainage

The warehouse building will be surrounded with U shaped ditches to prevent rainwater from standing. The rainwater in the ditches will be disposed into the soil by perforated underdrainage extended to the outside of the site. No special rainwater drainage will be provided in the annexed buildings as in case of the existing facilities.

## 4-3-2 Building Design

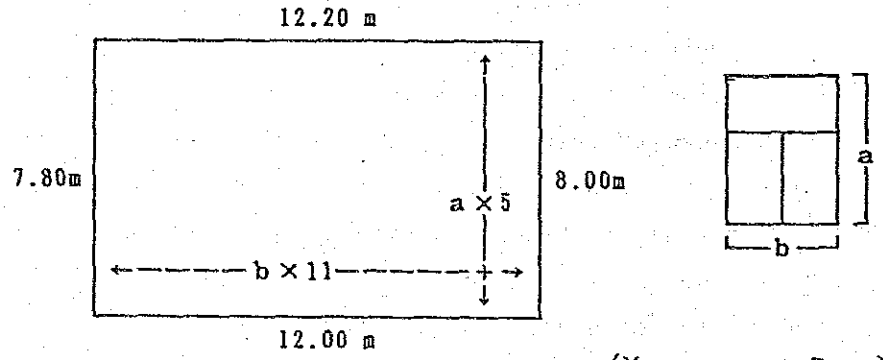
### (1) Floor Plan

#### 1) Warehouse Building

Since the main object of storing is maize, the warehouse building size is calculated based on the measurement data of maize stacking.

With respect to a stacking method, the "3 bag unit stacking" will be employed as is being introduced at depots in Malawi, in which the 3-bag basic unit is stacked in alternative directions at odd and even number layers. The number of layers will be 23 which is again used generally by ADMARC as the standard.

The size of the basic stack is decided as 1.58 x 1.10 m ≒ 1.738 $m^2$ based on the measurement data of the local maize bag (90 kg.) as shown below:

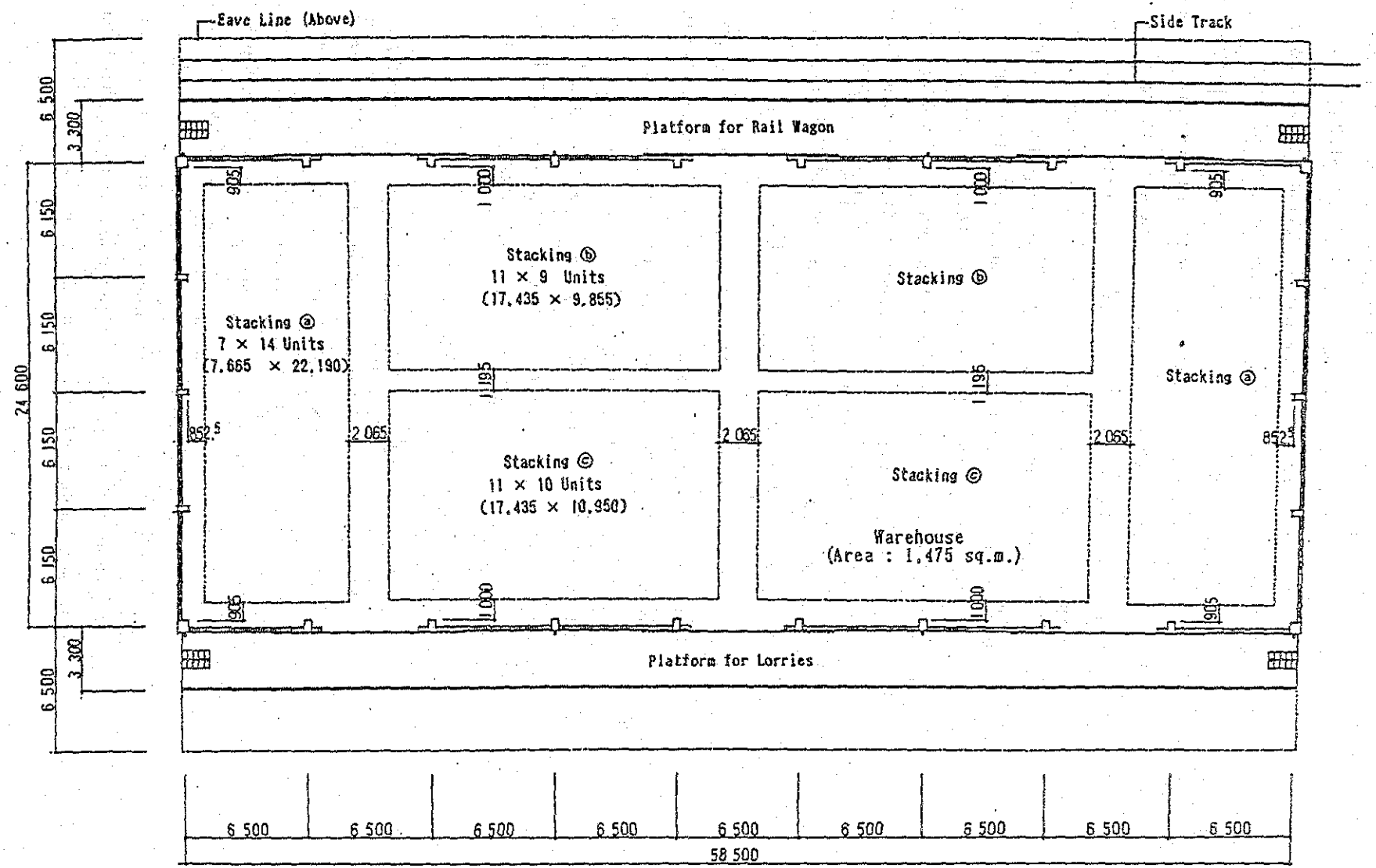



(Measurement Data)

Therefore, the number of bags per unit area will be 3 ÷ 1.738 ≒ 1.73 bags/$m^2$, and the storage capacity per unit area in 23 layer stacking will be 1.73 bags/$m^2$ x 23 layers x 0.09 ton/bag ≒ 3.58 tons/$m^2$.

When the grain storage average values of 27.5% for passage and 72.5% for net stacking area are used, the building area will be as follows on the storage capacity of 3,700 tons:

$$3{,}700 \text{ tons} \div 3.58 \text{ tons/m}^2 \div 0.725 \fallingdotseq 1{,}425.5 \text{ m}^2$$




WAREHOUSE - PLAN

The structural span layout is given to cover the above area. It is desirable that the span of girders be around 24 meters from structural reason and warehouse operation and the beam span is an economical value of 6 to 7 meters and the number of beam spans multiple of 3 for the proper allotment of entrance as generally seen in Malawian warehouses. The main passage linking the doors will have a minimum width of 2 meters to allow working with conveyors. The stacking is laid out with a space of about 1 meter as the central and peripheral passway and as the space of anchoring fumigation sheets. Then, the girder span of 24.5 m and the long side of the building 6.5 m x 9 spans = 58.5 m can be obtained as shown in the following figure. The floor area calculated center to center of the wall is 59.07 x 24.97 ≒ 1,475, and the net stacking area is and the net stacking area is 72.3%.

An entrance doorway will be provided at every 3 spans, and it is 5 meter wide and 4 meter high to facilitate the stacking by conveyors near the entrance. On both long sides of the building, platforms for wagons and lorries will be provided with an effective width of 3 meters continuing over the whole length of the building to facilitate loading and unloading work.

2) Annex Buildings

The office building will include an office room for a tally clerk of the project warehouse, a kettle room for the office, a shower room for workers, a toilet and a chemicals store room. The office room and the chemical storage room will each have an area of 27.5 $m^2$ assuming one to two staff for the office room and the storing of the provided fumigation sheets, sprayers, fog machine and their chemicals. The number of showers, toilets and wash stands is determined upon assumption of the maximum number of worker of 60 people.

The instrument house will be 3 m x 5 m assuming the space for weighbridge instruments and entering on the log sheets.

3) Facilities Summarized

The scale and contents of the facility mentioned above are summarized as follows:

| | | | |
|---|---|---|---|
| Warehouse | area : | 1,475 $m^2$ (59.07 x 24.97) | 1 building |
| | capacity: | 3,700 tons (maize equivalent, 23 layers stacking) | |
| Office building | area : | 90 $m^2$ (6.00 x 15.00) | 1 building |
| | contents: | tally clerk office chemicals store room, kettle room, shower and toilet | |
| Instrument house | area : | 15 $m^2$ (3.00 x 5.00 m) | 1 building |
| | contents: | instrument room for rail weighbridge | |

(2) Sectional Plan

1) Warehouse Building

The warehouse will be of raised floor, which keeps approximately the same height as that of wagon and lorry beds for higher efficiency of loading and unloading. Moisture-proof sheets will be put under the floor slab. The floor slab will be cast fair-faced, avoiding plaster work susceptible to cracking. The roof will be a common and simple gable type for economy and rainproofing, provided with eaves large enough to cover rail wagons and lorries so that loading and unloading can be carried out even if it rains.

Although skylight on the roof is generally used in ADMARC warehouses, there is no necessity for a warehouse to be so bright and from the viewpoint of radiation heat prevention and material selection problem, skylight will not be employed.

Overhead clearance inside the warehouse will be designed to allow stack working of 23 layers. The upper part of the long side outer wall will have continuous opening for ventilation provided with a net to prevent entry by birds and rats. On top of the roof, a continuous ventilator will be provided for natural air ventilation.

2) Annex Buildings

It is assumed that the office room in the office building will be occupied not by the depot supervisor but by a tally clerk, subordinate to the former. Therefore, the grade of the building will not exceed that of the current supervisor's building. Floor finish will be generally terrazzo and the outer wall will be of brick. The roof will be of wood construction over which a ribbed steel sheet will be employed. The height of the eaves will be equivalent to the existing office building at about 3 meters, and a false ceiling will be provided in each room. Windows will be of the glass louver which is locally available and doors will also be locally made of wooden flush type. The instrument house will basically be the same as that of the office building.

(3) Structural Plan

1) Design Criteria

In the Republic of Malawi, building design is based on British Standards, so will the project building in principle. As no maximum momentary wind velocity in the project area is recorded at the meteorological

station, it is assumed to be 33.3 m/s, the maximum value adopted in other construction projects in Malawi. This value offers sufficient safety, judged from the natural environment and the present conditions of buildings in the project area. Similarly, because no seismic data are available in Malawi, the horizontal seismic factor of k = 0.05 is adopted for elasiticity design, based on the 25 gals value shown in the seismic factor distribution chart of the world published by the Architectural Research Laboraroty.

2) Roof Construction

Since it is desirable that the warehouse have no pillars for the convenience of goods handling, and taking transportation and erection by local workers into consideration, the roof will be of the large span construction using structural steel, and the truss frame-work will be the steel angle commonly used in the local construction. While the truss construction in the existing warehouses mostly have horizontal bottom chords, the project warehouse adopts a parallel chord truss (slanted bottom chord) for workability of stacking goods.

Pillars will be locally available reinforced concrete for the sake of material procurement and implementation schedule.

3) Foundation and Floor

While the soil bearing capacity at the site will be found by soil survey, at least 10 tons/$m^2$ is expected. Therefore, the foundation and floor will be of reinforced concrete direct foundation. The floor will be of reinforced concrete, provided with expansion joints between the base girder and the floor slab to prepare for the future unequal settlement.

4) Material

The main structural materials will be of the following standards.

| | |
|---|---|
| Steel material | JIS standard products |
| Reinforcing bar | BS standard products procured in countries adjoining to Malawi |
| Cement | Regular portland cement, Malawi or Zambia standard products |

(4) Building Equipment Plan

1) Electrical Installation

[Power supply] Supplied from the overhead transformer in the site, 3 phase 3W, 400V, 50Hz for power source and of single phase 2W, 230V, 50Hz for lighting.

[Power receiving] A main distribution board will be provided in the warehouse building, which supplies power to the office building distribution board.

[Motive force power supply] Power supply for conveyors will be provided near each entrance of the warehouse building. The specification and the total number of the arranged conveyors are assumed as follows:

| | | |
|---|---|---|
| Horizontal conveyor | 3 phase, 400 V, 1.5 kW : | 4 units |
| Stacker | 3 phase, 400 V, 2.2 kW : | 2 units |

[Lighting fixture, socket outlet] The lighting will be mainly by fluorescent lamps as in the existing buildings. A lighting fixture will be attached with a guard net and switches will be provided near the entrance, one for the passage and another for other areas independently. On the eaves at the entrance is provided a lighting fixture and near the entrance a socket outlet. Lighting fixtures and socket outlets will also be provided properly in the annex buildings.

2) Plumbing Work

[Sanitary fixtures] The water closet will be the western style with a low tank, and urinals the wall hang stall type. A wash basin and a slop sink will also be provided. The shower head will be of a fixed type.

[Water supply] The water supply will be of the gravity system from the existing elevated tank supplying to each sanitary fixture, kettle room, shower and outdoor bibcock.

[Drainage] Sewage and other waste water are accumulated in the sedimentation tank, of which the top portion permeates into the soil through the permeation tank.

3) Ventilation

[Ventilation] Ventilation fans will be provided in the toilet, kettle room and chemicals store room.

(5) Finish Materials

The building material will in principle be the same kind as that of the existing ADMARC warehouses. However, as mentioned in the basic design policy, for the parts for heat insulation, waterproofing and dust proofing should be specially considered for satisfying the storage function of a warehouse. The following are the specifications for the main finish of the warehouse.

[Roof] The roof material will be ribbed metal sheet commonly used in Malawi. Sheets will be of high-heat resistance and weather proof. Fasciae of the eaves and both edges will also be metal sheets of the same make.

[Outer wall] The outer wall will be of brick work widely used locally for its high heat insulation. The inner side will be plastered and painted to prevent dust generation,

and the outer side of the long side wall will be of facing brick work, and the outer side of the gable wall will be plaster worked and painted.

Concrete pillars will be plaster worked and painted on both inner and outer sides.

[Floor] The floor will receive dust proof painting touch for the purpose of cleaning and dust prevention. The platform will be of fair-faced concrete.

[Others]

| | |
|---|---|
| Entrance | Steel hanger door of 5,000 (W) x 4,000 (H) with wicket built in the panel constructed with ribbed metal sheet. |
| Bird net | The bird nets commonly used in the existing warehouses have the nets too coarse to effectively prevent ingress of birds and rats. The net about 25 mm sq. made of stainless steel will be used. |
| Roof top vent | Metallic continuous ventilator for natural air ventilation will be provided. One with an effective opening of 500 mm will be suitable. |

### 4-3-3 Equipment Plan

The equipment required in a cereal warehouse are goods handling equipment, measuring apparatuses, inspection device and fumigation devices. The equipment in this project will be selected based on Handling and Storage Plan (3-3-2), and with importance on the easy maintenance and control, and high durability.

The equipment to cope with the function and scale of the project will be as follows.

[Conveyor and Stacker] When bearing bagged cereals from a rail wagon into the warehouse, multiple number of conveyors are

assembled for efficient work. When taking out the goods, the conveyors will be assembled in reverse direction. A conveyor and stacker will have a capacity of 90 kg bags and 4.8 m high stacking.

[Sack Barrow] Since a lorry is not allowed to enter the warehouse in this project, the bag transfer is performed with conveyors in principle. However, for inspection sampling, and at bags broken, the bagged cereal may be more conveniently moved on a sack barrow. The sack barrow is also effective for moving other equipment and materials. The loading capacity will be 250 kg for 2 bags and allowance.

[Pallet] Dunnage is used to prevent bagged maize which is laid at the lowermost of stacking from moist damage due to high relative humidity around the floor. In Malawi timber logs have been in use so far as described before. Since logs have not the same dimensions in diameter and length, but also being easy to move, it needs to make them fixed with iron cramps and nails. And this is a reason why present dunnage shows uneven level, and moreover causes sometimes breakage of bags by uneven load of weight.

After delivering a whole stack, logs need to be disassembled by removing cramps and nails for floor cleaning and sterilizing. However this process is sometimes omitted because of much troublesome in spite that insect damage is anticipated.

The project plans to include timber pallets which are available locally for the purpose of efficient goods handling, better tight stacking and easy insect protection. This is expected to become a model of warehouse dunnage in Malawi.

[Rail Weighbridge] The weighbridge will be such type as to match the specification of wagons operated in Malawi, which calls for a loading capacity of 37 tons and a total length of about 13 meters.

[Platform Scale] This is necessary to complement the method weighing the total weight by the rail and truck weighbridge and is used when a broken bag needs repacking.

[Moisture Meter] This is used to determine from the moisture content the quality of cereals at entering, leaving or during storage. To be selected is a type using ordinary dry batteries, which can be applied to maize, sorghum, millet, rice and guar beans.

[Balance] To weigh samples to be analyzed for inspection. The bowl will be big enough to hold cereals.

[Trier] Used to take samples directly from the bag for inspection. Triers should be suitable for the bag material and size, characteristic of cereal.

[Sample Tray] A small tray is used as a sample container at inspection. A large tray is used when returning the sample to the bag.

[Fumigation Sheet] Used to cover up the stacking and retain the gas at fumigation. The sheet is easy in handling if it is small and weighs less than 50 kg, but connecting more than two sheets becomes necessary. As the stacking is not so big in this project, an ordinally size sheet is applicable. To prevent poisonous gas from leaking through the connections or clearance between the floor and sheet, clips and sand bags will be prepared.

[Sprayer] Used to sterilize and exterminate bacteria and vermin in and out of the warehouse. Manual type for easy maintenance.

[Fog Machine] Used to disperse the chemicals (solution, emulsion) turning it into aerosol to suspend in the air for exterminating blight-causing insects.

[Thermometer] To measure temperatures important for storage condition in the warehouse. Wall hanging type.

Among the equipment requested in the project proposal by Malawi side, some are excluded with the following reasons;

- Forklift is quite useful in the palletizing system and carrying heavy goods such as bale of cotton lint and jute bags. It is therefore dispensable for the project because bagged maize is carried by conveyors and stackers.

- Regarding with bag sewing machine, hand stitching can be available enough for sewing purpose due to rare need only in the case of bag-breakage while handling.
- As for truck weighbridge, existing one will answer the purpose.
- For gas-mask, local procurement of a canned gas-absorber as consumable parts is indispensable for further continuous operation. The project excludes gas marks because it is not confirmed yet.

The equipment to be granted as appurtenances of the project warehouse are listed as follows.

LIST OF EQUIPMENT

| Name | Specification | Quantity |
|---|---|---|
| Goods Handling Equipment | | |
| Horizontal conveyor | For 100 kg bag, horizontal type, electric-powered, 7-8 m, with steel strip | 4 |
| Stacker | For 100 kg bag, prone type, electric-powered, about 8 m, with steel strip | 2 |
| Sack barrow | loading capacity 250 kg, two rubber tires | 5 |
| Pallet | Wooden construction, 1.8 x 1.8 x 0.15 m | 380 |
| Measuring Apparatus | | |
| Rail weighbridge | Weighing 50-60 tons, mechanical type, about 13.37 x 1.67 m, officially inspected | 1 |
| Platform scale | Weighing 200-300 kg, dial type officially inspected | 2 |

| Name | Specification | Quantity |
|---|---|---|
| Inspection Device | | |
| Moisture meter | Battery type | 2 |
| Balance | Weighing 200-300 gr. | 2 |
| Trier | Single, for big and small grain | 2 each |
| Sample tray | Large size | 5 |
| Sample tray | Small size | 20 |
| Fumigation Device | | |
| Fumigation sheet | For methyl bromide, hydrogen phosphate, 18.3 x 12.2 m, with sand bag and clip | 12 |
| Sprayer | Back carrying type, manual, about 10 liter tank | 2 |
| Fog machine | Portable type, 5-10 liter tank, high temperature type or room temperature type | 2 |
| Warehouse Control Device | | |
| Fire extinguisher | ABC type, chemical weight 3-4 kg. | 6 |
| Thermometer | Wall hanging type, officially inspected | 2 |
| Ladder | Aluminum, about 7 m | 1 |

## 4-4 Project Execution Structure

### 4-4-1 Execution Plan

The construction work of this project will be performed by a Japanese specialist company with vast experience in overseas construction and with the capability of completing the work. They will be chosen by bid from multiple candidate companies. Producing little amount in building materials, Malawi imports most of those materials from neighbouring countries and from Europe. Importing however, has become difficult in recent years as mentioned in the procurement plan of equipment and materials.

Therefore it is reasonable to procure them from Japan except the primary products and a part of ancillary materials which can be obtained in Malawi. The above policy is appropriate to keep the schedule and secure the quality and performance.

It is also hard to find the experienced workers for erection of steel structure and building equipment. It is desirable to send experts from Japan for a short period and to let them advise in performing the following kinds of work. The assigned company should rather accomplish the construction work by their own hands hiring local workers than to sublet them to sub-contract companies.

(Experts to be sent, Kinds of works, Numbers and Period)

| | | |
|---|---|---|
| Roof worker | Erection of steel truss, Steel sheet roofing, Hanger door installing | 2 persons x 3 months |
| Equipment worker | Building equipment | 1 person x 3 months |
| Machinery worker | Rail weighbridge installing, Assembly of conveyors and stackers | 1 person x 1 month |

If materials and equipment are supplied from Japan, it is expected to take about 5 months to obtain them through ordering, manufacturing, packing and transportation. Import materials are limited to finishing materials used after the construction of the roof, and the pillars will be of reinforced concrete, to reduce the waiting time in work schedule. Reinforced concrete structure works like base and pillars are to be finished before the arrival of imported materials, so that it may be a key point how to obtain steel bars quickly and easily from the neighboring countries around Malawi.

The rainy season is from November to April in Malawi. From the working plan, excavation, filling and concreting are expected to be done in this rainy season. Therefore drainage during excavation and prevention of concrete from mixing with the rain water

should be considered. A construction company familiar with Japanese domestic works is unlikely to fail but extra precautions are to be made when filling soil for raised floor. That is, if the compaction of filling is not enough, a slab settlement will be caused. As temperatures during the rainy season are high, the concreting should be carried out in the early morning rather than during the day and curing for cast concrete by sprinkling enough water is needed to avoid quick drying.

4-4-2 Undertaking of the Project

At the implementation of the project, the scope of works covered by Japanese Grant Aid and the scope of works and items to be borne by the fund of the Malawi Government are appropriately classified as follows. Among them, site clearance including removal of trees and transfer of obstructive site lighting facilities must be completed before the commencement of respective construction work.

(1) Scope to be covered by Japanese Grant Aid

1) Construction of the warehouse, office building and instrument house (including building equipment)
2) Railroad siding construction (including a pit for the rail weighbridge)
3) Removal of the fence and installation of a new gate for the railroad siding
4) Construction of a driveway in the premises
5) Rainwater drainage for the warehouse
6) Provision of various equipment including installation of the rail weighbridge

(2) Scope to be borne by Malawi Side

1) Site clearance and levelling (including removal of trees, obstructions and banking)
2) Partial removal or transfer of the site lighting poles and wires
3) Telephone installations