UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

EVALUATION OF LOCAL CURRENCY PROGRAMS

Chegutu Bulk Grain Depot

BEST AVAILABLE

JULY 1987

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CHEGUTU BULK GRAIN DEPOT PROJECT

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MAJOR FINDINGS

a. Depot Completed

The Chegutu Bulk Grain Depot was completed in August 1985, although grain was accepted in January of that year. The depot was officially opened on April 25 by the Minister of Agriculture.

The depot, which forms part of a network of depots throughout the country, has a capacity for 68 000 tonnes of grain stored in bulk and 60 000 tonnes stored in bags. This amounts to 15 percent of the nation's grain storage capacity at present, and some seven percent of the projected capacity which will be required by the year 2000.

The United States Agency for International Development (USAID) granted $5 400 000 in local currency. This funded the entire project except for the imported machinery required, which was supplied through Danish Aid. The USAID funds were derived from the 613-K-601/602/603 and 613-K-605 commodity import programmes.

b. Management

The project was successfully completed within the time expected and over budget by two percent. The silos were in full utilization within months of the projects completion.

The project was managed with exceptional efficiency and professionalism. Funds were released on time in accordance with projections. There were no delays.

c. Effect on Farmers

Those farmers who are geared and equipped to handling grain in bulk find the depot to be of enormous benefit in terms of saving in both time and money. The farmer does not, in effect, benefit directly from any saving on grain bags as this is borne by the Grain Marketing Board.

d. Grain Marketing Board

The Grain Marketing Board has felt the beneficial impact of the Chegutu Bulk Grain Depot in many ways. The depot has had a marked effect in reducing the handling of grain from the Chegutu area, and thus reduced operating expenses. The depot has had a significant effect in reducing the foreign currency required for them. The depot has played a major part in recent large exports of maize in bulk from Zimbabwe.

e. USAID

Officials from the Grain Marketing Board and the consulting engineers for the project have been enthusiastic in their praise for the donor, the United States Agency for International Development mission in Zimbabwe, for the way in which the funding was administered. The fact that USAID officials were familiar with the implications and technicalities of the project meant that the normal requirement for numerous explanations and reports was avoided.

RECOMMENDATIONS

a. Further Depots

The Grain Marketing Board has a plan for the development of Grain Storage Depots throughout the country. This will cater for Zimbabwe's needs until 2000AD. It is planned that bulk storage facilities will be developed on an integrated basis in the communal and commercial farming areas in Zimbabwe. Large depots, based on the design of the Chegutu facility will be built to serve the commercial farming areas and areas of high consumption. These have a small foreign currency component, amounting to some 15 percent of the total cost. It is envisaged that small steel silos will be erected to serve the communal farmer. These have a higher foreign currency content amounting to approximately 75 percent of the total project cost.

Based on the experience of the successful Chegutu Bulk Grain Depot, USAID may consider that further support for the large scale depots using counterpart funds is justified and warranted. The smaller steel silos will require a significant amount of foreign currency, other donors have shown interest in these.

Grain Marketing Board's plan for bulk grain storage development is a worthwhile project that will benefit the rural and urban populus and will contribute to the alleviation of starvation and poverty in Zimbabwe and the SADCC region. It provides opportunities for a multi-donor co-operation and would be a worthwhile target for local currency counterpart funds.

It is worthwhile noting that the Norton Bulk Grain Depot was also funded by USAID and was officially opened in April 1986.

USAID has also agreed to fund rural depots in communal areas and to fund the expansion of Lions Den silo.

IMPACT OF THE BULK SILOS AT CHEGUTU

Introduction

On Thursday, April 25, 1985, Senator Denis Norman, the then Minister of Agriculture, officialy opened the Bulk Silos at the Grain Marketing Board Depot in Chegutu. This report is about the impact of the Grain Bulk Silos on the farming community.

This section of the report is a complement of the main report that covers statistical and technical aspects of the Bulk Silos at the Grain Marketing Board Depot in Chegutu. This section is deliberately concentrated only on the impact of the Bulk Silos as viewed by the farmers.

While maize is named as the key grain in the discussion, it should be remembered that other cereals such as wheat, barley and sorghum can also be handled at the Bulk Silos.

Impact

The views of the agricultural leadership in Chegutu are discussed below. The strength and validity of the views is that they reflect the concensus of opinion leaders of the Chegutu farming community who use the Bulk Silos.

Among the leaders interviewed the following have agreed to be quoted:-

i) The Chairman of the Grain Producers Association of Chegutu who is also the National Vice Chairman of the Grain Producers' Association of Zimbabwe, Mr Neivel Sparks.

ii) The President of the Institute of Agricultural Extension of Zimbabwe who is also the Regional Agricultural Officer for Chegutu, Mr Dick Sheppard.

iii) The Manager at the Chegutu Farmers Co-op, Mr Mike Truman.

iv) A leading farmer, Mr Jan Der Linde.

The concensus of the above leadership on the impact of the Bulk Silos was prioritised as follows:-

a) Saving Money

The "bulk nature" of the system meant that farmers could save money by not buying grain bags. Grain bags are not only expensive but are hard to come by because they have to be imported.

b) Saving Time and Labour

The Bulk Silos are saving the farmer time and labour for handling the maize from harvesting to selling at the Grain Marketing Depot. Bulk Silos dispense with bagging, and bagging meant packing the bags, weighing, and sewing them before laboriously loading them on the truck. Thus scales and bag loading equipment or more men were needed, thereby adding costs to the farmer.

Similarly, additional man-hours were wasted at the Grain Depot during unloading of the bags. The new system thus brought in a tremendous saving on man-hours. That reflected indirect profit in that the labour force could be released to do other farm duties such as picking cotton. Cotton is one of the major crops of Chegutu and it is labour-intensive because it is hand picked. Thus the release of labour from the chores of maize harvesting for the labour-intensive cotton picking is one of the biggest blessings in disguise that the Bulk Storage brought to the farmers.

c) Reduce Post Harvest Losses

The minimal handling of grain which is characteristic of the Bulk system is coupled by the shorter time the grain spends on the farm, from the time it leaves the field, has introduced tremendous savings on post harvest losses.

Those farms situated near high density areas found that thieves were finding it more difficult to steal from bulk than hitherto where they only had to lift already sewn bags.

d) Saving of Foreign Currency

Foreign currency is very scarce in Zimbabwe and any measure that has a component of saving foreign currency is most welcome. The saving on grain bags which was a consequence of the Bulk system has meant a direct saving on precious foreign currency for Zimbabwe. The farmers hope that the foreign currency saved could be utilised to import commodities like agricultural equipment and spares.

Farmers therefore wished that more Bulk Silos be built so as to save a substantial amount of foreign currency.

e) Private Sector Encouraged

As a result of their commanding height and conspicousness coupled by the knowledge of the fact that the Silos were a multi-million dollar project, the Bulk Silos have had a positive psychological effect on the large scale commercial farmers. They see a bright future heralded by the high capital infrastructure and a potential for continued aggressive expert drive. It is on that score that the farmers hope that the exporting of Zimbabwe's grain be done in bulk also. That would mean full exploitation of the benefits of bulk handling.

f) Excellent Product

Still on export, the farmers believe that the Silos would improve the storage of their grain and hence provide an excellent product on the international market. Again it is that kind of belief which boosted morale of the farming community.

g) No Effect on Production Pattern

Turning to the question of production pattern, the farmers were unanimous that the silos had not had significant effect on grain production pattern. The reason for that was, while provision of infrastructure was one thing, the pricing policy was another. Pricing policy was for the time being more powerful and farmers responded to it much faster than any other factor.

Summary and Conclusion

From the above concensus, it can be concluded that the Bulk Silos at Chegutu Grain Marketing Depot has had and continues to have positive impact on the agricultural community. The positive impact manifests intself in the following:-

a) Saving the farmer money on grain bags.

b) Saving the farmer time and labour by circumventing the laborious task of sewing and weighing bags before loading them on trucks.

c) Reducing post harvest losses on the farm especially from theft of bags ready for dispatch.

d) Saving Zimbabwe foreign currency intended for jute grain bags.

e) Encouragement of the private sector through morale boosting of the white commercial farmers.

f) Improvement of grain storage resulting in an excellent product on the international market.

At the time of compiling the report, the Bulk Silos had not had a significant effect on changing the production pattern of grain. The pattern was being influenced more by pricing policy than by other factors.

List of References

Der Linde, J 1987 Farmer, Personal Communication

Sheppard, D 1987 Regional Agricultural Officer Chegutu and President of Institute of Agricultural Extension, Personal Communication

Sparks, N 1987 Chairman of Grain Producers Association of Chegutu and Vice Chairman of the Grain Producers Association of Zimbabwe, Personal Communication

Truman, N 1987 Manager of Farmers Co-op at Chegutu, Personal Communication

Other farmers spoken to expressed the same views but declined to be quoted saying that only their Chairman and President could speak for them.

SUMMARY OF CHEGUTU BULK DEPOT PROJECT

The Government of Zimbabwe has a long term development strategy for bulk storage of grains in Zimbabwe operating with the Grain Marketing Board. This strategy was initiated by the erection of a Bulk Grain Silo complex at Chegutu, with a capacity for 68 000 tonnes of grain.

The Chegutu Bulk Grain Depot was funded by USAID local currency generated from the 613-K-603 and 613-K-605 Commodity Import Programmes. The mechnical plant and foreign exchange requirement for the Chegutu Bulk Grain Depot was supplied through DANIDA (Danish International Development Agency) on extremely favourable rates.

The programme was put out to tender. The main contractors were Wade Adams Construction (Construction), BAK Electrics (Electronics) and Cimbria Unigrain Ltd (Mechanical Plant). The construction programme was started in November 1982 and the complex was officially opened on 25 April 1985 (though a certain number of catwalks and platforms were not completed until August of 1985).

The Depot accepted imported wheat from January of 1985 and maize deliveries from March of 1985.

Erection and commissioning of the Silo complex was completed very satisfactorily. Only the normal technical problems were experienced. Credit go to USAID, Ministry of Finance, Economic Planning and Development, DANIDA, the implementing Ministry, (Ministry of Lands, Agriculture and Rural Resettlement) for the successful completion of this project. The funding was distributed by the Ministry of Lands from a vote of credit to the Grain Marketing Board against a projected cash flow calculated by the Grain Marketing Board for the project and disbursed against approval by the consulting engineers.

The depot caters specifically for bulk deliveries from surrounding commercial and communal farmers, although bagged deliveries are accepted. In 1985 23% of deliveries came from the Communal Areas. As of 10 April 1987 14% had been delivered by the Communal Areas. The recipient Communal Area Depots, Mhondoro and Murambedzi, have their grain transhipped by the Grain Marketing Board to Chegutu. Deliveries to these two Communal Area Depots by that date had been 18 400 and 29 030 tonnes respectively.

There has been only one change to the project. This was the installation of a rail intake hopper. It was realised that this additional facility would be necessary in receiving maize. This was because of Chegutu's importance strategically for the supply of grain to the Midlands, and possibly Matabeleland, during future droughts through importation or movement of buffer stocks from producing to consuming areas.

The Depot is at present full to capacity due to the vast maize intake of the last two years, and temporary storage. The areas for bag storage commissioned under the project are full with a further 60 000 tonnes of maize in bags.

SUMMATION

Management of the Grain Marketing Board are extremely happy with the implementation of the Chegutu Bulk Depot project and its usefulness both for storage and in its development strategy. The Deputy General Manager Operations and Engineering was very complimentary of USAID in the way that funding was forthcoming with minimum delay and the ease with which they were able to utilise it. This was especially in comparison to certain other donor agencies which require much red tape in project approval and implementation. It is also very happy with the mechanical plant supplied through DANIDA funding and the service supplied by Cimbria Unigrain Ltd in terms of the plant and backup spares. This is the only recurrent cost area of the project and will be covered by Government through Grain Marketing Board budgeting vote once the agreement with Cimbria ends in seven years time.

A secondary important fact arising from the Chegutu Bulk Depot project is its usefulness for the study done by the Dangroup for Government on the Masterplan for Development of Bulk facilities. The experience gained in this first project has proved useful in formulation of the proposed plan This plan has been accepted by Government and Grain Marketing Board as their development strategy to ensure efficient, economic storage, creation of a strategy on buffer stocks for the country and for SADCC food strategy. The latter is still in its formation stage. A figure of 0,25 million tonnes to be held by Zimbabwe is being discussed but Grain Marketing Board feels this seems rather small. We shall have to await a final decision by SADCC ministers to be able to assess the full implications on the Zimbabwe bulk storage strategy.

While touching on the subject of the development plan for bulk storage, it must be said that it is a necessary and costly development aspect of Government. Donor agencies are coming forward and offering substantial assistance. However to complete the plan, especially with Government's stretched resources, beneficial funding as supplied by USAID for the Chegutu Bulk Depot needs to be continued. This is necessary to achieve the development aims and assist with the increased amounts the agricultural sector has produced for the country and can produce for the region.

The only criticism voiced in discussions with Grain Marketing Board management was with regards to project costing. To have to forecast budgetary costs accurately for large projects spanning 2 - 3 years taking into account inflation and other constraints, and to be expected by Ministry of Finance to only use funds exactly equivalent or below the budgetary forecasts, is complicating Grain Marketing Board's project appraisals. It also gives little leeway to modifications or perceived necessary changes in projects.

(Source: Grain Marketing Board Documentation/Files. Discussions with Grain Marketing Board Management)
(Dangroup Report)

SUMMARY OF THE "MASTER PLAN FOR DEVELOPMENT OF BULK FACILITIES FOR THE GRAIN SECTION" BY DANGROUP, CONSULTING ENGINNERS AND PLANNERS A/S

INTRODUCTION

Government has plans for development of bulk storage facilities for grain. Under these development plans USAID has assisted with construction development of two new bulk silos south of Harare, Chegutu and Norton.

Grain Marketing Board, which will generate the silo complexes as part of a network of storage facilities, found that Danish equipment and machinery would be preferable for the abovementioned silos.

Based on experience gained from the Chegutu project, Government made a request to DANIDA for further assistance in this field. It was found that additional basic planning data for the silo development would be needed in order to define short and long term needs. A master plan study for development of bulk facilities for grain was therefore initiated by DANIDA.

Field work was undertaken in April 1984 by a team of four specialists from Denmark and two from Zimbabwe. Running discussions were held with the Grain Marketing Board staff in Harare, and a number of field trips were made to selected Grain Marketing Board depots and grain production areas in Zimbabwe.

The study concerns an integrated and comprehensive plan for development of storage facilities in Zimbabwe. It covers a 15 year planning period from 1985-2000. During this period all aspects of demand, supply, distribution and storage are covered. The report covers maize, wheat, sorghum and soya beans.

The plan has been based on the following criteria:

- Anticipated grain production and consumption.
- Safe storage with low losses.
- Saving of foreign currency.
- Efficiency and cost reductions (avoidance of bottle necks).
- Development of buffer stocks.

The development element is aimed at playing a role in expansions within communal areas.

MAIN FINDINGS

Existing storage is based on bags. This is extremely flexible and Grain Marketing Board has proven its ability to handle even considerable fluctuations in intake with high efficiency [illegible]. The proposed system is less flexible and based on fixed [illegible] does, however, have many advantages and was considered viable [illegible] with due consideration to the need for training of technical and managerial staff.

An integrated silo system will have a number of advantages:

- Higher efficiency and reduced congestion in the intake [illegible].
- Reduced costs in transport and handling throughout the chain from producer to consumer.
- Reduction of foreign currency spending on bags, tarpaulins and fumigation.
- Lower losses.

The suggested system should also give incentives to high production and a better quality in communal areas.

It is Government policy to avoid importation of maize and to keep wheat imports down to a minimum. It is expected that the agricultural sector will receive sufficient incentive to produce.

The storage system is planned for an equilibrium situation where fluctuations in production and demand will be within the limits of the buffer stocks. Drought periods and bumper crops will occur and the system is designed to handle both export and import situations.

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THE DEVELOPMENT PLAN

An integrated development plan has been drawn up with the following proposals:

- Construction of 32 new silos divided into four categories in addition to the six existing silo complexes. Extensions to three existing complexes.
- Extensions of bulk storage facilities from the present 416 000 tonnes to 1,07 million tonnes by the year 2000.

There are four categories of silos:

1. Main silos.
2. Satellite silos (2 categories - communal and commercial areas).
3. Shipment silos.
4. Distribution silos

Main Silo Depots	Number	
Production Area	7	
Consumption Area	2	(Included are the existing silo complexes at Aspendale, Banket, Lions Den, Concession, Chegutu and Norton)
Satellite category 1 (Commercial)	12	
category 2 (CAs)	8	
Distribution	5	
Shipment	4	
	--	
	38	

Besides these, bag storage will remain in small depots. It is recommended that Grain Marketing Board rationalize the number of depots and look to working with other possible procurement channels, eg, co-operatives.

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PROJECT INVESTMENT AND VIABILITY

The total cost of the basic programme is calculated at Z$64,6 million of which Z$12,6 million will be the foreign currency component.

SILO TYPE	TOTAL COST (Investment 1985-2000 in Z$1000)
Main	22 356
Satellite	31 073
Shipment	2 328
Distribution	8 632
	---
	64 389

Within the 15 year planning period the first phase (1985-95) will amount to Z$55,5 million which leaves Z$8,9 million for the last five years.

The benefits of the system will only materialize in full when the key elements have been developed. However within the first five years (1985-90) the report particularly points at the development of the following projects:

- All main silos (extension of existing complexes plus new complexes at Bulawayo, Bindura and Cleveland Dam).
- The construction of four small shipment silos.
- Satellite silos at: Karoi, Mhangura, Mvurwi, Centenary, Middle Sabi.

It is also suggested that a special type of Satellite silo be installed in the communal areas of Magunje, Murewa, Mt Darwin and Guruve.

The above projects are mentioned in a priority ranking although the final choice must be up to a more detailed implementation plan to be worked out by Grain Marketing Board.

INVESTMENT IN COMPLEMENTARY FACILITIES

The plan also points at the following complimentary investments:

- Investments in improving the railwagons (@ Z$2 300 per wagon, total cost between Z$2,3 and Z$3,5 million).
- Investment in improving the road transport facilities.
- Drying facilities at the satellite complexes in Communal Areas.

Grain Marketing Board is not involved in grain drying. However, in order to have safe storage in Communal Areas and improve intake, it is suggested that Grain Marketing Board undertakes drying on a pilot basis. The first priority projects in Communal Areas consist of four complexes. For each complex a 25 tonne drying capacity per hour will be required at an equipment cost of Z$170 000. Two buffer bins and elevators at a cost of Z$50 000 will be required bringing the total cost to Z$800 000 for the four first priority projects.

SILO CONSTRUCTION

The existing concrete type of silo is found to be the cheapest and best suited. The plan has been based on these with a few modifications to intake capacity, cleaning and aeration.

It has been found that sufficient skill and capacity exists in the local construction sector for plan implementation.

COMMUNICATION, MANAGEMENT AND STAFF

Grain Marketing Board has at present a relatively well functioning management, communication and control system.

The future success of the development plan will depend upon the training of mechanical and managerial staff to handle the 32 new complexes. The present training school shall be extended and further courses introduced.

(Please note that costs shown are 1984 figures. In present values Grain Marketing Board estimate at least a 50% increase.)

(Source: Dangroup Report - Grain Marketing Board Management)

SUMMARY OF GRAIN MARKETING BOARD BULK DEVELOPMENT PROGRAMME (1 JULY 1986 TO 30 JUNE 1995

INTRODUCTION

As per the provisionally approved Review of the Public Sector Investment Programme, Grain Marketing Board's bulk development programme for the above period was for the provision of bulk storage facilities at Bulawayo, Bindura, Mvurwi and Mhangura. Since this submission, Grain Marketing Board has had an opportunity to examine in depth the proposals contained in:

a) "Master Plan for Development of Bulk facilities for the Grain Sector" (final report) and the follow up.

b) Investment Plan for Development of Bulk facilities for the Grain Sector (draft report).

In the light of the above reports and their recommendations, the Grain Marketing Board has put forward a revised programme which has been approved by the Agricultural Marketing Authority.

THE BASIS OF CHANGE IN THE PROGRAMME

In the revised programme proposal, the Bulawayo project is retained as first priority. The rest of the programme has, however, been altered to allow for integrated bulk systems in regions. This consists of strategically located shipment silo complexes through which grain from the hinterland satellite bulk depots will be shipped to main distribution depots or consumption areas. Since it will allow for total bulk handling from the producer to consumer, such a system will be more efficient than the mixture of bag and bulk system in all areas until the completion of the programme. The revised programme accords a high priority for the development of bulk facilities in the Communal Areas.

PROJECT DETAILS

The large scale projects (+20 000 tonnes) will consist of vertical reinforced concrete silos and plants similar to those at Chegutu and Norton. The foreign content will be limited to plant and equipment (15% of total project costs).

For the small scale Communal Area projects, it is thought that:

i) remoteness of location;

ii) high establishment and overhead costs;

iii) procurement of materials;

will be unacceptably high when related to the sliding gear required for construction of concrete silos. It is therefore proposed that silos and machine houses at these complexes should be of imported prefabricated steel erected on concrete foundations (import content 75% of project cost). DANIDA have indicated they might be prepared to provide 100% financing for these projects.

Both large and small scale complexes will have:

- Cleaning systems.
- Bulk intake and discharge facilities.
- Bagging off equipment.
- Weighbridges.

All of these will contribute to a more efficient intake and despatch of products. Provision will also be made for installation at later dates of aeration and temperature detecting systems. All complexes will have limited bag storage facilities.

PROJECT JUSTIFICATION

The storage of grain in bulk silos is a more efficient system than bag storage. Its introduction will result in significant time and cost savings for Grain Marketing Board, producers and consumers.

The advantages:

a) Considerable saving in annual outlays for imported grain bags.

b) Reduction in Tarpaulin costs (used for covering bags).

c) Reduced manpower for intake, outturn and weighing.

STEEL SILOS FOR COMMUNAL AREA PROJECTS

Grain Marketing Board proposes 12 small scale steel silo complexes in Communal Areas by June 1995. In terms of the proposed programme, the first two of these complexes will be located in Mukwichi and Chiweshe Communal Areas. They will serve as pilots for the remaining 10 small scale projects, which will be started in 1990/91. The use of imported prefabricated steel components for silos and machine houses is a departure from the normal Grain Marketing Board practice of using reinforced concrete for these structures. The reasons for opting for the use of steel on these complexes was covered earlier.

CONCLUSION

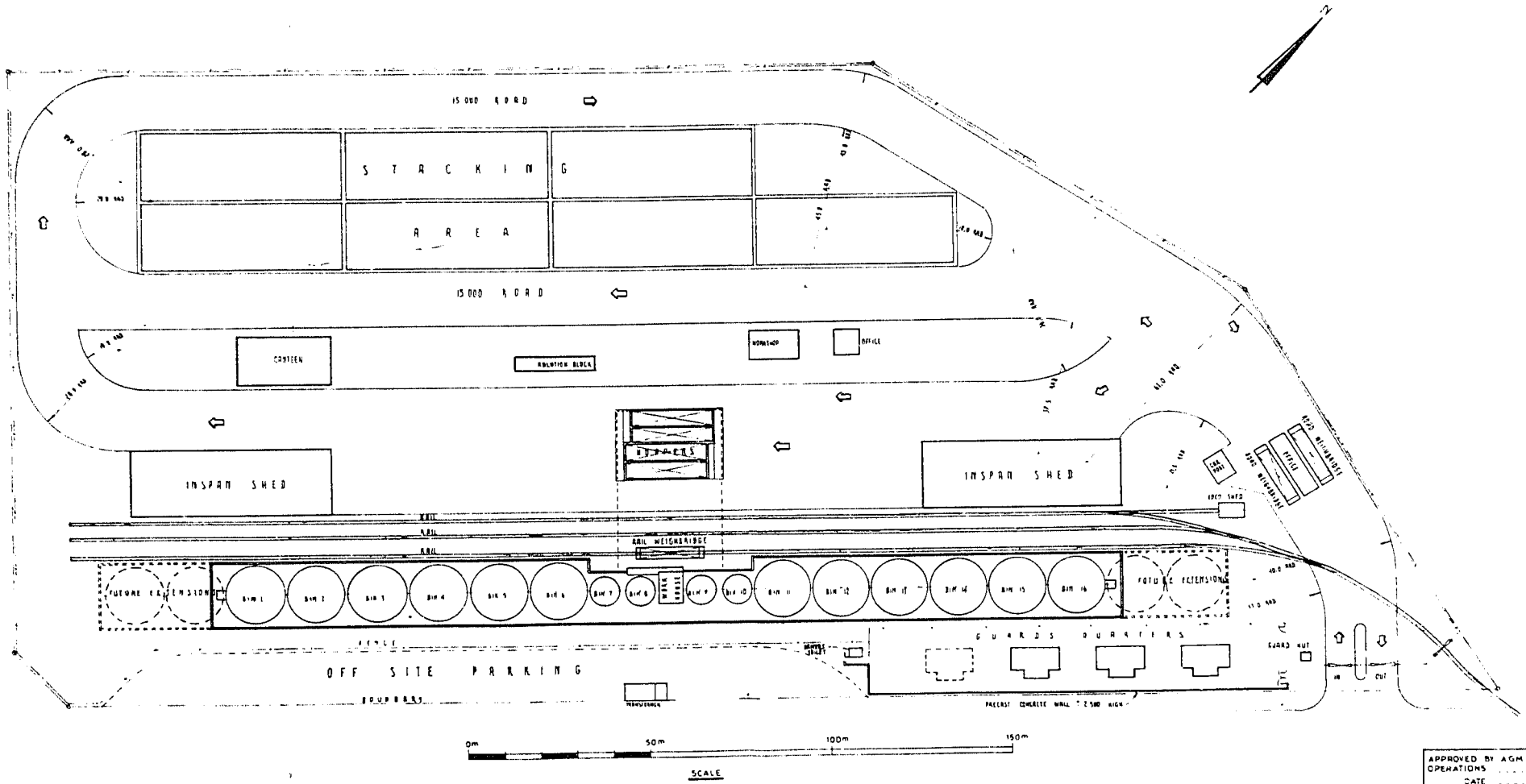
With existing bulk facilities only one third of Grain Marketing Board's intake can be received in bulk. Of these only one, Aspendale, is located in a major consumption area. With these limited facilities a large proportion of the Grain Marketing Board's inter depot transfers, even from bulk facilities, has to be in bags. The implementation of the proposed programme will increase the possible bulk intake to over 50% by the end of phase I and to over 70% by the end of phase II. In addition, the completion of the Bulawayo silo complex which supplies about 27% of national consumption requirements will enable bulk maize to be transferred to this depot. The programme will therefore result in the possible operation of a total bulk handling system over most of the country.

For further details of phase I and II see attached appendices 5 - 7.

(Source: Grain Marketing Board Bulk Development programme proposal.)

Appendix 1

CHEGUTU BULK HANDLING DEPOT LAYOUT



APPROVED BY AGM OPERATIONS
DATE

GRAIN MARKETING BOARD

ENGINEERING DEPARTMENT

HARARE

AMENDMENTS	APPROVED BY AGM	DATE
[illegible]	[illegible]	[illegible]

CHEGUTU BULK HANDLING DEPOT

REVISED LAYOUT

		DATE	AGM ENGINEERING	SCALE
DESIGNED	[illegible]	[illegible]		1:500
DRAWN	[illegible]	[illegible]		DRAWING No
TRACED				SHA/2/
CHECKED	[illegible]	[illegible]	DATE 14 2 84	

Appendix 2

GRAIN MARKETING BOARD BULK DEPOT AT CHEGUTU

by Eng A P Norman, BSc(Eng), MIwerE, CEng, MICE, MConstE(Zim)

Stewart, Scott & Partners, Harare

1. INTRODUCTION

In 1966 the Grain Marketing Board obtained the Chegutu site with the intention ultimately of developing it as an elevated bulk grain storage depot. Owing to lack of funds it was decided that initially the site would be used as a bag storage depot, but at the same time its suitability for future bulk development was established. With this in mind a basic silo layout was prepared, but only facilities for a bag handling depot were constructed in the first stage.

In 1980 the Board reintroduced a programme for silo development, the first to be the Chegutu site. Prior to this, and excluding the extensions to the Aspindale depot in Harare, the last silo construction undertaken by the GMB was the Lions Den depot completed in 1972.

The relative advantages and disadvantages of storing grain below ground, in horizontal bulk stores, elevated multi-tube nested storage bins and isolated freestanding bins were investigated, and the Board's acceptance of the last method in the past and for the foreseeable future is well documented (Ref 1); this system is well suited to the wide variety and grades of grains accepted at the Board's depots, length of storage, climatic conditions and pest control requirements in Zimbabwe.

2. DESIGN BRIEF

The design brief called for the following criteria and facilities.

(i) Total storage capacity of 60 000 t.

(ii) Road intake and two intake conveyors having a combined capacity of 300 t/h.

(iii) Offtake facilities in bags or bulk or road or rail transport totalling 150 t/h from each bay.

(iv) Grain fumigation on intake or bin turnover.

SILO PROPOSALS

Based on the Board's design brief the following proposals were submitted and accepted:

Civil

(i) Four 180 intake hoppers, 15,7 m long x 9,0 m wide x 1,0 m deep with combined intake capacity of approximately 120 t.

(ii) 2 x 15,24 m dia large bins with 30 m wall height, each with a capacity of approximately 5 000 t.

(iii) Four x 7,62 m dia small bins with 28,66 m wall height each with a capacity of approximately 2 000 t.

(iv) Machine tower 7 m x 2 m x 52 m high with 10,0 m deep basement.

(v) Intake tunnel with provision for 2 intake conveyors.

(vi) Reclaim tunnel under bin.

(vii) Steel framed overbin gantry carrying the loading conveyors.

(viii) Mezzanine floor over control room and intake area to accommodate bagging-off equipment with chuting to rail and road.

Mechanical

Two intake conveyors were selected, each rated at 150 t/h, and one built to serve each pair of rail intake hoppers. During the course of construction the intake system was redesigned to accommodate intake from a single rail intake hopper (see paragraph 9). To match intake capacity 3 x 150 t/h elevators are provided, with provision for each elevator to be used for intake or reclaim purposes should it be necessary to use these elevators in either mode in the event of an elevator breakdown or for turning over a bin.

Since the Board required a single row of free standing bins equally distributed about the central machine tower, 2 x 150 t/h over bin conveyors were selected to serve the two legs of the complex.

Initially fumigation of the grain will be effected by means of Phostoxin pellets automatically discharged into the grain flow at the head of the overbin conveyor, but provision has been made for forced circulation of fumigant or cooling air through the bins if required at some future date.

Bagging-off will be undertaken on the mezzanine floor with chuting to rail transport, and there is provision for bypassing the bagging machines for bulk discharge to road or rail. To match the outturn capacity of the plant, 5 automatic bag weighers and 4 double head bag stitchers are provided, having a combined capacity of 300 t or 2 300 bags per hour.

4. SITE GEOLOGY

Investigations conducted prior to the purchase of the site indicated a typical foundation profile of 3,0 m of clay overlying a reworked to residual greenstone schist. Penetrometer tests revealed that the depth of the weathered greenstone schist varied in depth from 5,5 m below Bin No 1 to 7,0 m below Bin No 16. A perched water table was recorded at a depth of 4,0 m. Prior to undertaking detailed foundation design for the complex a supplementary investigation was conducted, using a Fortes percussion boring rig along the centre-line of the proposed bins. The purpose of this investigation was to verify the earlier find the extent and probable founding depth of a pilot foundation and the necessity for providing a permanent casing for any piles. Conclusions reached from these investigations were:-

(a) Auger bored piles (200 t capacity) would found at depths varying from 8 to 10 metres and would require partial temporary casing to prevent side collapse.

(b) Tubular bored piles (of 1 capacity) would found at depths varying from 6 to 8 metres.

In both cases maximum settlement under load was assessed at 15 mm due to the elastic deformation of the pile shaft.

5. DESIGN

Based on the above investigations the initial decision was taken to found all bins and a section of the machine tower on 200 t augured piles. However, as the equipment for installing this capacity pile was not available in Zimbabwe and would require foreign exchange for temporary importation, alternative designs were prepared based on strip footings for Bin Nos 1 to 8 and the tender documents called for rates for the two proposals. Internal diameters of 15,24 m and 7,62 m were chosen for the large and small bins respectively to accord with the sliding equipment available in Zimbabwe, and based largely on the German Code of Practice DIN 1055 Sheet 6 a wall thickness of 200 mm was chosen for all bins. To minimise the depth of the reclaim tunnels and machine tower pit, flat floors were selected for the large bins, constructed 150 mm above final ground level on compacted fill to minimise ingress of moisture at the ringbeam/bin wall interface. Each large bin is provided with 3 outlets to facilitate emptying but even with this provision the last 30 - 40 t of grain must be shovelled manually or by some auger conveyor and provision has been made for the labour.

A 50 mm compressible layer is provided between the reclaim tunnel roof and the bin floor to prevent transmission of load to the tunnel in the event of pile settlement or elastic shortening.

The walls are lined and provided with dust-tight thin wall 125 mm thick concrete panels, bolted flat roofs (for the small bins) formed with precast prestressed concrete inverted chapel sections with concrete infill.

As with the bin walls, the 32 m high machine tower was designed for uniform construction; cold steel channels incorporating shear bars were cast into the walls to accept the post-tensioned intermediate machine floors constructed on completion of the slide. For aesthetic reasons, and to meet possible slide marks between adjacent shutter panels, the internal face of the tower was finished providing a wall thickness varying between 300 mm and 120 mm. To provide machinery access several openings were incorporated in the tower walls, the largest being 5,8 m x 3,0 m.

The original silo design provided for a rail weighbridge to record offtake in bags or bulk, but with the prevailing drought resulting in reduced maize yields this facility was redesigned to incorporate a rail intake hopper below the weighbridge deck to accept bulk rail intake primarily from sources outside Zimbabwe. Discharge from the rail intake hopper is by means of twin contra-rotating conveyors with final discharge through the intake tunnel roof on to either of the two intake conveyors.

The two overbridge gantries totalling 210 m in length were designed as IBS plate steel framed structures with articulated joints between pins to accommodate differential settlement.

6. CONSTRUCTION

The civil tender was awarded in November 1987 and the piling contractor commenced work on site in December 1987. As an alternative to the 260 m auger bored piles called for at the time of tender, the Contractor offered 105 m Franki bored piles with savings in cost and foreign exchange content. After consideration of the two offers and prices received for strip footings, it was decided to found Bins 1 to 8 on strip footings with the balance of the bins and one wall of the machine tower on Franki piles. To accommodate the resulting increase in number of piles it was necessary to increase the width of the bin ring beams from 0,90 m to 1,45 m and to arrange the piles in chevron pattern.

The 340 mm dia percussion bored piles were constructed using temporary steel casings that were withdrawn as the pile shafts were concreted. The average founding depth of the piles and strip footings were 8,6m and 3,0 m respectively and compared favourably well with predictions made during the foundation investigations.

During the piling sub-contract it was decided to provide piled foundations to Bins 7 and 8 due to their close proximity to the 10,5 m deep machine tower pit and the concern that side slips in this pit during excavation could undercut the strip footings in the immediate vicinity.

Subsequent events proved this concern was justified, in that considerable difficulty was experienced in stabilising the sides of the pit excavation, with several slips occurring and resulting in the exposure of large sections of the adjacent bin shafts. The extent of these slips was such that two piles were fractured necessitating their having to be cut off and replaced with cast-in-situ columns. In addition to those fractured, concern was felt for the integrity of the remaining exposed piles; load testing was

considered but due to the inaccessibility of the pile heads it was decided to reinforce the pile group as a whole by the introduction of additional intermediate piles and this was carried out using 350 mm dia (45 t capacity) purpose made bored Franki piles after the silos had been partially backfilled and stabilised.

Construction of the reclaim tunnels, bin ring beams and floors progressed concurrently with the machine tower pit and the first bin was slid during June 1983 over a total period of 24 hours. Sliding rates varied from 450 mm/h during the day to 350 mm/h during the night where temperatures fell regularly to about 5 degrees C; over the 36 m high wall an average sliding rate of 420 mm was achieved. No fall-outs occurred during the slide but minor horizontal cracks were observed in sections of the wall during the first evening. The most likely cause of this cracking was inadequate vibration at the interface and rate of slide not reduced sufficiently to take account of the rapid decrease in air temperature accompanying sunset.

The bin circumferential reinforcement was delivered to the contractor in bulk in 12 m lengths, cut in half on site for ease of handling on slide, cold worked by twisting and radiused to suit the bin diameters. To facilitate fixing as the slide progressed prefabricated ladders were formed using the inner and outer vertical bars with 8 mm rings fixed welded the heads of which were bent over to secure the horizontal bars in position. The bin walls were poured using Grade 20 concrete with an average slump of 115 mm which after wood floating yielded a coarse textured, but not unattractive wall finish. Prior to commissioning the bin walls will be checked by water spraying and any porous patches cut out and sealed. This procedure will be repeated towards the end of the maintenance period.

Sliding of the 52 m high machine tower superstructure was undertaken in November 1983 and was completed in 6 days. As the slide progressed a total of 73 window and door frames were cast into the walls together with numerous inlets referred to in Paragraph 5.

Construction of the intermediate work floors was carried out using conventional propped deck formwork commencing at the lower floor and using the preceding floor for support. Access to the floors is provided by means of an open grid steel stair welded to plates slid into the walls together with a passenger lift serving all main floors.

Construction of the road intake hoppers was effected by backfilling over the intake tunnel with cement stabilised fill and after shaping to the required profile the surface was used as a permanent back shutter for the hopper walls. The hoppers are covered with an open steel grid permitting delivery vehicles to drive on to the hoppers and discharge directly into them.

Mass intake by rail is catered for by the provision of a shallow intake hopper built below the rail weighbridge rail deck from where the grain is evacuated by two chain conveyors through the roof of the intake tunnel on to the intake conveyors.

MECHANICAL HANDLING PLANT CONVEYORS

Anti-static, flame-proof polyester-polyamid 2 ply belts were selected for the intake, overbin and reclaim conveyors with a nominal trough angle of 70 degrees and idlers at 1,50 metre centres; side or guide rollers were not permitted and the belts are designed to be self-training. All belts are provided with belt tension take-up devices of the screw or counter-weight type depending on their length. All conveyors are driven by shaft mounted reduction gear boxes and totally enclosed motors giving a belt speed of 2 m/s. Loading of the intake and reclaim conveyors is by means of manual-or-pneumatic operated slide valves and liftable feeders with spillage. Discharge from the overbin conveyor into the bins is achieved by means of a manually propelled tripper mechanism running on the conveyor side support rails.

Bucket elevators

Three bucket elevators, each rated at 150 t/h are provided with mild steel buckets fixed at 380 mm centres on 450 mm wide 5 ply polyester-polyamid belts. Each elevator is driven by means of shaft mounted reduction gear boxes giving a belt speed of 2,5 m/s and each drive is fitted with run-back prevention devices and speed guards that trip the drive motor in the event of the belt slipping.

Cleaners

To provide the required maize cleaning capacity (300 t/h), 4 x 75 t/h cleaners were selected and mounted 2 per floor on the third and fourth floors. Each cleaner is provided with 13 sq m of sieving area with a screen speed of 310 rpm. Fine rubble and dust chutes are provided per machine and aspiration is effected by means of integral cyclofans with a capacity of 11 000 cubic m per cleaner. Cleaned grain is discharged into 2 x 75 t builder bins and then either in bulk to rail or mezzanine floor for bagging off or returned to the elevator buckets when recirculation is required.

Aspiration

Dust extraction from the elevators intake conveyors, reclaim and overbin conveyors is provided by a 14 450 cubic m/h cyclofan while the air discharge from the cleaners is vented through a 22 200 cubic m/h cyclofan. Rubble and dust extracted from the cleaners and cyclofans are ducted to the mezzanine floor area, where they are bagged off for disposal or, in the case of broken grain, sold for animal feed. Both legs of the reclaim tunnel and the intake tunnel are provided with exhaust fans.

Bagging-off equipment

Eight auto bag weighers each having a capacity of 22 t/h (250 x 90 kg bags) are provided within the machine tower at the mezzanine floor level. The bag weighers are arranged in four rows of two each standing over conveyor belts that deliver the filled bags to the sewing machines, and from there by chutes to the rail trucks. The original design provided for the sewing machines to be immediately adjacent to the bag weighers.

Operational experience has shown that the bag contents have to be dropped down chutes to stitching to prevent damage to the sewing machine needles, due to coming in contact with the old cotton kernel, and the layout was changed accordingly.

ELECTRICAL PLANT

A separate contract was let covering the electrical connections to and control of the mechanical handling plant, internal, yard and security lighting and air-conditioning to the ancillary buildings. For control purposes three alternative systems were included in the tender documents namely relay logic, solid state logic and a programmable logic controller. In line with modern day trends the Board opted for a programmable control system and the controller was incorporated into the panel in the control room. A controller having 256 input/output was specified to provide sequence and parallel flow interlocking to ensure that no two lines of plant can discharge into a common point simultaneously. Sequence and parallel interlocking are provided to facilitate the following grain flows.

) - Intake grain from road or rail hopper and transport to any selected bin via a variety of routes using one or the intake elevators.

) - Intake grain as a above but via elevator using two elevators.

) - Reclaim from any bin and recirculate to any other bin.

nd

s - Reclaim from any bin and load out to road or rail in bulk or in bags.

Before initiation of any of the above starting sequences the following conditions must be satisfied:

a) Start-up alarm initiated.

b) Start period is "on" to energise the mimic panel start devices.

c) Main aspiration fans are running.

d) Tunnel exhaust fans are running beforehand intake or reclaim conveyors can be energised.

e) No simultaneous "intake" and "reclaim" is taking place on any one bin, and,

f) No two slides leading into the same conveyor are open.

In addition to the interlocking system numerous trip and alarm systems are incorporated into the plant layout covering such conditions as high bin level, wrong bin selection, selected slide valve being closed, movable tripper being moved from selected bin position, etc.

For maintenance and emergency operating conditions interlock/by-pass switches are provided in the motor control panel and in these circumstances motor starting is only possible out of sequence at the motor.

9. ANCILLARY BUILDINGS

A double storey office and grading block is situated at the entrance to the depot flanked by two road weismeters to record incoming road deliveries. Two open sided fabricated steel structures are provided in the vicinity of the machine tower for the housing of other grains, grade 3 maize and rubble and dust from the grain cleaners. To complete the depot ancillary buildings, provision is made for a canteen, ablution block, workshop, guards quarters and drivers' latrine.

To cater for maize in excess of the bin capacity, 7 000 sq m of surfaced hardstandings have been provided for storage in big stacks.

10. MAIN CONTRACTORS

The main contractors engaged on the project are as follows:-

Civil Works - Wade Adams (Zimbabwe) (Pvt) Ltd
Mechanical handling plant - Cimbria Unigrain, Denmark
Electrical work - BAK Electrical Holdings (Pvt) Ltd
Passenger lift - Schindler Lifts (Zimbabwe) (Pvt) Ltd
Weismeter equipment - Avery Zimbabwe (Pvt) Ltd

11. ACKNOWLEDGEMENT

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Reference

1. "Free Standing Silos" by M Fokkens and J A Walters - Ilobolwana Engineer, March 1969.

Appendix 3

CHEGUTU SILO STORAGE AS AT 24/10/86

48 000 tonnes white maize
17 000 tonnes wheat

Chegutu Silo Storage as at 21/11/86

45 000 tonnes white maize
15 500 tonnes wheat

White maize intake week ending 17 October 1986 (1986/87)

DEPOT	COMMERCIAL BAGS	COMMUNAL BAGS	TOTAL INTAKE BAGS
Chegutu Silo	460 563	27 590	488 153
Chegutu Bag	187 573	71 382	258 955
Mhondoro	1 591	183 078	184 669
Nuremberdi		285 526	287 526
Total Deliveries for Zimbabwe till 21/11/86	9 613 060 bags 1 885 875 tonnes	7 020 739 bags 656 867 tonnes	
%	57%	43%	

Appendix 4

DELIVERIES OF MAIZE TO GMB FOR 5 YEARS ENDING 31.3.85

AREA	DEPOTS	TONNES	% OF TOTAL	% OF COMMUNAL AREA DELIVERIES 1984/85
Makonde	Karoi, Mhangura, Magunje	907 772	15,7	40
Mvurwi	Mvurwi, Centenary, Gurave	526 109	9,4	43
Hwedza	Hwedza, Mt Darwin * Shamva *	783 381	6,1	51
Murewa	Murewa, Mutoko *	235 176	3,6	100
Existing Silos Locations	Aspindale, Lions Den Bankat, Concession, Chegutu, Norton	2 291 168	36,4	
Others		1 871 561	29,8	
TOTAL		6 290 477	100,0	41

* Included amongst the 16 communal area projects.

Appendix 5

PROPOSED GRAIN MARKETING BOARD BULK DEVELOPMENT PROGRAMME 1985 TO 1995

		PHASE I					PHASE II				
LOCATION	CAPACITY (TONNES)	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95
Bulawayo	175 000	P	C	C							
Karoi	170 000		P/C	C	C						
Mukwichi	110 000 1		P/C	C							
Chiweshe	110 000 1		P/C	C							
Lions Den	120 000 2			P/C	C						
Maganje	160 000 3			P/C	C	C					
Mhangura	160 000				P/C	C	C				
Bindura	145 000										
	120 000 2					P	C	C			
Murewa	160 000 3						P	C	C		
Mvurwi	145 000							P	C	C	
Gurure	145 000 3								P	C	C
Centenary	130 000								P	C	C
TEN PROJECTS 4	175 000 (TOTAL)					P	C	C	C	C	C

1. Pilot small scale complexes for communal areas
2. Shipment silo complexes
3. Large Scale communal area projects
4. Small Scale complexes with capacities of 5 000 to 10 000 tonnes. These projects will be based on the findings of the two pilot projects at Mukwichi and Chiweshe. All ten projects will be at as yet undetermined communal or resettlement area locations.

P = Planning
C = Construction

Appendix 6

PROPOSED FUNDING STREAM FOR PHASE I OF THE GRAIN MARKETING BOARD'S BULK DEVELOPMENT PROPOSALS: AT CONSTANT 1985 PRICES

LOCATION	FUNDING x Z$1 000					TOTAL PROJECT COST x Z$1 000	REMARKS
	1985/86	1986/87	1987/88	1988/89	1989/90		
Bulawayo	330	5 640	3 200			11 560	
Karoi		1 360	5 880	1 800		9 040	
Mukwichi		1 160	1 160			2 320	
Chiweshe		1 160	1 160			2 320	
Lions Den			1 760	1 770		3 530	
Mgunje			1 310	5 130	2 180	8 720	
Mhangura				1 296	5 190	6 586	[1] 140 000 required in 1990/91.
Tsidzura					730		Planning only
Ten Projects[1]					300		Constructions scheduled for Phase 2.
TOTALS:	330	9 320	14 470	10 096	7 900		

1. Ten small scale projects (5 000 - 10 000 tonnes capacity each) in communal or resettlement areas.

2. INCLUDES PHASE 2 EXPENDITURE.

Appendix 7

PROPOSED FUNDING STREAM FOR PHASE I OF THE GRAIN MARKETING BOARD'S BULK DEVELOPOMENT PROPOSALS: AT INFLATED PRICES *

LOCATION	FUNDING x 1$1 000					TOTAL PROJECT COST x 1$1 000	REMARKS
	1985/86	1986/87	1987/88	1988/89	1989/90		
Bulawayo	330	6 970	4 260			11 560	
Karoi		1 880	7 210	3 030		12 120	
Kwekwe		1 440	1 550			2 990	
Chiweshe		1 440	1 550			2 990	
Lions Den			2 500	2 710		5 210	
Mangwe			1 860	6 000	5 580	13 440	
Mhangura				2 110	9 050	15 200	1) 4 040 (00 required in 1990/91
Bindura					560	2	2) to complete project.
Ten Projects 1					560		1) Planning only - Construction
							1) Scheduled for Phase 2
TOTALS	330	11 530	14 470	13 430	15 750		

1. Ten small scale projects (5 000 - 10 000 tonnes) in communal or resettlement areas.

2. INCLUDES PHASE 2 EXPENDITURE.

COSTS INFLATED BY 15% PER ANNUM UP TO THE START OF THE PROJECT AND BY 7,5% PER ANNUM DURING THE COURSE OF THE PROJECT.