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Grain handling on the farm

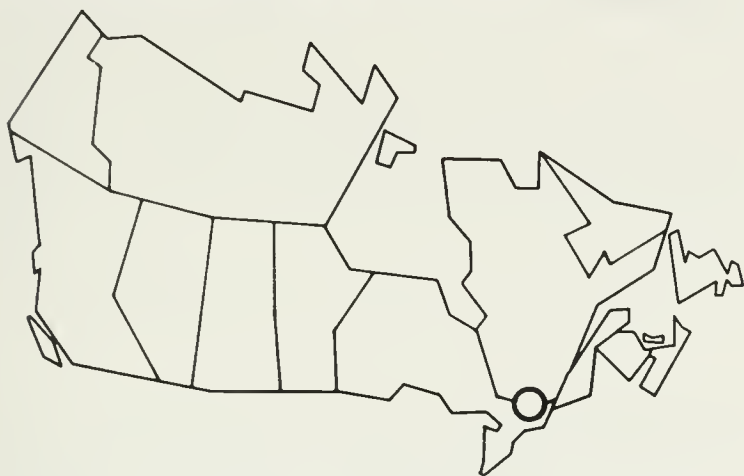


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GRAIN HANDLING ON THE FARM

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INTRODUCTION

This publication will help farmers plan and select a grain handling system.

If you would like more information about specific systems or help in planning the system, contact your provincial department of agriculture for the name and location of the agricultural engineer serving your region, or contact an agricultural engineering consultant.

Contact suppliers for information on specific pieces of equipment and their applications.

Standard system layouts and various component plans are available from provincial departments of agriculture.

PLANNING

Grain handling systems do not need to be costly and elaborate. In fact, often the only difference between a good system and a poor one lies in the planning. Remember that concrete is permanent and very costly to remove. A grain storage and handling system is a long-term investment that will give many years of efficient service if properly planned.

What features you need

Before forming any detailed plans, make a list of desired features. Inadequate capital may delay incorporation of some features, but proper planning will let you complete the system later.

The features on the list may include:

- aeration equipment;
- drying equipment;
- dump-and-go pit;
- bucket elevator;
- automatic controls;
- overhead hopper bins;
- weigh scale

Storage volume

Determine how much storage you need; this may be space for one harvest plus a 20-50% carryover. Consider the number of different crop varieties and the grades you expect in each variety. A grower who has one or two varieties may use fewer, larger bins, while the grower who has several varieties must have many smaller bins.

Location

Locate the grain storage facilities for easy access from fields and the road. A well-drained site with a low water table is best. If necessary, mound the area. The site should be isolated from the house to keep noise and dust to a minimum and for safety, yet should remain visible for security.

Build where electrical power is available. If your current or future plans include a dryer, check into the availability of three-phase power and possible access to natural gas. It may be more economical to set up the grain handling and storage facility where the utilities are available than to install utilities at another site.

USE UNDERGROUND ELECTRICAL LINES NEAR THE STORAGE AND HANDLING FACILITY.

To help prevent snow accumulation, build in a naturally sheltered area or include a shelterbelt in the plans.

Future expansion

Plan the system so it can be expanded. Increased storage space, drying or processing equipment will require additional land.

STORAGE STRUCTURES

Bins may be built from a variety of materials using many different designs (Figure 1). The base of a bin may be rectangular or circular with a flat or hopper bottom.

Materials

You can construct a bin of wood or metal or a combination of the two. A wood bin will require more maintenance and is neither as fire-resistant nor as rodent-proof as a metal structure. Insects may be more difficult to control due to the many cracks inherent in wood construction.

Galvanized or precoated metal structures are virtually fireproof, rodent-proof and maintenance free.

Design

Storages, whether wood or metal, may be of cylindrical, straight-wall, slant-wall or arch designs. Of these, the metal cylindrical type is most common.

Metal cylindrical bins (Figure 1) are easy to erect, available in many sizes and adaptable to mechanized unloading, aeration and drying systems. However, they must be securely anchored to prevent wind damage, must be filled and emptied from the center and erected correctly to prevent bin-wall failure.

Farms that produce a large quantity of grain of the same grade and variety may use large flat structures for grain storage (Figure 8). Properly planned, these may be equipped with mechanized loading-unloading and aeration and drying systems. When not used for grain storage, the structures may be used for machinery storage or other purposes.

Arch-roof buildings can usually be filled without the need for braces to support their inward-sloping

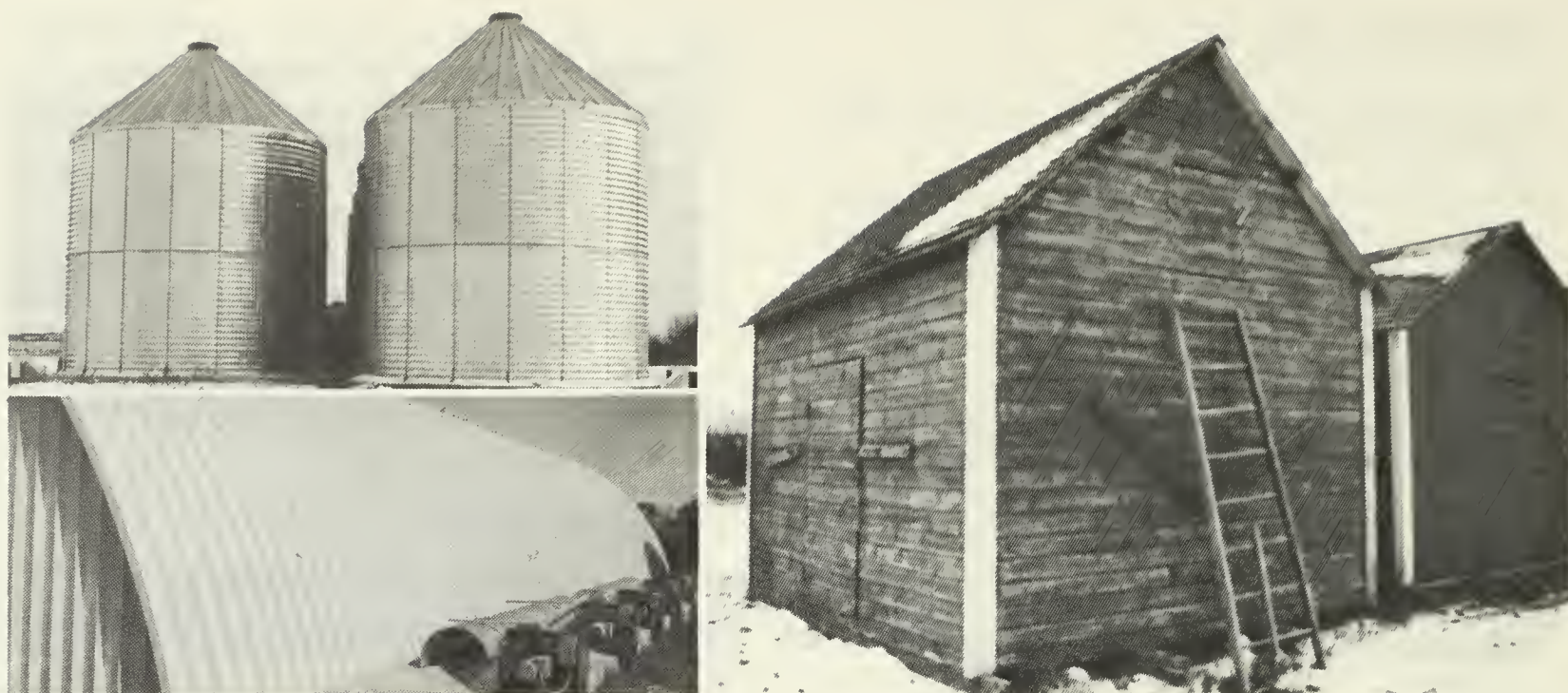


FIGURE 1 Types of grain storage structures

sidewalls. However, the vertical endwalls need additional support. Slant- and straight-wall buildings need additional support on all walls. Before using any of these types for grain storage, check with the manufacturer about bracing and maximum grain depths.

Flat or hopper bottoms

Flat-bottom storages equipped with underfloor unloading and sweep augers are efficient and eco-

nomical provided they are not filled or emptied frequently. Hopper-bottom bins are primarily used when bins must be filled and emptied frequently, such as holding bins in a dryer operation.

Hoppers may be at or below grade or elevated. Do not consider below-grade hoppers if the water table is high or if surface drainage is poor. An elevated hopper will require a support structure, increasing cost significantly (Figure 2). Hoppers may be built of metal, wood, concrete or plastic.

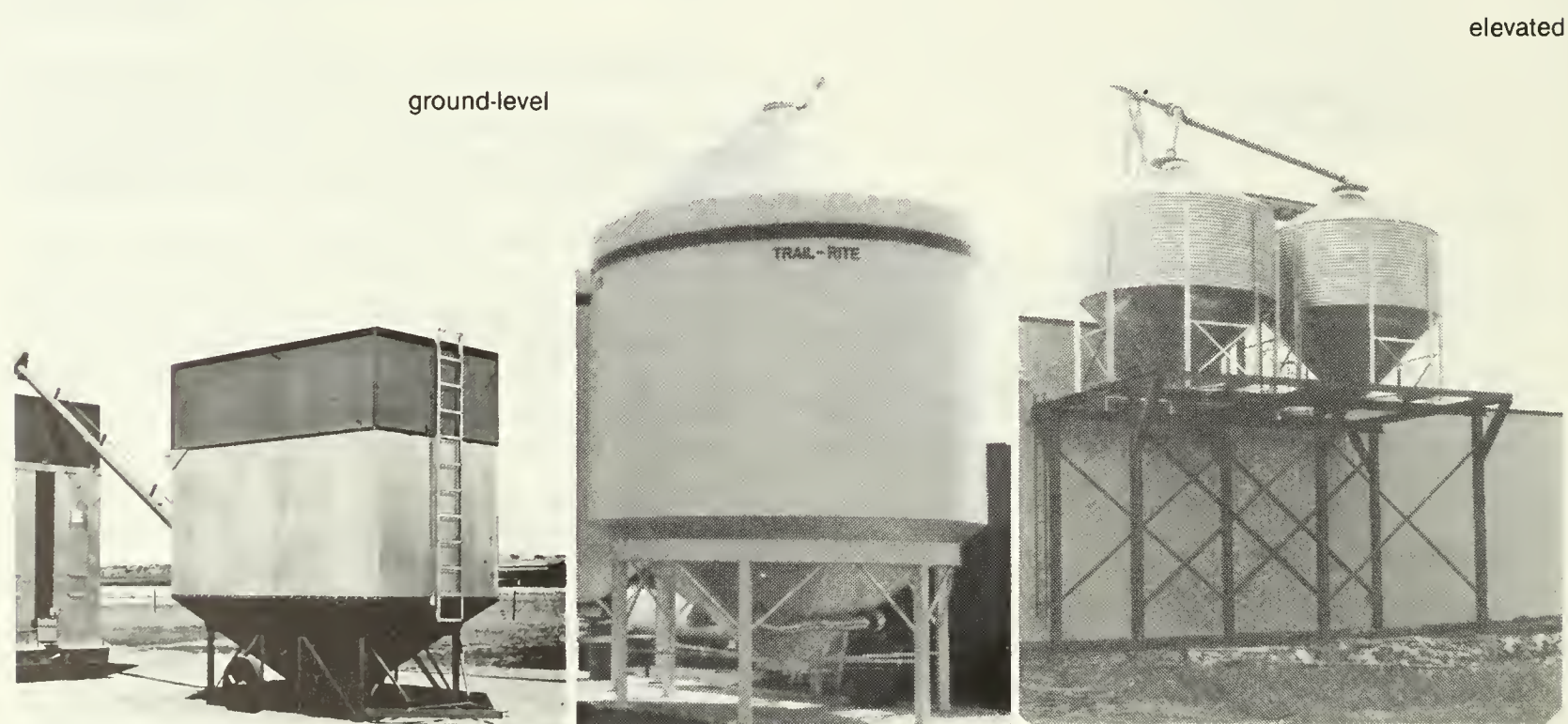


FIGURE 2 Structures to hold hopper-bottom bins

GRAIN STORAGE FOUNDATIONS

A foundation transfers the weight of the building and its contents to the underlying soil, preferably without excessive heaving or settling. However, for grain storage structures, the foundation may include tubes or a hopper for handling systems and ducts for conditioning systems. Foundation plans that incorporate various duct and underfloor auger layouts are available from your regional agricultural engineer or suppliers. When erecting metal bins with eave heights greater than 6 m, or when soil conditions are questionable, a soil test is recommended. Figures 3 to 8 show types of foundations.

Three types of foundations may be used for raised metal hopper-bottom bins that are supported by legs: slab, ring and pile. Because each best suits a specific application, consult an agricultural engineer before selecting one.

GRAIN HANDLING EQUIPMENT

Efficient equipment for moving grain in and out of storage is a necessity. You need enough capacity to keep up with the harvesting rate. A portable grain auger is usually sufficient for a "once in-once out" operation. However, if you move grain two or three times or handle large quantities, consider a bucket elevator.

Grain augers

A grain auger can operate at any angle from horizontal to vertical (Figure 9). Depending upon location and application, it can be powered by an internal combustion engine, an electric motor, or a tractor PTO.

Consider the following:

- As the elevation angle increases from 0° towards 90°, auger capacity decreases.
- The power requirements increase with angle of elevation to 45°, then decrease as the angle increases to 90°.
- Auger capacity and power requirements increase with speed (to a certain level).
- Intake exposure affects capacity. The normal exposure length is two to three times the auger diameter.
- Length does not affect capacity.
- Power requirements are proportional to auger length. Auger lengths are limited by the torque capacity of the auger shaft and coupling.
- Auger capacity is reduced and power requirements increased as the grain moisture content increases. If the moisture content increases from 14% to 25%, the

auger's capacity is halved and the power requirement increased approximately two to three times.

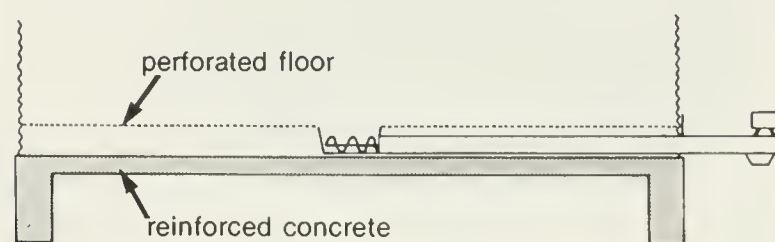


FIGURE 3 Foundation for circular storage without provisions for mechanized unloading, or for use with a completely perforated floor

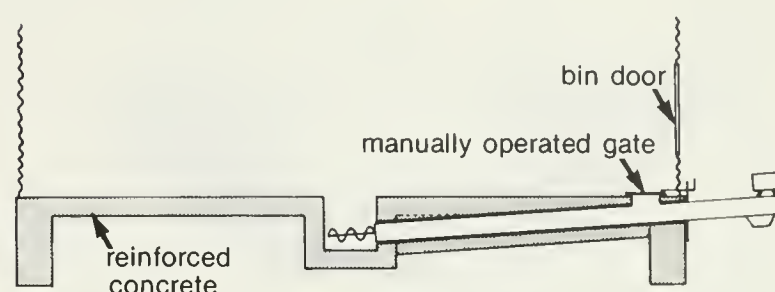


FIGURE 4 Concrete foundation for circular storage with a tube and well cast in place; the outlet of the underfloor auger must be high enough to provide clearance for the next method of conveyance. The manually operated gate should be opened only after grain flow to center well has stopped.

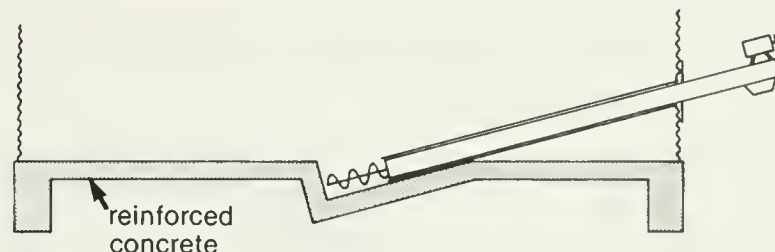


FIGURE 5 Concrete foundation for circular storage with a center-unloading inclined auger

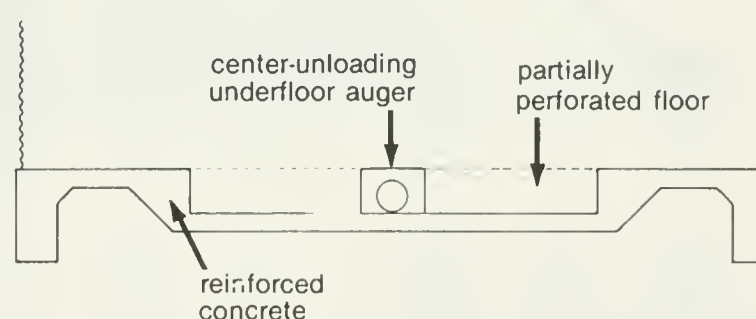


FIGURE 6 Concrete foundation for circular storage with a partially perforated floor

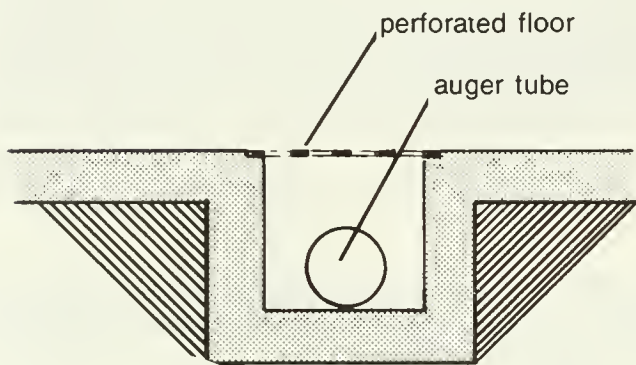
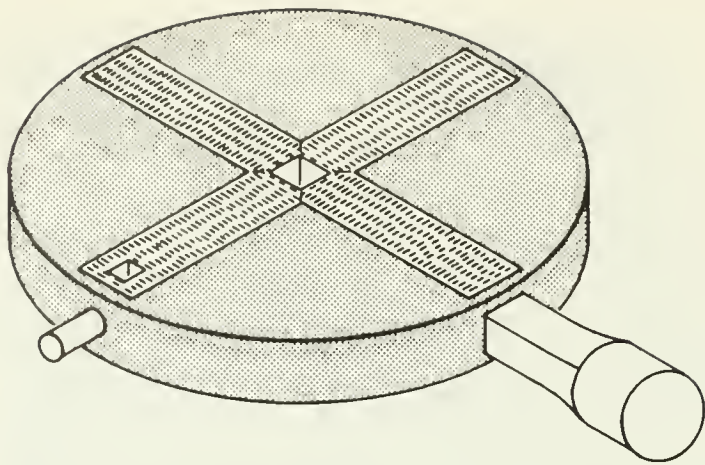


FIGURE 7 Concrete foundation for circular storage with flush-floor aeration ducts, allowing for an unloading auger within one of the ducts; different duct layouts may be used to suit individual needs.

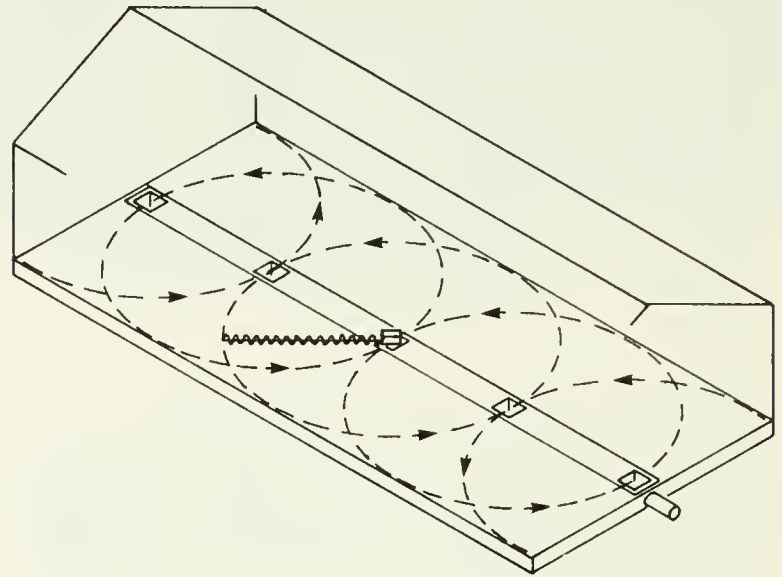


FIGURE 8 Concrete foundation for rectangular storage with either flush-floor ducts or tubes and wells cast in place

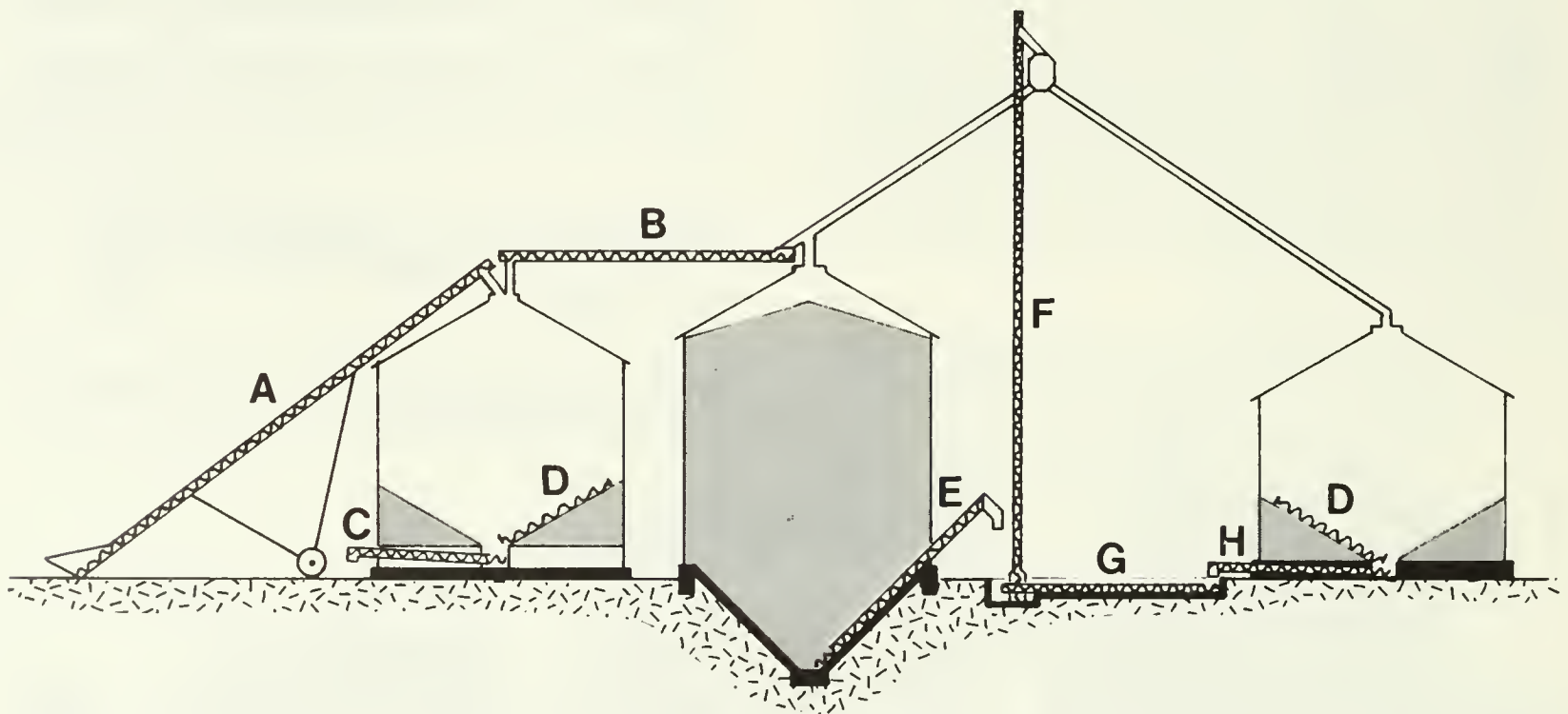


FIGURE 9 Auger applications
A Portable auger
B Horizontal overhead auger
C Unloading auger in plenum of drying bin
D Sweep auger
E Unloading auger for hopper-bottom bin
F Vertical auger
G Drive-over dump auger
H Unloading auger in bin foundation

- Grain damage increases with speed and with increased clearances between the flighting and auger tube.
- Vertical auger applications are limited to low lifts and low capacities.

Figure 10 can be used to determine the length of auger needed to reach a storage bin. For example: To reach a 6 m high bin with a horizontal distance of 12.5 m, an auger length of 14 m will be required. The auger's angle of inclination will be less than 40° .

Table 1 gives typical capacity and power requirements for grain augers. These are approximate; auger performance is affected by many factors, including grain type, grain moisture content, exposure length, and auger design.

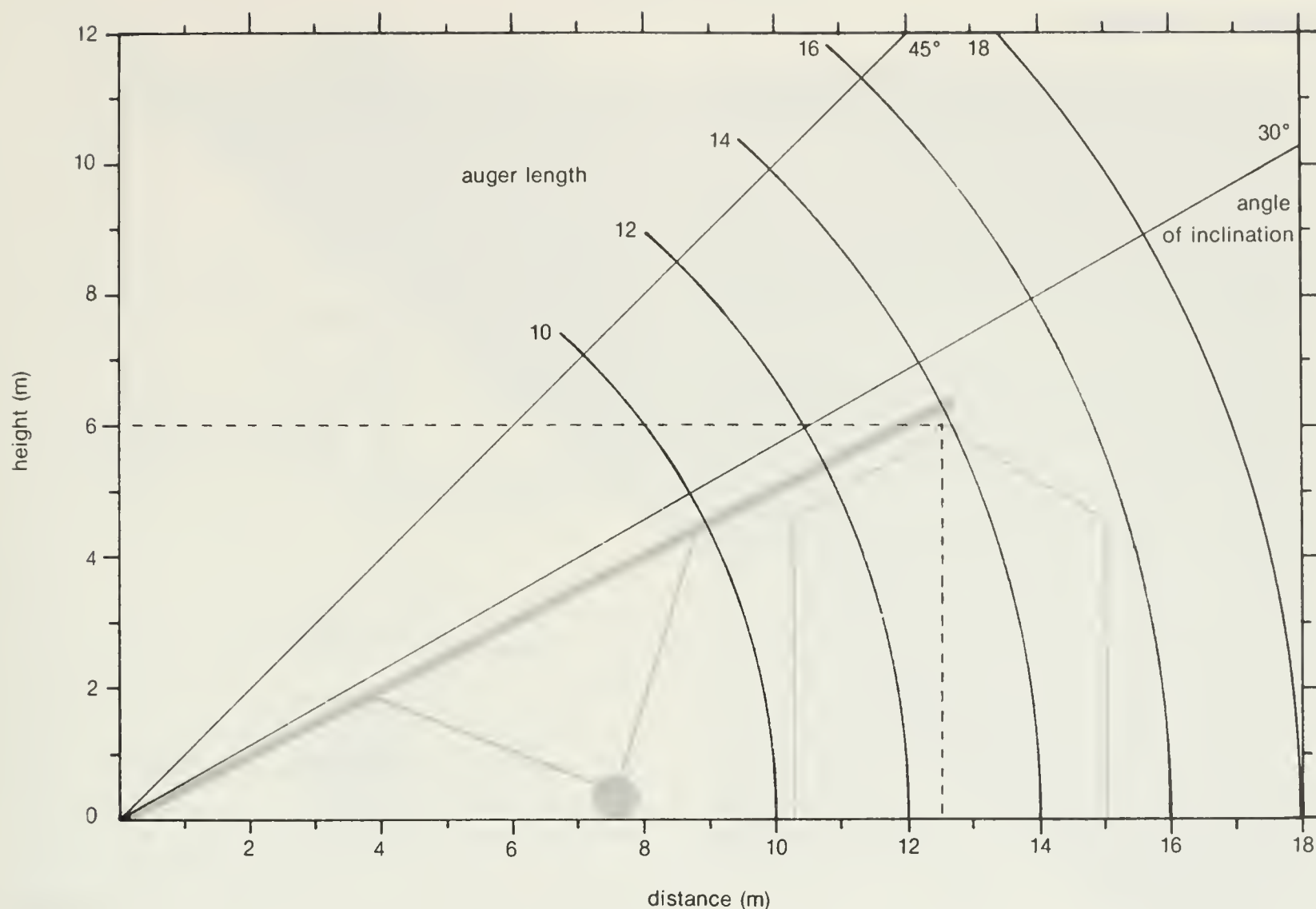


FIGURE 10 Grain augers — height, distance, length, angle

TABLE 1 POWER REQUIREMENTS (W/m) AND MAXIMUM CAPACITIES (m³/h) FOR GRAIN AUGERS

Auger		Auger angle of inclination									
dia.		0°		30°		45°		60°		90°	
(mm)	rpm	Cap.	Power	Cap.	Power	Cap.	Power	Cap.	Power	Cap.	Power
150	300	30	170	30	220	25	220	20	200	10	125
	400	40	220	35	300	30	300	30	250	15	170
	600	55	330	50	450	40	450	40	400	20	250
	800	60	490	60	575	45	575	45	520	25	330
180	300	65	270	54	345	46	345	39	320	22	200
	400	81	345	68	440	58	440	48	415	27	270
	600	102	515	88	690	75	690	61	610	37	370
	700	112	610	93	785	80	785	68	760	41	440
200	300	80	420	65	515	55	515	45	490	30	350
	400	100	540	80	685	70	685	55	635	40	400
	500	120	660	100	860	80	860	65	800	50	600
	600	130	800	120	1030	90	1030	75	1000	55	650
250	300	170	760	130	1000	110	1000	80	950	60	650
	400	200	1000	150	1300	130	1300	110	1200	75	800
300	200	235	855	195	1200	160	1200	125	1075	80	660
	300	305	1275	255	1750	220	1750	170	1665	110	980

NOTE: — The power requirements and capacities given are approximate and will vary with grain type and condition.

— The power requirements are for electric motor drive.

— Power train loss is not included.

Bucket elevators

Bucket elevators are the most energy efficient way to move grain vertically (Figure 11). Bucket size, shape and spacing vary; consult the manufacturer for applications and characteristics.

A bucket elevator is generally more expensive than an inclined auger and requires either a tower or a guy wire for support. The tower does not interfere with the placement of bins, other equipment or roadways but is more costly than a guy wire.

A bucket elevator has a higher mechanical efficiency than an auger and needs less maintenance. Depending upon use, these factors may offset the higher initial cost. Normally, 1000-1400 t of grain must be handled in a year before the system becomes economically practical. This limit will be lower if the system includes grain conditioning, cleaning or feed processing equipment.

Table 2 gives typical power requirements for different bucket elevator heights and capacities.

Use Figure 12 to determine the approximate spout lengths and the effective bucket elevator length required to maintain the desired downspout slope. For example: a holding bin 15 m from the leg with an overall height of 6 m and requiring a minimum downspout slope of 40°. From Figure 12, the effective bucket elevator length should be 19 m and the spout length 20 m.

Gravity systems

With gravity flow, material moves unaided by mechanical or pneumatic means. Figures 13 and 14 illustrate the recommended floor and spout slopes for gravity flow of several materials.

Spout capacity is affected by spout size and slope and the number of turns or direction changes made. Table 3 gives spout sizes for different capacities. To obtain maximum spout life and capacity make spouts as straight as possible.

Pneumatic systems

A pneumatic system consists of a fan assembly, a feeding mechanism and piping, and may include

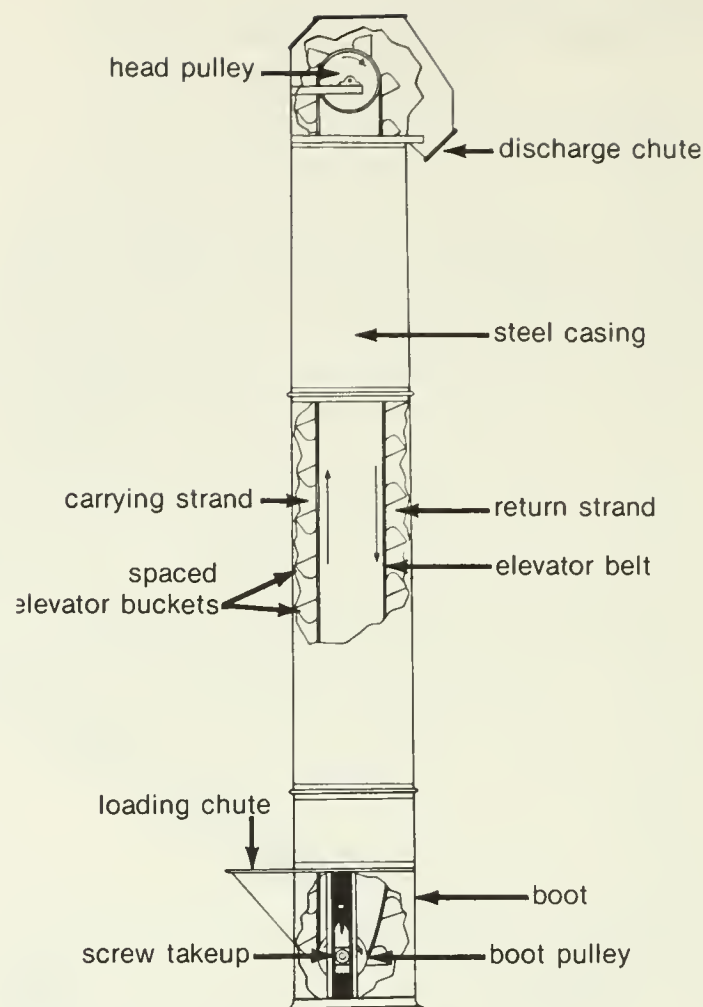


FIGURE 11 Bucket elevator

several cyclones. It moves the grain in an airstream within a pipe or tube.

The system's advantages include dust-free operation and grain movement that is not limited to straight lines. Its major disadvantages include low mechanical efficiency, high cost, greater wear and noise.

Figure 15 illustrates the combination system commonly used to unload bins. It employs negative pressure pickup and positive pressure discharge. Figure 16 shows a positive-pressure system primarily used to load bins.

Belt conveyors

Belt conveyors are endless belts revolving around two pulleys, as shown in Figure 17. They are effi-

TABLE 2 TYPICAL POWER REQUIREMENTS (kW)¹ FOR BUCKET ELEVATORS

Capacity (m ³ /h)	Lift (m)						
	12	15	18	21	24	27	30
21	1.1	1.1	1.5	1.5	2.2	2.2	2.2
37	1.5	2.2	2.2	3.7	3.7	3.7	3.7
57	2.2	2.2	3.7	3.7	3.7	3.7	3.7
73	2.2	3.7	3.7	3.7	5.6	5.6	5.6
90	3.7	3.7	5.6	5.6	5.6	7.5	7.5
103	3.7	3.7	5.6	5.6	7.5	7.5	7.5
126	5.6	5.6	7.5	7.5	11.2	11.2	11.2

¹ Based on manufacturer's recommendations

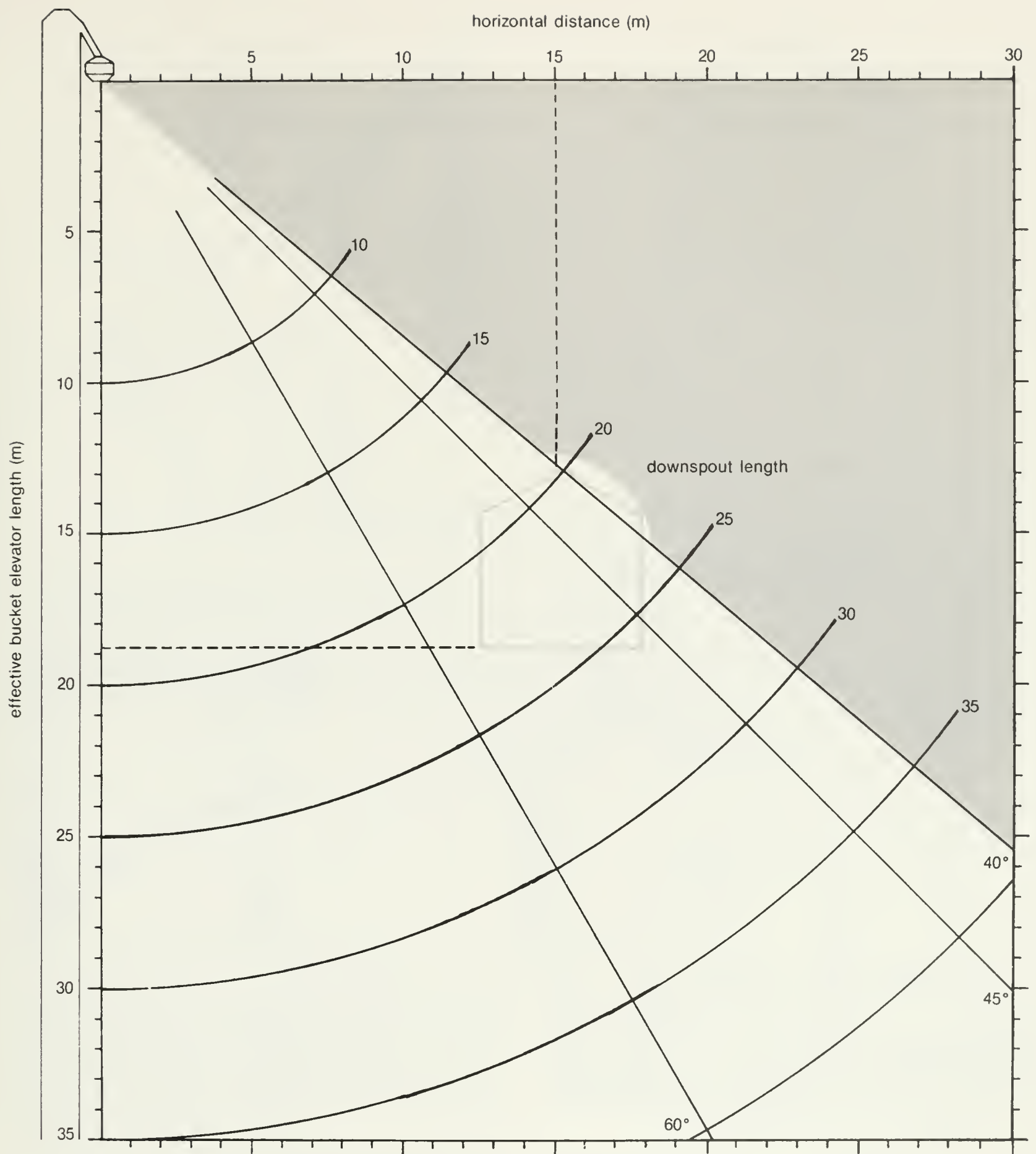


FIGURE 12 Effective bucket elevator length and downspout angle. The downspout angle should not be less than 40°; the effective elevator length is from distributor outlet to ground level.

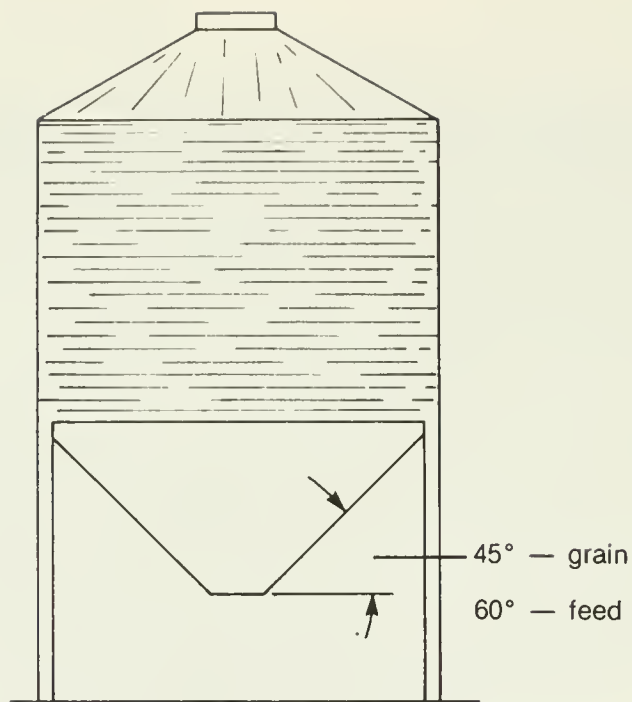


FIGURE 13 Floor slope required for gravity flow

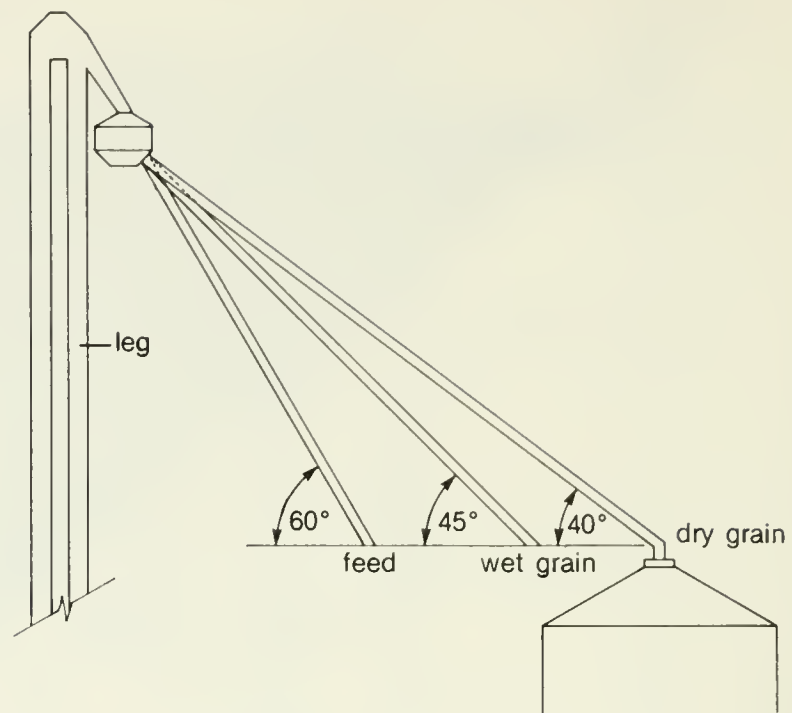


FIGURE 14 Spout slope required for gravity flow

TABLE 3 REQUIRED SPOUT SIZE

Capacity	Spout slope	Minimum spout size
25 - 50 m ³ /h	40°	150 mm dia. or 150 mm square
50 - 70 m ³ /h	40°	200 mm dia. or 180 mm square
70 - 90 m ³ /h	40°	250 mm dia. or 225 mm square

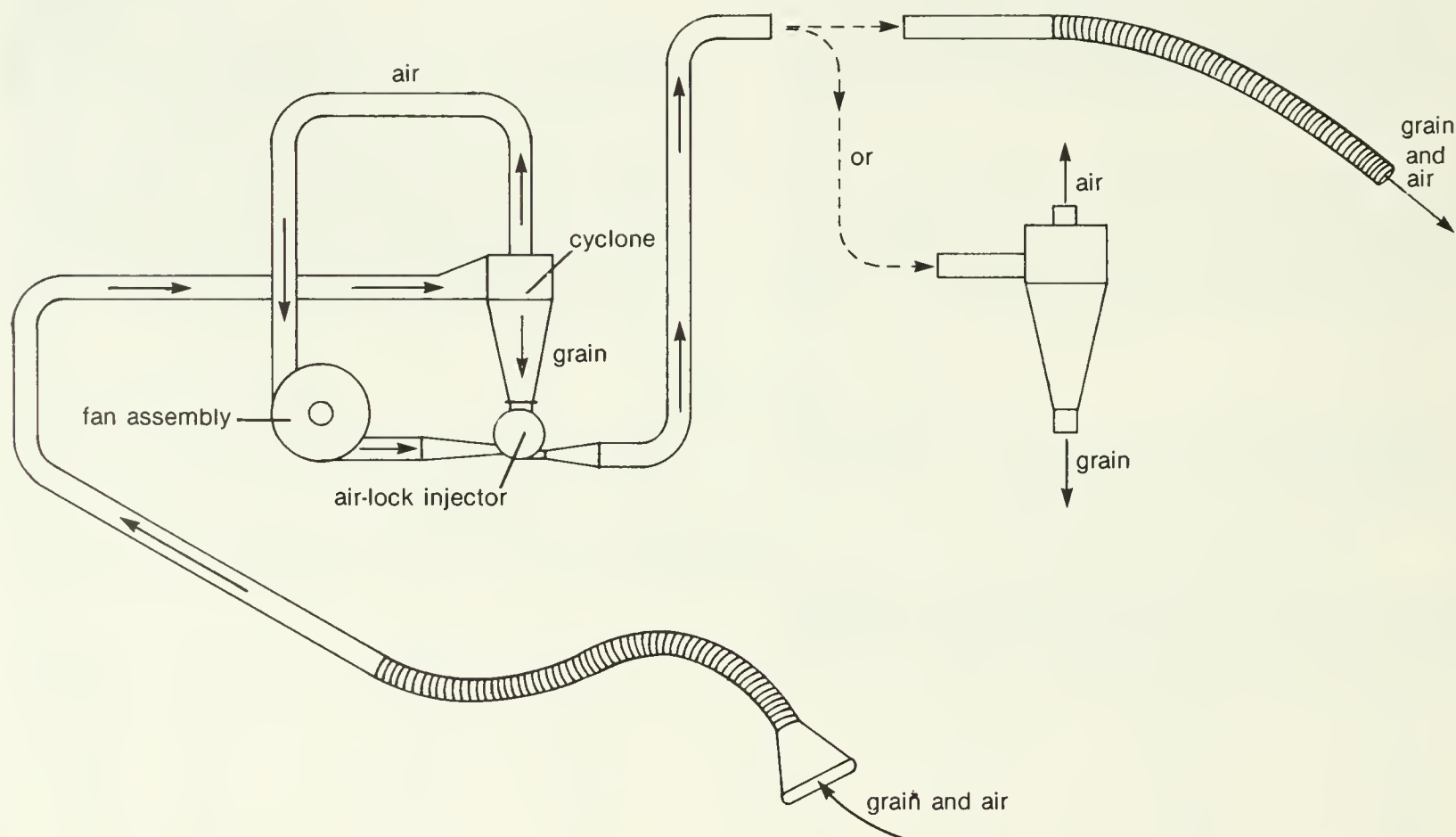


FIGURE 15 Combination pneumatic system that uses negative pressure pickup and positive pressure discharge

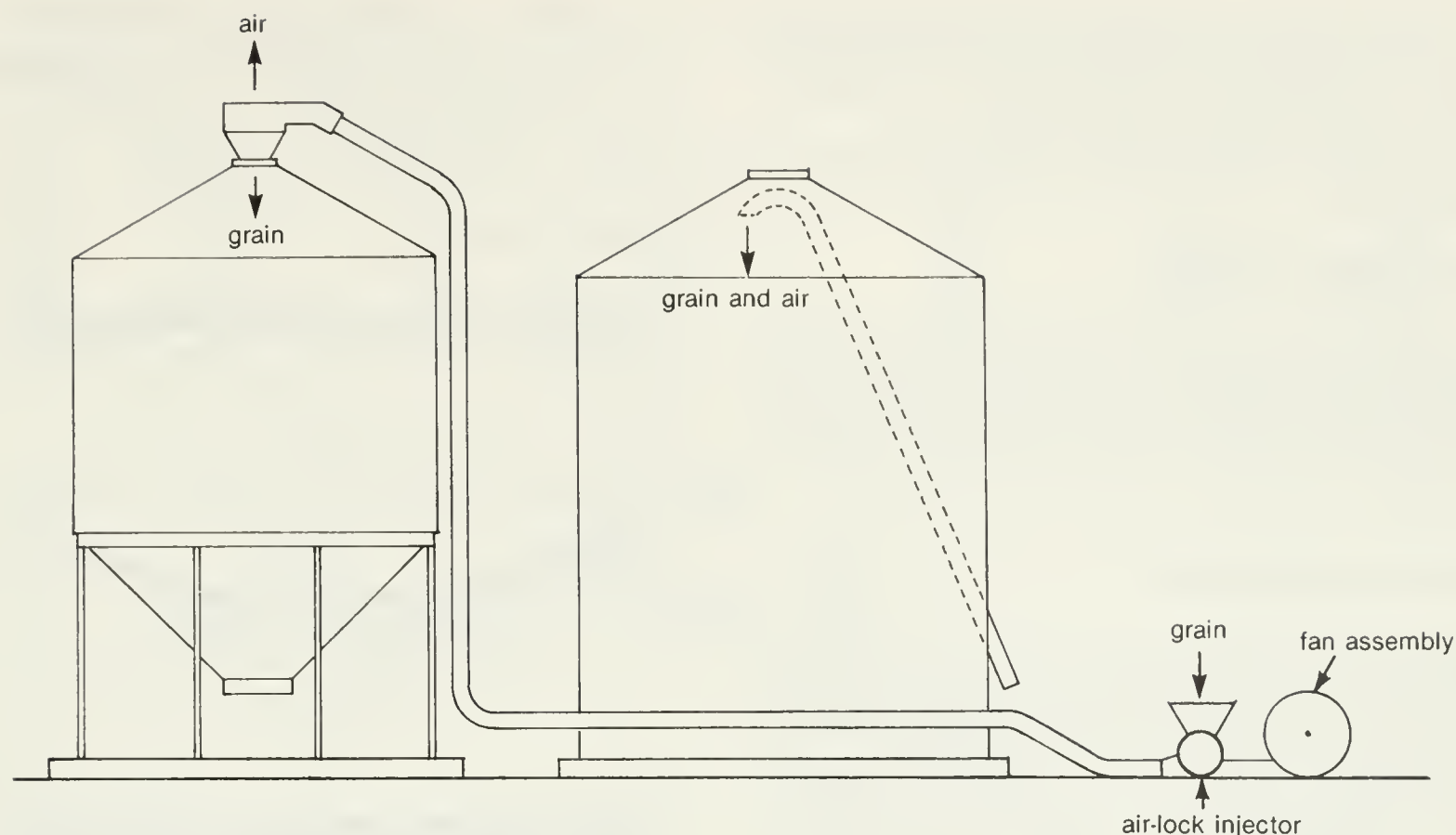


FIGURE 16 Positive-pressure pneumatic system

TABLE 4 BELT CONVEYOR CHARACTERISTICS WHEN MOVING GRAIN

Width (mm)	Belt speed (m/s)	Capacity (m ³ /h for 1 m/s belt speed)		Typical power requirements (kW) ¹
		20° Troughed	30° Troughed	
350	2.0	18.7	-	1.1
400	2.3	28.1	-	1.2
450	2.3	38.5	50.2	1.7
500	2.5	49.3	-	2.0
600	3.0	75.3	105.9	2.8
750	3.5	126.0	178.4	4.3
900	4.0	186.7	262.0	8.1

¹At maximum capacity for 20° troughed conveyor and at horizontal distance of 40 m, and allowing 600 W drive-train loss

cient horizontal conveyors for grains, especially those that crack or damage easily. Belt conveyors are suited to straight-line runs and where inclinations are less than 20°. The initial cost is high but this may be offset by the low power requirement and low maintenance costs.

Of the three types of belt conveyors shown in Figure 18, the troughed belt is most suitable for grain. The slider plate with side skirts has greater friction and wear; this limits lengths to about 30 m and belt speeds are lower than comparable troughed belts. The flat belt is not recommended for grain because grain's low angle of repose results in a very low capacity. Table 4 gives typical capacities.

U-trough augers

U-trough augers are primarily used to convey grain horizontally. Bearings suspend the auger slightly

above the bottom of the U-trough and are located between auger sections. This reduces wear on the trough bottom and, compared to a horizontal tube auger, the power requirements. Table 5 gives typical capacity and power requirements.

Drag conveyors

Drag conveyors (Figure 19) consist of a series of paddles attached to an endless chain moving in a stationary trough. They are primarily used to move grain horizontally or up a slight incline. When inclined, the capacity is reduced, depending on the material being conveyed and the angle.

Drag conveyors are less efficient than belt conveyors and more efficient than horizontal augers. The major advantages are good cleaning characteristics and low grain damage. Typical capacity and power requirements are given in Table 6.

Figure 20 shows a variation of the drag conveyor in which the chain actually travels in a continuous loop. This system can move grain vertically and horizontally to load or unload bins.

Table 7 gives a condensed comparison of grain conveyors.

PITS AND DUMPS

Figures 21 and 22 illustrate some of the pits and dumps commonly used. A below-ground pit may have water problems if the water table is high, if surface water does not flow away from its perimeter, or from rain and snow accumulation.

GRAIN SPREADERS

Mechanical spreaders may be used when filling large-diameter bins to distribute and spread grain or other material. This is especially important when aerating or drying as it allows a more uniform air-flow through the grain mass; however, an increase in static pressure for the same depth will result. Some common grain spreaders are shown in Figure 23.

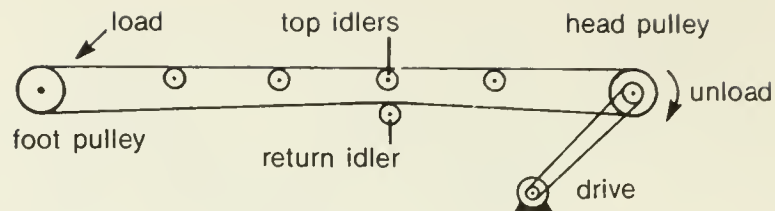


FIGURE 17 Belt conveyor

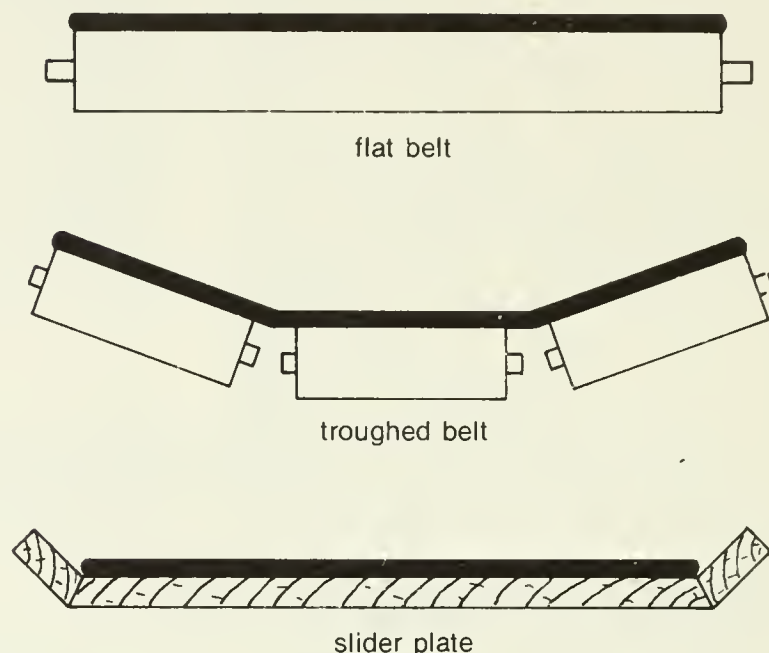


FIGURE 18 Types of belt conveyors

TABLE 5 U-TROUGH POWER REQUIREMENTS (kW)

Length (m)	150 mm		200 mm		250 mm	
	17 m ³ /h at 200 rpm	25 m ³ /h at 300 rpm	42 m ³ /h at 200 rpm	63 m ³ /h at 300 rpm	70 m ³ /h at 200 rpm	105 m ³ /h at 300 rpm
3	0.75	0.75	0.75	0.75	1.1	1.5
7	0.75	1.1	1.1	1.5	1.5	2.2
12	1.1	2.2	1.5	2.2	2.2	3.7
17	1.1	2.2	2.2	3.7	3.7	5.6
24	1.5	2.2	3.7	5.6	5.6	7.5
30	2.2	3.7	3.7	5.6	7.5	11.2
36	2.2	3.7	5.6	7.5	7.5	11.2

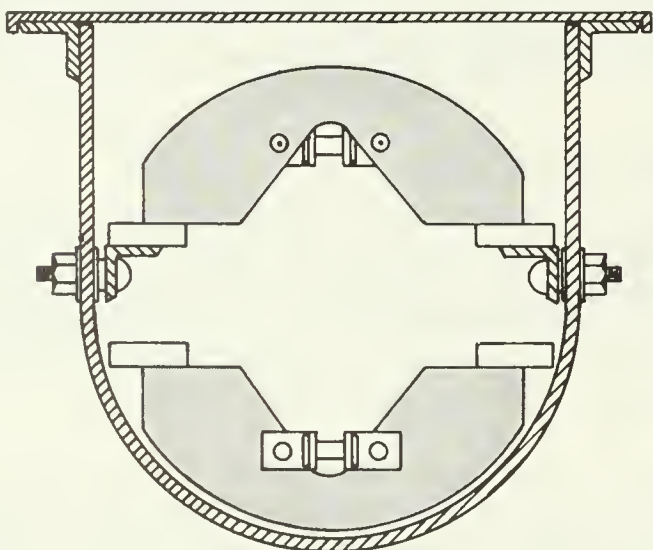


FIGURE 19 Cross-section of typical drag conveyors

BIN UNLOADING

The type of storage structure and foundation will determine to what degree mechanized emptying can be used. Rectangular flat storage will require more labor than a flat circular structure. Hopper-bottom bins may be emptied completely by gravity flow, requiring minimal labor.

Various foundations are illustrated in Figures 3 to 8. An auger tube and well cast in the foundation combined with an underfloor auger and sweep auger will reduce labor when emptying bins.

TABLE 6 CAPACITY AND POWER REQUIREMENTS FOR A TYPICAL DRAG CONVEYOR WHEN MOVING GRAIN

Size (mm)	Capacity (m ³ /h)			Power requirements (W/m)		
	at 30 m/min	at 38 m/min	at 45 m/min	at 30 m/min	at 38 m/min	at 45 m/min
150	23	28	34	52	65	78
230	46	58	69	105	132	160
300	78	97	117	180	225	268
360	104	130	156	238	300	360

TABLE 7 COMPARISON OF CONVEYORS

Type	Relative capacity ¹		Relative power requirements ²		Relative grain damage	Advantages	Disadvantages
	Vertical	Horizontal	Vertical	Horizontal			
Auger	1	1	1	1	2 ³	Portable Wide range available Low cost	Medium to heavy wear Limited to low angles of elevation Single sections limited in length
U-trough	-	2	-	0.5	2	Cost Reduced maintenance (compared to horizontal auger) Components easily accessible	Not self-cleaning Limited to low angle of elevation
Drag conveyor	-	2.5	-	0.37	1	May be self-cleaning Used for long distances	Wear factor Cost
Belt elevator	-	3.7	-	0.25	0	Low power requirement Used for long distances Low maintenance Self-cleaning	Cost Limited to very low angles of elevation
Bucket elevator	2.4	0	0.4	-	1 ³	Low maintenance Low power requirement High capacity for vertical lift	Limited speed range Needs support High cost
Pneumatic	0.2			4	2 ³	Self-cleaning Flexible	High power requirement High cost

¹ For equal lengths and power

² For equal lengths and capacities

³ Damage depends on wear and design

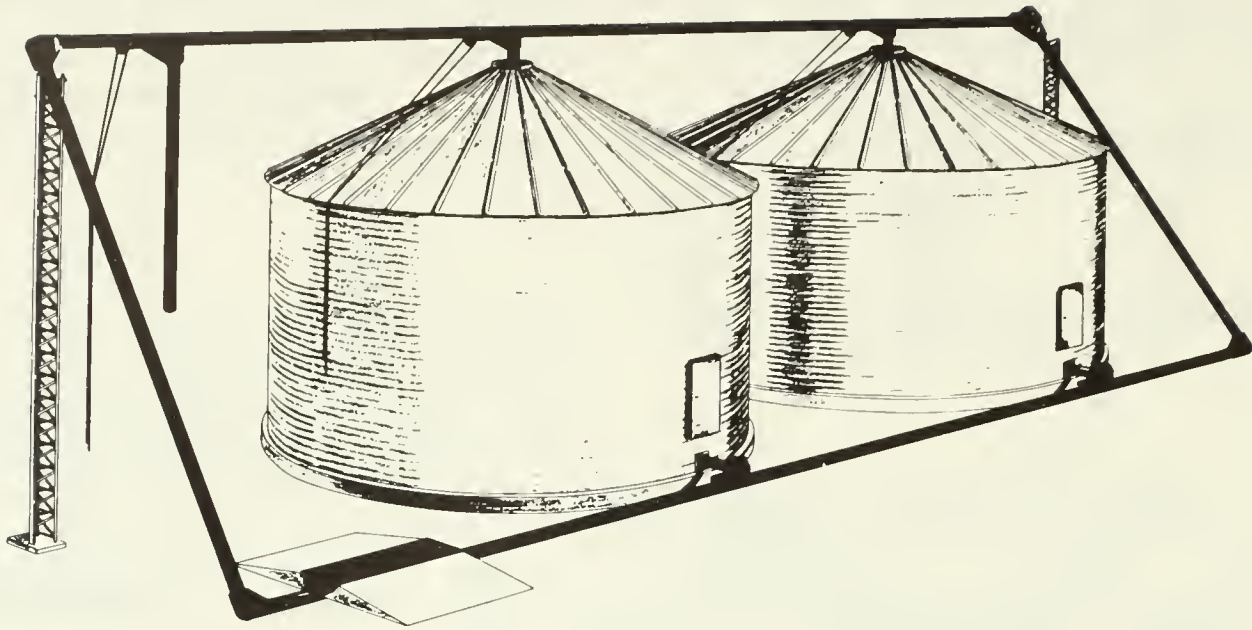
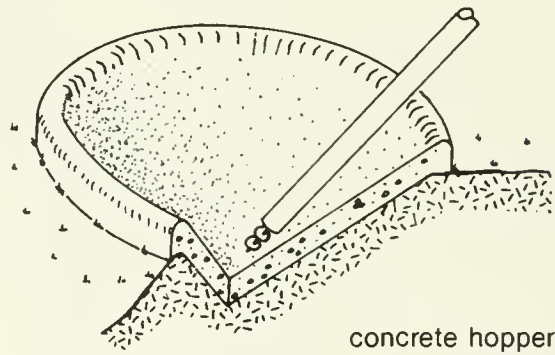
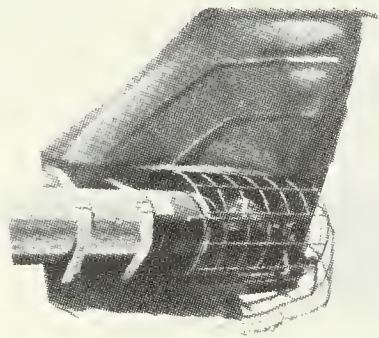


FIGURE 20 One type of drag conveyor

flexible hopper



concrete hopper

tractor or truck tire plus canvas



portable auger set into below-ground hopper

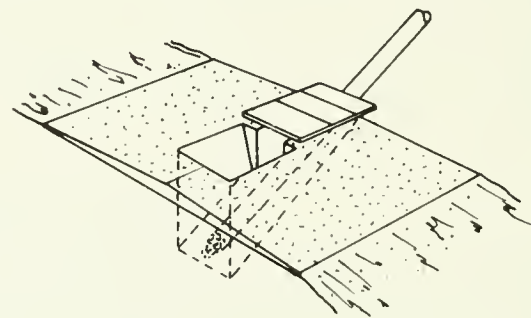
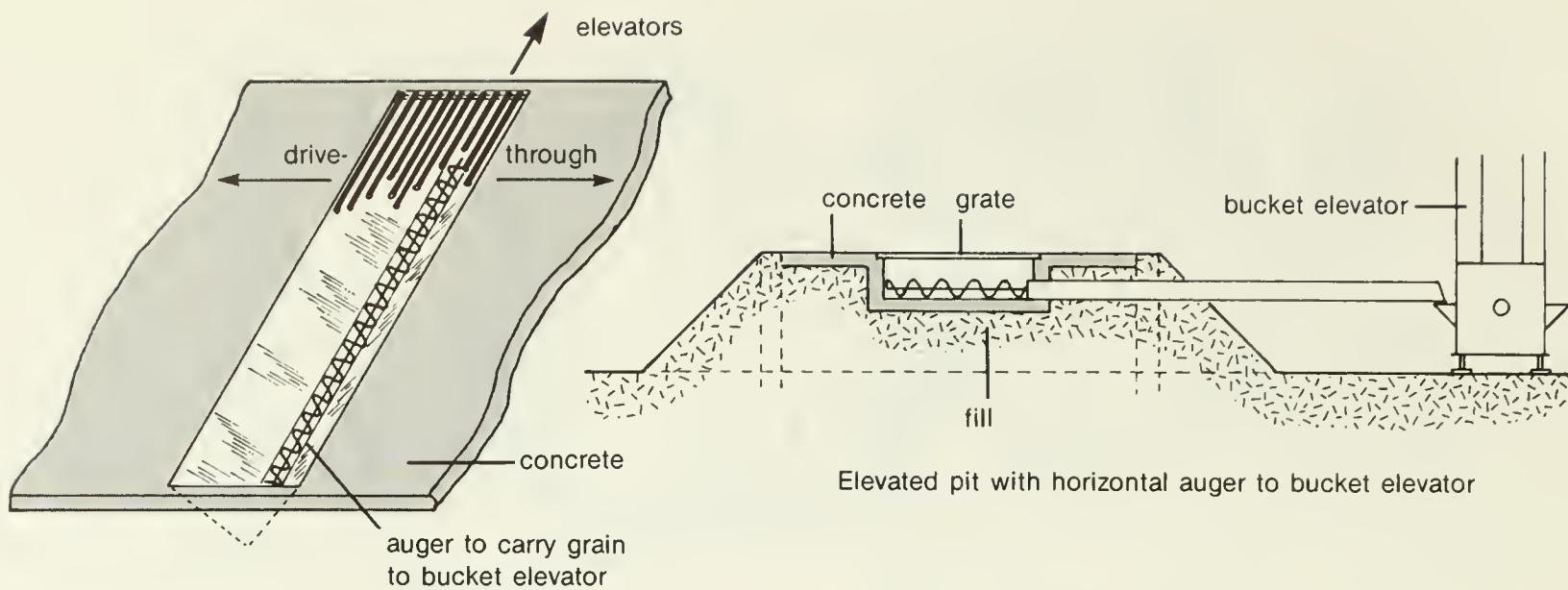


FIGURE 21 Types of pits or receiving dumps for grain augers

TABLE 8 COMPARISON OF ELECTRIC MOTORS

Motor type	Power range	Starting torque	Starting current	Reversing method	Characteristics	Typical uses
Capacitor-start, induction-run	To 7.5 kW	4 times rated load	3 to 5 times rated current	Electrical	Versatile motor, most popular for farm use	Water systems, grain augers, air compressors, milking machines, ventilating fans, agitators, run mixers
Capacitor-start, capacitor-run	1.5 to 15 kW	4 times rated load	3 to 5 times rated current	Electrical	Special capacitor gives improved performance in breakdown torque, full load efficiency, and power factor	Silo unloaders, large conveyors, barn cleaners, silage blowers, pumps, crop drying fans, bunk feeders, hammermills
Repulsion-start, induction-run	To 15 kW	5 times rated load	3 times rated current	Shift brushes	Expensive, handles large loads with little variation in current	Silo unloaders, barn cleaners, large conveyors, mixers, deep well pumps, feed grinders
Soft-start motors	5.6 to 37 kW	50-90% of rated load	2 to 2.5 times rated current	Electrical	Motors have special windings that allow relatively low starting	Crop drying fans, forage and silo blowers, feed grinders, centrifugal pumps
3-phase motors	0.37 to 300 kW	3 to 4 times rated load	3 to 4 times rated current	Electrical	Requires 3-phase power or a phase converter, may be used on single-phase power. Simple construction, versatile, trouble-free	Irrigation pumps, manure pumps, feed grinders, large conveyors, bucket elevators, mixers

¹ Reversing electrically is done by changing wires at the motor terminals



Concrete pad equipped with cross auger in shallow pit

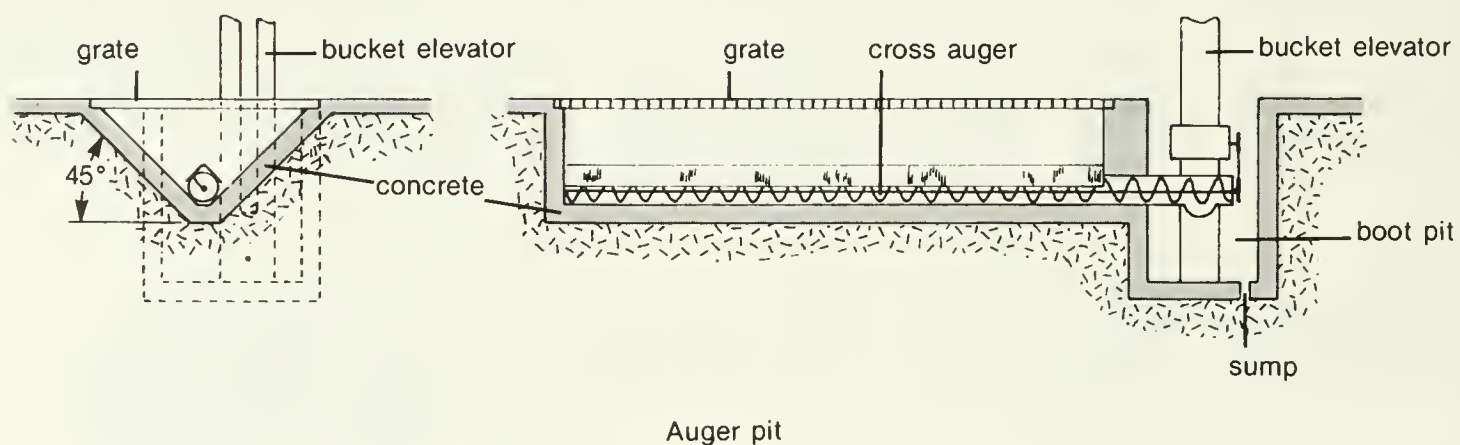
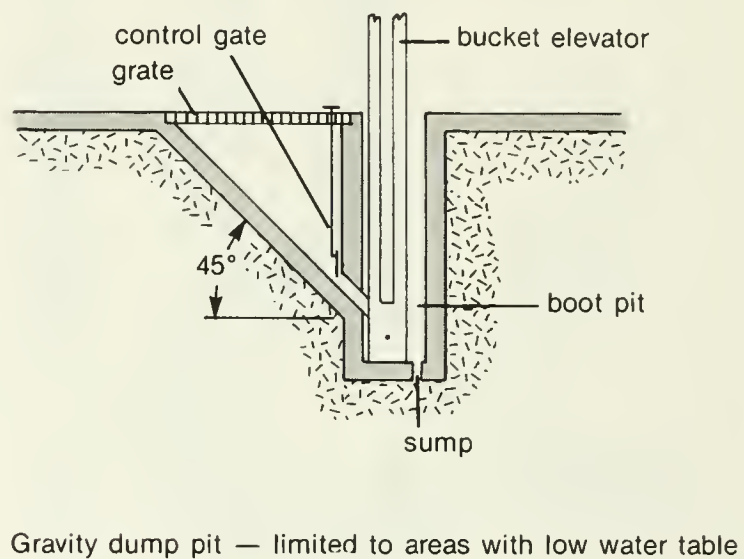
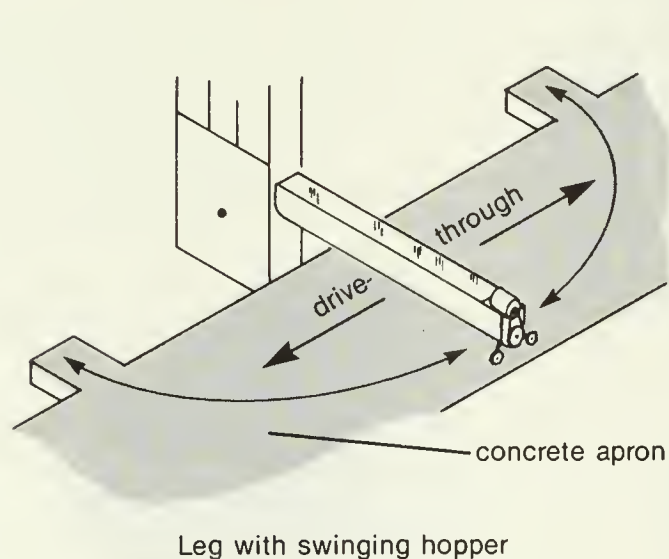


FIGURE 22 Types of pits or receiving dumps for bucket elevators



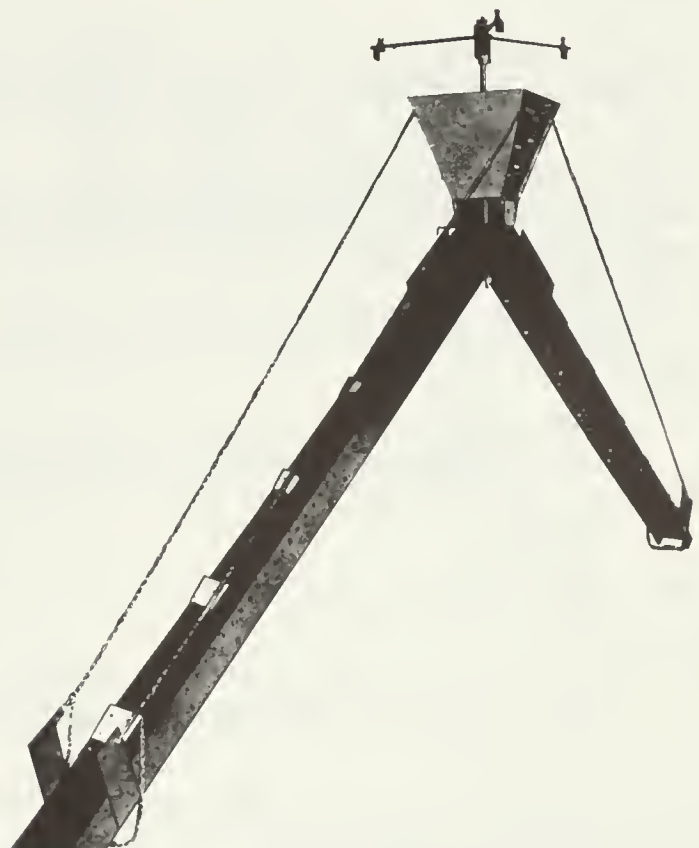
electrically operated tilting-pan type, 5-11 m bins



electrically operated, 5-11 m bins



gravity spreader, up to 7 m bins



gravity spreader, up to 18 m bins

FIGURE 23 Common types of grain spreaders

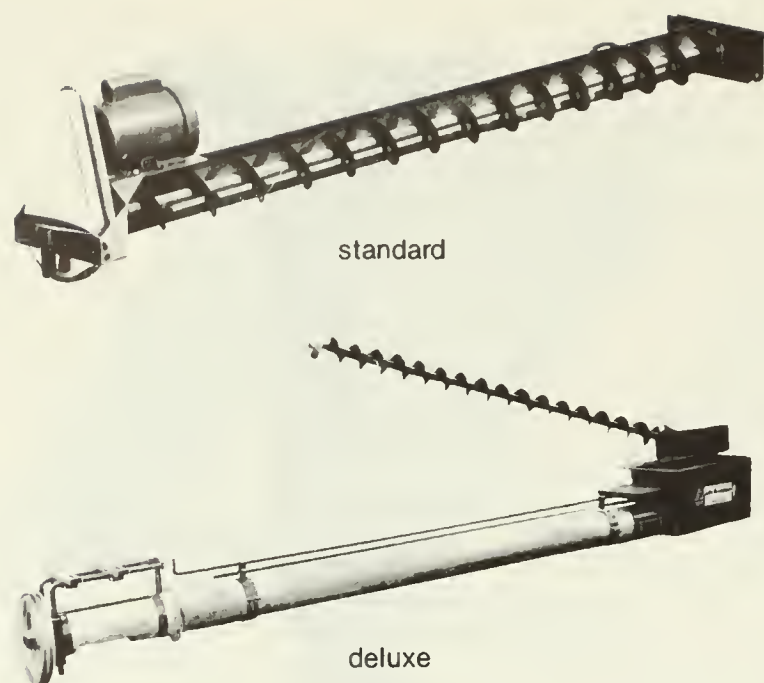


FIGURE 24 Sweep augers

Several sweep auger designs are available (Figure 24). The standard type is usually moved from bin to bin. The deluxe unit remains in one bin and is only engaged (manually from outside of the bin) after gravity flow stops. A single motor drives the underfloor auger and the deluxe sweep while two motors are required for the standard version.

Safety

Grain storage facilities have a number of potential hazards regardless of how well designed and built.

These hazards include suffocation in grain, contact with conveying and electrical equipment, and respiratory problems from dust, molds and pesticides.

The following safety measures will help prevent accidents:

- Never enter a bin to clear bridged grain when the unloading system is running. Use a pole to break the bridge while remaining outside.
- Never allow people in the bin while emptying or filling it.
- Keep visitors and other nonessential personnel away from the facility while it is in operation.
- Keep all shields in place including those over conveyor intakes and drives.
- Use approved electrical equipment and installation methods.
- Use suitable personnel protective equipment (PPE) when called for. This may include hearing protectors, dust masks, chemical-cartridge respirators or other PPE identified on pesticide containers.

ORGANIZING A SYSTEM

Once you have selected the site, determined the quantity of grains to be handled and stored, and evaluated present facilities and possible future expansion, plan the system on paper. Use the following guidelines to determine the size and layout:

- Keep movement of portable equipment to a minimum.
- Handling equipment capacity should exceed the expected harvest rate.

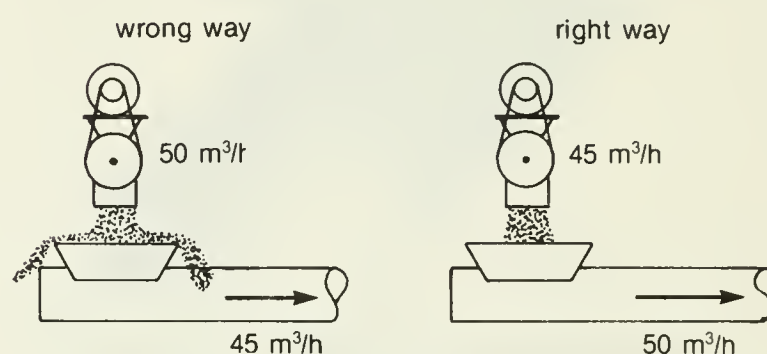
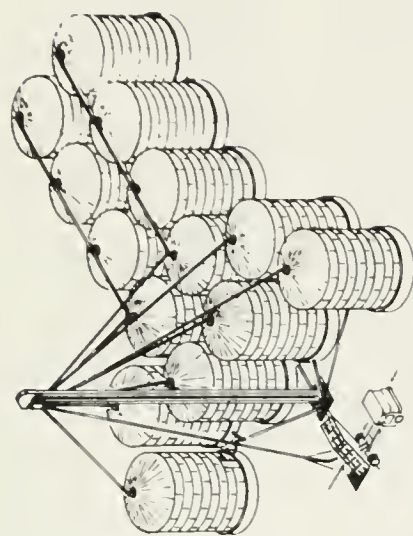


FIGURE 25 Conveyor selection

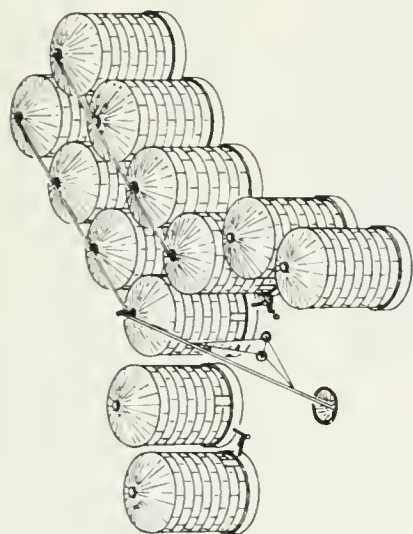
- Wet grain greatly reduces the capacity of grain augers but has little effect on a bucket elevator.
- Size the conveying equipment with future expansion in mind.
- Consider grain conditioning requirements.
- Plan so that the storage capacity may be expanded without requiring major modifications or creating obsolescence.
- Match conveying equipment. To avoid bottlenecks, each piece of equipment in the flow path should have up to 10% more capacity than the preceding piece (Figure 25).
- Allow sufficient room to maneuver grain trucks (see Appendix, Figure A3), including pup trailers.

System layouts

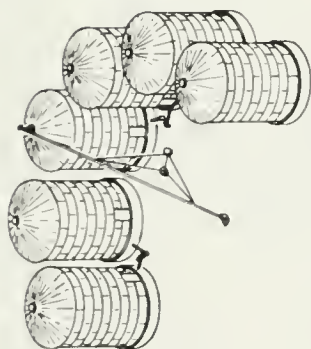
The system layouts (Figures 26 and 27) show how a system can be planned with future expansion in mind. Remember these are only ideas; the system suitable for your operation will likely be different. Various system layouts are available from equipment suppliers, consulting engineers and provincial departments of agriculture.



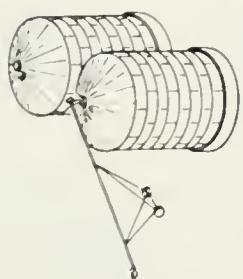
Stage 4



Stage 3



Stage 2



Stage 1

Bin size and number will determine auger length or bucket elevator length.

Leave a distance of 1 m between bins.

Position auger tubes in bin foundations so they can be removed without interference from other bins.

Elevate bin foundations sufficiently to provide clearance for ground-level conveyors.

Aeration bins may be installed at any stage.

Once a bin arrangement has been decided upon, consult your local agricultural engineer and the various equipment suppliers for plans and detailed advice.

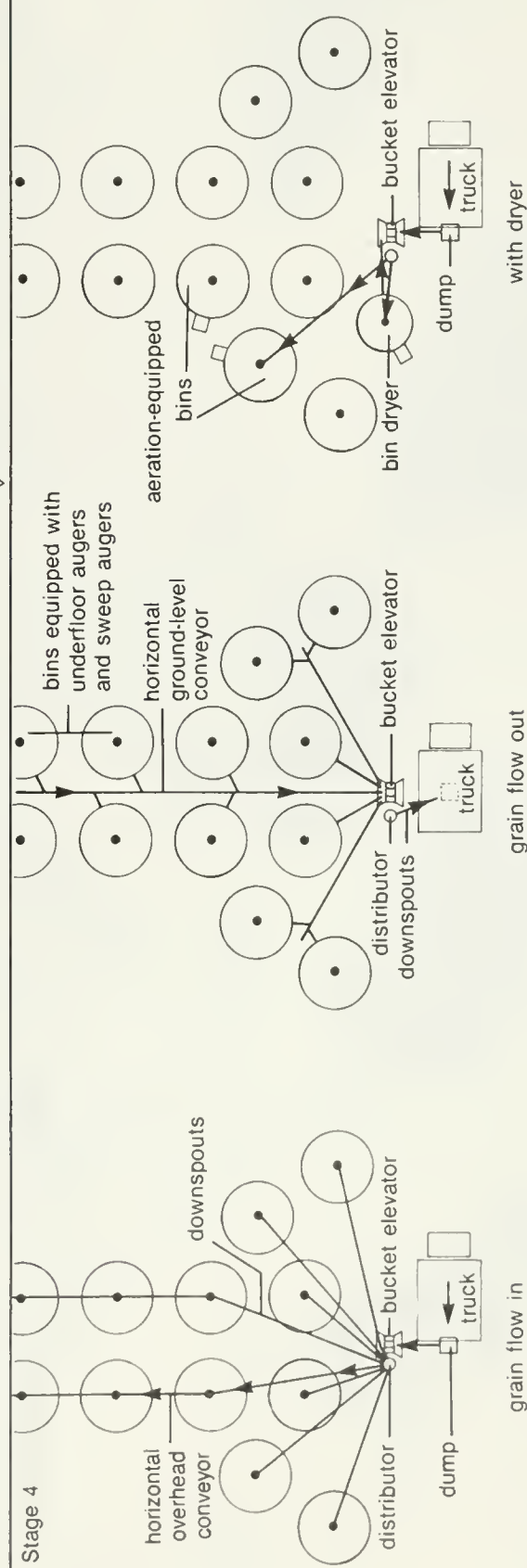
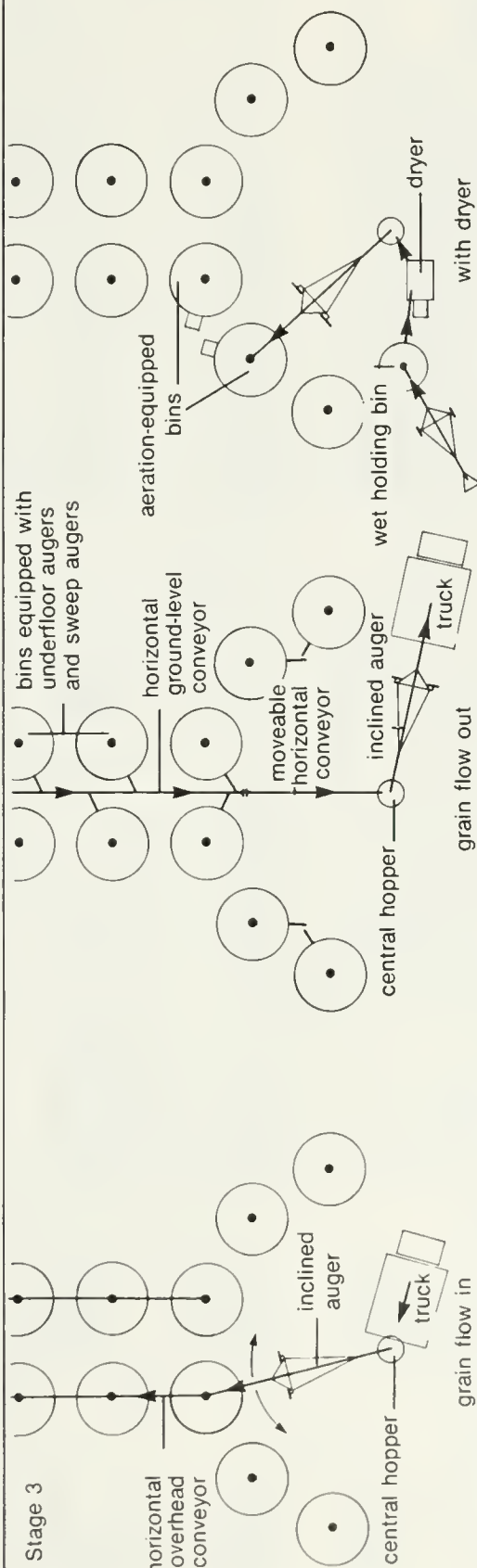
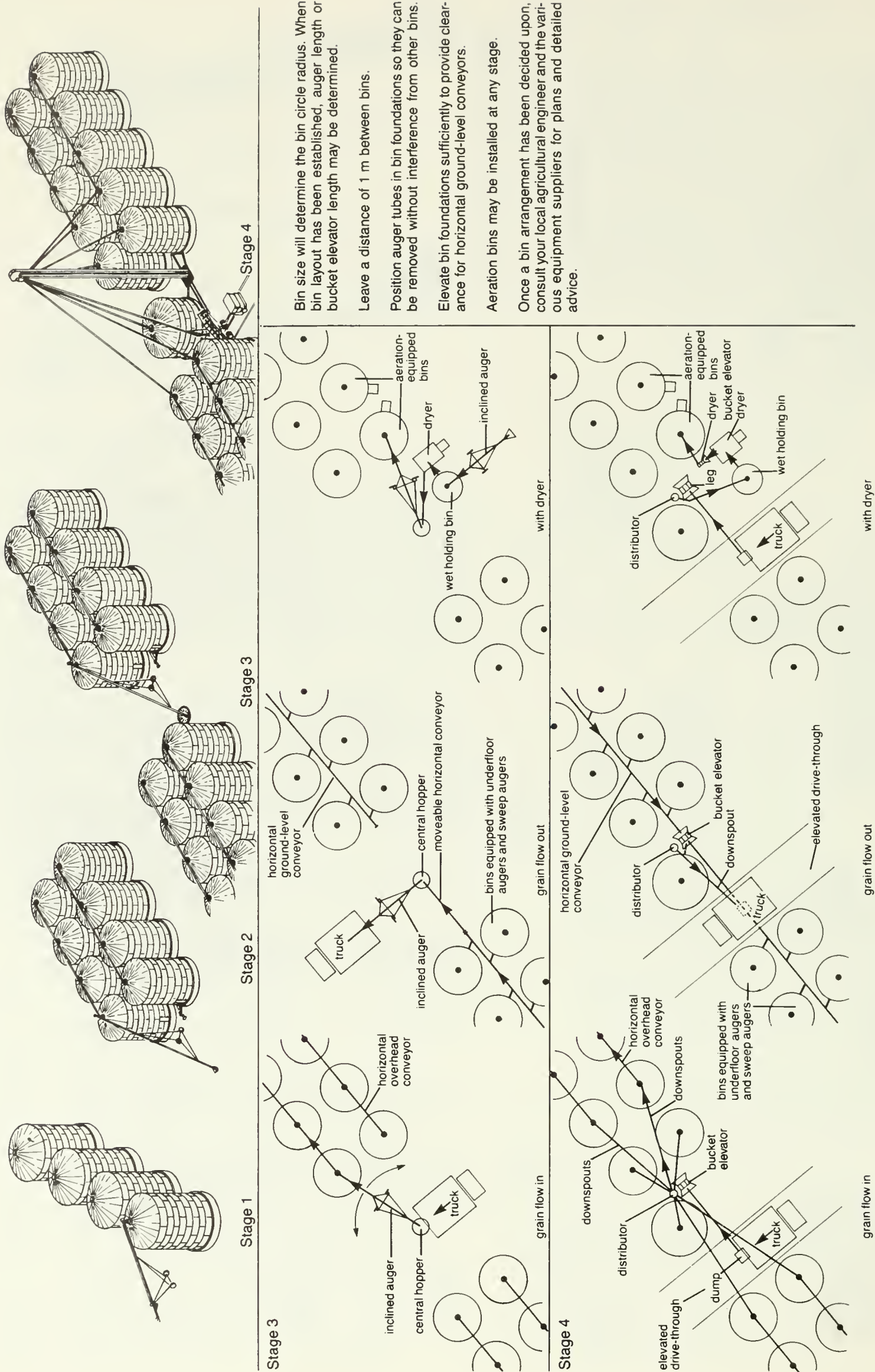


FIGURE 26 Semicircular bin arrangement



Bin size will determine the bin circle radius. When bin layout has been established, auger length or bucket elevator length may be determined.

Leave a distance of 1 m between bins.

Position auger tubes in bin foundations so they can be removed without interference from other bins.

Elevate bin foundations sufficiently to provide clearance for horizontal ground-level conveyors.

Aeration bins may be installed at any stage.

Once a bin arrangement has been decided upon, consult your local agricultural engineer and the various equipment suppliers for plans and detailed advice.

FIGURE 27 In-line bin arrangement

TABLE 9 COMPARISON OF ELECTRIC MOTORS

Motor type	Power range	Starting torque	Starting current	Reversing method	Characteristics	Typical uses
Capacitor-start, induction-run	To 7.5 kW	4 times rated load	3 to 5 times rated current	Electrical ¹	Versatile motor, most popular for farm use.	Water systems, grain augers, air compressors, milking machines, ventilating fans, agitators, mixers.
Capacitor-start, capacitor-run	1.5 kW to 15 kW	4 times rated load	3 to 5 times rated current	Electrical ¹	Special capacitor gives improved performance in breakdown torque, full load efficiency, and power factor.	Silo unloaders, large conveyors, barn cleaners, silage blowers, pumps, crop drying fans, bunk feeders, hammermills.
Repulsion-start, induction-run	To 15 kW	5 times rated load	3 times rated current	Shift brushes	Expensive, handles large loads with little variation in current.	Silo unloaders, barn cleaners, large conveyors, mixers, deep well pumps, feed grinders.
Soft-start motors	5.6 to 37 kW	50 to 90% of rated load	2 to 2½ times rated current	Electrical ¹	Motors have special windings which allow relatively low starting.	Crop drying fans, forage and silo blowers, feed grinders, centrifugal pumps.
3-phase motors	0.37 to 300 kW	3 to 4 times rated load	3 to 4 times rated current	Electrical ¹	Requires 3-phase power or a phase converter may be used on single-phase power. Simple construction, versatile, trouble-free motor.	Irrigation pumps, manure pumps, feed grinders, large conveyors, bucket elevators, mixers.

¹ Reversing electrically is done by changing wires at the motor terminals

ELECTRICAL EQUIPMENT

Electric motors and phase converters

Three-phase electric motors are more efficient and more economical than single-phase motors (Table 8). However, three-phase power may not be available at the grain handling and storage facility.

Phase converters allow three-phase motors to be operated on single-phase lines. Two types are available: static and rotary.

The static converter is primarily used for one- or two-motor systems. The converter is balanced or matched to the load to be operated. Additional motors cannot be added to the system after the converter has been balanced.

The rotary converter is used with systems that use several motors or where a different number of motors may operate at any given time. It is more expensive initially than the static type.

Consult the power or utility company before buying a system.

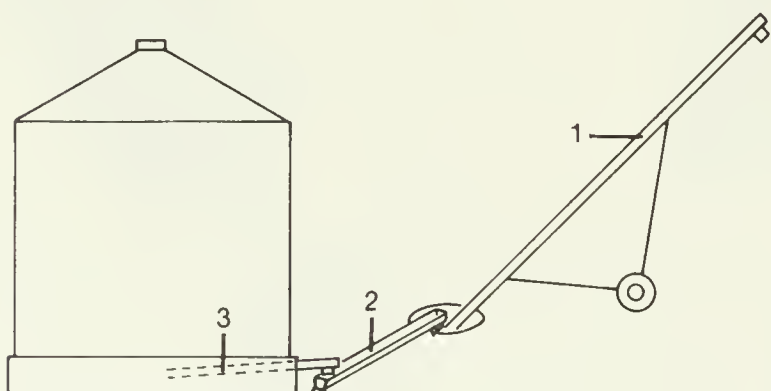


FIGURE 28 Sequencing

Electric controls

BIN LEVEL SWITCHES Bin level switches may be used for a variety of purposes, such as indicators when bins are full or empty or as controlling devices to start or stop conveyors.

SEQUENCING AND TIME DELAYS When several successive conveyors are used to move grain, they must be started and stopped in a given order.

The inclined auger (1) in Figure 28 should be started first, then the horizontal conveyor (2) and finally the underfloor auger (3). At shutdown, the sequence reverses.

This procedure prevents an accumulation of grain at transfer points during startup and shutdown. In addition, on shutdown it lets the conveyors empty, permitting easier startup.

Time-delay circuits may be necessary to allow sufficient time for one piece of equipment to reach operating speed before other equipment is started.

CHECKLIST IN PLANNING AND BUILDING A GRAIN SYSTEM

Take plenty of time and seek competent help in planning your system. Consult your local agricultural engineers, equipment and building suppliers and other farmers who have established a grain handling system.

It is easier and cheaper to do it properly the first time than to correct mistakes later.

Select a well-drained site with a low water table.

Get a soil test to be sure the soil will support heavy storage buildings and their contents.

Avoid locations where overhead power lines or trees will interfere with facilities.

Allow ample space for future expansion.

Locate the facility at least 45-60 m from the farm home to reduce effects of noise and dust.

Choose a site that can be seen from the farm home.

Provide good road access to the facility.

Contact the local electrical utility about electrical considerations.

Allow clearance for vehicles and movement of all handling equipment.

Consider snow accumulation.

Select conveying and conditioning equipment carefully, so that they have sufficient capacity and are coordinated.

PLAN BEFORE YOU BUILD OR BUY.

APPENDIX

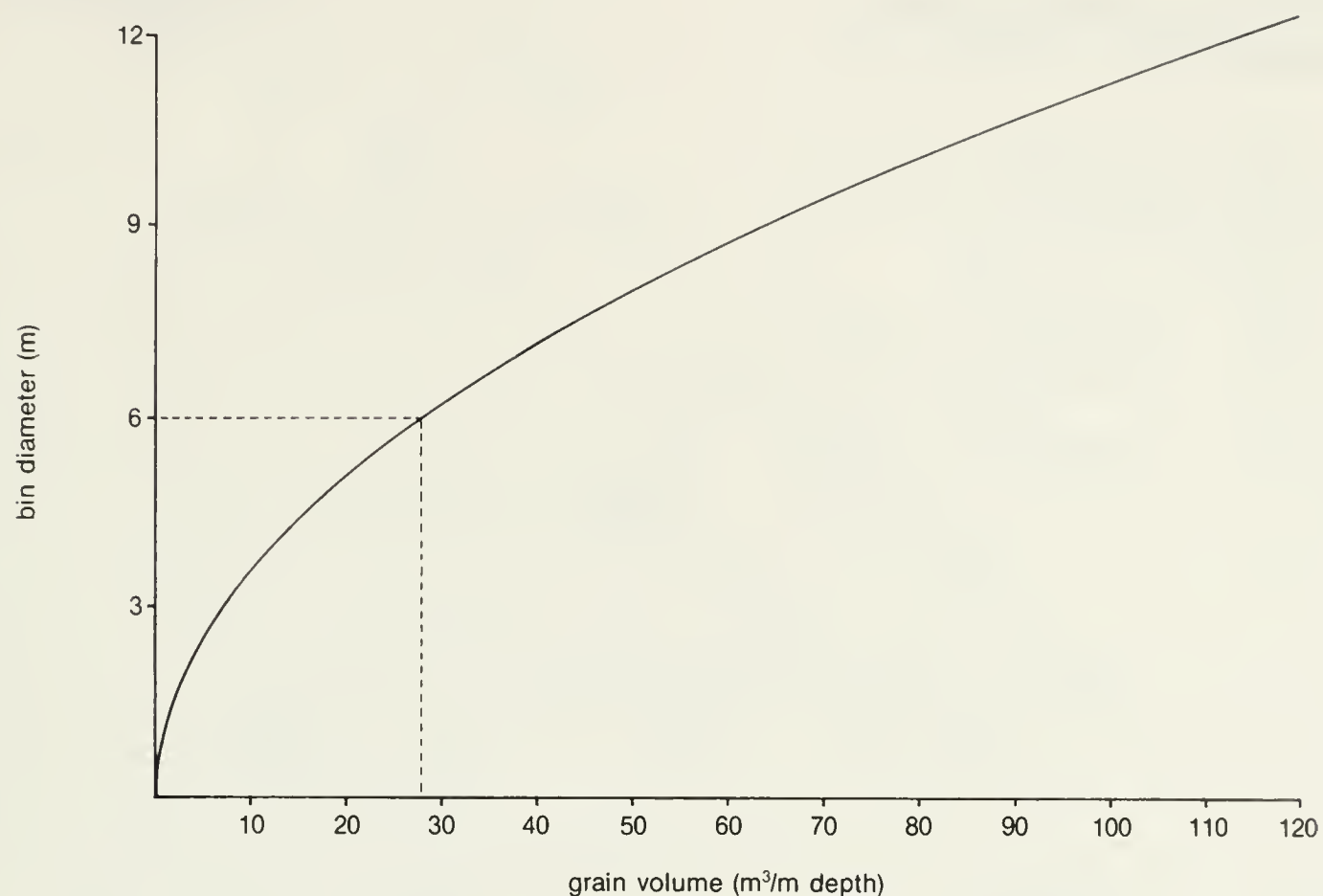


FIGURE A1 Bin capacity, not including area above eaves.
Example: a 6 m diameter filled to a depth of 3 m will have a grain volume of $3 \times 28.3 = 84.9 \text{ m}^3$

TABLE A1 ELECTRIC MOTOR AND GASOLINE ENGINE EQUIVALENCE

Gasoline engine size (kW)	0.4	0.5	0.75	1.1	1.5	2.2	3.0	3.7	6.0
Equivalent electric motor size (kW)	0.2	0.25	0.4	0.5	0.75	1.1	1.5	2.25	3.5

TABLE A2 FACTORS THAT AFFECT GRAIN BREAKAGE

Handling technique	Variable	Corn	Soybeans	Wheat
Drop	Drop height	yes	yes	no
	Orifice size	yes	yes	no
	Impact surface	yes	yes	no
	Spout end	yes	yes	no
Thrower	Belt speed	yes	yes	no
	Thrower distance	yes	no	no
Bucket elevator	Belt speed	no	no	no
	Boot feeding	yes	no	no
	Bucket loading	yes	no	no
	Bucket style	no	no	no
	Grain moisture	yes	yes	yes
	Grain temperature	yes	yes	yes

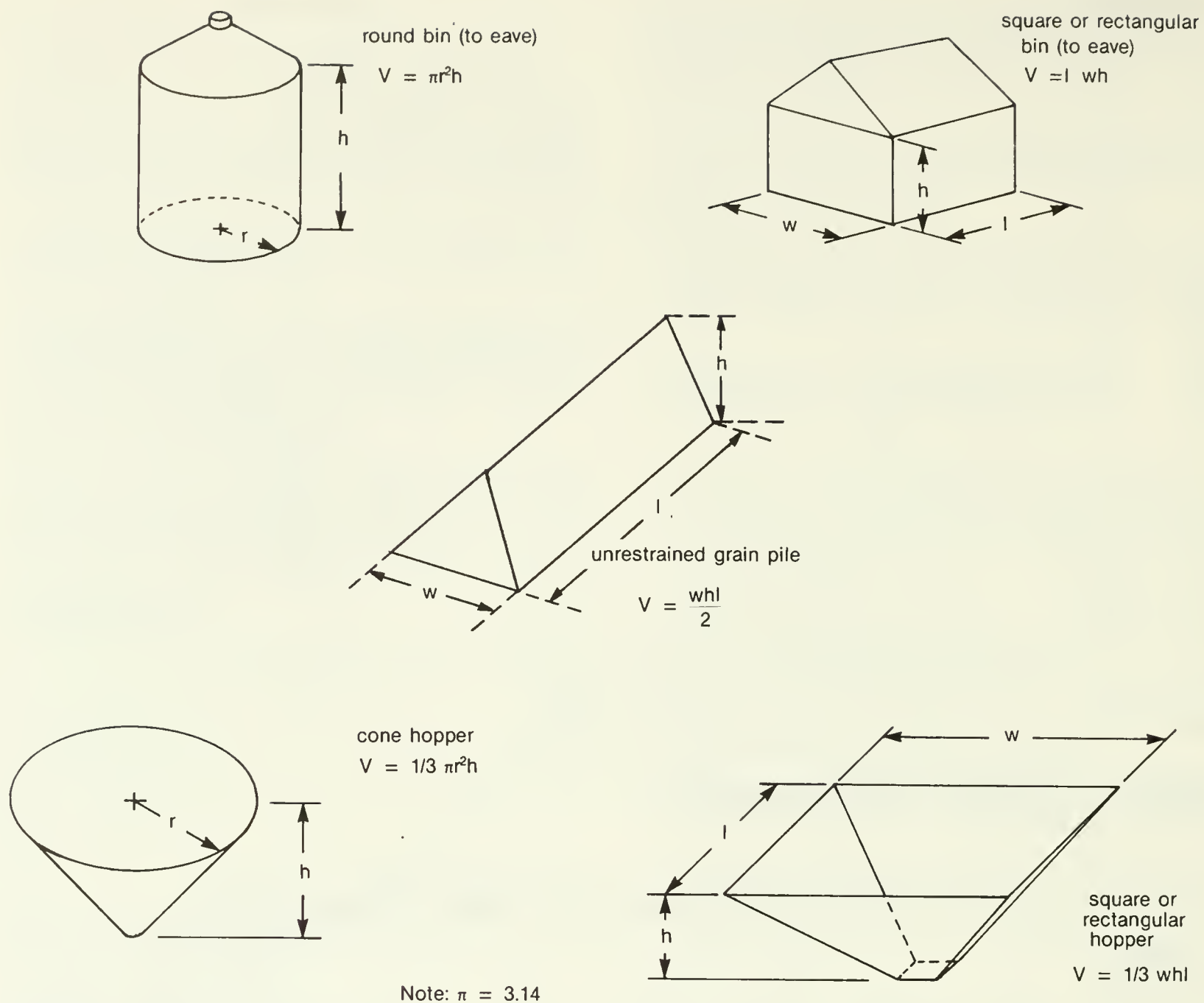


FIGURE A2 Volumes

Barley, buckwheat:
 100 kg/ha = 1.86 bu/ac
 100 kg = 4.59 bu

Corn, flax, rye:
 100 kg/ha = 1.59 bu/ac
 100 kg = 3.94 bu

Oats:
 100 kg/ha = 2.6 bu/ac
 100 kg = 6.49 bu

Rapeseed, mustard:
 100 kg/ha = 1.78 bu/ac
 100 kg = 4.41 bu

Wheat, peas, beans, clover:
 100 kg/ha = 1.49 bu/ac
 100 kg = 3.67 bu

Approximate average bulk densities

Wheat, peas, beans, clover	770 kg/m ³
Rye	730 kg/m ³
Corn	700 kg/m ³
Flaxseed	650 kg/m ³
Rapeseed, mustard seed	640 kg/m ³
Barley	620 kg/m ³
Buckwheat	610 kg/m ³
Oats	470 kg/m ³
Sunflower seed	290 kg/m ³

Converting the metric units in this publication into imperial measures

Length	millimetres (mm)	X 0.04 = inches
	metres (m)	X 3.38 = feet
Volume	cubic metres (m ³)	X 35.32 = cubic feet
	cubic metres (m ³)	X 1.31 = cubic yards
Mass	kilograms (kg)	X 2.21 = pounds
Speed	metres/second (m/s)	X 2.24 = miles per hour
Power	kilowatts (kW)	X 1.34 = horsepower

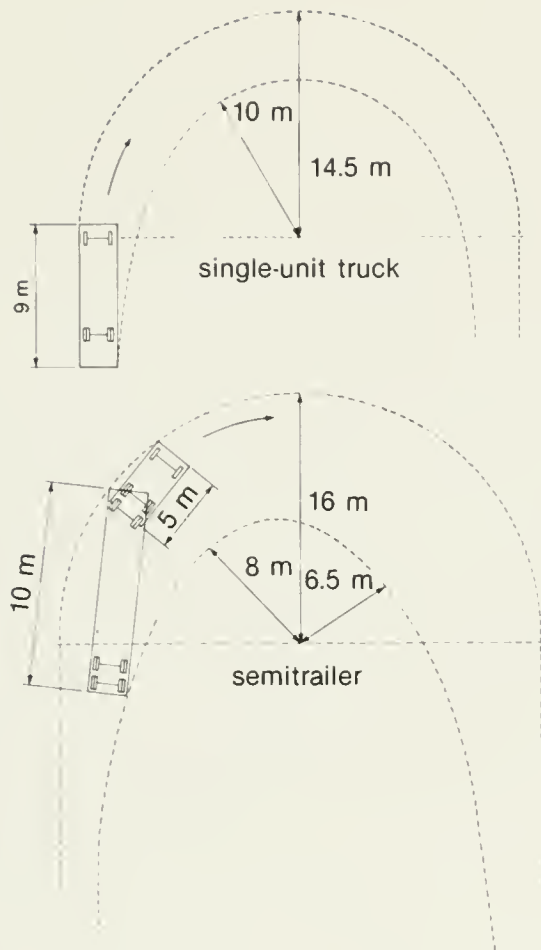


FIGURE A3 Minimum practical turning radii. These dimensions suit both A and B trains.

