Improvement of Postharvest Grain Systems

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GRAIN STORAGE AND HANDLING IN JORDAN: MINISTRY OF SUPPLY SILOS AT AQABA, JUWEIDEH, AND IRBID

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REPORT SUMMARY

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SUMMARY STATEMENT

This study was conducted to evaluate grain storage and handling in Jordan, MOS silos and warehouses at Aqaba, Juweideh, and Irbid, and recommend measures to prevent heating of stored grain in bins similar to the recent corn heating problem at Juweideh.

Based on site inspections and discussions with MOS engineers and technicians, specific recommendations were made to improve the performance of the MOS silos. The most important among the major recommendations was the installation of an aeration system. Other recommendations such as safe storage moisture levels, temperature monitoring system, and ferrous material separation were also made. The need for personnel training in the fundamentals of grain storage was highlighted.

The author met His Excellency Mr. Ibrahim Ayoub, Minister of Supply, who showed interest in this study, especially in the recommendations of the study and staff training.

GRAIN STORAGE AND HANDLING IN JORDAN: MINISTRY OF SUPPLY SILOS AT AQABA, JUWEIDEH, AND IRBID

Prepared by

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for the

AGENCY FOR INTERNATIONAL DEVELOPMENT
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Improvement of Postharvest Grain Systems

at the

FOOD AND FEED GRAIN INSTITUTE
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ACKNOWLEDGMENT

Special thanks are due to His Excellency Mr. Ibrahim Ayoub, Minister of Supply, for taking time to discuss the problems dealt with in this report and for showing special interest in this study.

Special thanks are also due to Dr. William Furtick, ADO, USAID/Amman, and Mr. Fuad Qushair, Program Specialist (Agriculture), USAID/Amman, for their help in this study. Thanks to Messrs. Mahmoud Abu Laban, Juweideh Silo Manager, Ahmed Jawarneh, Laboratory Chief, Juweideh, and Nabil Al Saie, Aqaba Silo Manager, for their special assistance to the author. Thanks are due to Mr. Salim Qunsol, Director of Projects, MOS.

LIST OF ACRONYMS

ADO	Agricultural Development Officer, USAID
AME	Asia and Middle East
FFGI	Food and Feed Grain Institute, KSU
GOJ	Government of Jordan
KSU	Kansas State University
MOS	Ministry of Supply, GOJ
OICD	Office of International Cooperation and Development, USDA
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

SUMMARY

His Excellency Mr. Ibrahim Ayoub, Minister of Supply, GOJ, showed special interest in this study by taking time to discuss the contents of this section with the author. He raised very relevant, interesting, and specific questions. He showed special interest in staff training especially for the Ministry's bread baking projects and grain storage. He inquired about and requested information in the form of brochures, publications, etc., on educational and training programs and the best institutions which may offer such programs. The author promised to send him this information.

In addition, His Excellency also pointed out that the moisture content was 15.5 percent in the corn imported recently from Thailand that created a heating problem in storage. MOS is not currently importing any corn from Thailand. MOS imports about 400,000 MT of wheat and about 100,000 MT of corn per year. Feed corn is imported by MOS to stabilize the market price only, because private parties also import feed corn. Wheat from the U.S. contains 12 percent or less moisture content. U.S. hard red winter wheat No. 2 is preferred. Soft wheat from Yugoslavia is not adequate. MOS would like to have a 6-month reserve of wheat in its storage system.

This study was conducted from November 11 to November 21, 1984. The author visited MOS silos at Aqaba, Juweideh, and Irbid, warehouses at Juweideh and Irbid, and flour mill at Juweideh. Based on site inspections, discussions with many MOS engineers and technicians, and the author's own judgment, the following remarks were made:

The MOS silo system was designed and installed by one of the most famous companies in the world.

2. The silo system seems to be well designed, well built, and generally well run.

The following recommendations were made to improve the performance of the silo system.

1. An aeration system should be installed at least in Irbid and Juweideh silos where grain is being or expected to be stored for more than 6 months. An aeration system could prevent a grain heating problem from arising due to moisture migration.

2. MOS should not buy any grain above 13 percent for storage up to 1 year and above 11 percent for storage up to 5 years. For oilseeds such as soybeans, the above quoted moistures, in both cases, should be lowered by 2 percent.

3. Soybeans should be handled satisfactorily in all the silos.

4. Grain grading factors such as moisture, dockage, brokens and fines, foreign materials, test weight, damage, and infestation should be determined in Aqaba silo before unloading imported grain cargo from ships.

5. An electromagnet should be installed in Aqaba silo to separate ferrous materials from grain.

6. Personnel training in fundamentals of grain storage should be treated as a top priority among MOS silo programs.

7. Whole warehouse fumigation should be discontinued. Instead, stack fumigation by using gas impermeable plastic sheets or tarpaulins and sand snakes should be practiced.

8. Tests for detecting hidden infestation in grains should be conducted in the MOS laboratory.

9. As a guidance for the future, the use of chain conveyors should be minimized. Instead, belt conveyors with appropriate dust collection systems should be used as much as possible.

10. For the diameter of MOS silo bins, it would be more appropriate to have three temperature cables instead of two, separated from one another by 120 degrees and located at a distance of 2/3 of radius from the center. The cables also should have any two adjacent sensors separated by a maximum of about 2 m. This is also intended for future guidance.

11. The feasibility of installing explosion vents on each bucket elevator should be studied. Explosion vents reduce the chance of extensive dust explosion damage in the silo.

12. Bearing temperature monitoring and alarm systems may be installed on critical bearings so as to reduce the probability of a dust explosion.

13. If the power factor of any silo is too low, improvement should be made by installing proper capacitors.

BACKGROUND

In the latter part of May 1984, the author was contacted under the centrally funded contract that exists between KSU (FFGI) and USAID by Robin Comfort an officer of USDA, OICD, AME, of Washington, D.C. The author was informed that Kenneth Laurent, then ADO, USAID/Amman, had contacted Robin Comfort requesting technical assistance for containing a heating problem of feed corn stored at GOJ, MOS Juweideh silo near Amman. An overseas teleconference was held between Mahmoud Abu Laban, Juweideh Silo Manager, Robin Comfort, and the author. The author gave technical advise over the telephone and wrote a letter to the silo manager with further details. The heating problem was contained by adopting a combination of appropriate measures by the MOS. However, MOS felt that a need for consultation (technical assistance) between a grain storage specialist and MOS silo engineers and technicians still existed and the author was assigned by KSU and USAID to this study.

OBJECTIVE

The objective of this report is to study the existing grain storage and handling system in MOS silos of Juweideh, Aqaba, and Irbid and based on the site inspections of silos in these three locations and meetings with MOS engineers and technicians, suggest necessary improvements for better grain storage and handling. The scope of work is shown in Appendix A.

EXISTING GRAIN STORAGE AND HANDLING SYSTEMS IN MOS SILOS

The civil and mechanical construction of all three silos was undertaken by Buhler-Miag of Switzerland and electrical construction was done by Siemens of West Germany. The civil construction was subcontracted to a Syrian company by the name of K Yukabian. There were many other subcontractors for constructing the silo. Equipment was very similar in all silos.

The facility was designed to store dry grain only. Wet grain should not be received because there is no dryer. Wheat for food (both imported and local), corn, and barley for feed are stored in the silos.

1. Aqaba

There are three types of bins in the older silo unit which was built in 1980. The schematic layout is shown in Fig. 1. The nominal storage capacities which vary with the type and condition of grain are as follows:

Type 1 bin, circular bins	30 bins each 1,500 MT capacity
Type 2 bin, small interstice bins	15 bins each 180 MT capacity
Type 3 bin, large interstice bins	10 bins each 450 MT capacity

Older unit storage capacity is approximately 50,000 MT. Storage capacities wherever mentioned imply nominal values.

The newer silo unit which was built in 1982 also has three types of bins as shown in Fig. 2. The capacities are as follows:

Type 1 bin, circular bin	45 bins each 2,000 MT capacity
Type 2 bin, small interstice bin	30 bins each 300 MT capacity
Type 3 bin, large interstice bin	20 bins each 600 MT capacity

The newer storage capacity is approximately 100,000 MT. The total storage capacity of the Aqaba facility is therefore 150,000 MT. Bin and other layouts of all three silos are similar in many respects.

This is an import grain silo and is located in the Aqaba port area. Grain is received in bulk from ships. The maximum ship size accommodated in the 4 year history of the silo was 52,000 MT. The usual ship size varies from 25,000 to 30,000 MT. The draft in the jetty is sufficient to accommodate usual bulk

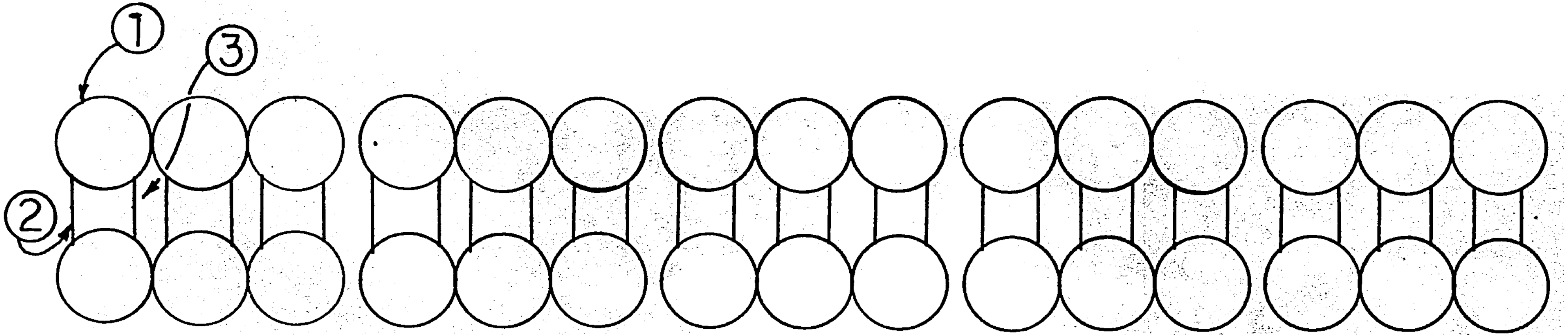


FIG.1 OLDER UNIT BIN LAYOUT

①, ②, ③ - BIN TYPES

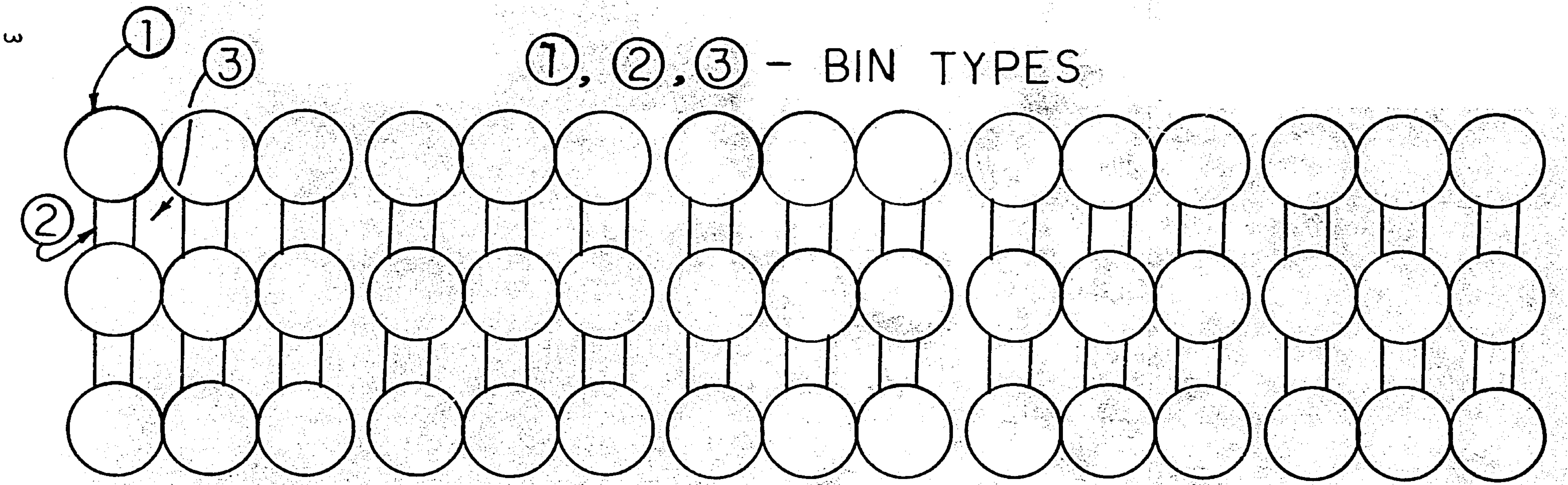


FIG.2 NEWER UNIT BIN LAYOUT

carrier size. The grain receiving facility consists of two mobile gantries on rail each provided with two pneumatic telescopic suction pipes. Each pipe has a maximum suction capacity of 120 MT/hr, thus making a total unloading capacity of 480 MT/hr. One of the gantries is also provided with a 240 MT/hr ship load-out (offtake) facility. Through a system of overhead chain and belt conveyor combinations, the grain is delivered in or out of the headhouse. Each piece of conveying equipment has been rated at 240 MT/hr maximum capacity. Except for the outdoor overhead conveying section between the gantry and headhouse and two screw conveyors for the dust bin, the main intake and offtake conveying in and out of the storage bins is accomplished by chain conveyors.

The silo is provided with four bucket elevators. Weighing, dust collecting, and bin temperature monitoring functions are also accomplished by the use of proper equipment. However, there are was no cleaning machine or metal separating electromagnet in this silo.

The grain is mainly delivered in bulk by trucks varying from 20 to 35 MT. Truck filling is easily accomplished by opening the gate mounted on the side draw-off spout installed on all outside round bins. The facility is also provided with bagging scales and machines with conveyors and chutes to load bags directly into two waiting trucks. The bag sizes may be varied from 50 to 100 kg, with the average size being 80 kg.

Pellet dispensers have been provided on each load-in chain conveyor on the bin deck for insect control.

Fire extinguishers have been provided at strategic places. Water lines to fight fires have also been installed.

2. Juweideh

Juweideh is an integrated facility consisting of a 135,000-MT grain storage silo, a 400-MT/day flour mill, five 12,000-MT bag storage warehouses for flour, sugar, rice, milk, oil lentils, etc., one 1-MT/hr Arabic bread bakery, and two refrigerated warehouses for perishables at different temperatures for meats, potatoes, onions, etc. Building of a feed mill at this location is in the process. This report will deal only with the grain storage function of the facilities.

The grain silo consists of two units. The first unit was built in February 1980 and has a 50,000 MT storage capacity. In 1982 the capacity was increased by an additional 85,000 MT in the form of another silo, thus making a total capacity of 135,000 MT.

Grain is received mainly from 20 to 35 MT semi trucks and weighed on one of the two side-by-side truck scales, one 60 MT and the other 70 MT capacity. The facility is provided with two hydraulic truck dump pits to empty the trucks by tilting. One of the two pits has a future provision of receiving grain from rail cars. Each pit dumps grain on a receiving chain conveyor. All the conveying equipment is matched to receive at a rate of 240 MT/hr from each dump pit. The facility is provided with four bucket elevators which discharge into 2- or 3-way pneumatic gates. At the time of the author's visit to the silo, wheat was reportedly being received at an approximate rate of 3,200 MT in a 16-hour working day.

The silo is provided with 8 working bins each 60 MT capacity, 4 working bins for delivery lines to the flour mill, and 4 working bins for delivery to the future feed mill.

The older silo unit consists of 30 round bins each 1,500 MT, 15 small interstice bins each 180 MT, and 10 large interstice bins each 450 MT capacity. The new unit consists of 45 round bins each 1,600 MT, 30 small interstice bins each 200 MT, and 20 large interstice bins each 500 MT capacity. There are drum separators and reciprocating sieve cleaners which are routinely used at about

100-200 MT/hr before delivering wheat to the flour mill. For delivery of wheat in flour mills, scales are used at a 600 kg/drop capacity. After the scale, the grain is stored in four shipping bins each 100 MT capacity. Two shipping bins are used for delivery to flour mills and the remaining two will be used for delivery to feed mills.

There are six other working bins for the bagging section and bulk shipment during inclement weather. Four working bins supply grain to four twin bagging scales with an average delivery of 400 MT/day. The standard bag size is 80 kg, however, the size may be varied from 50 to 100 kg. There is also provision for future offtake by rail cars.

For loading grain into the bins and taking grain out of the bins, the silo was provided mainly with chain conveyors and there is no belt conveyor.

The silo has been provided with a dust collection system and a dust bin. Dust and other cleanings are not used at present but future use in feed mills is contemplated.

3. Irbid

Total storage capacity of Irbid silo is 50,000 MT. This is also an integrated facility like Juweideh with three 12,000-MT bag storage warehouses and cold storage for similar commodities. Since the layout, equipment, and process are similar to the other two silos a description of the facility is not necessary. Equipment provision has been made for future expansion into a 400 MT/day flour mill and a feed mill.

CORN HEATING IN JUWEIDEH SILO

Feed corn recently imported from Thailand has already been delivered out of the silo system. There was no corn sample available at the time of this study and as such different quality factors could not be determined. From the verbal account of the Juweideh silo staff the following story is reconstructed.

Imported corn from Thailand was received in Juweideh silo in trucks loaded at Aqaba silo from May through September 1984. Moisture content in various truckloads ranged from 13.5 to 20 percent. Some consignments were so wet that drops of water were noticed to ooze from the grain and the grain did not flow through the truck dump hopper. The hopper had to be cleaned by manual labor. The grain temperatures were also high, somewhere in the 30's.

After a few days of storage the grain heated up to 50°C in some points of the bin.

After grain heating was detected, Juweideh silo management contacted Agricultural Research Center of Royal Scientific Society and Agriculture Faculty, Jordan University, for help but no reasonable solution was received. Then the author was contacted through USAID and USDA.

Silo management started turning the bin in two 8-hr shifts per day. In 16 hours approximately 4,000 MT of corn was turned. By turning, the temperature was reduced to 42-44°C. When put back in the bin the same grain was heated back to about 50°C in some points in the bin in 7-8 days of turning. Repeated bin turning was done to keep the temperature under control.

Water condensation was noticed on the bin bottom and also on the top. Sticky residues remained in the conveyors and other handling equipment even after the grain was completely delivered out of the silo. Some metallic parts were reportedly rust affected.

From this account it appears that the corn had a high moisture content to start with and because of the lack of an aeration system in the silo, moisture migration occurred due to diurnal and seasonal temperature variations during the period May to September 1984.

ANALYSIS OF THE EXISTING SYSTEM

The silos at all three locations studied by the author were well designed, well constructed, and generally well run. However, there is room for improvement. This analysis should not be misconstrued as any criticism. The following analysis and discussion are in order for future guidance and actions.

1. Use of a Chain Conveyor

Even though chain conveyors, because of their superior dust control features, are used in facilities where cleanliness is imperative, belt conveyors are the most widely used grain conveyors, especially for indoor applications in commercial grain silos, all over the world because of the many advantages they offer. The principal advantages of a belt conveyor over the chain conveyor are as follows:

a. Lower and easier maintenance - The idlers of the belt conveyors do not need frequent maintenance. They may be factory lubricated to last a long time. The belt can be trained (kept in the center) very easily by the use of training pulleys. Automatic gravity take-up system (automatic gravity tension adjustment) can be easily designed and installed on a belt conveyor to keep the tension uniform at all times. This prevents belt slippage on pulleys. In the chain conveyors used in MOS silos, manual tension adjustment is accomplished by tightening the take-up screws equally on both sides of the conveyor. Experience is needed to tighten the screws equally. It is difficult to determine when the conveyor chain needs tightening because the chain is housed in a box and can not be seem from outside. A loose chain will run in a somewhat snakeway pattern which when combined with accompanying iron or wood pieces can damage the chain links. The author saw many bent chain links in one of the silos he visited.

This type of incidence happens with chain conveyors. Replacing the chain links is time consuming and expensive.

b. Gentler grain handling - A belt conveyor carries the grain like a patient on a stretcher. The chain conveyor drags the grain against the walls of the conveyor housing. Grain kernels may get caught and rubbed in the small spaces between links and housing, causing some grain breakage.

c. Lower power requirement - For the same conveying capacity and distance (assuming horizontal conveying) belt conveyors overcome the friction created by the idlers and the grain does not create any additional friction. Chain conveyors drag the grain against the housing walls which requires additional power.

d. Lower noise - A belt conveyor is more resilient and rolls the rollers as it goes forward. The chain conveyor links rub against metal surfaces which creates more noise.

e. Lower initial investment - A lower horsepower motor and less metal in the belt conveyor (chain links are made from a special abrasion-resistant metal) in general, result in a lower initial investment.

f. Opportunities to shop around - The belt conveyor gives more flexibility to customers to shop around for spare parts such as belts. The spare part that is generally needed is the belt and that is very infrequent. The idlers generally last for years. A few spare idlers may be kept in stock. Belts generally need cutting and shortening and replacement may be needed after 15 years or more depending on use and care. There are many belt manufacturers in the world to shop from.

g. Faster cooling of heated grain by turning the bin - If the grain in a storage bin gets heated for any reason (like the recent corn heating problem in Juweideh), one way of cooling the grain and dispersing the hot pockets is to take the grain out of the bin and put it in a different bin (turning the bin) during a cool period of the day and run the grain through the conveyors to dissipate heat. A belt conveyor is open so grain cools faster than in a chain conveyor which is enclosed. Chain conveyors cool the grain slowly and require more runs. More handling creates more grain breakage.

h. Open conveying space more desirable to prevent dust explosion hazard within - Even though chain conveyors have probably not been linked with causing dust explosions, from a theoretical point of view an open conveying space with proper dust control in the surrounding area is a desirable principle.

For reasons mentioned above, belt conveyors are widely used in U.S. grain elevators (silos) and chain conveyors are seldom used. In countries where one has to depend on a foreign source for spare parts, it is wise to use a belt conveyor as much as possible and avoid using a chain conveyor if possible.

The chain conveyor, however, has some advantages such as:

a. Lower dust level outside of conveyor - The chain conveyor being enclosed results in less dust in the silo. However, belt conveyors may be designed with adequate dust control systems to keep dust at accepted levels. The superiority of the chain conveyor over the belt conveyor in dust control must not be accepted as the only reason for using a chain conveyor.

b. Suitability for some outdoor installations - The chain conveyor is more convenient and less costly (initial cost) for on the ground outdoor installations. In such situations, belt conveyors need expensive weather protection systems.

2. Absence of an Aeration System

There is no grain aeration provision in any of the three silos. The practice of ventilating stored grain (in a bin) with low airflow rates to maintain grain quality is called aeration.

Aeration is practiced to:

a. Prevent moisture migration by maintaining a uniform temperature throughout the grain mass

b. Cool the grain to reduce mold growth and insect activity

c. Remove those storage odors that are not persistent

d. Distribute fumigants in the grain mass. Preventing moisture migration and cooling the grain are the main purposes of aerating.

Moisture Migration

It has been argued that properly harvested, dried, and stored grain will keep for a considerable length of time. This is true if the conditions under which the grain is stored do not change. Unfortunately, the conditions do change as a result of temperature variations in the environment outside the storage structure.

Let us suppose grains are placed in storage during the summer. As summer gradually turns into winter, the average air temperature outside the bin decreases. This lowers the air and grain temperatures near the bin wall and the air density increases which causes a downward movement of the air along the walls due to natural convection. The air flows along the bottom of the storage and upward through the center of the warmer grain mass, leaving the grain mass near the central area of its cold surface. During its path through the bulk of the grain, the air picks up moisture which may be condensed as it comes in contact with cold air near and above the grain surface, resulting in wet grain in the upper 2 ft or more, at the top of the bin (Fig. 3). Spoilage may occur if no countermeasures are taken.

If the grain is stored in winter and the season gradually changes to summer the opposite situation from that described in the previous paragraph may occur: low grain temperatures in the storage and higher outside air temperatures. The air in this case flows down the center of the grain mass and rises along the storage walls. Moisture accumulation may take place in the bottom of the storage (Fig. 4).

Moisture migration due to natural convection can be prevented by eliminating or drastically decreasing the temperature differential across a grain storage wall. This can be accomplished by slowly cooling the grain.

3. Grain Storage Practice in Irbid Silo

At the time of my visit the Irbid silo was full with 49,824 MT of wheat. The silo was loaded with grain for the first time in December 1983. One-third height of all the storage bins was filled with imported hard red winter wheat from the U.S. The second 1/3 of the bins was filled with U.S. and Australian wheat in June 1984, and the remaining 1/3 was filled with Australian wheat in October 1984. This initial scheme of balanced filling was necessary for equal settlement of the silo structure. However, this scheme of mixing wheat from two different overseas sources should not be undertaken in the future. Wheat with different moisture levels and sources should be stored in separate bins. During my visit I was told that layers of Australian wheat in the bins were showing higher temperature than layers of U.S. wheat. In some bins, a temperature range of 19.5-31.5°C was recorded. This wide temperature differential within the bin may eventually lead to storage problems unless timely action is taken. The temperature within different locations in each bin should be analyzed everyday by comparing the previous temperatures. If there is a tendency

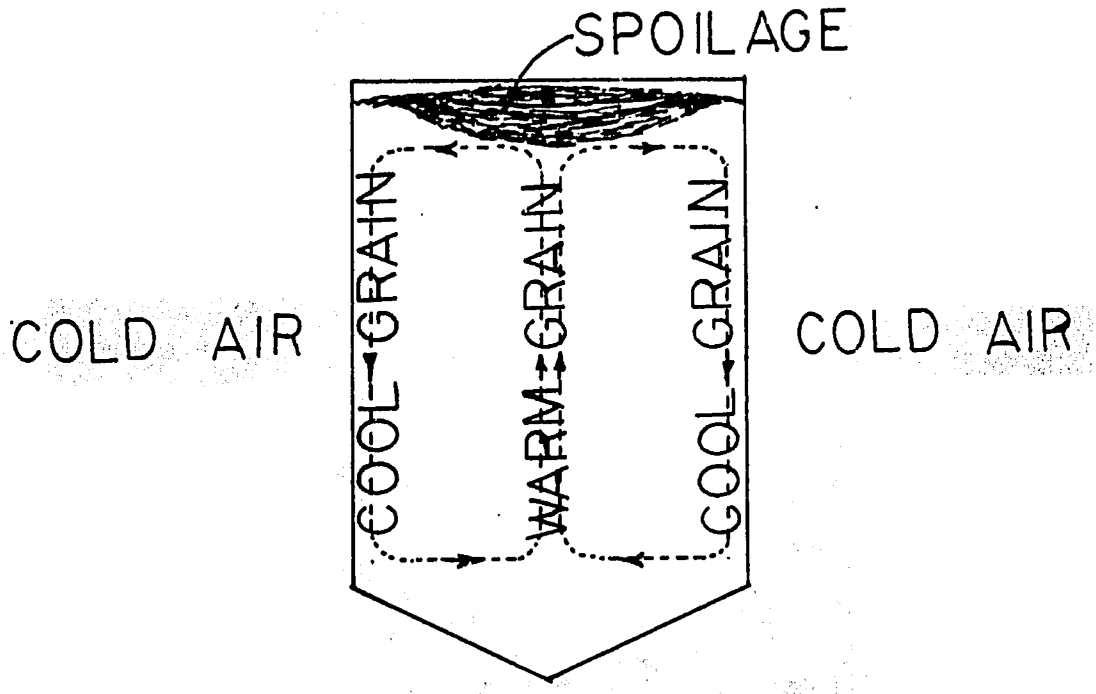


FIG. 3 GRAIN SPOILAGE IN WINTER

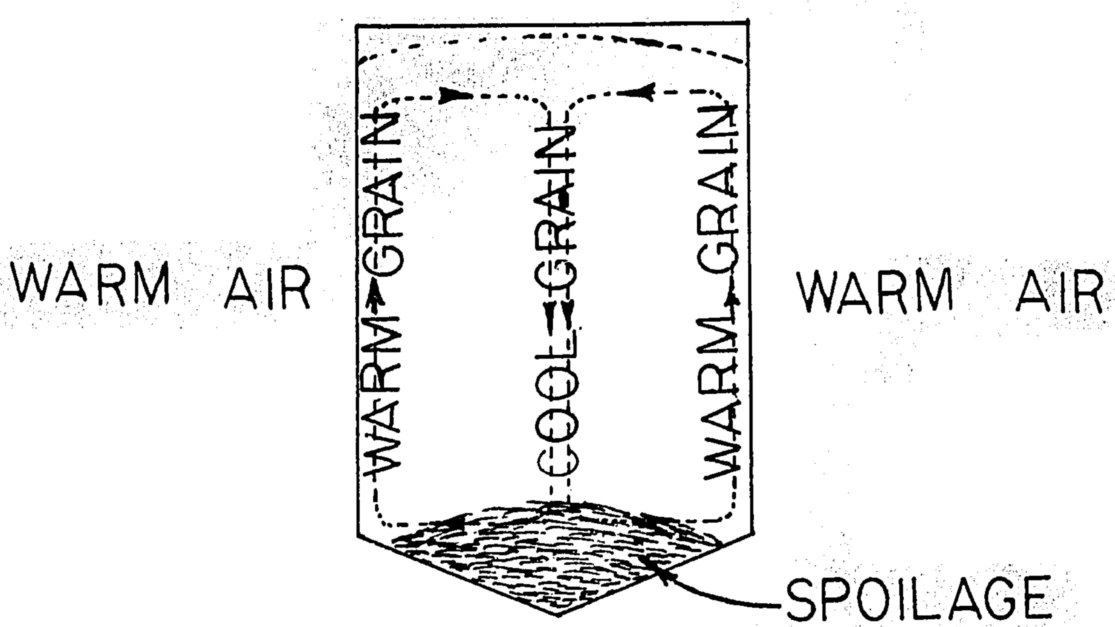


FIG. 4 GRAIN SPOILAGE IN SUMMER

for rapid temperature rise at any location within a bin, the bin should be turned immediately at a slow rate during a cool period of the day. If the bins would have been provided with aeration fans the fans could simply have been turned on without having to turn the bin and create additional grain breakage. Depending on how long the grain is stored in the bin, it may be necessary to turn the bin many times creating successivly more and more grain breakage and dust.

4. Hazards in Silos in General

The most important hazard that needs special attention is the grain dust explosion. Many devastating grain dust explosions causing partial and total damage of silos, feed and flour mills, and loss of life have occurred in the U.S. and Europe in recent times. To prevent this hazard, it is necessary to take appropriate technical and administrative measures.

Let us analyze how a dust explosion occurs. There are four factors that are jointly responsible for causing a dust explosion. They are dust, oxygen, spark source, and confined space. If any one of these four factors is absent an explosion will not occur. If one could remove all the dust from a silo, there would be no explosion. However, this is impossible and impractical. Next, if dusts could be reduced to such a level that a lower than an explosive concentration of dust would be present everywhere in silos - we would not have to worry about explosions either. That is also impractical at many points in silos such as elevator boots, heads, discharge points, etc. So, we need to live with a hazardous level of dusts depending on the volume of grain handled.

Removal of oxygen from the silo is impossible because air is the source of oxygen.

There are many conditions in silos under which a spark may occur. Smoking, welding, hot bearings, electrical sparks (short circuits), friction between two rubbing surfaces, etc., may cause an explosion.

There are many confined spaces in a silo - especially grain bins, bucket elevators, chain conveyors, etc.

To reduce the dust explosion hazards a combination of measures are usually taken such as using dust control and cleaning systems to separate dust from grains, explosion vents in bucket elevators, bearing temperature monitoring and control, bucket elevators outside the building, and many other measures.

Since the removal of oxygen from the silo is impossible and the use of inert gas such as nitrogen within equipment such as the bucket elevator is impractical, it is about hopeless to try to control the oxygen level in a silo.

Spark sources may be controlled with a great deal of success. External spark sources such as smoking, welding, gas cutting, brazing, soldering can be and must be controlled by administrative instructions. Nobody should be allowed to smoke on the silo premise except in designated areas such as offices, workshop, maintenance shop, control room, etc. Allowing people to smoke in outside areas makes it difficult to prevent outsiders such as truck drivers from smoking near the truck dump and throwing the cigarette butt in the dump pit in which case the burning butt may accompany the grain into the elevator and the bin creating a potential explosive situation. Welding, gas cutting, brazing, soldering, etc., should preferably be done in the maintenance shop. If on-site welding, etc., is necessary the work area must be thoroughly cleaned of dust and all equipment must be stopped. Measures must be taken not to drop smoldering metal pieces inside the spouts and other equipment and if they do precautions must be taken to be able to remove them completely and as quickly as possible.

During good weather the doors, windows, vents, etc., should be kept open to reduce the chance of pressure buildup that could result in an explosion when a fire occurs. Explosion vents on the head (top) of the bucket elevators pop open in case of an explosion within the bucket elevator and reduce the chance of spreading the explosion to other parts of the silo by preventing secondary and tertiary explosions. There are no explosion vents on the bucket elevator heads of MOS silos.

Many modern silos use a bearing temperature monitoring system especially in critical equipment such as bucket elevators, belt conveyors, dryers, etc. The idea is to watch, sound an alarm, as well as stop the machinery in case any bearing temperature increases above a preset dangerous value.

If the bearing temperature rises excessively, the grain dust on the bearing and surrounding environment may ignite and cause an explosion. By installing this system, a potentially hazardous situation can be detected and rectified. There is no bearing temperature monitoring system in the silos.

All three of the MOS silos seem to have reasonably good dust collection systems. However, an elaborate evaluation of the dust collection efficiency under the maximum loading condition may be undertaken over a period of time and if necessary additional collection capacity should be provided.

5. Conveyor Bridge in Aqaba Between the Gantry and Headhouse

Maintenance consideration of equipment on the conveyor including the raceway for electrical cables was inadequate. This conveyor being the only one from the gantry to the headhouse is a very critical piece of machinery and should be attended to frequently for maintenance and inspection. However, neither maintenance nor inspection is easy. The conveyor should have been a walk-in type with overhead roof, room, and accessibility for maintenance from either side and top and bottom of the belt. This conveyor is inadequately designed.

6. Grain Quality Laboratory in Aqaba Silo

Since Aqaba silo is the first point at which an overseas grain shipment is received, some very important quality factors such as moisture, dockage, brokens and fines, foreign materials, test weight, damage, and infestation should be determined prior to unloading the grain from a ship to ascertain if the MOS specified quality has been met by the grain exporters.

From the accounts presented by Juweideh silo staff, it is almost beyond doubt that the imported Thai corn had a high percentage of moisture at receipt in Aqaba silo either in the whole consignment or in different pockets of the cargo.

If Aqaba silo would be entrusted with determining the quality factors mentioned above, the potential danger of Thai consignment could be detected easily.

7. Absence of Magnets (especially in Aqaba)

Overseas grain is sometimes accompanied by nails, small and large pieces of iron, and strange things like tools. These pieces of iron should not be perpetuated in the MOS silo system and other plants. At some point the ferrous materials need to be separated from the grain and the sooner the better. The iron creates hazardous conditions and problems for silos and flour and feed mills. A small piece of iron such as a nail can get caught in the space between the rotor and housing of an airlock, thus stopping the airlock and damaging the rotor, metals can damage buckets and chain links. The iron pieces may rub and drop against the conveyor housing, spouts, etc., creating a potential situation for sparks. Somewhere on the receiving belt conveyor bridge, an electromagnet should be installed to separate iron from the grain.

8. Power Factor in Silos

Silos use a large number of induction motors. The more motors used the less the power factor. Low power factors are undesirable because the lower the power factor the higher the reactive power. Even though reactive power is a necessary evil, the power factor may be improved by using some capacitor bank immediately before the main power line goes into the control rooms of the silos. If MOS silos pay the electrical bill both on the basis of energy consumption and KVA it may be worthwhile to investigate the range of power factors under which each silo operates. If the power factor is lower than 0.8, it may be improved by using capacitors with proper KVAR rating. This will not only benefit MOS, it should also benefit Jordan Electric Authority.

I was told that at present there is no capacitor in the silos. Depending on the billing methods used by the Electric Authority, capacitor installation may save substantial money for MOS if the existing power factor is too low.

9. Maximum Grain Moisture for Safe Storage

At present there are no grain dryers in any silos. The existing system was planned on the basis of dry grain storage. MOS should not buy any corn beyond 13 percent moisture for a maximum of 1 year storage. For example if MOS buys U.S. Grade 2 corn without specifying a maximum moisture limit, MOS may get 15.5 percent moisture because Grade 2 corn allows up to 15.5 moisture and MOS is likely to have storage problems. If MOS buys lower grade corn, it may accept other lower quality factors such as damage, test weight, and foreign material but should not accept moisture higher than 13 percent. This upper moisture limit (13 percent) should be specified in the purchase order clearly. Moisture is not a grade factor in U.S. wheat but MOS may specify an upper moisture limit for wheat also. Moisture content for safe storage is shown in Table 1 below for guidance. In general, all grains (not oilseeds) with 13 percent or lower moisture content will keep for 1 year and 11 percent or lower moisture grain will keep for 5 years provided in both cases moisture migration is prevented.

TABLE 1

Moisture Content for Safe Storage, Percent

Cereal	Required for Safe Storage for 1 year	Required for Safe Storage for 5 years
Wheat	13-14	11-12
Corn	13	10-11
Barley	13	11

10. Storing Soybeans in Silos

Soybeans tend to split and break more easily than most grains if not handled properly. MOS silos are presently used to store wheat, corn, and barley but not soybeans. The silos should be able to handle soybeans without much difficulty. Even though pneumatic ship unloaders and chain conveyors in general tend to create more soybean breakage compared to bucket unloaders and belt conveyors, this should not create a big problem. Soybeans may be unloaded from ships at Aqaba and stored in all the silos. However, soybeans being an oilseed, deteriorate and develop rancidity more easily than grains. Therefore, MOS should not buy any soybeans above 11 percent moisture content preferably 10 percent.

AERATION RECOMMENDATION

If MOS plans to store grain in any silo for more than about 6 months an aeration system is recommended for that silo because without aeration there is no guarantee that grain will remain dry at all locations in the bin even though the grain was dry when put in the storage bin. The reason for this was elaborated earlier in this report.

Ambient temperature and relative humidity conditions in all the three storage locations meet the preconditions for successful utilization of aeration in bins.

If Aqaba silo is used mainly as a transit silo, aeration is not needed at Aqaba. However, it should be ensured that grain moves from Aqaba in less than 6 months to silos where aeration would be available.

Installation of an aeration system at Irbid and possibly Juweideh silos is recommended because in these two locations long-term grain storage is likely to be undertaken. The number of bins that should be provided with aeration fans depends on the quantity of grain MOS expects to store on a long-term basis. Since the temperature in the outside bins is more readily affected by the ambient seasonal and diurnal temperature variations than inside bins, the aeration fans may be installed in the outside bins only.

The aeration system may be similar for all bins of the same size. Different size bins, of course, will need different aeration fans and specifications.

Each silo may be provided with a few aeration fan and motor units mounted on wheels so that the units can be moved from one bin to another and connected to the aeration inlet of the bin easily. This will reduce the initial investment cost.

The detail design for fan and motor requirement for the recommended aeration is given below both for 1,500 MT and 1,600 MT bin sizes:

1. Aeration for 1,500 MT bins

   a. Design criteria

      Bin capacity - 1,500 MT
      Bin diameter - 27.9 ft (8.5 m)
      Bin height - 112 ft (34 m)

      The airflow rate for aeration in bins as large as MOS silos usually varies from 1/50 cu ft/min bu (1/46 cu m/MT) to 1/30 cu ft/min bu

(1/28 cu m/MT). For MOS silos assume 1/30 cu ft/min bu (1/28 cu m/MT). The design is based on wheat which gives the most resistance to airflow among all common grains. Wheat test weight is assumed as 58 lb per bu (743.5 kg/cu m) where bushel is a volume measure used in U.S. grain marketing and equals 1.25 cu ft (.0354 cu m).

b. Calculations

Cross-sectional area of the bin	= $(3.14)(27.9/2)^2$
	= 612 sq ft (56.80 sq m)
Volume of the bin	= 612 x 112
	= 68,544 cu ft (1,941 cu m)
Amount of grain in bushel	= 54,835 bu
Approximate weight of grain in a bin	= 54,835 bu x 58 lb/bu
	= 3,180,430 lb = 1,443 MT
Total airflow needed for grain	= 54,835 bu x 1/30 cu ft/min bu (cfm/bu)
	= 1,828 cu ft/min (51.77 cu m/min)
Airflow rate per unit of floor area	= 1,828/612 = 3 cu ft/min sq ft (cfm/bu)
	= 0.92 m/min

From the plot of Fig. 5 for wheat, the static pressure drop per ft of grain depth for a loosely filled bin is 0.06 in of water. The static pressure drop for the total bin height = .06 x 112 = 6.72 in of water. Adding 50 percent for grain compaction and other losses, the needed static pressure from a fan = 6.72 x 1.5 = 10 in of water.

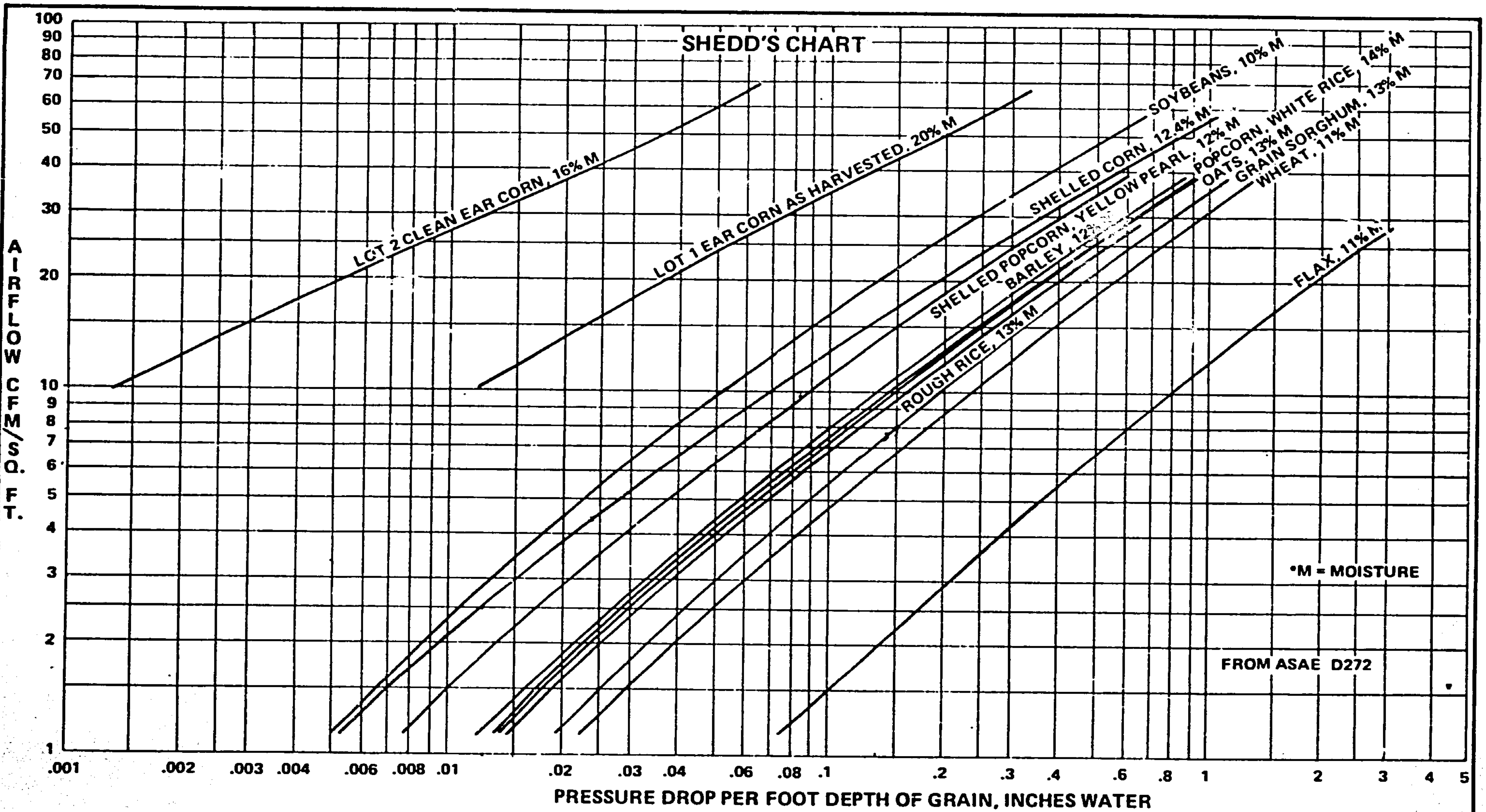
The fan should have a minimum capacity of 1,828 cfm delivered at 10 in of water static gage pressure. The motor HP is usually calculated by the following formula:

$$HP = cfm \times \text{static pressure in inch of water}/3{,}000 = (1{,}828 \times 10)/3{,}000 = 6.1 \text{ HP}$$

Therefore, the fan and motor for aeration should have the following specifications:

Fan - 2,000 cfm delivered at 10 inch of water static pressure. A centrifugal fan should be used

Motor - 7 1/2 HP



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CALCULATIONS	Example
1. Assume Grain Column 1 ft. square.	$1 Ft.^2$
2. Determine Grain Depth.	50 Ft.
3. Determine Desired CFM/BU.	1/10Cfm/Bu.
4. Calculate Airflow ($CFM/FT.^2$) = Depth x 1 $ft.^2$ x CFM/Bu. x .8 $\frac{Bu.}{Ft.^3}$	1 x 50 x 1/10 x .8=4
5. Read Chart Horizontally Along Line Representing Airflow to the appropriate Grain Curve.	Read along 4 to Corn
6. Read Down to Pressure Drop per ft. Depth	Down to .021
7. Multiply Pressure Drop x Total Depth for Static Pressure.	50 x .021 = 1.1
8. Add 50% for Grain Compaction.	1.1 x 1.5 = 1.7"S.P.

2. Aeration for 1,600 MT Bins

The basic design criteria are same as 1,500 MT bins except for the bin height which is 120 ft (36.5 m) and storage capacity.

Volume of grain in the bin = 612 x 120
= 73,440 cu ft (2,080 cu m)
= 58,752 bu

Approximate weight of grain in the bin = 58,752 x 58 lb
= 3,407,616 lb = 1,546 MT

Because of the density variations and grain compactions a storage capacity up to 1,600 MT seems possible. Considering 1/30 cfm/bu airflow, total airflow needed from the fan = 58,752/30 = 1,958 cfm (55.5 cu m/min). Air velocity = 1,958/612 = 3.2 cfm/sq ft (1 m/min)

From the plot shown in Fig. 5 for wheat, the static pressure drop per ft depth of wheat = 0.065 in of water gage. Total pressure drop in the bin = 0.065 x 120 = 7.8 in of water.

Increase this pressure drop by 50 percent to account for grain compaction and nonuniform distribution of brokens and fines in the bin. Minimum static pressure needed from the fan = 1.5 x 7.8 = 11.7 in of water. Use 12 in of water.

Motor HP = (1,958 x 12)/3,000 = 7.9 HP

The following specifications for fans and motor may be used: centrifugal fan capacity about 2,000 CFM delivered at 12 in of water gage.

Motor - 10 HP

3. Direction of Airflow

Whether air should be drawn downward through the grain (suction system) or blown upward through it (pressure system) is a subject of controversy when aeration is discussed.

There are advantages and disadvantages associated with each system. The author recommend pressure aeration, blowing air upward through the grain, for the following reasons:

a. When a duct distribution system is used, a pressure system will always result in more uniform air distribution for the same fan and duct combination.

b. Warmest grain is located near the surface where it can be easily observed. With suction systems, the warmest grain is deep within the grain mass.

c. If warm grain is loaded on top of grain that has already been cooled, warm air is driven upward and not drawn into the cool grain.

d. Natural cooling can occur more rapidly as the warmest areas lie near the surface.

e. The fan will add 2-3°F of heat to the air, reducing the humidity of the ambient cooling air.

The chief disadvantage of pressure aeration is the condensation that occurs on the roof in cold weather or when the grain has heated. This condensation is not a great cause for alarm, if handled properly. The vents on the bin top should be opened and a small portable exhaust fan with about 2,000 cfm at 0.5 in water with a 1/2 HP motor may be used on the bin deck (gallery) to exhaust air quickly from the open space above the grain surface in the bin.

It is also possible for a pressure aeration fan to blow rain or snow into the duct. A small roof will shield the fan from rain. When snow or rain might be blown into the grain, the fan should be turned off.

Before installing the recommended aeration system, the structural feasibility in making an air inlet opening near the bin bottom must be thoroughly examined preferably by the original designer. Constructional modifications should be done preferably by the same builder(s).

A thorough study should also be conducted to determine the quantity of grain that MOS expects to store on a long-term basis (6 months or more) in each of the three silos. On this determination will depend the equipment requirement. It appears that Irbid silo may store more grain for a long-term basis than other silos.

4. Use of Bin Temperature Sensors

For a bin diameter of about 8 m, use of three temperature cables rather than two is usually recommended because a satisfactory representative sample of temperatures within a bin can be obtained by a minimum of three cables. In the MOS silo round bins there are two cables, each with six sensors along the entire height. The number of sensors in each cable are fewer than usually recommended. The recommended distance between two adjacent sensors should be kept within 2 m. With only six sensors and two cables it would be somewhat difficult to assess the grain conditions in between two adjacent sensors and in between two cables.

For future guidance, it is recommended that for about 8 m diameter round bin size, MOS should use three temperature cables separated from each other by 120 degrees and at a distance of 2/3 the radius from the bin center. The adjacent sensors of each cable should be separted by a distance not more than 2 m.

PERSONNEL TRAINING RECOMMENDATION

It appears that many key personnel of the silos have been reasonably trained in running the day to day function of the silos. There are also a few exceptionally capable persons in the silo system. However, it seems to me there is a weak link in the system. As a general rule, key members of the silo operation, maintenance, and management somewhat lack in the fundamental knowledge of grain storage and causes and prevention of grain losses. The members should be trained in the engineering and biological aspects of stored grain including quality standards for grain. The training material should include among other subjects, interrelationship of grain moisture and environmental factors such as temperature and relative humidity; control of grain moisture to maintain quality in storage, biology of insects, fungi and rodents, physical and biochemical changes in grain created by fungi, health hazards created by fungi, detection, identification and control of insects, fungi and rodents, grain quality standards, sampling and grading.

Personnel training may be accomplished by any of the two methods:

1. Send the personnel to a reputed institution for an appropriate short course.
2. Bring a group of trainers to impart training to the personnel here in Amman.

Either method has advantages and disadvantages. The principal advantage of the first method is closeness to a technologically superior environment from which the trainees are likely to learn new ideas through field trips, demonstration, etc. The disadvantage is this method is costly. The main advantages of the second method are: (1) low cost, (2) can train more people at one time, and (3) local problems can be dealt with in the training site under local conditions. The disadvantages are: (1) inaccessibility to storage facilities having alternative storage methods and (2) inability to adopt new ideas and grain storage practices, that can only be grasped through on-site observations.

Grain storage like any other technology undergoes continual change. Personnel already trained should be kept up to date by sending them periodically to relevant international conferences, short courses, or simply study tours.

For the development of the silo system and Jordan's grain storage and processing technology base, a few academically superior personnel from the silos may be sent abroad for graduate degree programs in agricultural engineering, flour milling, feed milling, baking science, and cereal chemistry areas.

OTHER RECOMMENDATIONS

1. Warehouse Fumigation

Present fumigation practices in the warehouse seem somewhat faulty. Whole warehouse fumigation should be discontinued for the following reasons:

a. Fumigation should always be done under sealed conditions. No warehouse can be completely sealed--leakage occurs through the louvered doors, windows, all door and window frames, at the eaves, and many numerous other points.

b. Whole warehouse fumigation is costly because the entire volume is fumigated no matter whether the warehouse is full or partly full.

c. If the fumigation is not done properly, insects develop resistance to fumigants.

d. Fumigation is mainly used for insect control. I was told that MOS warehouses are fumigated primarily to control rats and mice. Separate chemicals should be used for controlling rats and mice.

e. Whole warehouse fumigation puts the entire warehouse out of use for the duration of fumigation.

Instead, fumigation should be carried for each stack of stored product. Fumigation should be carried by covering the stack with a gas impermeable tarpaulin or a suitable plastic material large enough to extend a few feet on the floor on all sides. Sand snakes should be put on the tarpaulins spread on the floor so as to closely seal the floor against fumigant leakage.

2. Detection of Hidden Infestation in Grains

Nowhere in the silo system is any test conducted for detection of hidden infestation. Testing for hidden infestation is recommended. A few simple tests are presented below:

- Staining methods for detection of hidden infestation

a. Acid Fuchsin Stain

(1) Prepare the dry solution

(a) Weigh out 0.5 g acid fuchsin

(b) Measure 50 cc of glacial acetic and 950 cc distilled water and mix

(c) Add the acid fuchsin to the glacial acetic acid and water mixture

(d) This dye solution can be stored for a long time and may be used repeatedly until it becomes murky

(2) Soak grain to be treated for 5 min in warm water

(3) Drain off water and cover with acid fuchsin solution for 2-5 min. If left longer, the kernels may absorb enough solution to make the identification of the egg plug difficult

(4) Pour off dye solution (retain for future use) and wash grain in tap water to remove excess dye

(5) Examine the kernels to locate the gelatinous egg plug with stain a deep cherry red. Note that feeding punctures and mechanical injuries stain a lighter color than the egg plugs

b. Berberine sulfate solution for staining weevil egg plugs

(1) Prepare aqueous solution containing 20 ppm of the alkaloid berberine sulfate

(2) Soak grain in this solution for 1 min

(3) Examine kernels under ultraviolet light. The stained egg plugs will fluoresce intense yellow. Feeding punctures and mechanical injuries do not fluoresce

c. Gentain violet stain

(1) Prepare 1 percent gentain violet aqueous stock solution

(2) Weigh out 5 g of wheat sample and soak in warm water containing a wetting agent, detergent for 30 seconds

(3) Drain off the excess water by placing the sample in a wire container, wash, then put the wet wheat on a dry towel for a few seconds

(4) The wheat is exposed for 2 min in a solution which contains 10 drops of the staining solution (1 percent gentain violet aqueous stock solution in 50 ml of 95 percent ethanol)

(5) Pour off the staining reagent and wash the sample in clear water for 20 seconds

(6) The weevil egg plugs are purple color and are very easily seen while the kernels are still wet or in water. Gentain violet does not stain the endosperm of the wheat kernel

- Sodium silicate flotation methods for detection of hidden infestations

a. Materials, reagents, and solutions

(1) Materials

(a) One-liter beakers

(b) Hydrometer

(2) Reagents and solutions

(a) Sodium silicate (water glass) solution at specific gravity of about 1.190 (mix equal parts of sodium silicate and water)

b. Procedure

(1) Method

(a) Prepare the sodium silicate solution and place in 1-liter beaker or comparable container

(b) Weigh out sample to be tested. Any size sample may be used

(c) Place sample in solution and stir mixture

(d) Roughly 50-70 percent of the infested kernels will float on the surface. These may be checked by sectioning

(e) Solution may be reused

(2) Results

(a) Accuracy of this method leaves much to be desired; however, it is easily used in areas outside the laboratory and is relatively inexpensive

(b) Accuracy of the method should be checked for grains being tested

- Cracking flotation method for determination of internal insect infestation

a. Materials, reagents, and solutions

(1) Materials

(a) Balance

(b) Sieve - 8 in diameter No. 12 Tyler Standard or equivalent (with openings 0.055 in or 1.397 mm)

(c) Laboratory grinder - Labconco mill (Laboratory Construction Company, Kansas City, Missouri, 66132, USA) or equivalent set at 0.061 in

(d) Buchner funnel and filtering flask

(e) Petri dishes

(f) Ruled analytical filter paper or 10xx bolting cloth

(g) Microscope - 15x-30x wide field, binocular

(2) Reagents and solutions

(a) Alcohol solution - 60 percent alcohol (isopropyl) saturated with any lead-free gasoline

(b) Glycerine-water solution (1 part glycerine, 1 part water)

b. Procedure

(1) Method

(a) Mix sample of grain thoroughly using a Jones, Boerner, or equivalent grain divider. Cut out a sample of slightly more than 100 g

(b) Weigh out 100 g and sift through a No. 12 sieve to remove any external insects in the sample (make note of number and species)

(c) Grind the sieved sample to crack the grain roughly the size of 1/4 of a kernel of wheat

(d) Transfer the cracked grain to a 1- or 2-liter Wildman trap flask

(e) Add about 600 ml of 60 percent alcohol saturated with gasoline, then add 200 ml of gasoline

(f) Stir the contents without splashing

(g) Fill the flask with alcohol-gasoline solution and allow material to settle for 15 min

(h) Trap off gasoline layer and filter through ruled analytical filter paper or 10xx bolting cloth

(i) Transfer filter paper to petri dish to which several drops of glycerine-water solution has been added

(2) Results

(a) Using the binocular microscope, examine the filter plate

(b) Record whole insects, major insect parts, whole larvae, cast larval skins, and larval head capsules

CONCLUSIONS

The MOS silos at Aqaba, Juweideh, and Irbid have been well designed and built. The silos are being operated reasonably well. However, a few minor additions, modifications, and operational procedures are advised to reduce the risk of grain spoilage and improve the performance of the storage system. Key personnel training in fundamentals of grain storage is recommended. Some guidance for future administrative decisions in procuring grain and equipment has been given.

PAGE 01 AMMAN 09921 2512162 2420 099250 AID0907

ACTION AID-00

ACTION OFFICE STAG-02
INFO NEPD-04 NEDP-03 NETC-04 FM-02 CMGT-02 SAST-01 SIFA-01
NEMR-03 PELO-01 HAST-01 /024 A4 825

INFO OCT-00 NEA-07 /007 W
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TO SECSTATE WASHDC PRIORITY 3277

UNCLAS AMMAN 09921

AIDAC

FOR ST/AGR/AP, RAJA JAFFAN
----NE/TECH/AD, GEORGE MILLER

E.O. 12356: N/A
SUBJECT: ASSISTANCE TO MINISTRY OF SUPPLY (MOS) - NOMINATION OF DR. E. HAQUE

REF: (A) AMMAN 09669 (B) STATE 315634

1. USAID HAS RECEIVED A COPY OF LETTER SENT BY MOS TO THE NATIONAL PLANNING COUNCIL APPROVING DR. HAQUE'S NOMINATION REFERRED TO IN PARA 1 REF (A). MOS WILL PROVIDE TRANSPORTATION IN JORDAN IN CONNECTION WITH HAQUE'S ASSIGNMENT.

2. WE HAVE MADE RESERVATION FOR DR. HAQUE AT SHEPHERD HOTEL WHICH IS WITHIN WALKING DISTANCE FROM THE U.S. EMBASSY. HE SHOULD TAKE TAXI FROM AIRPORT TO HOTEL FOR UP TO THE EQUIVALENT OF $15 (JD 5.6) WHICH SHOULD BE REIMBURSABLE.

3. SINCE DR. HAQUE IS ARRIVING ON EMBASSY WEEK-END (FRIDAY AND SATURDAY) AND BECAUSE EMBASSY WILL BE CLOSED ON SUNDAY, NOV. 11, 1984, INSTEAD OF NOV. 12 (VETERAN'S DAY), WE REQUEST THAT UPON ARRIVAL, DR. HAQUE CONTACT EITHER DR. WILLIAM FURTICK (HOME TEL. 665315) OR FUAD QUSHAIR (HOME TEL. 815705). QUSHAIR WILL CALL ON HAQUE AT HOTEL AND ACCOMPANY HIM SUNDAY (11/11) TO MOS AND OR TO JWEIDEH WHERE THE MOS SILOS ARE LOCATED.

4. THE CONSULTANT'S SOW REQUESTED IN PARA 4 REF B FOLLOWS: SOW — SCOPE OF WORK

(A) - THE CONSULTANT WILL INSPECT THE GRAIN STORAGE SILOS OF THE MINISTRY OF SUPPLY (MOS) AT THREE LOCTIONS: JWEIDEH NEAR AMMAN, AQABA AND IRBID AND ADVISE MOS STAFF (ENGINEERS AND TECHNICIANS) ON THE PROPER METHODS OF HANDLING AND STORING OF GRAINS UNDER THE CONDITIONS AT EACH LOCATION.

(B) - OF PARTICULAR IMPORTANCE TO THE MOS WILL BE THE STORING OF CORN. CONSULTANT WILL ADVISE MOS ON SAFE STORAGE MOISTURE AND TEMPERATURE LEVELS OF CORN (AND PERHAPS OTHER GRAIN) AND NEEDS FOR ANY NECESSARY MODIFICATIONS IN THE SILOS SUCH AS VENTILATION OR AERATION EQUIPMENT, ETC. TO REDUCE HAZARDS WHICH COULD RESULT FROM HEATING UP. THIS IS IMPORTANT AS THE MOS RECENTLY EXPERIENCED A PROBLEM OF EXCESSIVE HEATING UP OF CORN IN THEIR SILOS AT JWEIDEH.

(C) - THE CONSULTANT WILL ALSO MEET WITH MOS ENGINEERS AND TECHNICIANS WHO WILL BRIEF HIM ON THE PROBLEM(S) WHICH THEY HAVE ENCOUNTERED.

(D) - BASED ON HIS OBSERVATION, DISCUSSIONS WITH

AMMAN 09921 2512102 2420 099250 AID0907

APPROPRIATE MOS STAFF AND ANALYSIS, PREPARE REPORT FOR SUBMISSION THRU USAID TO MOS WITH HIS RECOMMENDATIONS ON GENERAL IMPROVEMENT AND EFFICIENCY AS WELL AS ON STAFF TRAINING.
BOEKER

10-26-01
AP
Due 11/1

APPENDIX B

Itinerary for Dr. Ekramul Haque
Grain Storage Consultant
Prepared by Ministry of Supply

Sat., Nov. 10, 1984	: Arrives and proceeds to Shepherd Hotel
Sun., Nov. 11, 1984	
08:00 - 11:30	: General tour of Juweideh Project including silos, mill and storage facilities
12:00 - 14:00	: Meeting with project managers
Mon., Nov. 12, 1984	
08:00 - 13:00	: Carry out a general and detailed study of the methods used in grain storage at Juweideh silos, analyze problems and recommend appropriate solution thereto
13:00 - 14:00	: Discussion about fundamentals of grain storage and affect of various factors on the quality maintenance of stored grain
14:00	: Discussion
Tues., Nov. 13, 1984	
08:00 - 12:00	: Inspection tour inside the silos (conveyors, drives, gates, pathways, dust collection, electrical system, etc.), analyze and recommend appropriate solution for problem areas
12:00 - 14:00	: Discussion at the Conference Room between Dr. Ekramul Haque and officials responsible for the silos and laboratory covering the positive and negative aspects of the grain storage methods presently used at the silos and those methods recommended by the consultant
14:00	: Discussion
Wed., Nov. 14, 1984	: Travel to Aqaba. Program similar to that for Juweideh silos
Thu., Nov. 15, 1984	: Carry on with above program for Nov. 14, 1984
Fri., Nov. 16, 1984	: Return to Amman - Rest
Sat., Nov. 17, 1984	: Inspection tour inside the flour mill at Juweideh. Observe, study, and discuss methods of storing flour used at the mill, recommend and advise on the best methods to be used. Consultant will meet with the flour mill manager, discuss and exchange views with him on this subject

Sun., Nov. 18, 1984	: Irbid silos. Carry out task as for Juweideh
Mon., Nov. 19, 1984	: Discussion with Juweideh silo manager and other officials about recent corn heating problem and staff training need Demonstration on the use of a portable operated electronic moisture tester
Tue., Nov. 20, 1984	: Preparation and discussion of report in USAID/Amman
Wed., Nov. 21, 1984	: Discussions and exchange of view and ideas with the Minister of Supply and Director of Projects, MOS
Thu., Nov. 22, 1984	: Leave for United States