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DAMP GRAIN

keep it cool!

then dry it

CANADA DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE DEPARTMENTS OF AGRICULTURE OF MANITOBA, SASKATCHEWAN AND ALBERTA.

DAMP GRAIN

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NATURE DEALS AN EMERGENCY

Prairie farmers harvested a large volume of damp grain in the fall of 1968. By the time winter set in, some had been dried, but millions of bushels remained in farm storage and piled in fields. Freezing temperatures helped preserve it, but with warmer weather approaching, wet grain will soon spoil. It must be dried if it is to be kept any length of time.

Grain dryers are resuming operation – but it will take time to move all the grain that has to be dried. Spring break-up will undoubtedly delay movement of grain to dryers. Emergency measures are necessary if damp grain is to be saved till it gets to the dryer.

SAFE GRAIN STORAGE

The table shows moisture levels for safe grain storage. For storage longer than a year, even lower levels or aeration may be required.

Grain	Moisture Content %
Wheat	14.6
Durum Wheat	14.6
Barley	14.9
Oats	14.1
Rye	14.1
Flax	10.6
Rapeseed	10.6
Corn	15.6

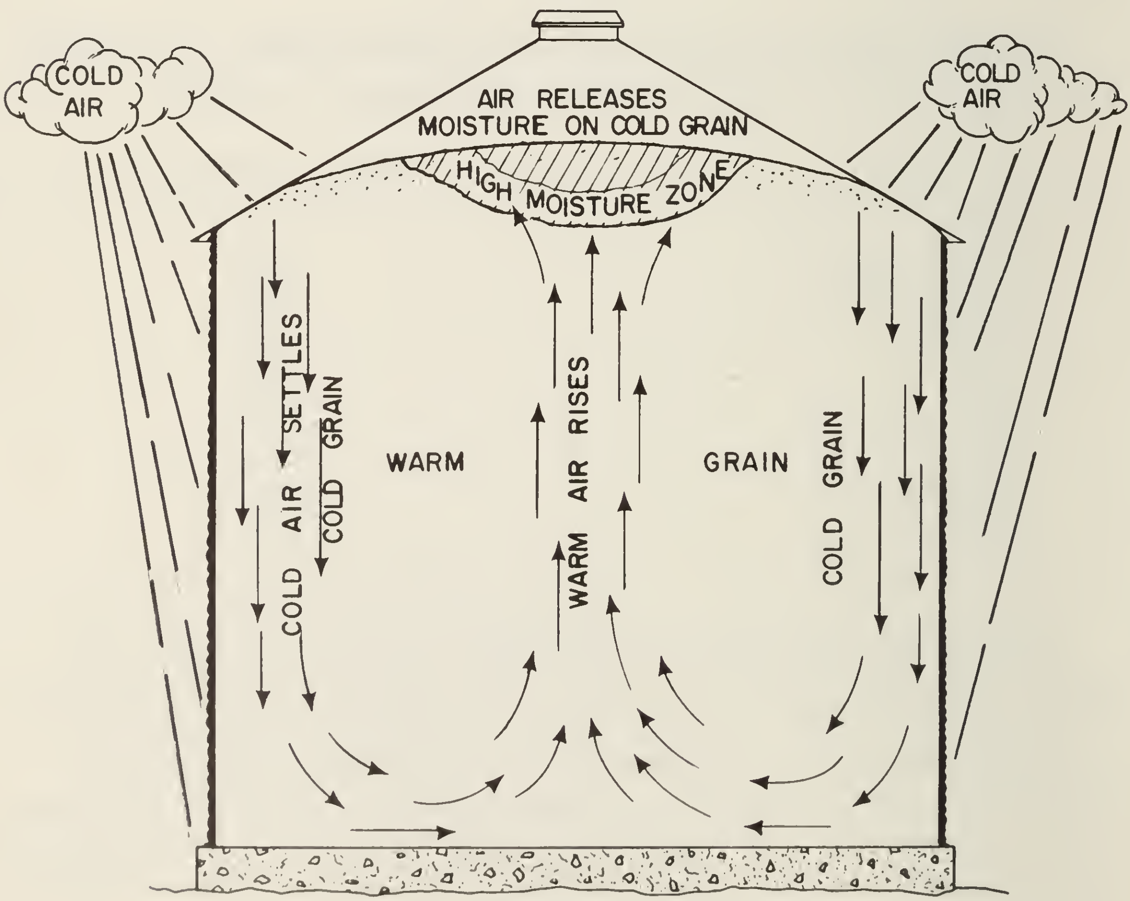
Molds and insects infest all stored grain in one form or other. The higher the moisture content, the faster molds and insects will multiply. At low temperatures there is little activity, but as soon as it warms up, the organisms start to work, and generate more heat. Investigations at the Canada Department of Agriculture Research Station at Winnipeg show that heating originates in small pockets throughout the bin or pile. A pocket will heat up quickly, then burn itself out. The heat spreads to the surrounding grain, speeding up growth of more pockets.

Temperatures in active mold pockets may exceed 145 degrees F. The heat not only damages the quality of the grain, but heat stable by-products may be formed, some of them toxic. There have been cases of infertility and abortion in cattle and swine due to toxins formed by the same molds that cause heating in damp grain.

CHECK STORED GRAIN

Damp grain will not keep. Even tough grain may spoil because of moisture movement within the mass. Differences in temperature set up air currents in the pile, tending to carry moisture to the cooler grain areas. These temperature differences are caused not only by changing outdoor temperature, but also by mold activity, direction of the wind, and sunshine.

Thoroughly check every bin or pile to know what particular heating conditions prevail. Surface crusts will be obvious, and should be removed. Crusts are caused by moisture carried by warm air circulating in the mass condensing on the cooler grain near the surface. Moisture dripping from the ceiling, or leaks in the roof may wet the surface and cause crusts to form. Melting snow may cause the same condition on outdoor piles.



Uneven grain temperatures cause air currents in stored grain. Moisture carried along condenses in the cooler areas. Heating starts in the dampest and warmest places.

Pockets of high moisture within the mass are more difficult to locate. Their position depends on storage conditions since moist air circulates with temperature changes.

Temperatures change slowly in unaerated grain, so the surface may be cooler than the center of the pile in winter, but may be warmer than the center in spring, or when the sun shines on the side of the bin.

Temperature near the bottom of a bin with a concrete floor would not change as much as in a bin on skids.

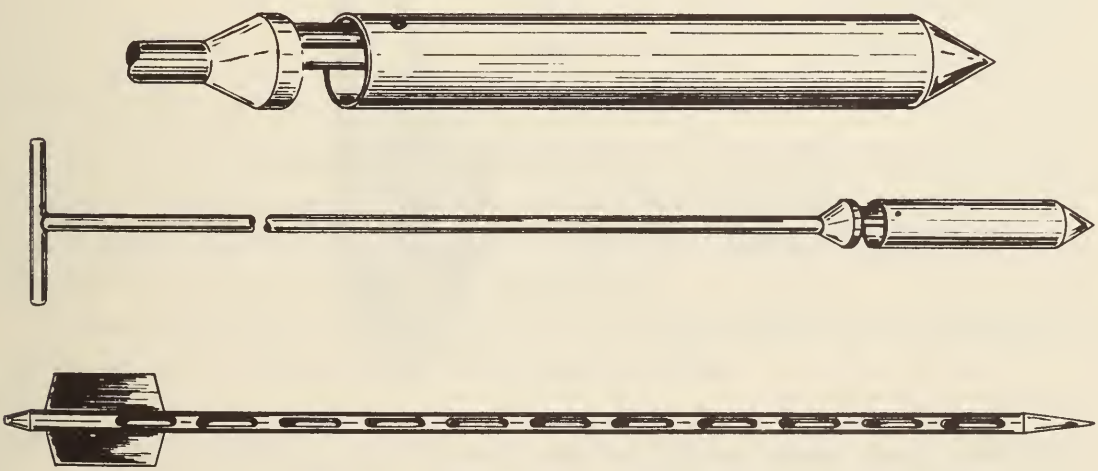
WHAT CAN BE DONE WHILE WAITING FOR THE GRAIN DRYER

Use a grain probe to get samples from various parts of the bin. Test these samples to see if moisture content has changed over winter, and to see that temperatures are within safe limits. Check temperatures daily in many suspected locations to get an early warning of trouble.

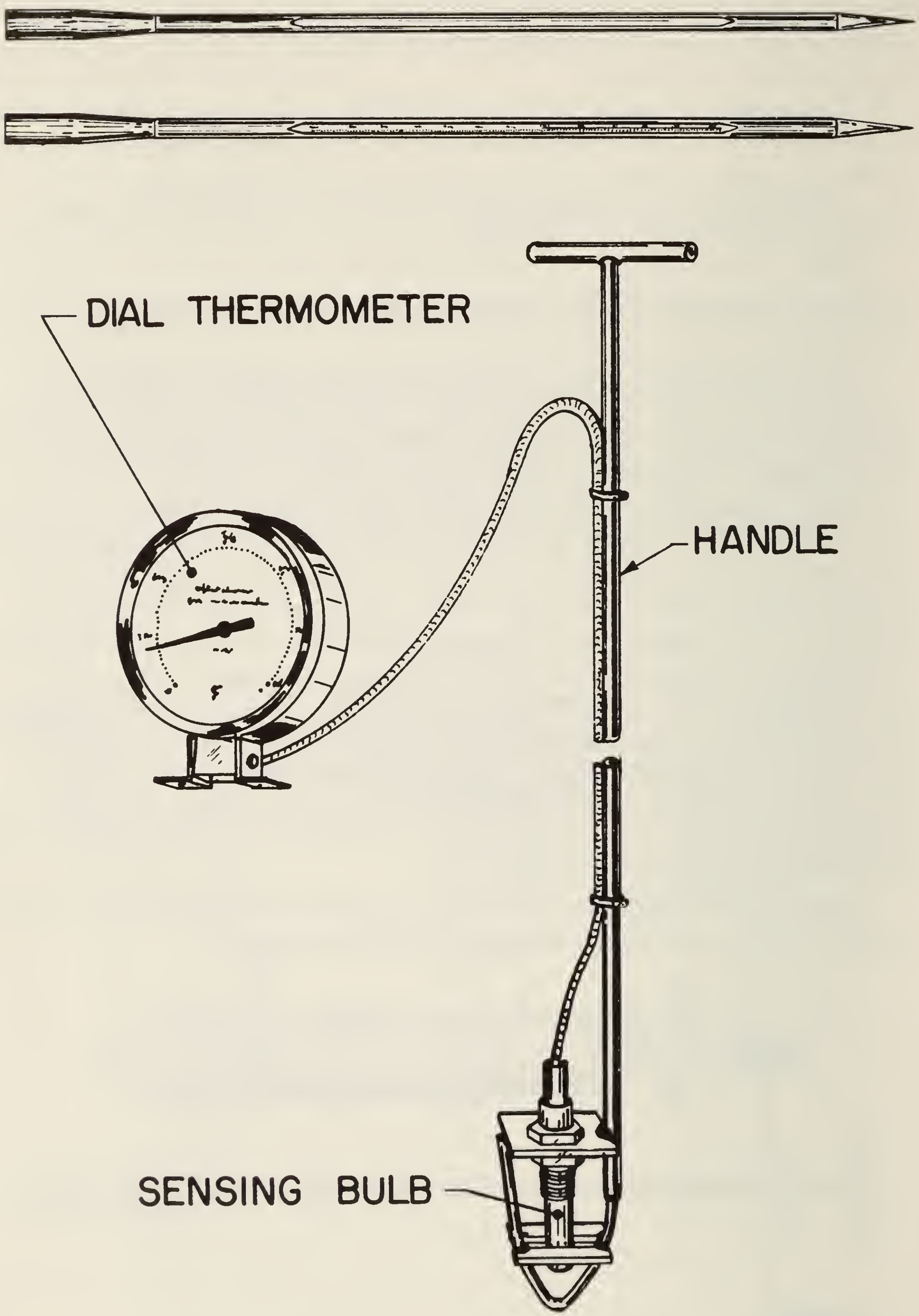
Steel rods may be used to check for heating but thermometers are quicker and more accurate. Rods or thermometers must be left long enough to come to a steady temperature. Alcohol thermometers within apparatus heavy enough to insert into a grain mass may require 30 to 40 minutes to register an even temperature. Then the thermometer must be read quickly on withdrawal. Rods may have to be left in place even longer.

Temperature can be observed more readily by using a dial thermometer equipped with a remote sensor to probe the grain pile. Such an instrument is a good investment for a grain grower. It can be read in place, saving time, and can also be used to check dryer operation. Attach the sensor to a rod before inserting it into the grain bin. The sensor must be protected, but not insulated from contact with the grain.

Small mold pockets can quite easily be missed when checking temperatures. If there is any doubt, the grain should be turned.



Grain probes are useful for sampling all parts of the bin.



Thoroughly probe the grain with bin thermometers to get an early warning of heating in mold pockets. With a dial thermometer, improvise a handle (about 3/8 inch rod) and bulb cage (can be lighter rod) to protect the sensing bulb, but not insulate it from the grain.

TURNING THE PILE

Any rise in temperature is a signal to turn the pile. Augering breaks up the pockets of mold growth, and cools the grain when the air temperature is less than the grain temperature. Bins can be emptied onto plastic sheets spread on the ground outside, and later refilled. Grain in machine sheds may be moved from end to end.

Piles on damp ground could be moved to a more suitable location, and benefit from the aeration. Pile grain on high, dry ground, preferably on a plastic sheet, and don't mix snow with the grain when moving it.

Once turned, grain is safe for two weeks at the most depending on moisture content, temperature, and molds present. Keep checking the temperature until the grain can be dried properly. Continue to auger the grain as long as the temperature rises. Keeping the grain cool can prolong the time to the next augering or until drying.

INSULATING GRAIN FROM HEAT

Table Shows the Effect of Temperature on Damp Grain

Moisture Content (%)	Temperature (^{o}F)	Beginning of:
15	61	Germination Loss
	63	Fungus Heating
	64	Insect Heating
17 1/2	50	Germination Loss
	52	Fungus Heating
	64	Insect Heating
20	41	Germination Loss
	46	Fungus Heating
	64	Insect Heating

After moving outside grain in cold weather, cover the pile with plastic to keep out warm air, and use straw, hay or other material to provide insulation and reflect radiation from the sun. This may help to keep the grain a little cooler – but still check that temperature!

Aeration is perhaps the most effective and practical way of keeping the temperature down until grain can be dried properly.

FORCED AERATION

Forcing air through a grain mass brings the grain temperature to that of the air and tends to even out temperature and moisture content. Portable bin aerators or fan and duct systems can be used for this task. Don't install bin aerators until the grain is turned because air will flow around the mold pockets unless they are broken up first.

Don't count on aeration to do much drying. The air is unheated, and drying with unheated air requires more air flow and time. Aeration should help control spoilage until a dryer is available.

After drying, the aeration system could be used to cool the grain. Warm wheat from the dryer cooled down to 50°F. removes about 1% moisture. Batch type dryers could then handle more grain.

AIR FLOW FOR AERATION

Fans should deliver between 1/10 and one cubic foot per minute (cfm) of air flow per bushel for aeration. This is more air than normal for aerating dry grain. Use aeration rates closer to one cfm for higher moisture contents and heating grains. Oats and barley can be aerated the same way as wheat; flax needs three times as much pressure to force the same air flow through it.

Air can be forced into the ducts or sucked out. When grain temperatures are uneven, have the air move from the cool grain areas to the warm grain areas to keep moisture from condensing in the grain. Upward air flow is probably better for long, flat storages since more uniform air flow would then be obtained from the ducts.

DUCT SYSTEM

See diagrams for various ideas on building and arranging ducts. A variety of materials can be used, but ducts and floors must be strong enough to hold whatever grain is piled on them. Emergency systems may be adequate but not efficient. If the system is to be used in future years, it may need reworking and more careful design.

Make the main duct end area one square foot for every 1000 to 1500 cfm of air. That is, for 3000 bushels of tough wheat in a bin, plan for 300 cfm air (1/10 cfm × 3000 bu.) and a 0.3-square-foot duct (300 cfm ÷ 1000). This duct can be made 3-sided with 1-inch × 8-inch lumber. If the grain is damp and heating, 3000 cfm might be needed (1 cfm × 3000 bu.), along with a 2-square-foot duct (3000 cfm ÷ 1500). The duct would have to be about 1 1/2 feet by 1 1/2 feet.

Keep ducts spaced a distance equal to 1/2 the grain depth. Close off the end opposite the air entry. Keep duct ends 1 foot to 1 1/2 feet from walls. If a main duct is used with laterals, the total end area of the laterals should equal the duct end area.

For perforated floors, be sure air is not blocked from sections of the floor. For piles outdoors, run a main duct along plastic sheets on the ground and pile grain over the duct along its length. Keep pile height about equal to the spread on each side of the duct. A retaining wall of bales or plywood may help keep the pile from spreading too far. The total area of duct or floor openings should be about 1/10 of the total floor or duct surface area.

FAN

Consult fan dealers to obtain the proper size fan and determine the power needed to run it. The fan size depends on the amount of air (cfm), amount of grain (bu.) and the air resistance or static pressure. Static pressure depends on air flow rate and grain depth as well as the kind of grain. Eight feet of wheat, oats or barley aerated at one cfm builds up 2 inches of water static pressure. Dirt and chaff in the grain, and crops having small seeds increase static pressure. Clean out dirt and chaff if possible, and in any case use a spreader in the bin or attached to the auger when augering.

Remember air from the fan has to get out of the bin (or into the bin if the fan blows out). Bin outlets (or inlets) should be at least twice the area of the pipe between the fan and the duct.

PORTABLE BIN AERATORS

Portable bin aerators may be useful for small bins if the grain is not heating badly. Turn the grain or probe extensively to be sure there are no mold pockets before relying on the bin aerator. Propeller fan units have a low air flow. Centrifugal fan types are better – some may give 500 cfm in a bin – enough for 5000 bushels at 1/10 cfm per bushel, but only 500 bushels at one cfm per bushel. Be sure air enters the bin as far from the aerator as possible. Be sure moist air is exhausted outside the bin.

AERATING

Operate the fan when outside air is at least 10 degrees cooler than the grain, and the relative humidity is below 80%. For grain over 15% moisture content the fan may as well operate continuously except during fog, rain, or high outside temperatures. If the fan operates when air is warmer than the grain, moisture could be added to the grain, and cause high bin pressures.

To see how cooling is progressing, check temperatures of the exhaust air or in the grain farthest from the duct. Temperatures similar to outside temperature show that cooling has been accomplished. *Continue probing for mold pockets.* If aerating hot grain from the dryer, the fan can be stopped when measurements show the grain has completely cooled. Ventilation openings and ducts should be closed to prevent circulation of damp or hot air during storage after the fan is no longer needed.

HEATED AIR DRYING

As soon as possible, heated air dryers must be used. Local elevator agents or "Ag. Reps." know where custom dryers, or dryers for purchase are available. Provincial extension personnel have bulletins describing different drying systems. Heated air dryers offer the best emergency drying. Natural air and supplementary heat methods dry too slowly for grain that has started to spoil.

CAUTIONS FOR DRYER OPERATORS

Grain damage during drying is caused by excessive heat. Check for hot spots in the plenum with extra thermometers. Plenum temperatures vary up to 60°F in some dryers; check various locations with extra thermometers until the hottest one is located and install a thermometer at that location. Use this temperature to set the dryer. Check accuracy of air and grain temperature controls and gauges with a second thermometer. Be sure the hottest *air* stays below the safe temperatures shown in the table. Don't rely on temperatures measured within the grain.

	Temperature of Hot Air, °F		
Type of Dryer	Milling Wheat	Flax and Feed Grains	Malting Barley Rapeseed and Seed Grain
Batch	135	180	100
Recirculating*	135 to 160	200	110
Continuous*	135 to 150	180 to 200	110

*Note: Always begin at the lowest temperature and increase it only as tests indicate that no damage is being done.

Use the Board of Grain Commissioners for Canada free testing service to determine if dried wheat has been damaged. Two samples are required, one before and one after drying. For complete information contact your elevator agent.

For representative samples from non-recirculating batch dryers draw grain from all across the drying column or layer. Grain closest to the heat is driest.

It is not advisable to dry high moisture cereals more than 4 percentage points at one time. Dry in two steps, cooling in between, or dry at seed grain drying temperatures. Otherwise, seed coats can be cracked during drying, reducing the storage life of the dried grain.

Be sure to cool within 10°F of outside temperature, or 40°F, whichever is higher. An aeration system could aid cooling.

Don't overdry the grain since the chance of grain damage is increased, there is unnecessary weight loss and valuable dryer time is wasted.

Prevent recirculation of warm moist air back into the dryer.

Straw or trash in the grain interferes with air flow, and with metering and unloading mechanisms on dryers. Cleaning before drying may be advisable.

Keep the dryer fan speed up to recommended RPM. Modulating valves must have a lower limit not exceeding 100°F.

Be sure truck and auger capacities are adequate to keep the dryer operating. The auger needs up to twice as much power to start when full of wet grain, compared to augering dry grain.

OIL SEEDS

Oil seeds reduce air flow, compared to wheat. Drying time is increased, as are temperature and moisture differences across the grain column or layer. Run oil seeds quickly through the dryer, and dry a second time, if necessary, or reduce the thickness of the drying layer.

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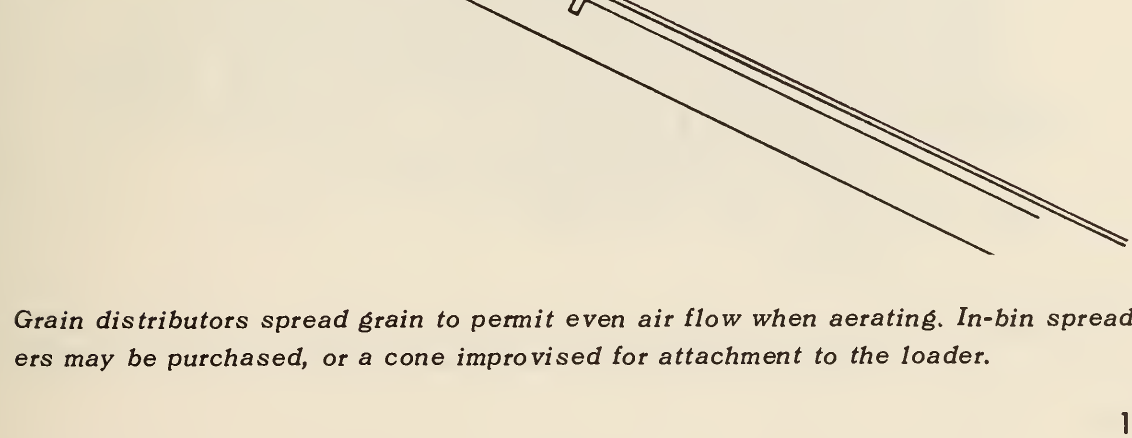
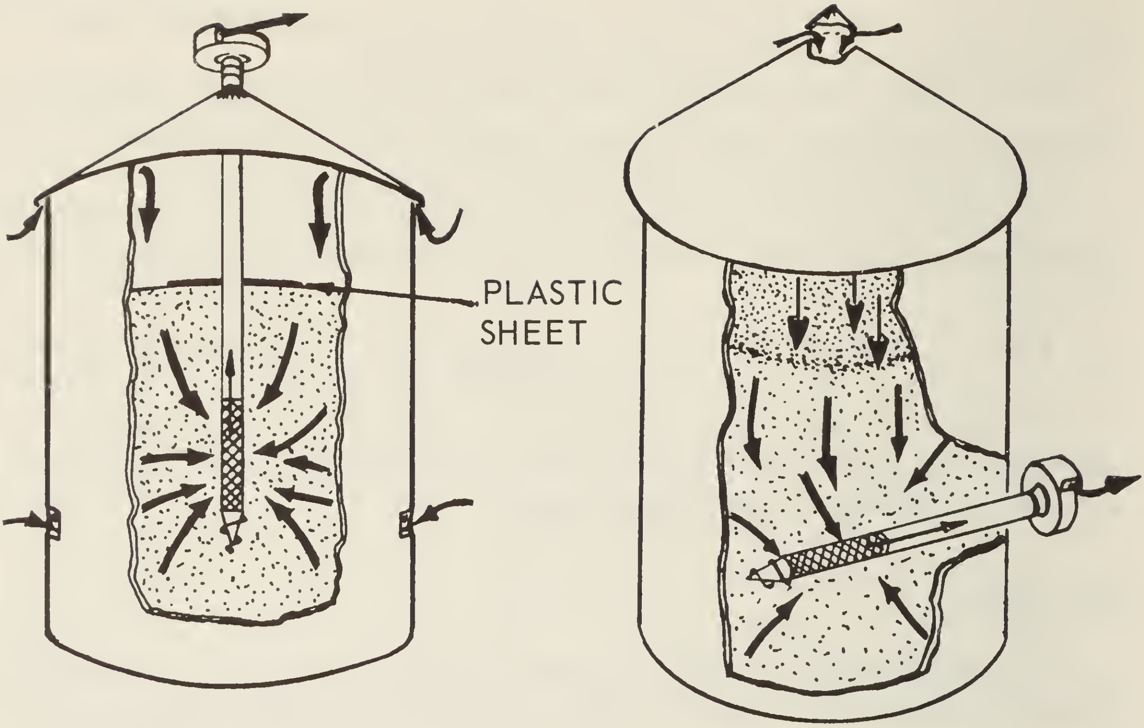
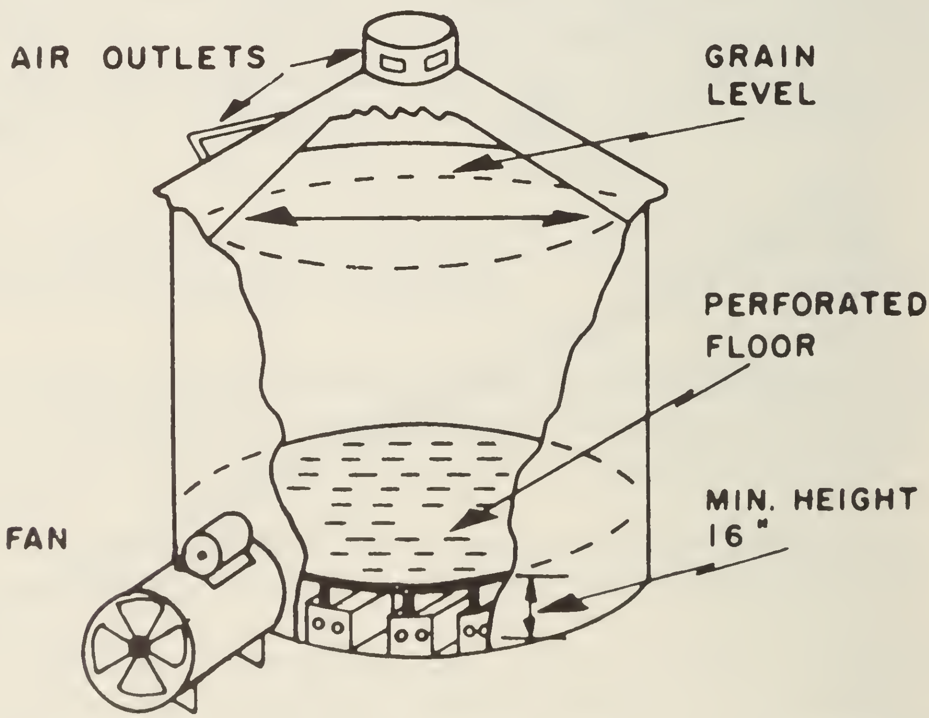


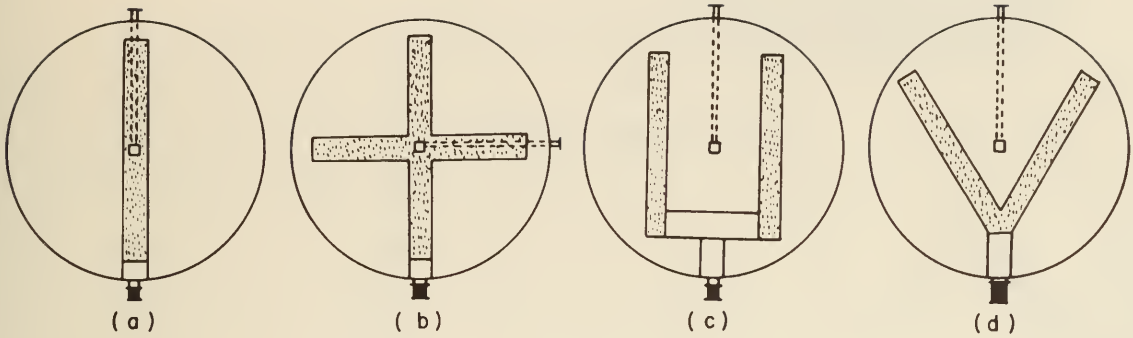
Grain distributors spread grain to permit even air flow when aerating. In-bin spreaders may be purchased, or a cone improvised for attachment to the loader.



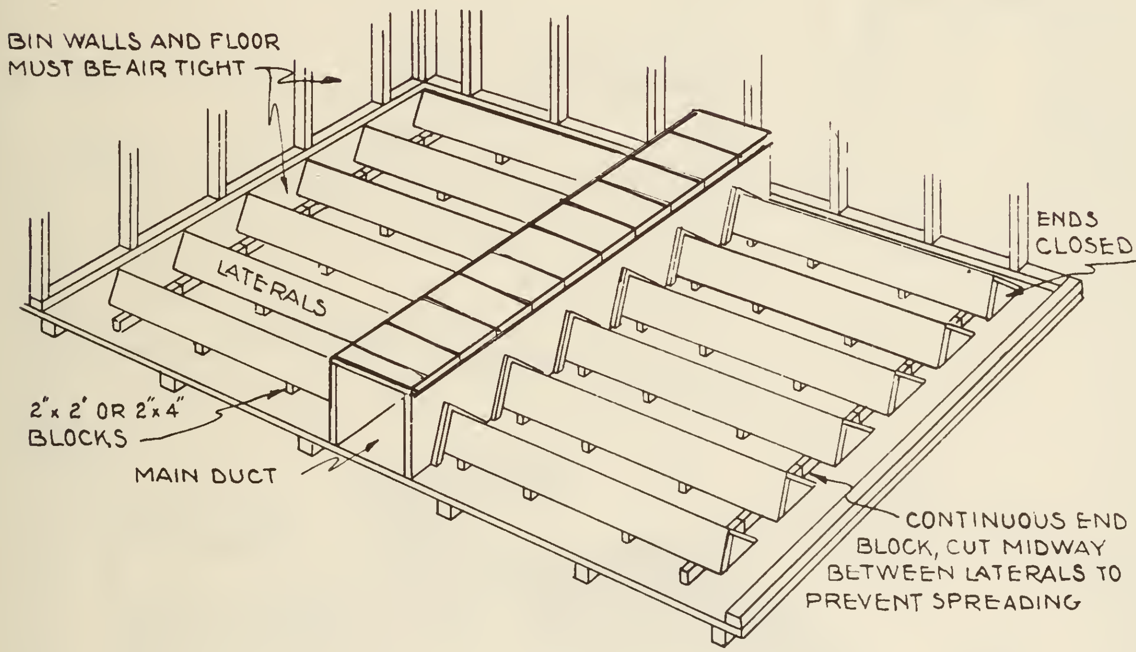
Portable bin aerators can be quickly installed in small bins. Be sure mold pockets are broken up by augering before relying on aerators. Allow air inlets so that air is drawn through all parts of the grain mass. A plastic sheet prevents "short circuiting" the air next to the pipe. Exhaust moist air outside.



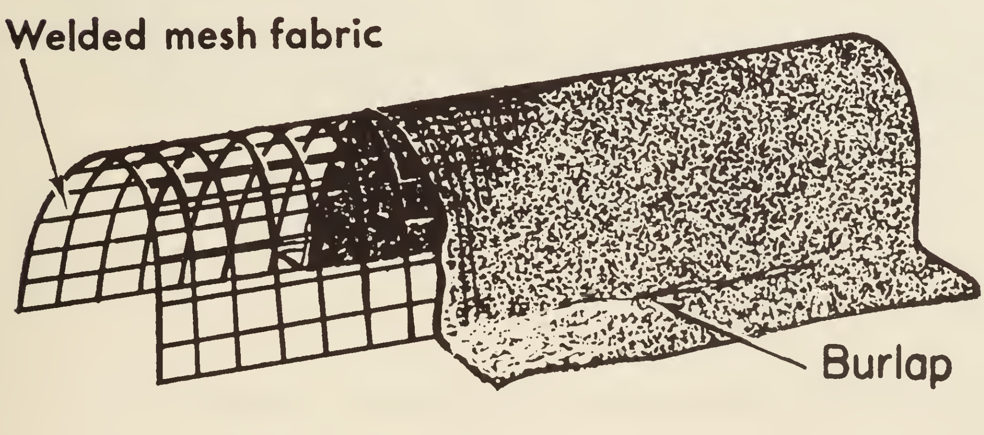
Perforated false floors permit bin aeration.



Ideas for duct arrangement on the floor of a circular bin.

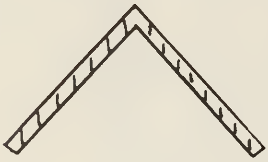
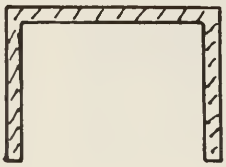


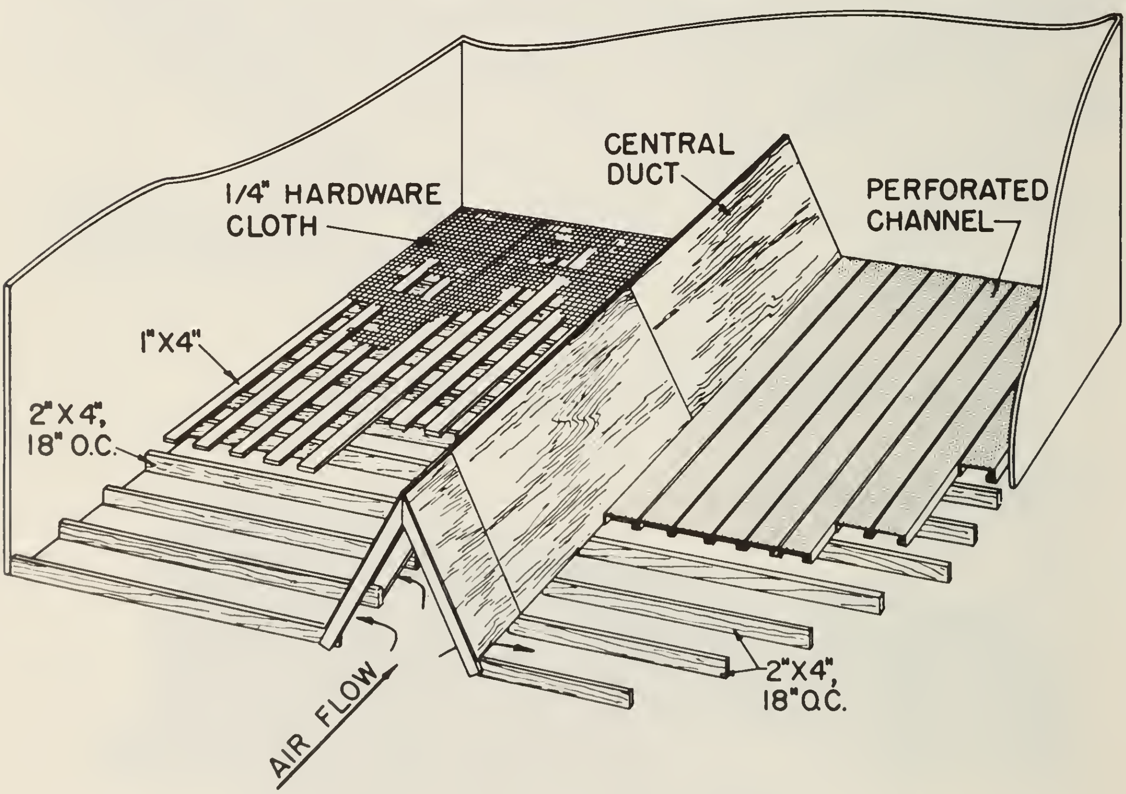
Main duct and laterals for aerating a rectangular bin.



Any material strong enough to support the grain weight, and provide at least 10% of the surface for air to flow through can be used as a main duct.

Lumber Needed to Construct Lateral Ducts of Various Sizes

SHAPE	LUMBER SIZE	OPENING AERA	
		SQ. IN.	SQ. FT.
	1X8 1X10 1X12	25.3 41.6 61.9	0.18 0.29 0.43
	1X8 1X10 TOP 1X8 SIDES 1X10	45.0 60 76	0.31 0.42 0.53



Perforated floors may receive air from a central duct.

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