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Crop Management

Saving Fuel in Corn Drying

Bill Wilcke, Minnesota Extension Engineer

The combination of low corn prices and high fuel prices makes it especially important to consider ways to save fuel while drying corn this fall. Prices for both liquefied petroleum gas (LPG; mostly propane) and natural gas are expected to be higher this fall than in the past. Typical heated-air corn dryers fueled by LPG use about 0.02 gallons of LPG per bushel per percentage point of moisture removed. This means that every point of moisture removal that can be avoided in these dryers will save about 0.02 gallons of LPG per bushel of corn harvested.

Here are some possible approaches for reducing fuel use in corn drying:

- **Harvest whole-plant corn silage or high-moisture ear corn** instead of shelled grain that must be dried. Farmers who raise ruminant animals might consider altering their rations and feeding more silage or ground ear corn. Farmers who don't have the necessary harvesting equipment might be able to hire custom harvesters. Farmers who don't have storage facilities for these crops might be able to use silage bags or temporary bunkers.

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- **Store ensiled high-moisture corn.** Instead of artificially drying shelled corn, livestock producers who can feed high-moisture corn might consider storing some of their crop in silos or in silage bags as ensiled or fermented, high-moisture corn. The naturally occurring bacteria that cause fermentation need high moisture levels to become active, so corn should be harvested at 25 to 30% moisture. One of the most common problems that occurs during storage of high-moisture corn is that corn dries to less than 25% moisture in the field before the silo is full. Corn stored at less than 25% moisture is often too dry for bacteria to cause fermentation, but it's at an ideal moisture for fungi to cause mold damage. If you plan to store high-moisture corn, start harvest early and make sure the silo is full before the corn gets too dry. Attempts to rewet shelled corn that is too dry to ensile are usually unsuccessful.

- **Delay harvest to take advantage of drying in the field.** But only consider this option if it's early in the season, you have good drying weather, and you don't have disease or insect problems that are causing stalks to lodge or ears to drop. Harvesting corn at lower moisture means less water must be removed. For corn that will be fed during winter, livestock producers who delay harvest until temperatures drop to near freezing might be able to avoid drying altogether. If corn can be aerated in storage to keep its temperature near 30°F, it can be safely stored at up to 18% moisture or so through the winter months. But wet corn must be fed or dried by spring! If there's any chance that corn will be stored into warm weather the following spring and summer, make sure that its moisture is 15% or less when it is stored.

- **Reduce overdrying.** Corn buyers usually prefer corn at 14 to 15% moisture, and with proper storage management, corn can be safely stored for six to nine months at these moisture levels. Although some stored grain managers intentionally dry corn to lower moisture levels to reduce storage risk, this is an expensive strategy. Overdrying increases drying costs (especially when fuel costs are high), it reduces dryer capacity (the number of bushels that can be dried per day), and it reduces the number of bushels that are available for sale (because grain is sold by weight,

and you are removing water that could be sold at the price of corn). Overdried corn is also more susceptible to cracking and breaking during handling.

- **Switch to in-storage cooling.** If corn is currently dried at high temperatures and then rapidly cooled in the dryer, some fuel can be saved by switching to cooling corn in the storage bin instead of in the dryer. Almost no moisture is lost when freshly dried corn kernels are rapidly cooled immediately after drying. But, if corn is unloaded from a dryer while it is still hot and is transferred to storage where it is cooled slowly using the storage bin's aeration fan, the corn will lose one to two percentage points of moisture during the cooling process. This means that if the final target moisture is 15%, the dryer can be unloaded when the corn reaches 16 to 17% moisture instead of drying it all the way to 15% moisture. In-storage cooling saves the fuel that would be needed to remove the last one to two points of moisture and it reduces the amount of time that corn spends in the dryer, which greatly increases dryer capacity. For more information, contact the University of Minnesota Biosystems and Agricultural Engineering Department and ask for the bulletin *Dryeration and In-Storage Cooling for Corn Drying.*
- **Use dryeration.** Dryeration is similar to in-storage cooling, except that corn is intentionally left hot (called steeping or tempering) for 4 to 12 hours. During this tempering period, moisture and temperature gradients equalize within freshly dried kernels, which enables the kernels to lose two to three percentage points of moisture during cooling. Compared to rapidly cooling corn in the dryer, dryeration reduces energy use, increases dryer capacity, and improves corn quality (better test weight and fewer cracked kernels). It is best to transfer corn from the bin where cooling takes place to a different storage bin after it goes through the dryeration process to avoid problems that might be caused by condensation on the inside walls of the cooling bin. For more information, contact the University of Minnesota Biosystems and Agricultural Engineering Department and ask for the bulletin *Dryeration and In-Storage Cooling for Corn Drying.*
- **Consider using natural-air drying** instead of heated-air drying. Natural-air drying is an in-storage drying process that uses bins equipped with full perforated drying floors and fairly large fans (approximately 0.75 to 1.0 fan horsepower per 1000 bushels of corn for bins that are no deeper than about 18 ft). Natural-air drying works well in the upper Midwest, but harvest must be delayed until corn moisture drops to about 22% moisture in the field and drying requires several weeks of fan operation. In many years, drying is not completed before winter and corn is kept cold during winter and drying is finished in early spring. Although natural-air drying uses no LPG or natural gas, it does use an average of about 1 kWh of electricity per bushel of corn to operate the drying fan. Cost effectiveness of natural-air drying compared to heated-air drying depends on the relative costs of LPG or natural gas and electricity and on how favorable the weather is during the drying season. For more information, see the University of Minnesota Extension Service bulletin *Natural-Air Corn Drying in the Upper Midwest, BU-6577.*
- **Use combination drying.** If you do not like some of the limitations of natural-air drying, you can partially dry corn to about 20% moisture in a heated-air dryer and then finish drying it in a bin equipped for natural-air drying. Combination drying allows you to harvest corn earlier than you can with just natural-air drying, but it uses less fuel and produces better corn quality than complete heated-air drying. For more information, contact the University of Minnesota Biosystems and Agricultural Engineering Department and ask for the bulletin *Combination High-Speed, Natural-Air Corn Drying.*
- **What about alternative energy sources?**

Solar. Quite a bit of solar grain drying research was conducted about 20 years ago. Because solar energy is a fairly diffuse source of energy (not many British Thermal Units or Btus of energy are available per square foot of surface area per day), it is not a good replacement or supplement for the fuel used in high-speed, heated-air dryers. These types of dryers use millions of Btus per hour and it would take very large solar collectors to replace the LPG or natural gas needed to produce this amount of energy. Solar energy could be used as a supplemental heat source for low-temperature, in-storage drying systems that operate over a period of several weeks. But, research has shown that these types of dryers actually work fairly well without any supplemental heat. In fact, there are some disadvantages to adding supplemental heat—including potential overdrying of the crop and the cost of building and maintaining the solar collectors.

Biomass. Some research on using biomass fuels such as wood, hay, and crop residues for drying corn was also conducted about 20 years ago. Use of biomass fuels showed some promise, but energy prices stabilized and research funds dried up before the equipment and systems for using biomass were fully developed. Biomass fuels are attractive because they are renewable, some biomass fuels are fairly energy dense (significant number of Btus produced per pound of fuel), and producing biomass fuels might reduce farmer dependence on fluctuating energy prices and supplies or even present the opportunity for farmers to sell fuel. Here are some questions to consider if you are interested in using biomass fuels to dry corn:

- Can biomass be harvested ahead of corn harvest, or will time and labor for harvesting fuel compete with time and labor for harvesting corn?
- What is the expected moisture content of the biomass fuel, and will you need to dry it before you burn it? The higher the fuel moisture content, the lower the net energy production per wet pound of fuel.

- Is special equipment and facilities needed to harvest, transport, and store the biomass fuel or can you adapt equipment and facilities that you already own? If you have to buy special equipment, don't forget to include the cost of that equipment in your cost per Btu calculations.
- How hard is the fuel to handle? Does the fuel flow on its own and can the fuel supply system be automated, or will a lot of labor be required to keep the burner supplied with fuel? For example, it might be relatively easy to set up an automatic fuel supply system for a fuel in pellet or granular form, but it would be more difficult to set up an automatic system that uses logs or large bales.
- Can you buy a burner that will handle the fuel you have in mind and that will supply the number of Btus per hour that are needed? Several companies produce small biomass burners, but not many companies produce the larger sizes needed for heated-air corn dryers. If you decide to build your own burner, keep in mind that it can be difficult to come up with a design that provides the right amount of air for complete combustion, is easy to feed, can withstand high temperatures for long periods of time, and provides for convenient removal of ash, clinkers, or slag.
- Will removal of biomass from the land reduce soil quality and make it vulnerable to erosion? For example, using all the cobs from a crop of corn might not have a very large effect on the soil, but removing all of the corn stalks would.
- Is there a positive net energy balance for using the biomass fuel? When you subtract all the energy required to grow, harvest, and transport the biomass fuel from the energy produced by burning it, how much are you gaining?
- Is the biomass material that you are considering more valuable as food, feed, or an industrial feed stock than it is as a heating fuel?
- Is use of the biomass fuel cost effective? When you add up the costs for equipment, labor, and other inputs for producing, harvesting, transporting, storing, and burning the biomass product, is the cost per Btu competitive with other alternatives?

For more information on any of these topics, contact Bill Wilcke in the University of Minnesota Biosystems and Agricultural Engineering Department in St. Paul, Minnesota (wilck001@umn.edu or 612-625-8205).

Machinery Systems

Assessing and Alleviating Soil Compaction After a Wet Spring

Ronald T. Schuler, Wisconsin Extension Engineer

During this growing season, wet spring soils may have created excessively compacted soil causing potential yield losses. This fall, after harvest, crop producers will have an opportunity to alleviate the effects of the excessive soil compaction through deep tillage. Numerous methods are available to help producers assess the degree and depth of compaction in their fields. If excessive soil compaction is evident, then proper deep tillage operation is important.

The best indicator of the yield limiting impact of excessive soil compaction is the growing plant. Plant height patterns in the field corresponding to wheel traffic may be an indicator of compaction. Studying the rooting patterns will also be very useful. If the root system is not the same on both sides of the row, wheel traffic may be the cause. Compaction caused by tillage may occur more uniformly across the field.

Identifying and locating the compaction can be done by probing the soil with a soil sampling probe or a cone penetrometer. The force required to push the sampling probe into the soil is an indication of compaction. Observing at what depth the greatest resistance occurs is useful in adjusting the tillage depth. The cone penetrometer is designed to measure the pressure required to push a steel cone into the soil to determine areas of high pressure (compaction). You should do the evaluation in several areas of the field and along a fence line where no traffic has occurred for many years. If a significant difference is observed, consider deep tillage.

The most common practice of alleviating soil compaction effects is subsoiling. This tillage operation is most effective when the soils are dry enough to ensure good fracturing. The tillage depth should be one to two inches below the compacted layer. Selecting the proper shanks and points are important to create the desired soil mixing and crop residue cover.

The best way to solve soil compaction problems is to avoid it by not working on wet soils. But during some growing seasons, producers don't have a choice. In that case, they should consider managing compaction by using recommended tire pressures, proper tractor weighting, and only performing cost effective field operations.

What's a Good Combine Operator Worth this Season?

Ronald T. Schuler, Wisconsin Extension Engineer

This growing season may result in corn and soybean crops that will create a challenge for good combine operators. With the midsummer weather causing a great deal of crop stress on corn and soybean plants, special combine adjustments may be needed to harvest the potentially smaller ears of corn and smaller beans and corn kernels. Evaluating harvesting losses can help you determine if your combine is adjusted appropriately.

A good operator should be able to maintain losses at one percent or less of the crop yield. If the yield is 150 bushels per acre, the losses should be less than 1.5 bushels per acre with proper combine adjustments. However don't expect to obtain a zero loss. Making adjustments to harvest every last kernel or bean often will lead to excessive levels of broken crop in the combine bin.

Just a few minutes are required to get an estimate of the harvesting losses. To determine corn ear losses, count the ears left in an area equal to one hundredth of an acre having a width equal to the combine harvesting width. With a 15-foot head (six 30-inch rows), the length of the area will be 29 feet (435.6 divided by 15). Each full-sized, unshelled ear (three-quarters of a pound) in the area represents one bushel per acre loss.

For corn kernels and soybeans, use an area of ten square feet. Twenty corn kernels or 40-50 soybeans lost in this area add up to one bushel per acre. The area can be determined by using a wood frame or string. For corn and row soybeans, the area should be centered on the row and have a width equal to the row spacing. For 30-inch rows the area would be four feet long. For drilled beans, use multiple rows to obtain a nearly square evaluation area of ten square feet.

Make loss determinations at several locations and calculate an average. If losses are greater than desired (one percent of the crop yield), machine adjustments need to be made. Smaller ears, kernels, or beans due to crop stress are one characteristic that may require adjustments in the combine.

For smaller ears, the snapping plates on the corn head may need to be moved closer together to ensure that the small ears are not pulled through the head. Ear losses should be maintained at less than one-half percent of the total yield.

For smaller corn kernels and beans, the threshing unit, cylinder-concave, or rotor-grate may need to be adjusted for a smaller clearance. In the cleaning area, the cleaning sieve and/or the airflow may require adjustment.

A good operator should periodically take the time to check the combine losses. By reducing the losses by one bushel per acre, the benefits of the time spent making the adjustments are quickly realized. For a 6-row combine (30 inch rows) harvesting five acres per hour, the return is $9.00 per hour at $1.80/bushel corn—well worth the time to make the adjustments. The key for good operation with minimum loss is to adjust the combine for the crop conditions.

Livestock Systems

HVLS Fans for Free Stall Barns

David W. Kammel, Wisconsin Extension Engineer

There has been a lot of interest lately in a new type of fan that has potential use in free stall barns. HVLS—High Volume Low Speed—fans are a large diameter paddle fan that can range from 8-24 feet in diameter. They use a 3/4 hp motor, rotate at approximately 60 rpm, and operate on the same principle as the ceiling fan you might have in your living room or bedroom. The foils or blades are horizontal and push air downward. This vertical air column hits the floor and moves horizontally and radially away from the center of the fan. The main purpose of the fan is to increase the velocity of the air in the area of influence.

HVLS fans have been marketed toward industrial applications to keep workers in large areas cool by increasing air velocity. An article in the June 2001 issue of *Dairy Today* discussed the application in several California free stall barns. They found energy savings to be one benefit of the system. Fans are placed approximately 60 feet apart. One fan mounted in the middle of the barn over the feed driveway can potentially influence the entire barn width. The impact of these or of any velocity fans on cows is hard to determine or measure, but certainly many farms have installed the traditional 3-4 foot diameter high-speed axial fans to increase cow comfort in the hot humid summer. This system may be an alternative.

It is still early to know if these fans are equivalent to the current design recommendations for high-speed fan systems. It will be critical to determine spacing and mounting height specifications to ensure that the fans have an influence area sufficient to provide a desired design velocity, and to determine the fewest fans necessary to provide the desired velocity. There is a lot to learn, but here is some preliminary information I can provide for those interested in pursuing this option.

I have been on two farms in Wisconsin that have installed HVLS fans and have measured velocities. One had a 4-row barn with head-to-head stalls; the other had a 6-row barn. In both barns, fans were spaced at 60 feet on center. During both visits there was a 500-600 fpm wind velocity impacting the barn. The velocities measured were similar in both barns. You can feel the influence of the fans walking down the feed alley. It is similar to a light breeze hitting your face. As you walk toward a fan you feel the velocity hitting you in the face; as you walk under the fan it is a very turbulent velocity. As you walk away from the fan the velocity hits your back until you are between two fans where it becomes turbulent again.

Wind does have some effect on the velocities measured depending on where you are in the barn, but I tried to discount the wind velocity in the measurements. The velocities I report here assume little or no wind velocity effect. I recorded 15 second average velocities with a wind anemometer at several locations and averaged the readings. In one barn we closed the curtains and doors to measure velocities only from the fans. The horizontal velocity at the cow's face at the bunk ranged from 200-350 fpm in a direction perpendicular to the length of the bunk. It is highest (350 fpm) at the center line of the fan at the bunk and decreases to 200 fpm at the bunk between two fans. The velocity is highest at the floor (300-400 fpm) at the center of the feed lane and decreases at face height (200-300 fpm). In the feed/scrape alley the horizontal velocity was approximately 250 fpm and usually perpendicular to the length of the alley. At the middle of the head-to-head stall row the horizontal velocity was approximately 150 fpm. In the back alley next to the outside wall the velocity diminished to 50 fpm or the outside wind velocity overpowered the fan-induced velocity. We will learn more in the next couple of months when other farms install these fans.

The cost of the fans is approximately $3500-$3900 depending on diameter plus the cost of controls and installation. For the 4-row, 170-stall free stall barn, three fans were purchased and installed for approximately $11,000. Each fan uses approximately 300 watts. Some electric utilities are already considering offering rebates for energy efficiency, but this is such a new concept that details will have to be worked out when additional information is available. As far as I know, the only company manufacturing the fans is the HVLS Fan Company. Their web page is http://www.hvls.com and their phone number is 877-BIGFANS. If you are considering trying this system please feel free to contact me, at dwkammel@facstaff.wisc.edu or 608-262-9776, to discuss the pros and cons. Contact the company to get information on the fans and to find a dealer in your area. Since this is such a new system I would also recommend getting in contact with a farm that has installed the fans to learn about their experiences.

Safety and Health

Healthy Farmers, Healthy Profits Project Tip Sheets Available

Marcia Miquelon, Wisconsin Outreach Specialist

Since 1996, the University of Wisconsin Department of Biological Systems Engineering has been home to the "Healthy Farmers, Healthy Profits" project. The project's goal is to find and share tools and techniques that are efficient, profitable, and reduce the risk of musculoskeletal injuries to dairy farmers, berry growers and small-scale, fresh-market vegetable growers in the Upper Midwest. Workers in these types of industries are at high risk for stress and strain injuries, due to the prevalence of hand labor, stoop labor, and repetitive movements in their work. They are most likely to adopt safer tools and methods that also increase their profits through increased efficiency, labor time savings, and better product quality.

For example, the project promotes the use of mesh bags for washing leafy greens such as salad mix and spinach. Without the bags, most small-scale growers would need to lift greens from the wash water one handful at a time, holding the weight of their arms and the wet vegetables many times over as the greens drain. A mesh bag, which is available for under $5.00, enables the grower to wash and drain many handfuls of greens at a time, a method that is approximately 50% faster. With this kind of labor savings, the low-cost tool will rapidly pay for itself and improve profits. Meanwhile, the worker's risk of repetitive motion strain to the hands, wrists, and arms is reduced.

Short tip sheets about mesh bags, along with fifteen other topics, are available for free from the "Healthy Farmers, Healthy Profits" project. The quickest way to obtain these materials is to visit the project web site at www.bse.wisc.edu/hfhp/. If you are interested in obtaining multiple copies for distribution to dairy, berry or vegetable farmers, call the project at (608) 265-9451 (Vegetable, Berry) or (608) 262-7408 (Dairy).

The project is funded by the U.S. Centers for Disease Control and Prevention's National Institute of Occupational Safety and Health. Tip sheet topics include:

- Packing shed layout
- Mesh produce bags: easy batch processing
- Standard containers
- Narrow pallet system
- A specialized harvest cart for greens
- Plans for a specialized harvest cart
- A rolling dibble marker for easy transplant spacing
- Streamline your sales area
- Stretch out your season with hoophouses
- A strap-on stool for field work
- Motorized lay-down work carts
- Long-day lighting in dairy barns
- Use silage bags
- Build an on-site calf feed preparation area
- Use bottle holders for newborn calves
- Move calf feed and supplies by wagon

Tractor Headlights and Flashers Prevent Collisions–Even During Daytime Hours

Mark Purschwitz, Wisconsin Farm Safety and Health Specialist

Personal observation indicates that few tractor operators use their headlights and amber flashers as they travel on public roads during daytime hours. Operators need to remember two things: Most roadway collisions involving farm machines occur during the day; and part of the responsibility of the operator of a slow-moving vehicle is to make the vehicle as visible as possible to other motorists.

Use of headlights and flashers at all times during roadway travel is an important part of visibility. Of course, SMV emblems and other markings are important, but lights and flashers help a tractor or other machine stand out against a background of fields, trees, or anything else, and give the motorist extra time to make a safe approach. Extremity lighting or marking has the same intent—to make the outer edges of a machine more visible.

Additionally, if a collision occurs, tractor operators have an additional defense by showing that they used their lights and flashers. Not using them, when they were available with the flip of a switch, can raise questions about who was to blame, especially in litigation. Using lights and flashers to make equipment as visible as possible removes the excuse that the equipment could not be seen soon enough to avoid a collision. Day or night, a smart operator wants to show he or she made every reasonable effort to be visible and is committed to roadway safety.

Publications

Planning for Construction Projects on a Small Farm

Paul Dietmann, Wisconsin Agricultural Extension Agent

It's summertime and the thoughts of many small acreage farmers turn to…building stuff.

Whether it's fences, lambing sheds, feeders, or corrals, there are always a few construction projects that can be done on the farm to make life a little easier. However, not every farmer has the skills or ability to design and construct the things they need on their farm. Hiring skilled professionals to do the work can be costly, particularly when the project could be accomplished simply and cheaply if only the farmer had a good set of construction plans to follow.

This is where the *MidWest Plan Service* (MWPS) and the *Natural Resource, Agriculture, and Engineering Service* (NRAES) come to the small acreage farmer's rescue. MWPS is a consortium of agricultural engineers from land grant universities in the Midwest and NRAES is the corresponding organization in the Northeastern United States. For many years, these two organizations have provided farmers with plans for all sorts of do-it-yourself projects.

MWPS and NRAES construction plans run the gamut from simple hay feeders for sheep, to modern swine nursery facilities. Some of the very old MWPS plans we have in our office include big, elaborate poultry houses and schematics for farmhouses.

My first exposure to MWPS plans came from a reference book that my dad used for years: *Practical Carpentry* (The Goodheart-Willcox Co., Inc., 1963). My dad's construction bible included several ingenious MWPS plans including one for a double movable farrowing house that's convertible to a 300-bushel grain bin and another for a poultry range shelter on skids.

While times have changed and there may no longer be much need for a combination farrowing house/grain bin, MWPS and NRAES continue to develop construction information and educational materials to meet the needs of farmers.

No beef producer should be without MWPS-6, *Beef Housing and Equipment Handbook* (136 pages; $7). This handbook includes plans for a variety of cattle handling facilities including corrals, loading chutes, and treatment areas. It also has plans for feed storage, feed bunks, cattle guards, and more. It contains a great deal of planning data such as bunk space per head for cattle of various sizes, square feet of shelter cattle need under different conditions, the amount of feed and water cattle will consume and volume of manure they will produce. It also offers some tips on farmstead layout and other useful information.

Sheep producers will find the *Sheep Housing and Equipment Handbook* (MWPS-3, $10) to be a valuable reference tool. Here you'll find plans for lambing sheds, hay feeders, watering systems, etc. The book also has planning data similar to that in the *Beef Housing and Equipment Handbook.*

The *Swine Housing and Equipment Handbook* (MWPS-8, $8) is geared more towards confinement hog production rather than pasture-based or loose housing systems. However, it still has quite a bit of information about feed handling, utilities, and building design, which could be useful information for small-scale producers.

MWPS also offers a *Horse Housing and Equipment Handbook* (MWPS-15, $7), *Dairy Freestall Housing and Equipment Handbook* (MWPS-7, $22), and many other livestock publications. NRAES also has quite a number of publications related to dairy.

For farmers who are not producing livestock, NRAES has recently released an excellent publication for people interested in greenhouse production: *Greenhouses for Homeowners and Gardeners* (NRAES-137, $25). It contains everything from plans for building or buying a greenhouse to troubleshooting problems. NRAES also has a variety of publications on storage

facilities for fruits and vegetables, and another publication on construction of *Facilities for Roadside Markets* (NRAES-52, $8).

MWPS and NRAES have several publications that contain useful information about construction methods. *The Farm and Home Concrete Handbook* (MWPS-35, $6) is very helpful in planning any sort of concrete construction project, whether you are doing the work yourself or hiring it done. The *Post-Frame Building Handbook* (NRAES-1, $14) shows many construction details and stresses the engineering aspects of post-frame building. The *Farm Buildings Wiring Handbook* (MWPS-28, $10) starts at the building's service entrance and covers all aspects of wiring from that point.

Even if you hire somebody to do the construction work on some of these more complicated projects, the MWPS and NRAES handbooks can help you become a more informed project supervisor.

These books and many other MWPS/NRAES publications can be ordered from either the University of Minnesota or the University of Wisconsin.

MWPS Orders
219 Biosystems and Agricultural Engineering
University of Minnesota
1390 Eckles Ave
St. Paul MN 55108
mwps@gaia.bae.umn.edu
(612) 625-9733
http://www.bae.umn.edu/extens/mwps/

MWPS Orders
Biological Systems Engineering Department
University of Wisconsin
460 Henry Mall
Madison WI 53706
(608) 262-3310

Editor's note: Besides new MWPS/NRAES material requests, we frequently recieve inquiries about old plans and materials pertaining to on-farm building and construction projects. The sidebar article below discusses how to access this historical information.

Old Agricultural Building and Equipment Plans

Bill Wilcke and Kevin Janni, Minnesota Extension Engineers

Are you interested in tracking down an old MidWest Plan Service (MWPS), USDA, or land-grant university building or equipment plan that you remember seeing in the past, but can't seem to find? Some old plans are now available via the web due to efforts by MWPS and by the North Dakota State University (NDSU) Agricultural and Biosystems Engineering Department.

In the past, engineers working for MWPS, USDA, and land-grant universities developed and distributed plans that farmers and contractors could use to build livestock buildings; grain, hay, and feed storage facilities; and other farmstead facilities and equipment. But many of the agricultural engineers who had the interest and expertise to develop detailed plans have retired, and most plans have become outdated as building codes, lumber specifications, and the scale of agriculture have changed. Additionally, it was time consuming and expensive to develop detailed plans, which in many cases were modified by farmers and builders anyway. As a result, the MWPS, USDA, and most universities have stopped developing and distributing plans.

But the ideas and concepts that were expressed in those old plans are still useful for some farmers today—especially small-scale farmers, and we continue to get requests for plans. To help meet the demand, MWPS and the NDSU Agricultural and Biosystems Engineering Department have started scanning old plans and making them available on their websites. You can download plans from the MWPS website at no charge and then print them using your own printer. Some plans on the NDSU site can be can be downloaded at no charge, or you can order paper copies from the NDSU Agricultural and Biosystems Engineering Department. There is a charge of $2 to $4 for paper copies. Ordering information is available on the web site.

The web address for the MidWest Plan Service site is:
www.public.iastate.edu/~mwps_dis/mwps_web/fr_matls.html

The web address for the NDSU site is:
www.ag.ndsu.nodak.edu/abeng/plans

If you use any of the plans from these sites, or from other sources, keep in mind that the plans should be used only to generate ideas. You should not build directly from the plans unless you or someone who is working with you is qualified to update the plans.

The MWPS site includes the following disclaimer:

This plan provides conceptual information only. ***Neither Midwest plan service nor any of the cooperating land-grant universities, or their respective agents or employees, have made, and do not hereby make, any representation, warranty or covenant with respect to the specifications in this plan.*** *Additional professional services will be required to tailor this plan to your situation, including but not limited to: assurance of compliance with codes and regulations; review of specifications for materials and equipment; supervision of site selection, bid letting and construction; and provision for utilities, waste management, roads or other access.*

The NDSU disclaimer is as follows:

These plans provide conceptual information. Periodic changes in the National Design Specifications for Wood Construction, changes in building materials, snow load variations and the serious impact of deviations from the plan make it imperative that professional services be utilized to tailor these plans to your situation.

Book Details How to Develop Swine Breeding and Gestation Facilities

MidWest Plan Service (MWPS) has just released the book *Swine Breeding and Gestation Facilities Handbook*, MWPS-43, the third publication in a three-part series on swine housing and management. This book provides builders and swine producers with a thorough explanation of the process and challenges of constructing and managing a swine breeding and gestation facility.

Throughout MWPS-43, the focus is on the specific demands of the breeding and gestation facility. The book meets a variety of audience needs by combining discussions of housing management options with discussions of building layouts and equipment needs. Along with the discussions of management, layouts and equipment, other chapters explain manure handling options, environmental control systems, and utility requirements.

The book is extensively illustrated, with approximately 60 figures showing specific examples of the concepts being discussed. Also included are more than 40 tables, equations, and examples that provide detailed specifications for space requirements, manure production volume, ventilation rates, insulation levels, and light levels. Appendices to the book contain worksheets and forms for determining sow, gilt, and boar inventories.

MWPS-43, *Swine Breeding and Gestation Facilities Handbook,* was prepared under the direction of the Livestock Production Facilities Committee of MWPS. MWPS is a cooperative research and extension organization representing the 12 land-grant universities of the North Central Region of the United States.

Swine Breeding and Gestation Facilities Handbook, MWPS-43*,* costs $15.00 per single copy, plus sales tax. MWPS-43 and other books in the swine housing series can be ordered from either the University of Minnesota or the University of Wisconsin.

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Alternative Energy

Burning Shelled Corn to Produce Heat Energy

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The combination of high fossil fuel prices and low corn prices has spurred an interest in burning shelled corn to produce heat for buildings and for drying grain. Dry shelled corn contains a fair amount of energy and it is relatively easy to handle. Here are some factors to consider when making decisions about shelled corn vs. other fuels.

Fuel cost per unit of energy

Shelled corn contains about 7000 Btu (British thermal units) per pound at 15% moisture, or about 392,000 Btu per 56-lb bushel. It is better to use dry corn as a fuel source, because dry corn is easier to handle and store than wet corn, and because dry corn produces more energy per unit weight of corn. Energy content per pound of corn is dramatically lower for high-moisture corn because more of the weight of the corn is water, which doesn't produce any energy, and because more energy from the corn dry matter is needed to evaporate water from the kernels and less is available for heating.

In most cases, equipment used to burn corn (and other fuels) is not 100% efficient, so it is important to use burner efficiency in calculations for heat output. When comparing costs for using different fuels, it is easiest to compare cost per unit of energy produced; cost per million Btu is a common way to compare fuel costs. Cost per unit of fuel, energy content per unit of fuel, and burner efficiency all need to be considered in calculating fuel costs.

> Example: Calculate the cost per million Btu for 15% moisture shelled corn that costs $2.00 per bushel and is burned in a stove that has an efficiency of 65%.
>
> Cost per million Btu = [$2.00/bu ÷ (392,000 Btu/bu x 0.65 efficiency)] x 1,000,000
>
> = **$7.85 per million Btu**

Using recent prices and typical burner efficiency figures, the cost of fuel oil, propane, natural gas, and electrical heat ranges from $10.00 to $23.44 per million btu.

Keep in mind that the price for corn and for conventional fuels will fluctuate over time and that the cheapest fuel today might not be the cheapest fuel in the future.

Other costs for using fuel

Fuel cost per unit of energy is very important, but you also need to consider the cost for the burner, fuel storage, and other equipment needed to store, handle, and use the fuel, equipment maintenance, and labor to handle the fuel and remove ash. If you are considering new construction or are replacing a worn out system, you can compare the annual costs of owning and fueling conventional heating systems vs. corn burning systems. But if you already have a conventional system that is in

good working condition and will be kept as a back up system, then you need to compare the full cost of owning and fueling a corn burning system to the value of conventional fuel saved. A supplemental corn burning system can easily cost several thousand dollars, so annual ownership costs can be a significant addition to the cost of the corn fuel.

Labor costs are likely to be higher for corn burning systems than for conventional fuel systems, but may be lower than labor costs for bulky biomass materials (like fire wood, straw, or hay). Very little labor is required to fuel, maintain, and clean conventional fuel systems. Corn-fueled systems can be relatively easy to automate, but some labor is required to periodically refill the corn hopper and to remove the ash or clinkers that are left after corn combustion.

Fuel handling and storage

Corn is easier to handle than some other bulky biomass materials (wood, straw, or hay, for example) because it flows fairly well through hoppers and augers and because corn has a better energy to volume ratio (it takes less space to store the same amount of energy for corn than for bulky biomass materials). But corn is not as easy to handle and is not as energy dense as most conventional fuels.

Corn handling and storage will be relatively easy on farms that produce corn, but it will be more of a challenge for nonproducers—especially for people living in urban areas. Non-farmers will have some difficulty obtaining, hauling, and storing the amounts of corn needed for heating a home or other buildings. Also, the cost per bushel will probably be somewhat higher for people who buy a few bushels at a time.

Owners of corn burning systems who store corn inside their home need to use tight storage containers, clean up corn spills immediately, and avoid storing corn for long periods of time to prevent problems with rodents and with stored grain insects. Some species of insects that infest stored corn could also move into food products stored in the home.

Burner design

Designing corn burners is more challenging than designing burners for some other biomass materials because it's more difficult to get enough air into the fuel pile with shelled corn than it is for bulky biomass materials, and because corn ash melts at a different temperature than ash for some other biomass products. Corn ash tends to produce a hard, glassy slag that can coat the inside of the burner, and it can produce hard chunks (clinkers) that need to be removed frequently (perhaps daily). It isn't impossible, but it would be difficult to build a homemade burner or to modify a wood-burning stove that works well with corn. Several companies that have tried to build shelled corn burners have failed, so it might be best to buy a corn-burning stove from a company that has been in business for several years and that has a number of satisfied customers.

Long run needs for heat energy

In the short term, it might make sense to burn corn to produce heat energy, but it's hard to know whether burning corn makes sense in the long run. If our goal is to find something that farmers can grow that will help solve our need for heat energy, corn might not be the best answer. It takes a lot of energy to grow, dry, and transport corn, it takes a lot of energy to produce the fertilizers and pesticides used to produce corn, production of corn makes the soil more vulnerable to erosion than does production of some other crops, and corn might be more valuable for feed, food, and liquid fuel uses than for heat energy production.

Other sources of information

The Ontario Ministry of Agriculture, Food and Rural Affairs has a good web site on burning shelled corn as a heating fuel. Keep in mind that the web site uses Canadian dollars and a mixture of metric and English units. The web site address is:
http://www.gov.on.ca/OMAFRA/english/crops/facts/93-023.htm

Here are some questions, adapted from the Ontario website, that you should consider before purchasing a corn burner:

- What is the heat output of the burner? Do you know how much heat is needed to maintain the heated space at the desired temperature, to dry the crop, or to meet other needs for heat energy?
- If you are trying to heat your whole house with a stove or space heater, does the house layout allow for the convective movement of heat through the whole house? Most newer houses are not built to allow convective air movement.
- What is the size of the fuel hopper? Will it require filling on a daily, weekly, or biweekly schedule?
- What is the seasonal heating efficiency of the corn burner?
- Does the unit meet UL standards and safety requirements of your insurer?
- Does the unit have hot exposed surfaces that could cause burns to skin?
- What type of exhaust venting is required? Does it require a chimney with a flue liner or can a combination flue/fresh air vent pipe be used?
- Are you prepared to clean out the clinker daily and clean the heat exchanger of ash on a weekly basis?
- Will the stove handle granular solid fuels other than shelled corn? This is important in the event that the economics of burning corn become unattractive or an alternative low cost pelleted fuel becomes available.
- Will the corn burner be a primary heat source or act as a supplementary heat source? Stoves with small fuel hoppers will not meet heating needs for long periods of time, unattended.
- How and where will corn be stored?

Calendar of Events

August 21, 2001, **Existing Septic System Inspection Field Course**, Southern Research and Outreach Center, Waseca, MN. See sroc.coafes.umn.edu, or call 507-835-3620.

August 22, 2001, **New Septic System Inspection Field Course**, Southern Research and Outreach Center, Waseca, MN. See sroc.coafes.umn.edu, or call 507-835-3620.

August 23, 2001, **Wisconsin Farmstead Dairy Field Days**, Butler Farms, Whitehall, WI. Contact FMIC Wisconsin Farm Center at 800-942-2474, or Paul Dietmann, 608-355-3250.

August 23-September 3, 2001, **Minnesota State Fair,** St. Paul, MN. See www.mnstatefair.org, or call 651-603-6806.

August 29, 2001, **Horticulture Day**, North Central Research & Outreach Center. Grand Rapids, MN. See ncroc.coafes.umn.edu, or call 218-327-4490.

August 30, 2001, **Beef/Forage Field Day**, 4 miles south from Grand Rapids, MN on Hwy 169, then 1/4 mile East on the Harris Town Road. See ncroc.coafes.umn.edu, or call 218-327-4490.

September 4, 2001, **Grand Rapids Garden Club Tour**, North Central Research & Outreach Center, Grand Rapids, MN. See ncroc.coafes.umn.edu, or call 218-327-4490.

September 7, 2001, **Pasture Series: Managing Fall Growth**, West Central Research & Outreach Center, Morris, MN. See wcroc.coafes.umn.edu, or call 320-589-1711.

September 12-13, 2001, **Elementary Field Day**, Southwest Research and Outreach Center, Lamberton, MN. See swroc.coafes.umn.edu, or call 507-752-7372.

September 15, 2001, **Sheep Day**, West Central Research & Outreach Center, Morris, MN. See wcroc.coafes.umn.edu, or call 320-589-1711.

September 18-20, 2001, **Farm Progress Days**, Janesville, WI. See www.wifarmprogressdays.com, or call 920-478-3852.

September 21, 2001, **Ag Seminar for Clergy**, Southern Research and Outreach Center, Waseca, MN. See sroc.coafes.umn.edu, or call 507-835-3620.

October 3-7, 2001, **World Dairy Expo**, Alliant Energy Center, Madison, WI. See www.world-dairy-expo.com/gen.main.cfm.

October 5, 2001, **PDPW Biosecurity Conference with an International Flavor**, World Dairy Expo, Madison, WI. Contact FMIC Julie Gabris at 800-947-7379.

October 10-13, 2001, **National Onsite Wastewater Recycling Association Annual Conference and Exposition, "A Time for Onsite,"** Virginia Beach, VA. Contact 800-966-2942 or www.nowra.org.

November 5-7, 2001, **Third International Conference on Geospatial Information in Agriculture and Forestry**, Denver, CO. Sponsored by Veridian System International Conferences. Contact Dale Heermann, heermann@wmu.colostate.edu.

December 7, 2001, **Pasture Series: Over-wintering Livestock**, West Central Research & Outreach Center, Morris, MN. See wcroc.coafes.umn.edu, or call 320-589-1711.

Minnesota/Wisconsin

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