1973

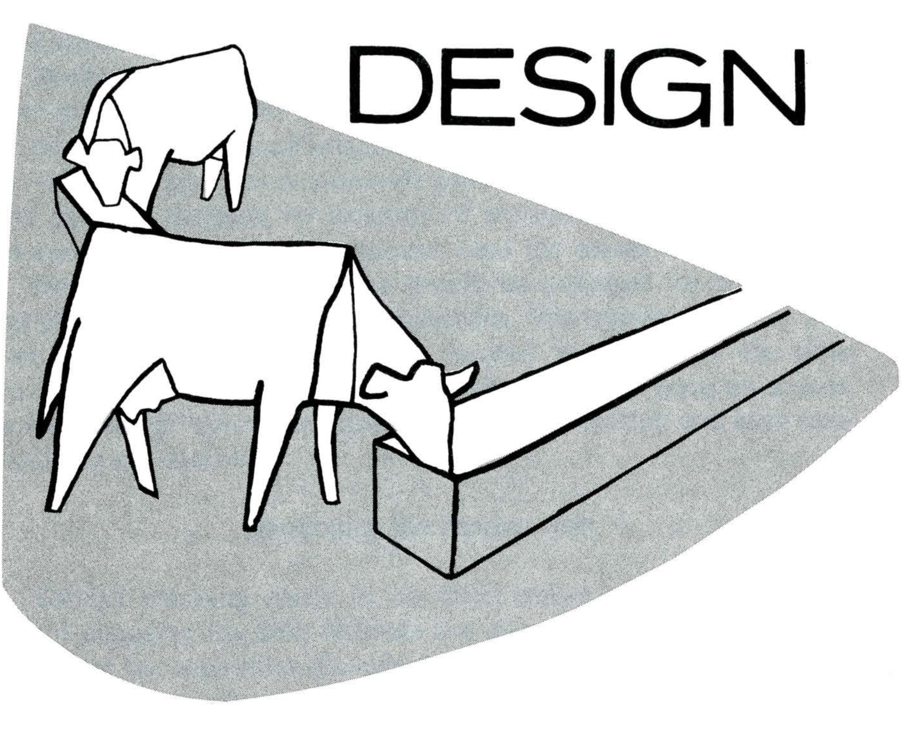
EC73-709 Feedlot Design

Norm Teter

Paul Guyer

EC 73–709

FEEDLOT DESIGN



Extension Service
University of Nebraska-Lincoln College of Agriculture Cooperating with the
U. S. Department of Agriculture and the College of Home Economics
E. F. Frolik, Dean J. L. Adams, Director

Feedlot Design

Norm Teter
Extension Engineer (Livestock Systems)
Paul Guyer
Extension Livestock (Beef Cattle)

Introduction

The time and expense required for sound feedlot design is an investment which should return manyfold future profits from the feedlot. The well-designed feedlot will contribute to maximum rate and efficiency of gain of cattle and to efficient use of labor and equipment.

Individual pens should be designed so cattle will eat at the slightest whim. Activity necessary to eat, drink and rest should be minimal. Design should minimize stress of mud, heat and harassment from wild animals or people.

Facilities should be designed for both cattle and handlers. They need to be arranged for quick, quiet and safe handling of cattle and for minimum labor requirements and work hazards for men.

A well-designed lot will provide pens for recovery of sick animals. Sick pens are designed for isolation of the sick from the healthy and are accessible to working equipment used for convenient treatment.

New or remodeled feedlots should be arranged for convenient and efficient use of labor and equipment. The operation center and feed and cattle alleys should be located to minimize the time required to feed and handle cattle. Feed bunks and waterers should be designed for quick and easy cleaning. Each motion and each stop should be productive.

Developing the Feedlot Plan

Careful planning needs to be done before construction starts. Before choosing the site, estimate the size of operation, then allow extra area for expansion. Calculate the area needed for the lot. Then start looking for a site.

Once your feedlot site is selected, aerial photos and contour maps are helpful in developing landshaping plans to take advantage of slopes, drainage and natural land features. The cost of making a topographical survey, contour map and careful plans on paper will be repaid many times in future efficiency and convenience.

Size of Operation

Points to keep in mind in arriving at your overall feedlot size include:

Cattle feeding requires constânt inputs of feeder *cattle, feed* and *water.* It is a production industry, not a speculative investment. The size of operation partly depends on the estimate of supply of these three basic raw materials.

Business relations in the community, money supply, land availability and personal family considerations play roles in size and character of the feeding program. The planned size should realistically fit future hopes.

Available equipment dictates that some sizes are better than others:

Available Equipment	*Size of Feedlot*
Automated bunks	200-600 head
One tractor-pulled mixer	2500
One truck-mounted mixer	5000-6000

Site Selection

Area Needed

A rule of thumb that gives a rough estimate of the area needed for feedlot development is that 100 head of cattle can be fed per acre of dirt lot. For each acre of lot, one to two acres of cropland are needed for waste disposal. For well-selected sites in drier areas of Nebraska, 120 head can be handled per each acre involved in the lot. A breakdown on a per-head basis would be about as follows:

1. Total area needed—350 to 490 square feet.
2. Pen area—240 to 300 square feet.
3. Feed and cattle alleys—40 to 60 square feet.
4. Starting and sick pen—10 to 20 square feet.
5. Working and loading alley—10 to 20 square feet.
6. Processing and storing—30 to 50 square feet.
7. Waste management facilities—20 to 40 square feet.

Space Requirements

Lot area:

140 to 180 animals per acre.

1 acre pens are convenient for 140 to 180 head.

Cattle alley:

14 feet wide, separate from feed alley is preferred.

Feed alley:

30 feet wide (min.) to give a place for snow.

Bunks:

6 inches to 9 inches per head. (Fed at least twice per day).

An acre lot needs 90 feet of bunk.

Water: Minimum of 12 gallons per day per head, 25 for continuous flow.

20 inches of space for each 30 animals.

An acre lot needs 10 feet of watering space.

Location

Waste management and odors are of major concern in selecting a feedlot location. New feedlots should be away from urban, housing and recreation areas. The size of the lot and zoning regulations will influence the distance. Preferably lots should be on the lee side (E or NE) of the closest urban area and dwellings in the feedlot vicinity. If to windward, as a rough guide, a feedlot should be one-half to one mile from an urban area for each 1,000 head in the lot. A 1,000-head lot should have a mile clearance; perhaps a 20,000-head lot would be acceptable with 10 miles clearance.

Topography and location should contribute to minimum expenditure for compliance with waste disposal regulations. Outside drainage should not come onto the lot. Locate the lot on high ground. Access to all-weather roads is necessary, and a rail siding is desirable for larger lots for in-shipment of feed grains.

The site should provide good drainage out of each individual pen and away from the operations area. Steep slopes should be avoided since they interfere with frequent consumption of feed and water, erode, complicate run-off control, and increase labor in feeding and management. Level land and slopes below 5% should be shaped to insure proper drainage.

Operations Center

The operations center should be located for most effective use of men and machines.

Office

A storage room (8′ x 10′) with cabinets on one wall is helpful in maintaining an efficient office. A building or space 24′ x 24′ divided into 3 rooms and a restroom should provide reasonable office space.

Parking, access, future expansion with secretarial space, and relation to business of receiving and shipping should be considered. If considerable grain is purchased, an office near the truck scale may be desired. Since the scale may also be used for cattle, cattle lanes to the scale from the working corral are convenient (Fig 1).

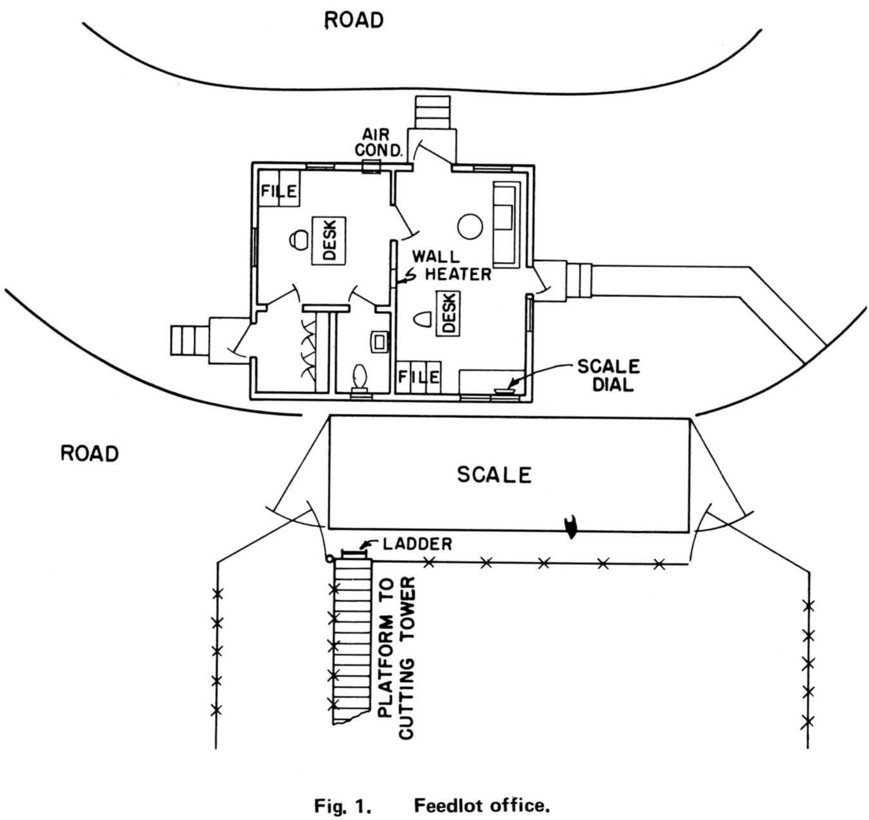


Fig. 1. Feedlot office.

Working Corrals and Cattle Shipping Facilities

Working corrals should be designed for easy movement. The curved principle with solid walls should be used as much as possible since cattle handle more easily in this type of facility.

Loading Chute: A stair step chute is better than a ramp. Steps should be 4 inches high and 12 to 14 inches wide. A reasonable dock height is 3'–8".

The loading chute must be accessible from the road and have space for spotting trucks. One arrangement for loading in relation to the office is shown in Figure 2. The cutting tower is close to the scale, the office and the loading chute. This permits top management supervision of cattle sorting for either receiving or shipping.

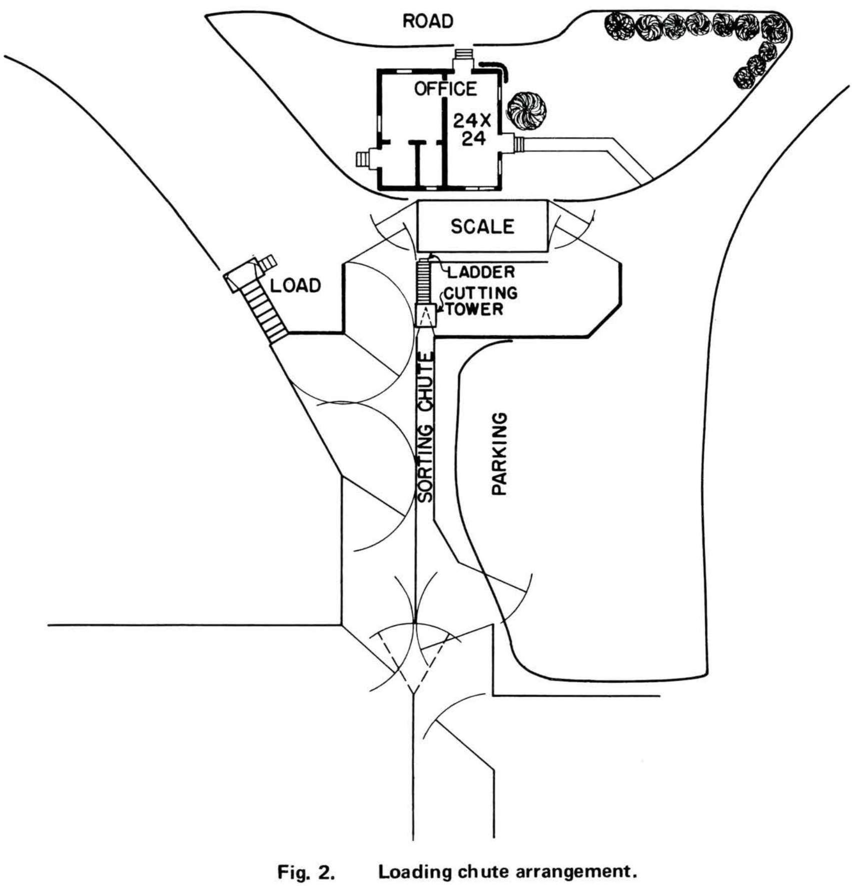


Fig. 2. Loading chute arrangement.

Chutes should be built with solid sides narrow enough to prevent turning of the cattle as they are loaded and with a curved principle if possible. They should be built with some type of bumper that fits flush with the truck when it is backed up sligntly off square. In large feedlots, especially where calves or light yearlings are fed, the loading chute should be built to unload from double-deck trucks.

Working Facilities

Working facilities need to be located some distance from the office to reduce the problem of noise and dust. In larger operations where cattle must be handled frequently and in all types of weather, the squeeze chute and perhaps the dipping vat may need to be housed within a building.

Holding pens should have 20 square feet per head. Sometimes it is desirable to hold a lot, commonly 250 to 300 head, in a large pen and to provide sorting to smaller pens. An area of 150 square feet can hold a truckload of cattle. Approach lanes from the lot can serve as a holding pen. The number and size of small pens needed for sorting will depend upon the amount of sorting needed to place the cattle in rather uniform lots.

Sorting gates can be set into the cattle alley to aid in sorting quickly and easily. In large feedlots a hexagonal sorting trap, shown in Figure 3, may increase labor efficiency. This trap enables cattle to be diverted from one place to any one of five other places.

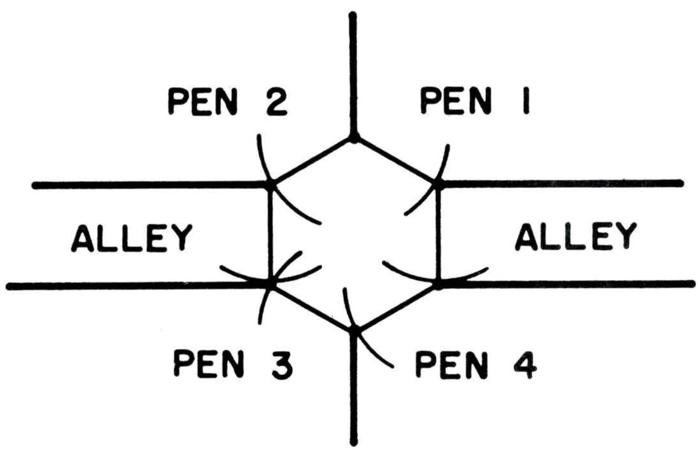


Fig. 3. Six gates set to give a hexagonal sorting trap.

Working chutes must prevent cattle from turning within them and climbing the walls. "V" chutes may slope in too much, giving the animal a foothold on the side of the chute. "V" chutes, 18" wide at the bottom and 27" wide at a height of 3 feet, are better than straight 28"-wide chutes or a chute with an abrupt change from a 18" to 28" width at a height of 24" to 28" (Fig. 4).

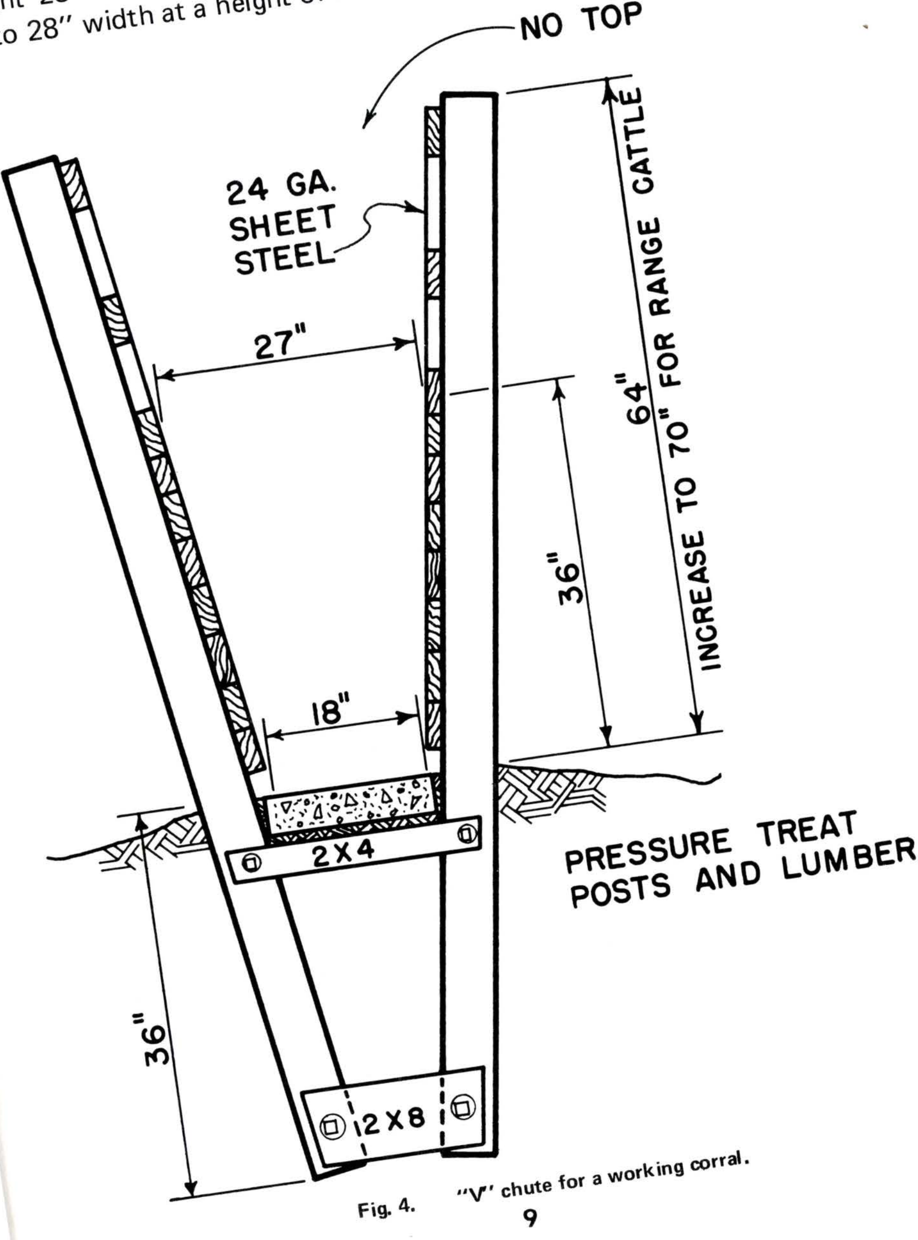


Fig. 4. "V" chute for a working corral.

Straight chutes should be limited to about 28 feet in length without blocking gates because pressure of pushing cattle can cause injury in long chutes. Solid sides help keep cattle quieter in a confined chute or close quarters. Solid sides with a visible escape ahead keep them moving well. Curved chutes work better than straight and may be longer than 28 feet. Radius of curvatures of 14 to 40 feet have been used successfully.

Backup checks should be installed in the working chute. Two types are commonly used, the overhead mounted and the side mounted. The overhead mount returns by gravity after cattle pass beneath. The side mounted are lightly spring-loaded for return to a horizontal position across the chute behind the advancing animal. A backup check needs to be installed every 15 to 20 feet.

Tilt tables serve well for calves up to 350 pounds but are cumbersome for larger animals. Tilt tables are usually set at a diversion gate from the chute as special chutes are not necessary for calves of this size.

Squeezes should have head gates with head restraint bars to facilitate blood sampling, dehorning and similar work on the neck and head. A walk-through type of head gate speeds work by allowing the animal to go straight forward instead of backing out.

Dipping vats are desirable, especially for those buying cattle from many sources. Treatment for lice, grubs, ticks and similar pests in dips is superior to sprays of either the hand operated or the automatic multiple spray type. Dips assure complete and thorough saturation of the entire animal quickly and efficiently.

Vertical cage vats are safe, economical, thorough and reasonably fast. They require hydraulic pumps to maintain the oil pressure used for cylinder operation. They are slightly slower than the swim vat. They can be enclosed in a heated building for winter operation.

Swim vats should have chute approaches, block gates, solid sides next to the jumping place, jumping blocks to give the animal secure footing to prevent injury from slipping, stair step exit ramp, and adequate drip pens to reduce waste of dip. Swim type vats should be emptied before freezing weather. The inlet water valve to vats should be padlocked to prevent the addition of water without addition of chemical.

Safety precautions must be taken to cover outside dips. Cage dips should be provided with a top escape door so an animal's head or the entire animal may be raised out of the dip in the event that power or mechanical failure leaves the cage on the bottom.

Hospital facilities may be built close to working corrals and conditioning lots for starting new arrivals. In larger lots, hospital facilities will also be needed at several locations in the lot, or a trailer especially designed for hauling sick cattle to the hospital area will be needed. Hospital pens should be well-drained and include a shed designed to minimize stress and provide a place that will contribute to the recovery of sick animals. The hospital area can be equipped with slings for supporting the animal, with medical supplies, hot water, refrigerator and a small record center for catalogs, records, informational bulletins and similar decision making aids.

Receiving or conditioning lots are needed where many cattle are handled. Lots designed for maximizing feed intake and minimizing effort needed to sort for treatment need to be near the working area.

These lots should be shallow with two feet of bunk space per animal and with ample water space provided at the rear of the pen. The lot should provide about 100 square feet per animal where mud is not a problem and have an area of not more than one-half acre.

Plans for cattle working equipment may be obtained from your county Extension agent. Modern fabrication techniques have provided shop-made squeezes, head gates, tilt tables, dips, chutes and scales that are well built. You may prefer to shop for good time-tested factory items rather than to spend your own time in the shop.

The Midwest Plan Service book, "Beef Housing and Equipment Handbook" is for sale by your county agent. Other plans that may be purchased from the Department of Agricultural Engineering include plans:

5835 - Six Corrals for Beef Cattle
5876 - Vat for Dipping Cattle
5920 - Corral and Feedlots for Beef Cattle
5940 - Cattle Dipping Vat and
Inspection Facility
5960 - Loading Ramp for Cattle
5991, 5974, 5952 - Beef Cattle Corrals
5779 - Expansible Corral
5790 - Corral Layout
6049 - Corral with Curved Chute for Cattle

Figure 5 shows a system of working corrals that might be installed between feedlots and the office and shipping center. The number of holding pens individually accessible from the movement alley can be varied in size and number to fit individual needs. The conditioning lot for caring for the newly received animals can be near the office for supervision.

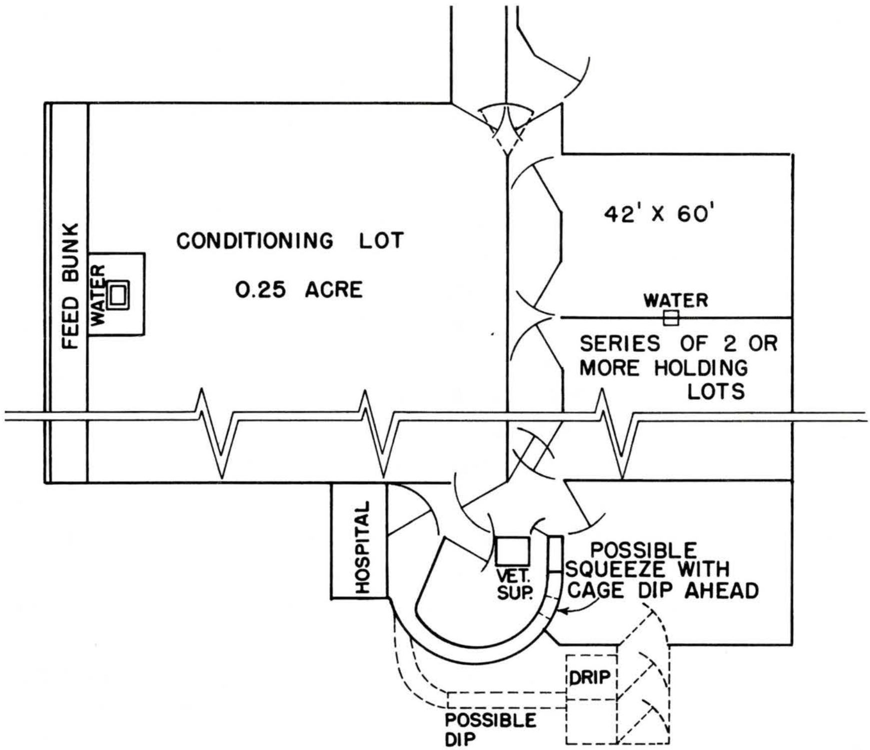


Fig. 5. Layout of working, treating, sorting and conditioning lots.

Feed and Feed Processing

The other main business negotiation of the a feedlot concerns feed buying or the storage of farm produced feed. Both bought feed and produced feed should be moisture tested and weighed into storage as well as weighed out. The scale is the indicator of input as well as output and good weight records allow close supervision of business productivity. Two types of moisture measurement are needed—roughage and grain.

Electronic moisture testers are available for grain and an electric oven serves well for silage, hay or ground feeds. An oven held at

$215^{o}F$ can be used for grain also if the purchasing arrangement permits the required 48 hours for a moisture determination. Most larger lots use the quicker, more expensive electronic meters. Buy feed on the basis of dry matter. Of course silage has to have adequate moisture to ensile properly.

Roughage handling (silage and hay) is the most difficult feed handling chore. Horizontal silos are better adapted to silage handling than vertical. Grain can also be ensiled in horizontal silos. Silo capacity varies with moisture, fineness and packing of the material. For estimating purposes, forage silage contains about 14 pounds of dry matter per cubic foot; ground ear corn, 30; and ground grain, 36.

Visualize the feed route and order of the feed loading to reduce time as much as possible. Three ingredients go into the ration: roughage, grain and supplement. They should all be accurately allocated to the ration. Roughage weighing is a problem. Load cells are available for direct weighing on the feed truck or wagon. Rough calibration can be made of the pressure of oil in the cylinders for the front unloader of the tractor. A pressure of an empty bucket can be compared with the pressure shown for various weights of material when the bucket is level at a given height. These pressures plotted against weight can be used as a calibration to record silage weight placed in feed wagons.

If a print-out scale is readily available, trucks with forage can pass the scale and receive their orders for weight of supplement and grain to be delivered with the roughage to a specified lot. The office or the feed center should have a board with a lot map and daily orders of amount and consistency of ration to be delivered. Each evening orders are moved from the board, altered if required and put on a supplementary rack. As lots are fed, orders are moved from the rack to the lot map. Double orders are needed for two feedings per day.

A smooth flow requires good records as well as good machinery.

Grain storage may be high moisture ensiled, dry, or a combination. High moisture grain is good feed and should be considered for cattle feeding. Good bunkers, good packing of well graded grinds, good covering and reasonable moisture control assures grain with good feeding quality. Grain may be removed with front end loaders or regular silage unloaders. Dry corn or grain can be purchased throughout the year.

Tips for design of the feeding center can be obtained from the book, *Planning Grain Feed Handling Center,* available from your county agent. If grain is ground, remember that it is cheaper to grind feed slowly over a long period of time than it is to use an over-sized mill requiring supervision.

Feeders of large numbers of cattle can afford to look into special types of processing equipment for use of fats in the feed, gelatinization of starch in the feed and similar higher priced processing systems.

The repair and maintenance shop is usually located near the feed processing center and not too far from the office. The office, cattle receiving, feed storage and processing and shop make up the area of heavy traffic. It should be well drained, have weather surfaced roads, be located for minimum snow drifting and served with adequate electrical power. Water needs are low at this center so the well can be closer to the feeding pens.

Feeding Pens

Cattle feeding may be in open lots or in buildings. Open lots expose the cattle to heat, blizzards and mud that reduce the efficiency of gain but the initial cost and operating costs are lower in open lots. Rainfall and drainage are principal factors in the decision between housing or open lot feeding. Mud can reduce gains drastically.

Lot shaping is an important part of the design. Land slopes of between 2 to 6% are best with the gentle grades of 2 to 4% being better adapted to mounding. Long steep slopes erode and give more problems in waste management. Debris basins on gentle slopes have greater capacity than debris basins on steep slopes and the slower moving runoff water settles solids out of the waste, reducing pollution problems.

Slopes of 3 to 4% are not well enough drained to be free of mud. The solution lies in lot shaping or mounding. Mounds with side slopes of 6 to 15% drain well and give good conditions. The slopes need to be maintained with yearly reshaping. Mounds "T" off of the apron. The top should be broad enough to permit smoothing and snow removal with a tractor and blade.

From a contour map estimate a balance of cuts and fills to give the drainage, debris basin, holding pond and mounds needed for a good lot. Set Extension Circular E.C. 71-795, "Waste Management for Feedlots," for ideas on lot placement and grading.

Drainage is of great importance. Bunks should have as nearly uniform slope as possible with no low parts to hold water. Drain the lower end. Roads should be graded with feed roads serving two bunks having the drain in the center, not on the side like normal roads (Figure 6). Culverts are needed for drainage crossovers.

Diversion terraces, dikes or drainways keep outside water off the lots. Lot location on the tops of hills reduces the problem of outside water.

Feedlot runoff can be caught, slowed to drop out silt and debris, and held to be pumped out for irrigation. Space must allocated for these waste management facilities. Debris settling basins are flat or slightly sloped at 0.1 to 0.2 feet in a hundred.

Slopes of over 300 to 400 feet in length need to have debris basins to prevent excessive runoff accumulation. Debris basin outlets can be through risers and underground pipe to a holding pond. The outlet problem on steep land increases lot costs.

If possible, design bunks to permit the wagons or trucks to unload going uphill rather than down.

Orient the lots to take advantage of sun, wind, topography and convenience of feed and cattle flow. Bunks run north and south, facing east preferably. This allows the sun to hit both sides to melt ice and dry out mud. Cattle feed better when facing downwind.

Snow deposits on the south side of barriers. Drifts occur at distances of 4 to 5 times the height of the barrier. Drifts will form 100 to 150 feet behind windbreaks formed by trees and 30 to 50 feet from normal windbreak fences. Feed bunks form drifts. Less snow will be deposited on the lots if windbreaks are far enough away to drift snow outside the lots.

Lots need distance from other property so wastes can be controlled without creating a nuisance. For each acre of feedlot, a minimum of one to two acres of disposal space should be allowed for waste. This disposal area is used to grow corn or other crops. If water is pumped from the holding pond to disposal areas, length of pipe is a consideration. A combination holding pond and reuse pit for irrigation water is a possibility to consider. Small horsepower pumps operating on automatic control are less costly than large pumps.

Feedlot construction consists of lot shaping, installation of water and electrical lines, casting bunk and water platforms, installing bunks and waterers and fencing in that order.

Waterers may be heated with thermostatically controlled electric

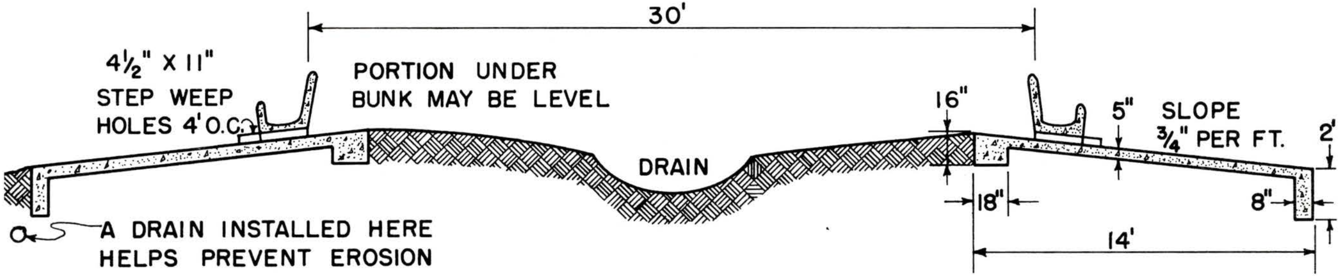


Fig. 6. Cross section of a feeding alley.

or gas heaters or may be kept continuously flowing to prevent freezing. Overflow from waterers should be taken away in an underground sewer pipe. Overflow in the lot increases problems with mud and waste. The design of 25 gallons per day for beef is about 20 gallons per day over winter-time consumption to allow for the use of continuous flow waterers. If electrical heat is used, the design of circuits should provide for reasonable voltage drop. Lighting loads should be added with heating to insure adequate wire size.

Copper wire has a voltage drop figured on the following formula:

$$D = \frac{22LI}{CM}$$

D = Voltage drop
L = Length of wire in feet
I = Amperes flowing
CM= Area of wire in circular mils (Table 1).

Table I. Size of electrical wire in circular mils (CM).

Size Am. wire gauge	*Area of wire circular mils CM*	*Size Am. wire gauge*	*Area of wire circular mils CM*
00	133,100	4	41,740
0	105,600	6	26,240
1	83,690	8	16,510
2	66,360	10	10,380
3	52,620	12	6,530

Watts are equal to volts X amperes (VI)

Aluminum wire has a voltage drop 1.6 times as great as copper of the same size and amperage. It doesn't damage a heater to work on low voltage but low voltage reduces the heat output and the loss of power in the wire coming to the heater is useless loss.

For two or more waterers, run wire circuits with two 220-volt power lines, a neutral and a tank ground. Ground all tanks to the green ground wire that is grounded back at the distribution panel. For water heaters the ground wire and the neutral wire should be the same size as the power wires.

Ground rods at each individual waterer are not recommended.

A combination continuous flow and heated waterer can be used. Water from the overflow can be returned to a sheltered collecting tank where it is screened, reheated and recirculated. This system concentrates the heating at one location so servicing and voltage drop is less, and conserves the water. It may cause problems from disease spread and water contamination.

Concrete bunk and water platforms should provide at least 7 feet of length for the animal. The 11 inches next to the bunk or water should be 4½" to 6" above the floor to cause the animal to step up with its front feet to feed or water. This keeps contamination of manure out of the feed and water (Figure 7).

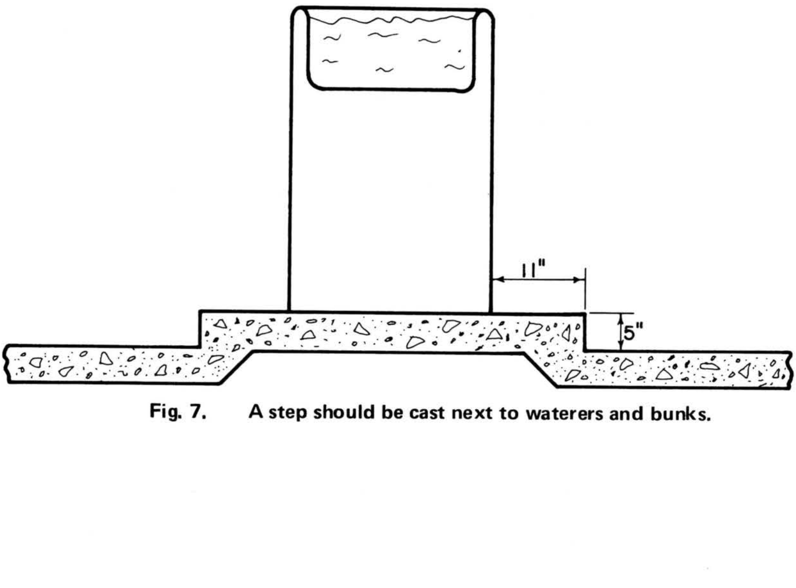


Fig. 7. A step should be cast next to waterers and bunks.

Fencing must be sturdy, kept taut under all conditions of temperature, and properly spaced to hold the animals. Cable fences are good and they are competitive in price. Five cables are usually enough for partition fences. Two cables are needed along the front of the bunk. Six cable fences are preferred in the cattle alleys. Figure 8 gives suggested cable or rod spacing for feedlot fences. Figure 9 suggests a way to make the 2-cable feed bunk barrier adjustable.

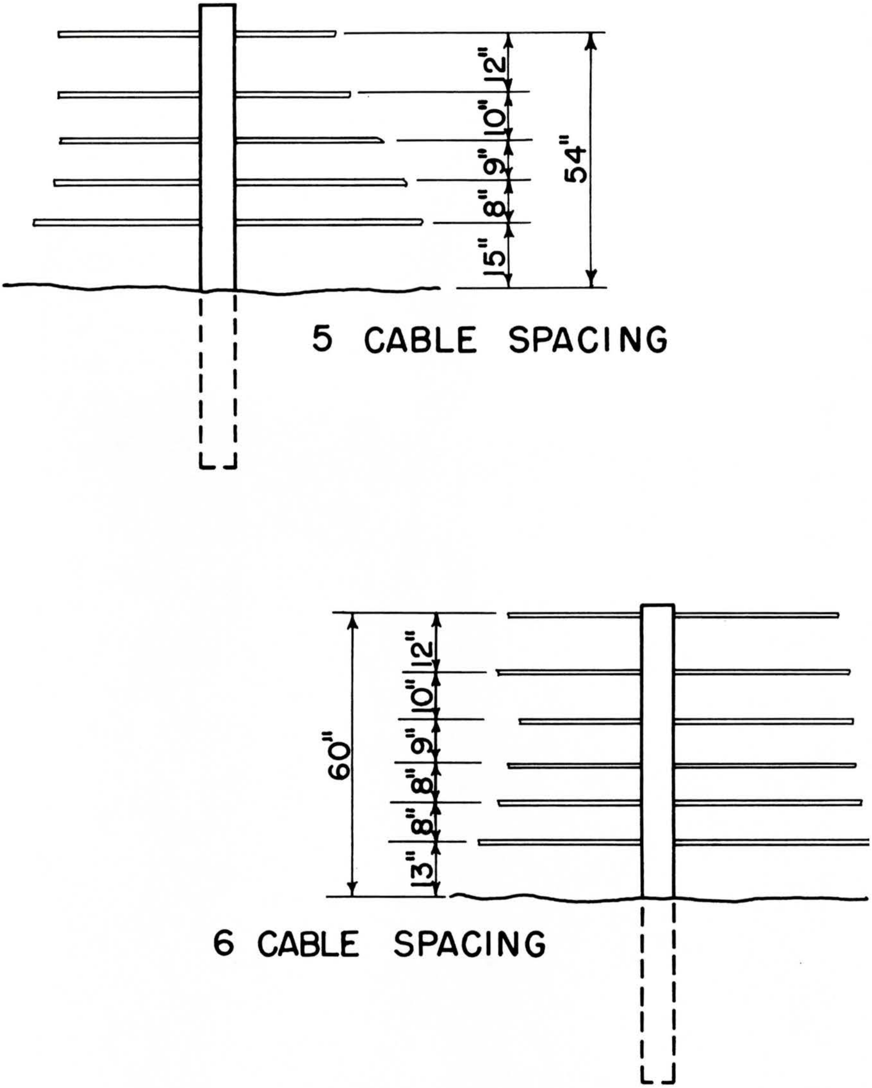


Fig. 8. Cable feedlot fences.

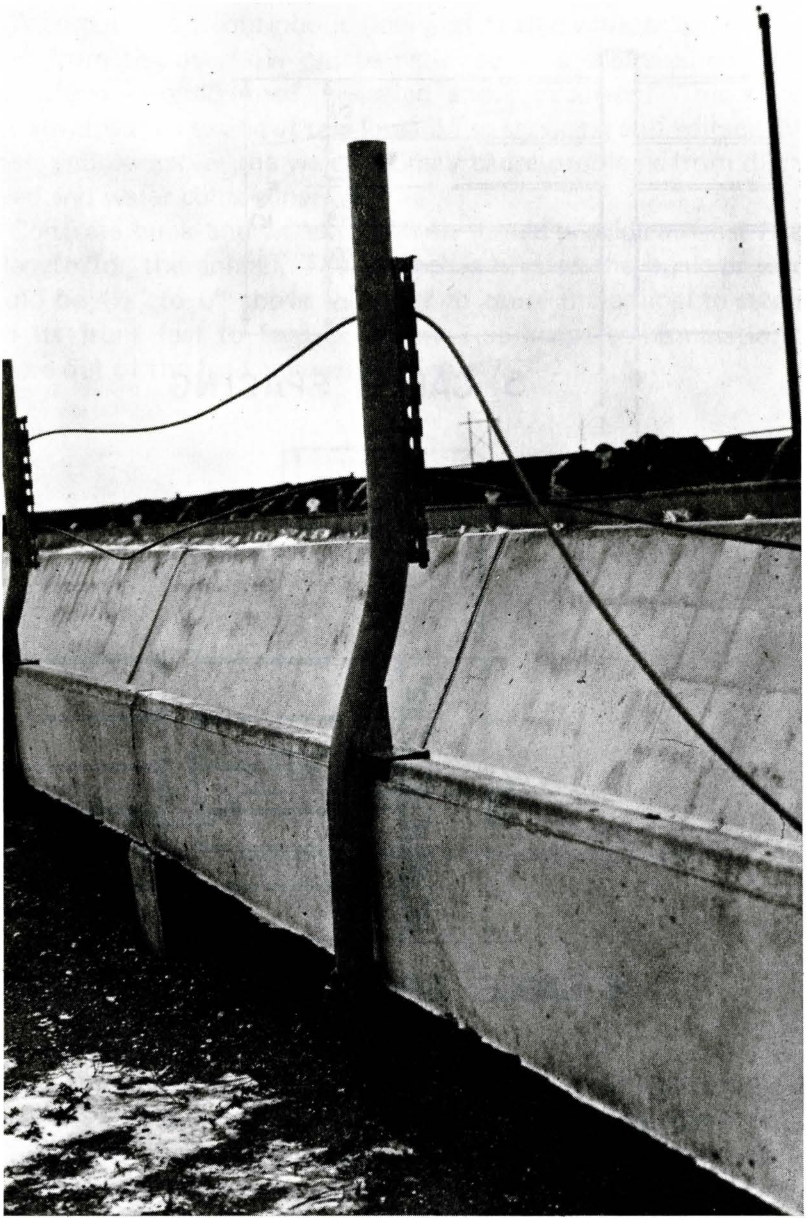


Fig. 9. Adjustable bunk line cables.

Sucker rod from oil fields welded to pipes set in concrete are used by some feedlots.

Cable runs should have a 12-inch tensioning spring made of 5/16" coiled spring steel for every 400 feet of fence run. The springs should hold the cables reasonably snug in hot weather.

Posts may be drilled for cables to pass through the post.

A double compression corner with the tensioning brace passing across the center post to hold it in line has given better satisfaction than a complete double assembly corner (Figure 10).

Gates can ordinarily be constructed better and cheaper in shops equipped with jigs for assembly than they can be built in the shop on the feedlot. If any special gates or equipment are needed they can also be specified as a part of the overall shipment of stocked gates and panels.

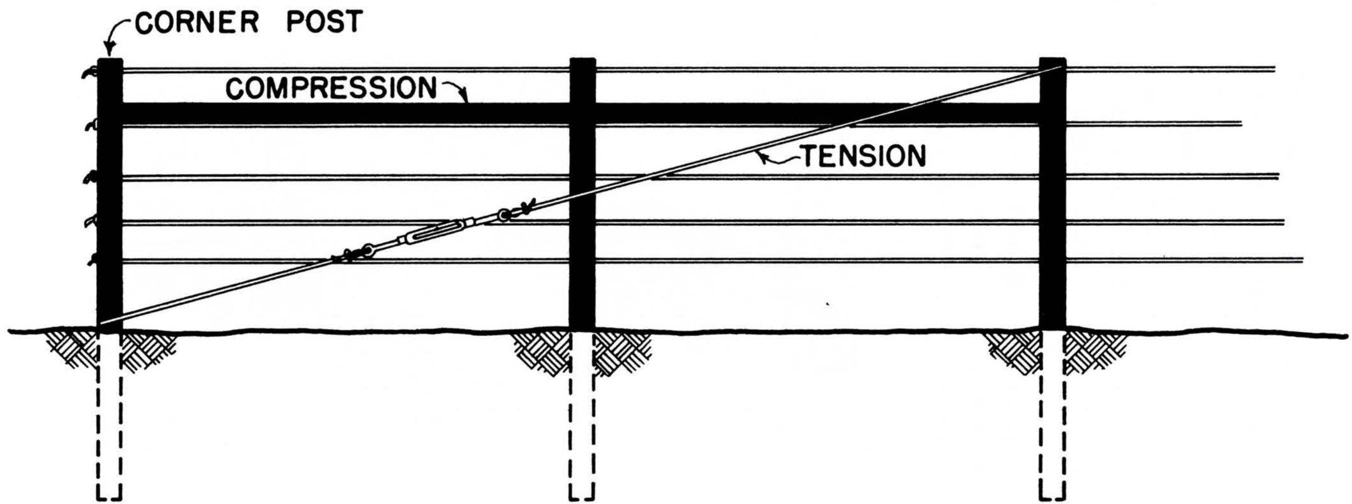


Fig. 10. Bracing of a corner or end.