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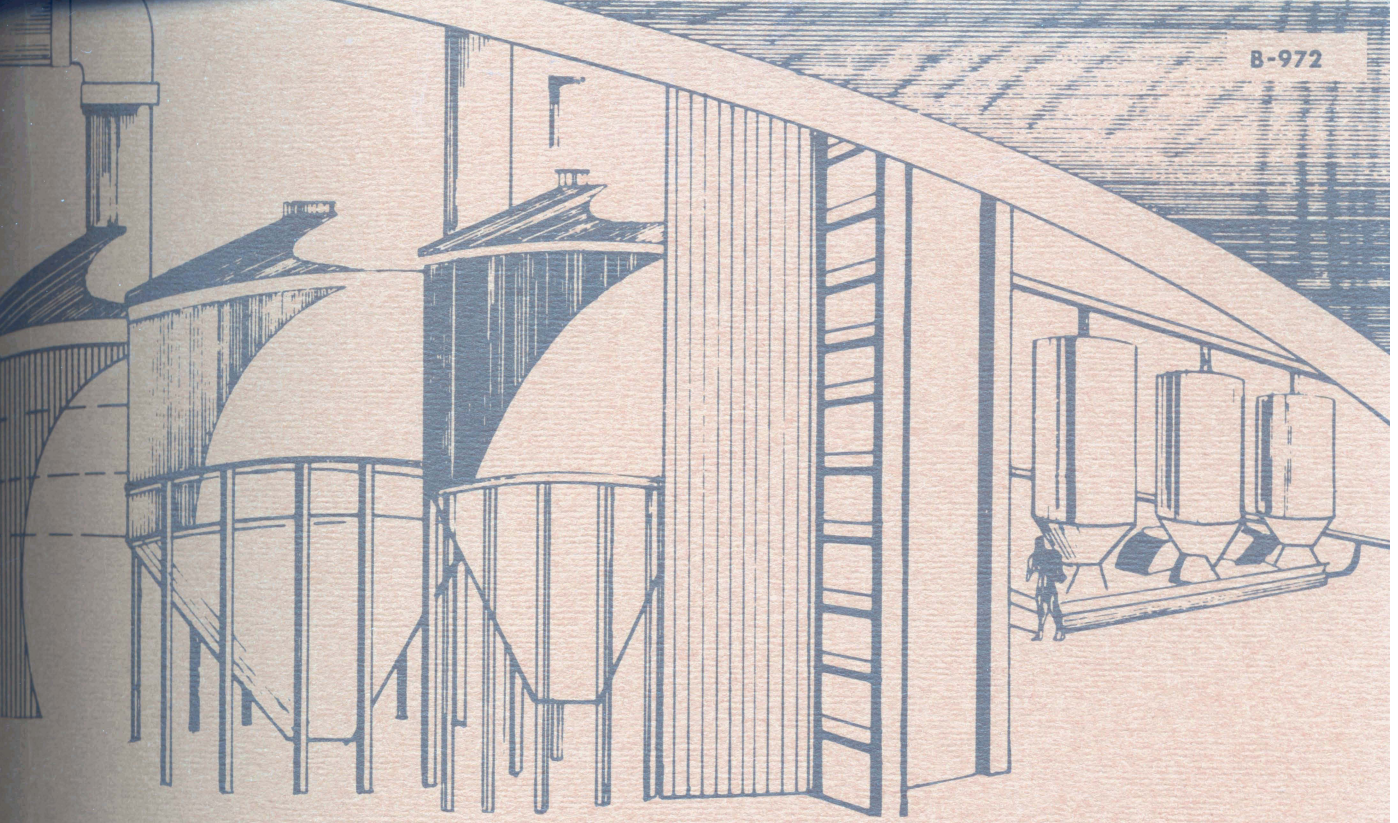

Farm Feed Processing

EQUIPMENT PLANNING DESIGN

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THIS PUBLICATION has been prepared to assist you in establishing your feed storage, processing and handling requirements, based on your own situation and need. By assembling the necessary information and using the System Planning Guide (Example, page 16), you can make a systematic analysis of your requirements.

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Farm Feed Processing & Handling systems

DESIGN, LAYOUT AND INSTALLATION of farm feed processing and handling systems require careful planning. The most common diffficulties and faults with existing systems usually can be traced to improper or inadequate planning.

Before you purchase feed storage or feed handling equipment, make some basic decisions. These decisions will guide you in equipment selection and construction phases of development, and will help eliminate costly mistakes and insure development of an efficient system.

This publication will assist you in establishing your feed storage, processing and handling requirements, based on your own situation and need.

By assembling the necessary information and using the System Planning Guide (page 16) you can make a systematic analysis of your requirements.

PLANNING PROCEDURE

Every poultry and livestock producer must store and handle feeds. Deciding how to do this job and where to place facilities and equipment is the planning phase of developing a feed handling system. The efficiency and economy of this system is determined chiefly during the planning phase.

Planning involves

- An objective analysis of the existing situation.
- An evaluation of your long-time production program objectives and needs.
- A thorough investigation of alternative possibilities.
- A decision regarding the system best suited to your situation and program needs.
- The development of a plan (permanent record on paper) of the overall layout as it is to be when completed.

Use data in this publication to assist you when planning your feed handling system and evaluating alternative methods.

Detailed cost, feed or construction information for specific systems or programs will require additional and more complete data. Sources of more specific information include equipment manufacturers and dealers, building materials manufacturers and dealers, contractors, consulting engineering firms and livestock production authorities.

Suggested Planning Sequence

1. Collect and record all pertinent data.
2. Analyze and evaluate data.
3. Determine system requirements.
4. Select type of buildings, feeding equipment and feed handling methods.
5. Prepare a plan or plans showing proposed locations of feed storage, processing center, corrals and feeding equipment.
6. Select the kind and size of mechanical equipment needed to accomplish desired feed processing and handling.
7. Select the kind and size of power and control equipment for machinery in the system.
8. Secure the technical and professional services needed to assemble and install the system.

The above is a suggested logical sequence of events leading to the development of a feed handling system. Usually you will find the steps so interrelated that actual progress requires concurrent development.

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No single system is likely to fit a given situation exactly in detail and layout. However, the schematic layouts presented may offer ideas for various enterprises common to Texas farms and ranches. Examine your plans for ways to improve and economize as well as to increase efficiency.

SYSTEM DESIGN PROCEDURE

Feed processing requires an efficient plant design layout. The system should meet three requirements: (1) provide adequate storage for grains, supplements and other feed ingredients; (2) provide convenient methods for conveying and handling feed through processing equipment; and (3) provide enough bulk storage for fresh feed so that proportioning, grinding and mixing can be either automatic or performed on a batch basis when this chore does not interfere with other farm jobs.

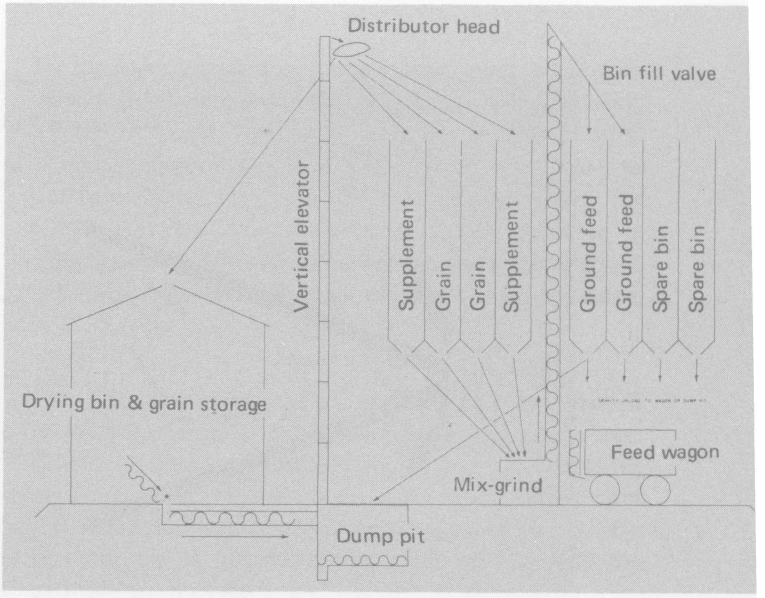


Figure 1. Flow diagram.

Information Required for Design Purposes

1. **Quantity** of materials to be handled or processed. (Table 1)
2. **Type** ration (number, form and percentage of ingredients in ration.
3. Location and type of **existing** facilities.
4. **Storage** required. (Table 2)
   a. Raw materials
   b. Processed ration
5. **Type** and **amount** of equipment required to provide capacity and desired product.
6. Distances involved (storage to processing—to feeding areas).
7. **Conveying** equipment
   a. Type
   b. Size
   c. Layout
8. Flow diagram (schematic diagram showing flow of materials).

Sketch the Layout

Using a scale of ¼ inch = 1 foot, lay out the area containing storage facilities you intend to incorporate into your farm feed handling-processing plant. Locate to scale all grain bins, tanks, driveway cribs and other structures which will be integrated into your plan. Leave adequate space for installation of conveying equipment and removal of portable bin unloading augers. Don't guess at the distances! Careful measurements will save you money when buying equipment—and your conveyors will fit better.

Table 1. Approximate daily feed requirements for livestock and poultry*

Dairy cows	10 lb. per day per cow
Beef cattle (dry lot feed)	20-30 lb. per day per cow
Swine	7-8 lb. per day per animal
Broilers	15 lb. per 100 birds per day
Laying flock	25 lb. per 100 birds per day
Growing flock	12 lb. per 100 birds per day
Turkeys	30-35 lb. per 100 birds per day

*To be used only for estimating capacity requirements of storage, processing and handling equipment.

Table 2. Grains and concentrates

	Whole		Freshly ground	
Product	lb./bu.	lb./cu.ft.	lb./bu.	lb./cu.ft.
Wheat	60	48	50	43
Barley	48	38.4	37	28
Oats	32	25.6	23	18
Rye	56	44.8	48	38
Corn shelled (dry)	56	44.8	48	38
Corn ear (dry)	70	28.0	45	36
Grain sorghum	56	44.8	42.5	34
Soybeans	60	48	37.5	30
Soybean oil meal	—	—	—	36
Linseed oil meal	—	—	40	32
Cottonseed oil meal	—	—	47.5	38
Alfalfa meal	—	—	22.5	18
Alfalfa pellets	55.5	42	—	—
Wheat bran	—	—	17.5	14
Molasses feed	—	—	28.5	23
Salt	85	68	—	—

Corn shelled (30%) moisture -.71 bu./cu.ft.
Corn—ear corn ground (30%) -.55 bu./cu.ft.

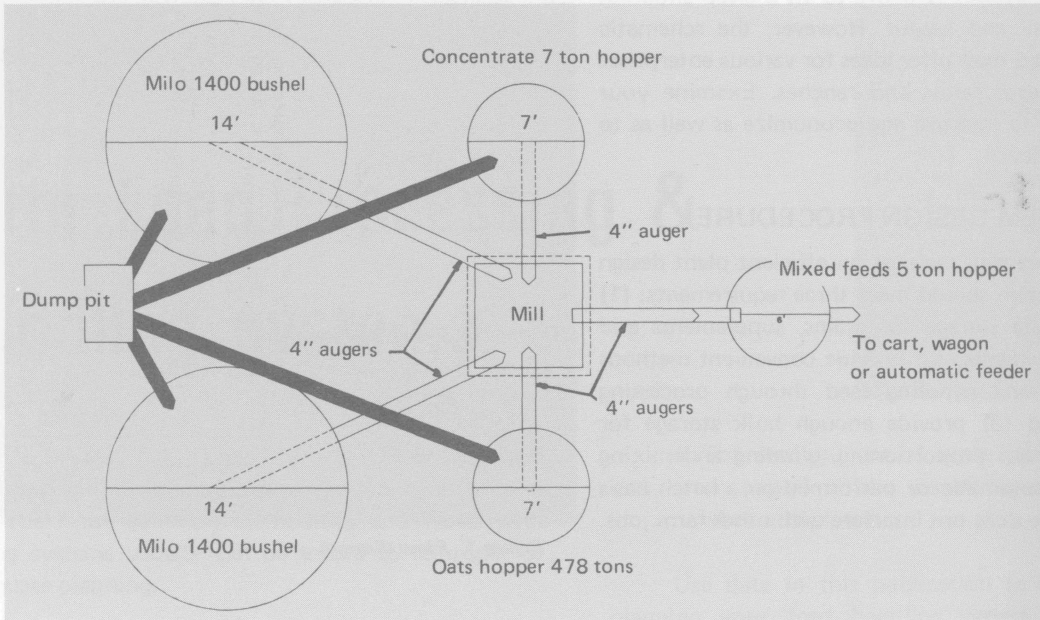


Figure 2. Material flow plan from receiving pump to wagon or automatic feeder.

Plan Material Flow

Using light pencil lines, indicate flow of feed grains and ingredients delivery or purchase until the ration is ground and mixed. From your sketch it will be easy to envision the numbers and estimate the sizes of bins which must be constructed to provide a complete system. If you are building from scratch, bin location is especially important to permit future expansion of storage bins or tanks. (Fig. 1)

Select Proper Equipment

After planning the basic method of handling feeds, select storage structures tentatively, locating them with respect to the feeding facilities; then select the equipment to accomplish the necessary flow of feed.

From the various types and sizes of commercial equipment available, select various components that will accomplish the desired flow. A logical way to do this is to begin where grain or feed enters the system, and select equipment that will move the feed along the desired route.

In a typical system, the following steps will be involved, and equipment selected for each step in order:

1. Conveying grain and ingredients into storage.
2. Removing grain and ingredients from storage.
3. Processing (proportioning, grinding and mixing).
4. Conveying finished feed ration to bulk storage bins or to livestock.

EQUIPMENT REQUIREMENTS

Conveying into Storage

Capacity. Determine the capacity required in bushels or tons per hour before selecting the conveying equipment. In selecting conveying equipment with capacity to match your harvesting, drying or grinding and mixing requirements, follow these suggestions:

200 to 400 bushels per hour. For farming and feeding operations where the automatic electric low-horsepower grinders are to be installed. With a unit of this size, it may be advisable to install a 200- to 250-bushel dump pit to serve as a surge or holding bin for truck delivery. This is the usual capacity for equipment with 4-inch augers and elevators with 5- by 4-inch cups. Such equipment is suitable for feeding a ground grain ration daily to up to 100 dairy cows, or up to 2,500 swine per year, or up to 500 head of beef cattle.

500 to 700 bushels per hour. For farms where harvested small grain, soybeans and shelled corn are hauled with a truck or several trailer wagons. With a processing unit of this capacity, install a 200- to 250-bushel dump pit to serve as a holding bin to permit continuous operation of the vertical elevator. Equipment is medium-sized, such as a 6-inch auger with 7" x 4" elevator cups. This equipment is suitable for 500 to 1,200 beef cattle or 5,000 swine per year.

1,000 to 1,200 bushels per hour. For farming operations where harvesting of small grain, soybeans and shelled corn requires large combines or four-row corn

heads. Install a dump pit or provide hoppers for rapid unloading of trucks and wagons. Equipment will be 8- or 10-inch augers with 8" x 5" elevator cups.

Equipment

Equipment for conveying feed into storage includes:

1. Receiving dump.
2. Vertical or inclined elevators or augers.
3. Distributor directing flow to storage or holding bins, wagon reloading spout or processing equipment.
4. Delivery augers or gravity spouts to bins, dryer or points of use.

Receiving dump

A below-surface concrete dump pit is most practical except where portability is required because of existing scattered bins or perhaps because of use on rented farms. The dump pit should hold 200 to 300 bushels of grain. It serves as a "surge" or wet corn holding bin for continuous batch dryers.

Vertical lift

Use either a vertical auger or cup-type elevator, depending on the size of system and amount of lift required. An auger requires three to four times more power to lift grain than does a cup-type elevator. In general, vertical augers wear out faster than cup elevators. The initial investment, however, is usually less for the auger installation. Large motors using three-phase current or phase converters may be required when using a vertical auger for large capacities and high lifts. Vertical augers are usually preferred for 200- to 400-bushel-per-hour systems and cup elevators for 1,000- to 1,200-bushel-per-hour systems. Either is satisfactory for 500- to 700-bushel-per-hour systems; the choice depends on life, height, price and power available.

Distributor

This unit controls flow of grain or feed to selected points of storage or use. (See figures 2 and 3.) Grain distributors are available with controls from two to 12 points. A six-duct distributor is usually required for farm use. Allow for "lost head" when using a distributor. This is about 24 to 36 inches and must be added to the vertical elevator height required.

Delivery to bins or place of use

For centrally located storage bins clustered around the vertical elevator, use gravity spouts for delivering grain and feed from distributor to bins or other desired points. (See figure 3.) Be sure to plan enough additional height on the vertical lift so that spouts will have enough slope for free flow. (See Table 3.)

For units using large, flat storage or where existing scattered bins are used, an impractically tall vertical elevator may be required if gravity spouts are used. In this case, it will be necessary to use horizontal augers to deliver grain and feed to bins or points of use. (See figure 3.) When using augers, always keep bins in straight lines so that one auger with multiple outlets can be used to fill several bins. Horizontal augers must be matched in capacity to the vertical elevator.

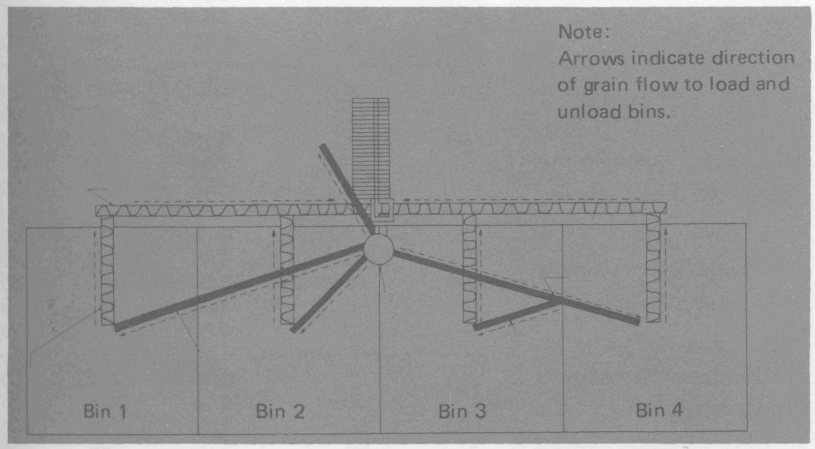


Figure 3. Flow pattern to and from grain or ingredient bins.

Table 3. Slope, vertical lift and spout length requirements for gravity flow of ingredients*

Type of material handled	Minimum slope from horizontal (degrees)	Required dimensions per foot of horizontal distance from elevated outlet to center of bin: Additional vertical lift for elevator above top of bin	Length of spouting
Dry grains and shelled corn	35	0.70	1.22
Coarse, dry, ground feed and pellets	45	1.00	1.42
Wet shelled corn, grains and finely ground feeds	60	1.75	2.04

*Example: The center of a bin to hold grain is 15 feet from the vertical elevator. To fill this bin by gravity from the elevator will require a smooth spout at a 35 degree incline. Allow 10½ feet (0.7 x 15) of additional vertical lift at the elevator. Spout will be 18¼ feet long (1.22 x 15).

Augers

Augers are used in countless situations for handling materials. They are adaptable to many farm feed and grain handling operations. To reduce labor to a minimum, it usually is necessary to incorporate several augers into the "system." Where more than one auger or component is part of the system, select and fit each to deliver a certain amount of material to the next auger or piece of equipment.

Selection of augers depends on several factors. Those most important to the farm feed processing system include:

- Kind of material to be conveyed
- Auger speed
- Auger length
- Intake opening
- Angle of inclination
- Capacity required

Data on auger capacity and power requirements appear in Tables 4 and 5. Observe the following precautions in the layout of any systems:

- Consider the maximum capacity-horsepower relationships of materials to be conveyed.
- If more than one kind of material is to be conveyed, check the maximum horsepower required. Choose the largest motor for the speed, capacity and angle desired. Motors should be totally enclosed.

Table 4. Maximum capacity and power requirements of 4-inch auger conveyors

Speed rpm	Angle from horizontal, °	Approximate hp per 10 ft. length	Maximum capacity, bu./hr.: Wheat	Oats	Ground feed ration
300	0	0.22	220	200	220
	30	0.26	170	160	230
	45	0.26	140	140	190
	60	0.25	105	105	160
	90	0.21	60	40	40
400	0	0.28	290	260	290
	30	0.34	215	200	335
	45	0.34	190	170	270
	60	0.32	150	130	215
	90	0.28	80	60	170
600	0	0.35	420	340	500
	30	0.46	300	270	525
	45	0.47	250	220	390
	60	0.46	205	175	325
	90	0.41	140	90	240
800	0	0.42	435	355	700
	30	0.55	345	300	650
	45	0.62	300	265	500
	60	0.58	245	205	205
	90	0.43	165	115	290

Table 5. Maximum capacity and power requirements of 6-inch auger conveyors

Speed rpm	Angle from horizontal, °	Approximate hp per 10 ft. length	Maximum capacity, bu./hr.: Wheat	Oats	Ground feed ration
300	0	0.50	810	770	890
	30	0.58	595	570	780
	45	0.60	490	470	600
	60	0.52	370	345	550
	90	0.45	230	230	500
400	0	0.60	1,000	900	1,030
	30	0.71	710	650	880
	45	0.70	580	530	670
	60	0.64	460	405	600
	90	0.55	330	270	560
600	0	0.80	1,180	1,050	1,270
	30	0.85	850	730	960
	45	0.90	690	600	820
	60	0.86	575	470	720
	90	0.80	450	340	650
800	0	0.64	1,100	1,000	
	30	0.98	870	735	
	45	1.05	715	600	
	60	1.05	595	480	
	90	1.01	465	355	

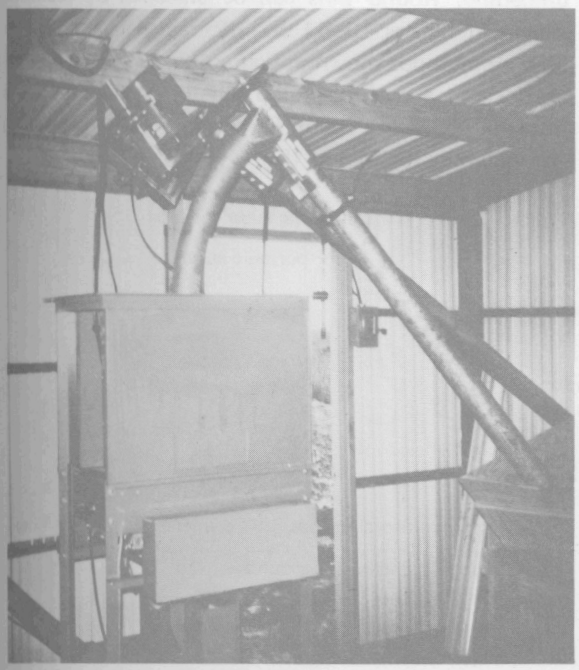


Figure 4. One of several automatic mills that control, grind and mix a ration with a minimum of supervision or labor. Augers deliver the ingredients from bins to the mill.

Figure 5. A vertical auger with feeding hopper for elevating grain from trucks to storage bins.

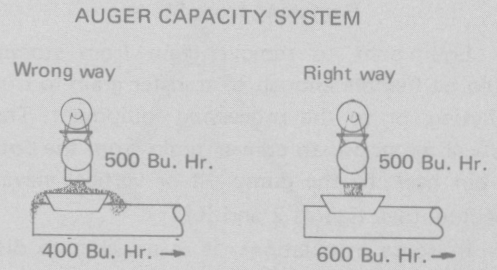


Figure 6. Augers should be selected to handle the quantities delivered to them by other augers in the system.

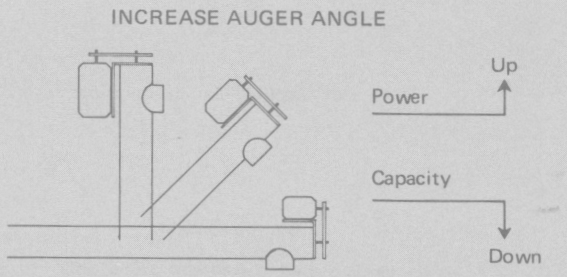


Figure 7. Increasing the angle of the auger increases the power required and reduces the capacity.

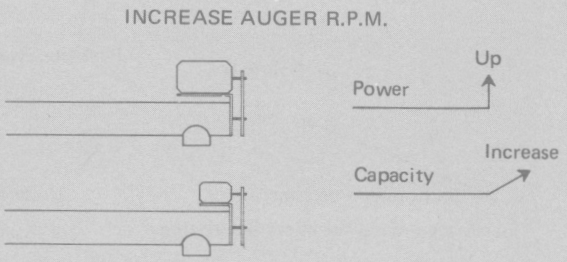


Figure 8. Increasing the r.p.m. of the auger increases the capacity but also increases the power requirements.

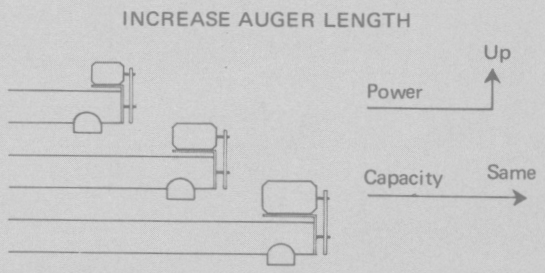


Figure 9. Increasing the auger length requires more power to maintain the same capacity.

Removing from Storage

Equipment to remove grain from storage bins should be flexible enough to transfer grain to trucks for marketing, or to the processing equipment. The most practical method is to convey grain from the bottom of the bin back to the dump pit or vertical elevator for reloading. (See figures 2 and 3.)

In some installations, it is possible to discharge bin-unloading augers directly into the vertical elevator intake. This method is limited to small installations or to larger systems using vertical storage tanks, since all bins must be grouped closely to the vertical elevator. Provide cross-conveyor to collect the discharge if grain is stored in several small bins or if flat storage is used. (See figure 3.) This is easiest to arrange if bin discharges are in a straight line. An auger in a U-trough, or an open drag conveyor can be used to transfer material from the bins to the vertical lift.

Equip all bins for either mechanical or gravity unloading. Round bins can be unloaded by methods shown in figures 10, 11 and 12; rectangular or square bins by methods shown in figures 3 or 12. If storage bins are located above the dump pit, they can be unloaded into the pit with a spout. Some additional arrangements are shown in 13, 14 and 15.

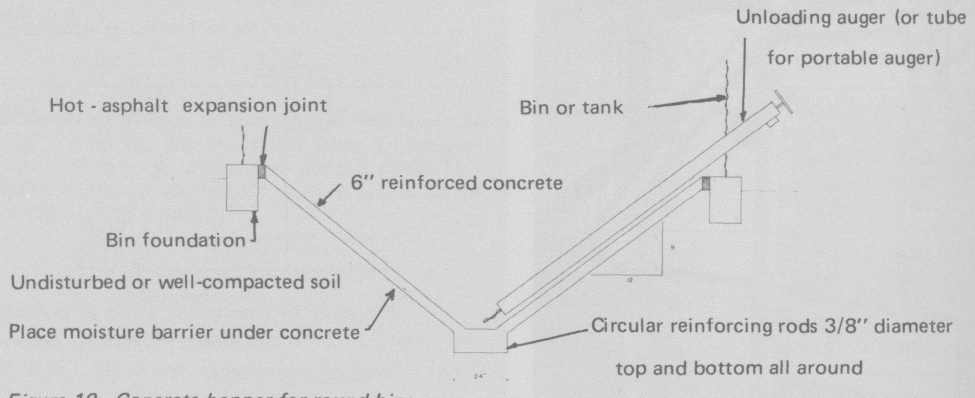


Figure 10. Concrete hopper for round bins.

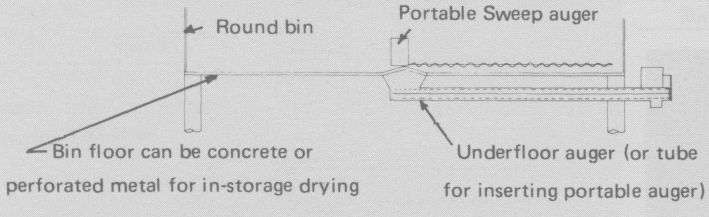


Figure 11. Equipment for unloading grain from round bins.

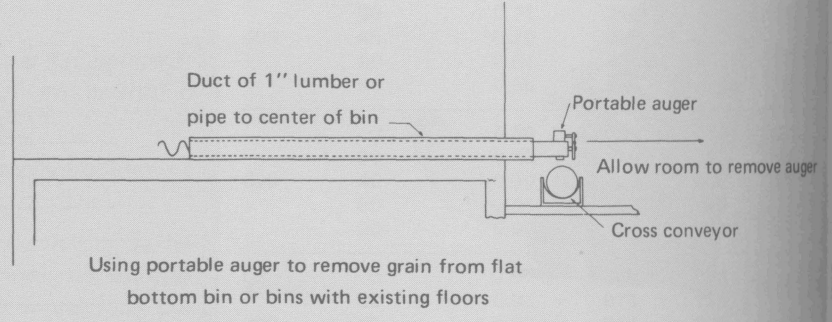


Figure 12. Using portable auger to remove grain from flat bottom bin or bins with existing floors.

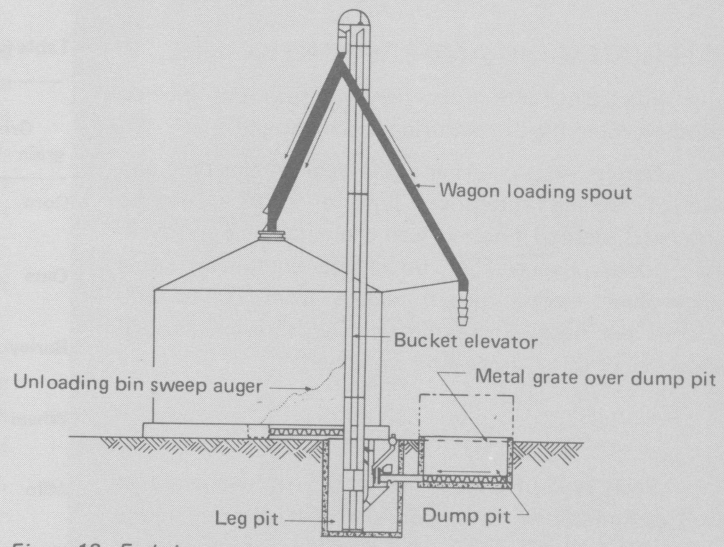


Figure 13. End view.

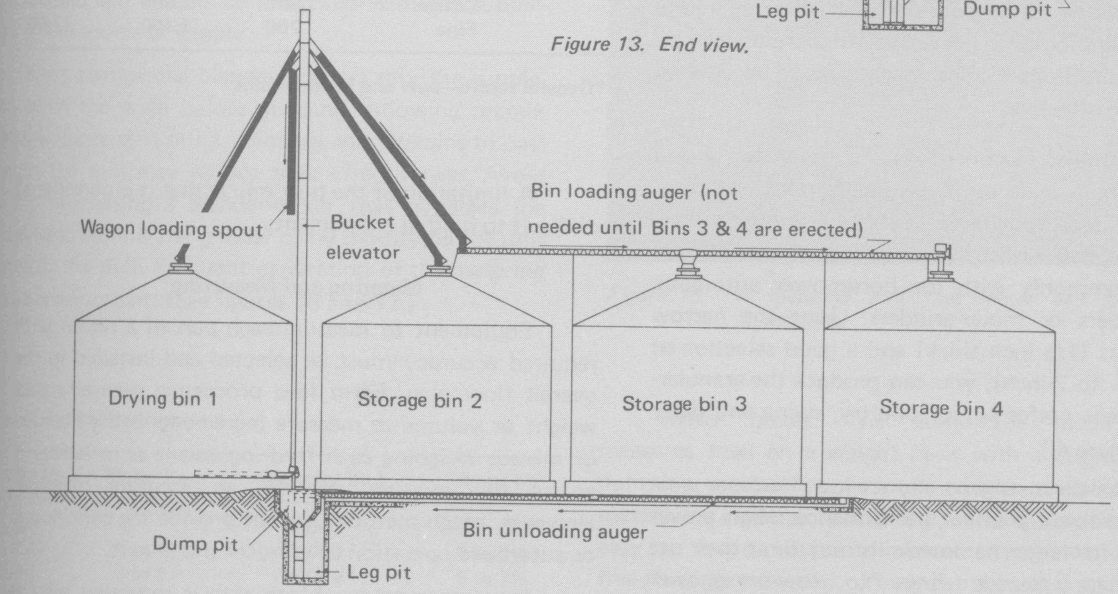


Figure 14. Side view.

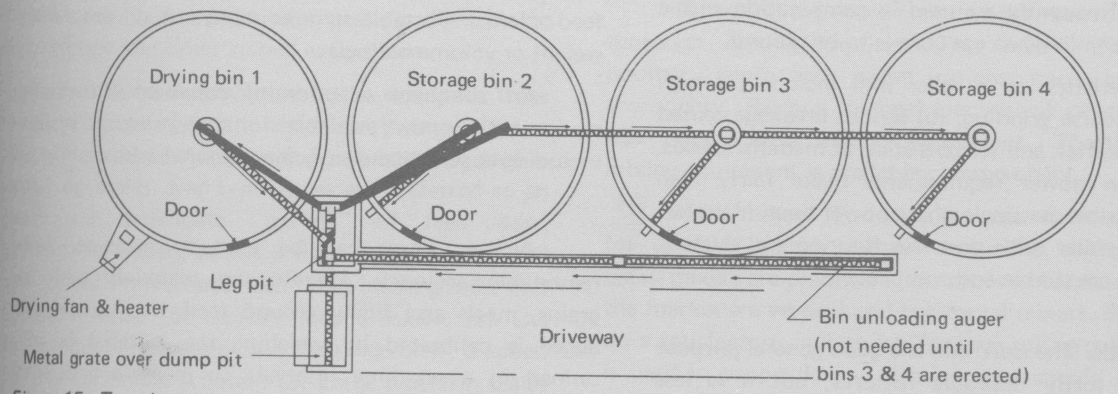


Figure 15. Top view.

Typical in-line processing system.

PROCESSING AND PROPORTIONING

Processing and proportioning operations include grinding, metering or measuring and mixing.

Determine processing equipment by the type and size of feeding enterprise, type of products to be processed, desired finished feed characteristics and available power. Capacity of processing equipment using single-phase electric power ranges from 50 to 300 bushels per hour. Three-phase power, if available, will allow use of larger processing equipment.

GRINDING

Each type of grinder has particular advantages, as well as limitations, to be considered in selecting equipment. All mills should be protected from tramp iron by a magnet in the hopper. The magnet must be cleaned regularly to be effective.

Hammermills. Hammermills are preferred if you plan to process a wide range of small grains, ear corn, shelled corn and roughages. Portable grinder-mixers often are equipped with hammermills. Hammermills are used most commonly with low-horsepower automatic electric blenders or mixer-grinders. Using the narrow blade hammers (1/8 inch thick) and a good selection of screens (1/16- to 2-inch), you can produce the granular-type fine grinds preferred for poultry, swine and dairy feeds. (See figure 4.)

Maintenance costs generally are low. Hammer wear does not significantly affect performance. High power requirements for larger hammermills may limit their use on single-phase electric lines to low-horsepower automatic electric mills.

Crimpers, crushers or roller mills. Crushers reduce material by pressing or squeezing it until the material breaks. They frequently are used in combination with a burr or hammermill when ear corn is to be ground.

Characteristics of a roller mill include (a) high capacity for coarse grinding; (b) serious breakage caused by foreign material; and (c) operation at medium speeds. Relatively low power requirements make fairly high capacities possible on single-phase power lines. Manufacturers report roller mills give less flouring and dusting. The machines are simple and compact.

Burr mills. The burr mill is a good general-purpose grinder with many desirable features, but it is less popular than roller mills and hammermills. Improved models that increase mill capacity and reduce maintenance are now available. These will handle small grain, shelled corn and ear corn.

Table 6. Approximate rates of grinding in pounds per hour*

Grain	Grinding classification	Size of motor 2 hp	3 hp	5 hp
Corn				
	Coarse	1,650	2,500	3,500
	Fine	620	900	1,200
Oats				
	Coarse	600	1,000	1,500
	Fine	225	350	450
Barley				
	Coarse	600	900	1,400
	Fine	150	250	500
Wheat				
	Coarse	1,600	2,400	3,000
	Fine	600	1,000	900
Milo				
	Coarse	1,800	2,600	4,000
	Fine	700	1,100	1,000

*General results—burr and hammermills

A limitation of the burr mill is that it is considered difficult to hold in adjustment.

Metering and Measuring

Equipment to measure each part of a ration with required accuracy must be selected and installed in the overall flow plan. Farm feed processing generally uses weight or volume to measure ingredients being blended or mixed. Weighing each feed ingredient as or before it enters the mixture provides an accurate measure. However, batch methods do not provide for continuous or automatic operation of grinders and mixers.

In some systems, batch size is regulated by the amount of the least ingredient. When that ingredient is gone, a flow switch automatically shuts off the equipment. For this reason, calibrated volumetric systems most often are used with blender-grinders in automatic feed plants. Portable grinder-mixers may use either weight or volume methods.

An adequate selection of commercial metering equipment is now available for any practical system including augers, blenders, scales and meter boxes.

Augers. These can be used to measure, with reasonable accuracy, free-flowing materials such as grains, meals and finely ground feed. In practice, the auger is calibrated by weighing the material it will unload in a set time interval. To measure a desired amount of ingredient, the auger is run for a calculated time interval based on its unloading rate. For accuracy, use a stop watch or electric timer. Augers must be recalibrated frequently to maintain accuracy.

Blenders. Commercial automatic equipment is available to proportion four or more ingredients to a ration in a preset ratio. These are available using variable speed augers, horizontal belts with adjustable feed tubes, or fluted wheels with adjustable feed gates. Various methods are provided for calibrating each ingredient as it passes through the blender.

This equipment provides a volumetric method of measuring grain and supplements for poultry, dairy, swine and other feeds where several ingredients are free-flowing. Blending equipment has serious limitations with materials such as bran or those containing fats which do not feed down well through small vertical gravity spouts. Materials such as drugs, minerals, vitamins and salt should be premixed with the supplement at the source of supply.

Most commercial blender-grinders mix the supplement with the grain before grinding. Allowing premix materials containing drugs, minerals and vitamins to pass through the mill may reduce their effectiveness. Avoid this by purchasing a blender-mixer that bypasses the supplement around the grinder or by modifying the unit to bypass the mill. Frequent calibration of the metering devices is important. (See figures 16 and 17.)

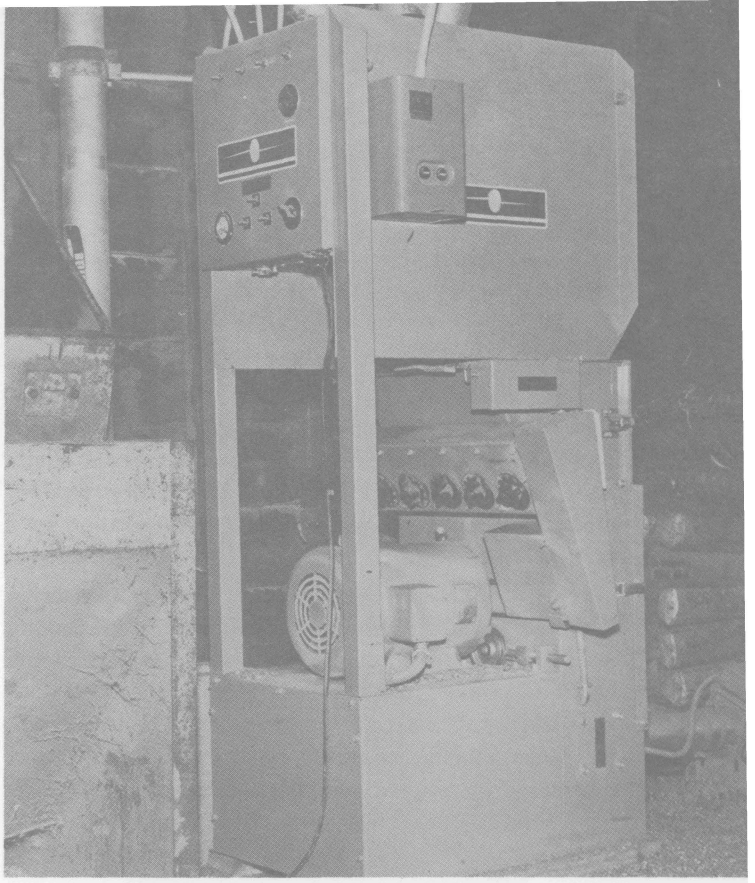


Figure 16. A metering mill that mixes and grinds four ingredients.

Table 7. Typical mixer ratings

Capacity (lb.)	Motor hp	Capacity (lb.)	Motor hp
250	½	2,000	3 to 5
700	1 to 2	3,000	5 to 7½
1,000	3 to 5	4,000	5 to 7½

Scales. Weighing on accurate scales is the only method acceptable for production testing, determining feed conversion and other animal evaluations.

Scales can be incorporated into a system in three ways: (1) For complex rations for dairy or poultry, a hopper-bottom bin large enough for a batch of feed is mounted on scales. Dial-type scales are preferred so an operator can anticipate "cut-off" of feed flow. Ingredients are added, one at a time, until the required weight for each is reached. Feed flows into a grinder and then into a mixer, or directly into a mixer. (2) The mixer is mounted on scales and each ingredient is added in turn to formulate a batch. (3) Large platform scales are used to accommodate a wagon, truck or grinder-mixer while it is on the scales. This method works well in large-scale feeding operations. It is desirable to have the scales under a roof.

Meter boxes. The dump-type meter, which measures feed on a weight basis with a counterweight dumping mechanism, is now widely available. These meters are reasonably accurate, simple, economical and easy to incorporate into almost any system handling free-flowing materials. They can be used to measure ingredients into a portable or stationary grinder-mixer or to measure feed into a feed wagon or truck. (See figure 18.)

Mixing

Generally, the more complex the ration, the more thorough mixing required. This means that dairy, poultry, lamb and swine rations must be mixed thoroughly. Rations for beef feeding will permit use of less complicated mixing equipment. The following mixing equipment is available commercially.

Batch mixers. To formulate separate feed batches for complex dairy, poultry, sheep and swine rations, batch mixers are practical. Two types of batch mixers on the market are vertical and horizontal mixers. Either will do a satisfactory mixing job for farm use, providing care is used in proportioning. Mixing time should exceed 5 minutes.

Vertical mixers. These use an upright inverted cone tank with a vertical auger in the center to mix the feed. The smaller, less costly mixers are usually vertical.

Typical stationary vertical mixers are available in models ranging from ½ ton, requiring a 3-horsepower motor, to a 3-ton model, requiring a 15-horsepower motor.

Portable grinder-mixers usually are equipped with vertical mixers. Their capacity is about 2 tons per batch. The height of ceiling required for installing vertical mixers is a limiting factor for stationary units. Typical 3-ton mixers require an overhead clearance of 20 feet.

The vertical mixer is well adapted for handling all types of well-ground grains and forages such as alfalfa hay, supplements and premixes. Use a dry type of molasses when it is to be mixed with a ration in a vertical mixer.

Horizontal mixers. These use a horizontal U-shaped tank. A horizontal shaft equipped with paddles or spiral ribbons provides the mixing action. Some horizontal mixers use three large augers mounted horizontally parallel. Because they require less head room, the larger mixers are usually horizontal and are most often used as stationary units. Power requirements range from 5 to 10 horsepower for a ½-ton mixer up to 20 to 30 horsepower for a 3-ton model.

The horizontal mixer is adapted for mixing coarse roughages, such as silages, with grain. It is preferred if molasses or other liquids are used in the ration.

Conveying Finished Rations

Processed feeds may be held in bins for future use or taken directly to livestock or poultry for immediate consumption. The type of grinding-mixing system used will influence handling of the finished ration.

Figure 17. Hammer mills that mix and grind also are available as roller mills.

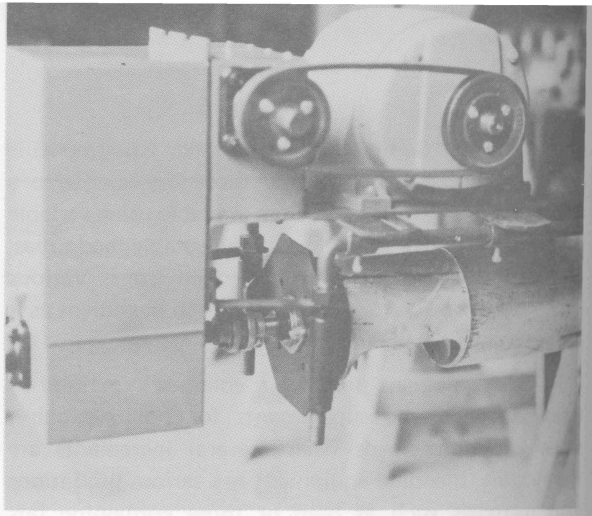


Figure 18. Volumetric metering devices that attach to augers can be useful in measuring feed ingredients or a finished feed ration.

With continuous automatic distributor systems, small automatic electric blender-grinders can be equipped with auger conveyors to transfer the finished ration from the processing site. With batch systems, horizontal or vertical mixers may be used to prepare small batches for immediate consumption or to prepare larger batches for storage. After mixing in either a batch or continuous system, the feed may be:

- Elevated directly into overhead gravity unloading bins to be withdrawn as needed for transport to point of consumption.
- Conveyed into hopper-bottom metal batch bins and augered into self-unloading feed wagons as needed.
- Conveyed directly to bulk bins that supply an automatic feeding system for livestock or poultry.
- Returned to dump pit to be elevated into storage.
- Conveyed directly into self-unloading feed wagon.

With portable grinder-mixers, the feed is usually taken directly to point of consumption and unloaded.

MOBILE POWER WAGONS FOR BATCH DELIVERY

Although power-unloading wagons require more labor than automatic distributors, they offer more flexibility in planning and operation.

Power wagon systems offer these advantages: (1) Feeding area can be located away from feed storage and processing area and can be changed to different locations with ease. (2) Size changes are easier to accomplish. (3) Forage storage need not be in same area as concentrate storage and processing, and need not be incorporated as fully into overall plan.

Power wagons with auger unloaders are suitable for handling grain and ground feed. They are satisfactory for transporting grain and filling self-feeders with concentrate.

If the power wagon is to be used to handle roughage such as silage and chopped hay, the type with drag or belt conveyors and mixing beaters is preferred. Many of these wagons will also handle grain or ground feed separately with optional, low cost grain-tight attachments (See figure 20.)

Figure 20. Delivery of the finished ration by wagon.

AUTOMATIC FEED PROCESSING CENTERS

One of the most recent developments in on farm feed processing systems is a complete "packaged" unit. These automatic feed processing centers usually include weatherproof overhead storage bins to hold 20 or more tons of grains and feed ingredients; a dump pit and vertical auger or elevator for loading into storage; processing equipment including proportioning devices, with a hammer or roller mill-blender; discharge conveyors. The finished ration may be conveyed to a holding bin, auger wagon or directly to self feeders.

These "packaged" units may be the solution to feed processing and handling problems when space is limited or where a producer has no existing facilities to incorporate into a system. (See figures 19, 21, 22 and 23.)

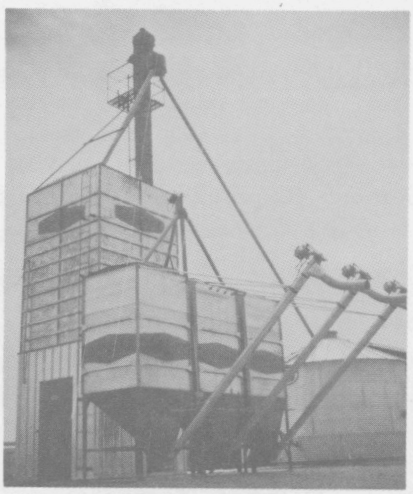


Figure 21. An automatic feed factory with three different ration bins for a swine operation.

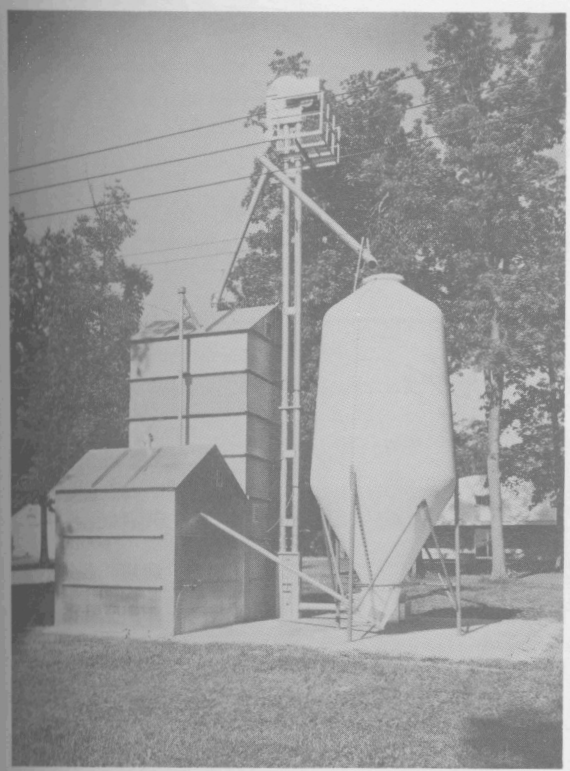


Figure 19. Complete "feed plants" are available. New devices including roasting equipment are being developed continuously.

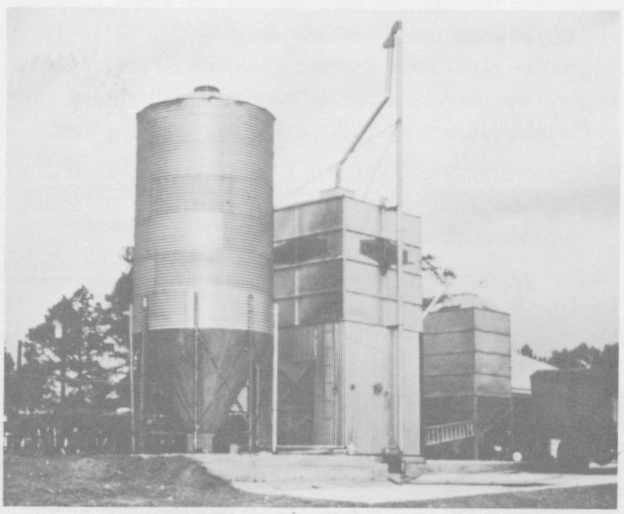


Figure 22. An automatic feed mill with overhead storage used in a dairy operation.

Figure 23. An automatic mill with extra grain storage that can be transferred to the overhead bins periodically.

SYSTEM PLANNING GUIDE

EXAMPLE

1. General data:

Number of animals or poultry: Laying Flock - 8000 Birds; Replacement Flock - 3200 Birds

What facilities exist: 5 Laying Houses; 2 Replacement Houses; ONE 5 Ton Hopper Bin

Is grain purchased or grown: Milo to be bought in 100,000# lots; Oats by truck lot

Other: Replace a complete house of layers each week, has electric cart for feeding

Intentions: Process own feed; automatic; add storage

2. A. Ration: **Required for determining number of bins**

Laying flock; 1420# milo; 80# oyster shell; 500# concentrate

Replacement flock; 1100# milo; 650# oats; 250# concentrate

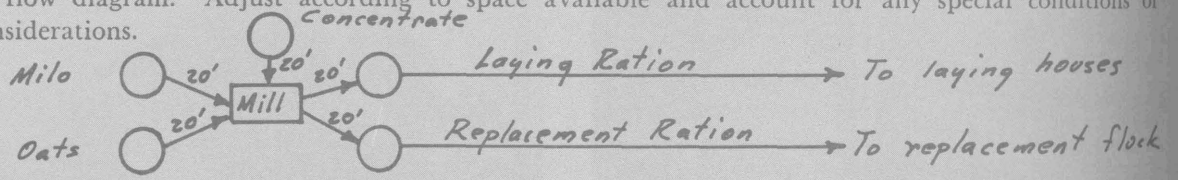
B. Storage space required for:

Grain (Kind and amounts each)	Concentrate (Kind and amounts each)	Processed (Kind and amounts)
100,000# Milo	12,500# Concentrate	25#/100 birds per day
600 Bushels Oats	oyster shells in socks	$\frac{8000}{100} \times 25\# = 2000\#$ layers
		$\frac{3200}{100} \times 12\# = 384\#$ or 400# replacement

3. Type and size of equipment that possibly fit into system:

Bins	Processing Equipment	Conveying Equipment
Milo - 100,000# = 1800 bu. bin.	Mill to process 2400#/day	Augers
Oats - 600 bu = 20,000# = 10 ton tank	Mix mill at 1200# per hour will require 2 hours operation per day	
Laying ration uses 5 ton tank on hand		
Replacement ration requires 3 ton tank		

4. Flow diagram (sketch all components) in tentative arrangement. Place tentative bins and equipment on flow diagram. Adjust according to space available and account for any special conditions or considerations.



5. Size conveying equipment (Compute auger sizes and horsepower requirements).

Milo: 4" auger at 45° (300 rpm) See Table 4 - $\frac{20}{10} \times .26 = \frac{1}{2}$ HP motor

Oats: 4" auger at 45° (300 rpm) See Table 4. - $\frac{20'}{10} \times .26 = \frac{1}{2}$ HP motor

Concentrate and Ration Augers: 4" auger at 45° (300 rpm) See Table 4. - $\frac{20'}{10} \times .26 = \frac{1}{2}$ HP motor

6. Have engineering drawings and specifications prepared.

Consult your county agent, power supplier, equipment dealers and visit any local installations for ideas and help.

Have working drawings, specifications and bid proposals prepared if competitive bids are to be requested. If installation is to be done by owner, it will pay to have plan checked by equipment dealer, equipment engineering department, and other available sources of competent aid.

COSTS

Changing from custom feed processing on the farm or at the feed mill to on-farm processing requires an additional investment in a grinder-mixer, building, augers and supplement bin, unless some of this equipment already is available.

Relevant costs to consider when comparing the two methods of feed procurement are the *custom rate per ton* and the *total cost per ton* for feed processing include depreciation, interest, insurance, taxes and repairs on the equipment and required working bins. (See figures 24, 25 and 26.) Variable expenses include additional labor and power required to operate the equipment. Ownership costs for grain bins are not relevant in comparing on-farm and custom processing, since the bins are common to both systems. Table 8 lists additional investment cost and annual ownership costs that would be incurred with on-farm feed processing for both the stationary mill and mobile grinder-mixer. Costs for the supplement bin are included in these estimates.

Annual ownership costs amount to $488 for the stationary electric mill and $491 for the mobile grinder-mixer.

Operating costs associated with the stationary electric mill are small. Cost of electricity for operating a 3 horsepower unit and augers was estimated at $.12 per ton of feed processed. Since the unit is automatic, the only labor required is for starting the mill and routine maintenance work. Total labor required for these chores was estimated at 30 minutes per week regardless of tonnage processed. With labor valued at $2 per hour, the annual cost of labor for a stationary electric mill would be $52.

Cost per ton of operating a mobile grinder-mixer generally exceeds that of the stationary unit. Approximately 20 minutes is required per ton of feed for hooking up, grinding, mixing and unloading. At $2 per hour, labor cost per ton of feed processed would be $.60. The cost for power supplied by a 50 horsepower tractor was estimated to be $.47 per ton.

A recent University of Missouri study* shows that farmers who processed an average of 332 tons of feed annually spent less than an hour a week with their mills. Most of this time was used for adjusting the mill for specific rations, changing screens and general mill supervision. Farmers expect these mills to last from 10 to 15 years, depending upon how much feed they process annually. Typical annual ownership and operating cost data developed in this study are shown in Table 8.

Table 8. Investment cost and annual ownership costs, by type of unit*

Item	Stationary electric mill	Mobile grinder-mixer
Investment	$3,175	$3,015
Annual ownership cost		
Depreciation, initial cost—10 years	318	300
Interest, ½ initial cost x 6%	95	90
Insurance and taxes, ½ initial cost x .7%	11	11
Repairs, initial cost, x 2% for mill x 3% for grinder-mixer	64	90
TOTAL	$ 488	$ 491

*On-Farm Feed Processing—Will it Pay? North Carolina Agricultural Extension Service, Cir. 490, February, 1968.

Table 9. Feed processing costs—electric blender-grinders*

		Annual costs for given tonnage					
		50	100	200	400	800	1200
Fixed Costs							
Depreciation, mill & accessories	(1)	$165.50	$165.50	$165.50	$165.50	$165.50	$165.50
Interest	(2)	60.00	60.00	60.00	60.00	60.00	60.00
Insurance and taxes	(3)	20.00	20.00	20.00	20.00	20.00	20.00
Housing, mill	(4)	10.00	10.00	10.00	10.00	10.00	10.00
Housing, auger wagon	(5)	20.00	20.00	20.00	20.00	20.00	20.00
Variable Costs							
Repairs & replacements, $0.066/ton	(6)	3.30	6.60	13.20	26.40	52.80	79.20
Maintenance time costs, $0.048/ton	(7)	2.40	4.80	9.60	19.20	38.40	57.60
Supervisory time costs, $0.24/ton	(8)	12.00	24.00	48.00	96.00	192.00	288.00
Electricity, $0.0875/ton	(9)	4.38	8.75	17.50	35.00	70.00	105.00
Total, $/year		$297.58	$319.65	$363.80	$452.10	$628.70	$805.30
Total cost in $/ton		$ 5.50	$ 3.20	$ 1.82	$ 1.13	$ 0.79	$ 0.67

*Based on a study of 103 mill users, an estimated $2,000 mill cost, and current labor costs.

(1) Based on an estimated average mill life of 12 years or 8.25%. Even though study indicated a reported expected life of 13.35 years, this seems more practical today with new technology.

(2) Interest at 6%/year on average investment or 3% of initial.

(3) Insurance and taxes—1% of new value.

(4) Housing on mill = required space x $1.00/ft.^{2} x 10%.

(5) Housing on auger wagon = required space x $1.00/ft.^{2} x 10%.

(6) Repairs and replacements = $0.066/ton based on average cost of repair and replacement of 49 mills.

(7) Maintenance time cost = $0.48/ton based on 13.7 minutes/week and average of 332 ton/year with time labor cost of $2.00/hour.

(8) Supervisory time cost = $0.24/ton based on 45.3 minutes/week and average of 332 ton/year with a time labor cost of $2.00/hour.

(9) Electricity costs = $0.0875/ton based on 3.5 KWH/ton for operating mill supply augers and discharge auger with electricity at 2.5 cents/KWH.

*Selecting Small Electric Mills for On-Farm Feed Processing Systems, University of Missouri—Columbia Extension Division, Science & Technology Guide, July, 1969.

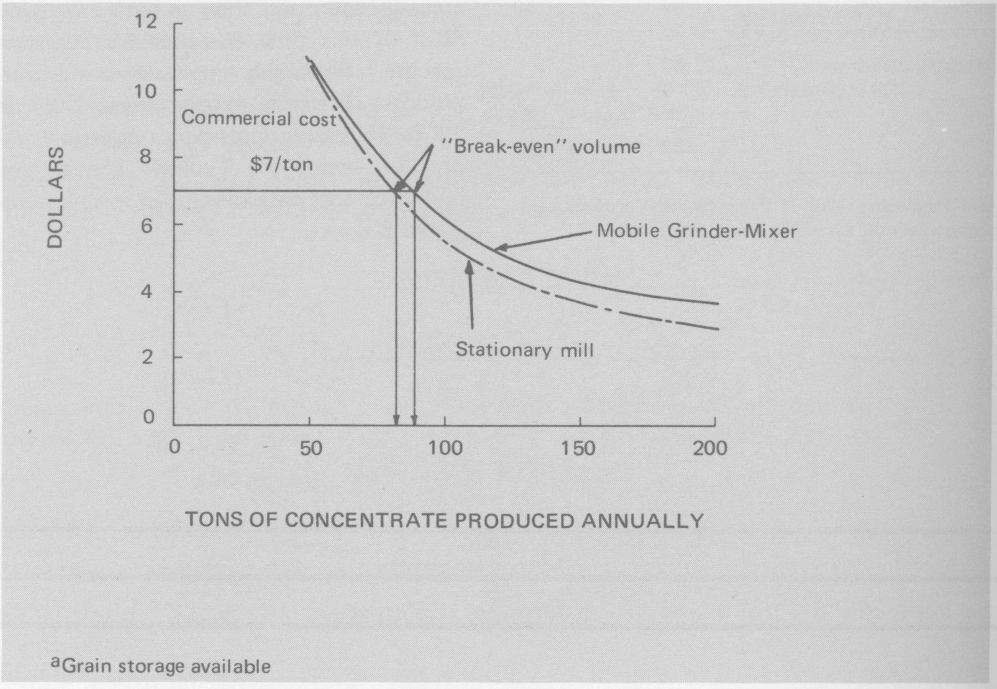


Figure 24. Per ton costs of processing feed on farm at different volumes and break-even point with commercial costs at $7 per ton[a].

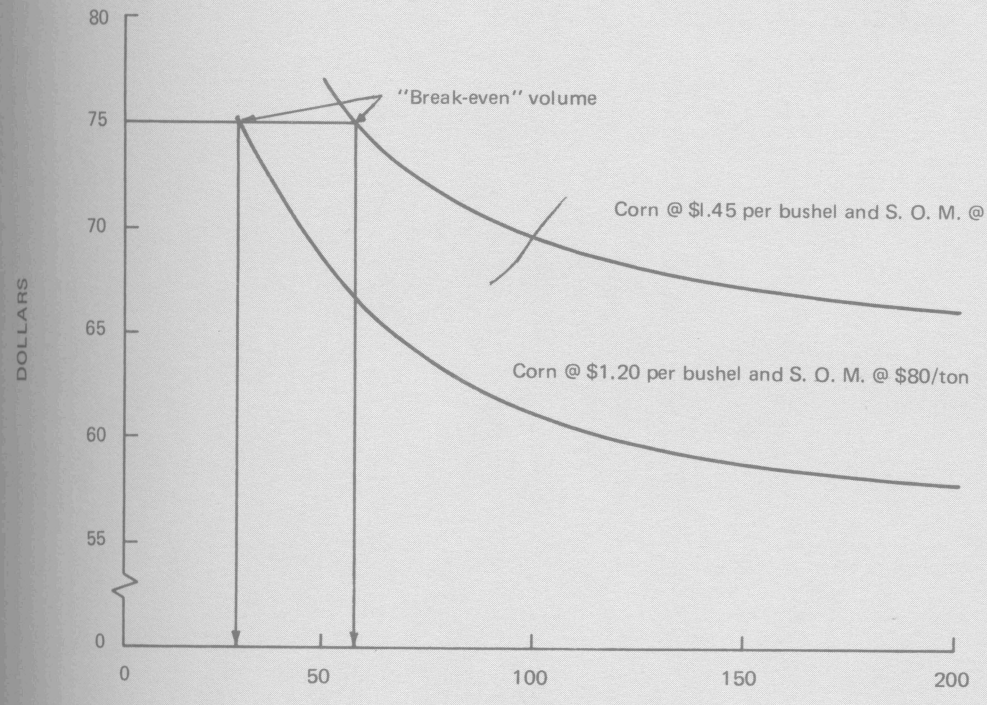


Figure 25. Stationary mill—per ton cost for a 16 percent ration prepared on farm at different volumes; two price levels for ingredients; and break-even point with purchased ration at $75 per ton.

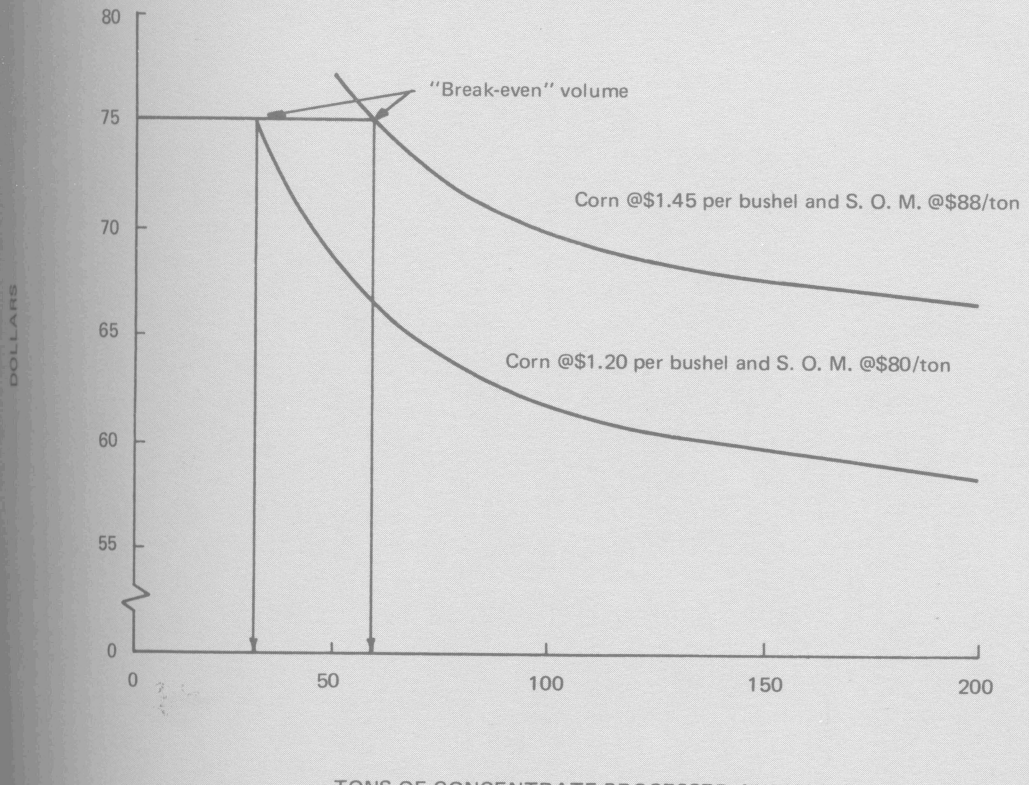


Figure 26. Mobile grinder-mixer—per ton cost for a 16 percent ration prepared on farm at different volumes; two price levels for ingredients; and break-even point with purchased ration at $75 per ton.

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