GRAIN QUALITY Task Force

Fact Sheet #38
September 28, 1998
Purdue University

Temporary Grain Storage Considerations

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Indiana is expecting large corn and soybean crops this fall. Given the low commodity prices, much of the harvest is expected to be carried into next spring, and possibly summer, in hopes of higher prices. Additionally, there is an estimated 125 million bushels of carryover corn, soybeans, and wheat on farms and at commercial elevators from the 1997 harvest, which will contribute to a shortage of available storage space. The Indiana Agricultural Statistics Service reports 356 million bushels of available storage capacity at elevator facilities and 650 million bushels on farms. With the carryover and a projected crop of 1020.4 million bushels, this would leave Indiana short of storage space by about 139 million bushels. Reports have been received from numerous storage bin manufacturers that requests for construction of additional storages has been high, but that sales have not been able to satisfy the demand due to a shortage of millwrights and construction crews. This means that Indiana elevators and farmers will need to utilize some temporary storage of grains in outdoor piles and suitable existing structures. Numerous requests have been received to assist with the sizing of aeration equipment (ducts and fans) for converting existing buildings and silage silos for dry grain storage. This fact sheet reviews key considerations when selecting a temporary grain storage structure.

Existing Buildings

Temporary grain storage facilities need to protect the grain from moisture, wind, birds, rodents, and insects. Thus, storage in an existing building (such as a pole barn, machinery shed, warehouse, or even livestock building) is preferred over outdoor piles. When deciding whether a given building would be a good choice for grain storage, the following should be considered. For additional information refer to AE-92 and/or contact the original building manufacturer.

Sanitation - A key question to ask oneself is whether a building under consideration can be sufficiently cleaned to safely store grain in it. If the building previously contained manure, ag chemicals, or petroleum products, it may not be possible to completely remove these materials and their odors so that grain will not be physically contaminated or pick up the odors. This could result in marketing discounts or outright rejection at the first point of sale. Also, one should carefully weigh whether the building is constructed in such a way as to keep birds and rodents away from the grain.

Sidewall Loading - Dry grain exerts a pressure on walls of about 23 pounds per foot of grain depth. Unless the building was specifically designed to withstand the pressure of grain or some other granular product, it will need to be reinforced by using cables between walls, or self-supporting interior walls. If the building was designed and erected by an ag building company, a “grain package” may be available from them. If not, an engineering consultant should be hired to design the necessary building modifications. Another option is to set free-standing bulkheads inside the building to keep grain away from the walls. Refer to AE-84 or AE-92 for the design of a self-supporting portable wall. The wall-pressure problem can also be avoided by buying metal grain bin rings (without roofs), and installing these partial bins inside the building. Grain could also just be placed in the center of the building in sloping piles that do not touch the walls. Obviously, the storage capacity of the building would be significantly reduced.

Storage Capacity - When trying to decide whether it is worth using an existing building for grain storage, one should first estimate how many bushels can be stored. It is disappointing to find how few bushels can actually be stored in some flat buildings, especially when buildings have low ceilings or when grain is not piled against the sidewalls. For example, consider a typical 60 ft wide by 80 ft long shed with 16 ft sidewalls. If the sidewalls are only sufficiently reinforced to retain 2 ft of grain safely, the total storage volume using a 1:2 side slope for the dry corn is about 19,293 bu (the end sections hold a total of 10,129 bu and the center section 9,164 bu; multiply total cubic feet by 0.8 or divide by 1.25 to get bushels). On the other hand, if eight 21 ft diameter bins (without roofs), each with a 16 ft sidewall height, were placed inside the building, a total of about 35,638 bu of grain could be stored. Four bins placed along each sidewall would allow for a sufficiently wide alley to drive a truck (or tractor and wagon) into (or through) the building and load the bins with an incline conveyor. If two additional bins could be placed in the alley in the center of the building the storage capacity would increase to 44,550 bu. The bins could be equipped with fans and ducts (or floors) for aeration cooling. Unloading augers could be placed at an angle through the sidewalls in order to feed the hopper of a second inclined conveyor that feeds into a truck or wagon. One other provision would have to be adequate roof venting to prevent condensation on the underside of the roof, especially during aeration.

Drainage and Vapor Barriers - Check the roof for leaks and estimate how difficult and expensive it would be to repair it. Make sure the area where the building is located is well drained. If the building does not have a concrete floor, place the grain on a vapor barrier (for example 6-mil plastic) to prevent moisture moving from the ground into the bottom layers of the grain. Even with a concrete floor it is advisable to cover the concrete with plastic, especially if the concrete is cracked. Moisture vapor will move through concrete and into the grain if the soil is wet below the concrete. For buildings with earthen floors, consider installing a new concrete floor with a vapor barrier under it. Keep in mind that new concrete floors should be allowed to cure for several weeks before grain is placed on them.

Filling and Unloading a Building - Grain handling is not as convenient in flat storage buildings as it is in round metal bins. Thus, it can be a labor-intensive challenge to move grain in and out of a building. There is some specialized equipment designed for this purpose that one could buy or rent. Portable grain augers can be used to fill a flat storage building by making openings in the roof, or by moving the auger around inside the building. Unloading can best be accomplished by using a front end loader that either feeds the hopper of an inclined auger, or directly loads grain into a truck or wagon. Pneumatic grain conveyors can also be used for filling and emptying flat storage buildings. If an above-floor aeration system will be used, place the ducts inside the empty building at the correct locations first. Then, carefully place small piles of grain along the length of each duct to stabilize them before filling of the entire building is started.

Aeration Cooling - Cooling the grain with aeration is extremely important for proper storage. Cool temperatures minimize mold growth, limit moisture condensation and accumulation, and control insects. Perforated ducts (full or half-round) placed on the floor work well for flat storage buildings. If the pile is leveled, duct spacing should be about equal to the pile depth. For a long triangular-shaped pile, one duct centered under the peak and running the length of the pile may suffice. Unusual pile shapes make aeration design tricky. An experienced aeration system designer should be consulted in these cases. Perforated steel aeration ducts (round or half-round) are the preferred choice, although plastic aeration ducts can also be used. Those increase the airflow resistance by about 10% and should be wrapped with diffusion screen to prevent the kernels from blocking the openings. Ordinary plastic drainage tile should be avoided because it does not have enough perforated surface area for good air movement. An aeration airflow rate of about 1/

10 to 1/5 cubic feet per minute per bushel (CFM/bu) is recommended for dry grain. For example, in a building 100 ft long and 60 ft wide with 26 ft of peaked corn in the center and piled 12 ft high along reinforced sidewalls, a single 30 inch diameter round perforated aeration duct placed down the center and two 14 inch diameter round perforated ducts in parallel and 15 ft to each side of the center duct would suffice. In order to deliver about 0.1 cfm/bu in airflow, the center duct would require an 18 inch diameter 3 HP axial fan delivering 5,700 cfm against a static pressure of one inch, and the outside ducts would require each a 0.5 HP 12 inch axial fan delivering 1,500 cfm against one inch of static pressure (see MWPS-29 for more information). At 0.1 cfm/bu the minimum cooling time is 150 hours. Halving the airflow rate doubles the cooling time.

Roof Vents and Air Exhausting - Positive pressure designs (air blowing into ducts and out of the top of the pile) are preferred for flat storage buildings. If aeration is used, roofs should be equipped with additional vents at 1 square foot of vent area for every 1000 cubic feet of air per minute (cfm) to minimize condensation on the underside of roofs. Condensate dripping results in crusted and molding grain surfaces. Provide plenty of air movement over the pile while the fans are running. This can be accomplished by installing additional ventilation fans in the building end walls. Also, run the fans often enough to minimize the temperature difference between the grain pile and outdoor air. Whenever the fans are off, they should be sealed to minimize convection currents through the pile (chimney effect). Aeration fans should remain sealed when operating the headspace ventilation fans alone.

Outdoor Piles

Elevator operators regularly pile grain outdoors for a few weeks or months when receipts at harvest temporarily exceed storage capacity and when rail cars are not available to move the grain ahead in the marketing chain. Sufficiently dry corn (15% moisture or less) stored in piles during only the cooler fall and winter weather does not usually need to be covered and aerated. It is when grain is stored into the following spring and summer that tarp covers are used and provisions need to be made for aeration. When deciding whether to store grain in outdoor piles the following should be considered. For additional information refer to AE-91 and/or ASAE Paper 88-6055.

Drainage and Vapor Barriers - If the grain must be piled outside on the ground, drainage is crucial. The pile should be on high ground and the earth crowned under the pile. Place a vapor barrier (for example 6-mil plastic) on the ground to keep ground moisture from wetting the grain unless the pile is on well-drained gravel-covered soil.

Covering a Pile - Plastic or tarp covering a pile will reduce wetting by rain and snow but may turn out to be an expensive, frustrating and labor-intensive undertaking for inexperienced farmers and elevator operators. Whether the pile is covered or not, the top surface should be smooth to aid in drainage. The cover should carry the water away from the piled grain to prevent wetting the grain. Condensation under the plastic may cause severe problems unless it is controlled with aeration. Airflow must flow near the plastic to reduce the condensation and carry the moisture away. Drainage tile under the plastic has been used as an air intake duct when the aeration fan exhausts air from the bottom of the pile. Sucking air with the fan through the pile and out of the bottom also aids in holding the tarp down in windy situations. The problem of providing aeration air entrance area to a tarp covered pile becomes so expensive that many question the feasibility of this approach to storing grain. Run the pile north and south to allow the sun to dry off the sloping sides. Avoid walking on the pile, and do not allow snow mobiling or skiing on the pile during the winter!

Support Walls - Grain depth in an outdoor pile frequently runs from near zero at the edge of the pile to a maximum at the center. For example, a circular pile that will hold one million bushels is just under 300 ft in diameter with a circumference of over 900 ft. Often some type of low retainer wall is used, such as concrete traffic dividers (barriers). The weight of the concrete is such that the barriers are stable and support the lateral pressure of the grain up to depths of 3-4 ft. Self-supporting or free-standing walls or bulkheads of triangular configuration are also used (see AE-84 and AE-92 for more information on their design). If made of either perforated steel or screen-covered wood, these bulkheads could also provide a means of getting aeration air into the pile. For smaller piles, large round bales can be used to form a bin wall, but will likely need to be restrained by wrapping with a cable. With a 5 foot grain wall depth, there is a force of about 115 pounds of force on each foot pushing the bale outward. Plastic along the inside of the bales is preferred to help keep grain from leaking out and to prevent water from entering. Peak the grain so it flows onto the top of the bales to form a smooth top. If the pile is covered, the plastic or tarp should drape over the top of the bales, so the water flows to the outside of the bales.

Aeration Cooling - The problem of getting adequate distribution of aeration air to grain in a large pile is obvious. For example, for a one million bushel pile at 30 ft in from the edge the circumference is 754 ft. The general recommendation on duct spacing is that ducts should be spaced no farther apart than the grain is deep. Thus, 48 ducts and fans would be required in this example. Without a cover, the air entrance area for a suction aeration system is the entire grain surface. The most serious problem in aerating tarp covered piles is caused by the tarp. The tarp has to be held in place through suction created by the aeration fans. If the tarp is held tightly against the grain surface, no air will enter the grain pile, and no aeration will be accomplished. The use of perforated bulkheads to contain piles of grain offers an aeration option that has proven promising. If a center tower is employed to fill the storage, aeration ducts and exhaust fans can be part of the center structure. The aeration air is drawn in through the perforated retainer wall and exhausted out of the center tower. This may provide the best opportunity to uniformly aerate a tarp covered pile. Air can be drawn along the underside of the tarp and perhaps reduce the extent of water condensation caused by rapid swings in night- and day-time temperatures (see ASAE Paper 88-6055 for more details).

Converted Dairy Silos

Silo structures for silage (stave and hoop, tile, poured concrete, galvanized steel, glass coated steel) have been used successfully for grain storage, both wet and dry, for many years. There are a number of considerations that need to be weighed in approaching the evaluation of an existing silo for possible adaptation for dry grain storage. For additional considerations refer to AE-93 and/or contact the original manufacturer.

Structural Soundness - The silo must be in sound structural condition, and hooped or reinforced sufficiently to store dry, shelled grain. Do not underestimate the importance of structural soundness, especially for an older silage silo. Make sure the walls will withstand the pressure of dry grain. Dry grain exerts more pressure on walls than does silage. Many newer silos were designed to handle the pressure of dry grain, but some older ones were not. Also, the steel rods on the outside of concrete stave silos have probably corroded and weakened over time. Carefully examine the condition of the silo walls and reinforcing rods, and if necessary, contact the original manufacturer to find out if the silo is currently strong enough, or can be made strong enough to hold dry grain.

Moisture Tightness - Check the roof and repair or replace it to prevent water leaks. Examine the sidewalls for evidence of leaks. The walls must be reasonably moisture tight. It might be possible to re-plaster concrete or concrete stave silos that have cracks and leaks. Some farmers have attempted to hang plastic liners inside of silo walls to protect dry grain from moisture. Unfortunately it is difficult to keep the plastic in place as it creeps especially during loading and unloading. Make sure the floor is good and is well above the ground surface outside of the silo. If the silo has an earthen floor that is below grade, consider adding fill, putting in a plastic vapor barrier, and pouring a new concrete floor several weeks before harvest. The doors and walls must be reasonably air tight to permit forced aeration.

Filling the Silo - Getting grain into an upright silo can be one of the biggest obstacles to their use for dry grain storage. If dry grain is to be marketed, the silo must have a fill system that will minimize grain damage. Silage blowers cause a lot of impact damage to grain kernels, so dry grain should not be run through a silage blower unless the grain will be fed relatively soon after harvest. Grains must be 1 - 2% drier to store in a ground state compared to their safe moisture as whole grain. This could mean significant shrink loss at 12 - 13% moisture content for long term storage. Dry corn should not be additionally ground to increase compaction. Silage blowers can be modified for use with dry grain by running an auger into the pipe just above the blower. However, silage blowers throw rather than blow, so they do not generate much air pressure. This results in low handling capacities (bushels per hour) of modified blowers. Most transport augers will not reach the tops of silos, but one might be able to at least partially fill silos that have side doors by running an auger into the highest door that the auger will reach. Vertical bucket elevators and pneumatic grain conveyors are the best alternatives. If no permanent installation is planned, renting a pneumatic grain conveyor from an equipment dealer, elevator, or other farmer may be the best temporary option to fill the entire silo, or the rest of a silo that was partially filled with an inclined conveyor. Make sure a cyclone is installed at the outlet to decelerate the grain before it drops into the silo.

Aeration Cooling - The silo must be equipped with an adequate aeration system to condition dry grain so that grain temperature can be controlled to reduce mold and insect activity and to prevent moisture migration. One could install a fully perforated floor, but placing perforated metal over the unloading trench, or installing a perforated round or half-round duct suffices. Normally one would size a dry grain (post-drying & cooling at 15% or less) aeration system in bins for 0.1 cfm/bu (cubic feet of air per bushel), which results in minimum cooling times of 150 hours. However, for tall silos one can go as low as 0.05 cfm/bu, which lowers the HP needed on the fan but doubles the cooling time. For example, a silo with a diameter of 20 ft and a fill height of 70 ft would hold about 17,593 bushels of level filled corn. In terms of sizing a fan, one might consider the following two options.

Table 1 - 1 HP 14” diameter 3450 rpm axial fan, which would deliver…

Depth, ft	Airflow, cfm	Airflow, cfm/bu	Static Pressure, inches
10	2,303	0.916	1.20"
40	1,298	0.129	1.86"
70	938	0.053	2.11"

Table 2 - 3 HP 18”diameter 3450 rpm axial fan, which would deliver…

Depth, ft	Airflow, cfm	Airflow, cfm/bu	Static Pressure, inches
10	4,028	1.603	1.98"
40	2,239	0.223	3.19"
70	1,623	0.092	3.63"

Option 1 (see Table 1) - Given this full silo airflow rate, one could place a 12 inch round perforated aeration duct on the floor of the silo through an access hatch, or in case the access hatch is a few feet above the ground, fill the silo to the level of the access hatch, lay the duct on top of the grain then fill the silo the rest of the way. Also install at least 1 ft^2 of vent area in the roof to allow the aeration air to escape.

Option 2 (see Table 2) - Given this full silo airflow rate, one would need a 14 inch round perforated aeration duct and at least 2 square feet of open vent area in the roof to allow the air to escape. At the 70 ft depth, this 3 HP fan is close to its efficiency limit for pushing air. One would need to check with the fan manufacturer for their maximum depth recommendation.

Positive pressure aeration that blows air into the bottom of the silo is the preferred system. Install 1 square foot of venting area (in the form of goose-neck or mushroom vents) at the top of a silo per 1,000 cfm to let air out of the silo when the fan is running. Dry corn blown into the silo should preferably be precleaned with a screen cleaner before it is placed in the structure. If a large amount of fines remains in the grain, effective aeration may become impossible. If aeration is not possible, then dry grain should go into the silo around 35 - 40°F. This either means cooling the grain in another storage bin, or running the dryer delivery during the night hours into the silo storage.

Table 3 - 15 HP 3500 rpm centrifugal fan, which would deliver...

Depth, ft	Airflow, cfm	Airflow, cfm/bu	Static Pressure, inches
10.0	8,086	3.217	4.05
20.0	7,432	1.479	7.14
30.0	6,744	0.895	9.28
40.0	6,268	0.623	11.11
50.0	5,800	0.462	12.40
60.0	5,360	0.355	13.28
70.0	4,996	0.284	14.00

In-silo Cooling of Hot Corn - Silage silos have been successfully adapted for in-silo cooling of hot corn. One farm system uses a pneumatic conveyor that transfers the hot corn from the dryer to the silos at 120-130°F and 16.5-17.5% moisture. The silos are equipped with full aeration floors and large enough fans to deliver sufficient airflow at full depth to cool out the corn within 36-48 hours. For example, a silo with a diameter of 20 ft and a fill height of 70 ft would hold about 17,593 bushels of level filled corn. In terms of sizing a fan, one might choose a high speed (3,500 rpm) 15 HP centrifugal fan that would perform as indicated in Table 3.

In this case, the normally recommended minimum cooling airflow rate of 0.5 cfm/bu would be understepped above a depth of 50 ft. One might consider filling the silo beyond that level after the first 50 ft are fully cooled out with corn closer to 16.5%, or with corn that has already been cooled in the dryer. As in steel bins, condensation management on the underside of the roof and the inside walls is critical. In addition to the normally recommended vent area of 1 ft^2 per 1000 cfm, which would require at least 5 ft^2 in the above example, exhauster fans that draw about 125% of the incoming cooling air should be installed on the roofs (check with the manufacturer regarding roof strength first).

Unloading the Silo - The silo must be equipped with an unload system that will preferably withdraw grain from the bottom center point. Either install a conventional grain unloading sump in the center of the silo floor, or simply run an unloading auger at an angle from one of the lower doors into the center of the silo. Some farmers have had success with inserting an open-ended aeration tube into the center of the silo and then unbolting the fan and sticking an unloading auger in through the aeration tube when it is time to unload the silo. Top silage unloaders will work but may generate additional kernel damage during unloading. Silos must not be side-tapped for gravity unloading into a truck or a conveyor hopper unless the structure is specifically designed for such side withdrawal. Removing grain from one side of the structure immediately reduces the pressure bearing laterally against that sidewall directly above the outlet point, and extending to the top of the grain mass. When the sidewall pressure of the grain directly above the outlet diminishes, as grain withdrawal continues, the wall area with the reduced pressure bearing on it tends to collapse inward. At the same time, the pressures acting on a given section “hooped” around the silo continue to push outward with the original force. These forces tend to move the wall section opposite to the withdrawal side outward, and cause the structure to form a slight out-of-round shape, bulging outward at the back side. This places some of the storage mass on a vertical line outside of the foundation and supporting wall below the bulge. The structure may then possibly receive permanent damage in shape and may be in danger of collapse from the eccentric loads of the stored mass.

Other Temporary Grain Storage Options

Various smaller temporary storage structures that may be reusable can be constructed using polyethylene sheeting, reinforced fiber sheeting, wire mesh, and wood or metal panels for holding grain in smaller volumes (see AE-84 for contact addresses). These structures can be set up inside an existing building or outdoors. If placed outdoors, various types of plastic sheeting is available to prevent rain and wind loss. For example, in Argentina, 23 ft diameter by 9 ft tall wire mesh structures are regularly used for temporary storage of corn, popcorn, soybeans, and wheat after harvest. The inside walls of these structures are lined with sheets of woven plastic mesh to hold around 3,000 bu of grain. Their cost is $300 per structure, which if properly cared for can last up to 5 years. Farmers install unloading tubes through a collar welded into the wire mesh at an angle about 4 ft off the ground. Aeration is possible in these structures despite the non-sealable sidewalls. However, it requires a perforated tube to be installed vertically in the center. A fan attached to a supply duct can be laid on the floor to connect to the center duct, or a fan attached to an aeration tube can be inserted vertically from the top in the center of the bin. In case aeration is not possible, grain should be dry and cool and stored preferably only during the winter months.

Maximizing Grain Quality in Temporary Storages

When storing grain in temporary storages it becomes even more critical to implement the four S.L.A.M. (Sanitation, Loading, Aeration, and Monitoring) steps to maximize grain quality. When coordinated, the S.L.A.M. management strategies will help to maintain grain quality, minimize marketable moisture weight loss, reduce operating costs, and preserve stored grain quality even in temporary storage structures.

Sanitation before loading grain into a temporary storage requires cleaning aeration ducts, floors and unload auger trenches, where insects thrive on grain dust and fine material; cleaning out insect harboring locations, such as weeds, trash, and moldy grain in and around temporary storages; spraying an approved post-harvest insecticide around the perimeter of the structure, 4 - 6 ft up any outside support wall; sealing the building and silo base openings including fans to provide barrier protection against insect entry at all locations below the roof eaves. Remember that sanitation is pest control! If grain is stored into warmer weather, consider top dressing it with an approved grain protectant (see ID-215 for more information).

Loading a temporary storage structure properly should include pre-cleaning (screening) the grain to remove as much broken grain, dust and fines that insects and molds thrive on. It also improves aeration and storability. Fines tend to build up below the loading spout. Temporary storages usually do not allow for coring and leveling once the structure is full (except for flat storages with existing underfloor unload systems). Leveling clean grain or removing the peak by coring makes it easier to manage stored grain and assures more uniform airflow. This is another reason why temporary storage should be limited to dry and cool grain that is stored during the winter months only.

Aeration to maintain grain temperatures as uniform as possible and as low as practical by managing aeration fans in temporary storages should aim at keeping grain temperatures below 40°F. Operate the fans intermittently during cold weather periods (preferably with an automatic fan controller) to keep the grain fresh and minimize condensation on the grain surfaces. Smell the exhaust air for any odors that might indicate grain spoilage. Fans should always be sealed whenever they are turned off to prevent premature rewarming due to the chimney effect and pest infiltration. If the grain is in good condition, it should not be rewarmed in the early spring. Instead, the fans should be kept sealed and the grain moved out of temporary storage as soon as possible.

Monitoring grain in temporary storages should occur weekly. The use of thermocouple cables is generally not feasible. However, special thermometers attached to long probes can be used to spot check even outdoor piles. Vacuum-assisted probes are also available to remove samples from depths that are impossible to reach with hand probes. Samples should be checked for temperature, moisture, signs of self-heating, molding, and insects (see ID-215 for more information). Grain in temporary storage should not be stored into warmer weather that would require the application of insecticidal protectants. In case of insect infestation, fumigation of existing buildings and outdoor piles is generally impractical, expensive and often ineffective. Infested grain should be moved into permanent storage structures that permit proper sealing to assure a successful fumigation before marketing the grain. When deteriorating grain conditions are observed, temporary storage should be discontinued and the grain moved as quickly as possible.

Safe Grain Storage Moisture - Because it is difficult to achieve sufficiently high and uniform air movement in flat storage buildings, outdoor piles, and converted silos, only grain that is dry enough for storage should be placed in temporary structures. Corn that will be fed through the winter months can be held at up to 16-17% moisture in smaller buildings and silos IF the corn is adequately cooled after the dryer, pre-cleaned to remove broken corn and fine material and an aeration system is installed. Although not recommended, if corn is to be stored in any temporary structure into the following spring, the moisture content should be no more than 14% moisture. Corn should be dried to 13% moisture for storage into the summer and beyond. Soybeans for storage through the following spring should be no more than 13% moisture, and around 12% for storage into the summer or beyond.

Summary

Grain can be successfully stored temporarily in outdoor piles, existing buildings, and converted silage silos. However, numerous considerations must be carefully evaluated before harvest begins. Minimizing the storage time and implementing the four S.L.A.M. steps are key management tools. One cannot expect good grain quality in temporary storage structures over the long-term. Grain should be moved out of temporary storages in January and February (no later than March) to avoid severe spoilage, self-heating, rodent, bird, and insect problems later on. Good inventory planning becomes critical in minimizing spoilage and deterioration. Consideration also needs to be given as to whether the expenses associated with temporary storages are economically justifiable compared to adding more permanent storage space at a location that can be more efficiently integrated into an existing handling facility.

Additional Resources

For additional information, request any of the following extension materials by contacting us at (765) 494-1175, or maier@ecn.purdue.edu:

AED-12 *Remodeling ear corn cribs for shelled corn* is an older reference concerning the adaptation of stud and pole frame cribs.

AE-84 *Temporary grain storage* is a newly revised extension publication from North Dakota State University with many illustrated and tabulated design details.

AE-91 *Temporary corn storage in outdoor piles* provides a good summary of a number of issues to consider when planning on piling corn outdoors.

AE-92 *Emergency grain storage in existing buildings* provides a good summary of a number of issues to consider when converting existing structures for grain storage.

AE-93 *Adapting silage silos for dry grain storage* contains details for converting on-farm silos and is available on-line at: http://www.agcom.*purdue.edu/AgCom/Pubs/AE/AE-93.html*

ASAE Paper 88-6055 *Aeration design for large flat storages and outdoor piles* discusses aeration system design problems and design modifications for larger commercial flat storages and outdoor piles.

ID-215 *Post harvest pocket guide* is a comprehensive handbook on stored grain management including S.L.A.M., drying, insect identification and control, mold identification and control, safety, and grain grading ($3).

MWPS-2 9 *Dry grain aeration systems design handbook* gives excellent technical guidelines on systems planning and layout for bins, tanks and flat storage buildings ($20).

Grain Quality Fact Sheets can be accessed on-line through the World Wide Web at:
http://www.agcom.purdue.edu/AgCom/Pubs/grain.htm
(select) Grain Quality
or http://pasture.ecn.purdue.edu/~grainlab
(select) On-Line Extension Publications
(select) Grain Quality Fact Sheets
Almanac: send e-mail to: almanac@ecn.purdue.edu message:
send grain guide
or send grain catalog
or send grain factsheet #38 (for example)
or send acsonline GQ-38