B-972

FARM FEED PROCESSING

... EQUIPMENT PLANNING AND DESIGN

THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
TEXAS AGRICULTURAL EXTENSION SERVICE
J. E. HUTCHISON, DIRECTOR, COLLEGE STATION, TEXAS

MECHANIZATION OF FEED processing and handling operations should be approached with caution. Mechanization is justified for one or more of the following reasons:

- To reduce labor costs
- To free labor for other profitable purposes
- To permit expansion for greater profit
- To reduce drudgery or eliminate undesirable tasks

Proper use of mechanized facilities and techniques requires detailed planning to obtain the desired results and at the same time keep investments in line with anticipated profit increases. By utilizing all available competent assistance, a detailed plan can be prepared. The livestock specialist, the economist and the engineer all can contribute to making their plan more complete and satisfactory.

This publication has been prepared to assist you in establishing your feed processing and handling requirements, based on your own situation and need. By using the planning sheet, on page 11, you can make a systematic analysis of requirements.

Ask some competent individual who is familiar with the equipment requirements you may establish to complete plans for construction. The final plan should satisfy one or more of the conditions outlined in the first paragraph and permit you to balance your investment costs against expected returns.

Farm Feed Processing

W. S. Allen, J. W. Sorenson, W. E. McCune*

The design, layout and installation of farm feed processing and handling systems require careful planning. The most common difficulties and faults with existing systems usually can be traced to improper or inadequate planning. Whether the system consists of only a hammer mill and bin or a more complex grouping of completely automated processing equipment, thorough planning can prevent mistakes and unnecessary costs.

The layout of a farm feed-handling and processing system fits into one of the following situations:

The use of existing facilities and equipment that may be added to or altered.

The design and installation of new buildings and equipment, and possibly the involvement of a new enterprise.

Both conditions require basic decisions and the collection of certain data to provide for immediate needs and future expansion. Such a planning procedure may include information on:

- Quantity of material to be handled or processed; based on feed requirements of type and number of livestock.
- Kind of material for rations.
- Location of present facilities.
- Type and amount of equipment to provide capacity and desired product.
- Storage required for raw and processed products.
- Conveying equipment sizes, layout and type.
- Preparation of a flow diagram.

The following principles of handling material should be kept in mind throughout the planning phase:

- Move materials as little as possible.
- Let livestock help as much as feasible.
- Handle materials in bulk or in some form suitable for mechanical handling.
- Provide for continuous flow and eliminate unnecessary operations.
- Mechanize operations that can be done so efficiently.

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

EQUIPMENT

Consider what types of product will be processed, what capacity is required and what finished feed characteristics are desired. Some of the common types of grinding equipment and what can be expected from them are discussed as follows:

Hammer Mill

Hammer mills are one of the most common pieces of equipment used for processing feed. The material is introduced into the housing of the machine and a series of hammers, bars or beaters turning at 1,500 to 4,000 rpm, beats and pounds the material until it is small enough to pass through a screen. Fineness of the product is controlled primarily by the size of holes in this screen. Characteristics of the hammer mill are (a) simple in construction, (b) versatile in operation, (c) generally free from significant damage by foreign objects, (d) freedom from damage when

*Respectively, Extension Agricultural Engineer, Texas Agricultural Extension Service; Agricultural Engineer, Texas Agricultural Experiment Station; Professor of Agricultural Engineering and Director, Texas Farm Electrification Committee, The A. & M. College of Texas.

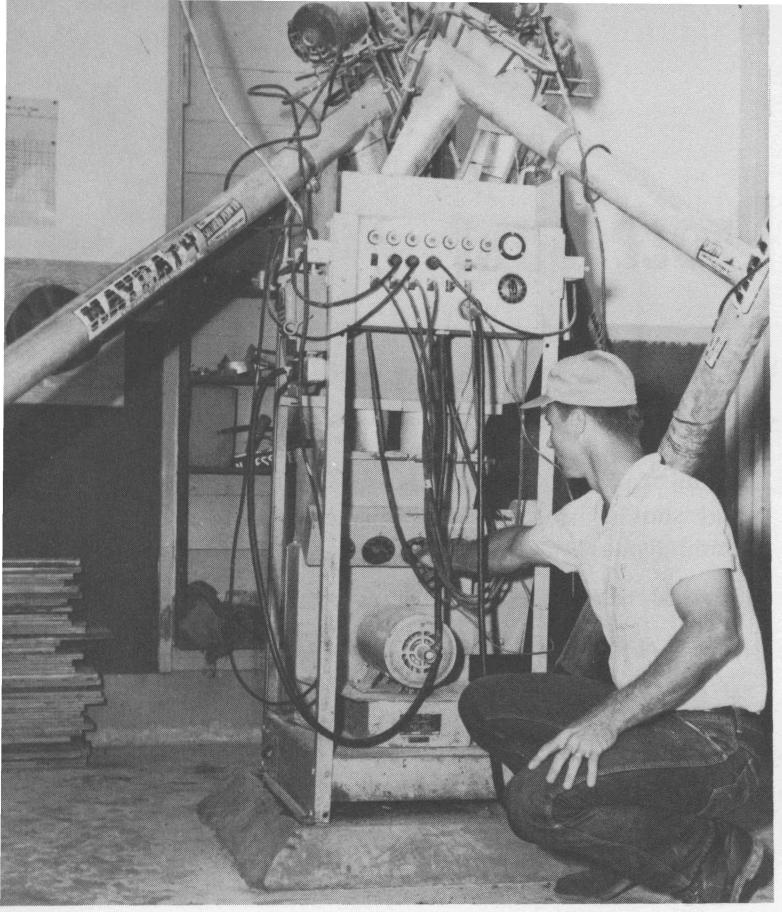


Figure 1. A small hammer mill equipped with an automatic mixing device and augers to bring the grain and supplement from storage bins to the mill. Another auger carries the ground mixed feed to a processed feed bin.

operating empty, (e) no loss in efficiency due to wear, (f) generally higher in cost than burr mills but less costly on repairs and upkeep and (g) relatively high horsepower requirements for high capacity.

Burr Mills

Burr Mills (sometimes called plate mills) have two rough plates—one stationary, the other rotating. The material is fed between the plates and is reduced by crushing and shear. Operating speeds usually are less than 1,200 rpm. Fineness of the product depends on the type and spacing of the plates. The space between the plates will increase if over-loaded or if foreign objects enter. Characteristics of the burr mill are (a) low initial cost but frequent replacement of plates, (b) relatively uniform product, (c) better adapted to coarse grinding than hammer mill but more power required for fine grinding, (d) generally run at low speeds, (e) excessive plate wear when operating empty, (f) breakage caused by foreign objects and poor results from worn plates.

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 hammer mill when ear corn is to be ground.

Characteristics of a roller mill include (a) less cost than the burr or hammer mill, (b) high capacity for coarse grinding, (c) serious breakage caused by foreign material and (d) operation at medium speeds.

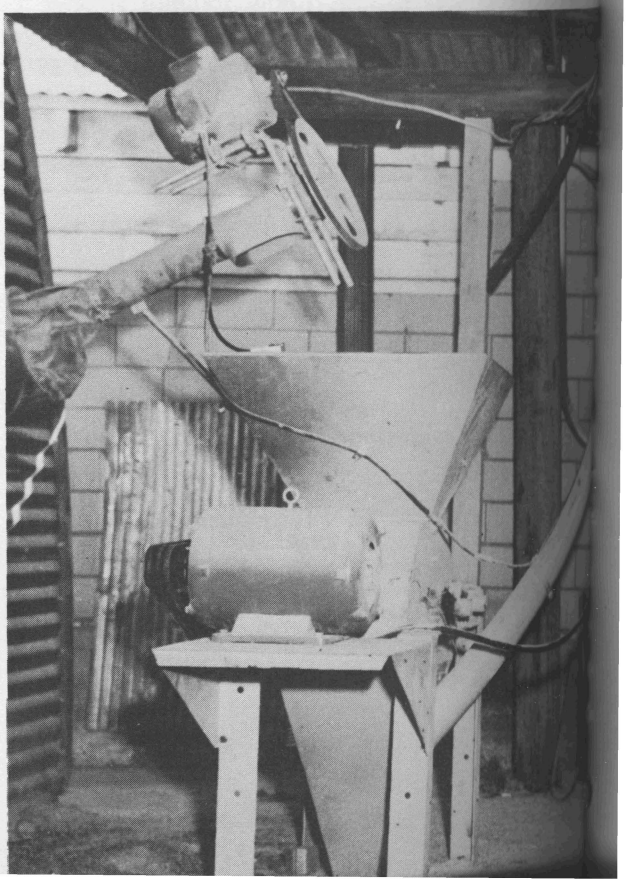
General

The grinding capacity of most equipment is affected by factors such as kind of grain, fineness of grinding and moisture content of grain.

The speed at which a mill should operate is specified by the manufacturer. It is unwise to exceed this speed as a means of increasing grinding capacity. A slight increase in speed will rapidly increase power requirements.

Many feed mills are equipped with blowers to elevate the ground grain and to save handling of feed. The blower has a considerable influence upon power required and feed mill capacity. Use of light-weight portable augers in many cases will

Figure 2. A crimper mill equipped with augers to move grain from the storage bin and the crimped grain to a mixer.



eliminate the need for an elevating blower on the mill.

The capacity of the feed grinder also is affected by the fineness of grinding. As fineness increases, capacity drops. In general, hammer mills are better for medium and fine grinding and burr mills, for coarse grinding.

Some grains require more energy for grinding than do others. For example, barley requires the most energy for grinding and milo the least. The capacity of hammer and burr mills decreases as moisture content of the grain increases.

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 a part of the system, each must be selected and fitted to deliver a certain amount of material to the next auger or piece of equipment. The selection of augers depend on several factors. The ones of most concern to the farm feed processing system include:

(1) The kind of material to be conveyed

(2) The auger speed

(3) The auger length

(4) The intake opening

(5) The angle of inclination

(6) Capacity required

Data on capacity and power requirements of augers appear in Tables 1 and 2. This information will permit a designer or user to estimate capacity and power requirements of augers that are to be a part of a system. Be sure to observe the following precautions in the layout of any system:

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 the totally enclosed type.

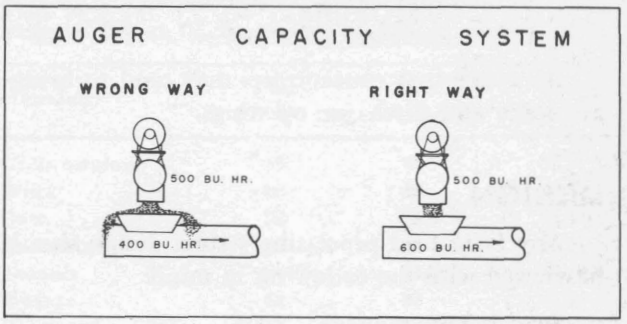


Figure 3. Augers should be selected to handle the quantities delivered to them by other augers in the system.

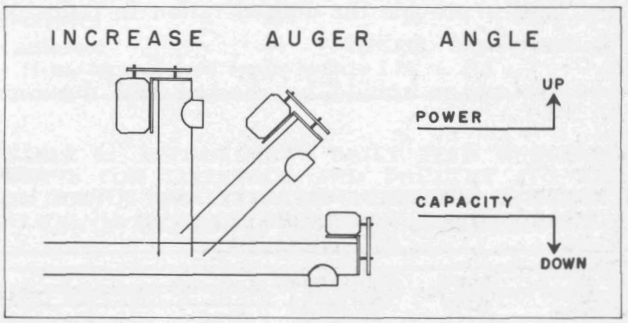


Figure 4. Increasing the angle of the auger increases the power required.

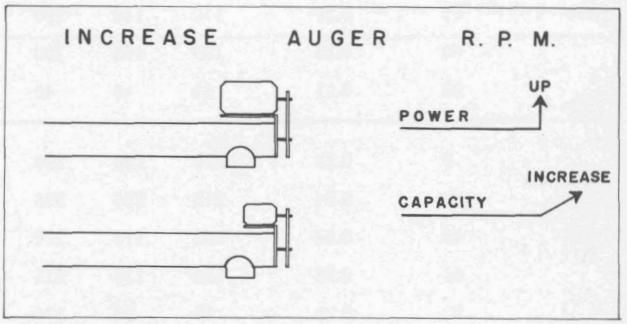


Figure 5. Increasing the RPM of the auger increases the capacity but also increases the power requirements.

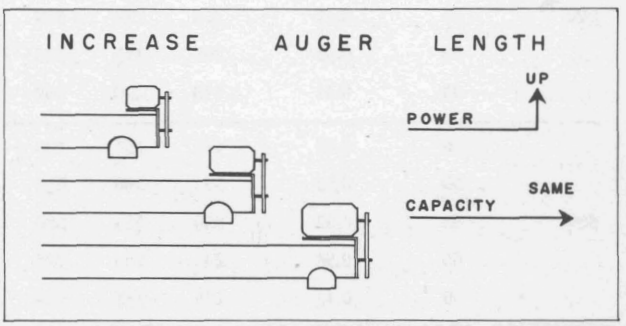


Figure 6. Increasing the auger length requires more power to maintain the same capacity.

Note that horsepower requirements are greatest with augers placed at angles of 30 to 60 degrees.

Be aware that concentrates may tend to bridge at intake and discharge openings.

DESIGN

Any farm feed processing system design should be viewed with the following in mind:

Does it save money?

Does it reduce labor or transfer labor to more useful work?

Will it provide the desired ration in terms of quantity and quality?

Any system should be checked and the cost and results measured against other means of doing the job before investments and changes are made.

Grinding and mixing can vary from a simple installation to a very elaborate one depending on the capacity and automation required. Any system should be checked and the costs and results measured against other means of doing the job before investments or changes are made.

Good, sound, long-range planning is essential whether all the equipment is installed at one time or if it is a step-by-step process. The following guide and an example of its use will help in the analysis of your system. Consult your County Agent, Power Supplier and Equipment Dealer as you assemble, analyze and plan this system. Some typical systems are shown here that may offer ideas for your operation.

TABLE 1. 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	Cornmeal
	0	0.22	220	200	220
	30	0.26	170	160	230
300	45	0.26	140	140	190
	60	0.25	105	105	160
	90	0.21	60	40	40
	0	0.28	290	260	290
	30	0.34	215	200	335
400	45	0.34	190	170	270
	60	0.32	150	130	215
	90	0.28	80	60	170
	0	0.35	420	340	500
	30	0.46	300	270	525
600	45	0.47	250	220	390
	60	0.46	205	175	325
	90	0.41	140	90	240
	0	0.42	435	355	700
	30	0.55	345	300	650
800	45	0.62	300	265	500
	60	0.58	245	205	205
	90	0.43	165	115	290

TABLE 2. 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	Cornmeal
	0	0.50	810	770	890
	30	0.58	595	570	780
300	45	0.60	490	470	600
	60	0.52	370	345	550
	90	0.45	230	230	500
	0	0.60	1,000	900	1,030
	30	0.71	710	650	880
400	45	0.70	580	530	670
	60	0.64	460	405	600
	90	0.55	330	270	560
	0	0.80	1,180	1,050	1,270
	30	0.85	850	730	960
600	45	0.90	690	600	820
	60	0.86	575	470	720
	90	0.80	450	340	650
	0	0.64	1,100	1,000	
	30	0.98	870	735	
800	45	1.05	715	600	
	60	1.05	595	480	
	90	1.01	465	355	

Capacities are interpolated from several sources of research and test data.

TABLE 3. APPROXIMATE RATES OF GRINDING IN POUNDS PER HOUR (GENERAL RESULTS–HAMMER AND BURR MILLS)

Grain	Grinding Classification	Size of Motor 1 Hp	1½ Hp	2 Hp	3 Hp	5 Hp
Corn						
	Coarse	600	800	1,650	2,500	3,500
	Fine	250	300	620	900	1,200
Oats						
	Coarse	300	450	600	1,000	1,500
	Fine	75	110	225	350	450
Barley						
	Coarse	300	500	600	900	1,400
	Fine	75	100	150	250	500
Wheat						
	Coarse	600	1,000	1,600	2,400	3,000
	Fine	200	225	600	1,000	900
Milo						
	Coarse	650	1,000	1,800	2,600	4,000
	Fine	225	300	700	1,100	1,000

TABLE 4. 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

TABLE 5. APPROXIMATE WEIGHT PER BUSHEL AND PER CU. FT. OF VARIOUS FEEDS AND THEIR RESPECTIVE NUMBER OF BUSHELS PER TON

Materials	Lbs. per bu.	Lbs. per cu. ft.	Bu. per ton
Grain sorghum	56	45	35.7
Wheat	60	48	33.5
Oats	32	25.5	62.5
Shelled corn	56	45	35.7
Peanuts	20-25	15-20	80-100
Barley	48	38	41.7
Corn meal	43	34.5	46.5
Broiler feed	50	40	40
Turkey concentrate	44	35	45.5
Hog concentrate	44	35	45.5
Laying ration	37	29.5	54
Dairy feed	25	20	80
Cattle feed	44	35	45.5

(1 bu. by volume is approximately 1.25 cu. ft.)

TABLE 6. APPROXIMATE DAILY FEED REQUIREMENTS FOR LIVESTOCK AND POULTRY (TO BE USED ONLY FOR ESTIMATING CAPACITY REQUIREMENTS OF STORAGE, PROCESSING AND HANDLING EQUIPMENT)

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

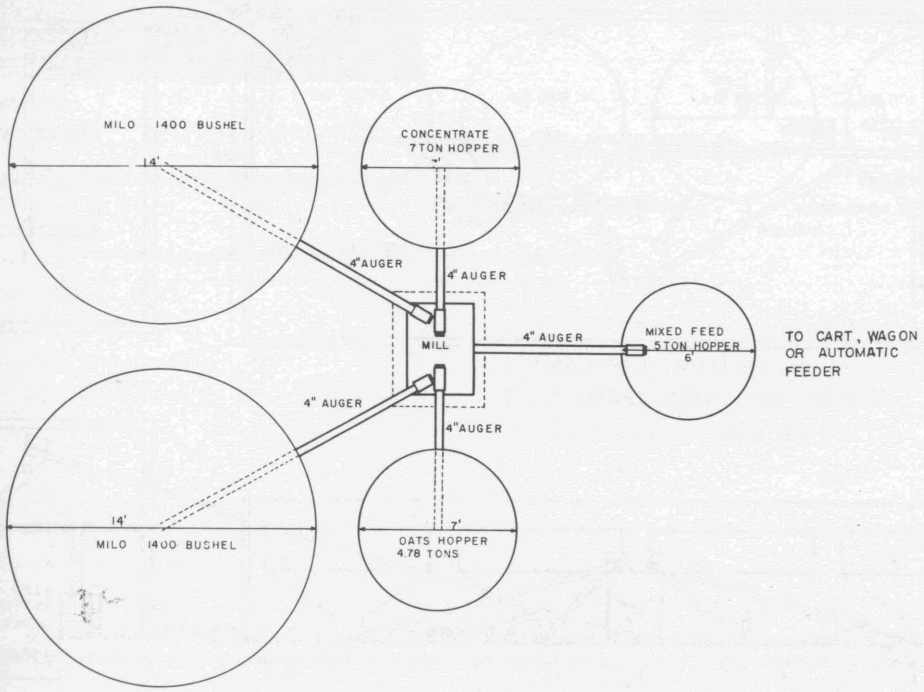


Figure 7. Poultry feed processing plant.

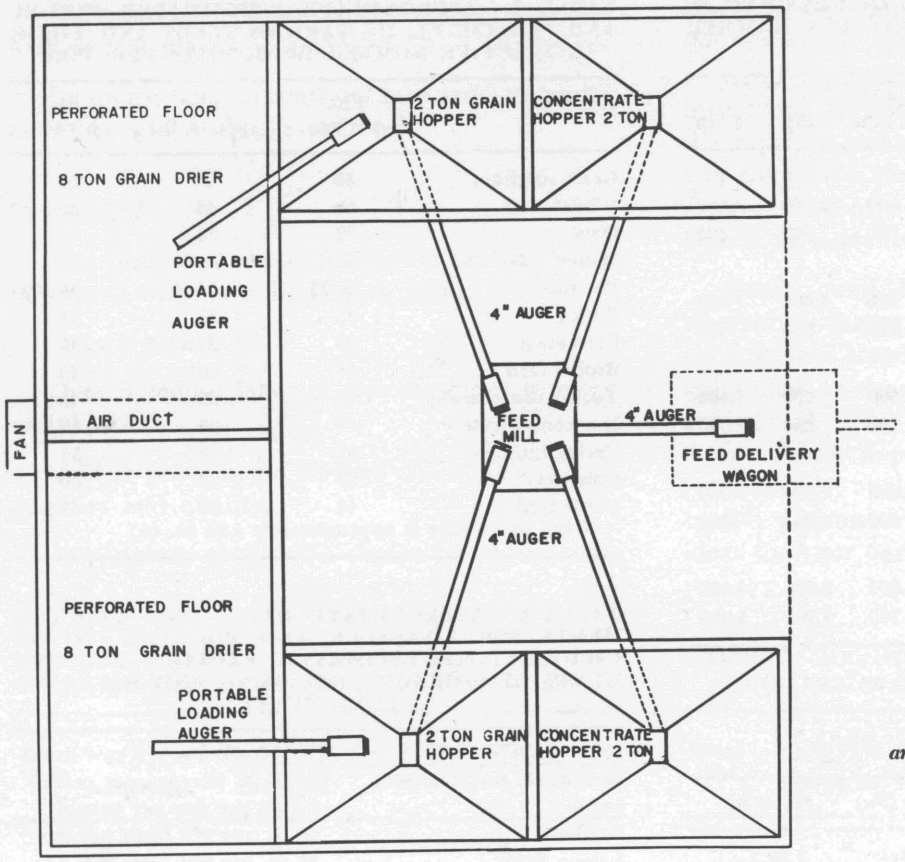


Figure 8. Swine feed processing and handling plant.

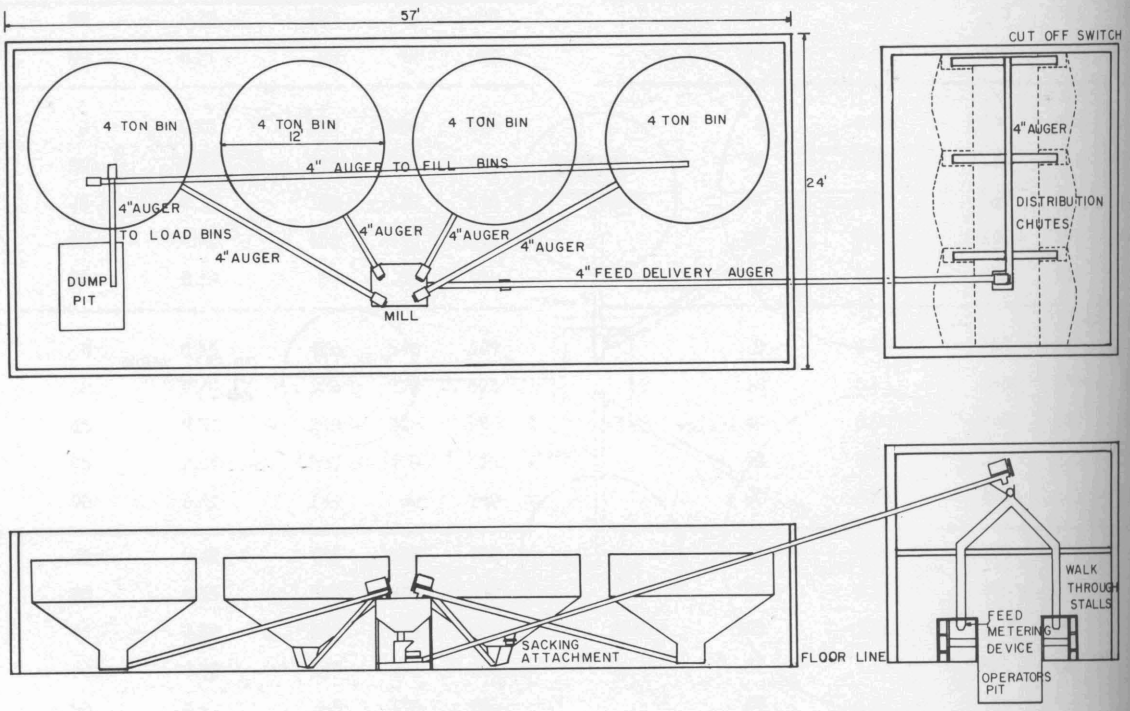
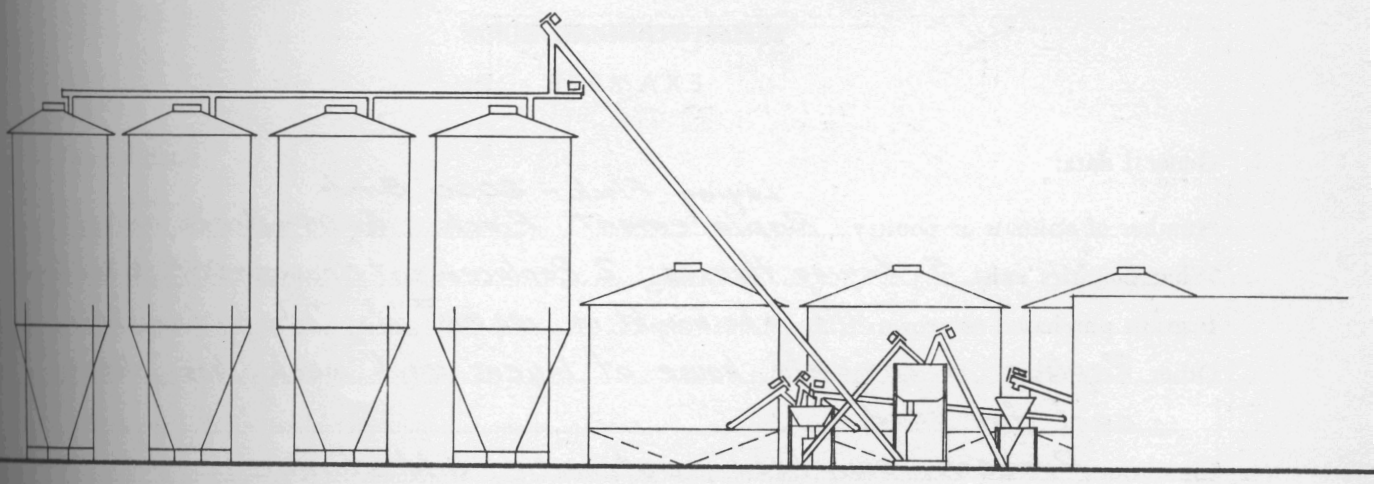
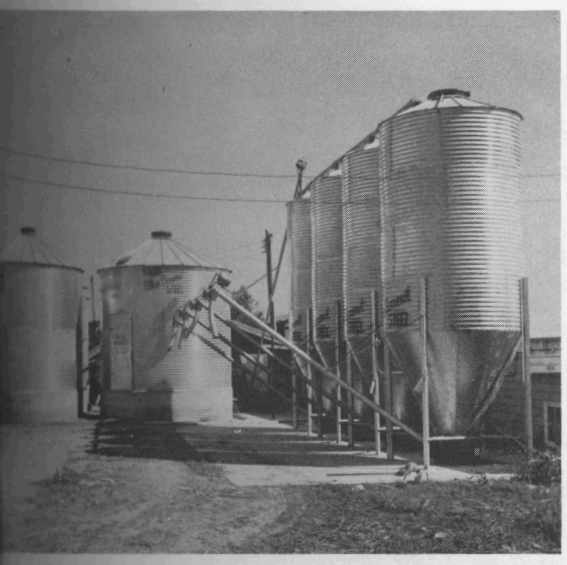


Figure 9. Dairy automatic feed processing and handling plant.





1- CRIMPER ROLLER MILL
2- PROPORTIONER AND MIXER
3- FABRICATED HOPPER

Figure 10. A complete system, including a roller mill, mixer, and storage facilities. Four different rations can be processed and stored. Processed feed is transported to turkeys on range by means of a self unloading trailer.

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 B

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

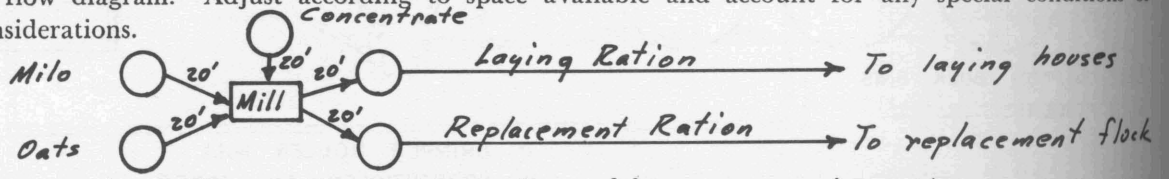
B. Storage space required for:

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 1 - $\frac{20'}{10} \times .26 = \frac{1}{2}$ HP motor

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

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

SYSTEM PLANNING GUIDE

1. General data:

   Number of animals or poultry.....

   What facilities exist.....

   Is grain purchased or grown.....

   Other.....

   .....

   Intentions.....

   .....

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

   B. Storage space required for:

Grain (Kind and amounts each)	**Concentrate** (Kind and amounts each)	**Processed** (Kind and amounts)

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

Bins	**Processing Equipment**	**Conveying Equipment**

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).

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.

Your County

EXTENSION AGENTS

can furnish you the latest information on farming, ranching and homemaking. They represent both The Texas A. & M. College System and the United States Department of Agriculture in your county.

Most county extension agents have their offices in the county courthouse or agriculture building. They welcome your visits, calls or letters for assistance.

This publication is one of many prepared by the Texas Agricultural Extension Service to present up-to-date, authoritative information, based on results of research. Extension publications are available from your local agents or from the Agricultural Information Office, College Station, Texas.

Cooperative Extension Work in Agriculture and Home Economics, The Texas A. & M. College System and the United States Department of Agriculture cooperating. Distributed in furtherance of the Acts of Congress of May 8, 1914, as amended, and June 30, 1914.
5M—1-61