GRAIN DRYING

PUBLICATION 1497 REVISED 1976

Copies of this publication may be obtained from
INFORMATION DIVISION
CANADA DEPARTMENT OF AGRICULTURE
OTTAWA
K1A 0C7

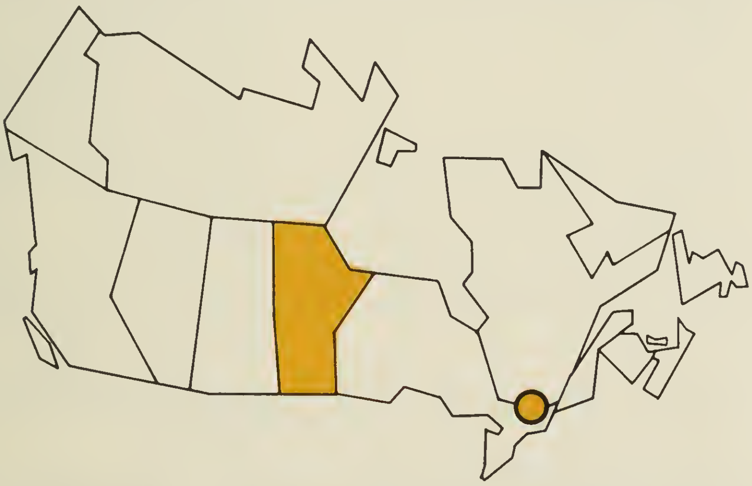
Printed 1973
Revised 1974, 1976
Reprinted 1978

10M-38888-1:78

Cat. No.: A53-1497/1976
ISBN 0-662-00203-2

National Printers (Ottawa) Inc.
Contract No. 01A 08-7-38888

A FEDERAL/PROVINCIAL PUBLICATION



CANADA/MANITOBA

GRAIN DRYING

O. H. FRIESEN, Agricultural Engineer,
Manitoba Department of Agriculture
Winnipeg, Manitoba.

This publication was originally produced by the Manitoba Department of Agriculture. Under the provisions of the Federal-Provincial Regional Cooperative Publishing Program, the Canada Department of Agriculture has agreed to print this publication.

CANADA DEPARTMENT OF AGRICULTURE
Publication 1497 Revised 1976

contents

GRAIN DRYING

importance of grain drying

Grain drying has become more common across the prairies in recent years and this practice should continue to increase. There are several good reasons for making a grain dryer a standard part of the harvesting system:

Earlier harvesting. When a grain dryer is used earlier harvesting is possible. Wheat, oats and barley can be threshed at 20% moisture content (MC) and then dried without loss of quality, grade or germination. When compared with harvesting at 14%, there is a difference of only 1 or 2 days in mid-August, but by mid-September it may be 4 days or more. If a wet spell occurs, the differences could be much greater.

Early harvesting allows a farmer to do a much better job of weed control through timely chemical application and tillage practices.

Longer harvest season. Extra hours in the morning and evening of each day and several extra harvest days each year are possible with a grain dryer. The number of hours available for harvesting can be doubled in many years, which could substantially reduce the overhead costs of harvesting equipment. For a farmer relying on custom harvesting, a grain dryer can be a great help in getting his harvesting done early. In any case, each combine can be used to harvest more acres.

Reduced field losses. Weather damage and losses due to wildlife can be reduced by harvesting at the tough or damp stages. A loss of one grade may mean a 2-5% loss in price and a 5% loss in weight, for a total loss of 7-10%. Harvesting before a rainy spell, instead of after, can therefore represent a considerable saving. Overdrying of crops in the field, which leads to shattering and crop loss, can also be prevented by earlier harvesting.

Straight combining of some crops such as sunflowers and corn is a necessity, and if these crops are harvested damp, field losses are greatly reduced. A dryer in the system may also make it feasible to straight combine other crops.

Eliminate spoilage in storage. When tough or damp grain is harvested and not dried, long-term storage frequently results in grain spoilage. Moisture migration within grain bins can make even tough or dry grain unsuitable for storage. Hot spots and insect infestations can be avoided by proper drying.

grain moisture relationships

Warm temperatures and damp grain promote grain spoilage through mold growth and insect infestations. To prevent spoilage, grain must be dried to 15.5% MC or less within a few days. The following table gives estimated allowable times to dry grain to 15.5% MC to prevent mold growth at various grain temperatures.

Grain temperature	Days
30°C	3
20°C	6
10°C	11
0° or less [1]	

Safe moisture contents for storage periods of 1 year or less are as follows:

Wheat	14.5	Rapeseed	10.5
Barley	14.8	Corn	15.5
Oats	14.0	Peas	16.0
Rye	14.0	Sunflowers	9.5
Flax	10.5	Mustard	11.0
Buckwheat	16.0	Canary seed	12.0

If longer-term storage is anticipated, lower moisture contents than those given may be required. This is because of moisture migration which may occur in grain bins as a result of changing outside temperatures. Aeration can be used to prevent this problem (see Aeration, p. 31).

Processing of special crops may also require lower moisture contents than those given above.

The amount of water that must be removed from grain is given in the following table:

	Final MC	litres/tonne removed from grain with an initial moisture content of				
		16%	18%	20%	22%	24%
Wheat, Oats, Barley	14%	24	49	75	103	132
Rapeseed, Flax	10%	71	98	125	154	184
		24%	26%	28%	30%	32%
Corn	14%	132	162	194	229	265

[1] Mold growths do not appear in frozen grain. Temperatures should be checked frequently to ensure that the grain is actually frozen.

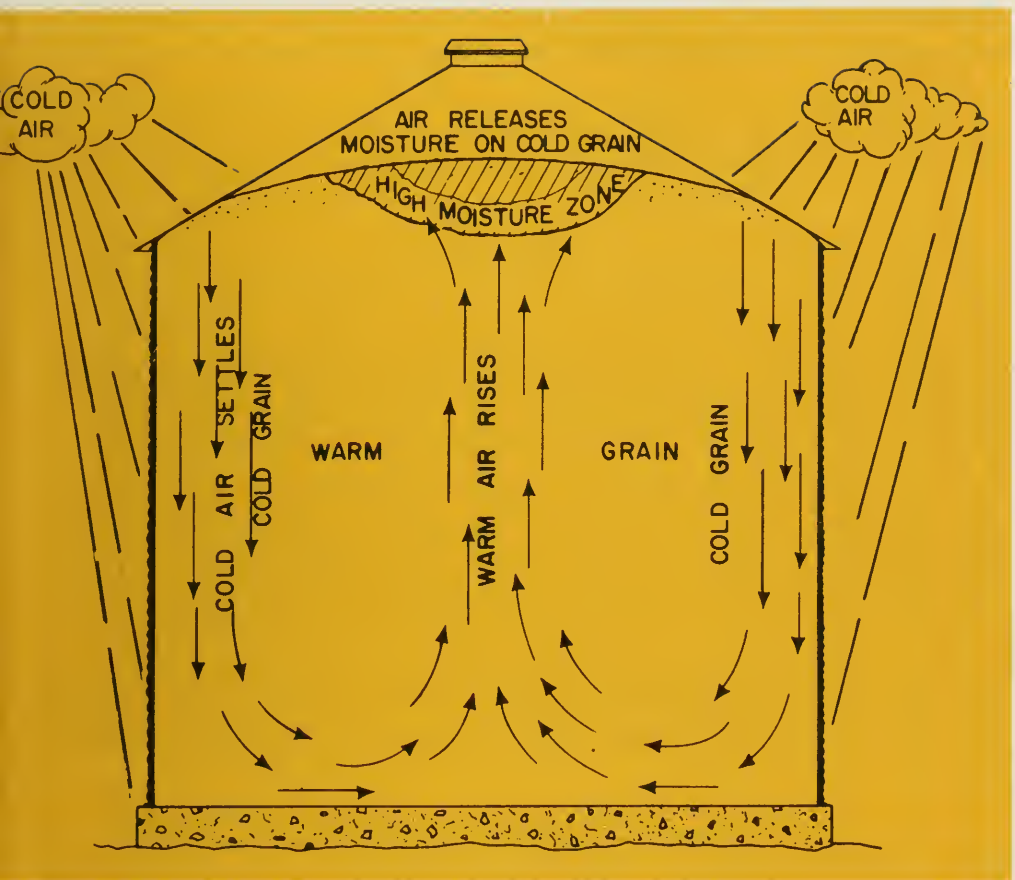


FIGURE 1

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.

To dry wheat from 20% MC to 14% MC requires the removal of 75 litres of water per tonne of grain.

When grain is dried rapidly (for example 6% MC drop in 2 hours or less) in a heated-air dryer, it is common to experience a moisture 'rebound.' Grain coming out of the dryer may test dry, but after a few days of storage it may test 1%, or even 1½%, higher. This is caused by the difference in moisture content within the grain kernels and the type of tester used. The outside part dries faster and gives a lower moisture reading immediately after drying. When the moisture content becomes uniform, it is found to be somewhat higher than first indicated. Problems of this nature are usually solved by overdrying the grain by about 1% initially.

drying temperatures

Natural drying of grain occurs when the relative humidity (RH) of the air is below the equilibrium point of the grain. When the relative humidity is above the equilibrium moisture content, the grain takes on moisture. Following are the approximate equilibrium grain moisture contents and the corresponding relative humidities:

Equilibrium grain moisture content	Relative humidity of air
12%	51%
13	58
14	65
15	72
16	78
17	83
18	87

For example, the average relative humidity during September and October at Winnipeg is about 70%. Natural air drying below 15% MC is therefore not very feasible during the fall in this area.

When air is heated, the relative humidity drops rapidly. When air at 15°C and 70% RH is heated to 45°C, the RH drops to 13% and when heated to 65°C, it drops to 5%. Thus, evaporation is greatly increased by heating the air. The amount of water that can be carried by air at 65°C is three times as much as air at 45°C.

To dry grain as quickly as possible it is desirable to use the highest possible temperatures. There is a limit, however, since grain can be damaged if it is overheated. The maximum allowable air temperatures are as follows [2]:

	Seed or malting	Commercial use	Feed
Wheat	60°C	65°C	80°C
Oats	45 *	60	80
Barley	45 *	55	80
Rye	45	60	80
Corn	45	55	80
Flax	45	80	80
Rapeseed	45 *	55 *	—
Peas	45	70	80
Mustard	45	45	—
Sunflowers	45	50	—
Buckwheat	45	45	—

*Higher temperatures may be acceptable for these grains, but lack of sufficient information prevents higher recommendations.

In most dryers there is a possibility that the grain will eventually reach the same temperature as the air passing through it. For this reason the maximum air temperature should not exceed the maximum allowable grain temperature. While the grain is at a high moisture content, it remains at a much lower temperature than the drying air, because of the high rate of evaporation. As the grain nears the 'dry' stage, it begins to heat up very quickly since the rate

2 The temperatures given above are the maximum allowable in hot air plenums. They are also conditional on the removal of not more than 6% moisture at one time, and drying to not more than 1% below the previously indicated safe storage moisture contents. Temperatures of 55°C or less are usually used in bin dryers.

of evaporation slows down. Once the grain gets below the 'dry' moisture content, it is much more susceptible to damage by high air temperatures.

Overdrying is expensive and time consuming. Extra fuel is required and there is a loss in grain weight. Overdrying by 2% MC means a loss of about 2.5% in weight, and in net sale value.

A common problem in grain drying is inaccurate temperature sensing. Thermometers may become damaged, or sometimes they are improperly located and don't indicate the highest temperature in the air plenum. Often the result is damaged grain, even though the temperature reading is within the limits given. The best insurance against this problem is to use extra thermometers in the air plenum and/or to check the actual grain temperatures nearest the hot air plenum with a temperature probe.

To find the highest acceptable air temperatures for milling wheat, for any particular dryer, two samples of wheat (one collected before drying and one after drying) should be sent to the Canadian Grain Commission, Winnipeg, Man., to check for damage to milling quality. The samples should be representative of the wheat going in and coming out of the dryer. If the quality is unchanged, a higher temperature can be tried, and two more samples sent in.

weather effects on drying

To understand the effects of various weather conditions on grain drying, it is necessary to understand the operation of the dryer controls. On most continuous-flow dryers and batch dryers with automatic shut-offs, the drying time is regulated by a thermostat located near the outside of the grain column. When the grain temperature reaches the preset level the unloading mechanism is started, or in a batch dryer the heat is shut off.

Wind and sun — Unshielded thermostats located on the outside of a dryer, can be affected by wind or sunshine. A cold wind blowing against the thermostat will delay its activation and, therefore, can cause overdrying at a setting that was previously satisfactory. In a two-column dryer, with each column controlled by its own thermostat, equal settings will result in one column moving faster than the other if a wind is blowing against one of them. This is often interpreted to mean that the windward side is drying much slower. This is a mistake, however, since the pressure created by winds is insignificant compared with the pressure inside a dryer (dryers frequently operate at a static pressure of 750 to 1000 Pa whereas a 30 km/h wind creates a pressure of 50 Pa). The column on the windward side can become seriously overdried as a result of the wind effect on the thermostat, and grain damage is more likely. This can be prevented by (1) shielding the thermostat from the wind, (2) running both discharge augers from the leeward thermostat or (3) mechanically operating the windward discharge auger at a speed equal to the leeward discharge auger.

The rate of drying grain with heated air is only very slightly affected by changes in weather conditions. The wind and sun can seriously affect the operation of thermostats if they are not properly shielded. The fuel cost is very dependent on outdoor air temperatures.

The wind itself has little or no detrimental effect on the operation of a dryer and it is not necessary to shield the dryer from the wind, except perhaps for operator comfort. Completely satisfactory drying was obtained with many dryers operating during the winter of 1968 without shielding, and with winds up to 50 km/h.

The effect of sunshine striking a thermostat will be the opposite to that of the wind. The thermostat on the sunny side will cause a higher grain flow rate than the one on the shady side. As wind and sun conditions change, thermostats have to be readjusted to prevent underdrying or overdrying. However, effects of wind and sun on the actual performance of the dryer are not significant.

Humidity — The relative humidity of the air is often thought to be a problem in drying grain. With natural or 'tempered' air drying it often does cause problems, but with heated air drying it can be practically ignored. The effect of added heat on relative humidity was mentioned on page 8. Air at 15°C and 100% RH when heated to 65°C will have only 7% RH. Air at 0°C and 100% RH when heated to 65°C will have only 2% RH. Even if 15°C air is heated to only 45°C the RH will not be over 20%. Only when fairly high air temperatures (over 20°C) are combined with high relative humidities and low drying temperatures (near 40°C) does the humidity act as a noticeable detriment to drying.

Grain temperatures — Differences in initial grain temperatures have a slight effect on the drying rate and fuel consumption. A difference of 30°C in the initial grain temperature results in a difference of about 10% in the time and fuel requirements. Changes in grain temperature occur very slowly in grain unless air is being blown through it, or heating is taking place.

Air temperatures — Differences in outdoor air temperatures have very little effect on drying rates, if the temperature of the drying air is kept constant. However, it does require more fuel to heat up the air from a lower temperature. When using a drying temperature of 65°C, the relative fuel consumptions are as follows:

Outside air temperature	Relative fuel consumption
15°C	1
—7°C	1.5
—30°C	2

Early fall drying is obviously much less expensive than winter drying and helps to take advantage of the other benefits stated earlier.

storage bin layouts

For a drying system to work efficiently, it must fit into the grain handling and storage system without creating a bottleneck. Easy transfer of grain from the truck to the dryer and into storage is essential. Holding bins are usually required to provide surge capacity for the dryer.

Various bin and dryer arrangements may be used to provide the required flexibility and convenience. In determining your needs, the following must be considered:

- Harvesting and drying rate desired.
- Total storage requirements (with future expansion in mind).
- Expected variety of crops (both in kind and grade).
- Existing facilities.
- Functions to be performed by the system (seed cleaning, drying, feed processing, etc.).

The simplest type of layout for drying is shown in Figure 2. This is used mostly as a temporary setup with relatively small amounts of grain. The surge bins sometimes consist of several large trucks. In either case, several extra men and trucks are needed during the operation, which makes it unsuitable for many harvesting systems.

Semicircular system — A simple bin arrangement, which is fairly popular, is the semicircular bin system (Figure 3). This system offers mechanical grain handling with minimum capital investment. Several points must be kept in mind when laying it out:

- Use sufficient radius to move equipment within the circle; to allow a truck to dump without damaging the auger; and to accommodate adequate storage.

A 36-40 ft (11-12 m) radius using eight or nine bins 19 ft (5.8 m) in diameter has proven satisfactory for many installations, and equipment is available from stock to fit this size of system. If the radius is less than 30 ft (9 m) at least one third of the circle must be left open for unloading.

FIGURE 2

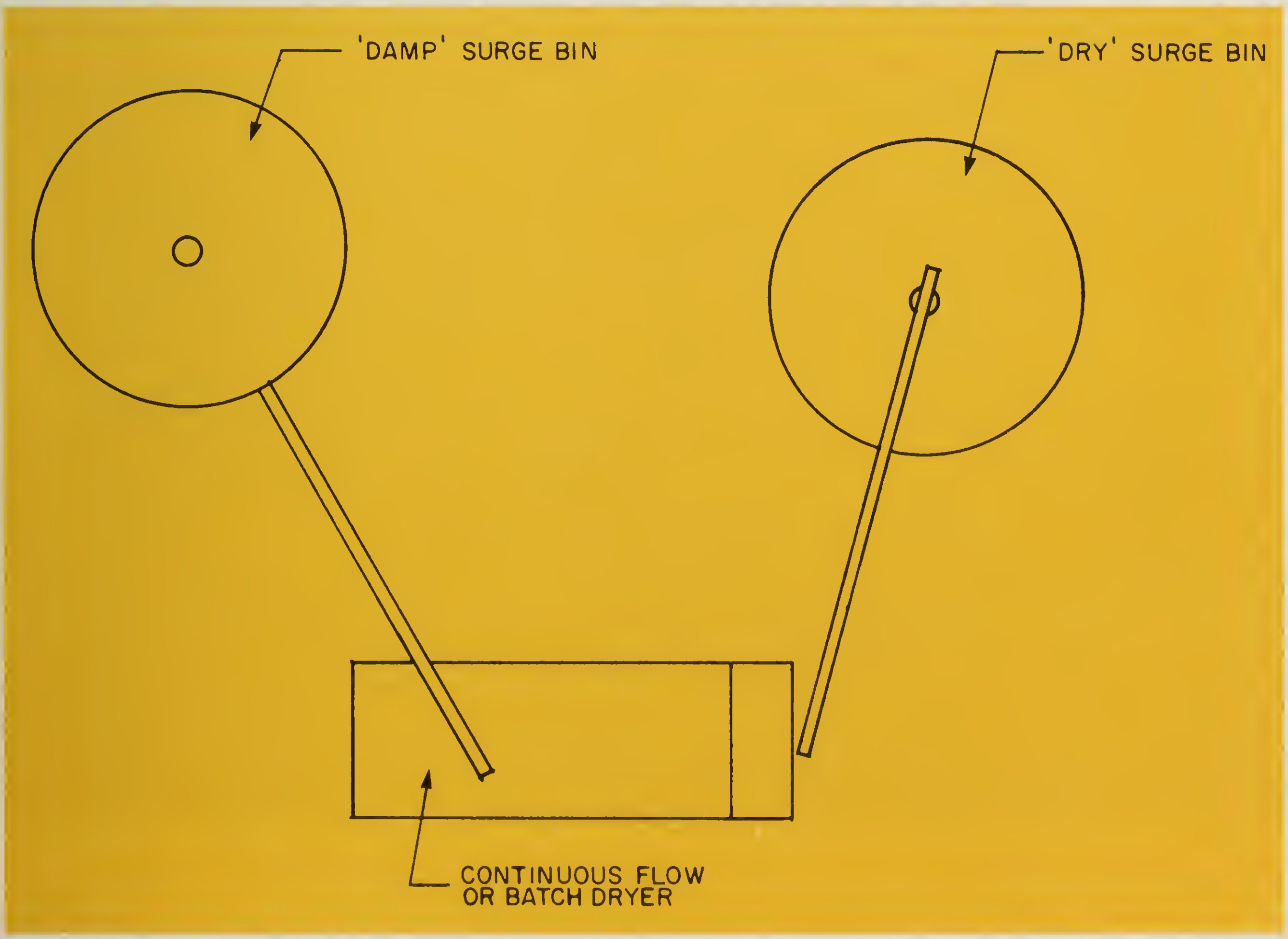
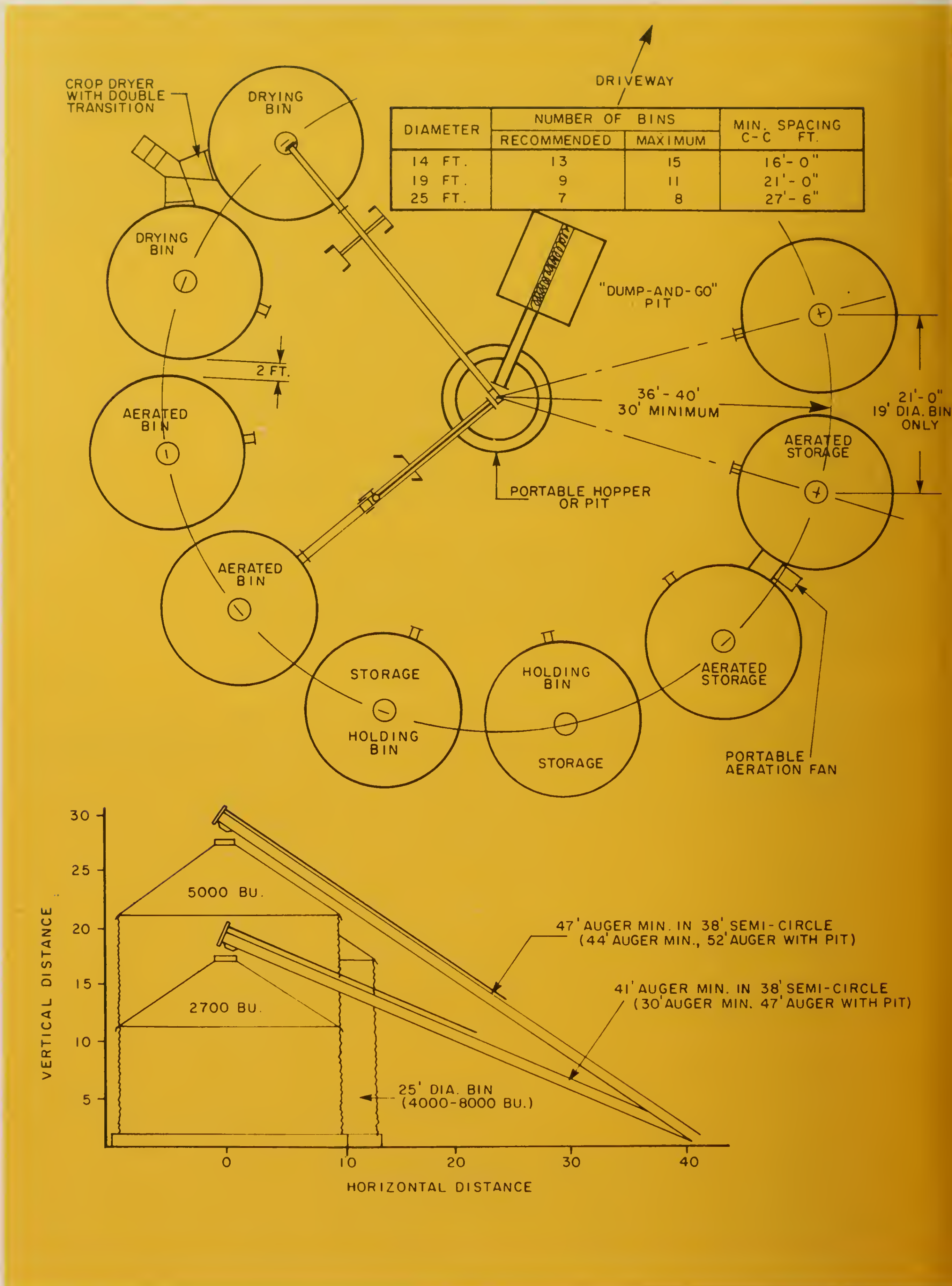
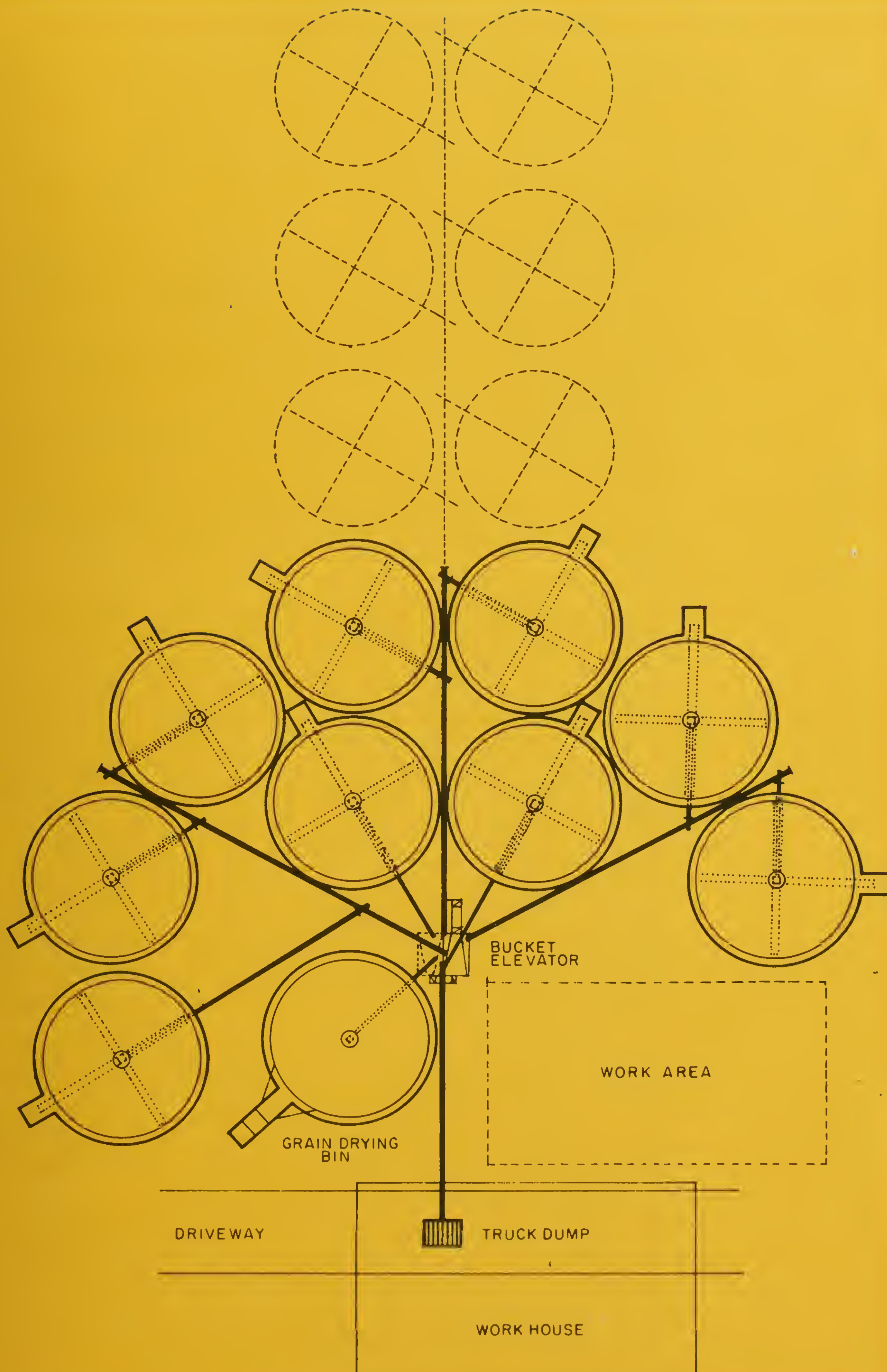


FIGURE 3   SEMI-CIRCULAR BIN ARRANGEMENTS FOR 14', 19' AND 25' DIA. BINS



DIAMETER	NUMBER OF BINS		MIN. SPACING C-C FT.
	RECOMMENDED	MAXIMUM	
14 FT.	13	15	16'-0"
19 FT.	9	11	21'-0"
25 FT.	7	8	27'-6"

FIGURE 4


BUCKET
ELEVATOR
WORK AREA
GRAIN DRYING
BIN
DRIVEWAY
TRUCK DUMP
WORK HOUSE

• Use a portable central hopper. A used tractor tire with the beads removed and a 16-gauge sheet metal bottom makes a portable and durable hopper. A rectangular hopper equipped with a cross-feed auger and an inclined unloading auger to the portable hopper can be used to allow quick dumping of the trucks during harvest.

This arrangement has the following advantages:

— It is easily covered to prevent rainfall problems.

— Shoveling in the hopper is eliminated for true dump-and-go convenience.

— The hopper is easily elevated to a level above the surrounding area or can be shallow enough to prevent drainage problems.

— Easy accessibility for dumping by backing in, or a drive-through setup using a grate over the dump hopper.

— Lends itself to processing the grain before it goes into storage by including a scalper or continuous-flow cleaner or dryer next to the hopper.

• A concrete track or an overhead rail simplifies the movement of auger equipment within the system, especially in winter.

• The foundations must be built up high enough to allow enough clearance for unloading and cross augers to work properly. Specifications and dimensions are available from equipment suppliers.

If the semicircular system is properly laid out, it can later be expanded to an in-line system, using a vertical elevator (Figure 4). Permanent bin unloading equipment is installed, and bins can be placed inside the semicircle. Detailed dimensions and layout variations for different types of operations (seed cleaning, feed processing) are available from bin and equipment suppliers. The work area could be the location for a feed processing center or a high-capacity continuous-flow dryer. In the latter system the bins inside the semicircle could be used as wet holding bins.

Double in-line system — Another bin arrangement that may be used is the double in-line system. It is used where labor savings warrant the increased costs required for the additional auger equipment (Figure 5). Some features to be considered are:

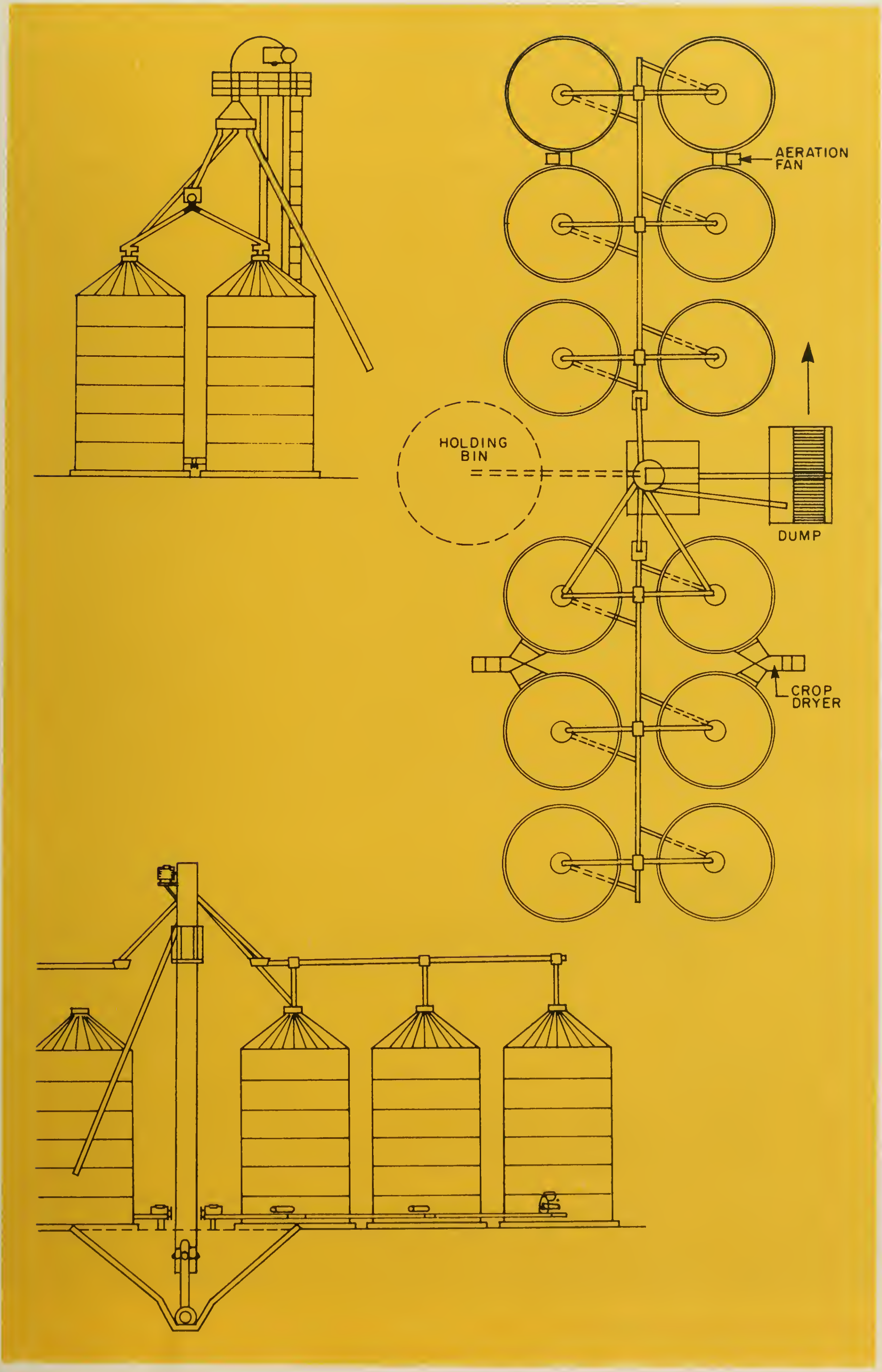
• The overhead auger system can be used to reduce the height of the leg where cleanout is not critical. Gravity flow may be preferable in commercial seed operations.

• Unloading tubes should be located to allow the unloading augers to be removed for transfer from bin to bin or for service.

• A rectangular pit with a cross-feed auger allows quick dumping without the problems associated with deep gravity-flow pits. Some operations include a high-capacity cleaning or drying process between the pit and the vertical elevator.

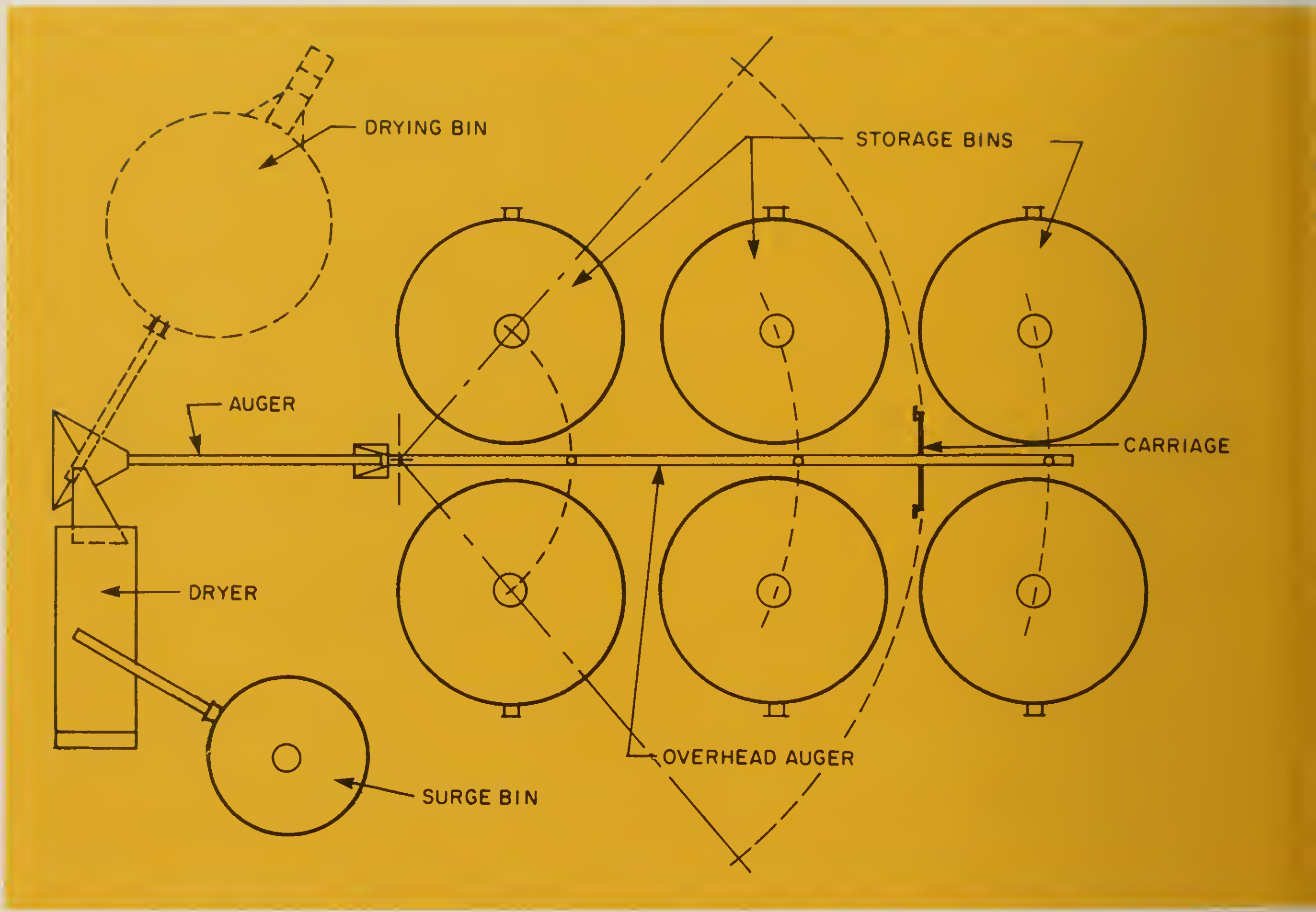
Simplified in-line system — A simplified in-line system is shown in Figure 6. This is a low-cost system that can be set up using ordinary, inexpensive grain handling equipment. An inclined auger feeds into the overhead auger, either from the truck or from the grain dryer. Dry grain can be placed directly into storage, whereas damp grain can be put through the dryer and then into storage using the same augers. This system is best suited for operations

FIGURE 5 DOUBLE IN-LINE SYSTEM



where the bins are filled and emptied only once or twice a year. The bins are unloaded by placing a portable auger into the unloading ports located along the outer sides of the two rows of bins.

FIGURE 6 SIMPLIFIED DOUBLE IN-LINE SYSTEM



GRAIN DRYING OPERATION

bin dryers

Bin dryers (Figure 7) require the lowest investment of any of the dryers commonly used. They are available in many different sizes and capacities and can be adjusted for various drying rates. Very little supervision is required in a properly set up bin drying system.

A minimum of two bins is required: one bin to be equipped for the drying process; the other bin, or bins, may be equipped with aeration equipment.

The dryer should be able to handle about as much grain in 24 h as will be harvested in a normal day. Therefore, the size of the drying bin should be selected on the basis of the anticipated harvesting rate. See the drying charts (Appendix) for an estimate of drying rates with various sizes of bins, heaters and stirring devices.

During batch-in-bin drying, the drying unit is started up as soon as the first truckload of wet grain is emptied into the drying bin. The burner is set for continuous operation during the period while the day's harvest is being placed in the drying bin. Batch drying can be carried on unattended and allows the operator to continue field work.

Depending on the moisture content of the crop, the burner may be left on all night, if necessary, to complete the drying process.

Air and grain temperatures should be checked occasionally during the drying process with a temperature probe.

When the batch is dry, it may be cooled with the dryer fan, or transferred to the storage bin and cooled by an aeration fan. Warm grain should be cooled down to within 5°C of the prevailing outdoor temperature or 2°C (whichever is higher) to prevent condensation in the bin.

During the cooling cycle the air continues to extract moisture from the grain. This means that warm grain from the drying bin may be transferred to the aerated storage bin at a moisture content slightly above the storage requirements. The amount of drying during cooling will depend on the temperature decrease of the grain. With a small decrease, the drying may be just enough to counteract the moisture rebound, whereas with a large decrease, it could be 1 or 2%.

Because the grain is dried in batches, good loading and unloading equipment is essential with this method. The drying bin should be located close to the storage bin or bins. Two drying bins can be set up to use the same heater and fan by using a 'Y' connector. This allows filling and emptying to take place without losing any drying time.

Advantages of batch-in-bin drying are as follows:

- Grain may be dried as it is harvested on a 24-hour cycle if required.
- The drying cycle can be controlled with a minimum amount of supervision.
- A grain layer of a few inches to several feet in depth can be dried efficiently. This can be desirable because the size of the batch will

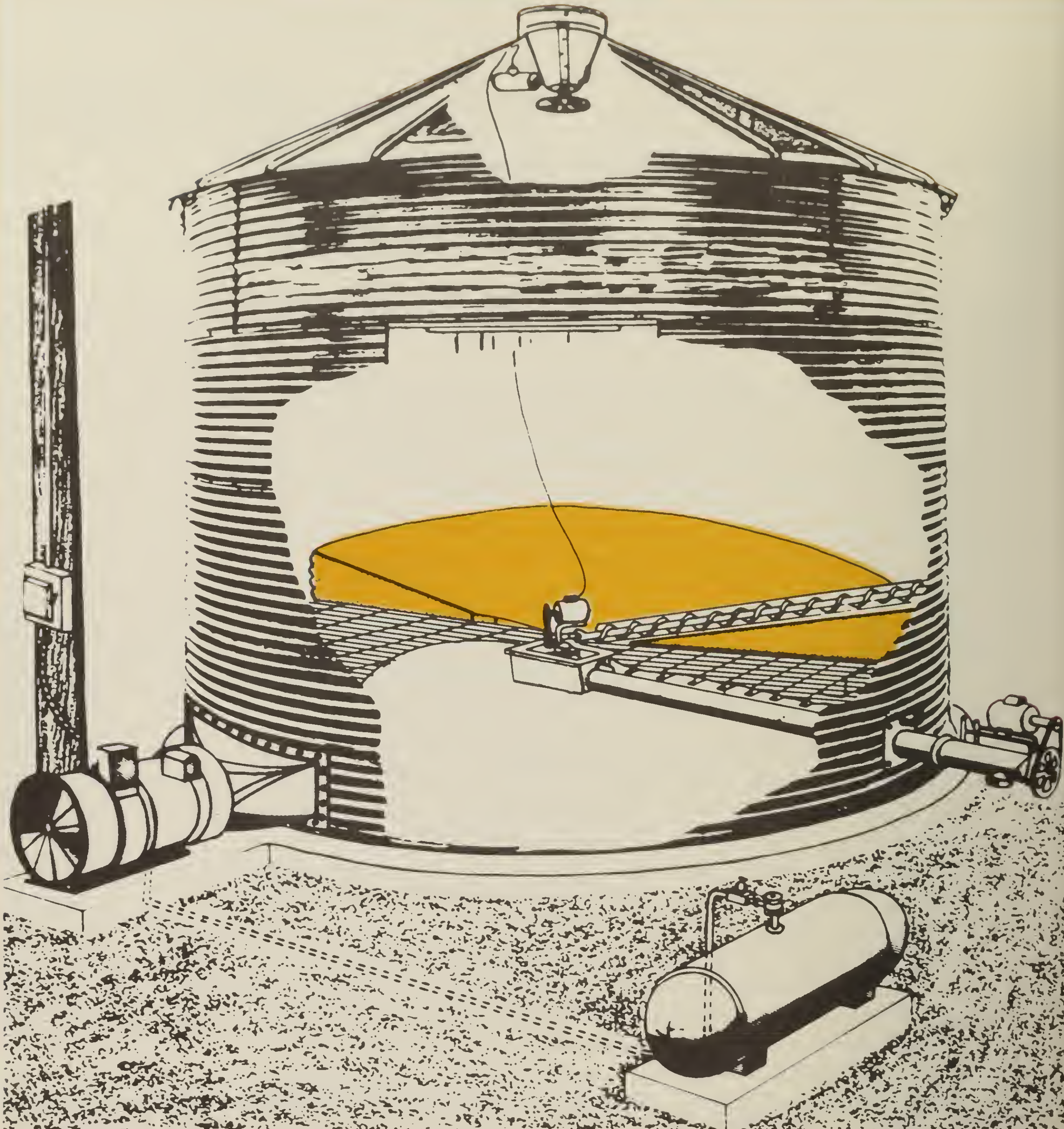


FIGURE 7

vary with the moisture content, and a full batch is not always obtainable under practical operating conditions.

- Regardless of the harvesting equipment used, the drying system can be matched to meet the demands of the harvest. By enlarging the drying floor area through use of a larger bin, or increasing the number of drying bins, a wide range of batch drying capacities can be obtained. Recirculation with stirring units can be used to increase both drying capacity and the size of the batches.

Recommended steps for drying — Carefully read the manuals supplied with each of the components of the system, and follow these basic steps:

1 After you have cleaned the floor, checked the seal around the plenum and checked all of the equipment to see that it is operational, begin filling the bin. Run the fan during filling to exhaust foreign material and dust that would otherwise interfere with the flow of air through the grain. A mechanical grain spreader should be used during filling to spread the grain evenly to provide a uniform resistance to airflow.

2 Measure the moisture content of the grain as you fill the bin to the desired level. This will help you to determine a suitable depth of grain to use and also to predict the drying time required.

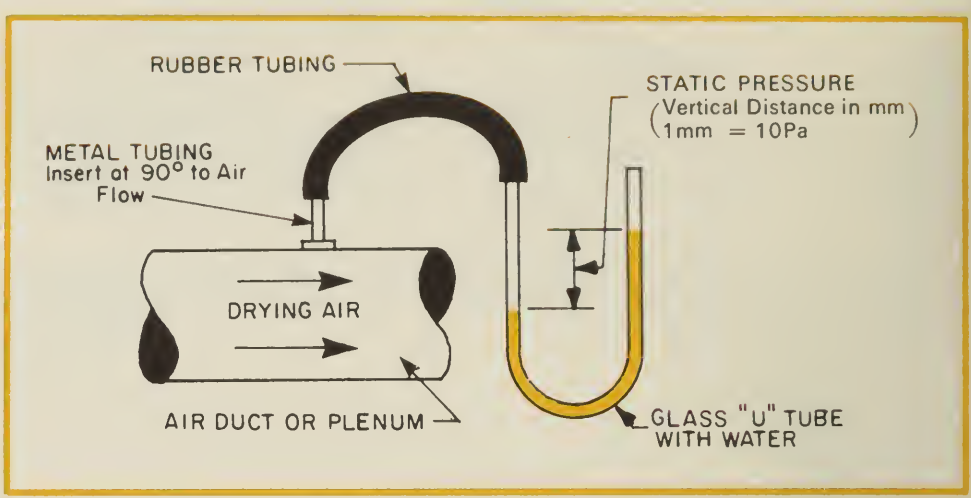
3 Load the bin to the recommended depths shown in the drying charts, or use a manometer or homemade U-tube to measure the static pressure buildup under the floor (Figure 8). The airflow can be determined by referring to the airflow charts supplied with the fan unit. A minimum airflow of 10 cfm/bu (500 m^3/h of air per m^3 of grain) is needed for efficient drying.

4 Adjust the controls to obtain the desired air temperature. If the dryer has an off-on burner control, regulate the propane or gas pressure to cycle the burner about every 30 seconds. A higher gas pressure will cycle the burner at a faster rate.

The Canadian Grain Commission, Winnipeg, offers a sample testing service for dried wheat. To determine if damage has been done by drying, send a 1-lb (500 g) sample from both before and after drying. Always start at a safe temperature, and proceed to a higher temperature when tests using the higher temperature indicate no damage. The safe temperature can vary with the type of grain and its moisture content. *USE THIS VALUABLE TESTING SERVICE WHENEVER YOU INCREASE THE AIR TEMPERATURE. WHEN DRYING AT A HIGH TEMPERATURE, USE THERMOMETERS TO KEEP A RUNNING CHECK ON THE HEAT CONTROLS.*

BIN DRYER

FIGURE 8
STATIC PRESSURE
MEASUREMENT



5 Check the grain moisture in the bin periodically. The drying will be even and the drying front uniform if the grain was clean, the depth uniform and the air distribution even. The location of the drying front will give some indication of how much more drying time is needed.

6 When the moisture content has been reduced to the desired level, cool the grain to within 5°C of ambient temperature or 2°C, whichever is higher. This can be done with the dryer fan, or by moving the grain to another bin and using an aeration fan.

Drying charts — The depth of grain used depends on the type of grain, size of fan and bin, temperature of air used and moisture content of the grain. The charts in the Appendix offer assistance in estimating drying rates. The values given indicate typical drying rates which are subject to the following influences:

- Uncleaned grain that can restrict the airflow.
- Poor uniformity of packing when a grain spreader is not used or is improperly adjusted.
- Frozen grain with frost crystals and snow.
- Inlet air containing precipitation (rain or snow) that slows drying, or using low drying temperatures when the outside air is warm and moist.

The depth of grain and temperature setting are selected from the charts. In general, the lower the temperature the slower the drying rate and the greater the allowable depth.

IF THE BIN HAS BEEN FILLED IN EXCESS OF THE RECOMMENDED DEPTHS, AND CONDENSATION IN THE GRAIN BECOMES EXCESSIVE (AS INDICATED BY A LACK OF AIRFLOW), REDUCE THE TEMPERATURE AND STIR THE GRAIN TO BREAK UP THE WET FRONT.

Always turn off the heater after the grain is dried to the accepted value, and cool the grain as previously indicated. This can be done in the drying bin or in aeration bins, according to the preference of the operator.

Spreaders, stirring devices and unloading augers — Various types of equipment are available to assist in handling grain into and out of bin dryers. Mechanical spreaders are available to automatically distribute the grain evenly over the drying floor. Stirring devices can be installed to mix the drier grain from the bottom with the wetter grain near the top during the drying operation. This allows greater depths of grain to be dried at one time. Charts of depths and drying rates for stirring augers are on pages 41 and 42. Unloading sweep augers and underfloor augers are practically a necessity for efficient operation of a bin dryer.

Detailed information on types of equipment, installation procedures and operation is available from suppliers who sell grain bins and bin dryers.

Moisture variation — Moisture variations between the top and bottom of a batch will depend on the initial grain moisture content, drying temperature, depth of grain and airflow rate. At 65°C drying temperature, with 1.2 m of grain and an average moisture reduction of 6%, a variation of 4 to 5% could be expected. This can be reduced by cooling the grain with air at a relative humidity above the equilibrium point. This adds moisture to the overdried grain near the bottom. Since grain swells as it takes on moisture, some grain should be removed from the bottom of the bin before cooling with damp air. If grain is thoroughly mixed as it is removed from the dryer, moisture variations from bin drying should cause no problems. One method of reducing moisture variations is discussed on page 30 under Alternated Heating and Cooling in Batch Dryers.

batch dryers

There are two types of batch dryers available — the stationary batch dryer and recirculating batch dryer.

Stationary batch — These dryers may consist of a horizontal bed dryer mounted on a wagon chassis, which operates similar to a bin dryer. Another type is the fully enclosed, two-column variety (Figure 9). Both types keep the grain in a stationary position throughout the drying process, with the same grain in contact with the hot air for the whole time. This results in overdried grain nearest the hot air and underdried grain near the outside. The grain is mixed as it is unloaded, and if proper temperatures are used, a satisfactory product results. Grain layers in stationary batch dryers are usually 18 to 24 inches (45-60 cm) thick, and the airflow rates are quite high, so moisture variations are not as great as in some other dryers.

Another type of batch dryer is the truck-box dryer. A heater and fan unit, similar to those used for bin drying, is connected to a main plenum which is connected to smaller ducts inside the truck box. These ducts may be located on the floor of the truck box or else suspended at mid-height of the box. If they are suspended, exhaust ducts must be provided at the floor of the box. Capacities vary with the fan and burner capacity, and size of the truck box.

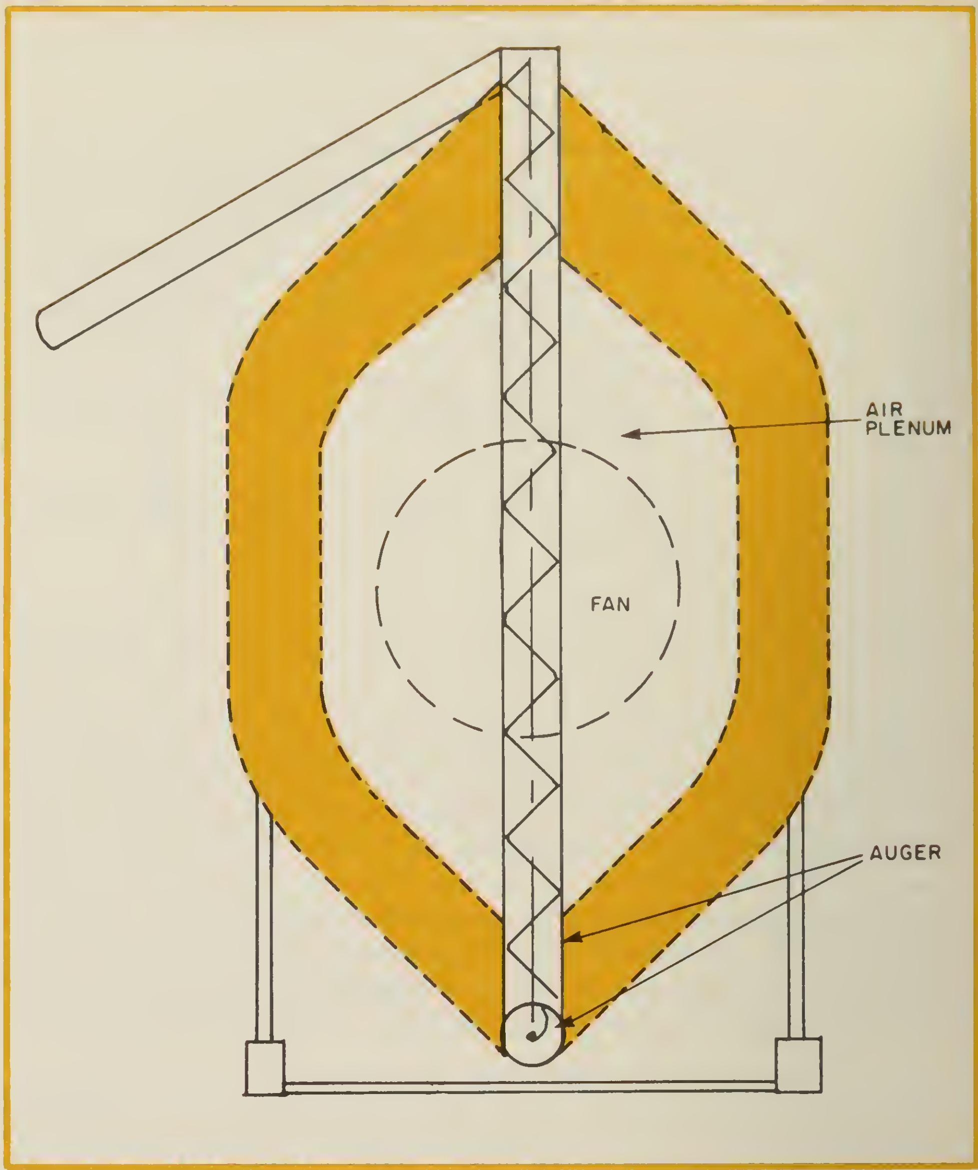


FIGURE 9
STATIONARY
BATCH DRYER

STATIONARY
BATCH DRYER

Recirculating batch — The recirculating batch dryers (Figure 10) constantly mix the grain throughout the drying process and, therefore, produce uniformly dried grain. The most common type has a vertical cylinder for the air plenum and a circular grain column about 18 inches (45 cm) thick around the plenum. A vertical auger picks up the grain at the bottom of the dryer and moves it to the top. A complete recirculation of the grain occurs about every 15 minutes.

Setting up a temporary batch drying system is normally quite simple since each batch is self-contained and may take several hours to dry. Sufficient holding capacity for wet grain and dried grain, and high-capacity augers to empty and refill the dryer are needed to make an efficient operation. Two holding bins of at least 500-bu (20 m^3) capacity each, or enough truck capacity for two batches of grain are required. The dryer should be set up with the fan facing into the wind if possible, so that the moist air and dust are carried away from the air inlet. A well-sheltered area may be preferable for a long-term setup. Buildings or fences often create a wind tunnel or swirl chamber effect, so care should be taken not to position the dryer where these effects may occur. Natural windbreaks or slotted fences are better than solid walls for reducing turbulence.

Drying rates for milling wheat with a 500-bu (20 m^3) recirculating batch dryer are about 100 bu/hour (2.7t/h) for 6% moisture removal, including ½ hour per batch for cooling, and ½ hour for loading and unloading. Feed oats can be dried at about 150 bu/hour (2.4 t/h) for 6% moisture removal, including cooling and refilling. Grain can be removed from batch dryers while it is hot and cooled later in an

RECIRCULATING BATCH DRYER

aerated bin. This would increase the effective capacity of the dryer by eliminating cooling time and allowing the grain to be removed from the dryer at a higher moisture content. This is covered in more detail under Dryeration, page 29.

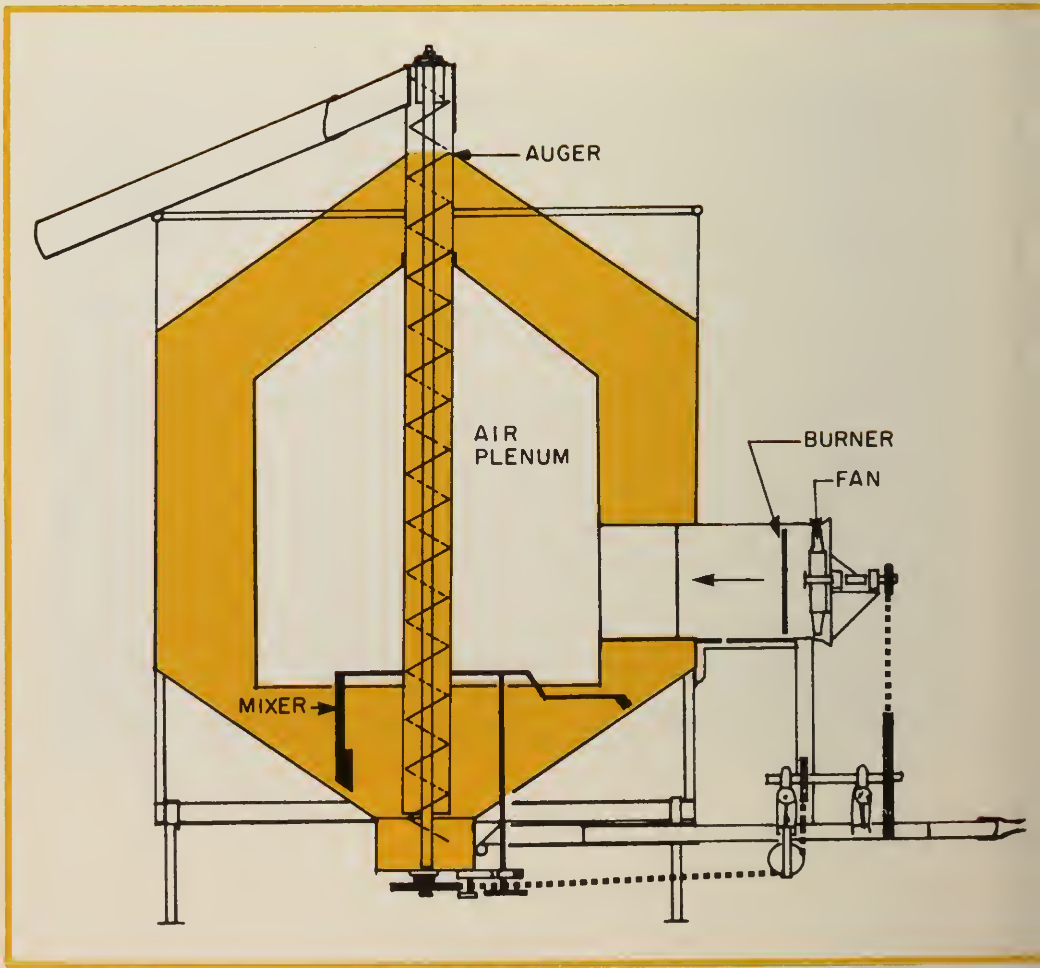
Temperature controls in batch dryers are subject to the same problems as in other dryers. Malfunctions of sensors, and their improper location in the hot air plenum and grain columns, can result in misleading temperature information. Extra thermometers should be installed in the plenum, and in the grain column right next to the hot air plenum, to reduce these dangers.

Samples taken from batch dryers for moisture checks must be representative of the grain throughout the entire thickness of grain column or bed. Careless sampling often results in seriously under-dried or overdried grain.

With recirculating batch dryers, a maximum air temperature of 5 to 10°C above those previously listed can be used until about the last ½ hour of drying. This can be done safely because the grain is uniformly dried and will not overheat while it is damp. On stationary batch dryers, the grain nearest the hot air plenum dries very quickly and would get too hot if higher temperatures were used.

Relatively small batches of grain can be handled by batch dryers, which makes them suitable for smaller operators and farmers with a wide variety of crops. They also have an advantage where crops must be dried in several locations since they are self-contained and easy to move.

FIGURE 10
RECIRCULATING BATCH DRYER



continuous-flow dryers

There are two main types of continuous-flow dryers — the column type and the tower type. Column-type dryers (Figure 11) have either two or four grain columns which are adjacent to hot and cold air plenums. The grain is loaded into a hopper at the top of the dryer, flows down on both sides of the hot air plenum and then past the cold air plenum, and is removed by augers. The grain is not mixed as it moves down and, as a result, the grain next to the hot air plenum becomes greatly overdried, whereas the outside grain receives little or no drying. Moisture differentials across a 12-inch (30 cm) grain column may be as high as 10-12% when the average moisture content is dry. The grain is mixed as it is unloaded and an acceptable product is produced if safe temperatures were used.

The moisture differential across the grain column depends on the initial and final moisture content, air temperature and flow rate, and the column width. In a comparison of two dryers with 6- and 12-inch (15 and 30 cm) grain columns, using the same fans, the average moisture differential was about 3.5% for the 6-inch (15 cm) and about 6% for the 12-inch (30 cm) column. The air moved more quickly through the 6-inch (15 cm) column due to the lower static pressure, and the air output of the fan was increased by almost 50%. The fuel consumption was also increased by about 50%, with very little difference in drying rates. As fan capacity is reduced or grain column width increased, more efficient use of the heat results but the moisture differentials are increased. With equal grain column widths, a higher capacity fan will produce a faster drying rate.

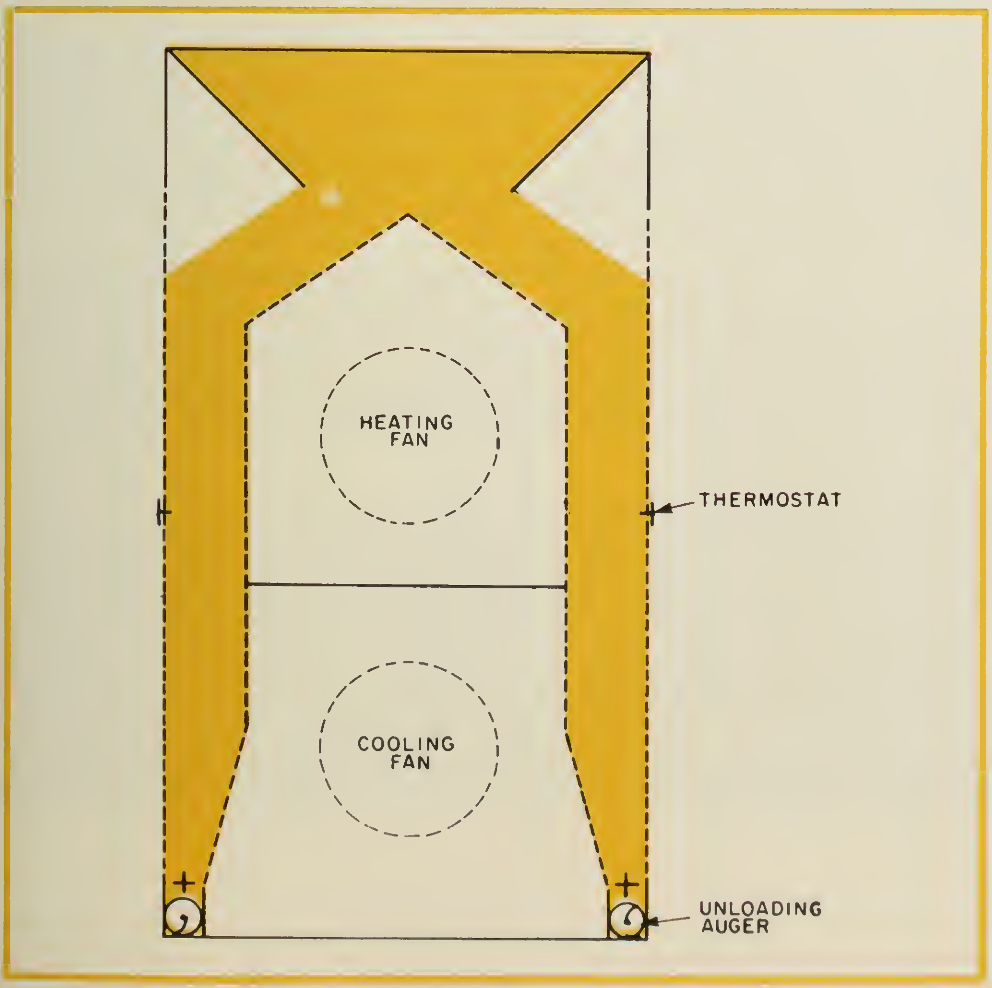
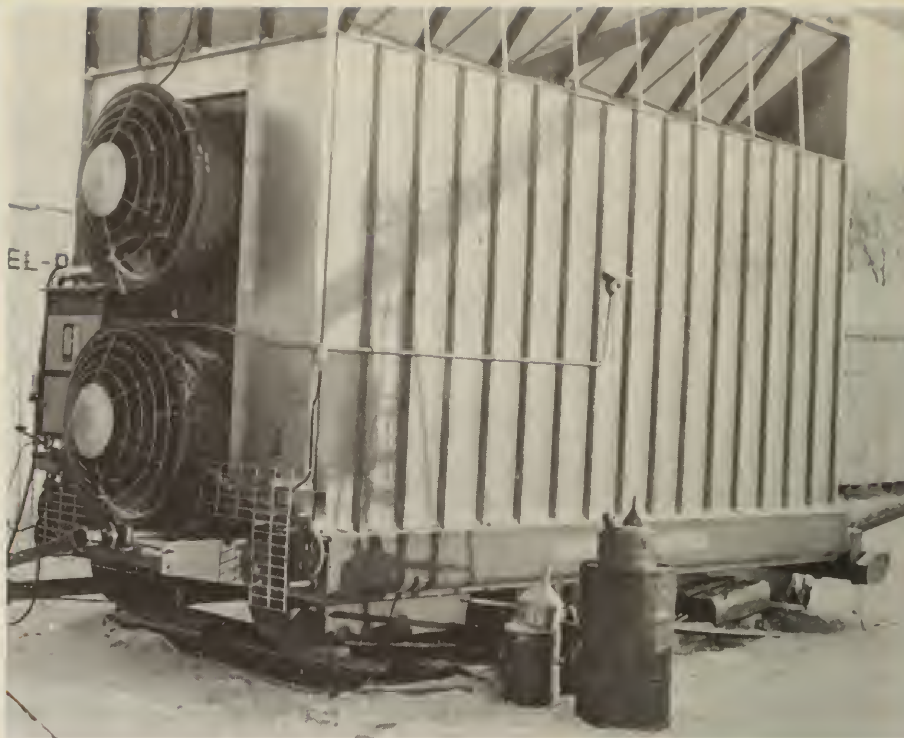


FIGURE 11
CONTINUOUS-FLOW DRYER



CONTINUOUS-FLOW DRYER

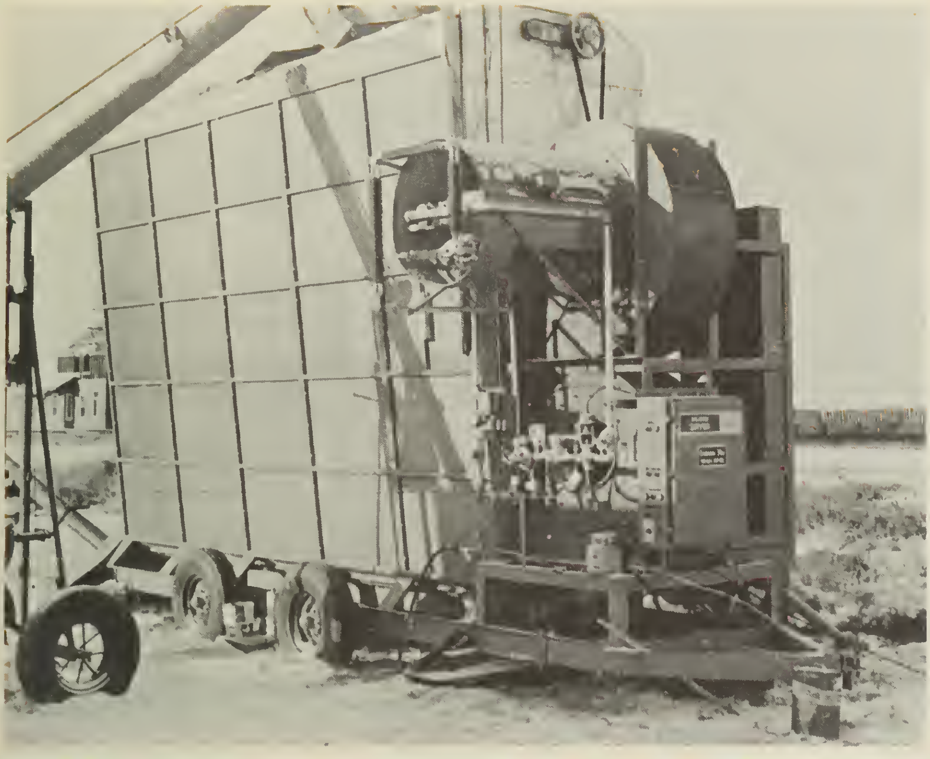
Fuel consumption for continuous-flow dryers is about 1 gal of propane for every 30-35 lb (1ℓ/3-3.5 kg) of water removed, with an outdoor temperature of —10°C. At 15°C they would remove about 50 lb of water/gal (5 kg/ℓ) of fuel.

Water removal rates are approximately equal for wheat, oats and barley, whereas the rate for flax is about 20% lower for the same temperatures. Flax, however, is usually dried at higher temperatures, so the amount of water removed per hour is roughly the same.

Drying rates vary with drying temperatures, airflow rates and dryer size. Two common continuous-flow dryers with 160-180 sq ft (15-16.5 m^2) of drying area remove water at a rate of about 700 lb/hour (320 kg/h) at 65°C from wheat, oats and barley. This amounts to about 155 bu/hour (4.2 t/h) of wheat going from 20% to 14% MC.

Many other sizes of dryers are also available. The advertised figures given for drying rates are seldom achieved in practice, and to get a practical figure it is usually necessary to rely on actual experience. Screen area, fan capacity and burner capacity will give some basis for comparison, although burner capacity is limiting only with very cold outdoor air temperatures and high drying temperatures.

Column-type continuous-flow dryers are not suitable for drying small amounts of grain, since starting and emptying of these dryers is quite inefficient, and accurate moisture control is difficult to achieve until a uniform flow is obtained. Automatically controlled feeding augers are required, unless a large holding tank is installed above the dryer. In a temporary setup, at least two holding bins of a minimum 1,000 bu (40 m^3) each (one for wet grain and one for dry) should be placed adjacent to the dryer to provide adequate surge capacity. In a properly planned grain



CONTINUOUS-
FLOW DRYER

storage and handling system the dry grain is moved directly into storage from the dryer.

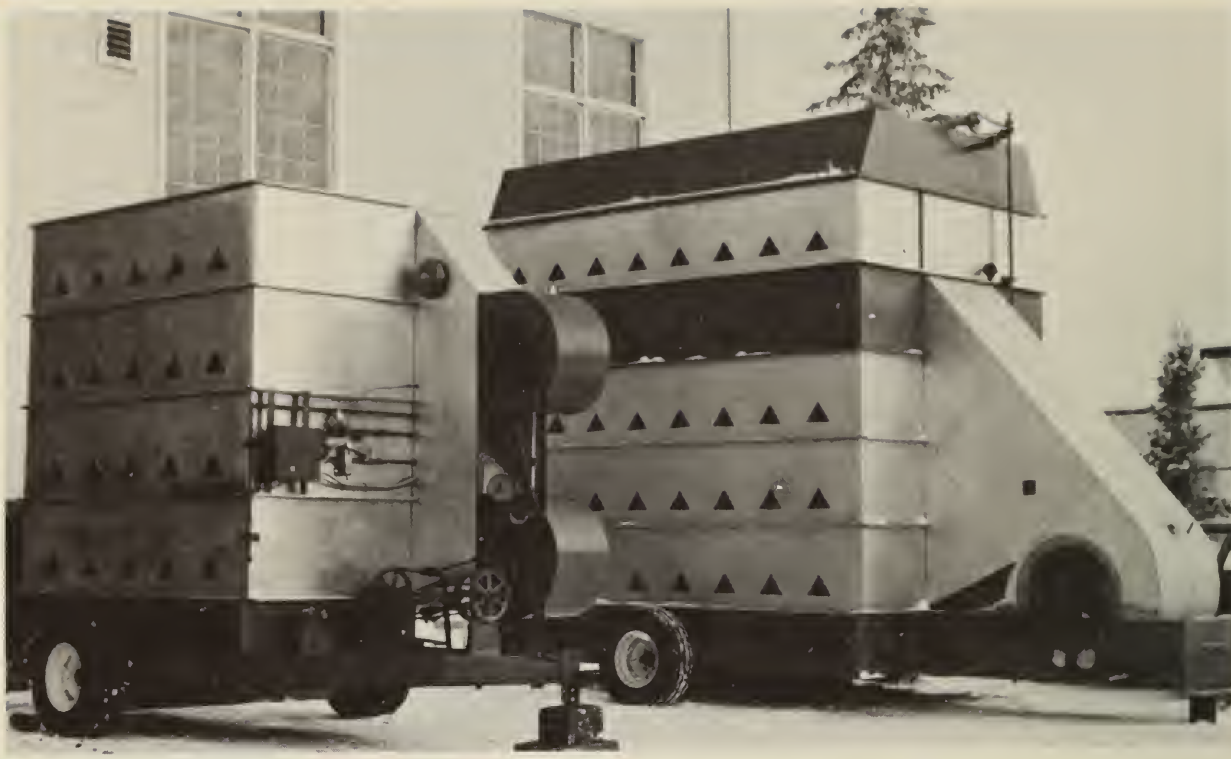
Setting the dryer up to face into the wind is desirable to prevent dust, trash and moist air from being drawn back into the fan and burner. In a permanent setup this is not always possible and so some shelter may be useful.

Moisture controls on continuous-flow dryers are frequently subject to sun and wind effects as discussed in Weather Effects on Drying, (page 9). Temperature sensors in hot-air plenums may be improperly located or may be inaccurate. Extra sensors should be placed in the plenum to get an accurate reading in the hottest part of the plenum. Temperature sensors installed in the grain column next to the hot-air plenum are also good insurance against grain damage. Gas modulating valves should allow the dryer to be operated at temperatures as low as 40°C.

When only a small amount of moisture is being removed from a light crop, such as oats, the metering augers on the dryer may limit the dryer capacity. Any straw or trash in the grain makes the problem worse, so that a preliminary cleaning operation would be advantageous.

Four-inch (10 cm) augers are often inadequate to keep continuous-flow dryers operating at maximum capacity, so at least 6-inch (15 cm) augers should be provided for both filling and removal. Filling augers that are automatically controlled are normally operated by electric motors. The power requirement for starting an auger full of wet grain is very high, and a much larger motor than normal is required. A variable feed cutoff should be used to prevent the auger from becoming fully loaded.

There are other types of continuous-flow dryers as well. A type



CONTINUOUS-FLOW DRYER

commonly used in terminal elevators is the tower or rack type where the grain is mixed continuously with the air and, as a result, all the grain is dried uniformly. This allows temperatures of 80°C or higher to be used on milling wheat without damage. A farm-size dryer of this type has been recently developed.

Concurrent-flow dryers in which the hot air flows in the same direction as the grain are also available. Since the hottest air is in contact with the wettest grain, and the air cools as it passes through the grain towards the drier grain, much higher initial temperatures (over 90°C) can be used without damage. Experience with this type is very limited in Western Canada.

cost comparisons

Costs of drying grain vary according to the type of dryer, number of bushels dried per year and the outside air temperatures. The following cost comparisons are based on these conditions:
Early fall drying — average outdoor temperature 15°C
Depreciation rate — 8%
Interest rate — 12%
Repairs & Maintenance — 1.5% per 100 h of operation
Propane — 40c/gal (9c/ℓ)
Electricity — 1.7c/kWh Tractor — 12c/kWh
19 ft (5.8 m) drying bin complete _____ $ 5,000
350 bu (12.7 m^3) recirculating batch dryer _____ 8,000
Continuous flow dryer _____ 12,000
Wheat being dried from 20% to 14% MC.

	Bin dryer	Recirc. batch	Cont. flow
kg water removed / litre propane	7	5	5
bu /hour	(see charts)	70	155
tonne /hour		1.9	4.2
Overhead costs /yr			
5,000 bu /yr	$ 775	$1200	$1740
10,000	850	1280	1800
20,000	1000	1440	1920
30,000	1150	1600	2040
50,000	1450	1920	2280
Fuel costs			
5,000 bu /yr	130	180	180
10,000	260	360	360
20,000	520	720	720
30,000	780	1080	1080
50,000	1300	1800	1800
Power costs	(electric)	(tractor)	(tractor)
5,000 bu /yr	10	200	160
10,000	20	400	320
20,000	40	800	640
30,000	60	1200	960
50,000	100	2000	1600
Total cost /bu (not including labor)			
5,000 bu /yr	18.3	31.6	41.6
10,000	11.3	20.4	24.8
20,000	7.8	14.8	16.4
30,000	6.6	12.9	13.6
50,000	5.7	11.4	11.3
Total cost /tonne (not including labor)			
200 t/a	$5.30	$9.10	$11.45
400	3.40	6.20	7.20
600	2.75	5.25	5.75
1,000	2.20	4.50	4.60

If the outside air temperature is —7°C, the fuel cost will be 50% higher; if the outside air temperatue is —30°C, the fuel cost will be twice as high as the figures given.

In most years an average of much less than 6% moisture would need to be removed from the grain, and the fuel and power costs would therefore be correspondingly lower. The drying rates would be higher and labor requirements lower for lower moisture grain.

The amount of labor required will vary according to the efficiency of the grain handling system associated with the dryer. Automatic controls and safety shut-offs can be used to reduce labor requirements substantially.

other processes

Dryeration — This is a process that can be used to advantage with grain dryers. It basically consists of taking hot grain out of the dryer and cooling it in a bin by aeration instead of using the dryer for cooling. This has three advantages:

- Higher drying temperatures can be used since the grain is not completely dried in the dryer.
- It eliminates the need for cooling time in a batch or bin dryer, or the cooling section in a continuous-flow dryer.
- It is less likely to cause stress cracks in the grain from heating and rapid cooling.

The grain is dried to within about 2% of dry, then removed from the dryer to an aerating bin where it is allowed to 'steam' for about 10 hours. It is then aerated at a rate of ½ to 1 cfm/bu (25 to 50 m^3/h per m^3 of grain) for about 12 hours, during which time it cools and the heat that is present in the grain is used to finish the drying process. Condensation that forms in the bin during the cooling process could cause problems if the grain was left in the bin, so it is recommended that grain be removed to another bin for storage.

Increases of up to 60% in the capacity of a grain drying system are possible with dryeration. This is due to less drying time in the dryer, the use of higher temperatures, and the elimination of the cooling process. Fuel savings of more than 20% are also claimed, due to better use of the heat present in the grain. The savings in time and fuel will depend on the initial moisture content of the grain, with greater percentage savings obtained with lower moisture grain.

An efficient mechanical grain transfer system is essential for dryeration since an extra handling is required. A hopper bottom bin equipped for aeration would make a good cooling bin. An ordinary bin with a drying floor and sweep auger can also be used. Bins with one or two air ducts across them are not suitable since the airflow is not uniform enough for this cooling-drying process.

Alternated heating and cooling in batch dryers — In batch drying, and especially bin drying where the grain is usually several feet deep, a considerable moisture differential is produced throughout the grain. The grain farthest from the heat may not be dried at all and, in fact, may be wetter than it was originally, when the average of the grain is 'dry.' During the unloading of a bin it is possible that the grain does not get completely mixed. To prevent problems arising from wet spots in the grain, batch dryers are frequently operated until the top layer is also dried. This results in considerable overdrying of the rest of the grain and a lower average moisture level than is desired.

To reduce the moisture differential, a drying process with alternate heating and cooling may be used. A cycle time of 3 or 4 minutes has been found to be effective, with 75% of the time spent in heating and 25% in cooling. During the cooling part of the cycle, the heat from the grain nearest the plenum is carried to the cooler grain and more uniform drying is obtained. In a comparison with continuous heat drying, the moisture differential across a 3-ft (1 m) grain depth was only one third as great with cycled drying. Slightly higher drying temperatures can be used with cycled drying, and the grain can be removed when the average moisture content is 'dry' without danger of wet spots due to insufficient mixing.

Aeration — Aeration is the process of moving small amounts of unheated air through a pile of grain. This is done to equalize the grain temperature in the bin and thus prevent moisture migration in bins that are exposed to drastic changes in temperature. It is also used to cool grain after drying, or to keep damp grain cool until it can be dried. An airflow rate of about 1/10 cfm/bu (5 m^3/h per m^3 of grain) is recommended for normal aeration. The air is usually pulled down through the grain and exhausted at the bottom. Some aerators are in the form of a vertical duct, which is placed in the center of the bin and the air is then exhausted at the top. Various layouts for aeration ducts are shown in the bulletin ***Damp Grain,*** CDA Publication 1398. Duct sizing and fan operation are also outlined. The fan should be able to produce at least 1/10 cfm/bu (5 m^3/h per m^3 of grain) airflow at 400 Pa. For aerating damp grain, an airflow of about 1 cfm/bu (50 m^3/h per m^3 of grain) at a static pressure of 500 to 750 Pa is needed.

Portable bin aerators for small bins are available with either propellor or centrifugal fans. The centrifugal type is generally preferred because some propellor fans have a net airflow of zero at high static pressures.

Aeration should not be considered as a substitute for drying. The amount of drying that is possible with the low airflows used is normally insignificant. The main purpose of aeration is to keep the grain at a uniform temperature to prevent moisture migration and resulting mold growth and insect infestations. The grain should be aerated as often as necessary to keep it within about 15°C of the average outside temperature. Fans should normally be run only when the relative humidity is below 75%. If the grain is damp and in danger of heating continuous operation is recommended. Cooling below 2°C is not necessary at any time. Warming grain above 10°C is also unnecessary.

Aeration fans should be run until a uniform temperature is obtained throughout the bin, otherwise the purpose of aeration is defeated. At 1/10 cfm/bu (5 m^3/h per m^3 of grain) about 1 week of operation is usually required to establish a new temperature.

Bins of 1,000-bu (40 m^3) size or less do not require aeration if the grain is put in dry. Larger bins require aeration when grain is stored for 6 months or more, or if the grain is tough or near the maximum 'dry' moisture content.

The larger the bin and the more drastic are the outside temperature changes, the more need there is for aeration. In-floor ducts are recommended on new installations since little extra expense is required, and the ducts can also be used as a passage for the grain removal auger. One aeration fan can be used to aerate several bins.

A flush floor aeration system with a 1 hp (750 W) fan is adequate for bins of 5,000 bu (200 m^3) under most conditions.

acknowledgments

To Westeel Rosco Ltd., Winnipeg, for the use of their drawings of bin arrangements, their drying charts and other information on bin drying.

To the Alberta Department of Agriculture, Saskatchewan Department of Agriculture, the University of Manitoba, the University of Saskatchewan and the Canada Department of Agriculture staff for their assistance and counsel in the writing of this publication.

appendix

DRYING CHARTS FOR BATCH-IN-BIN DRYING

WHEAT, BARLEY AND OATS, 14 ft diameter bins

Set thermostat as shown — Final moisture 14%

Dryer size	Initial moisture	Wheat			Barley or oats		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
14 FT DIA BINS							
SS-724, 5 hp 55°C	24	2	245	6.5	2	245	5.1
	22	2	245	5.5	3	370	6.5
	20	2.5	305	6	3	370	5.7
	18	3	370	5.4	3.5	425	5.5
	16	4	490	4.6	5	620	6
SS-724, 5 hp 45°C	24	2	245	9.5	2	245	8
	22	3	370	11	3	370	9.5
	20	3	370	9.5	4	490	11
	18	4	490	10	4	490	8.5
	16	5	620	9	5	620	7.5
SS-724, 5 hp 35°C	24	2	245	15	3	370	17
	22	3	370	16	4	490	18
	20	4	490	18	5	620	20
	18	5	620	19	5	620	17
	16	6	740	15	6	740	13
SS-724, 5 hp 55°C with stirring units	24	5	620	22	6	740	24
	22	6	740	21	7.5	925	22
	20	7	860	21	9	1120	21
	18	9	1120	21	12	1460	22
	16	11*	1360	17	14*	1720	17

*See page 43

FLAXSEED, MUSTARD AND RAPESEED, 14 ft diameter bins

Set thermostat as shown — Final moisture 10%

Dryer size	Initial moisture	Flaxseed Depth ft	Flaxseed Volume bu	Flaxseed Time hr	Mustard or rapeseed Depth ft	Mustard or rapeseed Volume bu	Mustard or rapeseed Time hr
14 FT DIA BINS							
SS-724, 5 hp 55°C	22	1	120	9	Do not dry above 110°F		
	20	1.5	180	11			
	18	2	245	12			
	16	2	245	11			
	14	3*	370	13			
SS-724, 5 hp 45°C	22	1.5	180	15	2	245	9
	20	2	245	17	3	370	13
	18	2.5	300	19	4	490	13
	16	2.5	300	17	5	610	12
	14	3*	370	15	5	610	11
SS-724, 5 hp 35°C	22	2	245	23	3	370	17
	20	3*	370	33	4	490	21
	18	3*	370	29	4.5	550	19
	16	3*	370	25	6*	740	21
	14	3*	370	21	6*	740	19
SS-724, 5 hp 55°C with stirring units					Use 110°F, not 130°F		
	22	3	370	27	5	620	33
	20	3	370	21	6	740	29
	18	3	370	19	7*	860	32
	16	4*	490	24	7*	860	27
	14	4*	490	19	7*	860	21

*See page 43

WHEAT, BARLEY AND OATS, 19 and 25 ft diameter bins ½-day fill

Set thermostat at 55°C — Final moisture 14%

Dryer size	Initial moisture	Wheat			Barley or oats		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	24	2	450	7.5	3	680	10.5
	22	3	680	9.5	4	910	11.5
	20	4	910	10	5	1130	11.5
	18	5	1130	9.5	6	1360	10
	16	6	1360	8	7	1590	7
SS-927, 7½ – 9½ hp	24	2	450	6.5	3	680	9.5
	22	3	680	8.5	4	910	10
	20	4	910	8	5	1130	10
	18	5	1130	8.5	7	1590	9.5
	16	7	1590	8	8	1800	8
SS-1227, 12½ hp	24	3	680	9	4	910	10
	22	4	910	9.5	5	1130	9
	20	5	1130	9	6	1360	9.5
	18	6	1360	9	7	1590	8.5
	16	8	1800	7.5	9	2060	7
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	24	2	785	9.5	2.5	980	11.5
	22	3	1175	11.5	3.5	1375	12.5
	20	4	1570	12	4.5	1760	12.5
	18	5	1960	11	6	2350	12
	16	6	2350	8.5	7	2740	8.5
SS-1227, 12½ hp	24	3	1175	12	3	1175	12
	22	3	1175	10	4	1570	12.5
	20	4	1570	10.5	5	1960	12
	18	5	1960	9.5	6	2350	10
	16	6	2350	6.5	7	2740	8
SS-724, 2 × 5 hp	24	3	1175	11	3	1175	10
	22	3	1175	8.5	4	1570	10.5
	20	4	1570	9.5	5	1960	10.5
	18	5	1960	8.5	7	2740	10.5
	16	7	2740	7	8	3140	8

FLAXSEED MUSTARD AND RAPESEED, 19 and 25 ft diameter bins ½-day fill

Set thermostat at 55°C					Final moisture 10%		
		Flaxseed			Mustard or rapeseed		
Dryer size	Initial moisture	Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	22	1	225	8	Do not dry mustard or rapeseed at temperatures above 110°F		
	20	1.5	340	10			
	18	2	450	8			
	16	2	450	8			
	14	3	680	6.5			
SS-927, 7½ – 9½ hp	22	1.5	340	11			
	20	2	450	12			
	18	2.5	565	15			
	16	3	680	13			
	14	3	680	10			
SS-1227, 12½ hp	22	2	450	10.5			
	20	2.5	565	14			
	18	3	680	15			
	16	4*	900	19			
	14	4*	900	13			
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	22	1	395	10			
	20	1.5	585	12			
	18	2	785	17			
	16	2	785	14			
	14	3	1175	15			
SS-1227, 12½ hp	22	1.5	585	10			
	20	2	785	14			
	18	3	1175	19			
	16	3	1175	17			
	14	4	1570	18			
SS-724, 2 × 5 hp	22	2	785	16			
	20	2	785	15			
	18	3	1175	12			
	16	3	1175	12			
	14	3	1175	11			

*See page 43

WHEAT, BARLEY AND OATS, 19 and 25 ft diameter bins 1-day fill

Set thermostat at 40°C | Final moisture 14%

Dryer size	Initial moisture	Wheat			Barley or oats		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	24	3	680	19	4	905	23
	22	4	910	21	5	1130	22
	20	5	1130	22	6	1360	22
	18	7	1590	21	9	2020	25
	16	10	2280	18	12	2720	18
SS-927, 7½ – 9½ hp	24	3.5	795	21	4	905	21
	22	4.5	1015	23	5	1130	20
	20	5.5	1250	22	7	1590	23
	18	7.5	1865	21	9	2020	22
	16	11	2500	17	13	2950	18
SS-1227, 12½ hp	24	4	910	23	4.5	1015	21
	22	5	1130	24	5.5	1250	22
	20	7	1590	23	8	1800	24
	18	9	2020	25	10	2280	25
	16	12	2720	18	14	3180	19
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	24	2.5	980	21	3.5	1375	24
	22	3.5	1375	22	4.5	1740	22
	20	4	1570	24	6	2350	24
	18	6	2350	19	8.3	3250	25
	16	10	3900	19	11.4	4460	20
SS-1227, 12½ hp	24	3	1175	20	4	1570	24
	22	4	1570	22	5	1960	26
	20	5	1860	24	7	2740	26
	18	7.5	2940	23	9	3520	23
	16	11	4305	18	3	5100	19
SS-724, 2 × 5 hp	24	3	1175	20.5	4	1570	22
	22	4.5	1740	23	5.5	2180	24
	20	5	2350	23	7	2740	25
	18	8	3060	25	9	3520	23
	16	10*	3900	16	13	5100	19

*See page 43

FLAXSEED, MUSTARD AND RAPESEED, 19 and 25 ft diameter bins 1-day fill

Set thermostat at 40°C — Final moisture 10%

Dryer size	Initial moisture	Flaxseed			Mustard or rapeseed		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	22	1.5	340	19	2	455	17
	20	2	450	21	3	680	21
	18	3	680	23	4	910	26
	16	3	680	21	4.5	1015	25
	14	3	680	17	5	1130	22
SS-927, 7½ – 9½ hp	22	2	450	19	3	680	19
	20	2	450	17	3.5	795	20.5
	18	3	680	21	4	910	21
	16	3	680	19	5	1130	25
	14	3	680	13	6	1360	23
SS-1227, 12½ hp	22	3	680	21	3.5	795	21
	20	3	680	19	4	910	20
	18	3	680	18	5	1130	23
	16	4	900	21	6	1360	21
	14	4	900	17	7	1590	19
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	22	1.5	585	19	3	1175	25
	20	2	785	21	3.5	1375	23
	18	2	785	19	4	1570	21
	16	3	1180	23	5	1960	25
	14	4	1570	21	6	2350	21
SS-1227, 12½ hp	22	2	785	19	3	1175	22
	20	3	1175	19	4	1570	25
	18	3.5	1375	19.5	4.5	1740	25
	16	4	1570	21	6	2350	27
	14	5	1960	27	7	2740	21
SS-724, 2 × 5 hp	22	2	785	17	3	1175	19.5
	20	3	1175	17.5	3.5	1375	21
	18	3	1175	15	4	1570	21
	16	4	1570	19	5	1960	21
	14	4	1570	15	6	2350	17

*See page 43

WHEAT, BARLEY AND OATS, 19 and 25 ft diameter bins 2-day fill

Set thermostat at 35°C — Final moisture 14%

Dryer size	Initial moisture	Wheat			Barley or oats		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	24	3.5	795	29	4	910	35
	22	4	910	32	5	1130	35
	20	5.5	1250	33	6.5	1475	34
	18	7.5	1865	35	8.5	1930	35
	16	11*	2500	29	15	3730	35
SS-927, 7½ – 9½ hp	24	4	910	35	5.5	1250	35
	22	5	1130	36	6	1360	33
	20	6	1360	34	7	1590	34
	18	8	1800	35	9	2020	35
	16	13*	2950	33	16	3630	37
SS-1227, 12½ hp	24	4.5	1015	35	5.5	1250	33
	22	5	1130	34	6	1360	33
	20	6.5	1475	34	7.5	1865	34
	18	9	2020	36	10	2280	35
	16	15*	3400	38	16	3660	33
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	24	3	1175	34	4	1570	37
	22	4	1570	36	4.5	1740	35
	20	5	1960	37	6	2350	37
	18	6.5	2570	34	7	2140	34
	16	10	3900	33	10	3900	29
SS-1227, 12½ hp	24	3.5	1375	36	4	1570	37
	22	4.5	1740	37	5.5	2180	36
	20	5.5	2180	38	6.5	2570	35
	18	7	2740	34	8	3060	33
	16	11	4305	32	13	5100	31
SS-724, 2 × 5 hp	24	4	1570	37	5	1960	32
	22	5	1960	37	6	2350	35
	20	6	2350	39	7	2740	34
	18	7	2740	34	8.5	3270	33
	16	10*	3920	23	13	5100	30

*See page 43

FLAXSEED, MUSTARD AND RAPESEED, 19 and 25 ft diameter bins 2-day fill

Set thermostat at 35°C — Final moisture 10%

Dryer size	Initial moisture	Flaxseed			Mustard or rapeseed		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	22	2	450	30	2.5	560	30
	20	2.5	565	30	2.9	650	31
	18	3	680	28	4	850	35
	16	3	680	20	3.3	760	32
	14	4*	900	21	5	1130	32
SS-927, 7½ – 9½ hp	22	3	680	46	2.6	600	29
	20	3	680	36	3.1	705	29.5
	18	3.5	800	34	3.8	830	30
	16	4*	900	28	4.7	1055	31
	14	4*	900	24	5.5	1230	30
SS-1227, 12½ hp	22	3	680	37	2.9	650	29
	20	3.5	795	36	3.3	750	29
	18	4	900	39	4	890	30.5
	16	4.5	1010	32.5	5	1130	29
	14	5*	1130	25	6	1360	27
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	22	1.8	690	39	2.2	860	36
	20	2.1	820	44	2.7	1040	37
	18	2.5	980	47	3.3	1270	39
	16	3.2	1250	49	4.3	1670	42
	14	4	1570	45	6.9	2700	55
SS-1227, 12½ hp	22	2	785	32	2.4	990	36
	20	2.5	980	37	2.9	1140	37.5
	18	3	1175	41	3.5	1370	39
	16	4	1570	45	4.7	1820	42
	14	5	1960	41	7.4	2875	55
SS-724, 2 × 5 hp	22	3.2	1250	37	2.8	1000	32
	20	3.8	1490	39	3.4	1280	33
	18	5*	1960	49	4	1570	33.5
	16	5*	1960	37	5	1960	35
	14	5*	1960	31	7.5	2900	47

*See page 43

WHEAT, BARLEY AND OATS, 19 and 25 ft dia bins with stirring devices twin-screw type

Set thermostat at 55°C — Final moisture 14%

Dryer size	Initial moisture	Wheat			Barley or oats		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
SS-724, 5 hp	24	5.5	1250	23	6.3	1430	23
	22	6.4	1450	22	7.5	1700	22
	20	8	1800	21	9.3	2110	22
	18	10.3	2340	22	12.4	2850	22
	16	11	2500	15	14.5	3300	17
SS-927, 7½ – 9½ hp	24	6	1360	22	7	1590	24
	22	7	1590	21	7.5	1865	22
	20	8.5	1930	21	10.2	2320	21
	18	11	2500	21	13.5	3060	22
	16	13	2950	16	14.5	3300	15
SS–1227, 12½ hp	24	6.5	1470	23	7.6	1740	24
	22	7.6	1725	22	9.0	2060	22
	20	9.2	2080	21	11.0	2520	22
	18	11.9	2700	20	14.3	3270	22
	16	14.5	3280	17	14.5	3280	14
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	24	5	1960	23	5.6	2190	23
	22	6	2350	22	6.6	2580	21
	20	7	2740	21	8.3	3250	21.5
	18	10	3920	21	11.4	4460	21.5
	16	14.5	5680	17	14.5	5690	18
SS-1227, 12½ hp	24	5.5	2160	23	6.2	2430	23
	22	6.5	2540	22	7.5	2930	21.5
	20	8	3060	21	9.3	3640	21.5
	18	10.4	4080	20	12.5	4900	21.5
	16	14.5	5680	16	14.5	5690	17
SS-724, 2 × 5 hp	24	5.8	2280	22.5	6.8	2660	22.5
	22	6.8	2660	21.5	8	3140	21.5
	20	8.2	3210	21.5	9.8	3840	21.5
	18	10*	3920	19	13	5100	21.5
	16	10*	3920	12	14.5	5690	16

*See page 43

FLAXSEED, MUSTARD AND RAPESEED, 19 and 25 ft dia bins with stirring devices twin-screw type

Set thermostat at 55°C — Final moisture 10%

Dryer size	Initial moisture	Flaxseed			Mustard or rapeseed		
		Depth ft	Volume bu	Time hr	Depth ft	Volume bu	Time hr
19 FT DIA BINS							
					110°F maximum		
SS-724, 5 hp	22	3	675	23	5	1130	36
	20	3	675	23	6	1360	32
	18	3	675	22	7.5	1700	30
	16	4*	900	19	7.5*	1700	45
	14	4*	900	15	7.5*	1700	20
SS-927, 7½ – 9½ hp	22	3	675	23	5	1130	32
	20	3	675	21	6	1360	28
	18	4*	900	24	8	1810	30
	16	4*	900	18	9*	2040	34
	14	4*	900	14	9*	2040	32
SS-1227, 12½ hp	22	4.5	1015	25	5.5	1245	31
	20	4.5	1015	24	6.5	1475	30
	18	5	1130	23	8	1810	26
	16	6*	1360	21	10*	2260	29
	14	6*	1360	19	10*	2260	22
25 FT DIA BINS							
SS-927, 7½ – 9½ hp	22	3	1175	35	4.5	1740	40
	20	3	1175	28	5	1960	41
	18	3	1175	24	6	2350	38
	16	4	1570	23	7	2740	35
	14	4	1570	21	8	3140	28
SS-1227, 12½ hp	22	4	1490	35	5	1960	39
	20	4	1760	32	6	2350	39
	18	5	1960	34	7	2740	42
	16	6	2350	32	9	3520	35
	14	6	2350	27	10	3920	30
SS-724, 2 × 5 hp	22	3	1175	21	5	1960	35
	20	3	1175	20	6	2350	36
	18	4	1570	22	7	2740	39
	16	4	1570	19	8	3140	33
	14	4	1570	17	8	3140	27

*See page 43

SHELLED CORN, 19 and 25 ft dia bins

Final moisture 13%

Units	Initial moisture, %	Total hp	Drying temperature and fill depth: 60°C Volume, bu	60°C Depth, ft	75°C use stirring device Volume, bu	75°C use stirring device Depth, ft
19 FT DIA BINS, USE THERMOSTAT						
SS-927	30	9.3	1000**	4.4*	1225	5.4
	25	9.3	1270	5.6	1760	7.7
	20	9.3	2000	8.8	2770	12.0
SS-1227	30	12.5	1000	4.4	1385	6.1
	25	12.5	1360	6.0	1880	8.3
	20	12.5	2200	9.7	3050	13.4
25 FT DIA BINS, USE THERMOSTAT						
SS-927	30	9.3	1060	2.7	1470	3.7
	25	9.3	1570	4.0	2180	5.3
	20	9.3	2660	6.8	3620	9.2
SS-1227	30	12.5	1215	3.1	1680	4.3
	25	12.5	1760	4.5	2440	6.2
	20	12.5	2980	7.6	4125	10.5
2 SS-927	30	18.6	1680	4.3	2320	5.9
	25	18.6	2350	6.0	3250	8.3
	20	18.6	3680	9.4	5100	13.0
2 SS-1227	30	25.0	1840	4.7	2550	6.5
	25	25.0	2540	6.5	3520	9.0
	20	25.0	3920	10.0	5430	13.8

Tables courtesy of Westeel Rosco

* Depths shown in these charts are maximum recommended because of static pressure limitations of the fan.

** Based on 21 hours drying time. All other capacities based on 18 hours drying time and 2 hours cooling time.

At drying temperatures over 60°C, a stirring device should be used. For more even drying it may be used at temperatures of 60°C or less.

Bin is considered full at 16 ft except when a stirring device is used. It is then considered full at 14.5 ft.

Drying rates are based on outside air of 10°C — 65% RH. These rates may vary at other conditions.

The Canada and Manitoba Departments of Agriculture have not checked the drying rates indicated and are not responsible for deviations from these figures.

CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:	
LINEAR			
inch	x 25	millimetre	(mm)
foot	x 30	centimetre	(cm)
yard	x 0.9	metre	(m)
mile	x 1.6	kilometre	(km)
AREA			
square inch	x 6.5	square centimetre	(cm^2)
square foot	x 0.09	square metre	(m^2)
acre	x 0.40	hectare	(ha)
VOLUME			
cubic inch	x 16	cubic centimetre	(cm^3)
cubic foot	x 28	cubic decimetre	(dm^3)
cubic yard	x 0.8	cubic metre	(m^3)
fluid ounce	x 28	millilitre	(mL)
pint	x 0.57	litre	(L)
quart	x 1.1	litre	(L)
gallon	x 4.5	litre	(L)
WEIGHT			
ounce	x 28	gram	(g)
pound	x 0.45	kilogram	(kg)
short ton (2000 lb)	x 0.9	tonne	(t)
TEMPERATURE			
degrees Fahrenheit	(°F-32) x 0.56 or (°F-32) x 5/9	degrees Celsius	(°C)
PRESSURE			
pounds per square inch	x 6.9	kilopascal	(kPa)
POWER			
horsepower	x 746	watt	(W)
	x 0.75	kilowatt	(kW)
SPEED			
feet per second	x 0.30	metres per second	(m/s)
miles per hour	x 1.6	kilometres per hour	(km/h)
AGRICULTURE			
gallons per acre	x 11.23	litres per hectare	(L/ha)
quarts per acre	x 2.8	litres per hectare	(L/ha)
pints per acre	x 1.4	litres per hectare	(L/ha)
fluid ounces per acre	x 70	millilitres per hectare	(mL/ha)
tons per acre	x 2.24	tonnes per hectare	(t/ha)
pounds per acre	x 1.12	kilograms per hectare	(kg/ha)
ounces per acre	x 70	grams per hectare	(g/ha)
plants per acre	x 2.47	plants per hectare	(plants/ha)