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ASSESSMENT of FOOD-GRAIN STORAGE FACILITIES

WEST PAKISTAN 1968

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ASSESSMENT FOOD GRAIN STORAGE FACILITIES
WEST PAKISTAN 1968

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I. SYNOPSIS

The purpose of this assignment was an assessment of food grain storage facilities in West Pakistan and schemes for materially increasing available storage capacity in the immediate future at minimum cost. The urgency of the situation is exemplified by the fact a sizable amount of the 1968 wheat crop is currently stored in temporary or emergency facilities not well adapted to quality maintenance for extended periods. Current estimates are a minimum of 300,000 and possibly 500,000 tons (long tons) additional food grain storage space will be needed to accommodate 1969 food grain production. A failure to develop adequate storage for this food grain could mean sizable economic losses for Pakistan.

This report includes only "short-run" recommendations. Recommended action could be initiated and completed prior to the 1969 food grain harvest. Action on recommendations will ease the immediate need, compliment West Pakistan's present food grain storage development program, and fit future accelerated programs when initiated.

At a future date, as soon as possible, an in-depth study of West Pakistan's "long-range" food grain storage and management needs is recommended. This study should consider the total grain storage and management needs from cultivator to consumer. This would include, in addition to storage facilities, transportation, marketing, quality controls, food grain handling and processing. A study of this scope would provide valuable guideline data for the development of an orderly, economical, and efficient grain management program -- a program designed to accommodate Pakistan's needs and growing agricultural production. Kansas State University, under existing contract arrangement with USAID could provide technical personnel to assist on such a study.

A. Summary of Assessment Recommendations.

1. Schemes for increasing food grain storage.

a. Make maximum use of existing house-type godowns.

(1) Bag Storage. Stored bags 15 high instead of the 10 bag height design or rated capacity. This would provide 250 tons additional, quality storage in each 50' x 100' house-type godown.

(2) Temporary Bag Storage (6 months or less). Enclose the porch areas either with brick walls between columns or plastic film curtains. Stack bags on porches leaving access to doors open. Possible added storage capacity 125 to 150 tons per 100' godown.

(3) Temporary Bulk Storage. Build bag bulk heads to support bulk grain storage within godowns. Potential increase of quality storage is 500 tons per 100' godown or 100% over design capacity.

(4) Bulk Storage. Reinforce and waterproof godown walls for bulk grain storage. Potential quality storage within each godown (12' grain depth) is 1,200 tons or (15' grain depth) 1,500 tons per 100' godown. A 150 to 200% increase in capaicty could be realized.

(5) Potential Increase in Storage Capacity. As of July 1, 1968, West Pakistan had accommodations for 304,500 tons wheat storage in house-type godowns. This represents 609, 100' or 500 ton units. The following table shows potential increased storage capacity in existing godowns:

TABLE I.

INFLUENCE OF SUGGESTED SCHEMES ON STORAGE CAPACITY OF EXISTING HOUSE-TYPE GODOWNS

Scheme	Godown Capacity (Tons)	Modified Godown Capacity (Tons)	Increased Storage Potential (Tons)
(1) Bags 15 high	300,000	450,000	150,000
(2) Porch storage	300,000	375,000	75,000
(3) Bulk (bag bulked)	300,000	600,000	300,000
(4) Bulk 12'	300,000	720,000	420,000
(4) Bulk 15'	300,000	900,000	600,000

b. Develop and initiate a program to encourage the immediate expansion of quality storage in the private sector. Especially the largerproducers (cultivators), those with 25 acres or more.

(1) Provide economic incentives. Guaranteed storage at attractive rate, low interest rate loans for construction, etc.

(2) Provide engineering services or plans for economical farm size godowns using readily available local construction materials (brick and concrete).

(3) Assist producers and local steel processors with the procurement and fabrication of quality food grain storage units adapted to local needs.

(4) Initiate an information program to inform producers of the incentive program and encourage prompt construction of food grain storage facilities.

c. Expand and accelerate the government food grain storage facility construction program.

(1) Make a special effort to have the 200,000 ton new house-type godown scheduled for completion in 1970 erected and ready for use by 1969.

(2) Consider the possibility of contracting for pre-fabricated metal warehouse buildings that should be completed prior to the 1969 harvest season.

(3) Consider the possibilities of purchasing and using temporary storage (plastic films, etc.) to provide "short-time" storage and protection for food grains produced in excess of available storage capacity in 1969.

2. Recommendations for minimizing food grain losses in storage.

a. Initiate and conduct an effective stored-grain insect control program.

(1) Establish a regular inspection program with specific schedules that call for treatment when needed.

(2) Train the managers of storage centers in the latest insect control techniques and materials.

(3) Equip managers of grain storage centers with the tools and materials needed for effective insect inspection and control.

b. Exclude birds and rodents from food grain storages.

(1) Install and maintain screens on ventilation openings.

(2) Install screened doors on storage entrances.

Note: Birds were noted as a problem in storages visited. Rodents or evidence of rodents was not noted.

c. Initiate and conduct a stored-grain quality control program. This will be necessary if bulk storage is to succeed.

(1) Establish a quality control and measurement program at all major grain receiving points. Sample, inspect and grade grains for foreign materials, moisture content, and grain quality.

(2) Equip grain receiving points with the tools needed for inspection and quality measurement.

(3) Train grain storage managers in techniques of grain inspection, quality measurement, and storage management.

d. Special management and requirements for bulk storage.

(1) Store only dry grain 12% moisture or less.

(2) Provide for aeration in storage if storage periods exceed 90 days without movement.

(3) Provide mechanical equipment for movement of grain into or out of storage.

II. INTRODUCTION

This analysis of West Pakistan's food grain storage facilities has been made possible through the courtesy and assistance of the Government of Pakistan and USAID/Pakistan officials. The assessment is limited to storage facilities for wheat and rice and considers only (1) schemes for increasing storage capacities within the immediate future, and (2) modifications in food grain storage management which would minimize in-storage losses. A more complete study is recommended for the solution of West Pakistan's long-range food grain storage and management problems. Statements and suggestions set forth have been discussed with GOP and USAID officials.

General Situation. Agricultural production of wheat and rice in West Pakistan has outgrown available storage facilities. A visit to grain storage sites and briefings with GOP officials revealed the government hired 383,084 tons (long tons) of godown space to accommodate the 1968 wheat crop. In addition, a sizable tonnage is held in temporary storage, in sacks, in the open under Bee Hive-type godowns, etc. This is inferior quality storage. Propects for adequate storage for the 1968 rice crop are not good. It is conservatively estimated, a minimum of 300,000 tons and probably 500,000 tons, additional storage will be needed for the 1969 wheat crop. This would be in addition to the 200,000 ton additional house-type godown space scheduled to be completed by 1970. It was noted some of the hired godown space is temporary at best and not readily adapted to quality control, protection, or efficient grain handling procedures.

III. WEST PAKISTAN GRAIN STORAGE FACILITY INVENTORY 1968

A. Central Government Storage Facilities at Karachi.

West Wharf, Karachi, New Concrete Godown	---	35,000 Tons
Thole Produce Yards - approximate	---	70,000 "
Landhi - Cement Godowns	---	160,000
Pipri - New Cement Godowns	---	112,000
Total Central Govt. Storage		377,000 Tons

B. Provincial Government Storage Facilities.

Lahore	---	201,500 Tons
Peshawar	---	61,800
Multan	---	127,500
Quetta	---	27,900
Kalat (Sub-region)	---	9,350
Karachi	---	200
Hyderabad	---	161,640
Total Provincial Govt. Storage		589,890 Tons

C. Private Storage Facilities.

1. Commercial Godown Capacity

Karachi	--- 500,000 Tons
Lahore	--- 500,000
Peshawar	--- 100,000
Rawalpindi	--- 100,000
Hyderabad	--- 100 000
Multan	--- 100,000
Quetta	--- 50,000
Sukkur	--- 100,000
Jacobabad	--- 50,000
Lyallpur	--- 150,000
Sahiwal	--- 50,000
Sialkot	--- 50,000
Bahawalpur	--- 50,000
Gujranwala	--- 50,000
Jhelum	--- 50,000
Total Commercial	2,000,000

2. Zamindar-Cultivator Storage - 2,000,000

3. Commission Agents' Storage --- 400,000

4. Roller Flour Mill Storage. --- 100,000

TABLE II

TOTAL GRAIN STORAGE CAPACITY
WEST PAKISTAN

Central Government Storage	377,000 Tons
Provincial Government Storage	589,890
Commercial Godown Operator	2,000,000

Total Grain Storage Capacity (con't)

Zamindar-Cultivators Storage	2,000,000 Tons
Commission Agents' Storage	400,000
Roller Flour Mill Storage	100,000
Total Storage	5,466,890 Tons

The above accounting of grain storage facilities is the most recent and accurate that could be assembled from available data. The Provincial and Central Government sector accounting is no doubt quite accurate as is the Roller Flour Mill Storage. Accounting in the Commercial Godown and Zamindar-Cultivator sectors is at best an estimate.

The author is in agreement with the source of these figures to the effect, they no doubt exceed by a sizable amount available storage of quality. In view of the fact these two sectors account for slightly over 73% of the total storage, the above total could be very misleading regarding available food grain storage in West Pakistan.

Certainly the usable storages of quality available to handle a reserve stock of food grains on a long range basic could easily reduce this figure substantially. The current shortage of adequate storage would substantiate this analysis. For a more complete evaluation of this area, a study of commercial storages from both a quantity of storage and quality of storage viewpoint would be advisable. It would also be desirable to study in more detail the storage on the larger farms, especially all producers cultivating over 25 acres.

IV. ASSESSMENT OF WEST PAKISTAN FOOD GRAIN STORAGE FACILITIES

A. Provincial Storage Visited.

The assessment was accomplished by making field trips to the storages and inspecting both the buildings and the condition of grain in storage. It was requested that a cross-section of storages in the various sectors be included in order that an accurate picture of the conditions could be observed. Cooperation was excellent on this request. The Provincial storage inspected in the Lahore area and the quantity of grain in storage at the sites were as follows:

Type of Storage	Capacity (Tons)
Gulberg Godown, House-type Godown	19,810
Gulberg Mill, Masonry Shed Adjacent to Mill (Leased)	260
Stadium, Masonry Enclosed Area Under Seats (Leased)	3,940
Model Godown, Concrete Above Ground With Hopper Bottom Bins and House-type Godowns	12,008

B. Private Storage Visited.

Private storages inspected were in the Lyallpur area. Types of storage visited and their capacities were as follows:

Type of Storage	Capacity (Maunds)
Saigol Model Farm	35,000
Cultivator Storage, Village 248 R.B.	---
Traditional Clay Bin (Bulk)	40
Small Clay Box in Home (Bulk)	10
Bag Storage in Room	10 (Bags)
Outside Brick Storage	100
Pile on Floor in House	10
Grain Bazar Lyallpur	---

The only commercial godowns visited were those leased by the Provincial Government in the Lahore area.

C. Assessment of Various Types of Storage.

1. House-type Godown. The standard house-type godown is a brick masonry structure with a concrete floor 50' wide 100' long and 20' high exterior with a reinforced concrete roof. See photograph in Appendix B. The Gulberg godowns were double units 50' wide 200' long x 20' high. These godowns have a porch along each side approximately 8' wide and 14' high with concrete floors. This shades the storage and protects the sidewalls from rain. Each large godown has 8 doors per side approximately 4' wide. There are 16 ventilators on each side and 4 on each end located approximately 3' from the ceiling. Design storage capacity 10 bags high normally is 500 tons per 100' godown. Current storage 13 bags high is 750 tons per 100' godown. Bags were stacked approximately 2' from walls with one 18" aisle lengthwise in the center of the building and cross ailses approximately 3' in front of each door. Stacking layout: each section, 6 bags across and 1 lengthwise between columns. Head space above bags was 6½ to 7' with bags stacked 13 high. These are high-quality godowns. The Government owns 304,600 tons of house-type godown storage at the present time. In the house-type godown at the Model Godown site, a trial with bulk storage using bags of grain as retaining walls was in process. This increased the capacity of a 100' unit to 1,000 tons with approximately 7' of head clearance.

2. Grain Condition in Storage. The grain inspected at the above godown site was PL-480 wheat in storage about 10 months. The grain was dry. The grain was infested with flour beetle. It had not been fumigated in storage to date. There was also evidence of a bird problem. There was no visable evidence of a rodent problem. Conditions around the storage were generally clean. The insect problem was the

most serious deficiency noted. A sizable loss is inevitable if this is not corrected immediately. These godowns can be sealed and fumigated.

3. Beehive-type Bins. Beehive-type bins are reinforced concrete hopper-bottom, octagonal clusters of bins with a capacity of 37.5 tons each. See photograph in Appendix B. The bins are supported on columns so the grain can be removed by sacking directly from bin spouts. These are excellent quality grain storage units. They are rodent proof, bird proof, and easy to treat for insects, if necessary. They have a flat reinforced concrete roof with man-holes for filling. The grain in these bins was in good condition.

4. Hired Godowns. Visits were made to two sites, the Gulberg Mill, and the Stadium in Lahore. See photographs in Appendix B. The grain was adequately protected from the weather at both sites. The storages were, however, not adapted to fumigation for insect treatment. Sizable losses from insect damage can be expected if grains are kept in such storage for extended periods. This is adequate emergency protection but certainly not desirable as a continuing practice for the GOP.

5. Private Godowns. A representative cross-section of cultivator storages was visited. In general, the grain was adequately protected from the weather at all sites visited. The small traditional storages were adequate and well adapted to local building materials. These producers apparently watch their grain closely and control insects by spreading the grain in the sun if a problem occurs. The large farm, the "Saigol Model Farm", was following good grain storage management practices. The wheat was stored, in bulk, in a brick masonry flat storage godown, capacity 35,000 maunds. Prior to placement in storage, the grain was cleaned to remove dirt, cracked grain, and chaff. The grain was treated in storage for insect control. The major deficiency noted was birds. They were not excluded from the storage. The management of this storage would, if representative, indicate that large producers could and would manage quality grain storage if adequately encouraged.

6. Estimated Grain Losses in West Pakistan. The importance of improved grain management to the economy and nutrition of West Pakistan is emphasized by the following data secured from Dr. A. O. Shaw at the University of Lyallpur.

TABLE III

ESTIMATED ANNUAL GRAIN WASTAGE FROM PRODUCER TO CONSUMER

Grain	Annual Loss (1,000 Maunds)
Rice	2,831
Wheat	18,783
Other Cereals	3,158
Millets	3,294

While it is not realistic to assume storage is the major source of these losses, it is reasonable to assume storage losses are sizable and certainly quality maintenance is a major factor to consider in any grain storage facility used or constructed.

V. RECOMMENDATIONS FOR INCREASING FOOD GRAIN STORAGE CAPACITY IN THE IMMEDIATE FUTURE

Three basic approaches for the expansion of available food grain storage are assessed and evaluated.

1. Making better use of government storage space already available.

2. Immediate expansion of private sector storage, especially the larger cultivators.

3. Immediate expansion of government storages.

There is good reason to believe a needed 300,000 to 500,000 tons additional quality storage capacity can be economically developed prior to the 1969 wheat harvest with prompt action on the above schemes.

A. Maximizing Use of Existing House-type Godowns.

These quality godowns are designed to accommodate 500 tons per 50' x 100' unit, bag storage 10-bags high. This has been a successful trouble free program for managing these godowns. It does not, however, make very efficient use of the potential volume of storage in these units. In view of the fact the government currently has over 600 of these 500 ton units distributed throughout West Pakistan first consideration should be given to making better use of this space.

1. Scheme one.

a. Bag Storage. Store bags 15 high instead of the 10 bag design storage height. This practice is being tried at the Gulberg Godown site and others. This increases the storage capacity of each 100' godown 250 tons or provides a potential of 150,000 tons additional quality storage.

b. Problems. Bags stacked 15 high are not as stable as 10-bags high storage. Occasional bag slides occur, especially if storage is adjacent to a railroad line, requiring labor to realign bags in storage. Storing bags 15 high requires more labor to place grain in storages than 10-bag high storage. The bag slides could be controlled by tying the bags at the 5th and 10th tiers. One-half inch rope ties across the bag stack at these tiers secured by wrapping and tying them around the edge bags would be adequate. Place a tie on every third bag along the edge of the stacks, all sides.

c. Storage Management Changes Required. No management changes are required to make this change except the ties suggested above.

d. Cost of Change. Approximately 1,500' of ½ inch rope for each 100' unit at very little cost. Some additional labor is required.

e. Time Required to Initiate. Could be initiated immediately.

2. Scheme two.

a. Temporary Bag Storage. Enclose the porches along the sides of the house-type godowns with either brick walls between porch column or plastic film sheets to exclude weather. Stack bags under the porches. Potential added storage is 125 to 150 tons per 100' godown with all doorways left open for access and ventilation. Total possible additional storage capacity 75,000 tons.

b. Problems and Limitations. Adapted for temporary storage of only 6 months or less. This type storage is not readily adapted to fumigation for insect control. Security of grain could be a problem, especially if the plastic curtain is used.

c. Storage Management Changes Required. No major management changes necessary. Grain is handled and stored in bags. Plastic curtains, if used, would require maintenance and regular inspection. This could possibly require a few minor changes at grain receiving or drying times since the porches would no longer be available.

d. Estimated Cost of Change. The estimated cost of brick enclosure would be 50 rupees per ton. Plastic curtains, installed, would cost 15 to 20 ruppees per ton.

e. Time Required to Complete Changes. Storage should be completed and ready for use within 90 to 120 days after contract or purchase agreement is completed.

f. Comment. The quality of storage proposed here is admittedly inferior to that proposed under 1, 3, or 4 of this section. It is, however, comparable or superior to some of the hired storage visited and emergency storage used for the 1968 wheat crop. It is low cost storage, conveniently located for efficient control and management by currently employed managers, and it could be made available in time to serve the immediate need.

3. Scheme three.

a. Temporary Bulk Storage. Using bags as support walls or bulk-heads, store grain in bulk within the godowns. This practice is being tried in the house-type godown at the Model Godown site at Lahore. Technology of bag bulk-head construction is known by the Lahore bin site manager. Potential additional storage capacity is 500 tons per 100' unit or 300,000 tons for the 600 house-type godowns.

b. Problems and Limitations. Grain in storage will be handled in bulk instead of bags. This will require new or different handling equipment. Bulk storage is adapted only to dry grain storage, 12% moisture content or less. Managers of storage centers may need training in technology of grain quality maintenance with bulk stored grains.

c. Storage Management Changes Required. Aeration of grain in storage will be required for long-time storage (over 6 months) to insure quality maintenance. Bulk handling equipment will be needed to fill and empty storages. Determination of moisture content of grain into storage will be needed. Moisture level should not exceed 12% for long term storage.

d. Estimated Cost of Change. Aeration equipment complete and installed per 100' godown is estimated at $5,000.00 (25,000 rupees). Cost of portable grain conveying equipment would be $1,000 (5,000 rupees) per 100' unit. Cost per 100' unit for aeration and conveying equipment would be 30,000 rupees. Total cost for the 600 100'-units would be 18,000,000 rupees for 300,000 ton additional storage or 60 rupees/ton.

e. Time Required to Complete Changes. It is estimated the aeration and conveyor equipment could be delivered, installed and ready for operation in approximately 6 months following a purchase order.

f. Comments. This scheme could provide 300,000 tons additional quality storage with no additional new construction. Aeration is considered essential to the successful use of this storage system, especially storage of 6 months length or more.

4. Scheme four.

a. Godown Modification for Bulk Storage. Reinforce and waterproof godown walls for bulk storage. Godown walls support the grain without bag bulk-head. Potential quality storage within godowns (grain stored 12' deep) is 1,200 tons, (grain stored 15' deep) 1,500 tons per 100' unit. Increase in storage capacity for 600 units: 420,000 tons (12' depth); 600,000 tons (15' depth).

b. Problems and Limitations. Grain in storage will be handled in bulk instead of bags. This will require new or different handling equipment. Bulk storage is adapted only to dry grain storage, 12% moisture content or less. Managers of storage centers may need training in technology of grain quality maintenance with bulk stored grains.

c. Storage Management Changes Required. Aeration of grain in storage will be required for long-time storage (over 6 months) to insure quality maintenance. Bulk handling equipment will be needed to fill and empty storages. Determination of moisture content of grain into storage will be needed. Moisture level should not exceed 12% for long term storage.

d. Estimated Cost of Change.

Aeration system complete per 100' unit	- $5,000.00	- 25,000 rupees
Conveyors - portable per 100' unit	- 1,000.00	- 5,000
Reinforcing steel per 100' unit	- 4,000.00	- 20,000
Waterproofing Paint per 100' unit	- 500.00	- 3,000
Labor per 100' unit	- 1,000.00	- 5,000
Total per 100' unit	$11,500.00	58,000 rupees

Cost/ton of additional storage is 50 to 80 rupees/tons.

See drawing - Appendix B for reinforcement schedule.

e. Time Required to Complete Change. It is estimated the aeration, conveyors and necessary construction could be completed and ready for use within 6 months after a purchase order was initiated.

f. Comments. Initiation of this scheme in all available house-type godowns would provide for the estimated additional storage needed. It would also be quality storage, conveniently located for efficient management.

B. Expansion of the Private Sector Storage, Especially the Larger Cultivators.

1. Present Farm Sector Storage. At the present time, it is estimated the Zamindar-cultivator storage capacity of West Pakistan is 2,000,000 tons. This represents 37% of the total storage in the country. There are 4,422,496 small cultivators operating farms of less than 25 acres. They cultivate approximately 28 million acres or 54% of the cultivated acreage. Estimates indicate these producers normally store and consume their own production. Small cultivator storages visited in the villages varied in capacity from 100 maunds to 10 maunds. Assuming an average storage capacity of 10 maunds per small cultivator, approximately 1,000,000 tons of the available 2,000,000 tons is owned by this group.

There are 400,000 tons in the ownership of the 367,487 cultivators operating acerages of 25 acres or more. These cultivators manage 21 million acres, or 46% of the cultivated land and market 80 to 90% of their production. They are, therefore, the major source of the food grains reaching government storage.

2. Potential for Increased Storage. If a program were initiated to stimulate these producers to store more of their production on a short-term (6 month or less) basis, it would greatly relieve the immediate need for more government storage space. Visits with several of these larger producers left the impression they would build storages if assured of a fair return on their investment. Many of these producers are, no doubt, economically capable of erecting their own storage and could do so in a relatively short time if given adequate incentive and encouragement. The quality of the grain storage observed at the Saigol

Model Farm was some of the best visited. Many of these producers have a need for an all purpose warehouse structure to shelter tools and equipment, seeds, fertilizer, and grain.

3. Program for Increased Farm Storage. A program that would encourage 10% of these large producers to erect 100 ton storage each during the next year could produce over 350,000 tons additional storage.

a. Specific suggestions for enacting such a program includes:

(1) Provide economic incentives. Guaranteed storage, low rate interest on loans for construction, etc.

(2) Provide engineering services or plans for economical farm-size godowns using available local building materials (brick and concrete).

(3) Assist cultivators and local steel processors with the procurement and fabrication of quality food grain storages adapted to local needs.

(4) Initiate an information program to inform cultivators of the program and encourage prompt construction.

b. Farm size, metal-bin bulk storage units, 50 to 100 tons capacity, could be imported, erected and equipped for a cost of $.80 to $1.00 per bushel capacity. This represents a cost of 150 to 200 rupees per ton.

c. No assessment is made in this report of commercial or other private sector storage.

C. Expand and Accelerate the Government Food Grain Storage Facility Construction Program.

The major factors of concern in this evaluation are the time element and the cost factor. The two types of storage facilities considered are (1) imported, prefabricated metal grain storage facilities and (2) the house-type godowns currently in use and under construction.

1. Procurement of new buildings.

a. New Steel Prefabricated Storage Buildings. All steel buildings assessed, with proper in-storage management are quality food grain storages. Storage losses will be minimum. Rodent, bird, insect, and security controls are not difficult to effect. The steel structure should provide a minimum of 15 to 20 years service with very low maintenance. After this, periodic painting to prevent rusting (every 3 to 5 years probably) will extend the effective life indefinitely. The limitations, advantages and disadvantages, of each building assessed are given in the specific building assessment. The price data is current and was supplied by Butler Manufacturing Company. Shipping charges and erection costs are estimates as per the cost information available. There is little difference between manufacturers in

the cost of buildings of comparable size, quality and strength. Buildings selected were sized to permit easy cost comparison with 50' x 200' x 20' house-type godowns used extensively in West Pakistan (example: the Gulberg godown storage, Lahore).

(1) Type I Structure. A panel-frame, clear-span gable flat storage unit. See photograph in Appendix B. This is a light-weight structure, not designed for bulk grain storage against sidewalls. It is evaluated only as sack or bag storage. The building is equipped with ventilators and large openings for convenient entrance or exit. It would also provide quality fertilizer storage, shelter for implements, etc.

(a) Building size.

216' long, 50' wide, 14' wall height. (Butler, RF - 21)

(b) Storage capacity wheat.

Bag storage 10 high	---	1,081 tons
Bag storage 12 high	---	1,300 tons

(c) Building cost.

Price CIF Karachi, Pakistan	---	$13,715.00
* Estimated shipping and erection	-	14,785.00
Estimated cost		$28,500.00
** Cost/ton storage (10 bags high)		26.00
** Cost/ton storage (max 12 bags high)	$	21.92

(d) Evaluation Comments.

(i) Building as evaluated not equipped with aeration or conditioning equipment.

(ii) Would not be easy to seal for fumigation insect control. Special covers would be required to be effective.

(iii) Does not include drying equipment, so will handle only dry grain.

(iv) Best adapted to (short-term storage) 6 months or less.

(2) Type II Structure. A rigid frame, clear-span gable roof, flat-type storage unit. See photograph in Appendix B.

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* Erection includes site preparation, required concrete work (foundation and floor), and steel erection.

** All tonnage based on long tons (2240 lbs.) of wheat.

It is a heavy duty all-purpose building. The walls are structurally designed to withstand direct pressures of bulk grain completely filled. The building will accommodate bag or bulk grain storage, fertilizer storage, implement storage or any general warehouse use. The building, as priced, includes ventilators and large openings to permit easy entrance or exit. If used for bulk storage the building will need aeration equipment and mechanical conveying equipment for grain movement.

(a) Building size.

200' long, 50' wide, 15' wall height. (Butler, RFS)

(b) Storage capacity wheat.

Bag storage 12 bag high	---	1,300 tons
Bulk storage maximum	---	4,000 tons

(c) Building cost.

(i) Type II (1). Bag storage, no conveyor or aeration equipment.

Price CIF Karachi, Pakistan	---	$24,410.00
* Estimated shipping & erection	-	15,590.00
Estimated cost		$40,000.00
** Cost/ton	-	$ 30.77

(ii) Type II (2). Bulk storage with aeration and minimum conveyor (6" portable auger).

* Erected building cost (a) above.	---	$40,000.00
Aeration and conveyor	---	12,000.00
Estimated cost		$52,000.00
** Cost/ton		$ 13.75

(iii) Type II (3). Bulk storage with aeration and complete mechanization (vertical lift, delivery conveyor, return conveyor, pit dump, and receiving scales - 30,000 lbs. capacity.)

* Erected building cost	$40,000.00
Mechanization cost	50,000.00
Estimated cost	$90,000.00
** Cost/ton	$ 22.50

(iv) Type II (4). System similar to (iii) above but using 4 storage bins (total capacity 16,000 tons.)

* Erected building cost	$160,000.00
Mechanization cost	165,000.00
Estimated cost	$325,000.00
** Cost/ton	$ 20.31

(d) Building evaluation comment.

Not well adapted to conditioning or treating grain in storage in bags.

Maximum suggested storage period in bags 6 months.

Bulk storage grain should not exceed 12 to 13% moisture when placed in storage.

Dry grain easy to keep for periods of 1 year or longer with aeration and treatment for insects.

Adapted to safe efficient insect control treatment with aeration.

Mechanization or partial mechanization essential for bulk handling.

Complete mechanization costly, however, not excessive in multiple units.

Mechanization can be added at any time either when the storage is erected or later.

(3) Type III Structure. A circular bolted steel, silo-type bulk grain storage unit. See photograph in Appendix B. This system includes a conveyor for filling and an aeration system. Inspection ports are included for inspection and entrance.

(a) Building size.

Diameter 48', wall height 48', center high 60'.

(b) Storage capacity wheat.

Bulk storage --- 2,000 tons

(c) Building cost.

(i) Type III (1). Single unit bin with minimum mechanism (vertical auger for loading, horizontal auger for unloading and aeration).

Price FOB factory	---	$10,000.00
Estimated shipping and erection	-	10,000.00
Minimum mechanization	---	6,000.00
Estimated cost		$26,000.00
Cost/ton		$ 13.00

(ii) Type III (2). Same bins as (a) above with 4 storage units (capacity 8,000 tons and completely mechanized handling), vertical cup elevator, dump pit, receiving scales 30,000# capacity, return conveyors each bin, aeration, and sweep auger bin cleaners.

Price FOB factory	$40,000.00
* Estimated shipping and erection	40,000.00
Complete mechanization	45,000.00
Estimated cost	$125,000.00
** Cost/ton	$ 15.65

(d) Building evaluation comments.

Not adapted to sack or bag storage.

Best storage for minimizing storage losses in long time storage (1 year or more).

Easy to condition grain in storage, (treat grain, protect from rodents or birds and pilferage).

Efficient space use requires minimum area for bin size (2,000 tons).

Simple to mechanize grain handling.

Most economical totally mechanized type of metal storage.

Total system capacity easy to enlarge by adding bin storage units as required.

TABLE IV

SUMMARY METAL STORAGE BUILDING COST

Structure Type	Storage	Storage Capacity (Tons)	Total Cost (Dollars)	Cost/Ton (Dollars)
Type I	Bag	1,081	28,500.00	26.40
Type I	Bag Max.	1,300	28,500.00	21.92
Type II (1)	Bag Max.	1,300	40,000.00	30.77
Type II (2)	Bulk	4,000	52,000.00	13.75
Type II (3)	Bulk	4,000	90,000.00	22.50
Type II (4)	Bulk	16,000	325,000.00	20.31
Type III (1)	Bulk	2,000	26,000.00	13.00
Type III (2)	Bulk	8,000	125,000.00	15.65

(4) Assessment of metal bin storages.

(a) Bag storage is more costly than bulk grain storage even when light weight structures are used.

(b) Bag storage in a metal building is more difficult to condition and treat than bulk storage.

(c) Building Type II is adaptable to both bag and bulk storage.

(d) Total mechanization in small units is costly. Partial mechanization is feasible.

(e) Total mechanization of multiple unit bulk systems can be procured at a lower cost/ton than bag storage.

(f) The metal tank or bin type storage with bulk handling is the most economical totally mechanized metal storage building system.

(g) Bulk metal storage should not be considered without aeration equipment.

(h) Grain stored in bulk should not exceed 12 to 13% moisture content levels.

(i) Type I and II flat storage buildings are adapted to use for many storage purposes, grain included.

(j) Type III metal tank storages are adapted only to grain and similar free flowing material storage.

(k) Safe storage for long periods (1 year or more) in metal building should be in bulk.

(l) Bag storage in metal buildings should be for periods 6 months or less, preferably.

(m) All metal storages, bulk or bag, should be inspected regularly (every 30 days) for possible insect development and treated if infestations reach warning levels established by entomologists (see inspection recommendations, Appendix C.)

(5) Availability. Steel buildings adaptable to grain storage use are available from American manufacturers in a wide range of sizes and building types. All buildings would require the use of local reinforced concrete for the foundation and floors. A breakdown of the time required to procure appears in Table V below.

TABLE V

THE ESTIMATED TIME SCHEDULE FOR PROCURING METAL STORAGES

Point of Origin	Time-Weeks
Fabrication @ factory after order is made	8
Factory to shipping port USA	1
Shipment USA port to Karachi	6
Karachi destination point	3
Erection at destination site	6
Minimum Estimated Completion Time	24
Probable time from order to completion	6-8 Months *

*If the unit purchased includes mechanical equipment for grain handling allow approximately twice the time to estimated completion date.

A Partial Listing of American Manufacturers Includes:

Behlen Manufacturing Co.
P. O. Box 569
Columbus, Nebraska, 68601

A partial listing of American Manufacturers con't.

Butler Manufacturing Co.
7400 E. 13th St.
Kansas City, Missouri 64126

Armco Steel Corp.
Metal Products Division
1001 Grave Street
Middletown, Ohio 45042

Columbian Steel Tank Co.
1509 W. 12 Street
Kansas City, Missouri 64101

Cuckler Steel Span Co.
P. O. Box 346
Monticello, Iowa 52310

Steel-built Structure, Inc.
1431 Regent Street
Madison, Wisconsin 53711

Similar structures are available from additional manufacturers in the United States and other countries.

b. House-type godowns

(1) Cost Comparison. The house-type godowns being erected under contract at this time are costing 200 rupees/ton. This compares very favorably with the cost of erecting concrete silo type storages. This price is currently estimated at 750 to 765 rupees/ton. Using an exchange rate of 5 rupees per dollar, the house-type godown storage is costing $40.00 per ton at this time. Referring to Table IV, it is noted this cost is higher than the cost of metal buildings.

These cost calcualtions are, however, based on the designed capacity of 500 tons for the house-type godown. If an increased capacity of 750 tons, (Scheme 1), possible by stacking the bags 15 high, or 1,000 tons attainable by converting to bulk storage (Scheme 3) is used, the investment cost per ton becomes competitive with the metal bins.

(2) Utilization. When used for bag storage (Maximum capacity 750 tons), the house-type godown compares favorably with bag storage in Type I or Type II steel storage. The steel buildings have a more flexible utilization factor than the godowns. They have large openings for the entrance and exit of equipment and they have no interior supports to obstruct interior movement. They can also be disassembled and moved to a new site if desired. For the storage of large

quantities of grain for long periods of time, the totally mechanized steel tank, Type III, is most economical including total mechanization which is not considered for bag storage. If the house-type godowns are used to maximum capacity (750 tons bag or 1,000 tons bulk), they provide competitive storage of excellent quality, structually.

c. Plastic grain storages.

(1) Description. Plastic storages have been used satisfactorily in the Arizona area of the United States as temporary, inexpensive storage for dry grains (12% moisture or less). If inadequate storage is developed under the other suggested programs, these storages should be used to reduce food grain losses in West Pakistan. The materials needed for these storages should be available on 60 to 90 days notice after purchase order. The storage is erected as it is filled. A 32' x 100' six mil, black plastic tarp is laid on a clean well drained area. Grain is augered on to the center line of the sheet as high as possible. Next a 40' x 100' 6 mil black polyethylene sheet is rolled over the pile and the edges are tucked under the bottom sheet and held in place by grain pulled to the edge. A 1/3 horsepower centifugal fan is placed at one end of the pile and the plastic is taped to the fan inlet. After sealing, the fan is turned on and sucks the plastic firmly in place. The fan is operated to keep wind from damaging the plastic cover.

Fence the area to exclude animals and secure the storage.

(2) Cost. A storage of this size will accommodate 150 to 175 tons of grain. This type storage could be erected and equipped for an estimated 35 to 50 rupees/ton of storage.

2. Procurement of used or surplus buildings.

There is a possibility a limited stock of surplus buildings could be secured. This objective was not explored in the limited time alloted to this assessment. The time lag between the procurement of used buildings (if available) and their erection is estimated to be equal to the new building time lag.

VI. SUGGESTIONS FOR IMPROVING GRAIN STORAGE MANAGEMENT

A. House-type Godown Improvement. The following are suggestions for improving the management and structure of house-type godowns.

1. Keep screens on ventilators in place and in good repair to exclude birds.

2. Make available at each door a wire mesh frame (1/2" to 3/4" grid) to use in the opening when doors are open. This will control the bird problem.

3. Install fumigation inlet pipes in the godown roof. This will permit complete sealing prior to fumigation application and reduce the hazard of handling fumigation material. Two rows of inlet pipes, 20' apart, approximately 13' from each wall (10 pipes per 100' godown is ample) should be installed for use liquid in fumigant application. Use a 2-1/2 ft. length of 2-1/2 inch pipe. Extend the pipe 12" above roof top. Fit the top with a pipe cap for positive seal. Mortar and seal the pipe into the roof structure.

4. Provide a method for lifting fumigants to roof. Suggested methods include a rope and pully system for small containers or a ramp or stairway at one end of a godown for rolling barrel lots to roof level.

5. Raise the godown floor level to truck or rail car level. This will expedite moving grains in or out of the godowns.

6. Where possible bring a railroad siding to the godown site for direct loading of railroad shipment.

7. Provide the operating manager of each major godown site a suitable set of grain testing equipment,--a probe and sieve plus instructions on their use. Then install a regular inspection program.

8. Purchase and use portable augers for filling and emptying godowns where bulk storage is practiced. These augers can be hand or gasoline motor driven if electricity is not available.

9. Long-term (1 year or more) bulk storage in godowns may require the installation of mechanical aeration equipment. This would not be difficult to do.

B. Beehive Bins. Secure a portable lift for the bags. The bags are currently carried to the roof by hand. A lift would be relatively inexpensive and would expedite the filling operation.

Some grain was stored in bags on the platform under the hopper-bottoms. This grain was infested with flour beetle. Treatment would require covering the bags with a plastic or similar air tight material and fumigating.

C. Observation Regarding Storage Inspected.

1. General sanitation surrounding all Government Storage was good.

2. The major problem appeared to be insects (flour beetles primarily). A delay in treatment will create substantial losses.

3. A regular inspection and treatment program is recommended. This is apparently not done at present as grains (PL-480 wheat) in storage 10 months had received no treatment since arrival.

4. A bird problem was also noted. This could be corrected.

5. The storages were apparently rodent free.

APPENDIX A

GENERAL INFORMATION

The following provides clarification of terms, abbreviations and items embodied in this report.

Abbreviations:

G.O.P. ---------- Government of Pakistan

USAID ---------- United States Agency for International Development

Weights, Measures and Amounts:

1 rupee	=	21 U.S. cents
1 maund		82.286 pounds
1 ton		Long ton = 27.22 maunds = 2,240 pounds
1 ton		46.67 cubic feet storage space bulk (wheat)
1 bag		224 pounds of wheat
10 bags		1 ton (wheat)
1 lakh		100,000 units
1 crore		100 lakhs

Terms:

Godown ---------- A grain warehouse

Maund ---------- Grain purchase or sale unit

All storage capacity calculations based on wheat storage.

APPENDIX B

GRAIN STORAGE STRUCTURES*

Government Storage

House-type Godowns - Gulberg Site Lahore

Model Beehive Bins Godown - Lahore

Typical Section, House Type Godown Bulk Storage Ties

Hired Government Storage

Gulberg Mill - Lahore

Stadium Storage - Lahore

Metal Prefabricated Buildings

Type I, Panel Frame Structure - Light Weight

Type II, Rigid Frame - Heavy Duty Structure

Type III, Circular Metal Bin - Large

Farm Size - Circular Metal Bins with Drying Equipment

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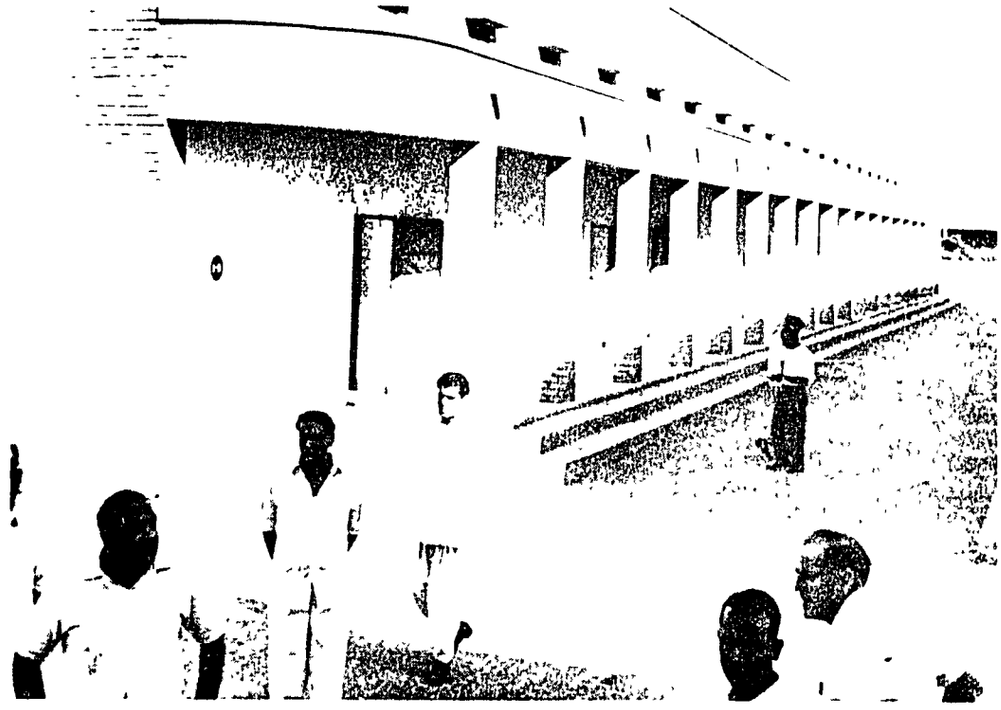
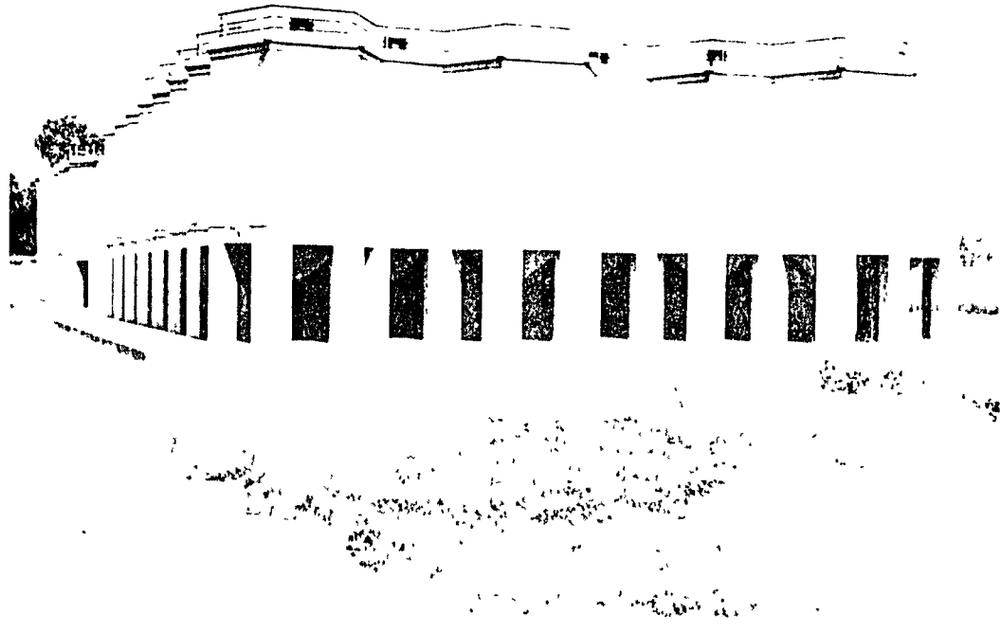
* Photographs on the following 5 pages.

Government Storage

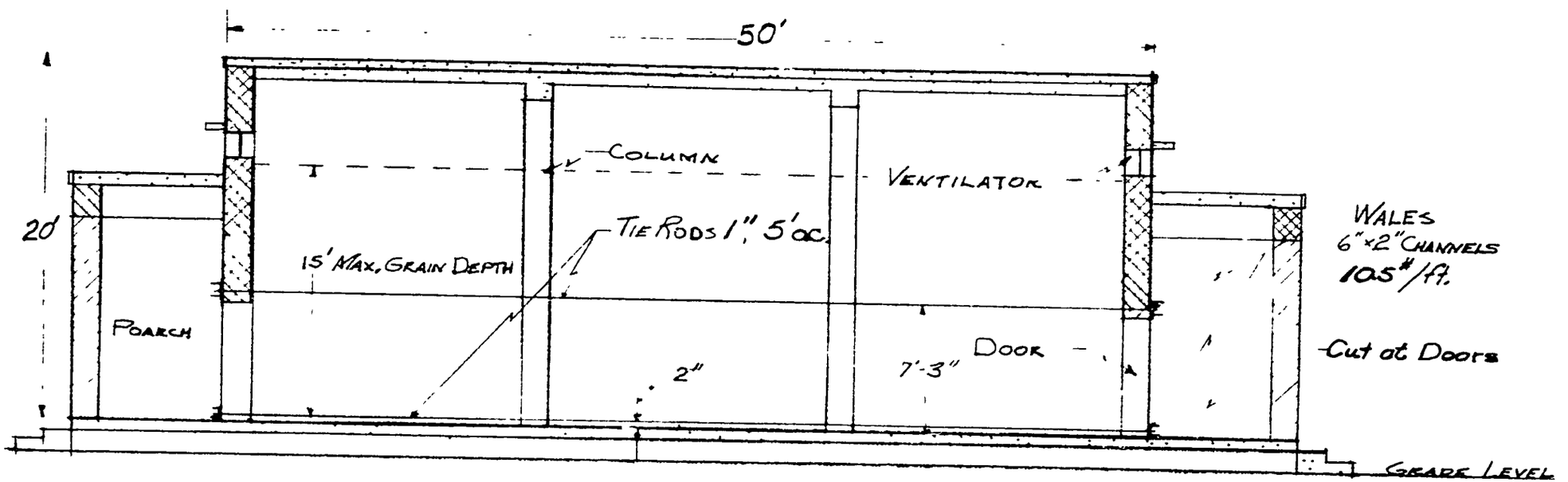


House Type Godowns - Gulberg Site Lahore



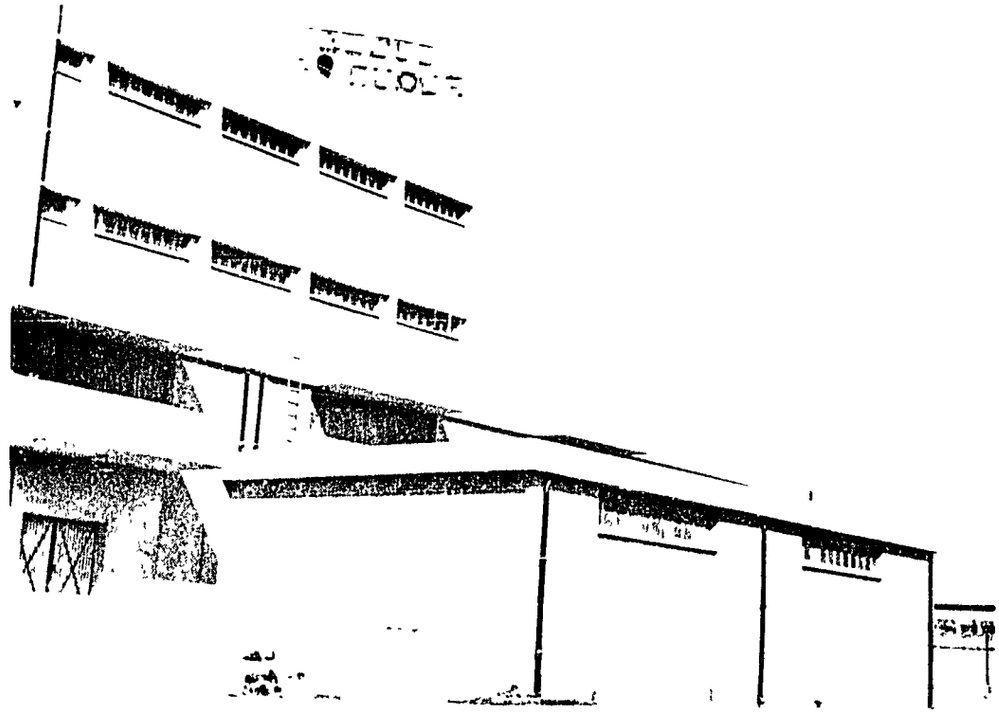
Model Beehive Bin Godown - Lahore

TYPICAL SECTION HOUSE TYPE GODOWN



BULK STORAGE TIES HOUSE TYPE GODOWN

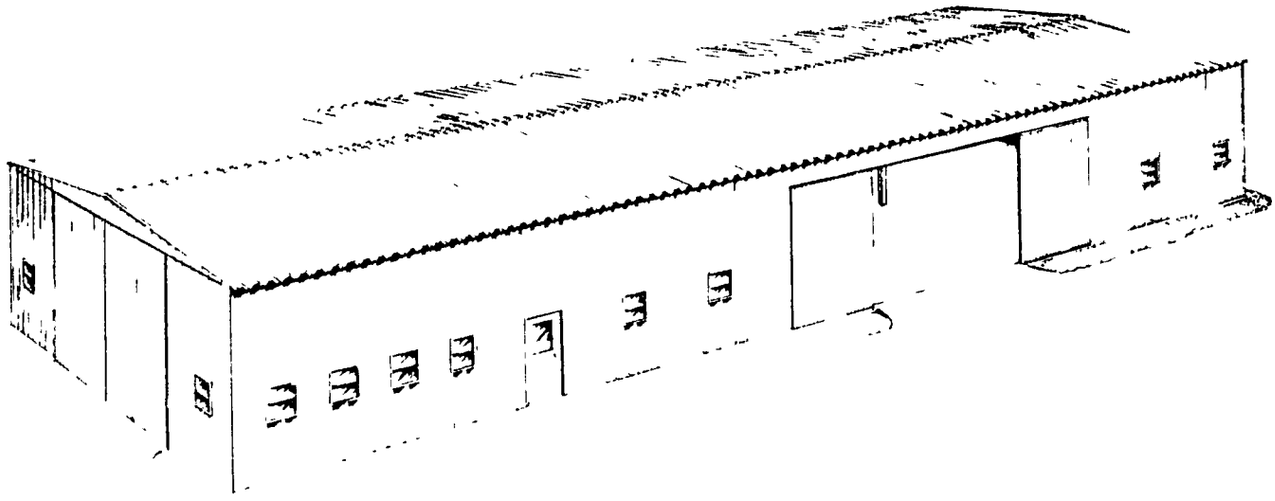
Hired Government Storage



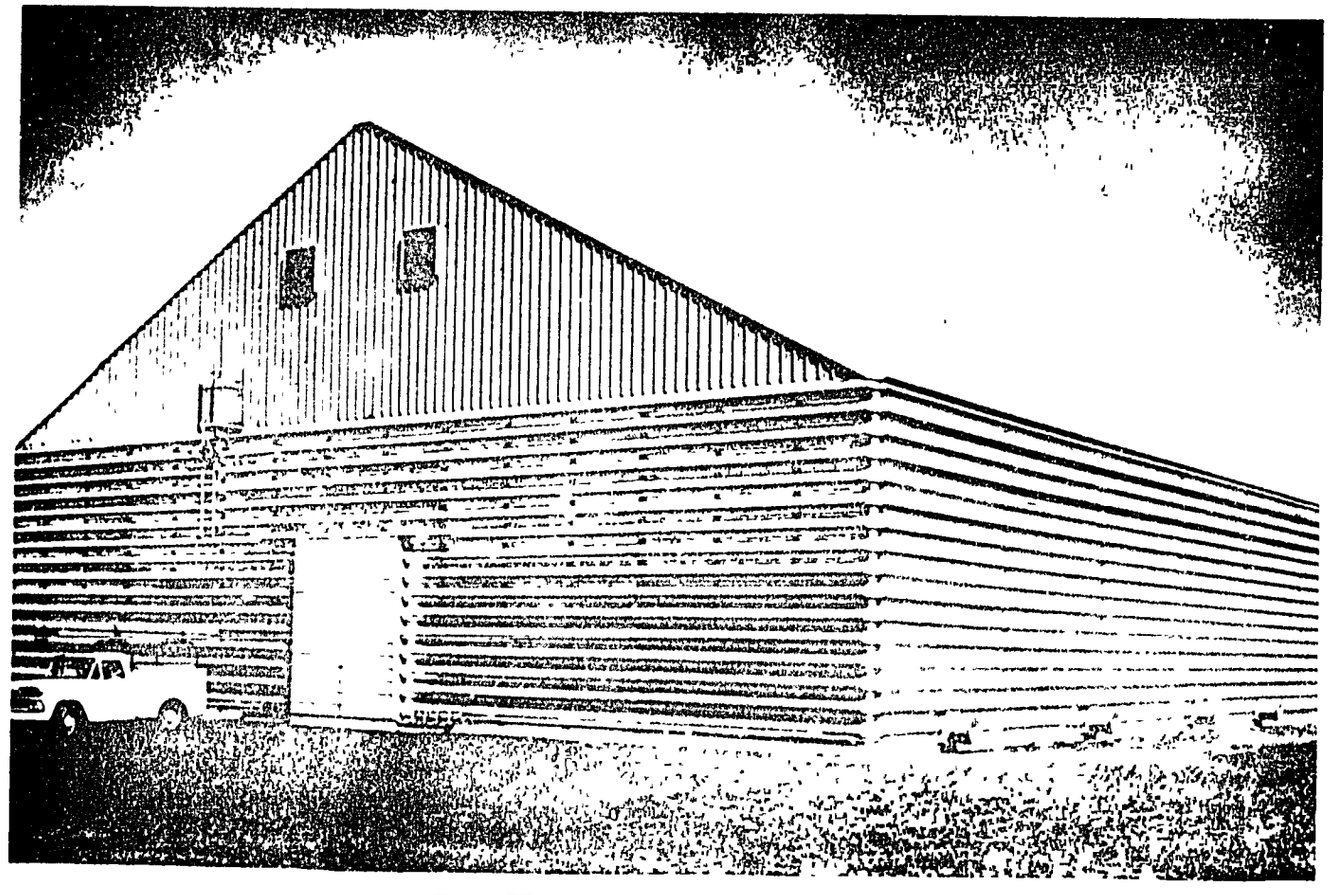
Gulberg Mill - Lahore

Stadium Storage - Lahore

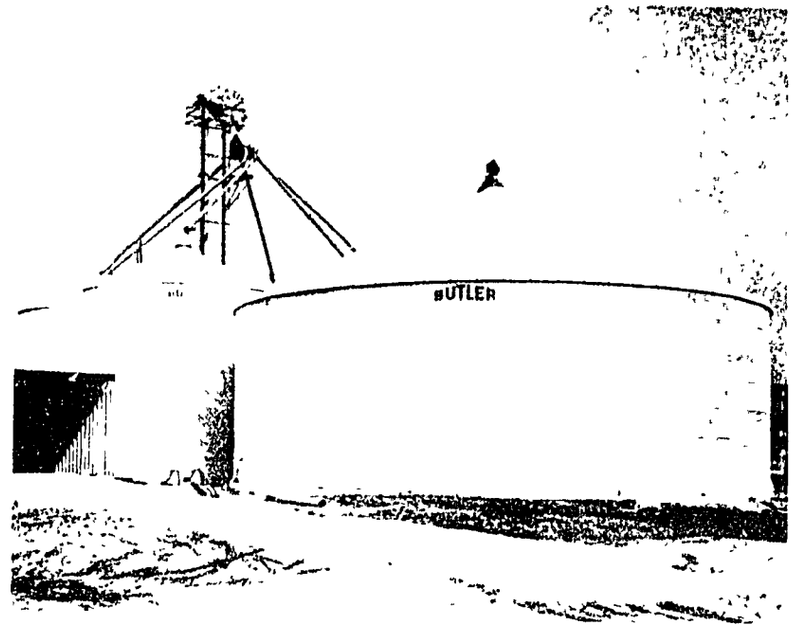
Metal Prefabricated Buildings



Type I - Panel Frame Structure
Light Weight



Type II - Rigid Frame - Heavy Duty Structure



Type III Circular Metal Bin - Large

Farm Size - Circular Metal Bins with Drying Equipment

APPENDIX C

REGULAR INSPECTION

About every 30 days take standard probe samples from the center of the bin and inspect them for insects.

Sift the sample through a 10- to 12-mesh screen. The screen will hold back the wheat, but insects will sift through.

Fumigate at once if you find even one granary weevil, rice weevil, or lesser grain borer per quart sample of wheat, or as many as five insects of other kinds (such as flour and grain beetles, cadelles, or grain moths) per quart sample.

Abstracted from: Insects in Farm-Stored Wheat - How to Control Them. U.S. Department of Agriculture, Leaflet No. 345, July 1965.

OTHER FOOD GRAIN DRYING, STORAGE, HANDLING AND TRANSPORTATION PUBLICATIONS

available from the
FOOD AND FEED GRAIN INSTITUTE
KANSAS STATE UNIVERSITY, MANHATTAN, KANSAS

No. 1 Rice Drying Technology and Equipment Which Might Be Applicable to Tropical Developing Countries. June 1968. Prepared by Dr. T. O. Hodges.

No. 2 Brief Description for A Corn Handling Facility in Tropical Areas. June 1968. Prepared by Dr. T. O. Hodges and Dr. H. B. Pfost.

No. 3 Structural Requirements of Grain Bins. July 1968. Prepared by Dr. T. O. Hodges.

No. 4 Report on Food Grain Storage, Marketing, Handling and Transportation in Jordan. July 1968. Prepared by John R. Pedersen.

No. 4A Photographic Supplement, Food Grain Storage, Handling and Transportation in Jordan. July 1968. Prepared by John R. Pedersen.

No. 5 A Proposal to Equip Metal Silos in Jordan with Aeration and Temperature Monitoring Equipment. August 1968. Prepared by John R. Pedersen.

No. 6 Review of Grain Storage, Handling, Processing and Distribution Problems and Proposals in the Republic of Korea. September 1968. Prepared by Alden A. Ackels, Dr. P. Gormely and Martin Keck.