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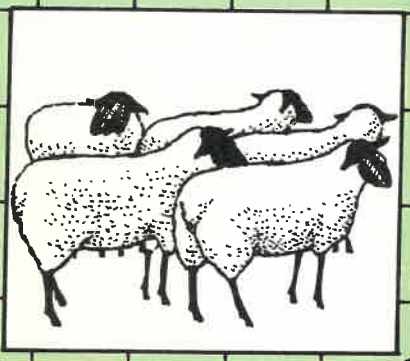

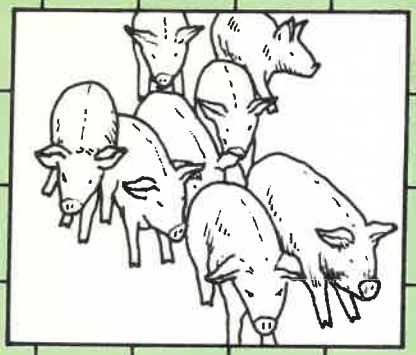

Small Farms -

Livestock Buildings and Equipment

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CONTENTS

SMALL FARMS -
Livestock Buildings and Equipment

There is no average small farm in this country; particular farming conditions are as varied as the background and motivation of individual farmers. Many part-time farmers try to earn a significant portion of their income from their land, labor and financial resources. Small farms of former urbanites or suburbanites often represent a way of life, such as a retirement home or place to pursue hobby or recreational interests, more than a way to earn a living. Other farmers are looking for self-sufficiency by reducing their dependence on the supermarket and other services as much as possible. Still others operate small scale farms on a primarily commercial basis.

In planning for new livestock buildings or adapting existing facilities, some typical goals are development of a new enterprise, adding a new facility to improve labor or production efficiency, or expanding a livestock enterprise to increase income. A project that begins as a hobby, can develop into a larger enterprise to offset costs and eventually lead to profit. Whatever your particular situation and goals, plan the whole farm situation as objectively and as far into the future as possible. When designing facilities, allow as much versatility as possible for future changes.

This booklet provides assistance in the planning, design and construction of small scale livestock buildings and equipment. The information can also help you adapt or modify an existing facility. Guidelines are included for basic farmstead planning, site selection and space planning. The chapter on livestock enterprises has options and housing requirements for various livestock. Partial confinement in 'cold' or unheated housing using natural ventilation is emphasized here. However, the sections on swine, dairy and poultry also show 'warm' housing for birthing, nursing and youngstock. Other chapters deal with construction, utilities, environmental control, waste and pest management, fencing, and safety requirements. Building and equipment plans are included.

The first criteria in planning is knowledge and experience of the livestock. Those without previous experience can gain knowledge through hiring an experienced hand, working along side an experienced hand (perhaps helping a neighbor for a few months) or gathering published information and experimenting with a few head of livestock. When experimenting, keep facilities as simple as possible.

Some management options are included for each species of livestock discussed. Further information on livestock management, machinery, land and tillage, and other factors crucial to the development of long term planning, can be obtained from the selected reference section and from local resources. The best sources for this type of information are often local Cooperative Extension county agents, farmers in your area, agricultural engineers, and other specialists at your state Land Grant university.

I—General Planning

ESSENTIAL FACTORS of LIVESTOCK PRODUCTION

Water is essential for livestock. Where water supplies are limited, costly, or of poor quality, water becomes a controlling factor in developing livestock centers. Potable (drinking quality) water is not needed for all purposes, but adequate quantities and quality are essential. Management practices also often require water for cleaning, sanitation spraying, waste removal, and summer cooling of animals.

Drainage is listed after water only because it is usually possible to improve, and often possible to correct drainage. Poor drainage has caused more problems, destroyed otherwise successful layouts, and frustrated more developments than any other factor. Many livestock manure management problems relate directly to drainage.

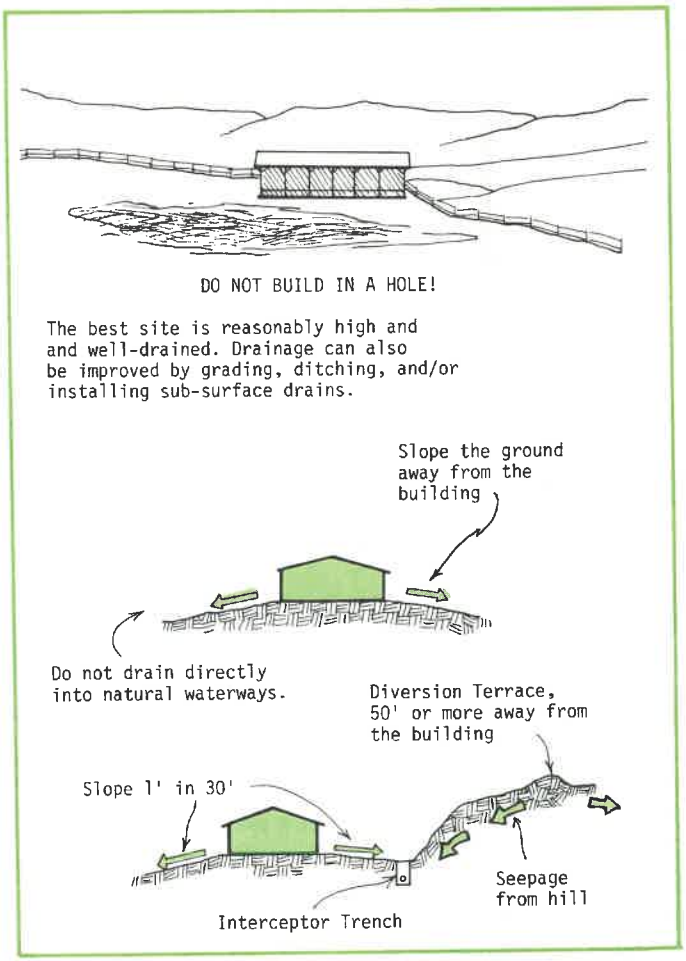
The best site is one that is reasonably high and well-drained but level enough so that it is not difficult to place buildings where they are wanted. DON'T BUILD IN A HOLE! Do not consider improving a farmstead that cannot be well drained by grading, ditching and/or installing subsurface drains. Do not drain from the farmstead directly into natural water courses. (Figure 1)

Production volume of a livestock enterprise affects, and is affected by, the whole farm and all operations. In the planning stages, consider the **full** impact of increased production volume—on livestock space needs, manure disposal, feed requirements, land use, machinery needs, traffic volume, odor and dust nuisances, as well as labor and service requirements.

Off-farm factors such as legal restrictions and regulations, rural housing development and other regional features are important to consider when planning a livestock production center. Clear plans with appropriate authorities to be sure they meet local zoning and construction permit requirements.

Odors, dust, noise and possible pollution by livestock manure can affect neighbors as well as family. Locate livestock and manure facilities downwind from living centers and control runoff before it leaves the farm. It is usually easier, in the long run, to avoid complaints than to adequately respond to one already raised.

Figure 1. Site selection and drainage.



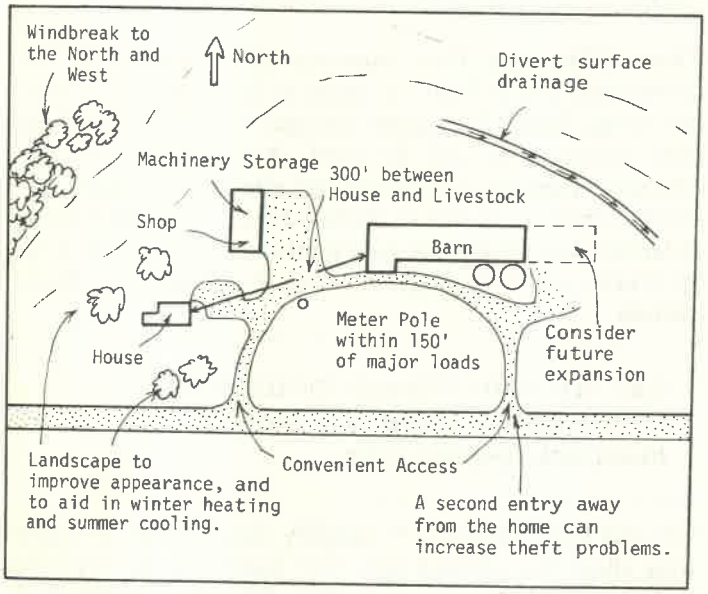
Manure management has become a critical factor because regulations can prohibit some developments, and require or prohibit certain management practices. General recommendations are difficult, because the manure disposal system will depend on the kind of livestock; size of enterprise; soil, rainfall, topography, and other natural features; and regulations adopted by national, state, and local governments.

A supply of drinking water, piped under pressure to various points on the farmstead is essential.

FARMSTEAD PLAN

Develop a farmstead plan including lanes, fences, yards, buildings, well, electricity, trees, land slope and drainage channels. Use this plan to study chore routes, find bottlenecks, and decide where improvements will do the most good. Remember that the design of buildings for livestock requires analysis of work patterns, machinery needs and space, as well as the space and environmental needs of the livestock. (Figure 2)

Figure 2. Farmstead Plan.



For help in selecting cropping programs and livestock enterprises compatible with your soil and other physical resources, obtain a *Soils Survey* from your county office of the Soil Conservation Service. Some counties have not been mapped, in which case, you can request that a map be made for your area. In other cases, a detailed soils map may already have been prepared for your particular acreage.

As the overall farmstead plan is developed, consider these factors:

Versatility and **options for expansion**. A hobby farm may develop into a business as farming practices and individual priorities change.

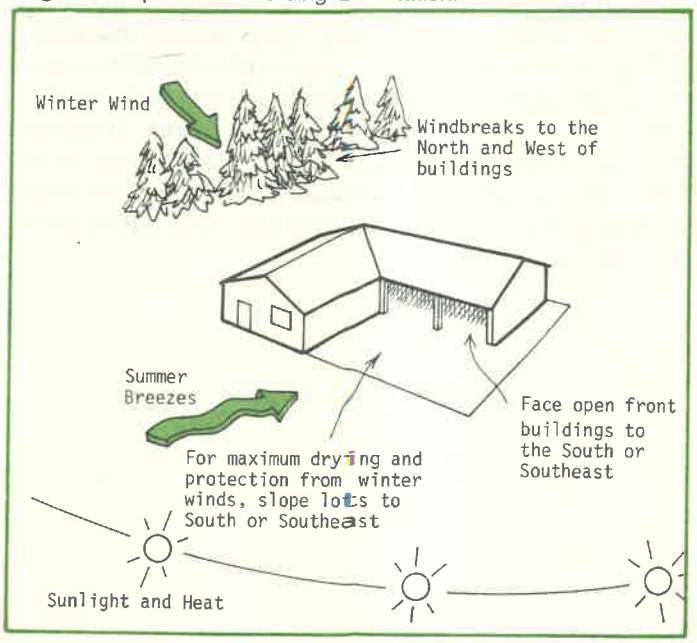
Space buildings to allow for expansion, easy access, fire safety, and isolation between various farm activities.

The single most important factor in selecting a site is drainage, both surface and sub-surface.

Liveability. Place the house and its grounds so prevailing winds carry barnyard odors away from them. Consider appearance. For example, put the manure pile out of sight or well screened from view. Consider the distances between the barn and house and the house and highway. Placing the house 100 feet from the highway helps protect it from traffic noise, but not too far to make it easy to clear driveway snow.

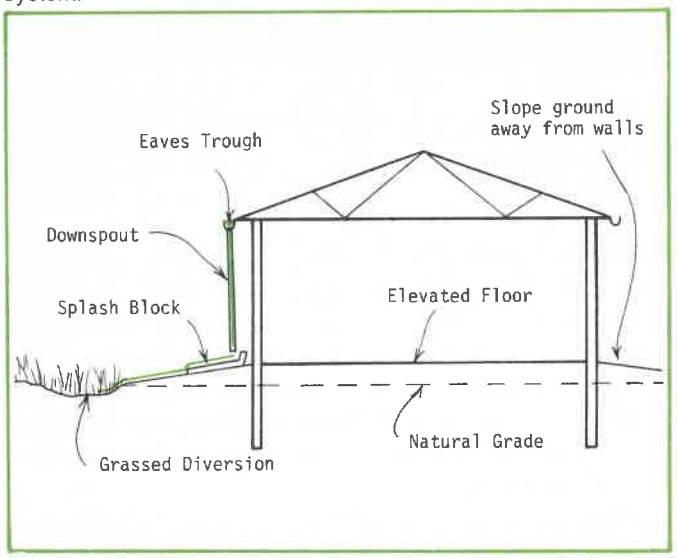
Weather. Windbreaks to the north and west protect the farmstead from winter winds, without blocking cool summer breezes. South facing slopes keep houses warmer in winter. Place feedlots to the south and east of barns. Face open front buildings south or east for maximum shelter and winter sunlight. Locate buildings relying on natural ventilation for exposure to prevailing winds, and away from surrounding trees, structures and land formations. (Figure 3)

Figure 3. Open Front Building Orientation.



Slope ground away from buildings to let rain and snowmelt drain away, as shown in Figure 4. Slope open lots toward a grassy area, but never into natural water courses that carry water beyond the farm boundaries. Divert unpolluted rain and snow melt around livestock areas.

Figure 4. Rain and Snow Melt from a Feedlot are Potential Pollutants. Handle as Part of a Livestock Waste Management System.



Roof gutters and drains help protect buildings and foundations, and keep rainwater away from lots and out of a manure management system. Construct diversion terraces to intercept surface water and carry it around, rather than into or across, an animal center. Terraces, dikes, road ditches, culverts, drainage tile, and sometimes paved drives are conduits to control surface water. Rain and snow-melt from a lot are potential pollutants; handle them as part of the livestock waste treatment system.

Accessibility. Provide year-round roads to the home and to livestock buildings for feeding. Earth moving and road building can be expensive, but are excellent investments. Good all-purpose, all-weather roads are essential to daily feeding, management and animal movement. Building around an existing facility because of the presence of a $500 road or avoiding a new location because of a $1,000 soil moving cost, may, in the long run, turn out to be a very expensive decision.

Carefully determine space for livestock, feed, bedding and associated equipment. Then plan for future expansion.

Existing Farmsteads. It is expensive to tear down buildings and build new ones, or to move large buildings. Changing the uses of existing buildings and relocating fences and gates around buildings can sometimes be done relatively inexpensively yet meet needs and priorities. If radical changes are necessary, or a new farmstead is being laid out, try to keep the best buildings and the best located buildings and develop the plans around them.

Chore Efficiency. Place buildings close enough to be convenient but at least 50′ apart to help keep fire from spreading. Store hay, grain storage, silage and bedding near where they will be used. Avoid hand carrying whenever possible. Conveyors and elevators are good for short distances—trucks or tractor-drawn wagons for long distances. Locate outside feed bunks so they can be filled by trucks or feed wagons without interference from animals.

Lay out barn interiors for daily chore convenience. Store feed close to the livestock feeding area.

Lay out barn interiors to simplify daily chores. Provide wide alleys for wheeled carts (see Table 7, p. 33). Handle materials in bulk to reduce trips. Minimize empty haul trips when doing a chore. Provide central storage areas and locate tools at the point where a job begins.

Plan for **manure removal** with a tractor and blade, loader, or gutter cleaner. Avoid interior posts, provide adequate headroom and use large doors in buildings and wide gates in lots.

II—Livestock Enterprises

PRODUCTION OPTIONS

Tables 1 and 2 summarize the resource requirements, potential costs and returns, and minimum space requirements for livestock farmers to compare various species. Refer also to the selected references, particularly the USDA publication *Living on a Few Acres* which may be available in your local public library, for an overview of the pros and cons of each type of small scale livestock enterprise.

Forage-Crops Production

Generally, the cheapest source of nutrients on small farms is pasture. But livestock production with forages as the main feed source can be one of the most complex agricultural enterprises with continual interaction between a large number of factors—including soils, plants, weather, pests and the livestock.

Successful livestock production, based primarily on forages, requires control of both the plant and animal aspects. Yet many producers devote too much attention to one, missing opportunities to improve efficiency by virtually neglecting the other. Develop a management plan for the feed and forage program so that building space requirements, fencing needs, management and labor requirements are fully developed and integrated in the planning stages. (Figure 5)

Figure 5. Study all Aspects of your Livestock Enterprise.

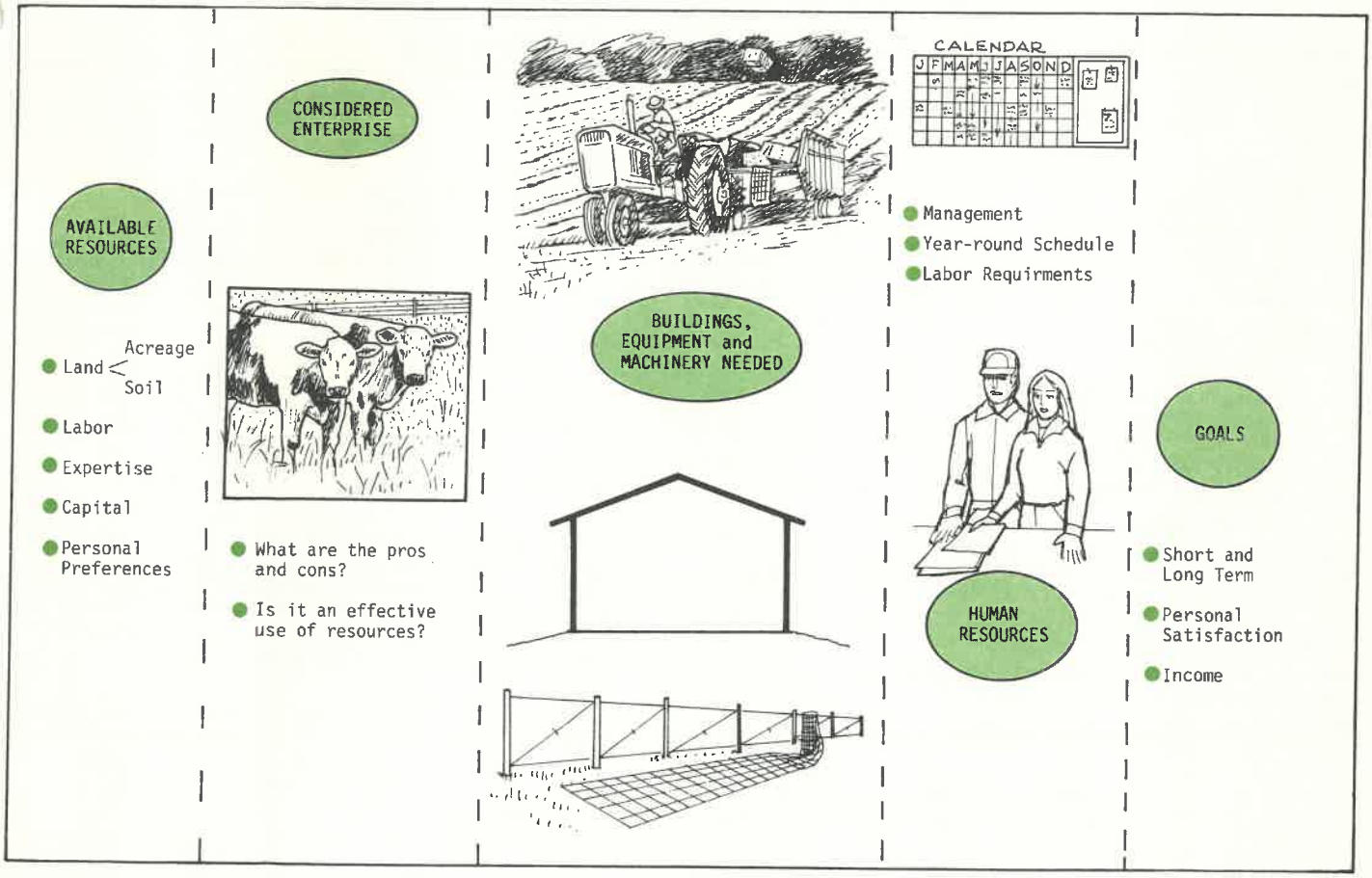


Table 1. Requirements for Part-time Beef and Dairy Enterprises for Small Scale Farms.

FACTOR	BEEF COWS	YEARLING STEERS	FEEDER CALVES	DAIRY COWS	VEALERS	DAIRY GOATS
UNIT	1 cow	1 steer	1 calf	1 cow	1 calf	1 doe
LABOR						
Daily Schedule[1]	some	little	important	essential	essential	essential
Decision,Responsibility[2]	little	slight	some	usually	usually	usually
Peak Season[3]	freshening	none	young	usually	usually	usually
Hours/Unit[4]	6-12/year	1-3/period	2-3/period	64-81/year	4-5/period	15-25/year
MANAGEMENT[5]	low	low	average	intense	intense	intense
LAND AREA per UNIT	2-5 acres	1-5 acres	1 acre	1-3 acres	0.1 acre	0.2 acre
CAPITAL						
Turnover Time[6]	12-14 months	6-9 months	6-8 months	1-2 year	6-14 weeks	10-15 months
Building Investment ($)	0-200+	0-200+	0-500+	300-2000+	0-200+	100-500+
Equipment Investment ($)	0-200+	0-100+	5-300+	200-1000+	10-250+	75-200+
Animal Cost ($)	350-750	350-450[7]	50-150[7]	800-2500	50-125[7]	125-600
CASH EXPENDITURE ($)[8]	180- 350	500-575	250-400	1000-2500	270-300	150-420
POTENTIAL GROSS RETURNS ($)	250- 350	480-580	200-440	1400-2500	250-370	200-600
MINIMUM UNITS NEEDED	10	5-10	10-100	25	40	5

[1]How important is timeliness and how important is keeping a rigid daily chore schedule to the success of the enterprise?

[2]How important is it for laborers to be able to make some daily decisions and accept some management responsibility?

[3]Peak season usually requires more than average labor and management. When does it occur, if ever?

[4]Work hours would be per usual growth period or per year.

[5]Each enterprise requires a different minimum level of managerial attention, with intense as highest followed by periodic (some periods of intense and some of low managerial attention), average and low.

[6]Amount of time from purchase to sale of item or amount of time for breeding animal to pay for herself through sale of product.

[7]Included as part of cash expense.

[8]Does not include interest on debts, labor, or taxes and depreciation on real estate.

Table 2. Requirements for Part-time Swine, Sheep and Poultry Enterprises for Small Scale Farms.

FACTOR	SOWS	FAT HOGS	SHEEP	POULTRY(Layers)	RABBITS
UNIT	1 sow	1 pig	1 ewe	100 birds	10 does
LABOR					
Daily Schedule[1]	important	some	important	essential	important
Decision,Responsibility[2]	some	little	slight	slight	some
Peak Season[3]	farrowing	none	lambing	usually	birth
Hours/Unit[4]	30- 40/year	1/period	1-2/year	80-120/year	50-60/year
MANAGEMENT[5]	periodic	low	periodic	intense	periodic
LAND AREA per UNIT	0.2 acre	0.1 acre	0.2 acre	0.1 acre	0.1 acre
CAPITAL					
Turnover[6]	6-12 months	4-5 months	10-12 months	14 months	10 weeks
Building Investment ($)	0- 250	0-40	10-100	0-1000+	50-300
Equipment Investment ($)	0-400	10-70	20-100	20-200	50-200
Cost of Livestock(Unit) ($)	90-150	20-55[7]	50-175	150-300[7]	90-110
CASH EXPENDITURE ($)[8]	350- 600	90-106	80-110	100-1300	500-700
POTENTIAL GROSS RETURNS ($)	400- 660	70-165	80-150	1400-2000	675-1000
MINIMUM UNITS NEEDED	5- 10	15-20	10	2	3

[1]How important is timeliness and how important is keeping a rigid daily chore schedule to the success of the enterprise?

[2]How important is it for laborers to be able to make some daily decisions and accept some management responsibility?

[3]Peak season usually requires more than average labor and management. When does it occur, if ever?

[4]Work hours would be per usual growth period or per year.

[5]Each enterprise requires a different minimum level of managerial attention, with intense as highest followed by periodic (some periods of intense and some of low managerial attention), average and low.

[6]Amount of time from purchase to sale of item or amount of time for breeding animal to pay for herself through sale of product.

[7]Included as part of cash expense.

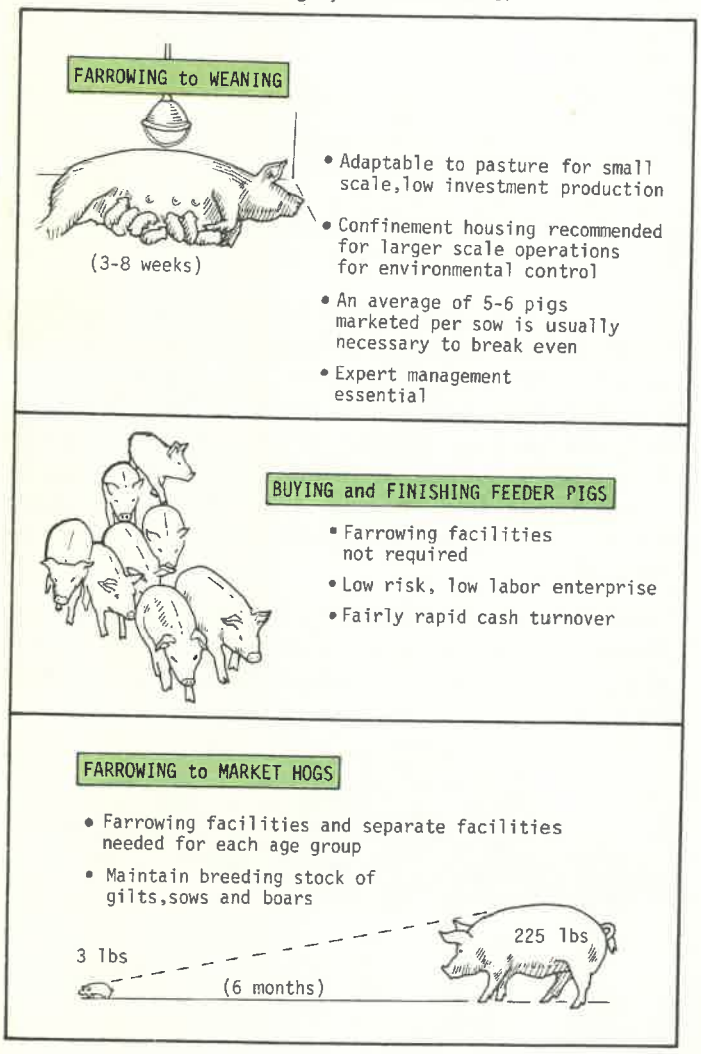
[8]Does not include interest on debts, labor, or taxes and depreciation on real estate.

Tables 1 and 2 were adapted from data developed by John E. Brockett, Area Farm Management Agent, Pennsylvania State Extension Service, 1981.

SWINE

With careful planning, swine can be an ideal part-time income-producing project. Swine production offers versatility in size, type of management system (labor or capital intensive) and production scheduling (part or all of the year). Although brood sows and boars require only minimal housing, the farrowing operation requires closed buildings and supplemental heat in cold weather. The facilities required for pigs depends upon the size of the operation, how pigs will be marketed, whether the pigs are raised in confinement or pasture, and how the production stages are divided (Table 3). Three typical marketing systems are shown in Figure 6.

Figure 6. Typical Marketing Systems for Swine.



Swine production offers flexibility in size, management system and production scheduling.

Table 3. Typical Growth of Swine.

Stage	Age	Average Weight
Early Weaning	3 weeks	10 lbs.
Late Weaning	8 weeks	40 lbs.
Growing	10 - 18 weeks	70 - 150 lbs.
Finishing	18 - 26 weeks	150 - 220 lbs.

MARKETING ALTERNATIVES

• Farrowing Pigs for Sale as Feeder Pigs

A farm that raises sows and produces (farrows) pigs for sale as feeder pigs needs good farrowing facilities and expert management to be profitable. Pigs can be farrowed without expensive confinement housing, using movable A-frame houses on pasture, for spring and sometimes late summer farrowing. This has the advantage of low investment for farmers inexperienced with swine. Rotate the fenced areas to rejuvenate pasture and for disease control. (Figure 7)

For larger scale operations, confinement housing is recommended to control the environment. A breeding program of multiple farrowing in which two or more groups of sows are each farrowed twice a year, makes continuous use of the capital invested in equipment and housing and distributes the marketing throughout the year. The profit or loss from a swine breeding herd is often determined by the number of pigs weaned and marketed per sow. An average of 14-16 pigs marketed per sow per year is usually necessary to break even.

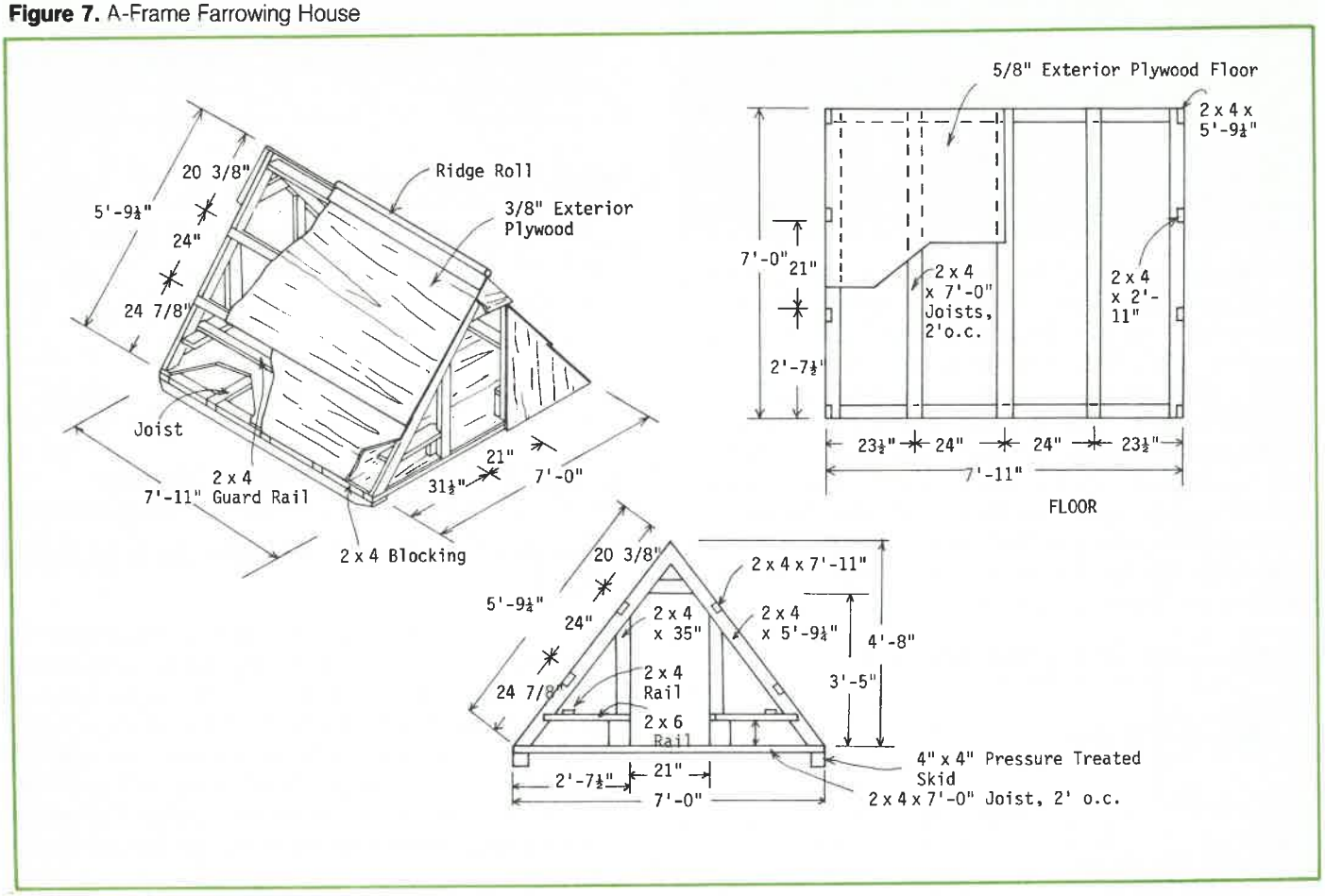
• Farrowing Pigs for Sale as Market Hogs

Good farrowing facilities and separate facilities for each age group provide better disease and environment control and waste handling. To eliminate the heated farrowing house, just one litter per year can be produced on pasture during warm weather. This lowers capital investment, but also decreases potential net cash returns.

• Buying and Finishing Feeder Pigs

Buying and finishing feeder pigs to sell as market hogs does not require farrowing facilities. This is a low risk, low labor enterprise with fairly rapid cash turnover from purchase to sale suitable for farms with grain to sell.

Figure 7. A-Frame Farrowing House



CONFINEMENT or PASTURE

Producers raise hogs in confinement:

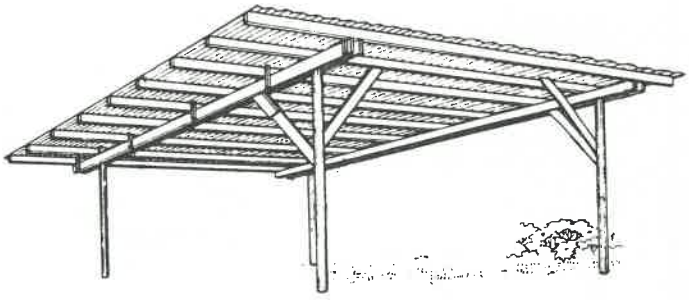
- when large numbers of hogs will be raised and capital is available.
- to cut labor and chore time with mechanical feeding and watering.
- when top level management is available.
- for better control of feeding, diseases, and management.
- for better year-round working conditions.
- to reduce animal use of high value land.
- when a multiple-litter farrowing schedule is used.

Pasture management is most practical for those who:

- desire minimum building investment.
- have pasture available for proper rotation necessary for disease control.
- farrow once or twice a year.
- farrow up to about 80 sows per year.

In a swine pasture operation, bred sows are kept in a fenced (woven wire) pasture with a simple, uninsulated movable wood shelter. When sows are ready to farrow, provide bedding for sows to "nest" in. Trim baby pig's teeth and vaccinate according to veterinary recommendations. Feed in an outside trough. Increase herd size by raising females from the litter. When the pasture system becomes too cumbersome, confinement facilities can be developed.

Protect pigs on pasture from high temperatures with sun shades, waterers, sprinklers, and wallows. The hogs need shelter during cold weather where they can group together for warmth.



PRODUCTION FACILITIES

One Pen

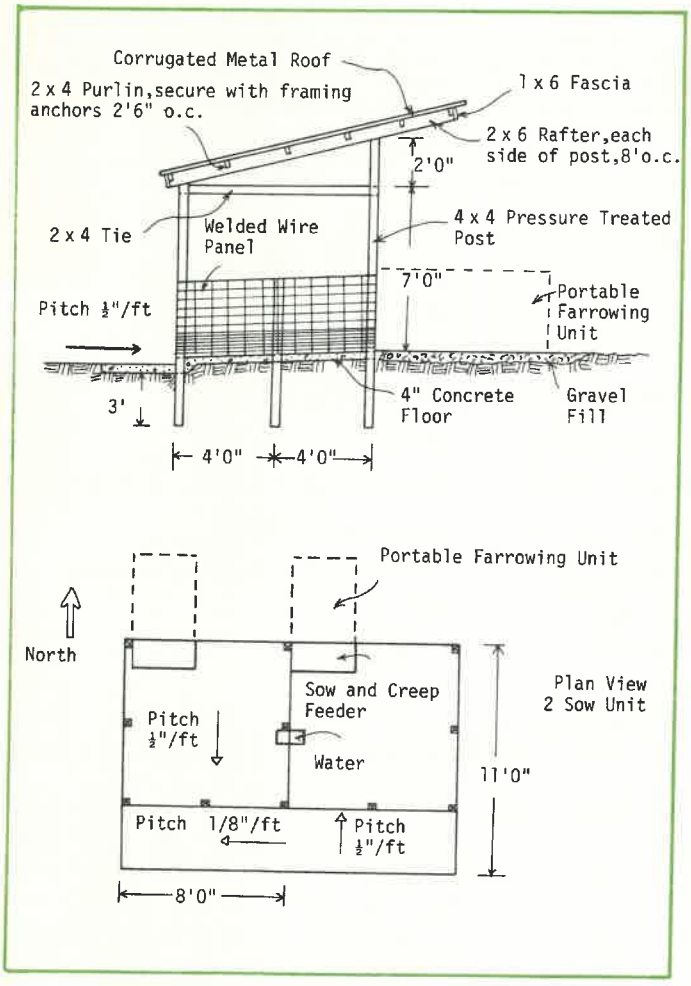
Farrow-to-finish production all in one pen is no longer common, partially because slower pigs in each group stay in the building too long, and there is not adequate clean-up time before the next farrowing. Further, the more expensive farrowing facility is not needed for finishing.

Feeder pig production is commonly a one-stage system, with pigs sold from the pens in which they were farrowed. Four litters a year can be raised to 40 to 60 lbs. in a single pen.

Two Pens

If pigs are farrowed, nursed, weaned and started in one pen to about 60 lbs and 12 weeks of age, they can be moved to a finishing unit for the next 12 weeks. Four litters a year can be raised this way in two pens. Some producers farrow 3 times per year—skipping a mid-winter litter to leave more time for slower pigs to reach 220 lbs and to avoid severe weather for farrowing and very hot weather at the end of finishing.

Figure 8. Swine Farrowing and Nursery Unit.



An alternative is to put half of the sows into the stalls for farrowing. Litters with the largest pigs are weaned and moved to a nursery pen when stalls are needed for another farrowing. The second group of sows and litters stay in the stalls until weaning. About 2 litters are grouped into each nursery pen, often after sorting by weight and vigor.

Three Pens

Three stages are common for large herds and 6 or more farrowings per year: farrowing in stalls where pigs are held until weaning; starting or growing in pens with supplemental heat, for pigs to weights between 75 and 125 lbs; and finishing in a unit for pigs up to market weight. As in two-stage systems, some sows and litters may be moved to nursery pens before weaning.

FARROWING

Typical Schedules

One Litter Per Year. Gilts are farrowed once a year in warm weather, often on pasture. The investment in buildings and equipment can be very small, but it is charged to only one group of sows and litters.

Two Litters Per Year. One group of sows is farrowed twice a year, usually April and October. If one of the farrowings is in cold weather, more investment in buildings and equipment is required; overhead is prorated to twice as many litters.

Multiple Litters Per Year. Two or more groups of sows are each farrowed twice a year. Confinement buildings are essential for this schedule. Because the facilities are charged to many pigs, the cost per pig may be the lowest of all possible schedules.

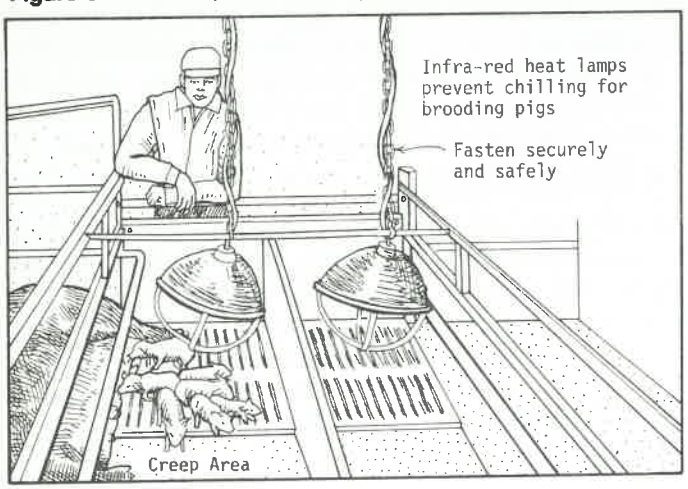
Farrowing Buildings

Farrowing in an enclosed building allows the manager to control the environment within the building. Baby pigs must be kept warm, dry, and free from cold drafts. A newborn pig needs an environment of about 90°F, then is content with about a 2° drop per day to 70°F. The sow, on the other hand, is most comfortable at about 60°F. To obtain these two temperatures at the same time, provide supplemental heat in the creep area.

HEAT LAMPS for BROODING PIGS

Infrared-heat lamps save an average of 1 1/2 more pigs per litter by preventing chilling. The first 12 to 24 hours after birth is a critical time for newborn pigs. During this period use a 250-watt heat lamp over the creep area. (Figure 9)

Figure 9. Heat Lamps for Brooding Pigs.



Heat Lamp Suspension

Suspend heat lamps at least:

- 30 inches above the bedding or 6 inches above the standing sow (whichever distance is greater) at farrowing time.
- 24 inches above the bedding in a protected area. Construct a strong sow-pig barrier to keep both lamp and cord out of sow's reach.
- Follow installation procedures outlined in Section IV—Utilities.

Infrared-heat lamps prevent chilling of new born pigs.

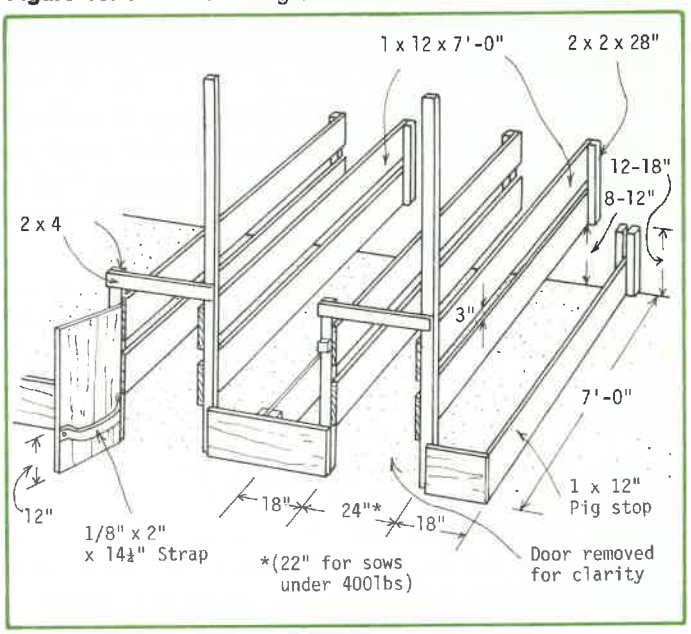
STALLS and PENS

Farrowing stalls provide the best protection from injury for small pigs (particularly for the first week or two) and also require less bedding, floor space, and labor than do pens. It is more difficult to catch pigs in a stall. The stall area is often used by producers farrowing 2-4 times a year to grow weaned pigs.

Many producers provide water and feed in each stall, while others release the sows daily. Feeding in stalls is especially recommended for larger herds.

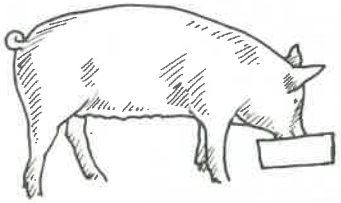
Buy or build stalls that have approximate dimensions and features shown in Figure 10. Farrowing stalls are commonly built from 1" lumber, 3/4" exterior plywood, or 1" galvanized pipe. Solid pig barriers can reduce drafts. Oak or some other hardwood is preferred to prevent animal damage.

Figure 10. Swine Farrowing Stall Dimensions.



GROWING

Growing is the period between weaning and when the pigs weigh about 100 lbs. Feed conversion is highest at 60°F, but this optimum environment for growing pigs may require a large investment in buildings and equipment.



Space and Facilities

Growing pens may be:

- the farrowing stall or pen after the sow is removed.
- pens in a separate growing building.
- pens in a combination growing-finishing building.
- subdivided finishing pens.
- full sized finishing pens.

FINISHING

Finishing is the stage from pig weights of about 100 lbs. to market size. Pigs are finished on pasture, shelter and drylot, in open front buildings, or in complete confinement. Although a finishing pig can stand low temperatures, fastest growth with least feed occurs at temperatures of about 55°F and at relative humidities of 50%-80%.

Space requirements vary with pig size and type of pen floor (bedded, solid, or slotted). Overcrowding tends to increase tail-biting and cannibalism, and may decrease rates of gain. More space than recommended has not improved the rate of gain or pig social behavior.

Re-grouping animals causes stress, while they determine a new social order and adapt to their new surroundings. If litters must be grouped, it is best to group them early. Weak pigs can be penned together to reduce competition. Some producers also group injured pigs.

SPRAY COOLING

Pigs can be kept cool at high temperatures through evaporation of moisture from their bodies. In confinement facilities, wetting pigs with a spray nozzle system and intermittent spraying during hot weather can improve rates of gain during hot weather. About 0.09 gallons of water per hour per pig is sufficient, or a spray nozzle with a capacity of 0.045 gpm per pig. Refer to Table 4 for nozzle sizing.

Table 4. Spray Cooling for Pigs.

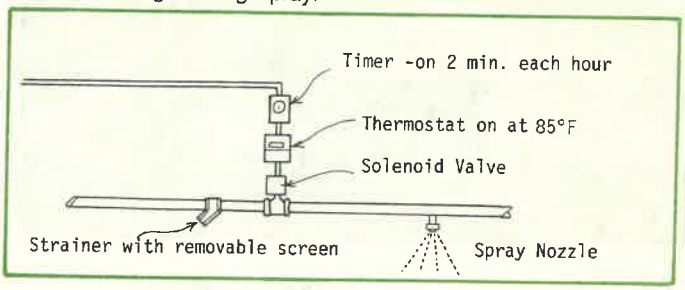
Pigs/Pen	Nozzle size (gpm)[1]
10	0.45
20	0.90
30	1.35

Spray on 2 minutes/hour.

Select a nozzle to cover at least 3/4 the width of the pen with a solid cone of droplets—not a mist or fog. Nozzle design (spray angle and pattern) and mounting height affect the sprayed area at pig height. Give the dealer your water analysis to help select the proper nozzle. Corrosive water or extremely hard water may require a noncorrosive nozzle that is easy to clean.

Locate the spray nozzle over the manure collection area of the pen connected as shown in Figure 11.

Figure 11. Pig Cooling Spray.



SWINE DATA SUMMARY

FEEDER and WATERER SPACE

Self-feeders: one space/4 pigs

Supplement feeders: one space/15 pigs

Sow feeders: 1'/sow self-feed, 2'/sows all fed at once

Waterers: one space/20 to 25 pigs.

BUILDING FLOOR SPACE

Sows and boars: 15 to 20 sq ft., without outside run.

Pigs to 40 lb: 3 sq ft/pig

40 to 100 lb: 4

100 to 150 lb: 6

150 to market: 8

100 to market: 5 sq ft under roof, at least 6 sq ft (many systems use 15 sq ft) on outside paved lot.

PASTURE SPACE

10 gestating sows/acre

7 sows with litters/acre

50 to 100 growing-finishing pigs/acre depending on fertility.

SHADE SPACE

15 to 20 sq ft/sow

20 to 30 sq ft/sow and litter

4 sq ft/pig to 100 lb

6 sq ft/pig over 100 lb.

BEEF

MARKETING ALTERNATIVES

There are several beef enterprises from which to choose. They range from the relatively low risk cow-calf and yearling "grass steer" operations to the higher risk and potentially higher return finished steer enterprise. The cow-calf operation has a 400 to 500 pound feeder calf as its saleable product. Yearling "grass steer" operators buy 400 to 500 pound feeders in the spring, put them on pasture for 5 to 6 months, then sell them as heavy (600 to 800 lb.) feeders in the fall. Producers of finished steers purchase 400 to 800 pound feeders and feed them to a finished weight of 1,000 to 1,200 pounds.

Feeder and dairy beef enterprizes both start with dairy or cross bred bull calves and sell them as 400 pound feeders or a weights of 1,000 to 1,200 pounds as finished beef. Steers take 16 to 20 months to develop from baby calves to finished beef.

In general, beef enterprises have relatively low labor requirements and can make use of family labor. Chore time is flexible, too. Capital investment *can* be kept low per unit if the farmer is careful. Most beef enterprises make extensive use of home raised forage which reduces cash expenses. The yearling "grass steer" has an additional advantage in that the producer has money tied up in the animals for only a short time (5 to 6 months). Unfortunately, beef enterprises usually have a relatively low net return per unit. They also require large acreages of either pasture or corn to be feasible.

Beef cattle require minimal shelter, principally to protect from winds and storms and during calving in winter. They do not suffer from the cold and have good weight gains as long as they are dry and have feed and water. Completely enclosed shelters without good ventilation can be detrimental to animal health.

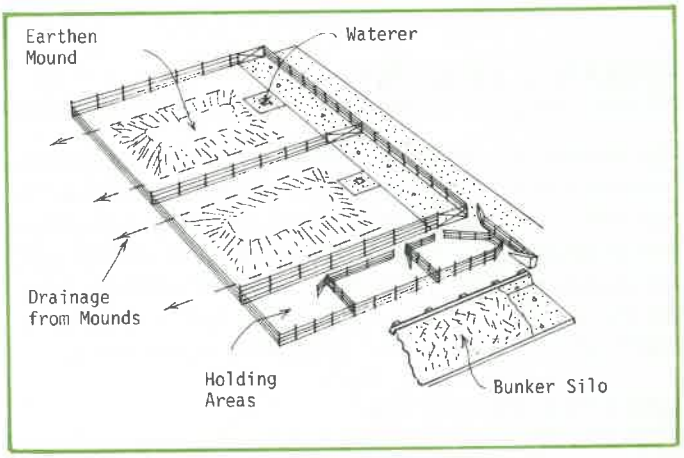
FEEDING FACILITIES

Cattle may be fed in an open lot, a barn and lot, or a total confinement barn. In areas with adequate space, good drainage and moderate annual precipitation, open yards with limited or no shelter are sufficient. Typically, feeding is done along a fence line. An earthen mound and good

Most beef operations make extensive use of home-raised forage.

drainage help keep the animals out of the mud. Most lots are unpaved, except for a strip of concrete along the feedbunk and around the water tanks. (Figure 12)

Figure 12. Open Feedlot with Fenceline Feedbunks.



If space is limited or drainage questionable, the yard may be paved. However, facilities to handle runoff are essential and manure must be scraped from the yards more often. Natural landscape features, a wind break and/or a sunshade may be the only protection needed.

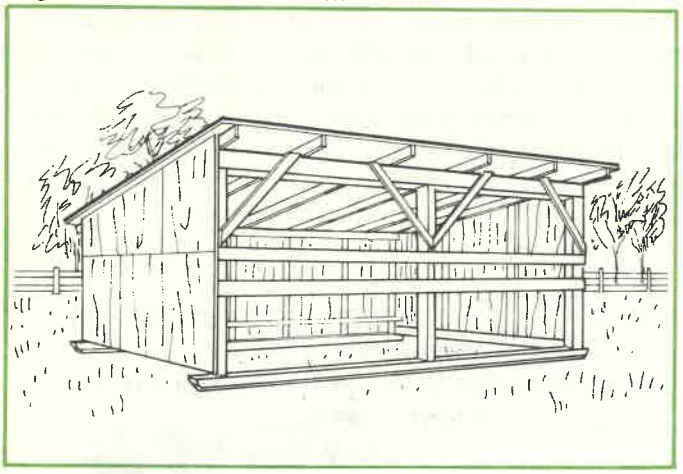
In cold, humid climates, shelter from wind, rain and snow, and a bedded resting area may increase animal comfort and feeding efficiencies sufficiently to offset the investment in buildings. Barns are usually built with one side open to the east or south —away from prevailing winter wind. The yards may be partially or completely paved depending on drainage and space available. Usually feed bunks and waterers are located outside to reduce the bedding needed and the amount of manure in the barn.

COW-CALF FACILITIES

Cows bred to calve in the spring can be wintered outdoors. Confining cows to **pasture** or lot near the farmstead just before calving makes it easier to observe and to help the cows if needed. In cold areas, a **calving barn** is desirable for winter calving and for sick cows. **Portable calf shelters** give calves on pasture a dry place to rest. (Figure 13)

An open front barn with electrical heat lamps makes an excellent unit for winter calving or for helping cows with difficult deliveries. Gates for pen dividers simplify cow and calf handling and permit easy cleaning. A frost proof

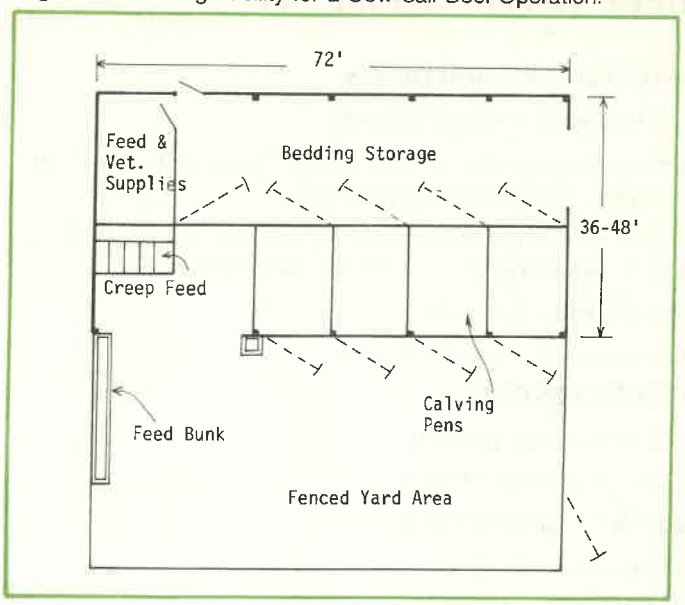
Figure 13. Portable Calf Shelter.



hydrant and buckets can supply water. A heat lamp provides heat for the calf if needed. A calf warming box with electric radiant heaters is good for weak calves on extremely cold nights. Closed barns are not good for calving because high humidities frequently contribute to calf sickness. Return cows and calves to an outdoor lot in 2 or 3 days.

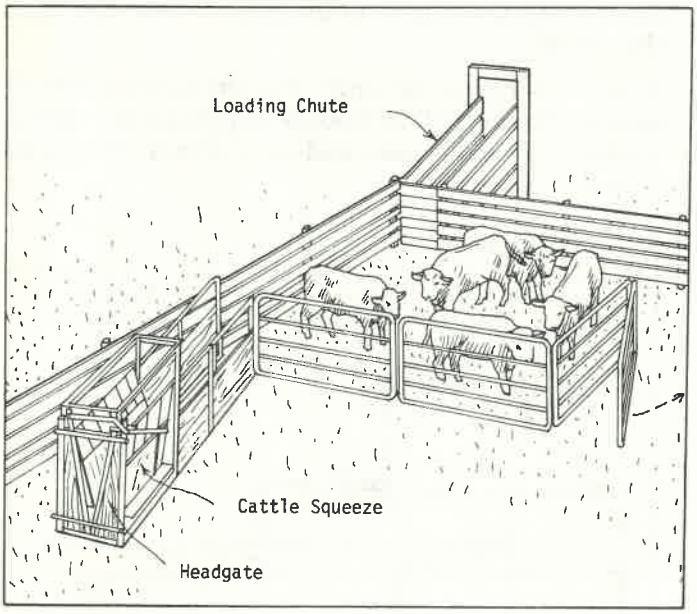
Keep mature cows, first calf heifers, bulls, and steer and heifer calves in separate feedlot areas if they are kept over winter. (Figure 14)

Figure 14. Calving Facility for a Cow-calf Beef Operation.

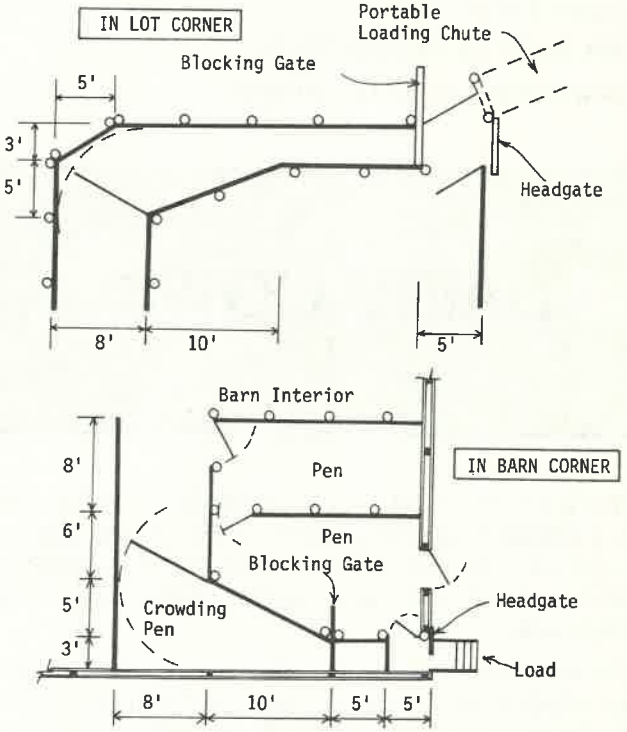


All cattle operations require a **corral** with a holding pen, working chute, and headgate (Figure 15). Fencing is a major requirement for the pasture. Line fences should be tight with either five strand barbed wire or 6 to 8 strand high-tensile wire. Internal fences can be three strand or single strand electrified.

Figure 15. Simple Corral Layouts for Beef Operation.



Corrals for small herds need not be complex. These systems are for animals in herds up to about 75 head.



BEEF DATA SUMMARY

FEEDLOT AND BUILDINGS

Hardsurfaced - 30 sq ft/animal.

Unsurfaced except around waterers, bunks and open-front buildings: 250 to 800 sq ft/animal.

(lower values for areas with 20″ annual rainfall or less, higher values for areas with 36″ rainfall or more).

Calving pen - 100 sq ft

Calving space - 1 pen/12 cows

FEEDER LENGTH

(All animals eat at once)

Calves to 600 lb. 18 to 22″

600 lb to market 22 to 26″

Mature cows 26 to 30″.

WATERERS

One watering space minimum for up to 40 head

CORRALS

Holding 14 to 20 sq ft/head

Crowding 6 to 12 sq ft/head

MOUNDS

25 sq ft/head.

Mound slopes: 5:1 (1′ rise/5′ run)

Lot Slope: 4 to 6′/100 ft

DAILY MANURE PRODUCTION

Feces and urine - 60 lb (1 cu ft)/head

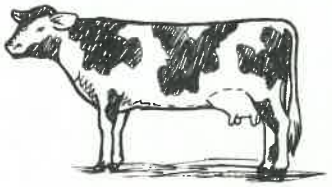
DAIRY COWS

Dairying for the small farm is generally limited to the family cow or dairy related enterprises such as producing youngstock. The cost to meet sanitation requirements typically requires that a dairy keep more than 20 cows to produce milk for sale.

Dairy cows require intensive management, a strict daily labor schedule throughout the year, and a high per unit capital investment. In addition, milk and milk products for sale are highly regulated and production must comply with stringent health regulations.

Dairy cows adapt easily to existing barns or sheds with provision for milking and milk handling. Stall barns, where cows are restrained in parallel rows of stalls, are common in cold regions where close confinement of animals provides heat to keep temperatures above freezing. Although dairy cows may be inside the barn most of the time, they are usually let out daily for exercise, to check heat periods, for supplemental feeding, or for pasture grazing.

Dairy cows require intensive management, an inflexible daily labor schedule throughout the year, and a high per unit capital investment.



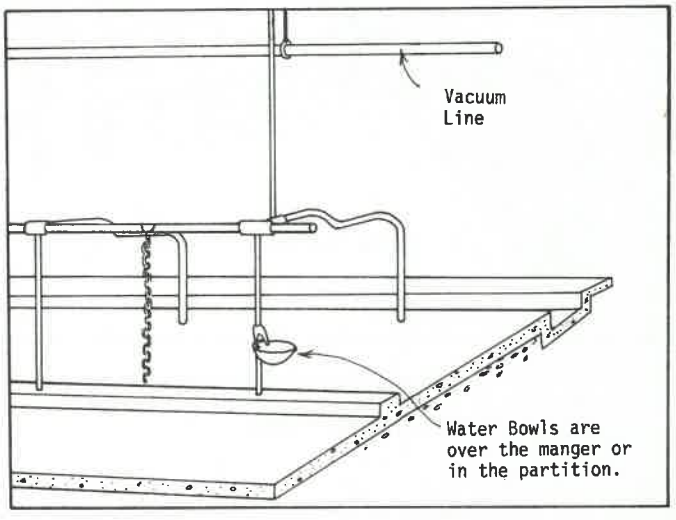
STALLS and PENS

Cows may be restrained with tie chains and/or neck straps, stanchions (neck yokes) or kept within pens (box stalls). Usually, the latter are used only for calving or special care. The restraining method used is based on personal preference.

The horizontal rail tie stall is simple, low cost, and effective for cow control. Cows can eat beneath the horizontal rail, but it keeps them closer to the gutter when they stand. (Figure 16)

Build tie stalls about 6″ longer than the distance from the point of shoulder to the pin bones. Widths are 75 to 80% of the length. For large cows, stalls are 5′ 6″ to 5′ 10″ long and 4′ to 4½′ wide.

Figure 16. Tie Stall for Dairy Cows.



The basic equipment needed to outfit a stall include:

- Stanchion or tie stall unit.
- Water bowl - attached directly to plumbing to give the cow free access to fresh water.
- If several cows are housed, consider running a 2" diameter galvanized steel or rigid plastic vacuum line for a milking machine.
- Electric cow trainers to keep cows properly positioned to keep them clean.

Stall Layout

The most common layout, two rows of cows, allows for expansion and smooth feed and manure movement. A drive is convenient for manure removal, faster bedding distribution and good summer ventilation.

Cows may face in or out in rows. A few cows may be placed in a single line with hay storage along one side of the barn. Milking and cleaning behind cows takes longer than feeding in front of them, so a central litter alley with stalls facing out is common. This layout keeps manure away from the walls and saves space since two litter alleys are wider than a common central feed alley. Stalls facing inward are better for central mechanical feeding and cow traffic to and from a milking parlor.

Dairy barns require good ventilation throughout the year.

FEED ALLEYS and MANGERS

Build concrete feed alleys and mangers as one unit. Fiberglass reinforced plastic, epoxy-coated or tile surface mangers resist corrosion from acids in feedstuffs better than smooth concrete. No dish, step, or wall is needed to hold feed in the manger, but the manger floor should be about 4" above the cow's front feet.

A feed alley and manger should be at least 6' wide to move feed carts without cow interference. If a row of hay bales is stored near the walls, add 2' to the width.

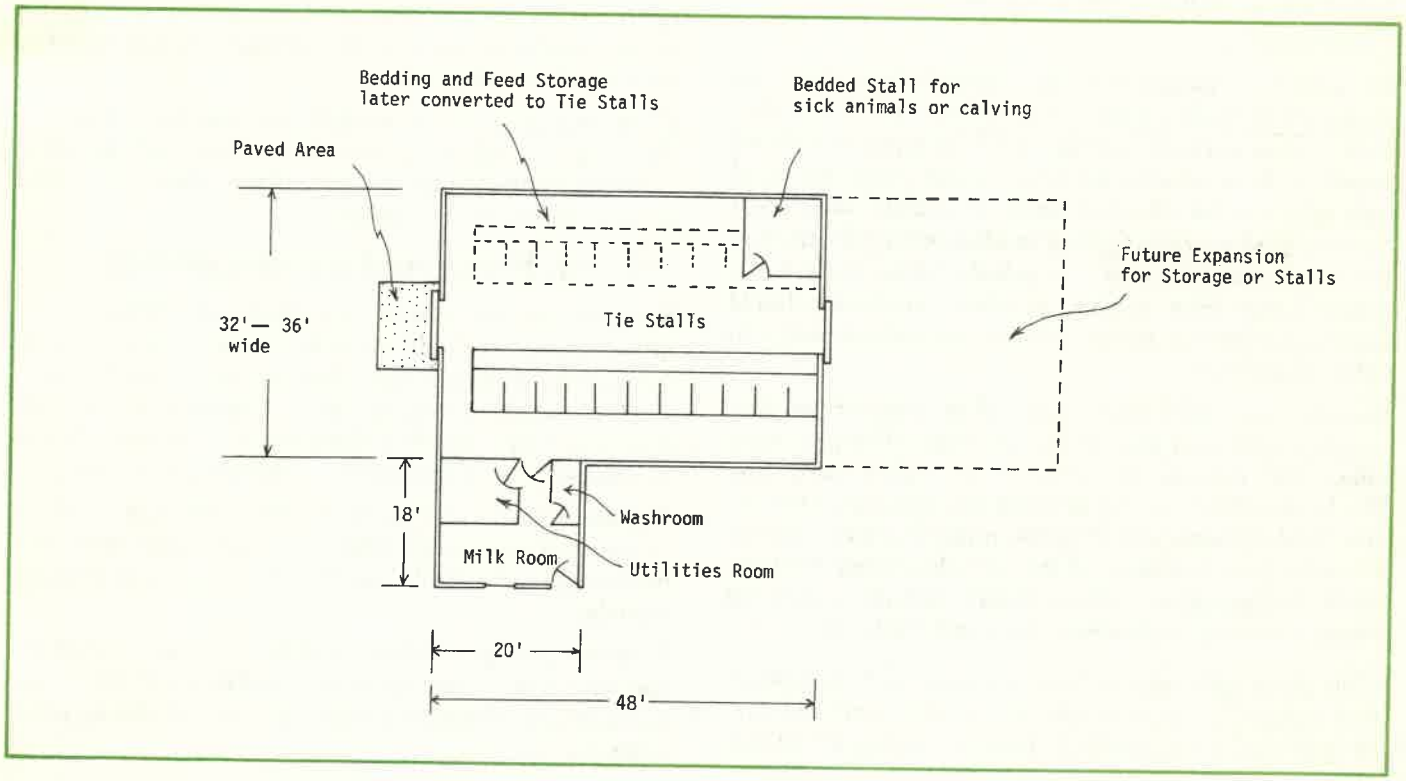
ATTACHED FACILITIES

Attach the feed storage, milk room, and manure loading area to the stall barn to reduce chore time and effort. Avoid blocking surface water drainage. Keep one end of a one story barn (or one end or side of a two story barn) free for future expansion. Locate the milk room at the end but in front (preferable south or east) of barns with milk pipelines. (Figure 17)

Keep calf housing separate from the milking areas but convenient to the milk room. Separate the manure loading shed from the milk room. Provide a hard, easily cleanable surface, such as concrete to park the manure spreader on.

Replacement heifers and **dry cows** often are housed in separate, more economical sheds, but on small farms may be housed with the milking herd.

Figure 17. An Expandable Dairy Barn.



RAISING DAIRY YOUNGSTOCK

Another livestock enterprise perhaps more attractive to the small acreage or part-time farmer than milking cows is raising dairy youngstock for herd replacement or for meat. This type of enterprise does not require costly milking equipment and in some cases allows more flexibility in chore routine, especially on a yearly basis planned around markets.

MARKETING ALTERNATIVES

Raising dairy youngstock can be divided into 4 categories. Environment and housing considerations for each are similar and dependent more on animal size and age than purpose. The categories are:

1. Raising heifer calves for dairy herd replacement.
   - Under contract for one or more dairy farmers.
   - Not under contract; buy and sell as a livestock dealer or through livestock dealers.
2. Raising dairy youngstock for meat.
   - Veal calves (veal as a specialty item).
   - Dairy beef.

The calves are usually purchased directly from the dairy farmer or through auction yards within 1 to 7 days after birth. Calves not to be used as dairy herd replacements are usually of little value to the dairy farmer except for what cash that can be obtained upon immediate sale. Most dairymen sell unwanted calves as soon as the colostrum in the cow's milk disappears — usually under 3 days. To reduce losses from disease, all calves purchased should have had colostrum which provides natural antibodies to fight off infection.

Dairy farmers cull from 20 to 30% of their cows from their lactating herd each year. These are replaced by new stock unless the purpose of culling is to reduce herd size. The farmer short on help or space may contract others to raise herd replacements. Progressive dairy farmers want to know the genetic makeup of the animals coming into their herds. Raising calves without genetic records reduces the animal's value as replacement for a milking herd.

While dairy bull calves and heifer calves not to be used as herd replacements can be sold by the dairy farmer as day-old (bob) veal, they could be fed out to weights of 150-250 pounds in 2-3 months and sold as veal. Calves of the heavier breeds are usually selected for veal, mostly Holsteins, some Brown Swiss and Ayrshires, and a few dairy-beef crosses. However, veal raising is a very specialized operation with high risks.

Bull calves, usually castrated, and cull heifers can be raised to heavier weights, 300-600 pounds in 6-12 months and sold as dairy beef. Since returns per pound of beef are much less, low cost feedstocks are used. Such animals might be used for the local food locker trade, especially the dairy-beef crosses.

FACILITIES and HOUSING

Methods of confinement within warm or cold environments include:

- individual pens within a building (warm or cold).
- individual elevated stalls for young calves.
- individual calf hutches.
- community or group pens for weaned calves.
- free-stalls in groups according to size.
- bedded packs in groups according to size.

The most desirable type of housing will depend on where the calves come from and what kind of housing they are going to in the case of herd replacements. For example, heifers raised as replacements for a herd being housed in free-stalls adapt better if raised in free stalls. Calves can be raised in cold environments if they are kept dry. However, calves raised for the first week of their lives in warm environments will have to be watched closely if switched over to cold housing later.

When new animals are brought onto the farm, minimize the danger of spreading disease to other stock by introducing new stock in groups and isolating them from other stock a minimum of 4 weeks.

Cold, Protected Environments

Research results indicate no significant differences in growth rates and health disorders between calves housed in a cold environment and calves housed in a heated barn. Cold calf housing systems are less expensive to build and maintain than controlled-environment structures because of reduced cost of insulation, ventilation and heating.

Provide protection for young animals from wind and drafts by using pens or stalls with solid sides. Equip pens with heat lamps for animals less than 8 weeks old during cold periods.

Poor ventilation in closed stables and calf houses encourages transmission of infectious diseases. Fresh air and sunlight help eliminate disease transmission among young animals.

In an open building, the temperature will be only slightly warmer than the outside temperature. Any attempt to close the building during cold weather creates more problems than the low temperature. If you try to close the building up tight to prevent freezing, you will find excessive frost accumulating on the underside of the roof. When it warms up, this frost melts and causes dripping in the building.

Warm Environments

'Warm' or environmentally controlled facilities provide comfortable working conditions which may encourage cleanliness and proper calf care. Also, water pipes and wet floors are not subject to freezing as they are in cold-barn systems.

The major problem with improperly designed warm barn systems is humidity. The health problems associated with high humidity are compounded by higher temperatures. Proper ventilation is extremely difficult to achieve.

Provide ventilation fans moving 1/10 cubic foot of air per minute (cfm) per pound of calf weight. Locate the fans to exhaust foul air from the calf nursery. Avoid drawing air from areas of older, larger calves to areas of younger calves. Without proper ventilation, moisture condenses on cold walls and ceilings, raises the humidity to undesirable levels encouraging transmission of pathogens and spores, which cause disease or fungus growth. The younger calves often do not have immunity to many disease organisms.

In hot weather, the ventilation rate can increase about ten-fold and the inlets will have to be opened wider. Do not rely on opening of windows, or on infiltration of air through cracks, as drafty conditions can result.

Install 2" to 3" of batt insulation (R-value:10-12) in walls and 4" to 6" (R-value:16-19) in ceilings for heat conservation. Heat produced by calves is insufficient to maintain building temperature in cold weather and permit the air exchange necessary for atmospheric control. The actual amount of heat required is related to the building wall and ceiling area, number and area of windows, the rate of ventilation used, the outside and inside temperatures, and the value of insulation installed. A rule of thumb is to provide a heating system with 1,000-1,500 Btu per hour of supplemental heat for each 100 pounds of body weight of calves housed.

To warm individual calves during their first week of life, suspend one 250-watt infrared radiant heat lamp above the stall or pen. Lamp height is adjusted and secured with a chain from the ceiling for the correct amount of heat. Elevate it so calves cannot reach or damage it.

Temperature of warm barns with calves in elevated stalls is recommended to be 50-55°F. For warm barns with calves in well bedded individual pens, ideal temperatures are from 45-50°F.

Confinement

When calves are small, isolate them from each other to prevent contact and disease transmission.

Individual pens. In cold or warm housing, provide each calf with a 4' by 6' or 5' by 5' pen with three solid sides 40"-48" high. The hay rack, grain box, and water or milk bucket can be mounted on the alley gate. Leave calves free to seek a comfortable, draft-free spot in the pen. Figure 19a is a variation of the individual pen design with outside runs.

Individual Elevated Stalls. Elevated stalls are approximately 20"-24" wide and 4' to 4-1/2' long. The stalls are commonly raised above the floor on legs or blocks or suspended from the ceiling. Depending on the design, the calf may be tied in the stall or kept in the stall with the aid of a tailgate. If calves are tied, use a tailgate for a couple of days to prevent the calf from backing out of the stall and accidentally hanging itself.

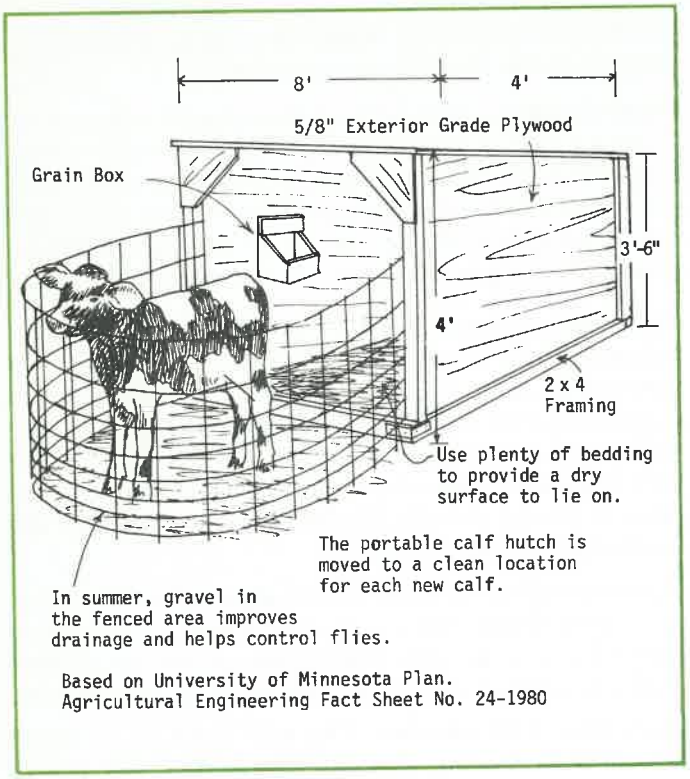
Elevated stalls are portable for easy cleaning and sanitizing. If you use slatted floor panels, the animals are exposed to air or drafts on all sides. For this reason, use the elevated stall only where there is careful control of the environment.

Individual Calf Hutches. The calf hutch is a simple, economical, portable unit that can be used for raising calves until weaning. Place hutches in a well-drained location such as clean sod, a layer of gravel, concrete paving, or a dry lot. The portable hutch is moved to a clean location for each new calf.

Place calves in the hutch as quickly as it is dry, following one good feeding of colostrum, regardless of the weather. Calves using their limited freedom of movement tend to seek out comfort zones, depending on weather and time of day.

The calf hutch should be 4' wide and 8' long, bedded deeply with straw. Straw is especially important in colder weather. Close pens on three sides and leave partially open on the fourth side, to allow access to the open-air. Open-air areas are either fenced, or the calf is tied so that it has access both to outside area and all areas inside. (Figure 18)

Figure 18. Calf Hutch.



Group (Community) Pens. During the age period from 2 weeks after weaning until 6 to 8 months of age, dairy replacements are commonly housed in community pens according to size. Separate calves from older animals to reduce competition at the feed manger. At younger ages, limit 6 to 8 animals per pen, since more concentrate per animal is needed at this stage of life. These pens are usually cleaned 3 to 4 times weekly.

Free Stalls. Size free stalls for heifers in proper proportion to the animals. Providing the proper stall size for groups of young animals subdivided by age or size can be difficult when the numbers are small. The usual result is that the stalls are improperly sized or an excessive number will be provided for each group, resulting in wasted space.

Arrange free stalls along an alley. The alley width is determined by the width of the tractor and scraper or by the size of the building, not necessarily by the space required for animal passage. A second alley provides room for animals while the first alley is scraped. (Figure 19b)

If bedding cost or availability is a problem, consider free stalls. When converting old buildings to heifer housing, free stalls may be desirable because stud frame walls can be pushed outwards by bedded packs; also ceiling heights can limit the depth of pack.

Bedded Packs. This housing arrangement for older heifers is low cost and easily provided in existing buildings. Considerable bedding is needed to maintain a firm and dry manure pack in earth-floored pens; even more bedding is required over concrete floors. Amounts used may vary from 2-8 pounds per animal daily, depending on types of bedding, size and density of animals, and other management procedures. The bedding pack will accumulate to a depth of several feet for each group of animals. The area adjacent to the feeding manger is difficult to bed properly and keep at an elevation permitting good animal access to the feed.

Some subdivision of livestock on bedded packs is required. If large numbers of older animals are grouped together with young animals, the competition for feed will prevent the younger animals from getting their share. Pen partitions of metal tubing, spaced planks, or farm gates must be stronger, and up to 5′ high, for crowded pens of heavier heifers compared to partitions of spacious pens of calves.

Panel stanchions in the feeding fence are useful to catch calves and heifers for inspection and treatment. Automatic waterers may be located for common use between two pens.

DAIRY YOUNGSTOCK DATA SUMMARY

Individual calf pens (inside): 4 × 6 or 5 × 5
Individual elevated calf stalls: 20-24″ × 48-52″
Calf hutches: 4′ × 8′

FREE STALL SIZES

Age	Width	Length
2 to 5 months	2'-0"	4'-0"
5 to 8 months	2'-6"	4'-6"
8 to 12 months	2'-10"	5'-6"
15 to 18 months	3'-2"	6'-0"
18 to 24 months	3'-10"	7'-0"

SPACE NEEDS in GROUP PENS

			Size per animal	
Heart Girth (inches)	Weight (lbs)	Age (months)	Feed Manger (inches)	Bedded Pen (square feet)
36	160	2	12	10
45	300	5	13.5	15
54	480	8	15	20
60	640	12	16.5	25
65	800	16	18	30
70	990	20	20	35
73	1110	23	22	40

Figure 19a. Individual Confinement Cold Calf Housing

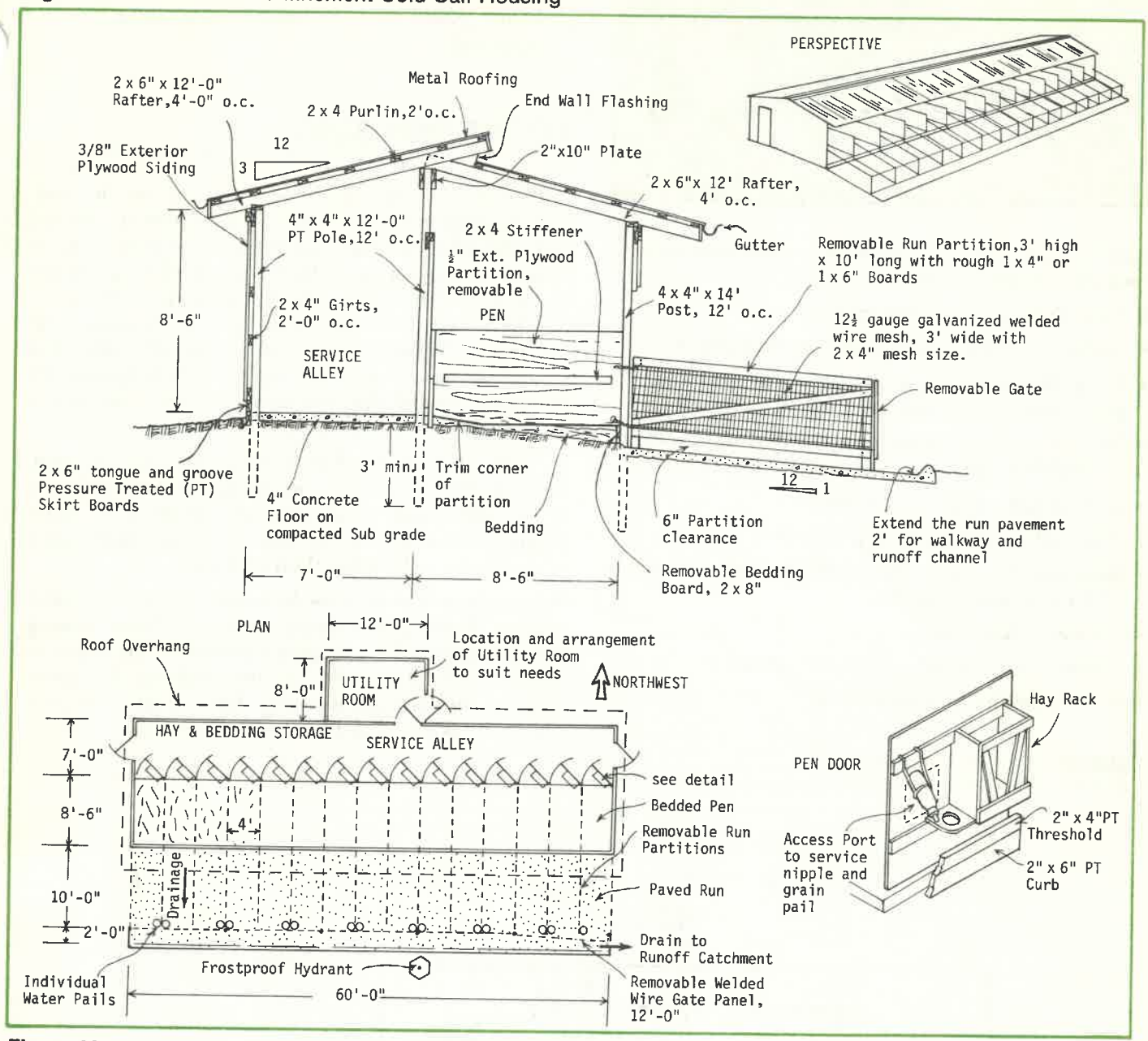
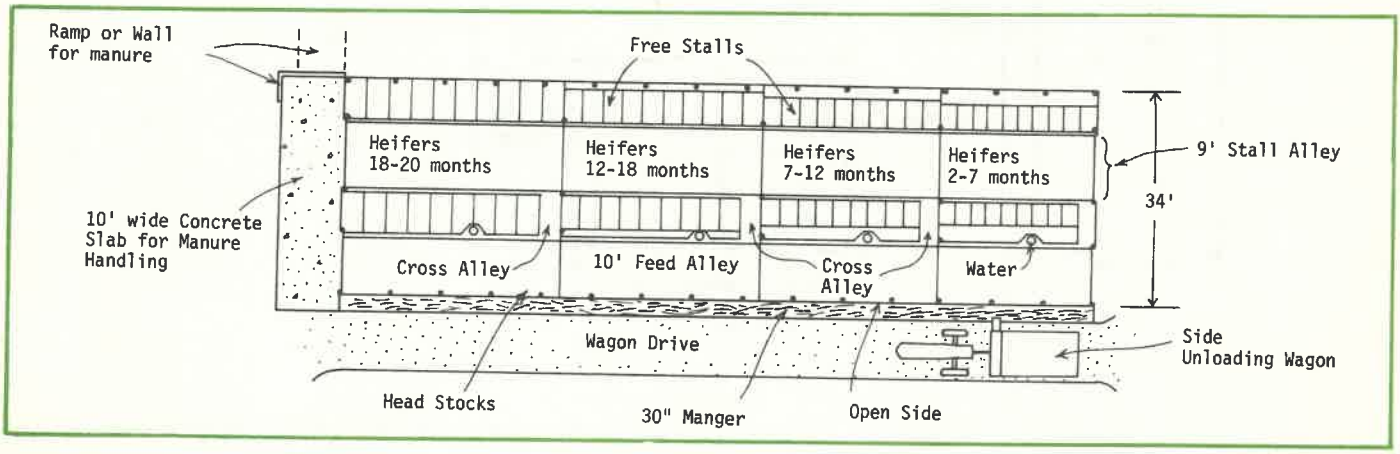


Figure 19b. Layout of a Two-Alley Free Stall Barn for Heifers



GOATS

Goats require only simple housing, but the best systems have the following features:

- a well drained, dry resting area.
- excellent ventilation with protection from drafts.
- hay feeders or other forage feeders which allow the goats to eat without being restrained.
- fresh clean water, always available from tanks with covered floats, pails or automatic heated waterers.
- well drained, fenced exercise area.
- clean milking room, screened from flies.
- bucks housed separate from milking goats to prevent odor contamination of milk.
- elevated milking stands.
- rodent-free grain and concentrate storage.
- portable folding pens for kidding.

Dairy goats do not require expensive housing.

LOOSE HOUSING

Protect dairy goats from wind, rain, and the hot sun. Because goats are a roving animal, they generally are not tied. Instead they either run in groups in open pens, or loose in individual pens. Stanchions confine goats too much, so it is difficult to keep them clean. Several goats may be housed in one area, with about 15-20 square feet per animal. Removable pen dividers, feeders, gates and large doors make it possible to get in with equipment. Be prepared to have double the number of goats after the first year unless kids are marketed.

In loose housing a bed-pack eliminates daily cleaning. Allow bedding, manure and hay to accumulate and form a dry insulative layer which the goats can lie on. Consider cleaning with a small tractor and scraper as a bedded pack is very dense and hard to clean by hand.

A management alternative to bedded packs is frequent cleanup. Bedded pack housing can lead to sloppy housing and dirty goats. Flies may get out of control, the ammonia level becomes unbearable, and the incidence of internal parasites and diseases increases. Farms that clean pens daily or weekly tend to have healthier animals.

Figure 20. Dairy Goat Barn Layout.

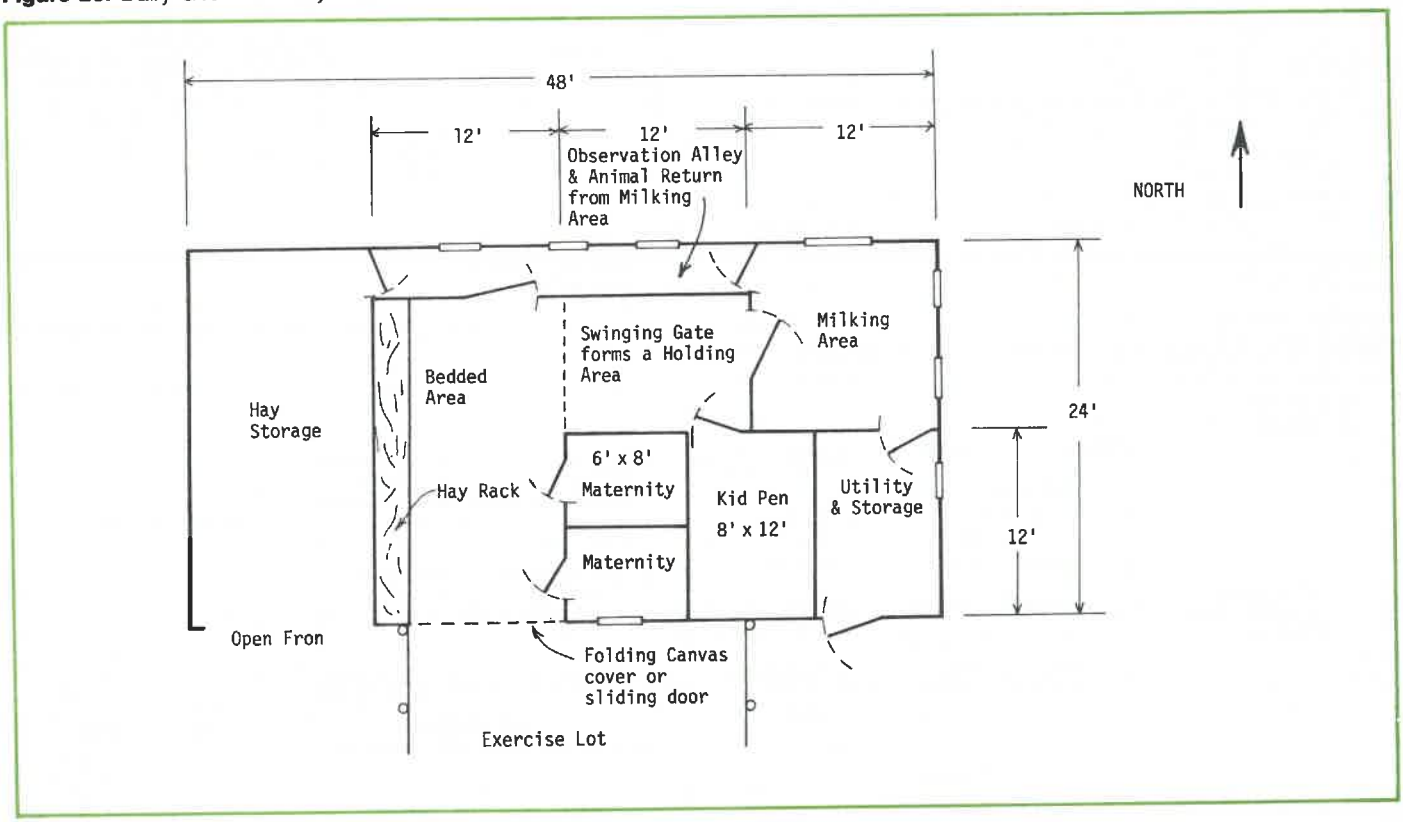
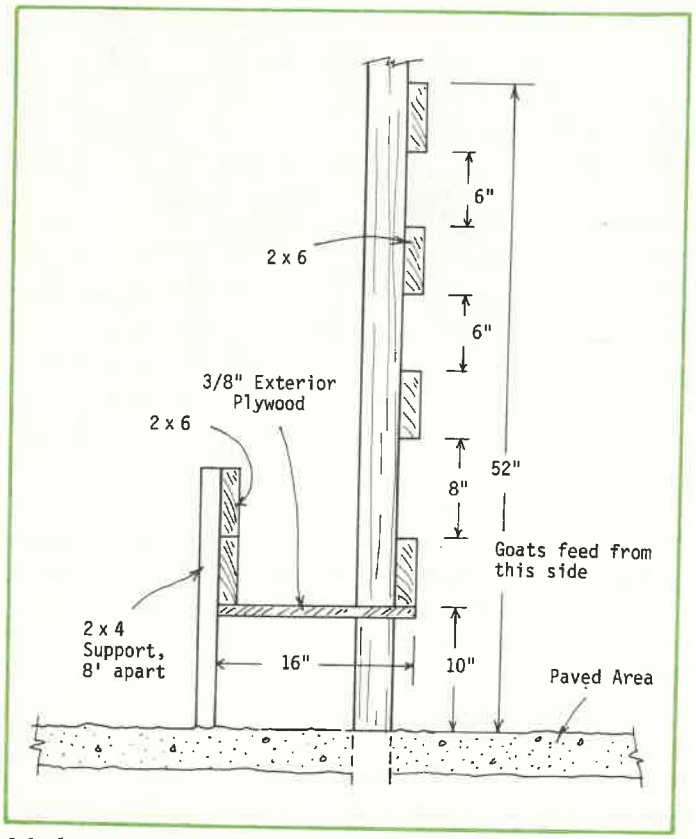


Figure 21. Fenceline Feeder for Goats



Mechanical ventilation may not be required since goats give off less moisture and body heat than cows. Never close windows completely, even in the winter, to assure adequate air movement. If animal density is high and there is no provision for natural air movement, a fan may be necessary.

Provide for housing different age groups, maternity areas, restraints for treatment and milking. Keep the milking goats in a separate area to assure cleanliness and milk quality. The floor plan in Figure 20 shows a separate milking parlor. Artificial lighting can encourage fall freshening, in addition to the normal spring freshening to assure more uniform year round milk production. House all breeding bucks in a separate facility downwind from the milking barn, otherwise their odor will give the milk an off-flavor.

An elevated milking stand, while not essential, is far more comfortable than squatting. Milking machines expedite the chore of milking 10 or more does.

FENCING

The fence for the exercise yard must be strong as goats will lean on it. Welded wire fencing, or 10 strand high-tensile fence 4′ high (5′ for bucks) works well. Some goats will get out of nearly any fence. In this case, place an overhang wire 10-12″ toward the inside and top of the fence, supported by offset pieces nailed to the posts. This wire may be electric, although barbed wire is usually adequate. Use snap hooks on gates as goats are able to unlatch other types of hardware.

GOAT DATA SUMMARY

SHELTER SPACE

Individual Stall - 36 sq ft (6 × 6)

Confined Open Pen - 20-25 sq ft/animal

Open Pen with Outside Lot - 15 sq ft/animal

FEEDERS

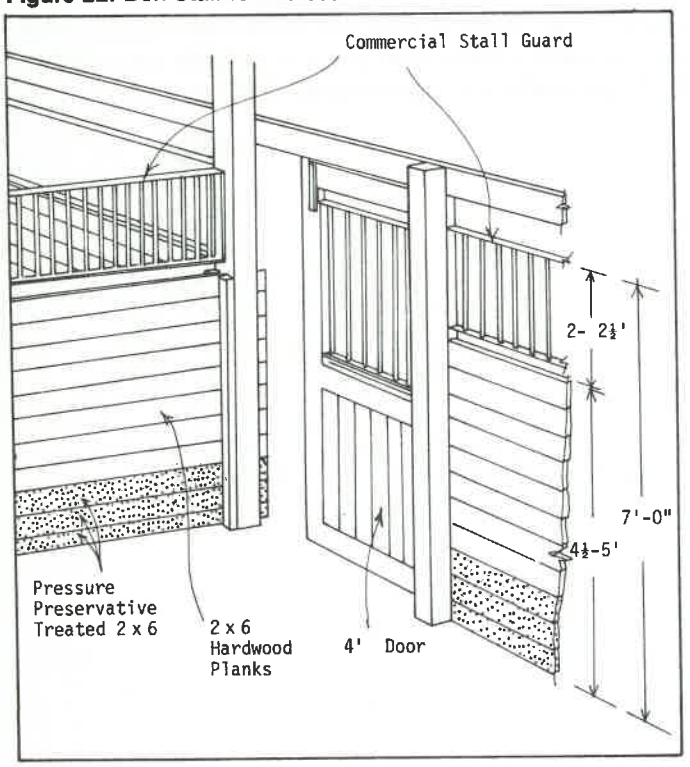
Use slatted hay feeders. Allow about 12″-18″ space/animal. Grain is generally fed on the milking stand during milking. Feed small goats in separate areas and make provisions for hay and grain feeding.

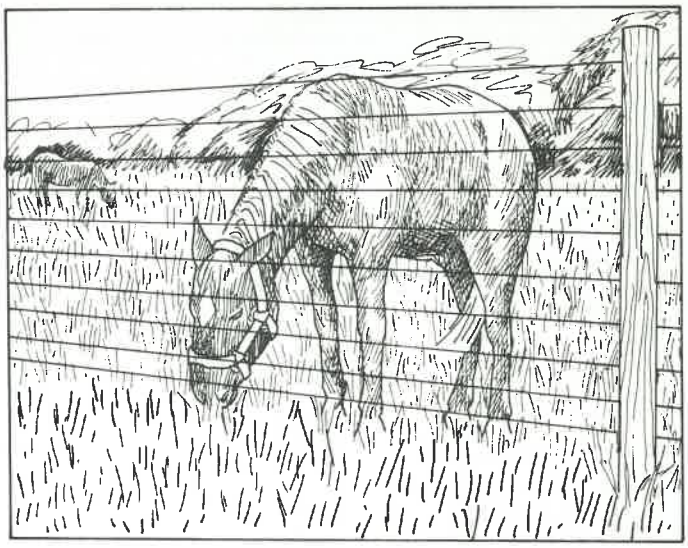
HORSES

Horse ownership is seldom profitable. But people on small farms often have horses for a hobby. Some people realize a profit from rearing riding horses for sale to stables or individuals.

Horses need little or no shelter, other than protection from the wind in severe cold or where fly and insect infestation is heavy. A horse, given a choice, stays outside in the sun or rain most of the time. A three-sided shed, open to the south or southeast protects horses from prevailing winds. Horses maintained in show condition are either blanketed and housed in enclosed stables or heat is provided in the stable. The amount of heating will dictate the amount of ventilation and insulation that must be incorporated to control condensation.

Figure 22. Box Stall for Horses





Doors, windows and louvers usually provide enough ventilation in an unheated stable, but avoid drafts. A room temperature of 32°F prevents freezing of water pipes and is comfortable for horses. Stale air, condensation, dust and drafts are harmful.

For many, the preferred floor is tamped clay or sandy loam free of rocks, but these materials must be replaced every few years. Plank floors are sometimes used, but also require periodic replacement, are noisy and can cause rodent and odor problems. Concrete, which is easily cleaned and permanent, needs deep bedding (10-12").

HORSE DATA SUMMARY

Space Requirements:

	Box Stalls, ft.	Tie Stalls
small (ponies)	10x10 - 10x12	3'x 6'
medium	10x12 - 12x12	5'x 9'
large	12x12 - 16x16	5'x12'
foaling	16x16 - 16x20	

Horses need little or no shelter, although they need protection from the wind in severe cold, and protection against flies.

SHEEP

Sheep require little labor, except during lambing when labor requirements can be quite high.

Types of small-scale sheep production include purebred production, feeder lambs, and small ewe flocks. Sheep require good pasture management, but little labor, except at lambing time. Some sheep may need assistance with multiple births.

Forages are the basic feed source. High quality grains are required before and after lambing. Sheep are well adapted to graze with dairy or feed cattle.

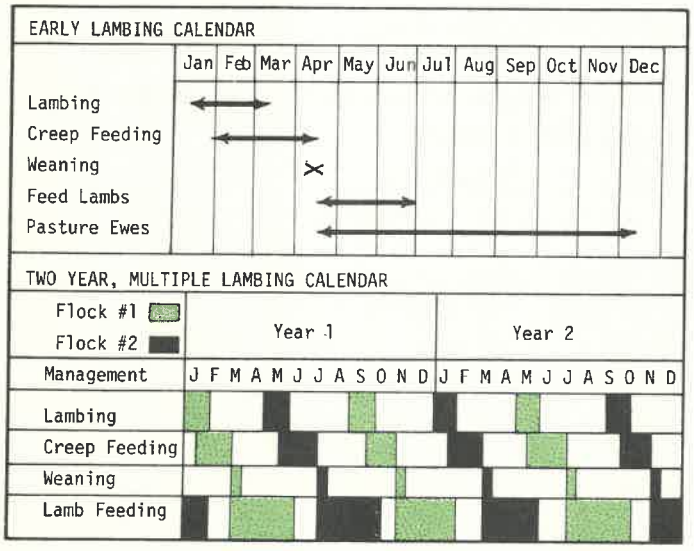
MARKETING ALTERNATIVES

Many sheep are bred to lamb early in the year. Wean lambs when 2-1/2 to 3 months old. Pasture lambs and ewes separately. In areas where pasture is limited, sell lambs at about 55 to 65 pounds as feeders.

Feeding lamb is another option that requires little labor, equipment, or acreage. Plan shelters to emphasize labor efficiency and good care since profit per animal is small.

Another alternative is accelerated lambing. Divide the ewe flock into two groups that lamb alternately every 4 months. Each group lambs three times in two years. Facilities are used three times per year. With more intensive facility use, a larger investment in buildings and equipment is economical.

Figure 23. Lambing Calendar Alternatives.



Marketing lamb and wool can be a problem in areas where sheep numbers are limited. Plan production with a specific market in mind. Consider pooling your lamb and wool with other producers.

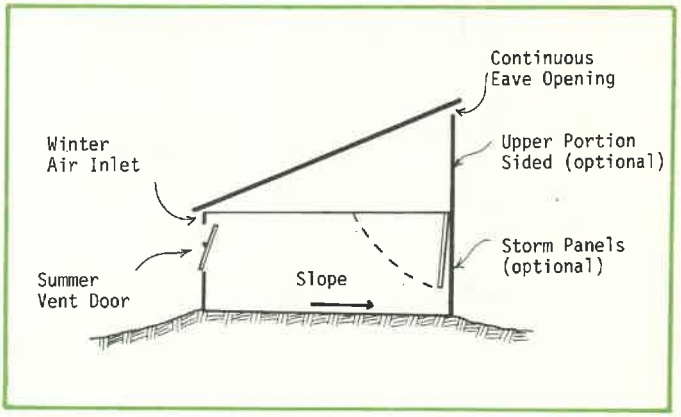
HOUSING

Sheep are commonly provided dry, cold, solid floor housing with outside lots. In cold weather, a warm area in a cold shelter is beneficial for lambing. Use lambing pens to reduce the number of orphan lambs. Centrally locate handling facilities so sheep can be easily moved. Make pens small so sheep are easier to catch and treat.

Locate barns and lots on a well drained south slope. Face the open side of an open-front building away from prevailing winds — usually south or east. A south or east exposure helps lots dry faster and are easier to maintain. Sheep do not tolerate mud; consider grading and filling to achieve desired slopes.

Partially close open-front buildings to reduce drafts in winter. Use overhead panels to help reduce drifting snow during severe storms. Continuous eave openings, 4"-6" wide, provide natural winter ventilation and reduce condensation under the roof. Open panels in the rear wall for proper summer ventilation.

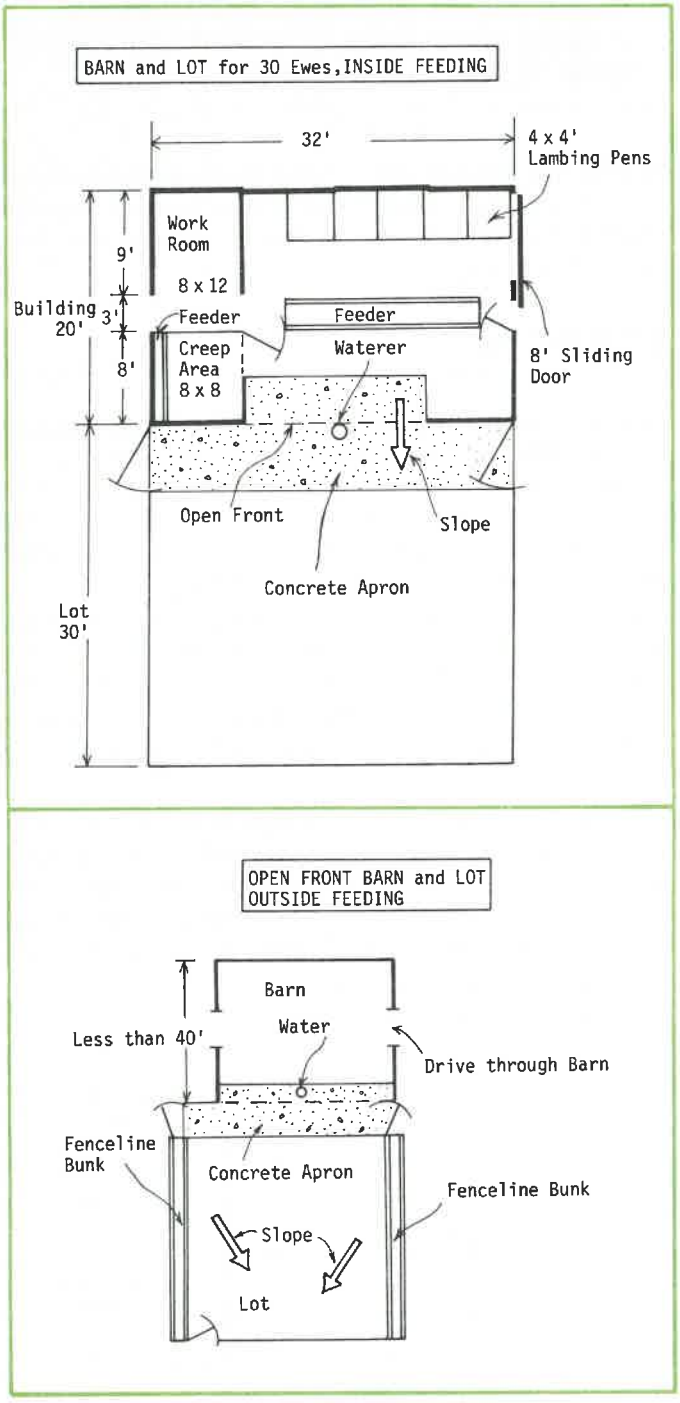
Figure 24. Open-Front Shed for Sheep.



Warm housing is not recommended because proper natural ventilation is difficult. Mechanically ventilate completely enclosed insulated buildings.

Use a 250-watt heat lamp suspended on a chain over the lambing pen to warm and dry lambs. Place electrical outlets overhead and keep cords short so if the lamp falls it will unplug. After lambs are dry and have nursed, supplemental heat is not needed.

Figure 25. Sheep Barn Layouts.



FENCING

Fencing to exclude dogs and predators is a major capital expense. Fencing without barbs is recommended, since barbs may tear sheep fleece. Further information on fencing is included in Section VII .

A breezy shaded area is essential as hot weather is much harder on sheep than cold.

SHEEP DATA SUMMARY

SHELTER SPACE

Open-front building with lot:

	Building	Lot
Feeder lamb	6- 8 sq ft	15-20 sq ft
Ewe	10-12 sq ft	25-40 sq ft
Ewe and lambs	12-16 sq ft	25-40 sq ft

FEEDER SPACE

Ewe—16" to 20"

Feeder lamb—9" to 12"

WATERER SPACE

Per automatic bowl: 40 to 50 ewes or ewes with lambs; 50 to 75 feeder lambs.

Per ft of tank perimeter: 15 to 25 ewes or ewes with lambs; 25-40 feeder lambs.

WATER CONSUMPTION

Feeder lamb—1½ gal/day

Ewe—2 gal/day

Ewe and lamb—2½ gal/day

LAMBING PENS

4' x 4' x 30" or 4 1/2' x 4 1/2' x 36 " with partitions a minimum 30" high.

Provide 1 per 5 to 7 ewes for flocks up to 25 ewes.

Provide 1 per 7 to 10 ewes for flocks up to 100 ewes.

LAMB CREEP SPACE

1 1/2 to 2 sq ft/lamb.

POULTRY

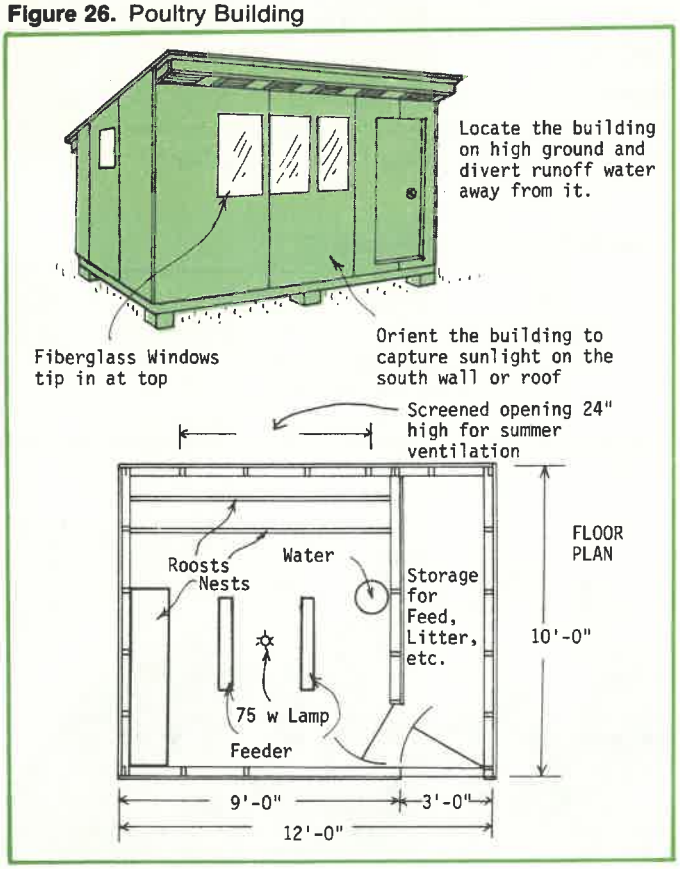
Today the production techniques of commercial poultry production result in market prices difficult to match by the small flock owner. But a small poultry flock can provide fresh eggs and meat for the farm, and surplus eggs can be sold at roadside or to neighbors.

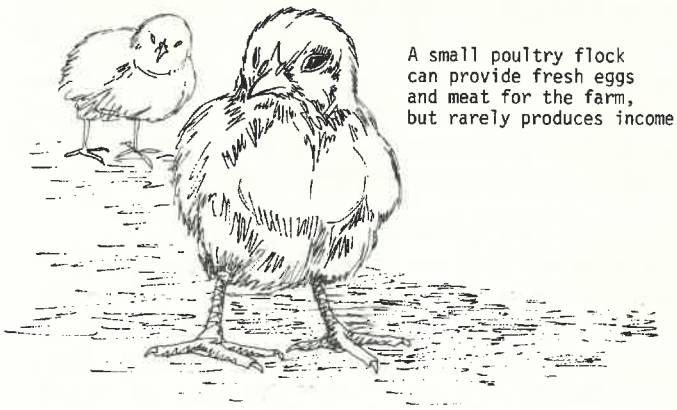
Flock size varies with each individual situation. A family of four will be well supplied with eggs from a flock of 15 to 20 layers.

HOUSING

While commercially designed chicken houses allow an absolute minimum (1-1/2 to 2-1/2 sq ft) floor space per chicken, the small scale farmer can provide up to 8-10 sq ft per chicken with straw, shavings or sawdust bedding (a 10' x 20' building for 20 hens) to lessen odor, flies, disease and rodent problems.

Figure 26. Poultry Building





A small poultry flock can provide fresh eggs and meat for the farm, but rarely produces income

Small flocks are best reared on litter with an outside exercise yard. Roosts should be provided with dropping boards beneath. Daily scraping of the dropping boards helps provide better litter conditions in the house.

Locate the building on high ground and divert runoff water away from it. Orient it so that one long side faces south or southeast for protection from prevailing westerly winds and to capture winter sunlight through translucent roof panels or through a row of windows to the south.

Brooding. Most laying flocks are started by brooding day old chicks. Electric hover and infrared brooders are common. Chicks are confined by a heavy cardboard guard to keep them from straying too far and to prevent drafts. Allow about 1/2 square foot per chick. Start brooders a day before the chicks arrive to get them adjusted. Temperature at chick level under the brooder should be 95°F. Lower temperature 5° each week until 65 to 70°F is reached.

Laying Hens. Birds may either be raised on the floor or in laying cages. Equipment includes feeders, nests for floor raised birds, and lights. Waterers are needed and probably some form of disinfectant or disease control agent periodically added to the water.

Lighting. An effective lighting program, both natural and artificial, can increase production. But two rules must be followed. **Never increase length of lighting period on growing pullets, and never decrease length of lighting period on laying hens.** Provide all night lights in the brooder house for the first week. For pullets in houses with windows and brooded between April and July, no additional artificial light is needed.

Raise pullets brooded between August and March on a declining light schedule. Do this by adding 5 hours to the day length when the flock will be 22 weeks old. Provide that amount of light each day during and the second week. Then reduce the daily light period 15 minutes a week. Then at 22 weeks the pullets will be on natural day length. Laying birds need a constant 14 hours or an increasing amount of light for maximum production.

PRODUCTION of BROILERS and OTHER FOWL

Broilers may be brooded and reared in the same house. Confine chicks to the brooding area with corrugated cardboard or small wire mesh. Cover the floor with 4″ of wood shavings or other absorbent material.

Turkeys require special care and equipment. It is preferred that land used for chickens or other turkeys should not be used as a range for another flock until at least three years have passed for disease control. Poults require a heated brooder house with 1-1½ square feet of floor space per bird until 8 weeks old. Older poults and adult turkeys are best kept in confinement in a well-ventilated building with a dry floor and tight roof.

Ducks or geese require less care and attention than the same number of chickens. Young geese can be put on pasture when they are only a few weeks old.

FENCING

Wire netting of 1″ to 2″ mesh in heights ranging from 48″ to 72″is commonly used for fencing small poultry yards.

POULTRY DATA SUMMARY

FLOOR AND FEEDER SPACE

		Floor Space	Feeder Space
Chicks:	0-10 wk	0.8 to 1.0 sq ft	1-2″/chick
	10 wk on	1-1/2 to 2	4″
Layers:	small	1-1/2 to 2	4″
	medium	2 to 2-1/2	4″
	large	2-1/2 to 3	4″

MINIMUM WATER REQUIREMENTS

Chicks—A 1 gallon waterer per 100 chicks at start. Start automatic waterers at one week. After 2 weeks, one station every 15′.

Layers—An 8′ automatic water trough for 400-500 layers, for floor birds.

MINIMUM NEST SPACE

One per 5 layers, open type; or 1 sq ft/5 layers in community nests.

Roosts—Replacement pullets (if roosts are used in laying house)—6″/pullet from 8 weeks, spaced 12″ o.c. Layers—8″/layer, spaced 12-14″ o.c.

RABBITS

Capital investment and space required to raise rabbits can be small compared to other livestock enterprises. Production alternatives are as a home meat supply or for marketing as meat, laboratory, pet, show or other breeding stock. There is also a small market for hides and Angora rabbit wool.

HOUSING and EQUIPMENT

In mild climates rabbits can be raised outdoors in shaded hutches or open sheds. In colder climates hutches should be in buildings protected from prevailing winds. During stormy or severe weather further protection from drafts may be necessary. Space heaters or light bulbs providing heat to 40°F may be necessary where the young are born. Proper ventilation is important when rabbits are raised in enclosed buildings to control disease.

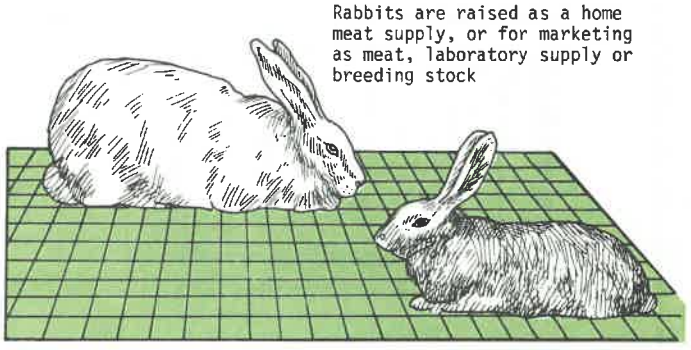
Some large commercial herds are raised in insulated fan-ventilated barns with $20-40 per doe invested in cages and equipment.

Rabbits require large quantities of fresh clean water. Automatic watering systems with electric heating cables will provide water during freezing weather.

Table 5. Rabbit Hutch Dimensions.

Height	2'
Depth	2½', max.
Length	3' for small breeds
	4' for medium breeds
	6' for large breeds

Raise on ½" x 1" wire mesh for disease control



Rabbits are raised as a home meat supply, or for marketing as meat, laboratory supply or breeding stock

III—Materials and Construction

Most utility buildings on small farms house livestock and store feed. They may also house a workshop or store machinery and other equipment. Today a barn is seldom an all purpose building. Buildings suitable for storage are often unsuited for animals. Separate the vehicle and maintenance shop from the animal housing and other storage, as high humidity and dust from feed and bedding in animal housing deteriorate tools and machinery. Separate buildings or solid cross partitions should be planned.

Single story, clear span structures supported by pressure treated posts are simple, versatile and economical. The interior can often be remodeled if farming ceases, expansion is planned, or other farming practices change. (Figure 27)

REMODELING OLD BARNS

Many old barns appear to have potential for a new life. With just a little fixing up and a little remodeling it will be perfect . . . or will it?

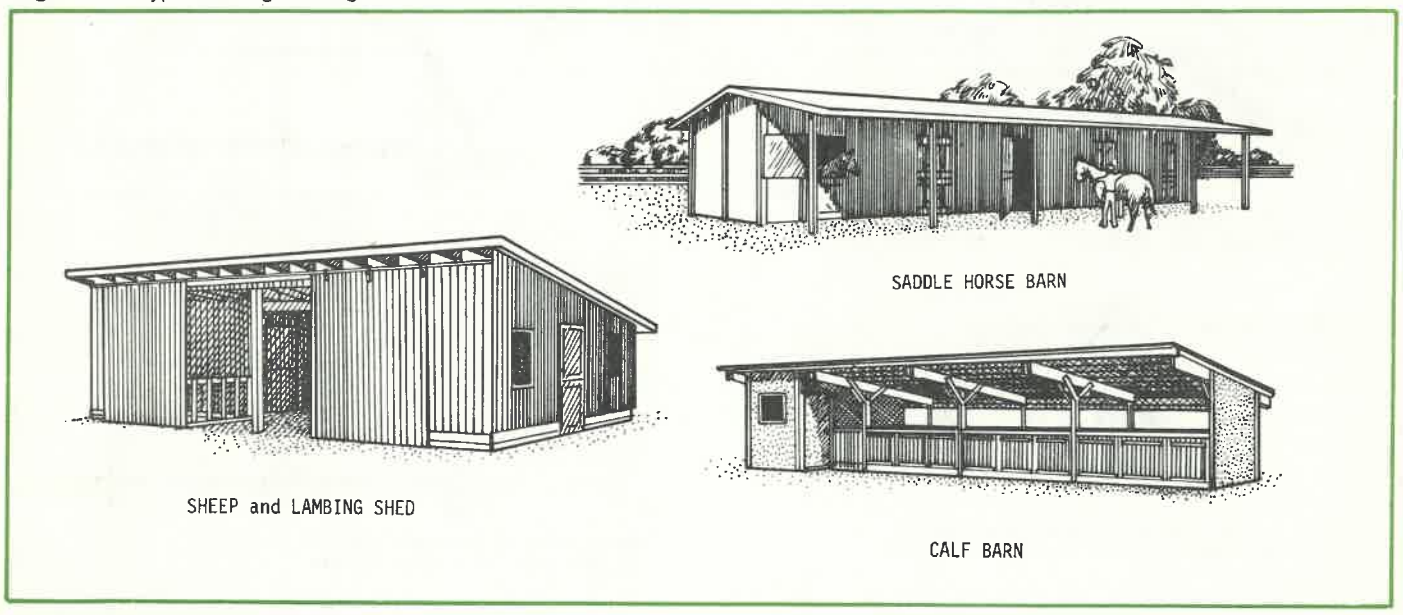
Here are some things to consider when looking over an old barn for a new program:

- What is the structural condition?
- What repairs are needed to restore the deteriorated parts of the building?
- What will it cost to repair? How much would a new building of equal size cost?
- How will the building be used in a new farming plan?
- What structural changes will be needed to fit the new plan?
- Is the location right?
- Will there be good drainage away from the building?
- Is there room for expansion?
- Will there be convenient year-round access?
- How will future operational costs in a remodeled facility, compare to a new facility?
- Will insulation and ventilation be adequate in the remodeled structure?
- Are the utilities, electric and water systems adequate?

Key structural points

Rooflines and tight roofing. A swayback roof indicates that it probably leaks even though the present roofing may be in good condition. It suggests rafters, rafter joints, or

Figure 27. Typical Designs using Pressure Preservative Treated Pole or Post Construction.



plates are rotted, or undersized, or that the walls are bowing out, leading to high maintenance and repair costs in the future.

Walls are held together at the eaves by cross ties or in heavy timber barns, cross timbers. Wooden peg connectors may have broken from overloading or rotting, causing the walls to bow out at the top.

Old barns may appear sound, but a close look at the joints may reveal partial rotting or breaks. A heavy snow or wind may cause a barn with poor joints to collapse suddenly. Walls bowed out at the bottom indicate rotted sills and foundation failures. (Figure 28)

Main sills and **foundation walls.** Correcting foundation wall and bank wall failure may be impractical or, at best, difficult and expensive. Rotting sills indicate dampness and a leaking barn. Tilting foundation walls indicate poor drainage around the footings, or lack of footings. A rotted main sill on top of the foundation wall is only a little less difficult to replace than a foundation repair.

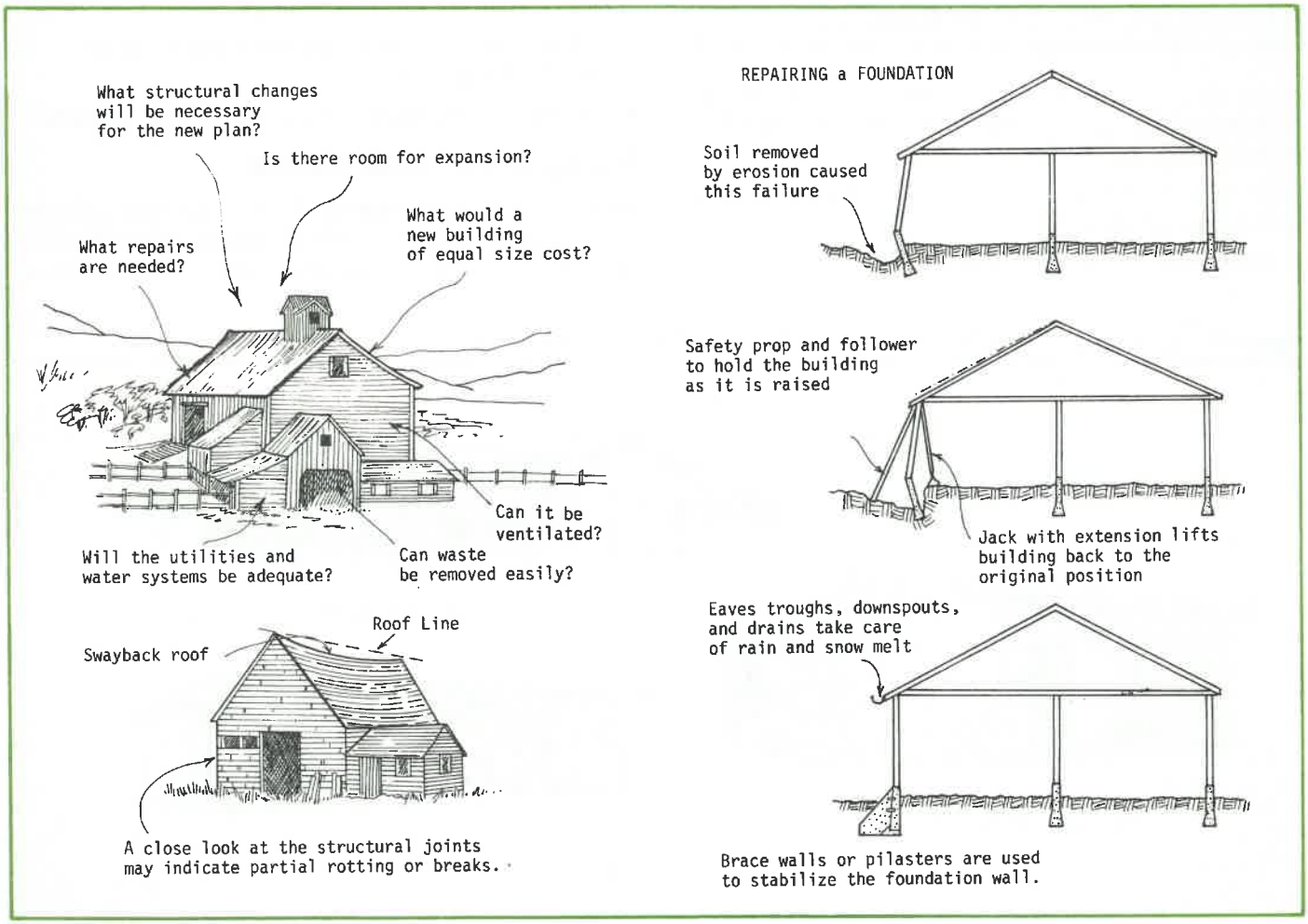
Old bank barns often have the foundation pushed in. Pressure of the bank and the repeated freezing and thawing of water in soil near the wall may cause the entire structure to lean in the direction of the tilted bank wall.

Foundation failures at corners. These failures are quite common and are usually caused by the lack of footings under the wall or because the barn has shifted. When replacing these corners, a footing below frost level is recommended before the wall above grade is replaced.

Floor joists and **beams.** The mow floor beams or joists that extend over the foundation sometimes are rotted at their ends. Floor joists and beams sometimes are broken by overloading or rotting. In these cases, placing new joists and beams alongside the broken or weakened member may be necessary.

Correcting foundation wall and bank failures may be impractical, or at best difficult and expensive.

Figure 28. Evaluating a Barn for Remodeling.



Interior considerations

Interior posts. Do any need replacing or are more needed to carry the heavier loads of modern farming? Particularly in multistory buildings, internal posts are in the way of the new space's use and cannot be easily moved since they support key structural components.

Headroom. Does the barn need more headroom for tractor operation or to keep from repeated head knocking?

Window frames. Do they need to be rebuilt? If so, are they sized to fit today's standard window sizes, or will special order windows be needed? Can many of them be covered with new lining and siding?

Roofing and **siding.** How much needs replacing?

Floors. Can existing partitions be used? For example, the cow platforms in an old dairy barn are often too short for today's larger breeds. The floor may need to be broken up with a jack-hammer and replaced to give enough headroom and proper drainage.

Electrical wiring. Be sure to follow the National Electric Code and conform to local electrical codes if rewiring the barn.

Adding **rodent proofing** and **insulation** frequently increases the cost of insulating an existing structure by a factor of two to five compared to cost of similar measures in new structures.

REMODEL OR BUILD?

The big attraction of remodeling is cash flow. Farmers can often do a little each year without borrowing money as with a new building. But consider the life of the remodeled structure. A 12-year life may justify major remodeling, but 5 or 6 years may not. As a general rule, if the cost of remodeling exceeds two-thirds to three-fourths the cost of a new facility, it is wiser to proceed with the new building. It may be possible to reuse some materials from the existing building. Keep your savings and investments in perspective. Don't let an existing building of small financial significance determine the outcome of a major investment.

BARN CONSTRUCTION

Framing

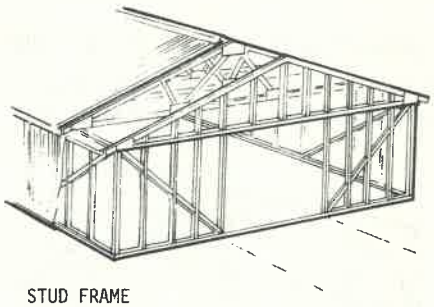
Stud Framing in most buildings is 2 × 4 or 2 × 6 vertical members or studs spaced 16″ to 24″ apart. Studs support the roof and exterior and interior wall coverings.

Advantages:

- Familiar to builders.
- Easily insulated.
- Convenient for finished interiors.
- Conceals wiring and plumbing.
- Prefabricated windows and doors easily installed.

Disadvantages:

- Usually more costly than other barn framing systems.
- Requires a separate foundation.



STUD FRAME

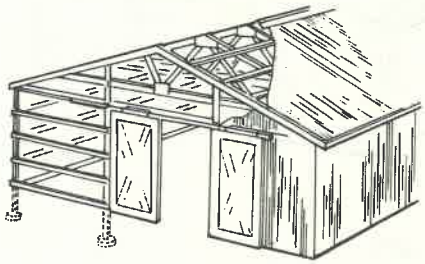
Pole/Post Framing. Preservative treated wooden poles (round) or posts (square) are both foundation and roof support. Horizontal members (girts) on the poles hold siding.

Advantages:

- Generally easiest to build of all construction types.
- Rapid erection.
- Often cost less than other types of construction.
- No concrete foundation is needed.
- Little site preparation even on sloping ground.
- Buildings are easily lengthened when more space is needed.
- Sides can be left open.

Disadvantages:

- Rocky soils and hardpan limit pole depth.
- Rarely more than one story high.
- May be difficult to insulate.



POLE or POST FRAME

Metal Framing. This type of building utilizes a series of fabricated steel (frames) to support both the wall and roof. Frames are usually 8′ - 20′ apart on special foundations.

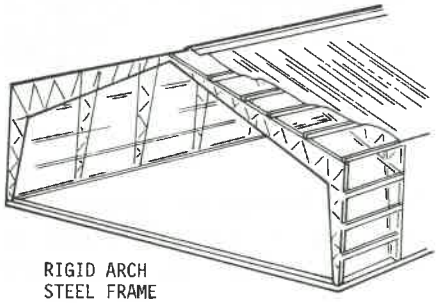
Wood or steel girts and purlins support the siding and roofing.

Advantages:

- May be sold and moved.
- Professional crew usually erects.

Disadvantages:

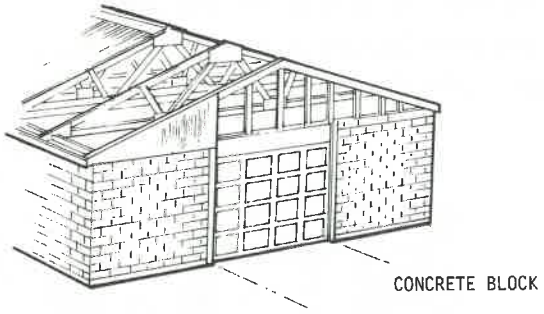
- May be more costly - particularly for widths less than 40'.
- May be difficult to insulate and line the interior.
- Difficult to maintain and repair from rust and corrosion caused by livestock environment.



Masonry walls are prefabricated masonry units or concrete block. Standard blocks are 8x8x16" with other sizes available for special uses. Blocks are usually hollow and laid with cement mortar. They can be stacked dry and coated with a surface bonding material.

Advantages:

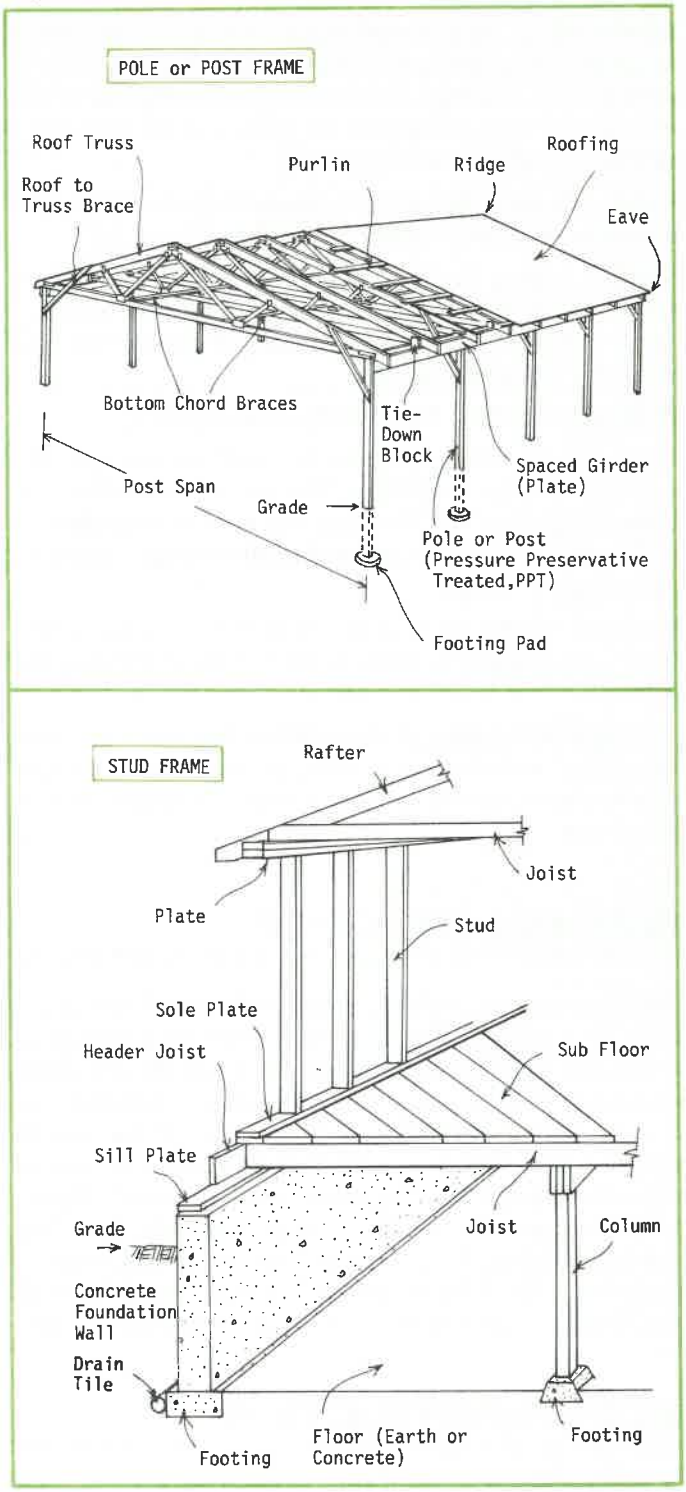
- Very resistant to mechanical and animal abuse.
- Not damaged by water or most farm chemicals.
- Easily cleaned.
- Interior and exterior surfaces go up together.



Disadvantages:

- Difficult to insulate well.
- Require non-freezing working conditions.
- May be more expensive.
- Require good planning of the building size and wall openings to minimize cutting the blocks.

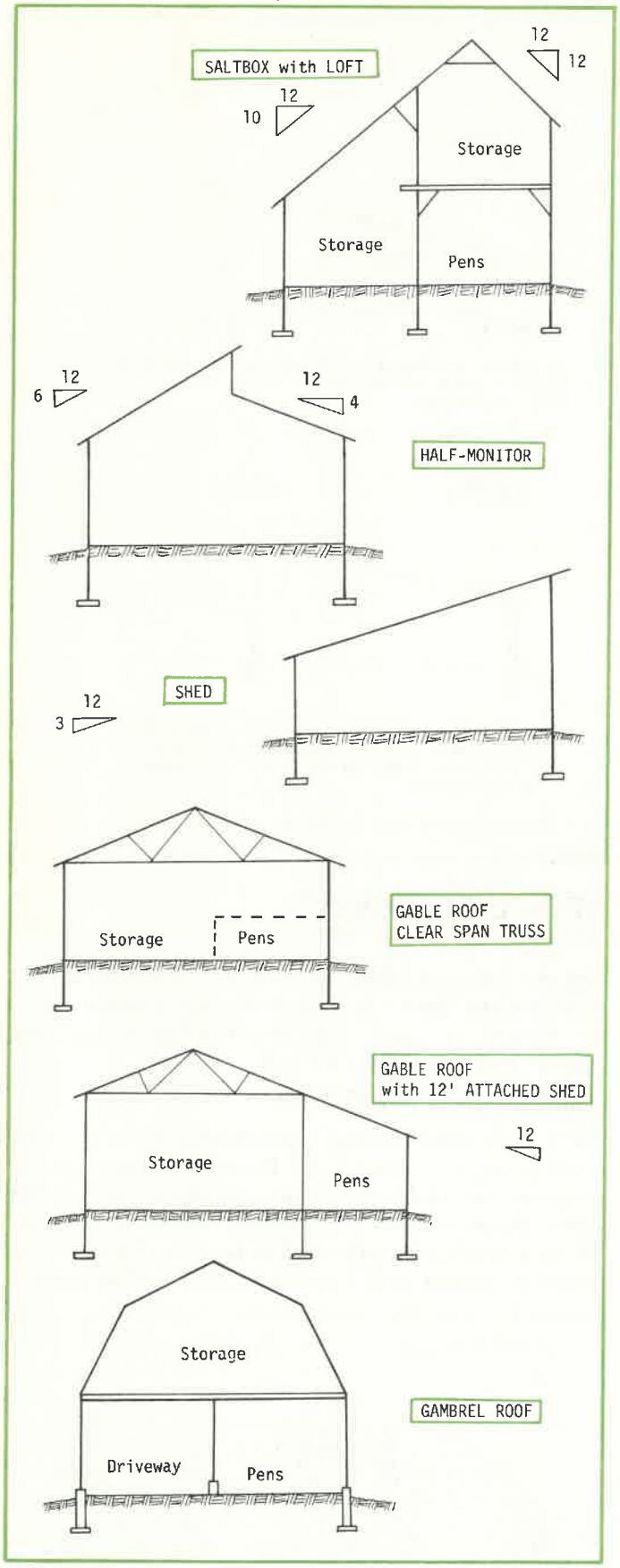
Figure 29. Building Components.



Two Stories. The two story barn is a pleasing reminder of farm history when the upper floor was designed to store bulky, loose hay. Baled hay stored at animal level can be more convenient than hay stored overhead.

Bank Barns. Sometimes a sloping site and gravity can be used to help to ease the handling of materials. The old bank barn built into the side of a hill is one example.

Figure 30. Typical Barn Styles



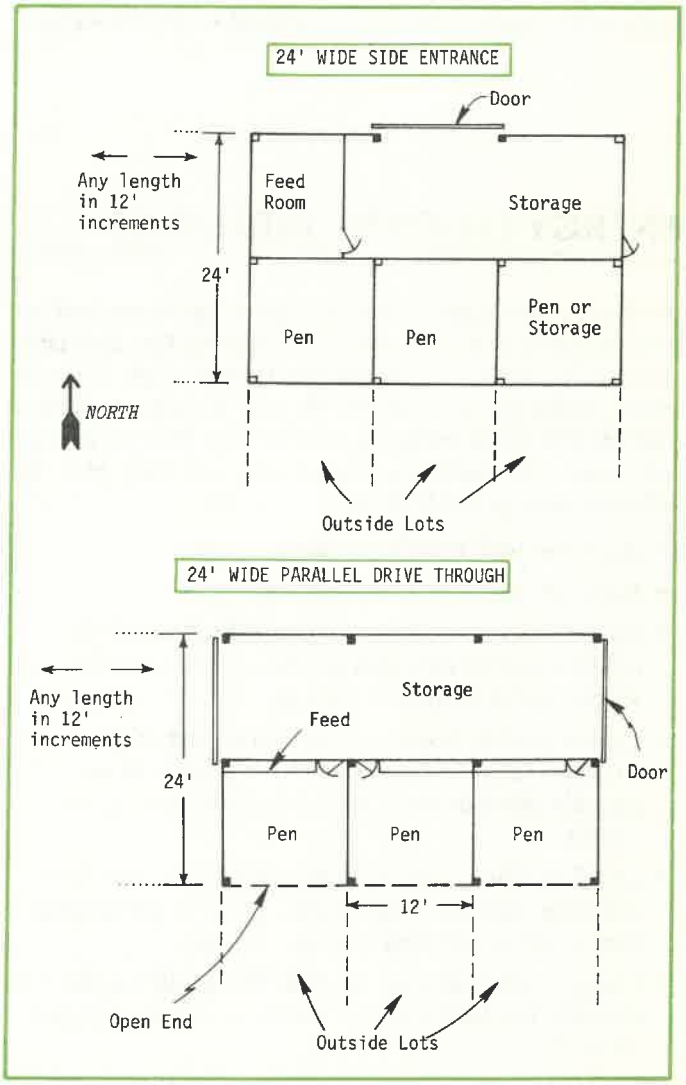
Be cautious about building into a hillside. Drainage and ventilation below grade areas are difficult. Divert runoff water from the roof and uphill sources from the barn. Also install foundation drain tile to intercept and remove seepage from the barn.

Post and Beam Framing. Heavy timber framing, once common on farms is now rare because of the high cost of labor and large timbers.

GENERAL PURPOSE LIVESTOCK BARNS

A general purpose barn houses more than one kind of livestock and their feed. On a small farm it may be the only building needed to shelter livestock and store crops. On a larger farm it may house several small activities while the principal business is carried on in a specialized building such as a dairy barn or a potato storage.

Figure 31. Typical Layouts for General Livestock Barns using Posts in 12' Modules.



Most livestock and feeds can be safely kept under the same roof, provided good ventilation and sanitation standards are followed, but do not keep automobiles, tractors, or vehicles in a building because of fire risk.

Shelter requirements for dairy and beef cattle, sheep, hogs, and chickens are the same in a general barn as in the special buildings discussed in other sections. The space planning summaries on page 33-34 can be used to develop your plan.

Build pens to separate animal species. If Grade A milk is to be sold, separate the milk cows from the other livestock. However, the amount of milk sold from a general barn usually does not justify the expense of meeting Grade A requirements. If cows and the milking utensils are kept clean and the stable well ventilated, there should be little difficulty in producing wholesome milk from healthy cows.

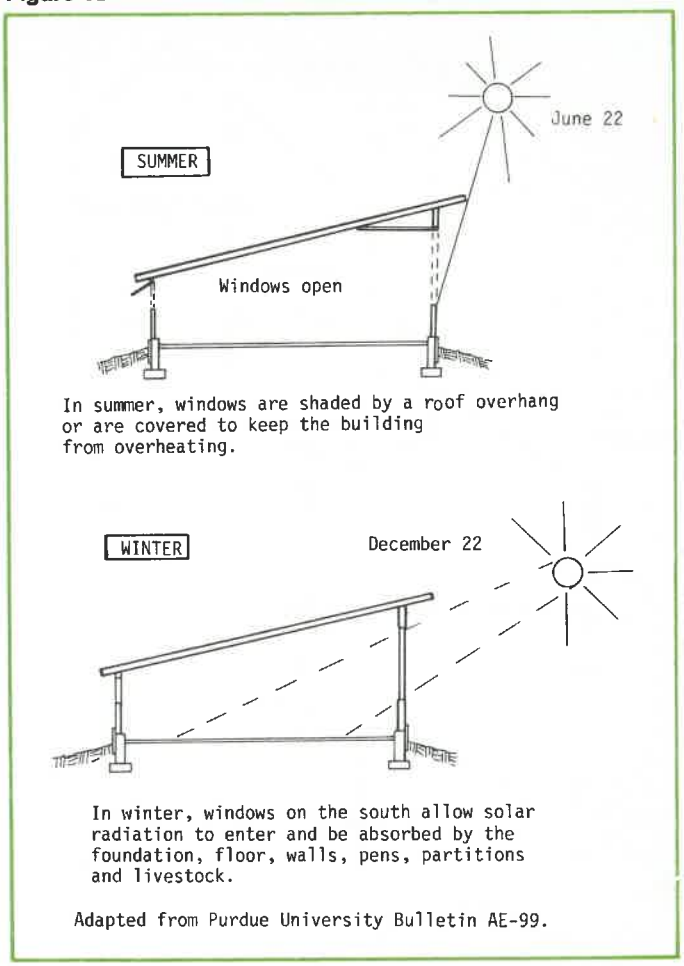
House poultry separate from other livestock. Use insecticides to control lice and mites which might otherwise spread to cattle and other animals. A planned program for rodent control is particularly important where several kinds of livestock and feed are confined in one building.

ENERGY EFFICIENT BUILDINGS

Building orientation, design and layout significantly affect environment and materials handling and the associated energy required to maintain good production. Once in place, buildings are hard to change, so poorly planned layouts will affect energy (and labor) demands for decades to come. The following suggestions will help plan for efficient energy and labor use.

- Have livestock travel to feeders.
- Naturally ventilate when suitable.
- Use windbreaks and face open buildings south to reduce weather extremes and lessen the need for supplemental heating or cooling.
- Design poultry houses, pig nurseries and other enclosed barns to capture as much solar heat as possible through south facing windows during the winter.
- Install insulated glass or storm windows to cut heat loss when the sun is not shining. This is particularly true in areas with much winter sunshine.
- Design roof overhangs to shade the south windows in summer but let it enter in winter as shown in Figure 32.

Figure 32. Passive Solar Livestock Structure



SPACE PLANNING

Use the following tables along with data summaries for each livestock species to estimate the space requirements for housing livestock, feed and bedding storage and support facilities. (Tables 6 - 12)

A space planning rule-of thumb

For a single story building approximately 1/3 of the total available space is needed for livestock shelter; 1/3 for roughage and bedding storage (200 days); and 1/3 for access alleyways, feed grain storage, and other facilities. This is a rough guide which will be modified if much of the feed is purchased, or if the animals are raised on pasture.

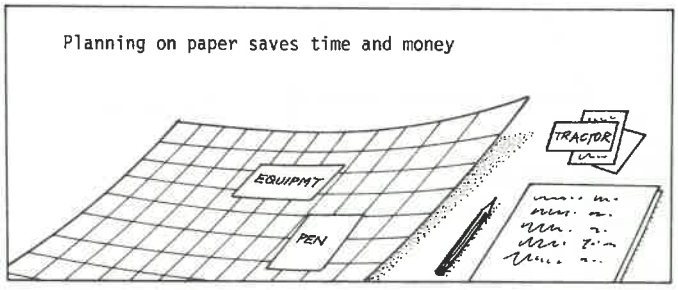


Table 6. Basic Pen Dimensions.

Live-stock	Minimum Width of Pen (feet)[1]	Height of Partition (inches)	Height of Ceiling (feet)[2]	Animal Access Door (inches)[3]	Height Throat of Manger (inches)
Cows	5	54	8-10	36 x 60	30
Calves	3	48	"	16 x 36[4]	24
Sheep	3	42	8-10	24 x 32	12
Lambs	2	42	"	11 x 24[4]	8
Hogs	4	36	7-8	24 x 36	-
Pigs	2	36	"	8 x 24	-
Horses	8	84	8-12	48 x 96	38 (Colts=32)
Poultry	-	ceiling height	7-8	12 x 16	-

[1]Allows animal to turn around with ease.

[2]For cleaning barn with tractor loader, the minimum height should be 8' or 9'. During winter months, the manure pack may build up as much as 3' to 4' deep unless frequently cleaned. A clear height of 10' allows a manure pack of 3' (desirable in open barns) without severely limiting head room. Reduce clear height to 9' in closed, warm buildings or to 8' where manure is removed from the barn daily. Maximum height that baled hay can be piled from a truck bed without excessive labor or an elevator is 10' to 12'.

[3]Minimum width by minimum height.

[4]Creep feeder. Varies with size of animal. The idea is to let young stock through while keeping the mothers out.

Table 7. Recommended Dimensions for Tie Stalls[1] for Horses and Cows[2].

	Width of Stall	Length of Stall[3]
800-lb. Cow	3' - 6"	4' - 10"
1200-lb. Cow	4'	5' - 6"
1600 lbs and over	4' - 8"	6' - 2"
Horses (medium)	5'	12'
Horses (small)	5'	9'
Ponies	3'	6'

[1]Chain or rope tie (not stanchion).

[2]When using stalls, a 6' wide litter alley with gutter is recommended.

[3]Length of dairy stalls is distance from feed manger to manure gutter. Length of horse stalls includes 2' for feed box.

Table 8. Recommended Minimum Widths for Service Passages.[1,2]

Kind of Passage	Use	Minimum Width
Feed Alley	Minimum recommended	40"
Feed Alley	for feed cart	4'
Driveway	for wagon, spreader, truck	9' (preferably 10')
Doors and Gate	Drive Through	9' (preferably 10')
Doors and Gate	to small pens	4'

[1]In general, the requirements for service passages are similar, regardless of the kind of animals.

Table 9. Animal Units.

Type of Livestock	Weights (lbs)	Head per Animal Unit
Horses	1000-1600	1
Cows	1000-1400	1
Bulls	1200-1600	1
Young cattle, 1 yr old	500- 700	2
Calves	50- 500	4
Colts (weanlings)	350- 450	2
Brood sows or boars	250- 350	2.5
Hogs raised to 200 lbs.	--	5
Ewes or bucks	150- 250	7
Lambs	up to 100	14
Poultry	4 to 6 each	100
Chickens raised	up to 4 lbs.	100

[1]An animal unit is based on feed consumption.

Table 10. General Space Requirements.

PEN SPACE REQUIREMENTS

- Provide separate pen for each species of livestock.
- Allow 100 to 120 square feet per animal unit based on Table 9 (complete confinement).
- Allow 50 to 60 square feet when animals have access to outside runs.
- Provide separate maternity rooms or pens with supplemental heat for expected winter or early spring births: 100 to 150 square feet for a cow or mare, 25 square feet for a ewe, 50 square feet for a sow.
- Creep feed space: 1 1/2 square feet per lamb or pig; 4 to 5 square feet per calf.
- Allow 3 1/2 to 4 1/2 square feet of floor space per mature laying hen in flocks of 25 or less.

FEEDERS and WATERERS

- Allow about 24 inches feed bunk space per individual animal when limited feed is fed at regular intervals. A little less is required for smaller livestock such as sheep and a little more for very large cows.
- Provide one feeding space for every four animals if self-feeders are used.
- Provide one drinking space for each pen and for each 25 animals.
- Provide one nest for each 4 to 5 hens and 3 to 4 inches of feeder space.

[1]More specific space information for each species provided in Section II.

Table 11. Storage Space Requirements for Feed and Bedding.

Kind of Feed or Bedding	Pounds per Cubic Foot (approx.)	Cubic Feet per Ton (approx.)
Baled Hay (closely stacked)	8-10	200-250
Baled Straw	7- 8	250-300
Sawdust	12	160-170
Bulk Grains[1]		
Shelled Corn	45	45
Ear Corn	28	72
Oats	26	77
Wheat	48	42
Feed Concentrates, Supplements		
Grains & supplement (mixed)	32	62
High protein supplement	50	40
Bran	13	150
Linseed or soybean meal	30-40	50-65

[1]One bushel of small grain equals 1 1/4 cu ft; one bushel of ear corn equals approximately 2 1/2 cu ft.

Table 12. Feed Storage Requirements,

Type of Livestock	Tons per 200 day Storage per Animal Unit (see Table 9)			
	Roughage	Bedding	Concentrates Grain	High Protein Supplement
Cattle	1-1/2 - 4	½ - 1	1 - 4[2]	1/4
Sheep	1 - 4	1	1 - 2[2]	optional
Swine	--	1 - 1-1/2	1 - 4	1/4
Horses	2	1 - 1-1/2	1	--
Poultry	--	0.2	1	1 - 2[3]

[1]Use to estimate space requirements only. Feeding livestock a balanced feed ration depends upon many factors. For further information on feeding, see your County Extension Agent.

[2]In some cases, animals are fed little or no concentrate or supplement—for example, wintering beef cows, and dry ewes. Feeder stock are fed less hay and more grain for weight gain.

[3]Chicken mash.

[4]Late first crop hay is poor quality and requires high amounts.

MATERIALS

READY-MIX CONCRETE

Concrete is a mixture of Portland cement, water, air and aggregates. The sand and gravel aggregate provides 2/3 to 3/4 of the concrete's volume at low cost. Proportion concrete for the job it performs. (Table 13)

Water. The strength of concrete depends primarily on the water cement ratio. Enough water is needed for full curing, but too much water weakens the concrete.

Cement content. Farm concrete is often exposed to severe conditions, so it requires a high cement content for durability.

Air entrainment. Tiny air bubbles formed in concrete by a chemical additive give the concrete greater weathering and

Table 13. Concrete Specifications for Farm Uses.[1]

Type of Use	Air entrainment, %	Maximum aggregate size, inches	WAYS TO ORDER A CONCRETE MIX: METHOD 1 — Sacks of cement per cu. yd.	METHOD 1 — Gallons of water per sack of cement	METHOD 2 — Minimum cement per cu. yd., lb.	METHOD 2 — Lb. water per pound of cement	BY STRENGTH — Compressive Strength, psi
Footings and protected concrete	4.6	1.5	5	7.5	460	0.65	3,000
Paved areas, feedlots, driveways, floors	5.7	1.5	6	6	560	0.53	3,500
Walls, pen partitions	5.7	0.75	7	6	660	0.53	3,500
Manure pits	5.7	0.75	7	5.5	660	0.49	4,000
Precast slabs, feed bunks	6.5-8.5	0.375	7.5	5	705	0.44	4,000

One mix of concrete is not suited to all farm applications. Concrete for footings and floors doesn't have the durability needed in confinement livestock buildings. The more cement and the less water in the mix, the greater the cost and the better the durability.

[1]*Successful Farming*. May 1978

frost resistance. Table 13 suggests the amount of air entraining for areas subject to freezing and thawing.

One and a half hours is available to place concrete after the water is added at the plant. This time is influenced by weather, but workability and quality always decreases as mixing time on the truck increases.

Concrete Work in Cold Weather. Cure concrete at least 48 hours before letting it freeze; it is best to prevent freezing for 4 to 5 days. Additives are available to hasten the curing process during cold weather. Do not place concrete over frozen ground.

Concrete Work in Hot Weather. The curing rate increases above 70°F. Evaporation of water from the concrete also increases. Wind, high temperature, and low humidity dry evaporation is to cover with 4 mil plastic after initial set and surface finish is done.

• Slip-Resistant Concrete Floors

Steel troweling brings fine aggregate and cement to the top, forming a glazed and slippery surface. Wood float and broom finished surfaces provide better animal footing; however, they tend to become smooth with wear.

Select roughness suitable for the animals confined. Deep grooves make cleaning and disinfecting more difficult and may cause foot and leg problems for smaller animals.

Roughen the surface while the concrete is wet but firm. Make grooves diagonal to the direction of traffic, using a 2′ x 8′ sheet of exterior plywood with wood strips attached, as shown in Figure 33.

• Curing

Concrete sets by a chemical reaction between cement and water. Keep the surface of the concrete damp at least 5 days. Curing will continue for months. Remove forms after about 5 days for slabs, 10 days for walls and 28 days for structural elements.

MASONRY

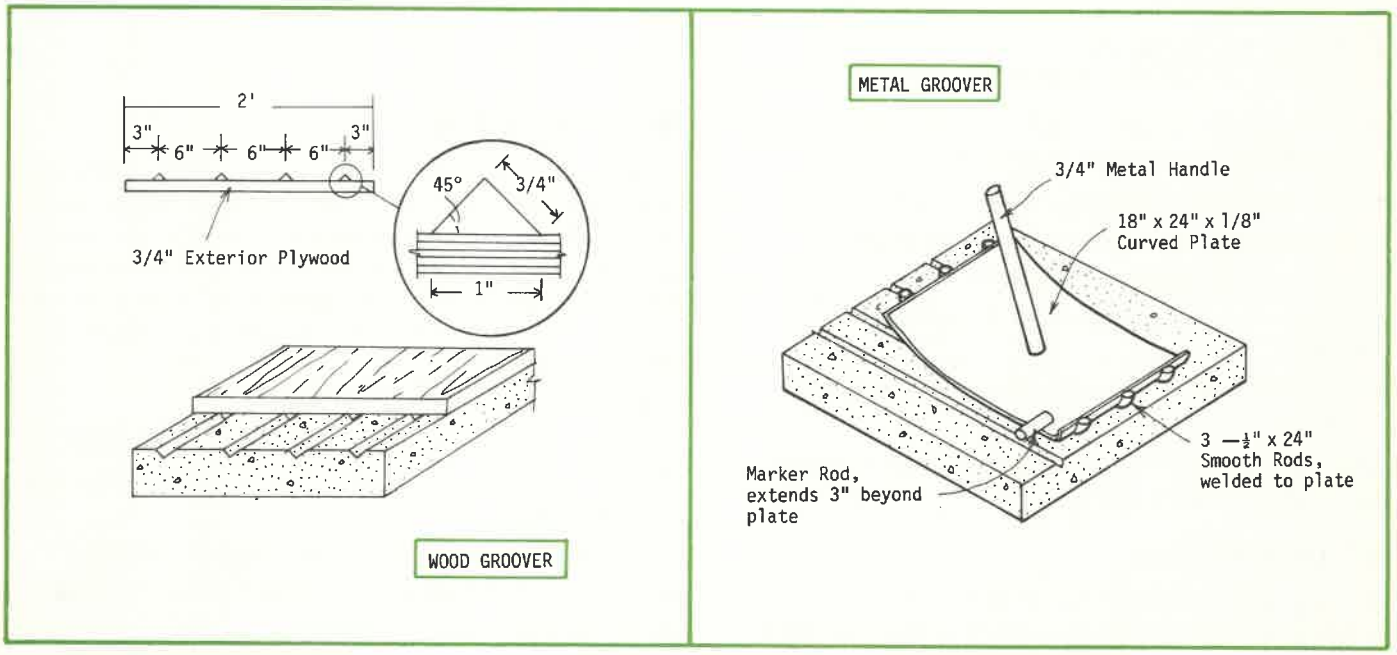
Repair and tuckpoint old masonry or lay new masonry with the mortar mixes listed in Table 14. Use mortar within 2 1/2 hours after original mixing when the air temperature is 80°F or higher and within 3 1/2 hours when at lower temperatures. Discard any mortar not used within these time limits.

Table 14. Recommended Mortar Mix Proportions by Volume.

Type Service	Cement	Hydrated lime	Mortar sand in damp, loose Condition
For ordinary service	1 - masonry cement[1] or 1 - portland cement	1/2 to 1/4	2 1/4 to 3 4 1/2 to 6
Subject to extremely heavy loads, violent winds, earthquakes or frost action	1 - masonry cement[1] plus 1 - portland cement or 1 - portland cement	0 to 1/4	4 1/2 to 6 2 1/4 to 3

[1]ASTM Specification C91 Type II.

Figure 33. Tool to Roughen Concrete Floors.



Procedures for laying masonry

1.Build corners first, 4 or 5 courses higher than center of wall. (Figure 34)

2.After laying each corner course, check alignment for level and plumb.

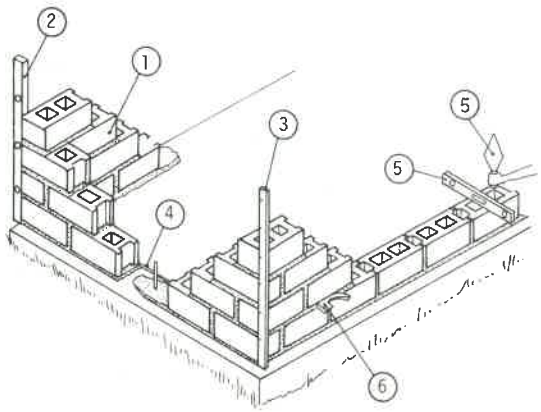
3.Locate top of masonry for each course with a 1x2 board with markings 8" apart.

4.Ensure horizontal accuracy with a mason's line stretched from corner to corner.

5.Bring block to proper grade and make plumb by tapping with a trowel handle.

6.Run a round "O" or "V" shaped tool along joints after mortar has somewhat stiffened to help provide watertight construction.

Figure 34. Procedures for Laying Masonry.



Steps are outlined in text, under heading Procedures for Laying Masonry

FOUNDATIONS

An adequate foundation is vital to the usefulness and life of a building. A foundation must resist:

- The weight of the building, snow, and contents.
- Soil movement caused by a change in moisture content, settlement, or frost action.
- Wind forces that tend to lift and overturn the building.
- Horizontal soil pressure if it is used as a basement wall.

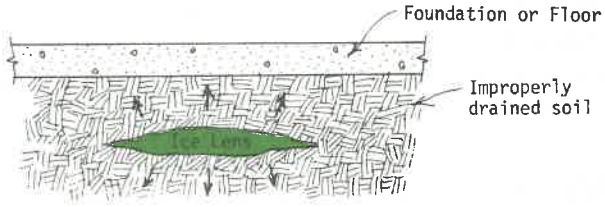
A foundation distributes these forces so that movement of the building is **small** and **uniform.**

Frost Action

Heaving and settlement due to frost action can harm a building's foundation. For ice layers or lenses to form in the soil and cause heaving, there must be:

- Freezing soil temperatures.
- Ground water close to frost line.
- Fine soil such as clay that rapidly draws water by capillary action from the water table.

As the frost penetrates the soil, water freezes in the soil pores. Freezing dries the soil and creates a capillary attraction which brings water upward to the frost line and causes the ice to thicken. A foundation can be lifted by a large ice lense, but it is more likely to saturate the soil and lower the soil bearing strength when it melts.



To prevent frost damage:

- Lower the water table on sites with drainable subsoil.
- Use coarse granular fill or a layer of non-swelling clay material with low capillary conductivity under the concrete.
- Install tile drains around the building to lower the water table below the frost line.
- Raise the building to increase the distance to the water table.

Granular fill reduces frost damage by preventing capillary water movement. Use large gravel or crushed rock with the fines screened out. Remove the subsoil to the maximum frost penetration depth if economically practical and replace with rock.

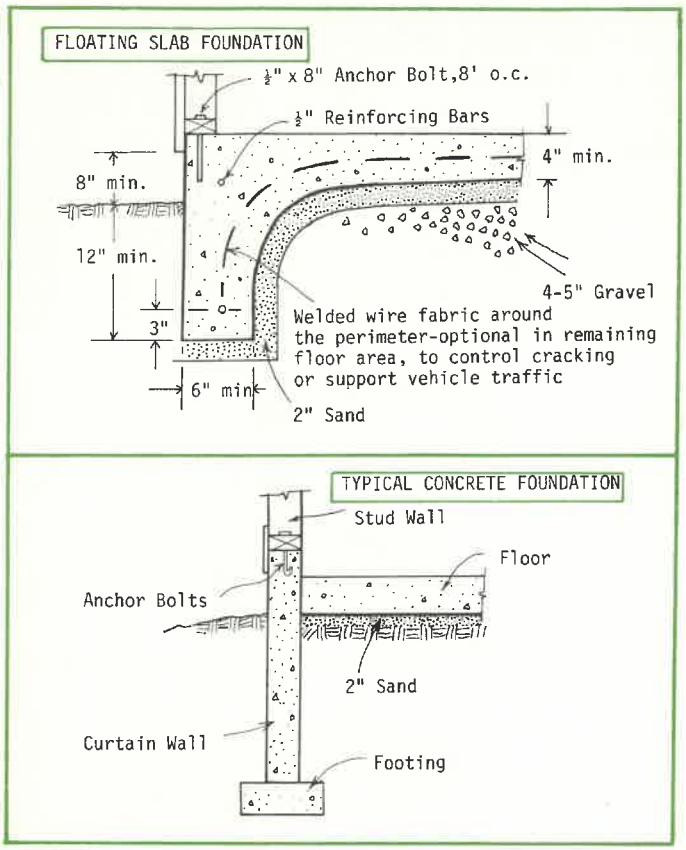
Floating Slab

A floating slab is well suited for garages, shops, and homes without basements. Cast the concrete floor and foundation as one piece. Thicken and reinforce the edge of a floating slab foundation to form a beam bearing directly on the soil. Extend the concrete below grade only 12" - 18" to prevent erosion from undermining the slab and rodents from burrowing under it.

When constructing a floating slab:

- Tie the thickened edge to the floor with welded wire fabric. Anchor the building to the foundation with bolts through the sill. (Figure 35)
- Compact fill dirt to prevent settling and cracking.
- Cover the fill with 4"-5" of gravel plus 2" of sand for good drainage.

Figure 35. Concrete Foundations.



Curtain Wall Foundations

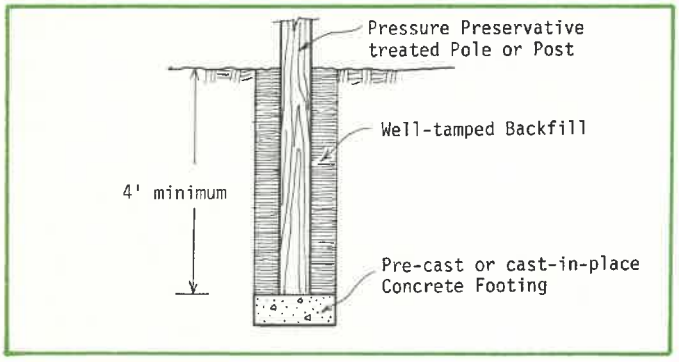
A curtain wall foundation is supported by soil both inside and outside the building. An independent concrete floor may be poured inside of the foundation. The wall may or may not have a footing. (Figure 35)

Post Footings

It is very important to place footings under posts in pole buildings. Snow loads and wind uplift can destroy a building without adequate footings. (Figure 36)

The footing may either be pre-cast or a concrete mix placed in the hole dry; the cement will draw water from the soil and harden. Increase the footing size for posts next to doors or in open walls where the distance between adjacent posts is greater.

Figure 36. Concrete Footing Pad.



FLOORING

Plank or clay flooring is preferred by many for horses, but concrete is better for other animals because it cleans easily and reduces rodent problems. Although deep, well-bedded manure packs provide comfort and warmth, they encourage insects and rodents if improperly managed.

Concrete feed aprons and floors with a minimum of vehicular traffic, and building floors should have a minimum thickness of 4 inches. Paved feedlots and building drives should be 5 inches and drives with heavy traffic 6" thick. In all cases, a well drained gravel base is recommended.

Slope all floors and feedlots for drainage. Recommended slopes for solid floors and paved feedlots range from 1/4 to ½" per foot inside ¾" per foot outside. Unpaved lots need to slope about 4' to 6' per 100'.

LUMBER

Size

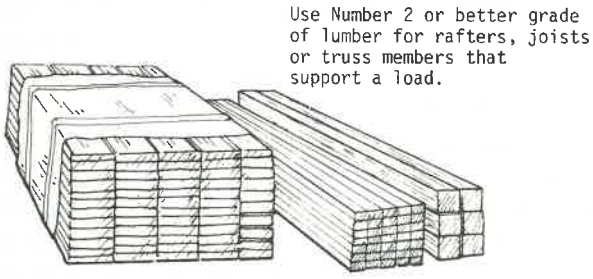
Table 15 lists the sizes of common construction lumber. A board foot is the unit of measurement of lumber.

Table 15. Nominal and Surfaced Sizes of Dimensional Lumber and Timbers.

Nominal Size	Actual Size in. x in.
Dimension Lumber	
2 x 4	1.5 x 3.5
2 x 6	1.5 x 5.5
2 x 8	1.5 x 7.25
2 x 10	1.5 x 9.25
2 x 12	1.5 x 11.25
4 x 4	3.5 x 3.5
4 x 6	3.5 x 5.5
Timbers	
6 x 6	5.5 x 5.5
6 x 8	5.5 x 7.5
8 x 8	7.5 x 7.5

Lumber is commonly in 8 to 20′ lengths in 2′ multiples. Longer lengths are available, but cost more. **Boards** are lumber less than 2″ thick; **Dimension** is lumber from 2″ to less than 5″ thick; **Timbers** are 5″ or more thick in the smallest dimension.

Use number 2 or better grades of lumber for rafters, joists or truss members that support a load. Use dry lumber for construction. Green, undried lumber warps as it cures and often causes wavy eaves, roofs or sidewalls.



Ungraded lumber does not have assigned strength properties and is used in construction as boards, battens, siding, shelving, paneling, stepping, etc.

Ungraded Lumber

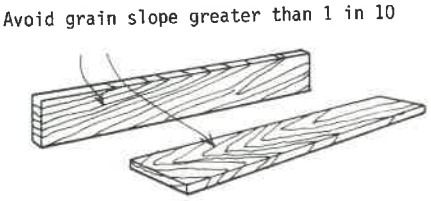
Sometimes you can buy ungraded lumber from a local sawmill, or cut lumber from your own logs. Select lumber for strong structural members by the following guide. This method will eliminate the weakest pieces, or about 25% of typical ungraded lumber.

1. Select lumber with knots or knotholes with a diameter smaller than one-quarter the nominal width of the piece. (Table 16)

Table 16. Maximum Recommended Knot Size.

Lumber Size	Maximum Knot Size
2x4	1"
2x6	1 1/2"
2x8, 2x10, 2x12	2"

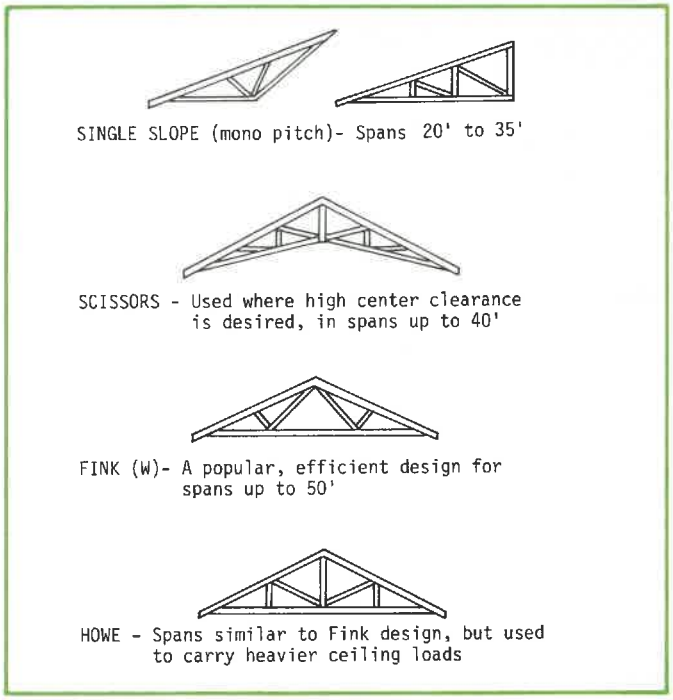
2. Reject pieces with 2″ or larger knots.
3. Reject rotted, split, checked, warped or undersized pieces.
4. Reject cross grain that slopes more than 1 in 10.



Roof Trusses

Roof trusses, either prefabricated or built on site, provide economical clear-spans from 20 to 60 feet wide. (Figure 37)

Figure 37. Common Truss Configurations.



Roofing sheets and shingles shed snow and rain better when slopes are greater than 3/12. For worker safety and economy, limit slopes to 6/12. Roof trusses are often two or four feet apart.

Roof trusses can be built on the job site, but quality control is difficult, especially if glue is used. Use dressed lumber. Quality trusses manufactured in a shop under controlled conditions are available in most areas. Many manufacturers use pressed metal plate connectors to provide an economical roof truss.

When ordering trusses, specify slope, span (length of trusses), and roof load. Roof load is basically snow load and ceiling load. Use roof loads recommended in your area.

Poles and Posts

A round pole with natural taper is stronger, and available in longer lengths than sawn timber posts. Natural pole taper provides a greater butt area for bearing and a larger cross section close to the ground line where the greatest bending stresses occur.

The sawn timber post is more uniform than a pole. Posts can be stacked and transported more easily than poles. Construction is normally faster because uniformly sized posts are easier to line up and connect to other structural members. In addition, many people prefer the straight, uniform appearance of posts.

Wood Preservatives

The center or heartwood of all species has some natural decay resistance. Sapwood has low resistance and must be treated if long life is desired. The most resistant species are bald cypress, cedar, juniper, black locust, osage-orange, catalpa, and redwood. Even these species are preservative treated where high decay hazards exist, and where failure would require expensive repairs.

Brushing or dipping oil preservatives is effective for wood exposed to moisture for short periods but is not adequate for long term exposure. Do all cutting, framing, and hole boring before treatment.

Pressure Preservative Treatment

Creosote is very effective against decay and termite damage. Creosote treated wood cannot be painted and has a pungent odor.

Pentachlorophenol, commonly called Penta, is a widely used oil-borne preservative and is highly toxic to fungi and termites. Penta in heavy petroleum oil is best for preservation, but is not paintable. Penta dissolved in light petroleum solvents is fairly clean and paintable. Penta dissolved in liquid petroleum gas is very clean and paintable.

Water-borne salt preservatives. Salt compounds of arsenic, chromium, copper and zinc are suitable where clean, odorless and paintable surfaces are necessary. Water, ammonia, or volatile acids are carriers for dissolved salts. The carrier evaporates after the treatment, leaving the dry salt within the wood.

For timbers in contact with soil, one-third to two-thirds pound of specific salts should be retained in each cubic foot of wood. Some of these salts are water soluble so should not be used in wet soil. Look for a stamp on the wood that tells that it is for soil contact.

On-site preservative treatment is possible but not recommended because it is difficult to get enough penetration and retain enough chemical to stop decay. Handle preservatives or treated wood with caution. Creosote can burn the skin, especially in hot weather. Treated wood should not be used where there is danger of contaminating food or animal feed.

ROOFING and SIDING

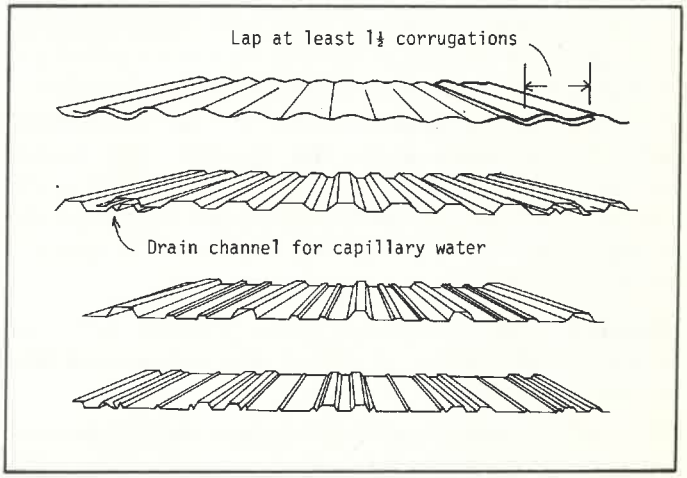
Nearly all roofing and siding materials are sold by the "square" (100 sq ft). Sometimes a purchased square is exactly 100 sq ft and does not include material for joints or laps. Other materials are sold based on coverage so the necessary overlaps are included. Check this difference when determining the cost of roofing and siding materials.

Metal Sheets

Ribbed or corrugated metal sheets up to 4′ wide with lengths from 8 to 40′ are readily available. Aluminum and galvanized steel are available with natural finish or with color coatings such as baked-on enamels. Metal roofs require little maintenance, but keep lead, zinc, manure, salt, and other corrosive materials away from them.

For best performance corrugated metal sheets should be used on roofs with 3 in 12 slope or greater. This slope reduces flooding of corrugations and seepage through the side or end joints during heavy rainfall or snow melt.

Figure 38. Typical Sheet Metal Configurations.



Galvanizing. The zinc galvanizing that protects steel from corrosion varies in thickness. Exposure tests in rural atmospheres show a useful life before "first signs of rust" of 7 years for 1.25 oz. zinc coating per square foot of sheet and 15 years for 2 oz. In industrial areas the useful life is reduced. "Seal of Quality" 2 oz. zinc coated sheets are more expensive and may require a special advance order. Because zinc thickness cannot be measured by visual inspection, look for the Zinc Institute seal or request a written certification from the manufacturer.

Fasteners. Special nails or screws with sealing washers are used to fasten metal roofing and siding. Only buy fasteners designed for this use and follow manufacturers' application instructions to reduce roof leaks and corrosion.

Dissimilar metals such as steel or aluminum that contact each other corrode rapidly. Use galvanized nails with lead heads or neoprene washers with galvanized steel sheets and aluminum fasteners with aluminum sheets.

Nails punch or depress the metal, so nail through the top or ridge of the corrugation for best performance and to reduce leaks. Self drilling screws with flat sealing washers are power driven in the flat or valley of the corrugation. Sidewall fasteners are placed in the valley of corrugated metal sheets.

Installation. Applying roofing to spaced purlins is hazardous, particularly on windy days. Step on sheets only where

there is a purlin and do not slip on wet sheets. Mark a line for nailing if necessary.

Wood Products

Shingles. Cedar shingles (or shakes) for roofing or siding are weatherproof, rustic and expensive. Usually shingles are nailed over a solid or spaced board roof deck or wall sheathing. Wood shingles perform well on roof slopes of 6 in 12 or greater. With lesser slopes they must be overlapped more.

Sheathing. Roof sheathing must be adequately supported to prevent sag or failure from snow loads. Plywood graded for engineered uses has an identification index which is a pair of numbers separated by a slash. The first number is the maximum spacing, in inches, for roof decking supports with the face grain across the supports. The second number is the maximum spacing for residential subflooring supports. Typical 1/2" plywood requires roof supports every 32" or less; 3/8" plywood requires roof supports every 24" or less.

Plywood. Only use exterior grade plywood outdoors, inside animal shelters, or where alternate wetting and drying may occur.

Plywood is manufactured in two basic types, exterior and interior, and in a variety of appearance grades within each type. The glue bond and the grade of the plies determine the type. Exterior plywood has waterproof glue lines and all plies are at least grade C. Sheathing has waterproof glue lines and grade D exterior plies. Sheathing and CDX plywood will not hold up to outdoor exposure unless covered with roofing or siding.

Asphalt Products

Shingles. Asphalt shingles and roll roofing are not commonly used on farm buildings because a continuous decking or wood sheathing is required. Asphalt shingles are asphalt-saturated felt or fiberglass that is surfaced with colored granules on the exposed side. Light colored shingles reflect solar heat better and last longer than dark ones. Interlocking or self-sealing shingles are best for windy areas.

Shingles are sold by the bundle which is 1/4 to 1/3 of a square (100 sq ft of coverage). High quality shingles weigh about 300 lbs per square and last more than 20 years. Install at least 240 lbs (3 bundles per square) shingles.

Corrugated Asphalt. Corrugated asphalt sheets can be installed on spaced purlins or spaced sidewall girts. They are available in 32" and 48" widths and are 78" long. If used on roofs where the slope is less than 3 in 12 or in areas with high temperatures and intense sun, space roof purlins 12" on center to reduce sag.

Roof Drainage

Roof gutters and downspouts collect and divert rain and melted snow or ice from feedlot areas to prevent pollution and to reduce mud problems. In regions with heavy snow, gutters are seldom used because snow and ice dams will form along the gutter and the edge of the roof, especially if the building is heated. If roof water is collected for storage and use, or if doorways, foundations and feedlots must be protected, then gutters or eave troughs are effective.

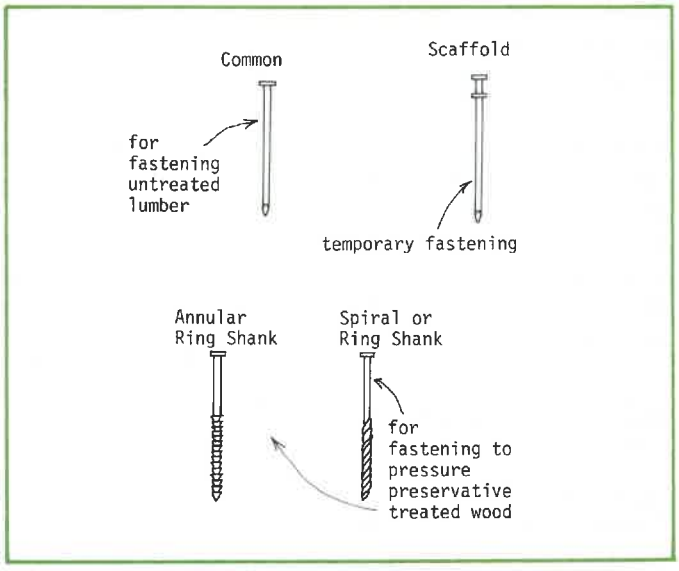
A five" gutter with 3" diameter downspout for every 1000 sq ft of roof area is satisfactory. Position the gutter to avoid damage from sliding ice and snow and fasten according to manufacturers' instructions. At the base of the downspout install an elbow and extension pipe or splash block to divert water at least 30" away from the building.

FASTENERS

Nails

Pressure treated lumber, especially creosoted poles, do not hold nails as well as untreated lumber because the preservative acts as a lubricant. Spiral or annular ring shank nails are used because they have a higher withdrawal resistance. Hot dipped galvanized pole or post building nails are recommended in all salts-treated lumber. (Figure 39)

Figure 39. Nails for Untreated and Pressure Preservative Treated Lumber.



Fasten rafters, girders, cleats or braces to the pressure treated post with 4" to 5" (20d to 40d) nails. Untreated framing members are fastened to each other with 10d or 12d nails. Examples include roof purlins to rafters, and tie-down cleats or braces to rafters or girders. Fasten 2 x 4 purlins on edge with six" (60d) nails. (Table 17 and 18)

Table 17. Nails Commonly Used.

NAILS	Length, Inches	SPIKES	Length, Inches
2d	1	16d	3½
3d	1¼	20d	4
4d	1½	30d	4½
5d	1 3/4	40d	5
6d	2	50d	5½
7d	2¼	60d	6
8d	2½	5/16	7
9d	2 3/4	3/8	8-12
10d	3	HARDENED THREADED NAILS	
12d	3¼		
16d	3½	8d	2½
20d	4	10d	3
40d	5	12d	3¼
50d	5½	16d	3½
60d	6	20d	4
		30d	4½
		40d	5
		50d	5½
		60d	6

Table 18. Suggested Nail Size and Application.

Suggested Nail Size	Application
8d	1" boards
12d or 16d	2" lumber
20d - 40d	More than 2" thick or 2" to posts
4d - 8d	To end nail studs
6d	3/4" plywood
4d or 6d	1/2" plywood
3d or 4d	3/8" plywood
60d	2x4 purlin on edge

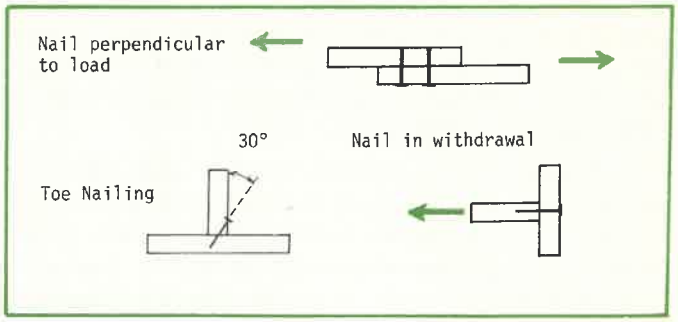
A nail that splits the wood has no load carrying strength. Lead holes not more than 3/4 the diameter of the nail can be drilled to prevent splitting without reducing the safe load carrying strength.

Drive toe nails at approximately 30 degrees and start them at one-third the length of the nail from the end of the piece. (Figure 49)

Other Fasteners

Bolts require more labor to install than nails. They are sometimes used where there is too little wood surface to hold enough nails to carry heavy loads. Do not forcibly drive bolts as the wood may split. Drill holes 1/32 to 1/16″ larger than the bolt diameter. Use standard cut washers and tighten snugly but not enough to crush the wood fibers. A variety of manufactured **metal framing anchors**

Figure 49. Methods of Driving Nails.



or joist supports are available to simplify construction and save time and materials.

Glue

Glued joints can be as strong or stronger than the structural members glued. However, flaws in glued joints are difficult to see and may fail under design load.

To make glued joints, use dry, smooth wood that is free of dirt, oil, and other coatings. Most purchased lumber is planed smooth enough for gluing. Preservative-treated lumber is not glued or it must be planed prior to gluing for maximum holding power. Be sure the moisture content of the wood is below 15% before gluing.

Waterproof glues (resorcinol resin) are recommended for farm buildings where moisture is present (livestock confinement buildings, outdoor equipment). Water resistant glues (casein) may be used for storage buildings where the moisture content of the wood is consistently low.

Gluing Procedure. Follow manufacturers' directions when gluing. Temperatures above 70°F are often recommended for curing. Apply enough glue so that when pressure is applied some glue will be forced from the joint. Do not skimp; the cost of the glue is a minor item in the total cost of construction.

Apply glue with a brush or paint roller. Put pressure uniformly on the entire joint with clamps, nails, screws, or other fasteners.

Keep joints under pressure for 4 to 8 hours so the glue sets and the joints will not separate. Leave pressure applied longer, if possible, and do not apply design loads for at least 24 hours after gluing.

BRACING

Adequate bracing in a building is essential. Along with inadequate fastening at joints, lack of bracing is a major cause of structural failure.

Temporary and permanent bracing strengthens and adds rigidity to the building frame. Temporary braces hold the frame in place during erection. Permanent bracing is required for the structural integrity of many buildings.

Wall Bracing

Lateral Bracing. Lateral or cross bracing in a wall may be obtained by 2 x 4 braces or metal strapping at each corner. Diagonal wood sheathing, fiberboard sheathing, or properly nailed plywood sheathing is better.

Post to girder braces attached at a 45° angle allow the girder to carry a heavier load, tie the girder down in heavy winds, and strengthen the building longitudinally. Girder to post bracing helps to securely fasten the two parts together. Generally girder to post bracing is not required in buildings less than 30 to 40′ wide and with posts spaced 8′ or less apart. (Figure 41)

A girder with properly designed and fastened girder to post braces at the third points of the girder span can carry 80% more load than one without braces. A 1/2″ bolt or four or five 30-40d pole barn nails spaced 2″ apart is a typical fastening schedule for the brace.

Post to truss or **rafter braces** (lateral knee braces) fasten the truss to the post and stiffen the walls laterally across the building width. Fasten brace as shown in Figure 41. Note that the brace extends to the top of the rafter or upper chord of the truss. Fasten the truss securely with 1/2″ bolts with washers or 30d or 40d deformed shank nails.

Roof Bracing

Roof bracing aligns trusses during construction and prevents buckling of members under load. Two types of bracing are needed.

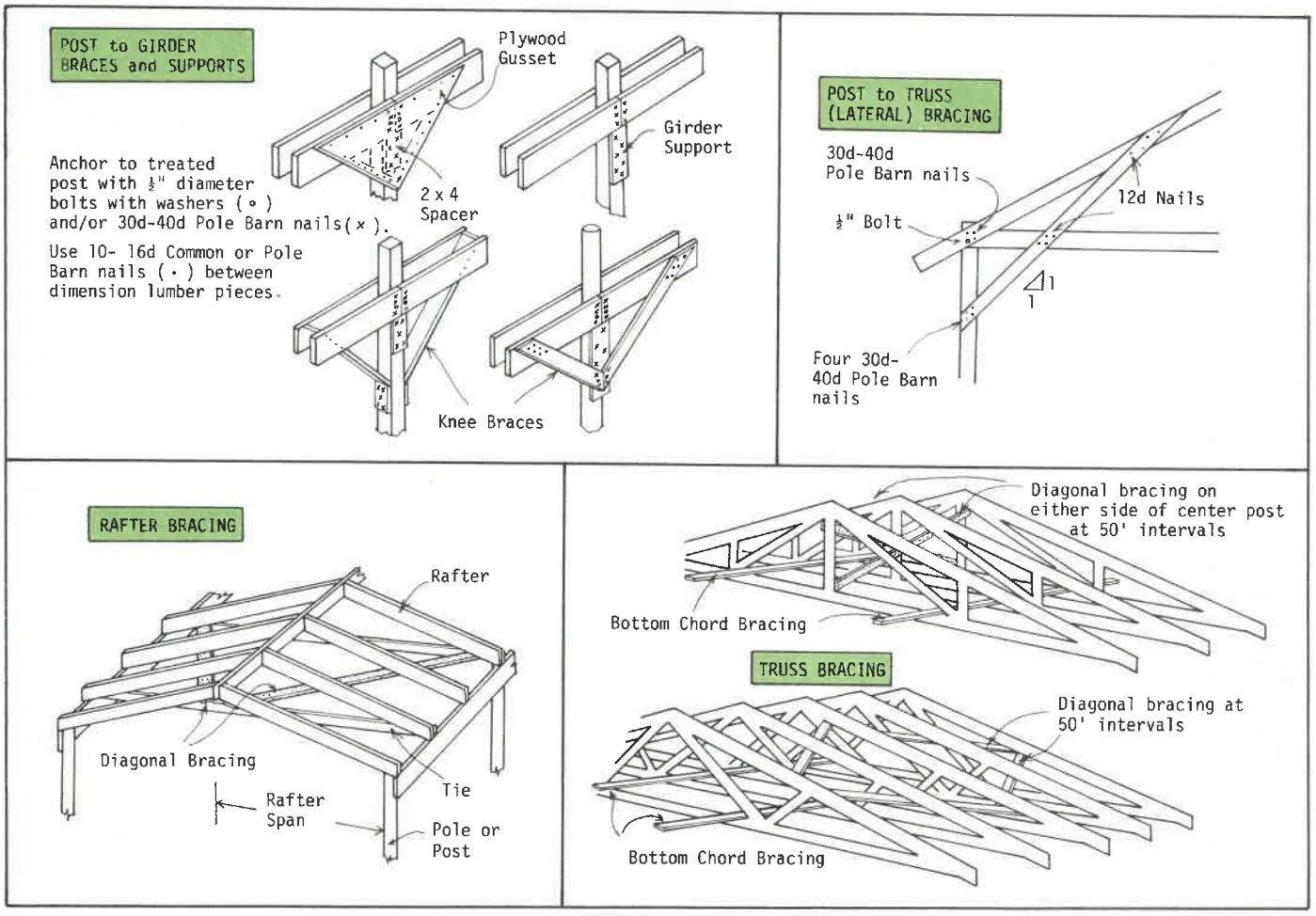
Diagonal bracing, also called wind or "X" bracing, keeps trusses vertical and prevents the trusses from buckling from wind loading. Install bracing at each end of the building and at 50′ intervals of building length. Diagonal bracing from the peak to the eave is often installed on rafters or frames where X bracing is not practical.

Bottom chord bracing, or horizontal bracing, replaces a ceiling and prevents buckling of the bottom chord. Install 2 x 4's continuously the entire building length close to each bottom chord joint unless a rigid ceiling is installed.

Install roof bracing as the trusses are being installed. Brisk winds come with little warning and can damage unbraced or poorly fastened trusses. Also install roofing material quickly to prevent wind damage.

End Bracing. Diagonally brace ends of buildings more than 18′ wide or 8′ high.

Figure 41. Braces and Supports.



IV-Utilities

GENERAL WIRING

Wire in compliance with the National Electrical Code, particularly Article 547 which refers specifically to wiring agricultural buildings.

Table 19. Wire Type and Use.

Wire Type	Use
SE (Service Entrance Cable)	Service Entrances. Interior wiring when all conductors are insulated.
UF (Underground Feeder Cable)	Underground, direct burial or for interior wiring in wet, dry, or corrosive locations, such as barns
NM (Nonmetallic Sheathed Cable)	Dry locations in homes. Not for damp, corrosive conditions.
TW (Moisture-Resistant Thermoplastic)	Single conductor for dry and wet locations.

If wiring is done by the owner, have an electrician and/or power company representative lay out the overall wiring.

Wire with moisture resistant, underground feeder (UF) cable. Do not wire with metallic conduit or plastic covered (Type NM) cable typically used in the home because these types are not moisture resistant.

- Ground all outlets and use 12 gauge wire or larger.
- In wet or dusty areas, special dust and moisture tight outlet boxes and lamp fixtures are recommended.
- Locate outlets as high as can be reached conveniently.
- Bond all metalwork in the barn together with a grounding conductor to reduce the chance for electrical shock.
- Bond water lines and metal drinkers, all metal stalls, metal building frame and floor reinforcing to the neutral wire at the main service entrance.

Main Service and Entrances

- Evaluate or have an electrical utility representative evaluate the main service to see that it is large enough to handle the new load.
- Size the main service box for at least 50% over the present planned load.
- Extend wiring from the load center or meter pole to carry the maximum electrical demand to the entrance panel at the barn. These conductors must be No. 8 wire or larger.
- Size the entrance panels for a major building other than the dwelling for at least 60 amperes, three-wire 120-240 volts. Small buildings (up to two branch circuits) may be supplied through 30-ampere switches and circuit breakers.
- Bond the neutral wire to a driven ground rod or buried ground wire at the service entrance.
- Do not locate service entrance in the animal room. Instead place in feed annex or outside the building in a weather proof enclosure.

Circuits

- Branch circuits serve permanently connected lighting, convenience outlets, and up to 1/2 hp motors that are not particularly sensitive to voltage drop. Size each branch circuit in service buildings for at least 20 amps.
- Protect each branch circuit by a fuse or circuit breaker.
- Protect motors with heavy starting loads with a time-delay fuse or circuit breaker.
- Install permanent motors of 1/3 horsepower or larger, fixed appliances of 1000 watts or over, and equipment requiring continuous service such as brooders, water systems, and food freezers on individual circuits.

Heat Lamps

Heat lamps for brooding have caused many farm fires. Follow these installation rules.

- Use porcelain receptacles to withstand high temperatures.
- Suspend by a wire or chain. Do not use an extension cord or hang the lamp by its cord.
- Select hard glass lamps which are heat resistant and weather proof. Red glass heat lamps avoid glare by reducing the visible light output.
- Protect with a metal reflector shield and wire guard.
- Keep out of animal reach.
- Make sure it is impossible for the lamp to touch bedding or other flammable material.

Other heaters for brooding include heavy-duty heat pads that are protected from animal damage, catalytic (not open flame) gas heaters or electric brooders.

Heat lamps for brooding have caused many farm fires.

LIGHTING

Wire lighting circuits with No. 12 wire. Table 20 suggests lighting for the various areas on the farm.

Incandescent light bulbs cost little to install, but burn more electricity per unit of light output than any other lighting. Fluorescent light fixtures have long life and more light output per watt than incandescent. If temperatures in a barn may fall below 50°F, equip fluorescent fixtures with low temperature ballasts. Also mount fixtures on 1" wood blocks rather than directly to the ceiling to allow air circulation around the entire fixture.

Mercury vapor or other high intensity, high efficiency lamps require high mounting heights to distribute the light. They are not recommended for barn lighting, but are useful for yard and security lighting.

Table 20. Lighting and Convenience Outlets.

Area	Lighting Outlets (100-150 watt bulbs)	Convenience Outlets (20-amp duplex)	Special Purpose Outlets
Alley	20 ft. apart, wall switch controlled.		
Pens	One for each pair of pens or every 150-200 sq. ft. of floor space. Use separate wall switch for alley and each side of pens.	One for each pair of pens.	Outlets for heating cable or heating devices as required to protect the water supply against freezing. Use individual circuit for these outlets.
Box stalls, pens with partitions	One for each box stall or pen. (For horses, 9' or higher or protected.) Poultry - one for each 100 sq. ft. of floor area. Use separate wall switch located at outside door for each room completely shut off from the rest of the barn.	One for each pen.	See above.
Stairways	One outlet each at head and foot.		
Hay storage	One for each 400-500 sq. ft. mow area, wall switch controlled. Locate so that chute & ladders are well lighted. Use dust-tight fixtures.		Individual branch circuits and outlets for crop dryers, elevators and conveyers if their use is anticipated.
Feed Storage	One for each 200-250 sq. ft. floor area, wall switch controlled. Use dust-tight fixtures.		As above.
Feed Preparation Rooms	One for each 150-200 sq. ft. floor area, dust-tight fixtures, wall switch controlled. One lighting outlet for any grinding or size reduction equipment, proportioning station, or record center.	One for each 30 linear ft. of wall perimeter. Do not plan for these outlets to be used for permanently installed equipment.	Individual branch circuits and outlet for each major piece of equipment.
Equipment Room	One for each 150-200 sq. ft. floor area, wall switch controlled. One lighting outlet for any equipment or center where close work is to be performed.	As above.	As above.
Maternity Pens	One for each pen. Illumination should be greater than for an ordinary pen--about 200 watts/100 sq.ft.	One.	One for brooder.
Entrance Lighting	One over entrance if not well lighted by other yard light. Allow for control from both barn & residence.	One near door on inside, or an outside receptacle near	
Yard Lighting	One all-night, automatically controlled light at midpoint in the yard, on a pole or building to provide lighting between the house and barn and adjacent areas. Additional switch controlled lights may be needed to light other areas visited after dark.		
Special Circuits			Barn ventilation fan.
Barn Entrance Light Control	A master switch to control all barn lights, except those controlled by other means (time clock, light intensity, etc.) should be located at the major barn entrance. If first entrance and last exit frequently occur at different locations, multiple control switches should be installed.		

WATER

Water Source

Be sure there is an adequate supply of potable (drinkable) water. The best source is a deep well. Shallow wells, springs and streams are other sources. Streams are almost certain to be contaminated, but they may be suitable for livestock.

Typical water needs are listed in Table 21. In general, each 1000 lbs of livestock requires 10-15 gallons of water per day. A milking cow requires double that. The pump should be large enough to supply the daily requirements in two hours or less. If the well can not supply water this fast, select a pump that does not overpump the source and provide storage capacity to make up the difference.

Table 21. Approximate Farm Water Requirements.

Water Use per Animal			gals/day
Milking Cow			20-25
Additional for milkhouse and barn sanitation (per cow)			10-30
Dry cow			10-15
Calves (1-1-1/2 gal/100 lb body weight)			6-10
Swine, finishing			3- 5
Nursery			1
Sow & litter			8
Gestating sow			6
Beef animal			8-12
Sheep			2
Horse			12
100 chicken layers			9
100 turkeys			15
Goats			1-2
Water Use Flow Rate		**Minimum**	**Preferred**
Automatic waterers			
Cattle, hogs or sheep (20-40 head per bowl)		1/2 gpm	2 gpm
Poultry (100-150 layers)		1/4	1
Cleaning hose for milkhouse and dairy utensils		3	5
Cleaning and manure removal hose for milking barn or hog house		5	10
Outdoor hydrant for uses other than firefighting		3	5

Livestock water consumption is affected by air temperature, size of animal, species, age, milk or egg production, type of ration, dry matter consumed, and other variables.

Average summer values are listed — use 60% for cool weather. Also use 60% of the tabulated livestock consumption for pond storage if the average year-round temperature is about 50°F.

Flow Rate

The water system flow rate is the quantity of water delivered in gallons per minute (gpm). It should at least equal the peak use rate, gpm. Estimate the peak use rate by determining the greatest water demand likely to occur at one time. The flow rate should be at least the peak use rate of the largest single fixture to prevent undersizing. Note that only approximate flow rates can be calculated.

Home Water System. The minimum flow rate for a home is about 6 gpm; 10 gpm is more desirable. Some water filters need 20 gpm for backwashing. Estimate future water requirements so an adequate flow rate will be available when needed.

Farmstead Water System. If water for livestock production is supplied through the home water system, increase the flow rate to meet those needs or provide intermediate storage. The minimum flow rate for a farmstead is 8 gpm, but 10 gpm is more desirable.

Water Distribution

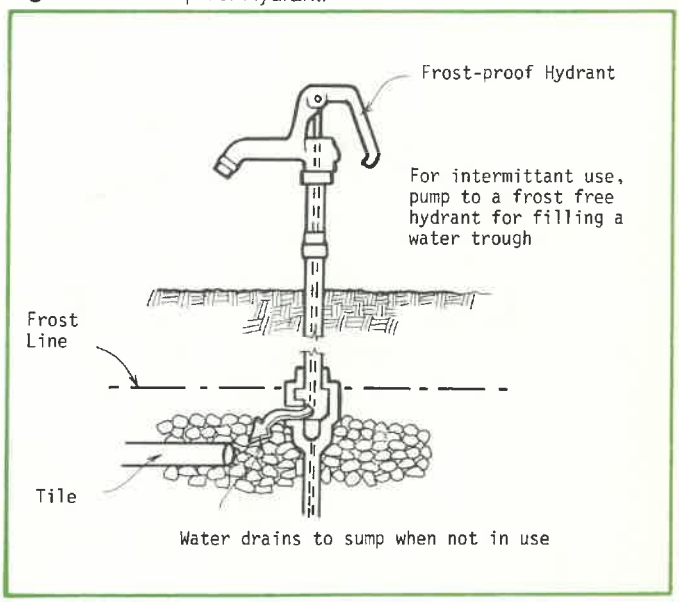
A supply of drinking water piped under pressure to various points on the farmstead is essential. Water may be hand carried, but this chore soon becomes burdensome. Water supplied by garden hoses can freeze. It is difficult to be sure that the livestock have adequate water at all times with these methods.

An underground pipe placed below the frost line to the barn should be considered as an absolute minimum. A one inch diameter service pipe from the well to a barn up to 1000 feet away supplies water for 10 livestock units.

It is best to provide livestock waterers with a poured concrete slab floor about 10' in diameter around each waterer to keep the ground from getting soft.

Insulate outside water tanks to reduce heating costs. Thermostatically-controlled heaters, heat tape and frost proof hydrants will also protect against freezing. To reduce ice build-up, locate a stock tank in a sunny area and protect it from northern winds. If the tank freezes over, break the ice daily so that livestock can get water as needed. They cannot get enough water by eating snow.

Figure 42. Frost-proof Hydrant.



V-Ventilation and Environmental Control

Naturally ventilated buildings provide good animal housing with low investment and operating costs. Proper ridge and sidewall openings allow natural ventilation to provide adequate year-round environment for most animals.

COLD BARNS

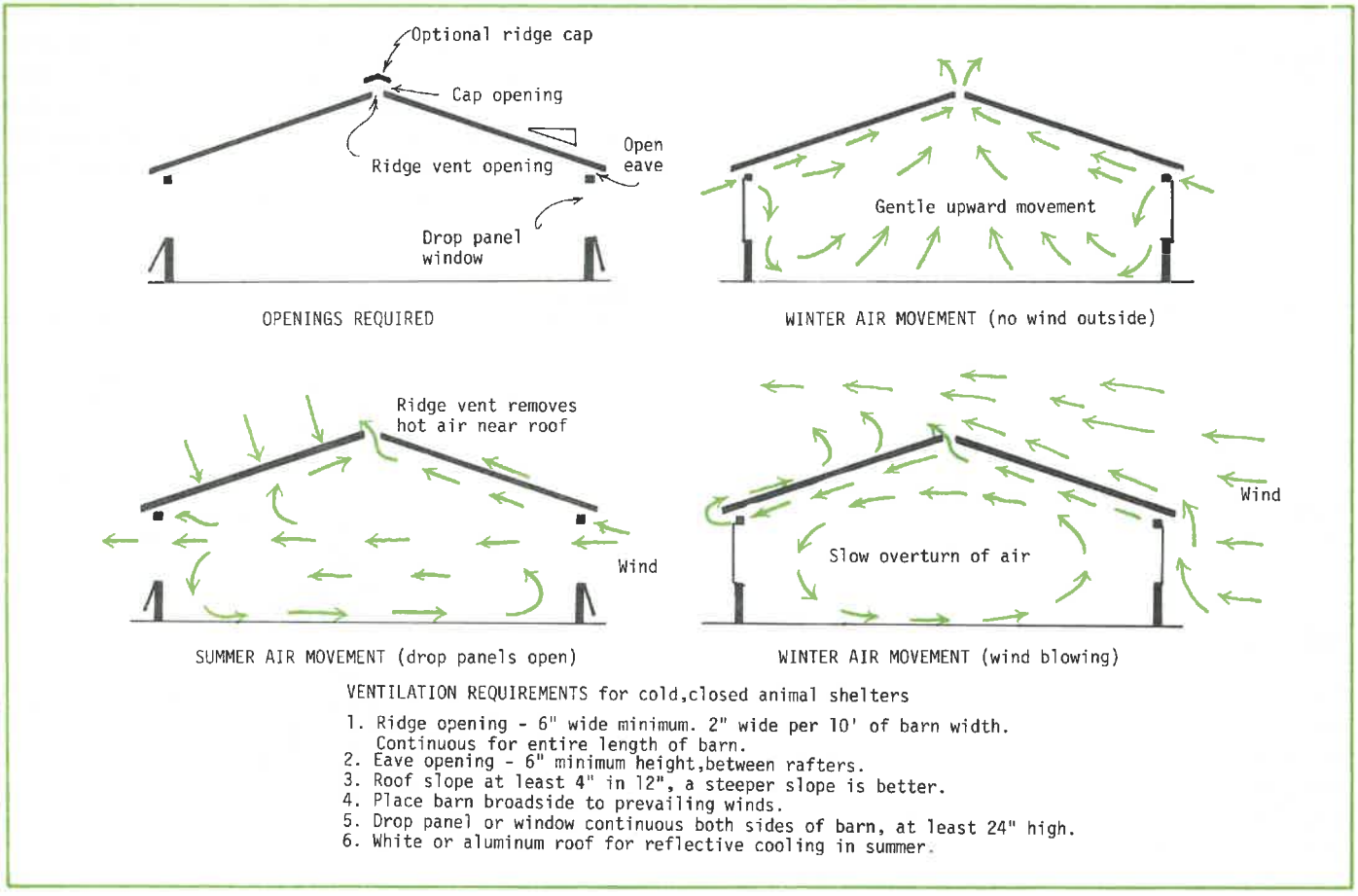
A cold barn has few or no fans. Non-mechanical ventilation relies on warmer, lighter air being moved by cooler heavier air to control temperature and moisture. Inside temperatures are no more than 5-15°F warmer or cooler than outside if the roof is insulated. Excess moisture will increase and condense on the roof if attempts are made to keep the barn warm.

An **open shed,** facing south, is the simplest cold barn. It can easily house cattle, sheep, hogs or horses and shelter necessary feed, bedding and some machinery. In addition, it has good natural ventilation, is easily cleaned with a tractor, and has access to outdoor exercise yards.

An **enclosed cold barn** and some of the requirements to make it work are shown in Figure 43.

- Ridge and eave openings are essential to create a continuous flow of air. The eave opening can simply be the open spaces between the trusses at the top of the wall.
- The roof must have at least a 4 in 12 slope to create a chimney effect to move air.
- Face the front of open buildings south or southeast and away from winter storms.

Figure 43. Enclosed Cold Barn Ventilation.



VENTILATION REQUIREMENTS for cold,closed animal shelters

1. Ridge opening - 6" wide minimum. 2" wide per 10' of barn width. Continuous for entire length of barn.
2. Eave opening - 6" minimum height,between rafters.
3. Roof slope at least 4" in 12", a steeper slope is better.
4. Place barn broadside to prevailing winds.
5. Drop panel or window continuous both sides of barn, at least 24" high.
6. White or aluminum roof for reflective cooling in summer.

In **winter**, always keep eave inlets open so the air movement will carry out moisture from the animals. On cold mornings, frost or water may form under the roofing; good air movement and air change remove most of it.

In **summer**, open the barn as much as possible so it functions primarily as shade. Large windows or wall panels that can open the sides one-third or more are desirable. The **ridge opening** is important to get rapid removal of heated air under the roof. An inch or two of insulation board under the roof also reduces the summer heat load.

WARM BARNS

If a barn is to be kept much warmer than outside winter temperatures, three things must be installed.

- **Supplemental Heat.** There must be an adequate and uniform heat source. While the animals do provide some heat, most small barns require a supplemental heater.
- **Insulation.** The barn must be well insulated. Old barns with hay overhead and low ceilings keep the heat near the animals. Today's warm barn is typically insulated with fiberglass or rigid foam plastic board insulation.
- **Ventilation.** Most importantly, the barn must have good, draft-free ventilation to remove excess moisture from the animals. This requirement is the most difficult one to meet. Barns with board and batten siding are often most comfortable because enough air filters in through cracks to remove excess moisture, but not enough to cause drafts and carry away too much heat.

Older, two story barns were well ventilated because they operated like a chimney. Low, insulated ceilings and tall, insulated ventilation stacks drew enough warm air from the many, closely confined animals below.

Narrow, adjustable slotted openings all around the eaves except 10 feet to each side of the fans, and fans exhausting stale air from the barn are often used to control humidity in today's warm barn. Different air flow rates are required during different seasons of the year. Figure 44 illustrates a simple baffle system to control air inlet rates, and Figure 45 shows a system to cut the capacity of a single speed fan for cold weather ventilation. Use table 22 to determine fan capacities and ventilation rates.

Never try to keep buildings warm by restricting necessary ventilation. Trying to save heat by shutting off fans causes excess humidity or water vapor in the air to condense on cold walls and ceilings. This condition is very bad for animal health and rapidly deteriorates the barn. Animal owners all too often create an unhealthy environment to provide warmth for themselves or because they do not understand animal needs. (Table 22)

Figure 44. Ventilation Inlet.

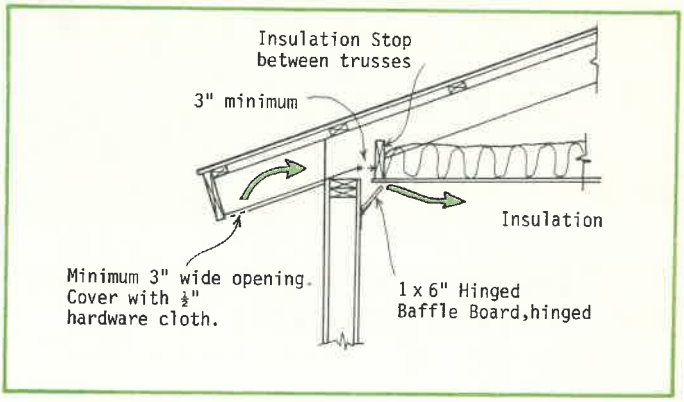
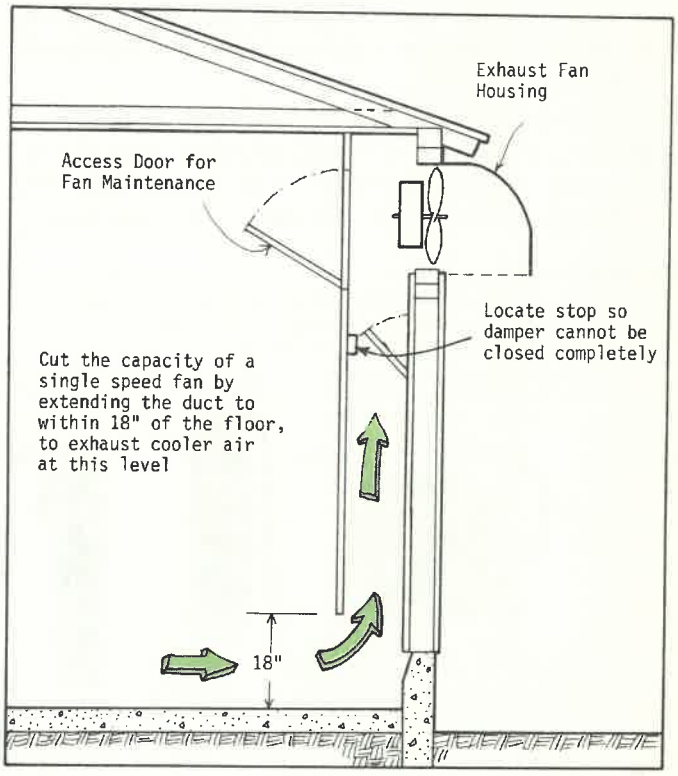


Table 22. Recommended Fan Capacity per Animal for Warm Barns.

	cfm, Cubic Feet per Minute			
Swine	Winter Continous	For Odor Control	Mild Weather	Hot Weather
Sow and litter	20	35	80	325
Nursery pig (30-75 lb)	3	5	15	35
Growing pig (75-150 lb)	7	10	24	75
Finishing hog (150-220 lb)	10	18	35	120
Gestating sow	12	24	40	150
Dairy				
Cows (in stall barns)	35	50	140	500
Poultry (per bird)	1/4	1/2	2	6
Sheep and Goats	Natural ventilation preferred			

Figure 45. Fan Arrangement to Conserve Heat in Cold Weather.



VI—MANAGEMENT

FIRE PREVENTION, PROTECTION and EXTINGUISHMENT

Fire prevention is the best protection. Prevention includes adequate wiring, good housekeeping, properly maintained heating equipment, lightning protection, proper storage of fuels, and avoiding spontaneous combustion.

Space buildings apart at least 50′ (75′ is better for fire trucks) to help reduce fire spread. Fire resistant exterior materials, such as metal siding and asphalt shingles, also help prevent the spread of fire between buildings.

Fire stop or completely cover both sides of a truss every 50′ with 1/2 inch gypsum board to slow fire spread through an attic.

Provide Fire Protection

Three components are necessary to sustain a fire: heat, air, and fuel. Removing any one component extinguishes the fire. Fuels include solids and liquids that will burn, and vapors from flammable liquids with low flash points. Since it is usually impossible to remove the fuel, fires are controlled by cooling the burning material, by cutting off the air supply, or both.

Portable fire extinguishers may control a small fire, or delay the development of a large one until help arrives. Equip every building **and** the fuel center with portable extinguishers located near entrances and high-hazard areas. The need is greater in rural areas, because it takes longer for fire equipment to arrive after a fire has been reported. Provide adequate water for fire fighting from a farm pond within pumping distance.

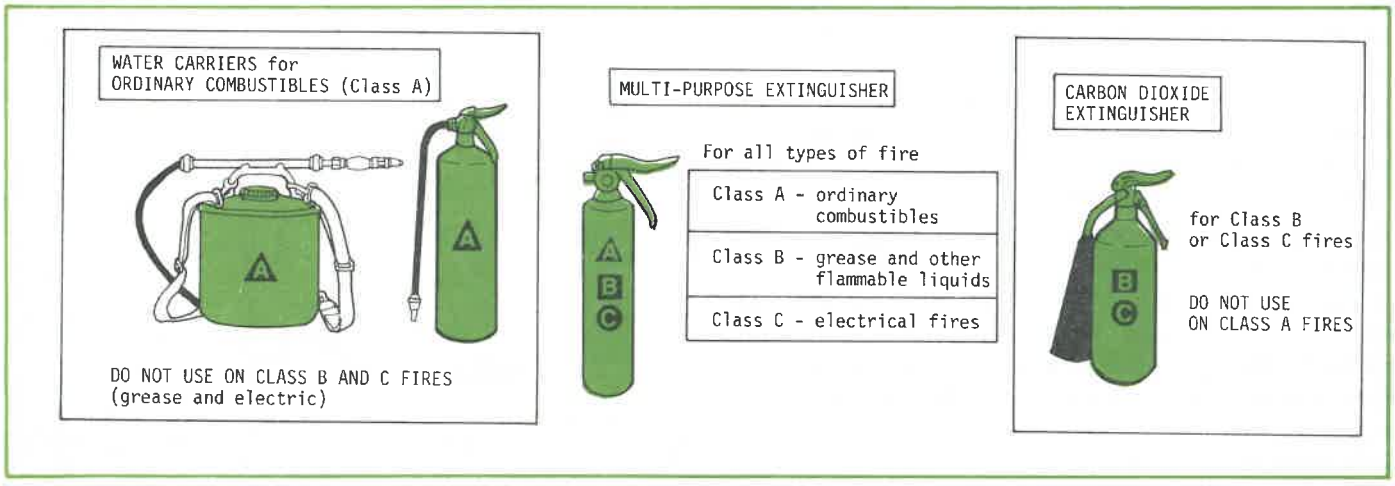
Not all extinguishers can be used on any type of fire since various flammable materials respond differently to treatment. (Table 23)

Table 23. Fire Classifications and Recommended Extinguishers.

Class of Fire	Material	Extinguisher Recommended
A	Wood, paper, textiles, grass, trash, similar materials.	Pressurized water (Dry chemical and carbon dioxide give temporary control).
B	Grease, gasoline, oils, paints, kerosene, solvents.	Multipurpose dry chemical, carbon dioxide, dry chemical foam.
C	Electrical equipment	Multipurpose dry chemical, carbon dioxide, dry chemical.

Locate fire extinguishers near doorways where they are available for immediate use.

Figure 46. Fire Extinguishers.



Water as a Fire Extinguisher

The first impulse is to put water on a fire. Water puts out some types of fires, but when used on others, disaster may result. For example:

- Water drowns out a Class A fire (wood, paper, straw, etc.).
- Water can spread a Class B fire (grease, oil, kerosene, etc.) that has to be smothered out. Smother a small Class B fire with a wet blanket.
- Water can conduct current from a Class C fire (electrical) to the person fighting it. Severe shock or electrocution can result whether the source of the water is a hose, fire extinguisher, bucket brigade, or wet blanket. Use a Class C fire extinguisher or turn off all electrical current and **then** use water.

Many small farms do not have a large enough water supply for fire protection. For limied fire fighting provide a flow of at least 10 gallons per minute through a 1/4" nozzle at 30 psi or 1200 gallons over a 2 hour period.

SECURITY

Farms are vulnerable to thieves, and the level of rural crime has risen in recent years. Take as many security precautions as practical, particularly if you do not live on the farmstead.

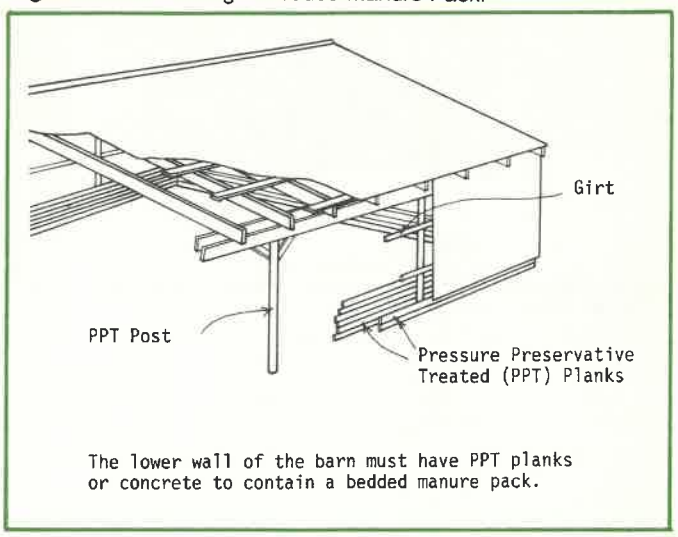
Orient garages so that doors are not visible from the road, are screened with plantings, or install self-closing doors. Avoid leaving the farmstead looking empty. Yard lights, parked cars, a noisy dog, or indoor lights left on all help. Good fences not only protect your livestock from wandering, they also inhibit trespassers.

MANURE DISPOSAL

Sheep and Cattle. Handle manure as little as possible. A manure pack works well for sheep and cattle during winter. That is, the manure is kept in the pen and every day enough bedding is added to soak up the urine and keep the animals clean. Less bedding is required if the easily cleaned manure is shoveled out each day. Typically, about 8 to 10 pounds of either straw, old hay or sawdust per 1000 pounds of livestock per day is used.

A manure pack provides comfort and warmth for the animals during the winter. Buildings must be high enough to allow 2 to 4' of buildup, yet still allow tractor cleaning in the spring. The lower portion of the building must have pressure treated planks or a concrete wall to contain the manure. If feed racks, waterers and partitions are adjustable in height they won't be buried in the manure. Place waterers outside bedded pack area to avoid excessive wetness. Manure packs tend to harbor rodents, especially around feed racks. For this reason, and lack of bedding, bedded packs are not used as much as they were twenty years ago. (Figure 47)

Figure 47. Barn using a Bedded Manure Pack.



The lower wall of the barn must have PPT planks or concrete to contain a bedded manure pack.

Poultry. Deep litter or bedding also works well for small poultry flocks and makes it easy to handle chicken manure. Daily scraping of dropping boards beneath roosts helps provide better litter conditions.

Horses and Pigs. Horse stalls and pig pens are usually cleaned daily. Wheelbarrows can be used to move manure from the pen to a manure storage area. A disadvantage could be running the wheelbarrow up a ramp to dump as the manure pile gets bigger.

Gutter cleaners placed adjacent to the pens make it easier to remove manure from the barn. Shuttle cleaners that move back and forth work well where only one gutter is needed.

Manure Storage

If manure is stored, screen the pile from neighbors and the road. It should be easy to reach so it may be cleaned out in the spring and cleaned twice per week during the summer to reduce fly breeding. Manure handling is less of a problem when livestock are turned out to pasture.

Keep surface drainage water from the manure pile or store manure under a roof. Polluted runoff must not enter water courses that leave the farm or be allowed to pool as flies and mosquitoes will breed there.

Well bedded manure will stack nicely without containing walls. Manure should be stacked on a solid floor so that it can be cleaned with tractor and loader. One or more walls can be used to push manure against during unloading and to screen the manure from view where desirable. (Figure 48)

Table 24 provides a guide to daily waste production and the size of storage required. A six month storage requires about a 10' x 10' area for each 1000 pound animal unit.

Figure 48. Manure Storage with Wall.

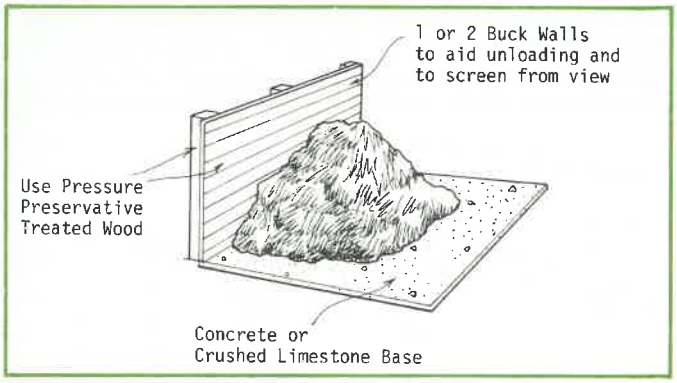


Table 24. Manure Storage Sizing.

	Daily Production, including bedding, cu ft	Storage Volume for 200 days, cubic ft.	Volume of Bedded Pack after 200 days cubic feet
Horse	2	400	---
Cow, dairy	2	400	250
Cow, beef	1 - 1 1/4	250	150
Pigs (1000 lbs., live weight)	1	200	---
Sheep and Goats (5 adults)	1/2	100	60
Poultry	1/4	--	60

RODENT CONTROL

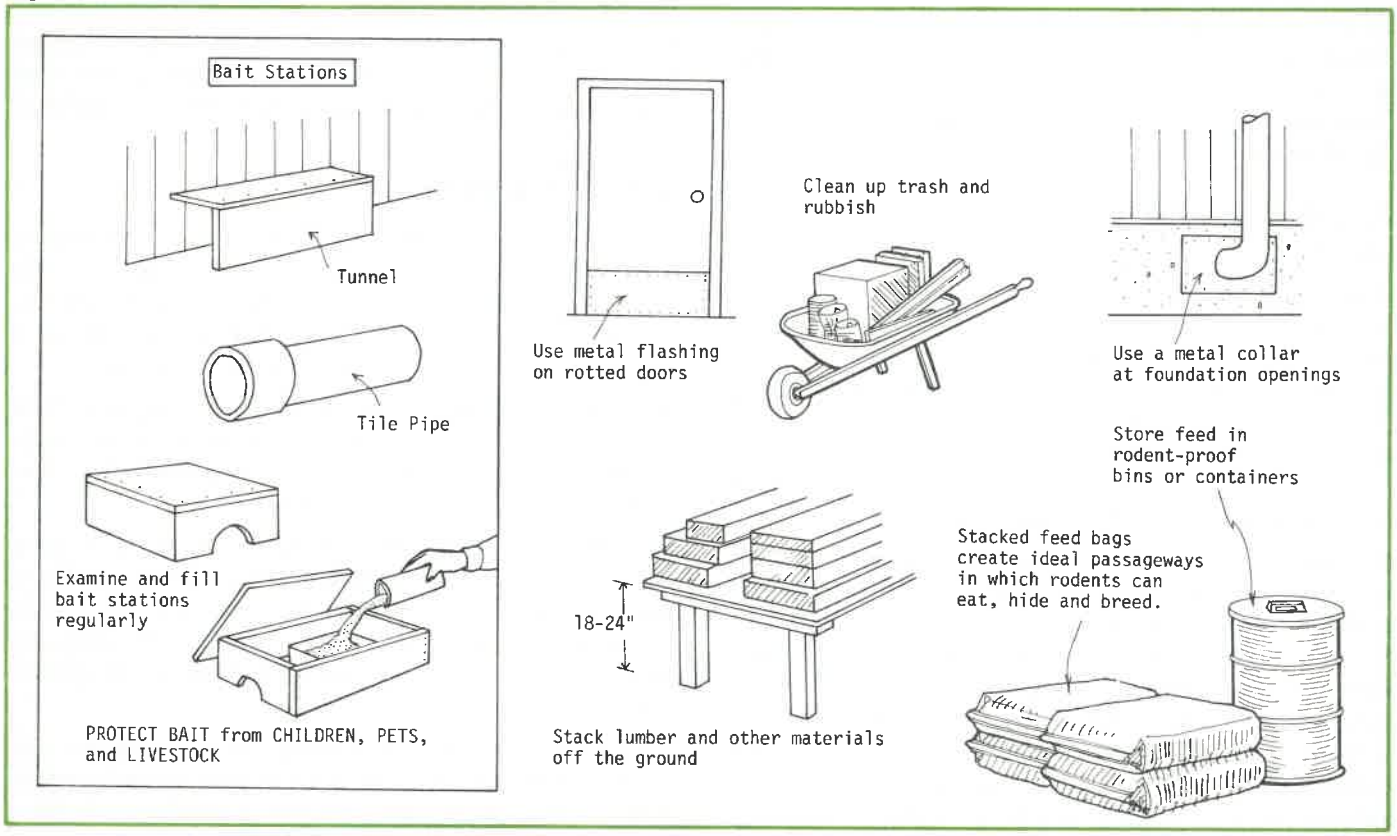
Rats and mice eat and contaminate feed, damage buildings, kill young chickens and spread many diseases and parasites. Concrete foundations and floors help deter rats.

In feed rooms and chicken coops, use metal shields at doors and screens over small openings. Stacked feed bags create ideal passageways in which rodents can eat, hide and breed. Store feed in rodent proof bins or containers. A 30 gallon drum or trash can will hold a 100 pound sack of feed. Feed from these containers rather than from open bags. Clean up all spilled feed immediately.

Areas under feedbunks are excellent breeding grounds for rodents. Design feedbunks to eliminate spaces beneath the bunk floor, or so that such areas can be easily cleaned.

Clean out trash, dumps, piles of old lumber or manure and garbage where rats and mice hide. Trim weeds around buildings. Clean corners inside buildings and crevices behind boxes along walls. Block any runs or burrows you may find and then set traps or use a poison. One permanent poison feeder kept stocked with bait will help keep mice and rats under control. Maintain a year-round poison bait program.

Figure 49. Rodent Control.



Insulated buildings with wall cavities, attics, and false ceilings are other good hiding spaces for rodents. Even though most insulation has no food value to rodents, considerable damage is often done by burrowing, chewing, and nesting. Install interior and exterior wall sheathings so there are no openings into the wall cavity. Block corrugated metal siding at the edges to prevent rodent access, and leave no exposed wood that rodents can chew to gain access. Leave no opportunity on side or end walls for rats or mice to reach attic spaces. Seal false ceilings and crawl spaces. Keep in mind that young mice can squeeze through a crack as narrow as a quarter inch.

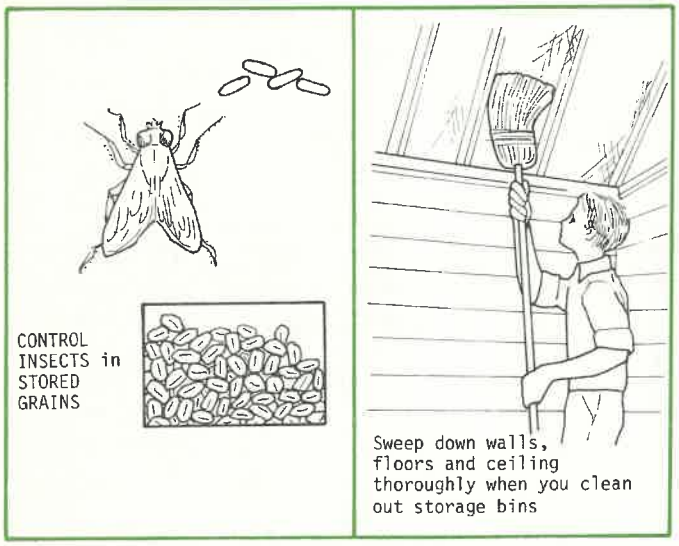
Barn cats help discourage rodents. However, cats treated as pets often become lazy if they are overfed. Sometimes cats develop a liking to field mice and will stalk them rather than barn mice.

FLY and INSECT CONTROL

Fly and insect problems are primarily caused by on-farm conditions such as manure piles, stagnant pools of water, spilled milk and damp corners which offer breeding places for insects during the warm summer months. Slope barn lots to drain without pooling water. A minimum recommended slope is 4′ in 100′ of lot length. Clean all fluid spills in the barn. Use concrete floors and walls wherever frequent washing and cleaning is necessary for sanitation.

Stored grains and feed provide breeding places for many kinds of insects, especially when moisture is present in amounts to cause mold, mildew, and caking. Store grains and feed at safe moisture content, in dry and tightly constructed bins, and do not store feeds beyond their shelf life. Keep dust and feed cleaned out of corners and dark areas. Occasionally, clean grainery and/or feed room if infested and fumigate to keep insect population under control. Consult your local Cooperative Extension office for information on currently recommended chemicals.

Figure 50. Fly and Insect Control.



DEAD ANIMAL DISPOSAL

Every livestock operation, no matter how carefully managed and operated, occasionally has the problem of dead animal disposal. Most states restrict disposal methods. Acceptable methods usually include:

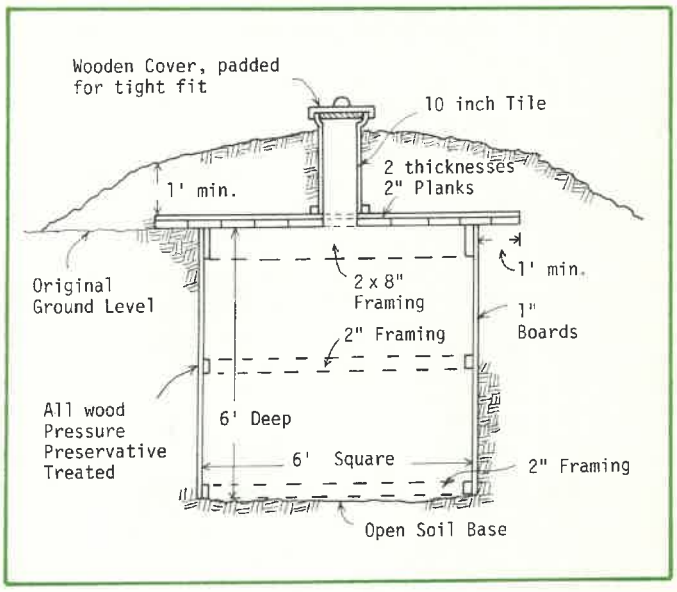
- A licensed disposal plant.
- Burying, with all parts of the animal covered with at least 4 feet of earth.
- Burning outside city limits if not in violation of local ordinances.
- Other methods approved by the State Veterinarian.

Dispose of dead animals as though an infectious agent were present. If insects, animals or birds feed on dead animals, they may contract disease or spread infections such as blackleg, anthrax, TGE, salmonellosis, etc.

Water drainage may also spread infections. Outbreaks of leptospirosis, etc., have occurred on farms downstream from farms experiencing these diseases.

See Figure 51 for a burial pit for smaller animals and poultry, if local regulations allow. Locate pits in a well drained area not subject to flooding and at least 100′ from any water supply.

Figure 51. Burial Pit for Small Animals and Poultry (if local regulations allow).



VII —Fencing

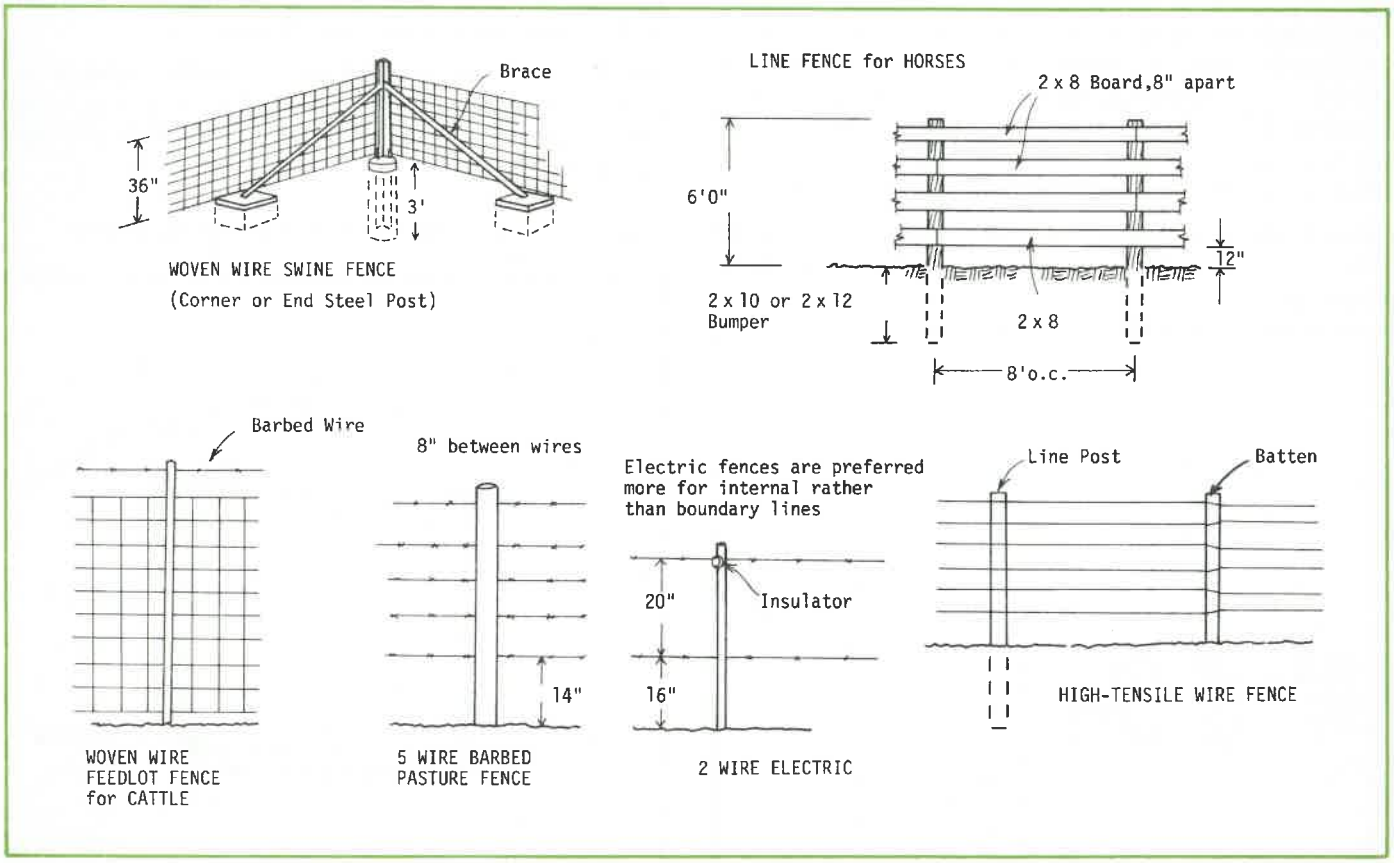
Large livestock operations with confined housing and feedlots use minimum fencing, but for small scale livestock farmers, fencing is often a major cost and structural undertaking. Fencing may be used to confine livestock, to protect or divide property, and to improve property appearance. Selection of fencing is based on its purpose, the cost and personal preference. The kinds of fencing commonly used include boards, woven wire, barbed wire, high-tensile wire and electric fence. (Figure 52)

Strong fences, such as high-tensile or woven wire or plank are commonly used to contain livestock, in corrals, feedlots and other areas where livestock are closely confined and may subject the fence to considerable pressure. Board fences, though expensive, can be very attractive as well as functional, and are often used on horse farms. Cable fencing or high-tensile fencing is excellent for feedlots and similar areas where unrestricted air circulation results in maximum cooling of the animals in warm weather.

HIGH-TENSILE WIRE FENCING

High-tensile wire fencing, developed in New Zealand, represents the most up-to-date fencing technology for livestock. American manufacturers and suppliers now provide materials for this type of fence design. Properly installed, this type of fence will last 20 years or more with low maintenance. The 10-wire design makes a reliable perimeter fence for sheep and cattle at a material and labor cost about half to two thirds the cost of an equivalent woven wire fence and about the same cost as 5 strands of barbed wire with similar end and corner post design. Its

Figure 52. Types of Livestock Fencing.



other advantages are its neat appearance, its adaptability to specific needs and its minimum damage to livestock hides.

Smooth 11 to 14 1/2 gauge wires are held in tension along pressure treated wood or fiberglass posts or a combination of posts and battens or droppers. The fence can withstand over 1200 pounds of livestock pressure or low temperature contraction without losing its elasticity, yet it is flexible enough to bend, wrap and tie in knots or clamp with crimping sleeves. The high-elastic limit of high-tensile wire reduces the stretch or sag problems associated with conventional wire fence. Since each strand is stretched to maintain 200-250 lbs of tension, sturdy well-braced corner and end posts are absolutely necessary. Line posts are smaller because they mainly serve to hold up the line. Tension in the wire is maintained by permanent in-line stretchers or tension springs. (Figure 53)

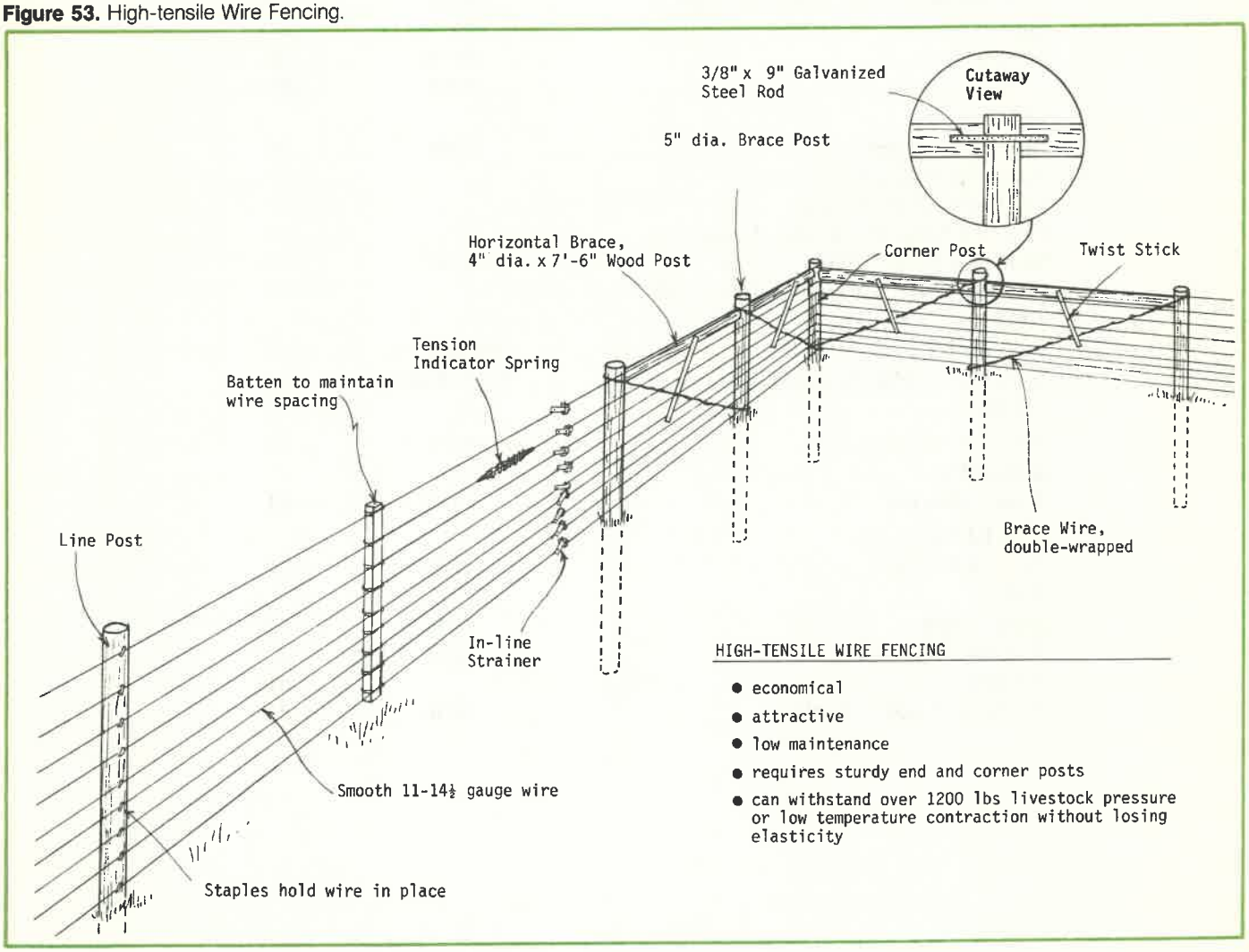
Designs for high-tensile fence systems of 6 to 10 or more strand non-electric and 1 to 5 or more strand electric fence are available for all kinds of livestock. Wire spacing and design depends on the kind of livestock to be contained or predators excluded. Section II outlines some specific fence requirements for individual animal species and poultry.

High-tensile Electric Fences

Electric fence works best as an internal division fence for pasture management or supplemental to perimeter fences for greater reliability or predator control. While electric fence is economical to install, maintenance has been a real problem as it was impossible to energize long runs without causing grass fires and related problems. Recent innovations in fence charger design and fence construction now make long runs of electric fence possible with low impedance, high voltage chargers with solid state electronics to electrify permanent fences without losing voltage or causing grass fires. This allows less maintenance in mowing grass under fence lines. Grounding is very important with these chargers.

Electric fences should be clearly identified with signs; often this is required by law. Electric fences, particularly near highways, are preferred more for internal rather than boundary lines.

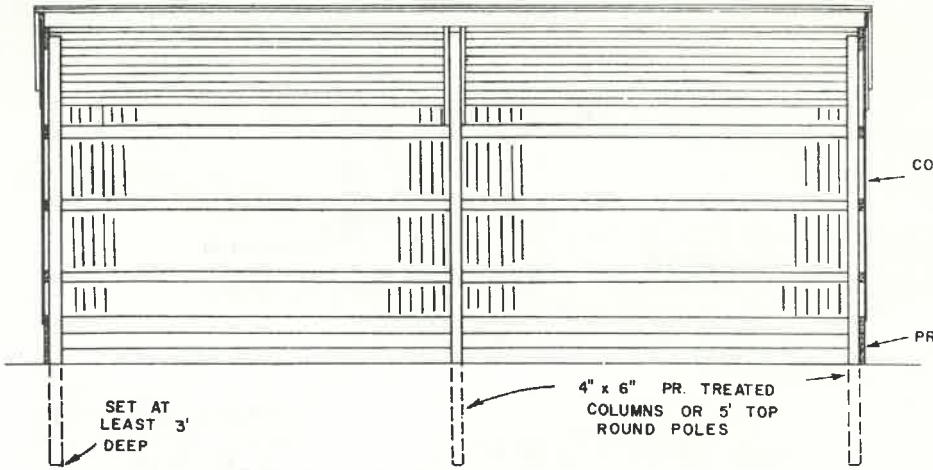
Figure 53. High-tensile Wire Fencing.



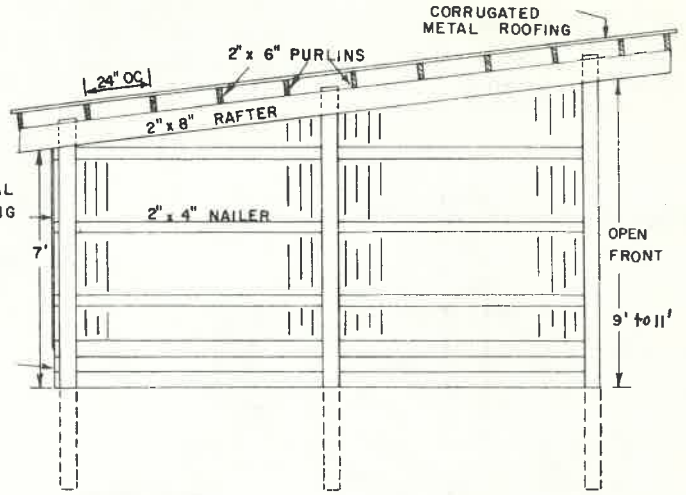
VIII—Plans

The following plans are a selection from the many plans available from the Extension Agricultural Engineer at your state Land Grant University.

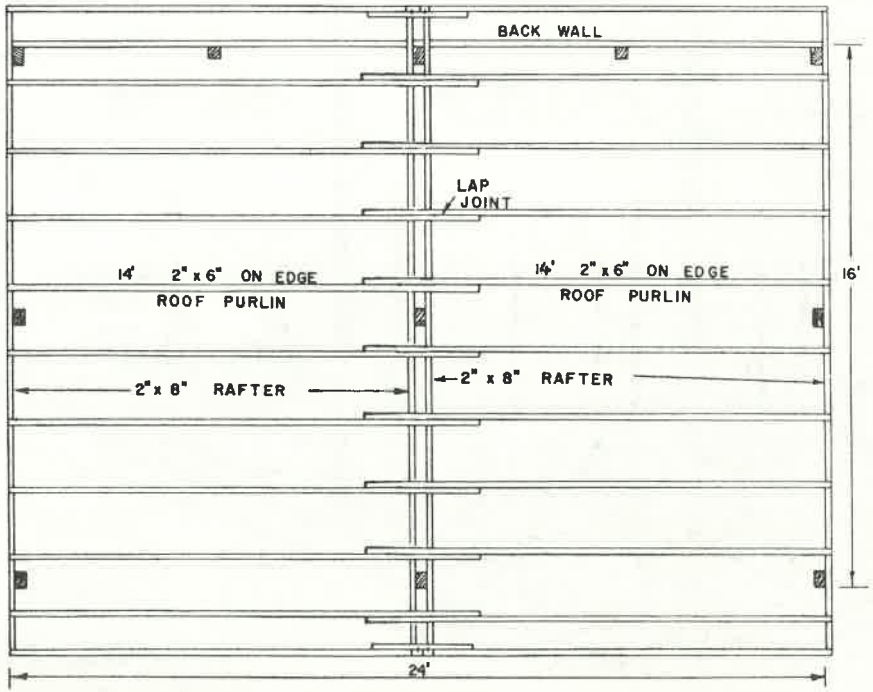
Fasten purlins with Sheet
Metal Framing Anchors



FRONT VIEW



END VIEW

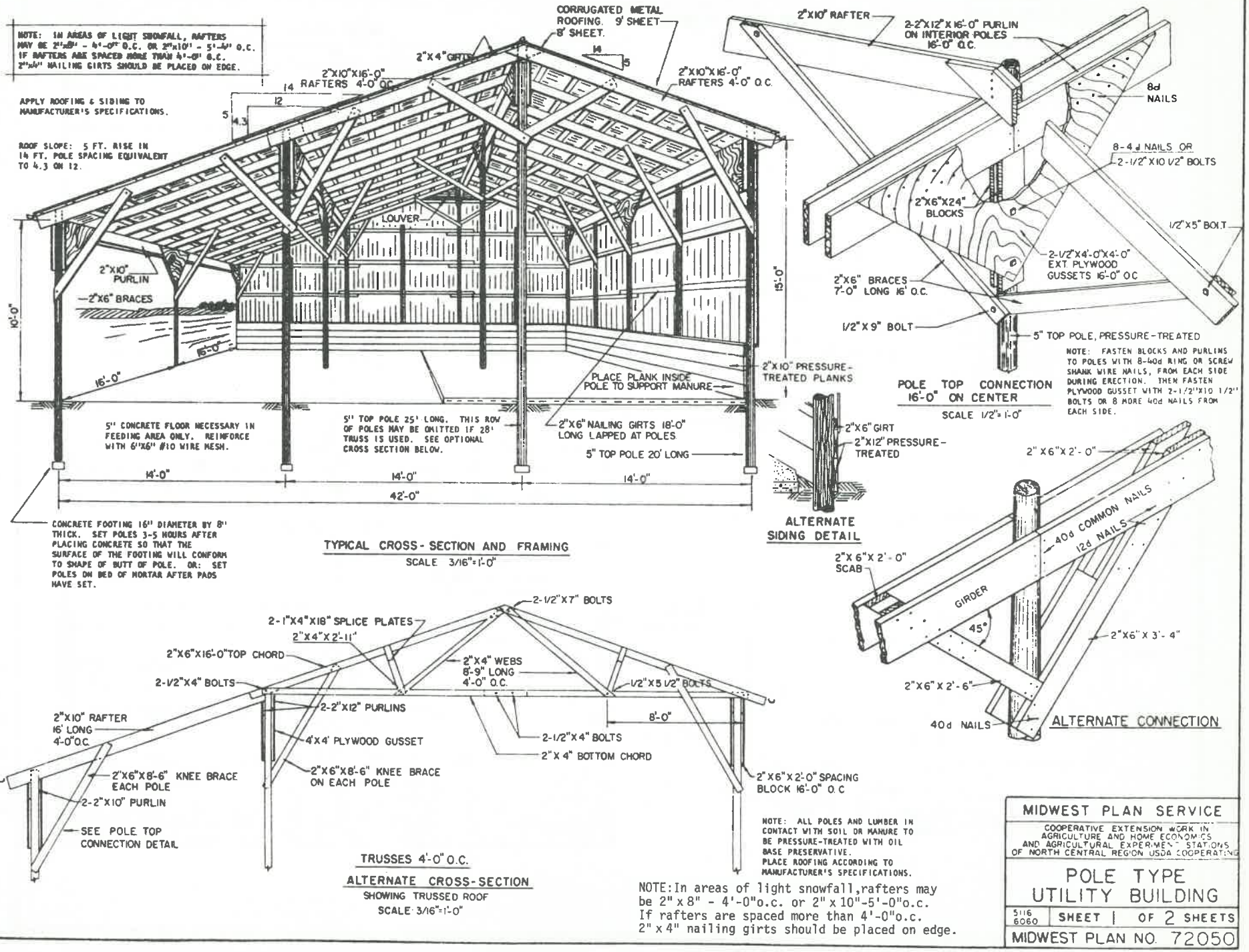


PLAN VIEW

PERSPECTIVE

Maximum Roof Load = 30 psf.

POLE TYPE UTILITY SHED			
DRN BY: ARG TRD BY: AKG DATE: 5-74	Penn. 721-65	SHEET 1 OF 1



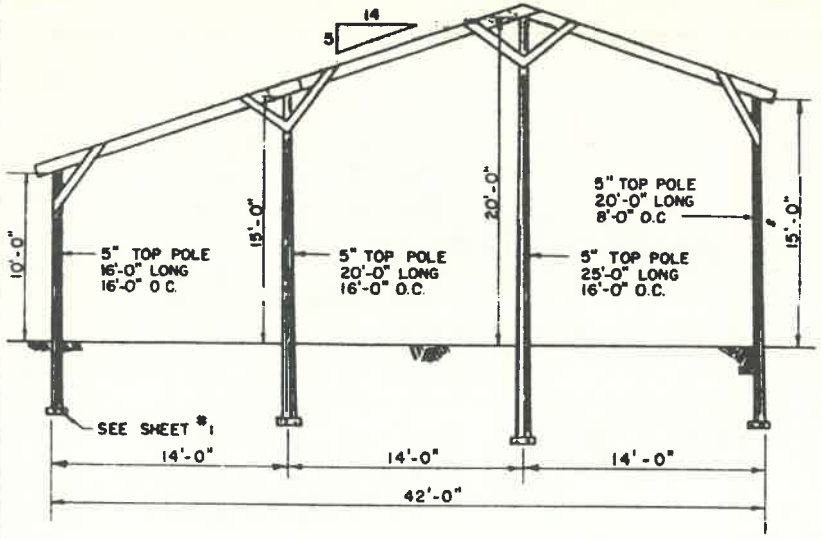
MIDWEST PLAN SERVICE

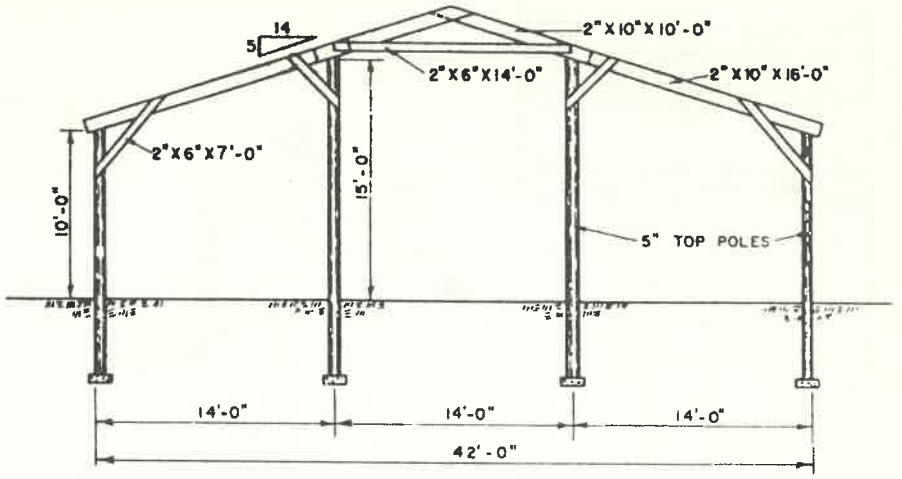
COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS AND AGRICULTURAL EXPERIMENT STATIONS OF NORTH CENTRAL REGION USDA COOPERATING

POLE TYPE UTILITY BUILDING

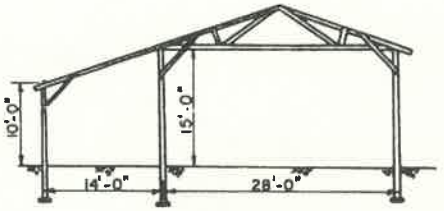
5116 6060 | SHEET 1 OF 2 SHEETS

MIDWEST PLAN NO. 72050

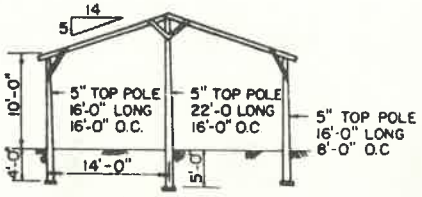




DEPTH OF POLES, FEET		
POLE LENGTH FEET	SOFT SOILS	ORDINARY & FIRM SOILS
UP TO 16	4 1/2	4
UP TO 20	5	4 1/2
UP TO 25	5 1/2	5
UP TO 30	6	5 1/2



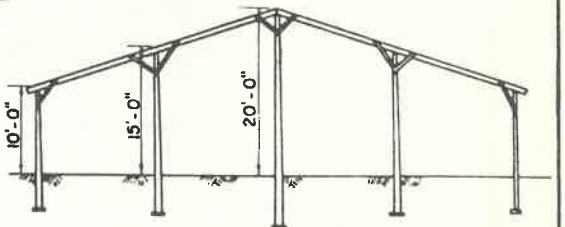
42' TRUSSED ROOF



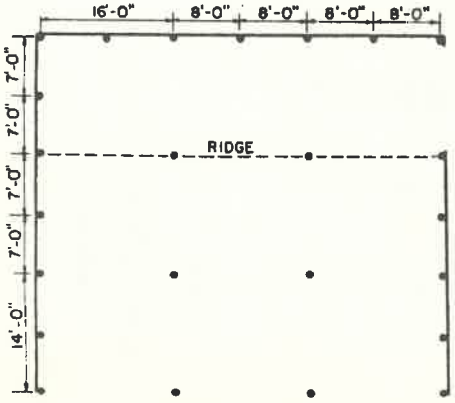
28' GABLE ROOF

ALTERNATE CROSS SECTIONS

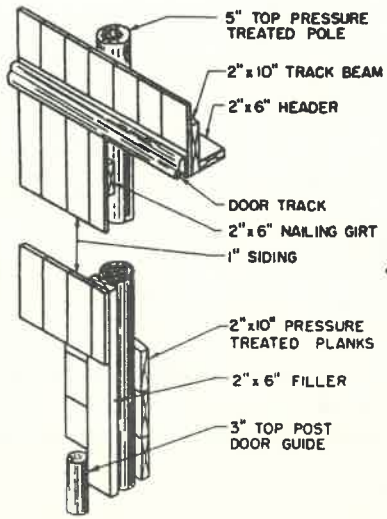
FOR MEMBER SIZES, JOINT DETAILS, AND BRACING REQUIRED, SEE SHEET #1



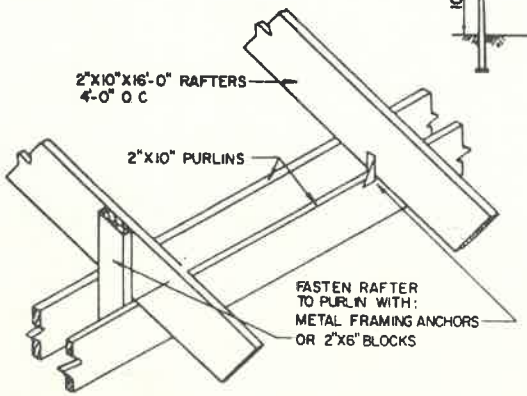
56' GABLE ROOF



TYPICAL FLOOR PLAN, 42' x 48'



DOORWAY FRAMING
SCALE 1/2" = 1'-0"



RAFTER TIE DETAILS
SCALE: 1/2"=1'-0"

MIDWEST PLAN SERVICE

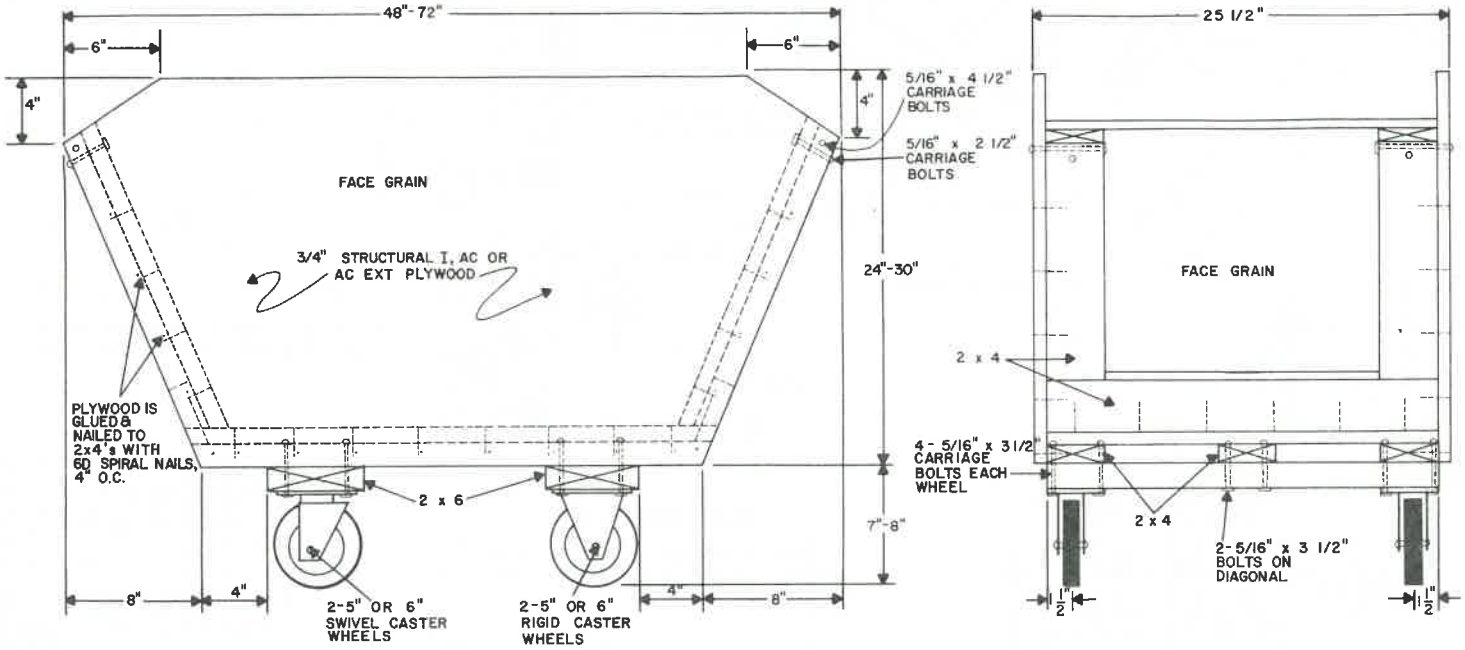
COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS AND AGRICULTURAL EXPERIMENT STATIONS OF NORTH CENTRAL REGION-USDA COOPERATING

POLE TYPE UTILITY BUILDING

5116 6060 | SHEET 2 OF 2 SHEETS

MIDWEST PLAN NO. 72050

FEED CART



SIDE VIEW

END VIEW

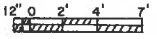
BILL OF MATERIALS

LUMBER AND OTHER CONSTRUCTION MATERIALS:

NUMBER OF PIECES	DIMENSION	GRADE AND KIND	USE
2 (48" CART) 3 (72" CART)	3/4" x 4' x 8' " " "	STRUCTURAL I, AC OR AC EXTERIOR " " " " " "	SIDES, ENDS, BOTTOMS " " "
2 (48" CART)	2 x 4 x 10'	CONSTRUCTION OR NO. 1 FIR	FRAMING
1 (72" CART)	2 x 4 x 12'	" " " " "	"
1 (72" CART)	2 x 4 x 14'	" " " " "	"
1	2 x 6 x 4'	" " " " "	"

FASTNERS AND OTHER HARDWARE:

AMOUNT	SIZE	ITEM
2	5" OR 6" DIAMETER, 400 LBS CAPACITY SWIVEL CASTER	WHEELS
2	5" OR 6" DIAMETER, 400 LBS CAPACITY RIGID CASTER	WHEELS
20	5/16" x 3-1/2" CARRIAGE, WITH WASHERS	BOLTS
4	5/16" x 4-1/2" " " "	"
4	5/16" x 2-1/2" " " "	"
1-1/2 LB	6d SPIRAL	NAILS
1/2 PT	RESORCINOL (WATERPROOF)	GLUE



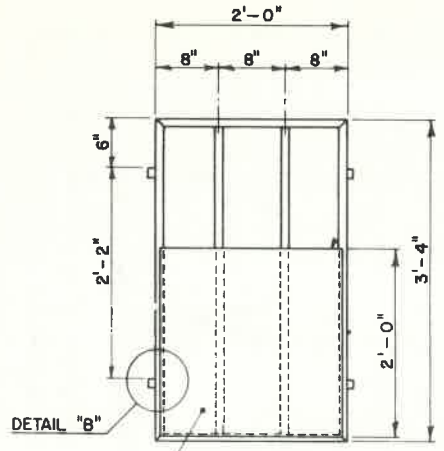
SCALE

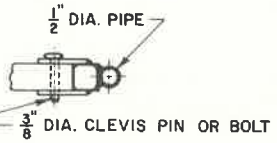
COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS

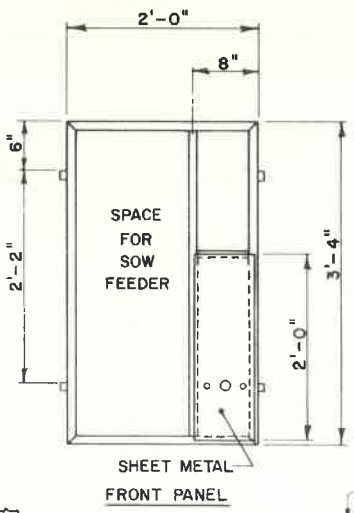
AND UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

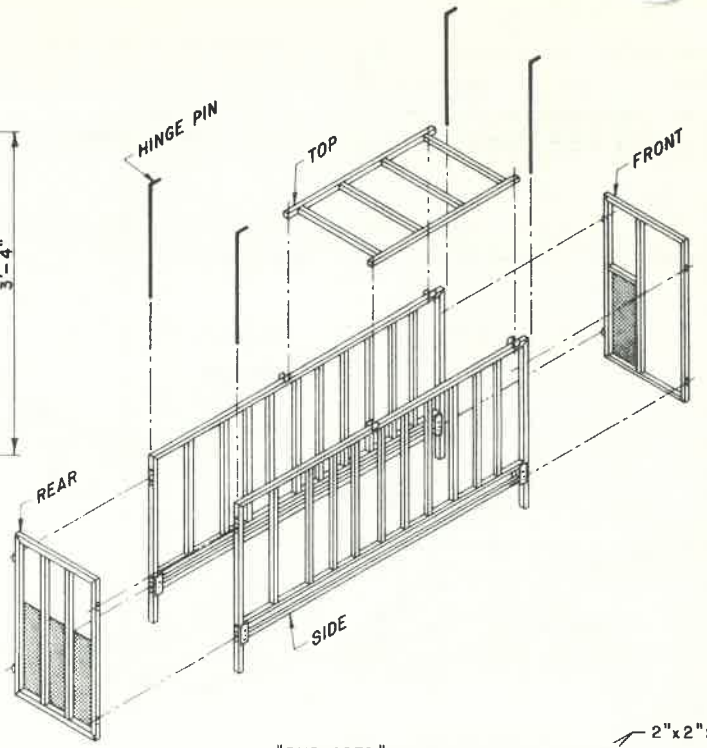
FEED CART

NY '82	EX. 6343	SHEET 1 OF 1

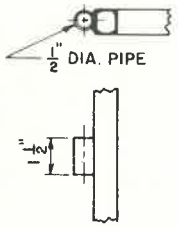




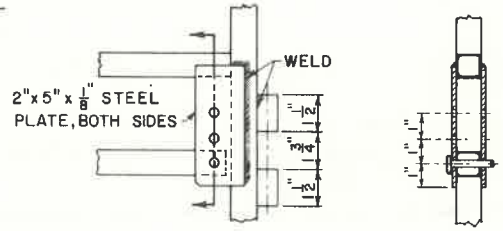




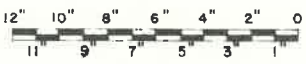
"EXPLODED" ISOMETRIC

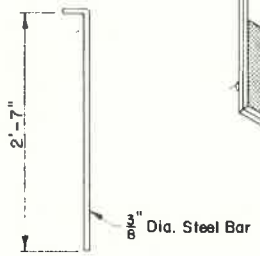


DETAIL "B"

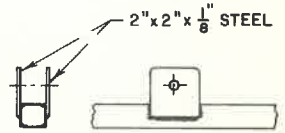


DETAIL "A"

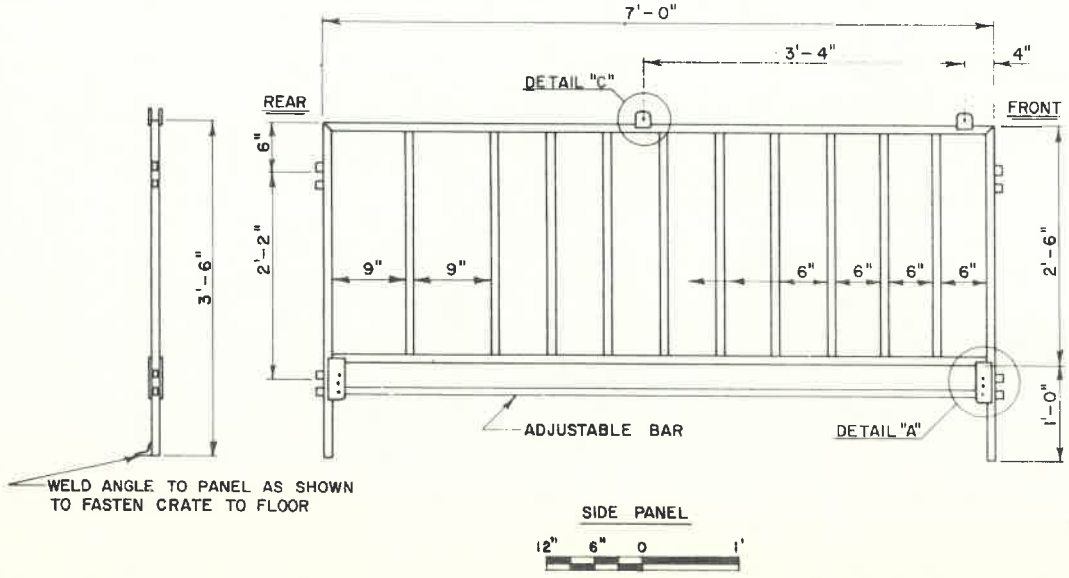




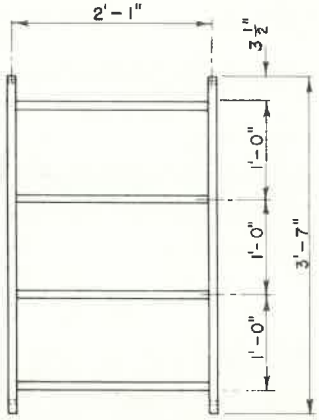
HINGE PIN



DETAIL "C"



SIDE PANEL



TOP PANEL
(OPTIONAL)

BASED ON: OKLA. STATE UNIV.
PLAN NO. OK-726-23

NOTE:
Unless Otherwise Noted All Material Used Is
1" Square Steel Tubing

BILL OF MATERIAL (Per Crate)

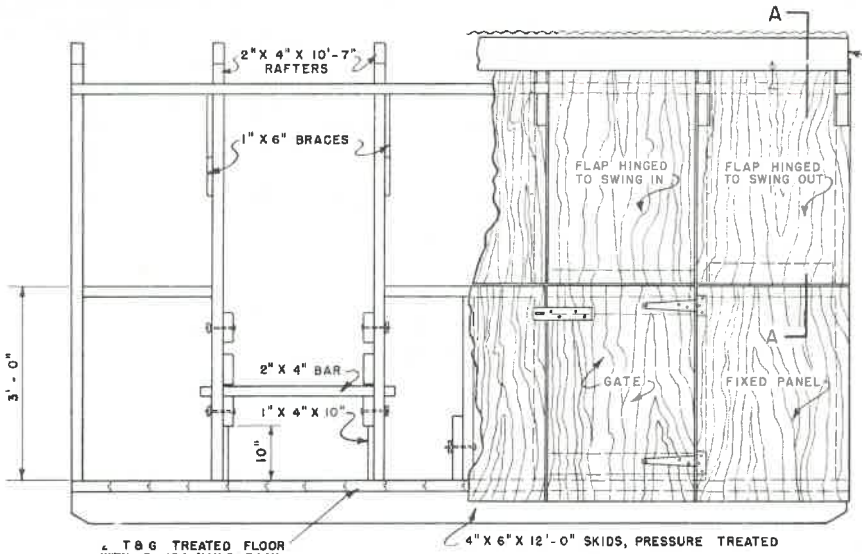
ITEM	REQ'D
1"x16 Ga. Sq. Tubing	160'
1/8"x2" Flat Bar	5'
16 Ga. Sheet Steel	2'x3'
1/2" Dia. Pipe	3'
3/4" Dia. Round Bar	12'
3/8" Dia. Clevis Pin	8

COOPERATIVE EXTENSION WORK IN
AGRICULTURE AND HOME ECONOMICS

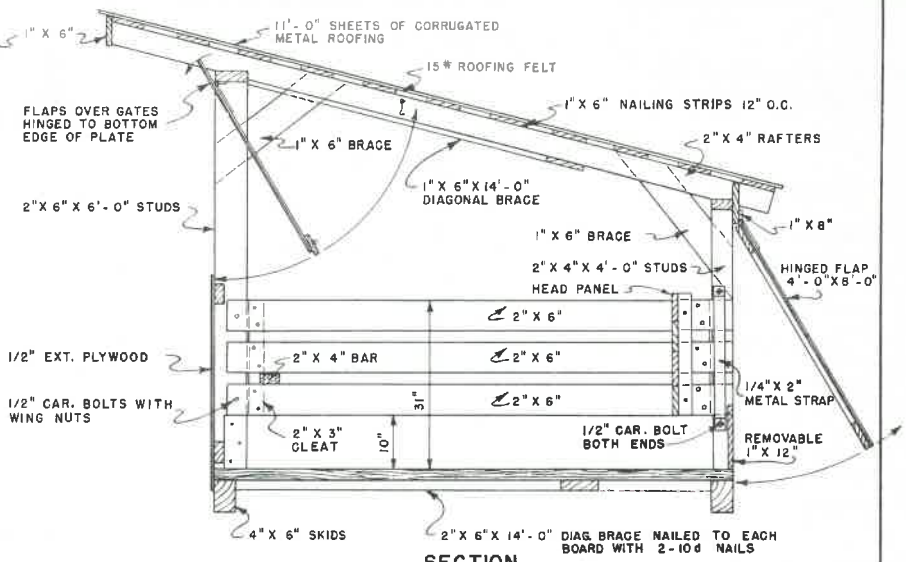
AND
UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

FARROWING STALL
KNOCK DOWN TYPE

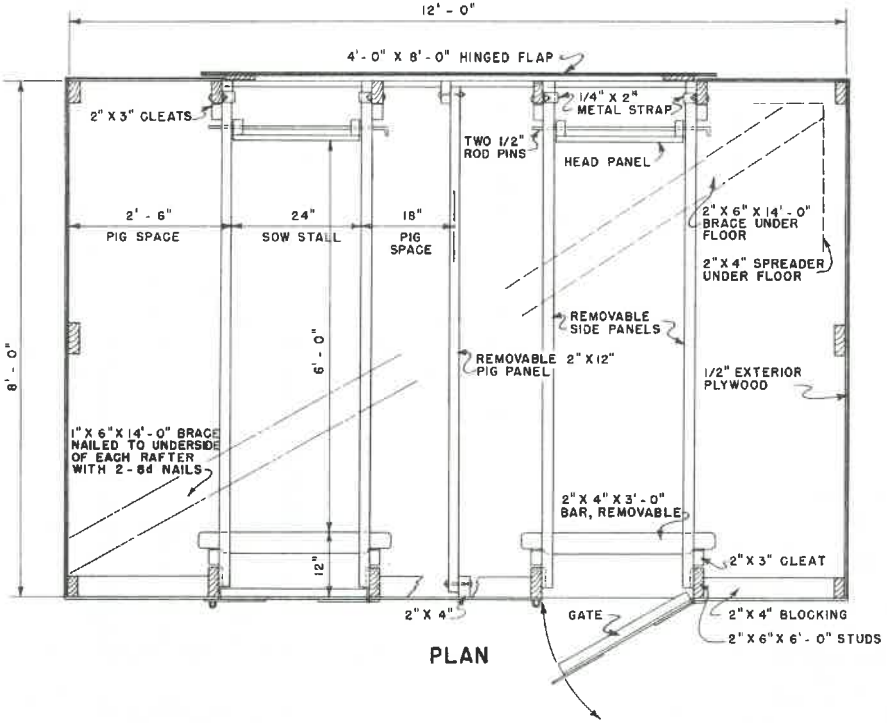
OK. '76	6243	SHEET 1 OF 1



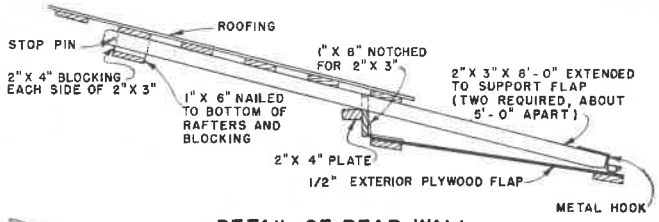
FRONT ELEVATION
(CUT AWAY TO SHOW FRAMING)



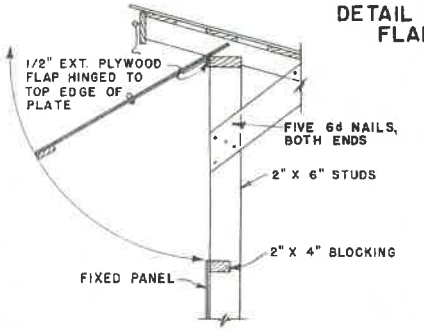
SECTION
(THRU FARROWING STALL)



PLAN



DETAIL OF REAR WALL FLAP SUPPORT



SECTION A-A
(FLAP OPEN)

SCALE: 0 1 2 FT.

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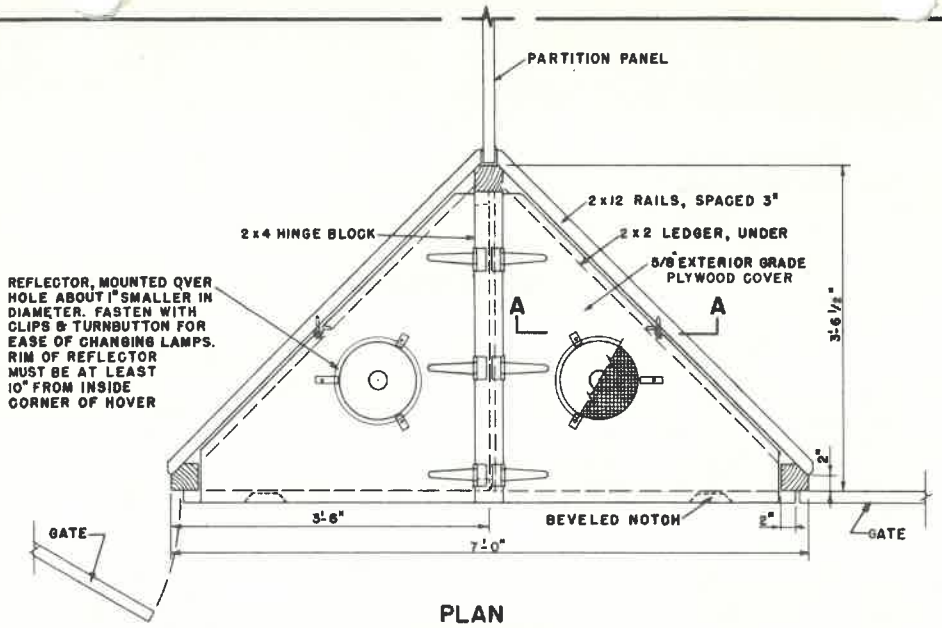
TWO PEN MOVABLE HOG HOUSE WITH TWO REMOVABLE FARROWING STALLS

USDA '56	EX. 5821	SHEET 1 OF 1

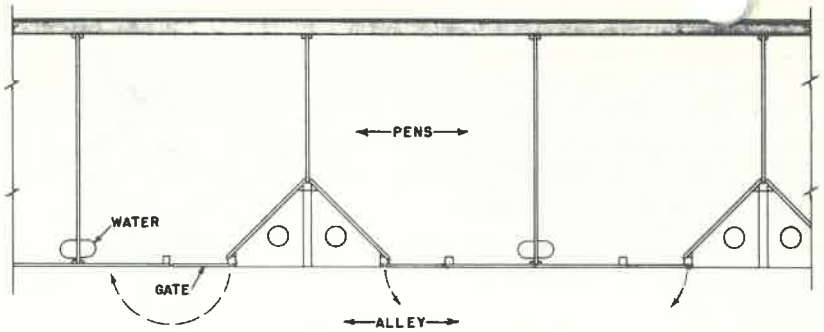
09



PLAN

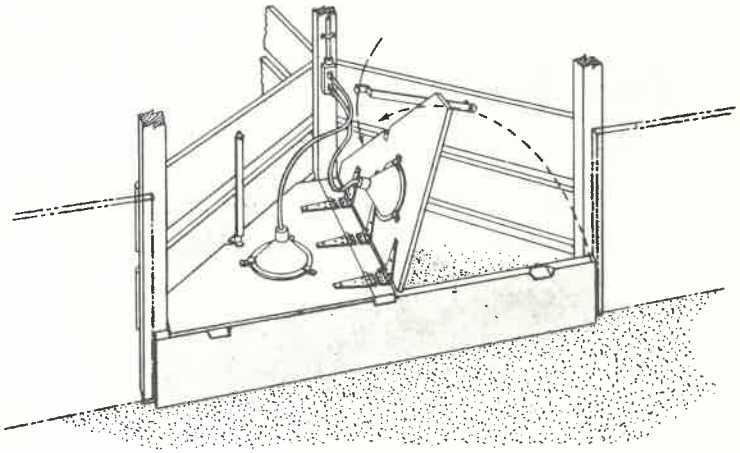
DOUBLE UNIT FOR TWO PENS

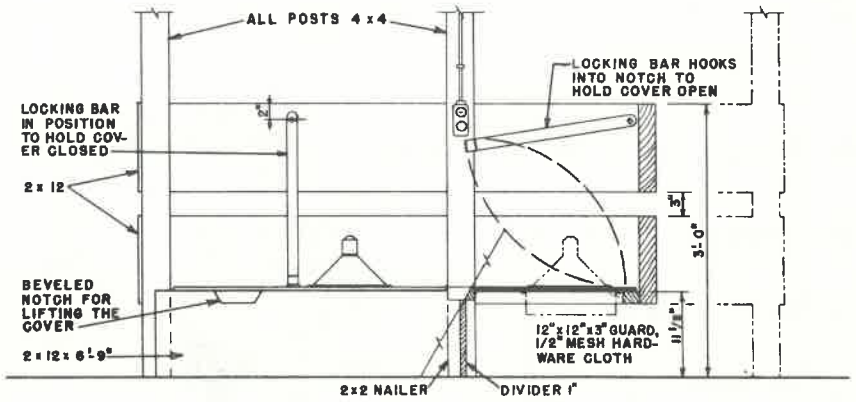
0 1 FT.



PEN ARRANGEMENT

0 2 4 6 FT.

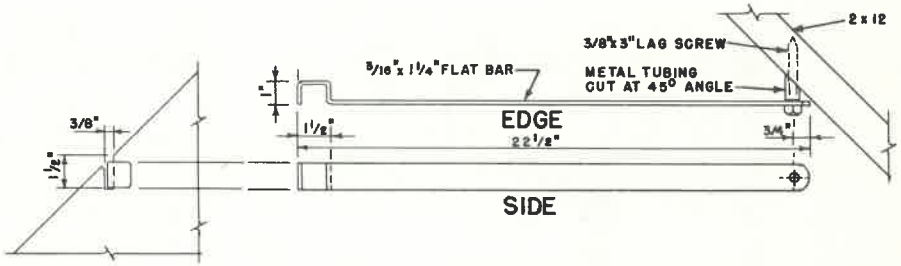




ELEVATION

CUT-AWAY AT A-A TO SHOW CONSTRUCTION

0 1 FT.



SIDE

SHOWING NOTCH IN COVER PANEL FOR LOCKING BAR

LOCKING BAR DETAILS

HOLDS COVER OPEN OR CLOSED

GENERAL HOG HOUSE WIRING RECOMMENDATIONS

1. USE No. 12 A.W.G. TYPE UF, NON-METALLIC SHEATHED CABLE WITH GROUND WIRE.
2. DO NOT USE MORE THAN 16 LAMPS (8 DOUBLE UNIT BROODERS) PER 20 AMPERE CIRCUIT.
3. USE ONLY GROUNDED TYPE DUPLEX CONVENIENCE OUTLETS.
4. REFLECTORS MUST BE FITTED WITH PORCELAIN RECEPTACLES WITHOUT SWITCHES WITH COVERED TERMINALS OR PIGTAILS CONNECTED TO OUTLET WITH No. 16, TYPE HSJ RUBBER COVERED CORD.
5. PERMANENT AND MOVABLE BUILDINGS MUST HAVE PROPERLY FUSED SERVICE ENTRANCE BOXES.
6. THESE RECOMMENDATIONS ARE SUBORDINATE TO LOCAL REGULATIONS.

RECOMMENDED INCANDESCENT LAMP SIZES

MILD WEATHER	60 WATT
COLD WEATHER	100 WATT
VERY COLD WEATHER	150 WATT (MAX.)

CAUTION: DO NOT USE INFRARED LAMPS!

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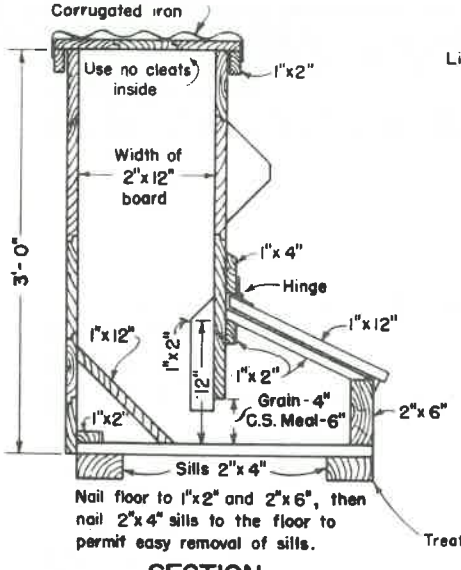
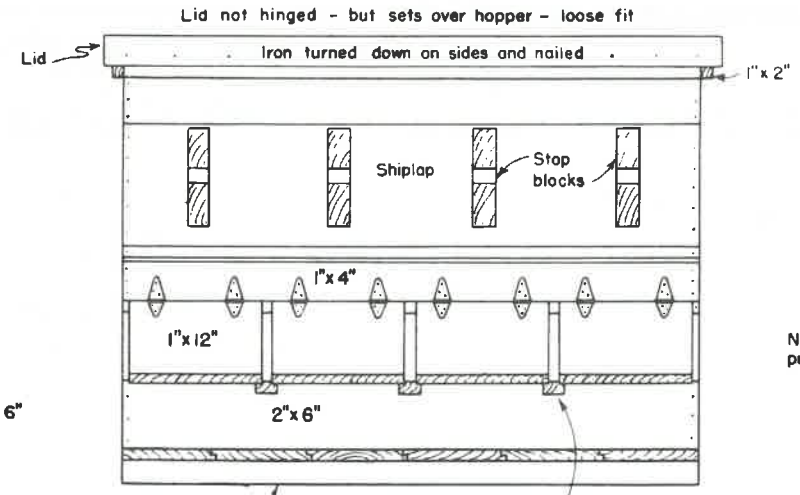
ELECTRIC BROODER FOR PIGS
HOVER TYPE... FOR INCANDESCENT LAMPS

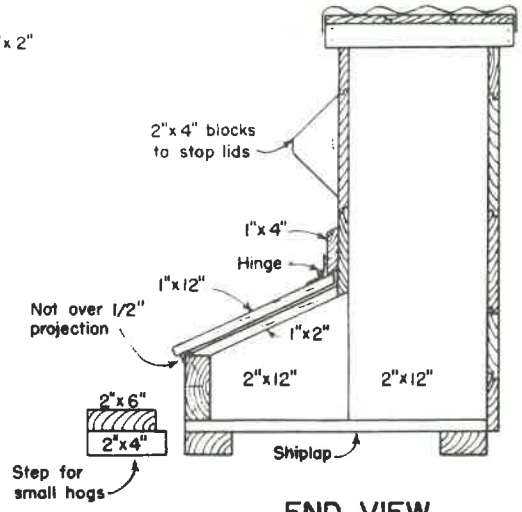
USDA '60	EX. 5907	SHEET 1 OF 1



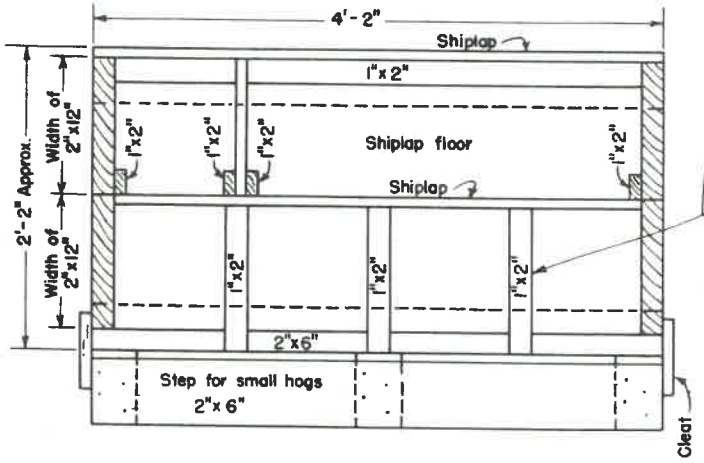
SECTION



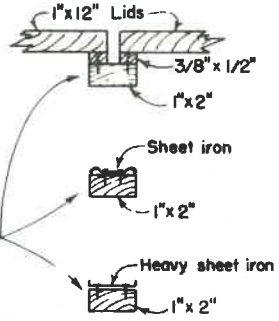
FRONT VIEW



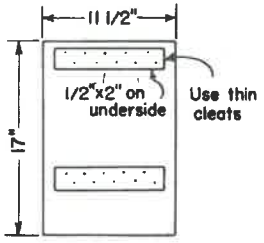
END VIEW



FLOOR PLAN



Three ways of rainproofing trough divider strips. Sections of 1"x2"s shown.



TROUGH LIDS

BILL OF MATERIAL

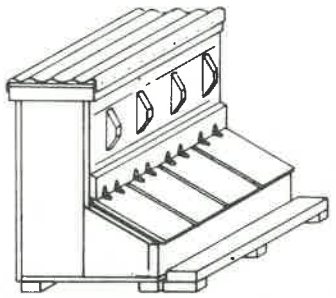
(Fir lumber is easier to work than hard pine.)

- 1 - 2"x4"x10'
- 1 - 2"x12"x8'
- 1 - 2"x6"x9'
- 1 - 1"x12"x14'
- 3 - 1"x2"x12'
- 1 - 1"x4"x4 1/2'
- 1 - 1/2"x2"x8'
- 1 - 3/8"x1/2"x10'

45 board feet shiplap (to cut 4'-2" and 2'-2")
1 piece sheet iron 2'x4'-9"
4 prs.-4" strap-hinges (heavy)
Paint, 1/4 gal.
Nails, 16d, 8d, 6d, 4d, 3d

NOTE:
Place feeders back to back for double feeder.

Scale: 0 1FT.



PICTORIAL

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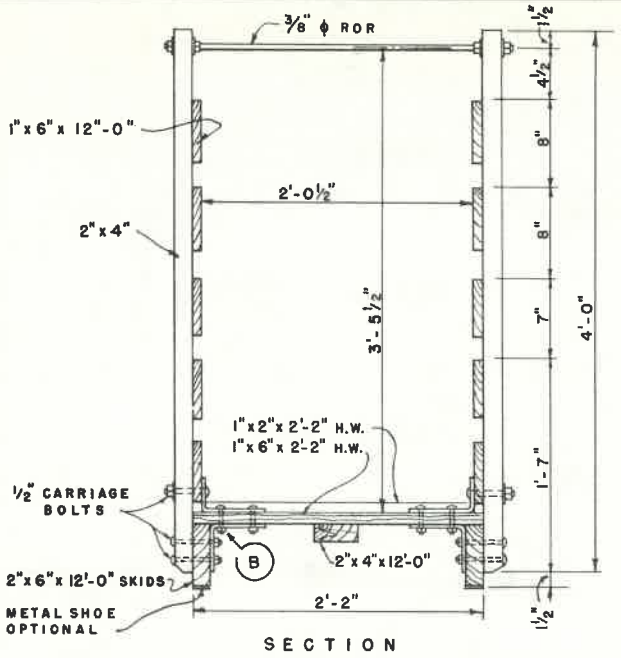
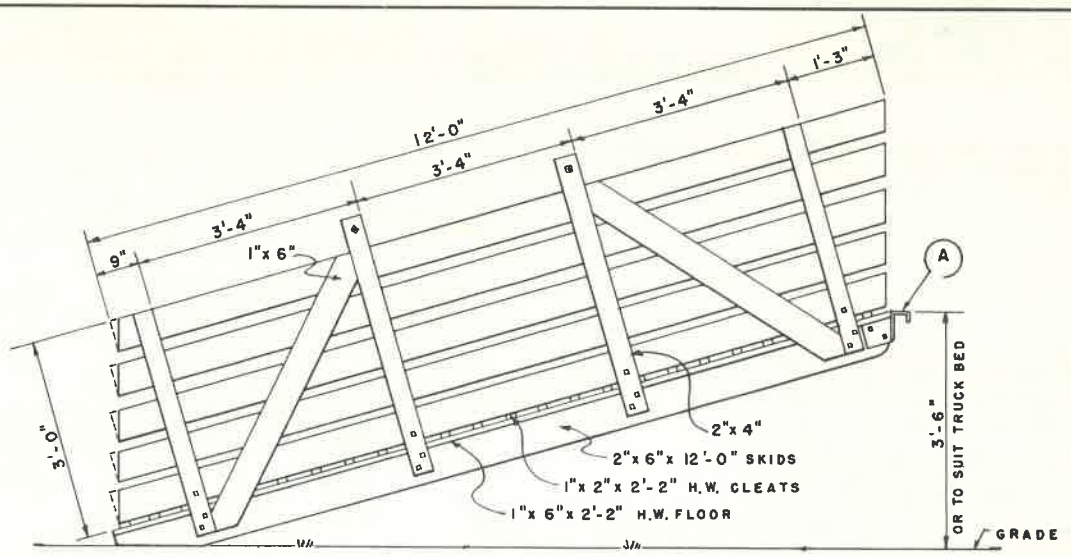
SELF - FEEDER FOR HOGS

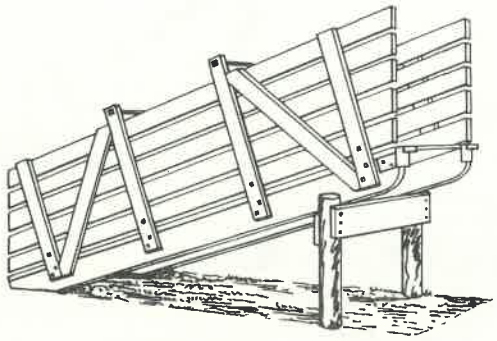
TEX. | EX. 5756 | SHEET 1 OF 1



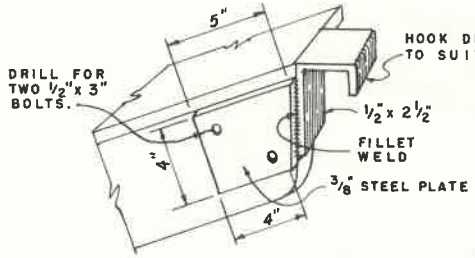
SECTION



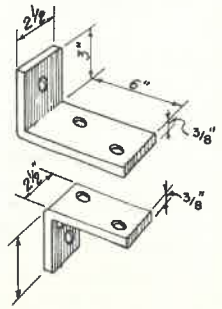
ELEVATION



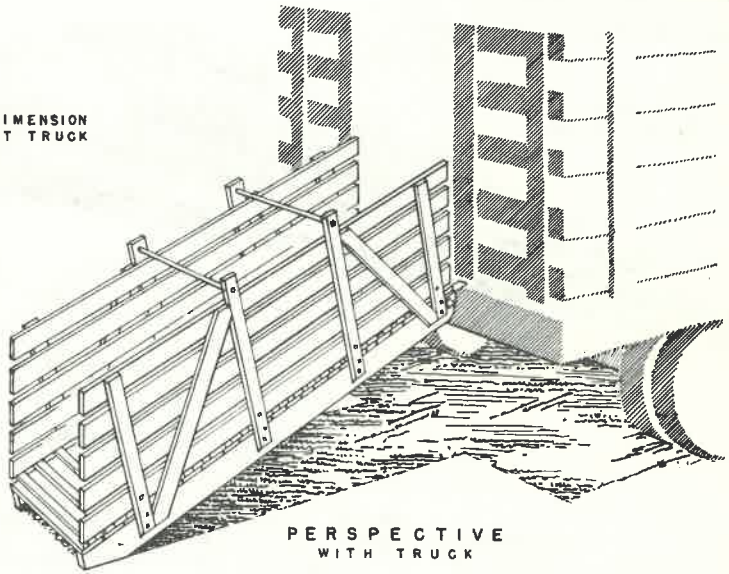
PERSPECTIVE
SEMI-PERMANENT INSTALLATION



METAL HOOK
DETAIL "A"
2 REQ'D., ONE RIGHT & ONE LEFT.



STEEL ANGLES
DETAIL "B"
8 OF EACH REQUIRED



PERSPECTIVE
WITH TRUCK

NOTE:-
IT IS RECOMMENDED THAT ALL WOOD BE TREATED WITH WOOD PRESERVATIVE AFTER CUTTING.

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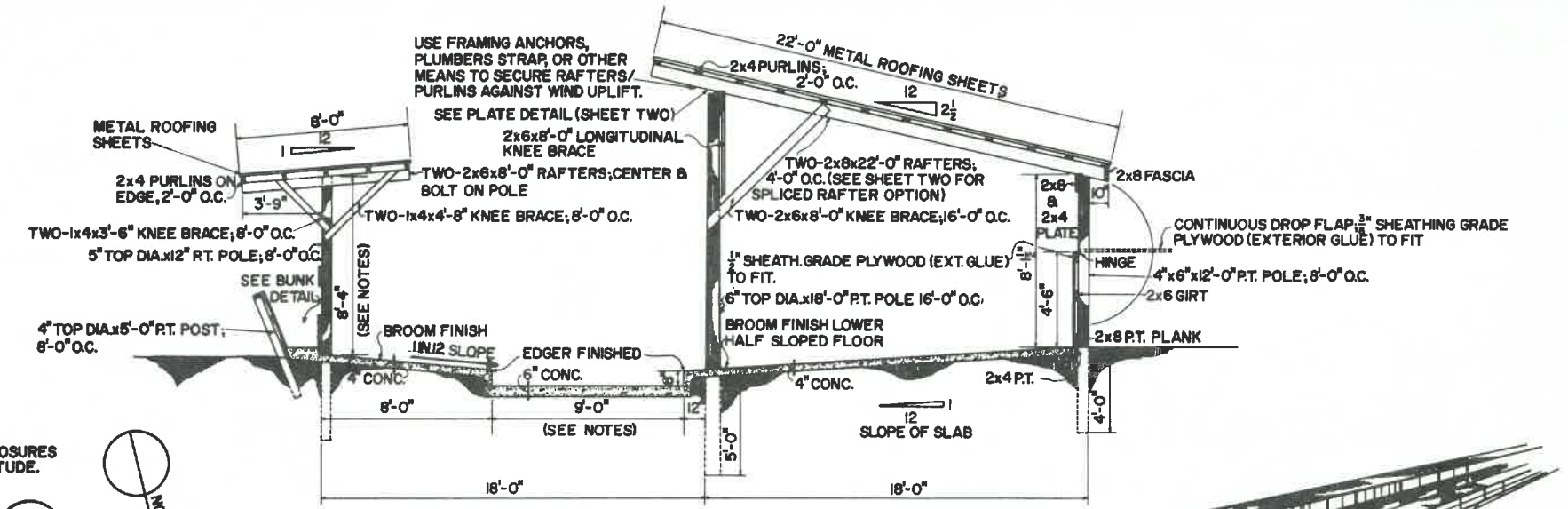
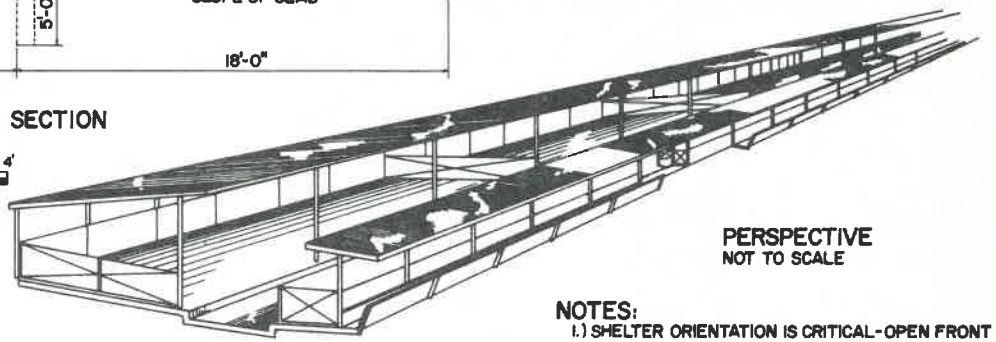
PORTABLE LOADING CHUTE FOR HOGS

USDA '54	EX. 5799	SHEET 1 OF 1

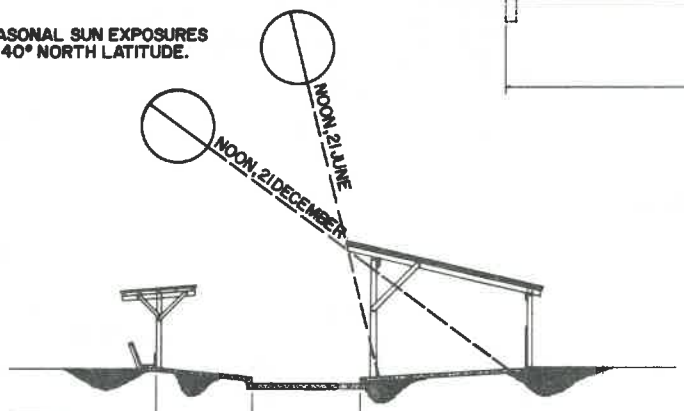


CROSS SECTION
SCALE.
12" 0 1' 2' 3' 4'
6"

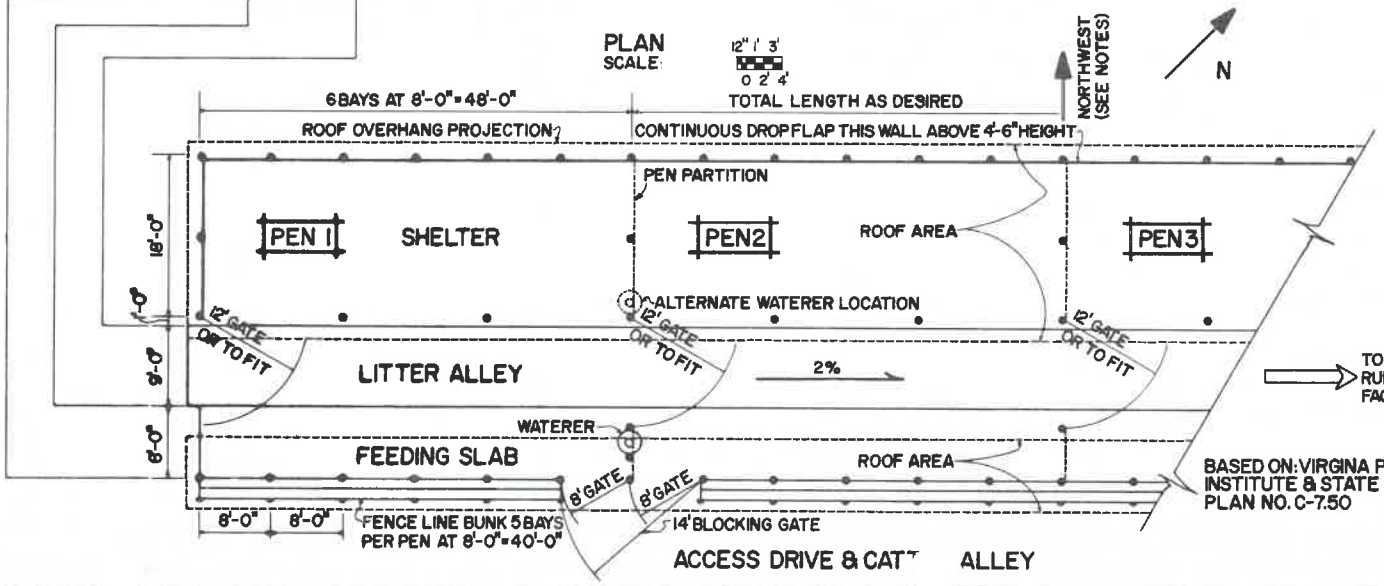


PERSPECTIVE
NOT TO SCALE

SEASONAL SUN EXPOSURES AT 40° NORTH LATITUDE.



PLAN
SCALE:
12" 1' 3'
0 2' 4'



TO MANURE & RUNOFF HANDLING FACILITIES

BASED ON: VIRGINA POLYTECHNIC INSTITUTE & STATE UNIVERSITY PLAN NO. C-7.50

NOTES:

1.) SHELTER ORIENTATION IS CRITICAL - OPEN FRONT SHOULD FACE TO SOUTHEAST.
2.) SLOPED FLOOR AREAS ARE SELF-CLEANING NO BEDDING IS REQUIRED.
3.) IT MAYBE NECESSARY TO INCREASE BUNK ROOF CLEARANCE FOR FEED WAGON PASSAGE-MEASURE EQUIPMENT TO BE USED.
4.) LITTER ALLEY WIDTH VARIABLE, DEPENDING ON MANURE HANDLING EQUIPMENT. SELF-LOADING MANURE SPREADERS REQUIRE GREATER WIDTH WITH FLOATION TIRES.
5.) LITTER ALLEY CAN BE SCRAPED BY TRACTOR OR AUTOMATIC ALLEY CLEANERS; ALLEY FLUSHING MAYBE POSSIBLE IN WARM CLIMATE. ELECTRIC DRIVETHRU GATES ARE SUGGESTED ALONG LITTER ALLEY TO FACILITATE MANURE-SCRAPING TRACTOR MOVEMENT.

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
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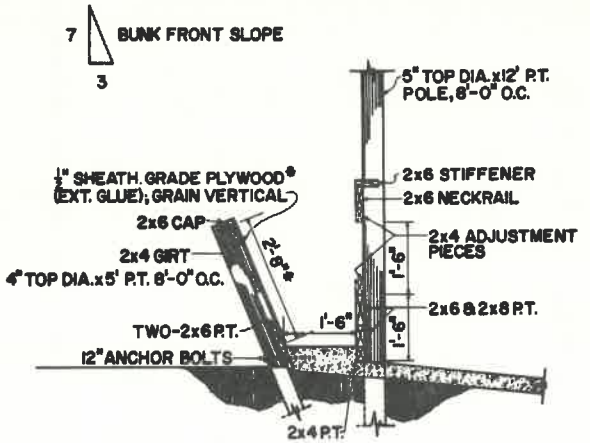
BEEF FEEDING PENS
COUNTER-SLOPED

VA. '78 | 6297 | SHEET 1 OF 2



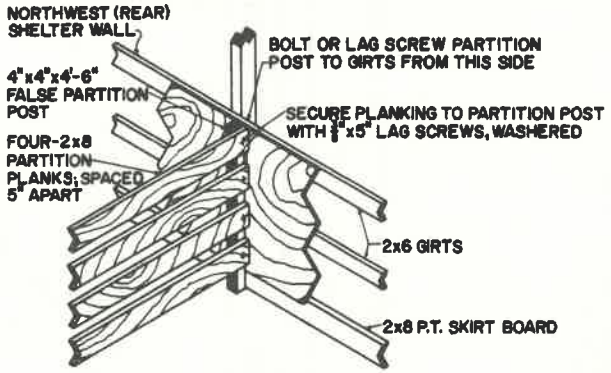
*PLYWOOD BUNK LINER CUT IN 2'-8" LENGTHS FROM STANDARD SHEET (3 PIECES PER SHEET)

BUNK DETAIL
SCALE: 12" 6" 0 1' 2' 3' 4'

AREA OF ANIMAL USE	NUMBER OF HEAD PER 48' PEN	
	50*	63
	AVAILABLE ANIMAL AREA FT²/HD	
RESTING SHELTER[1]	17.5	13.9
FEEDING SLAB	7.7	6.1
TOTAL SLOPED FLOOR	25.2	20.0
LITTER ALLEY	8.6	6.8
TOTAL ANIMAL AREA[2]	33.8	26.8
	AVAILABLE FEEDING SPACE IN/HD	
FEED BUNK	8.9	7.0

*50 HD/PEN RECOMMENDED HOT WEATHER PEN POPULATION UNTIL EXPERIENCE IS GAINED IN FACILITY MANAGEMENT.

1) DOES NOT INCLUDE FEED BUNK ROOF SHELTER.
2) TOTAL ANIMAL AREA IS 68% ROOFED.



PEN PARTITION DETAIL
NOT TO SCALE

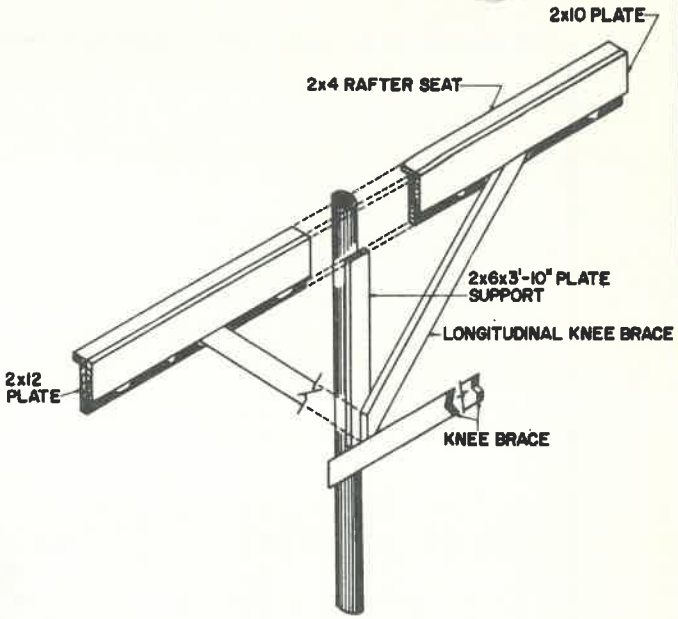
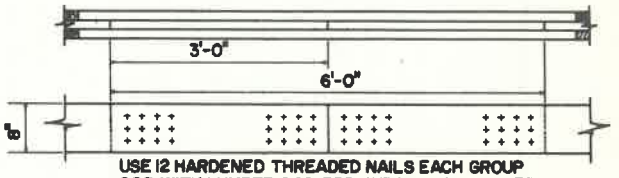
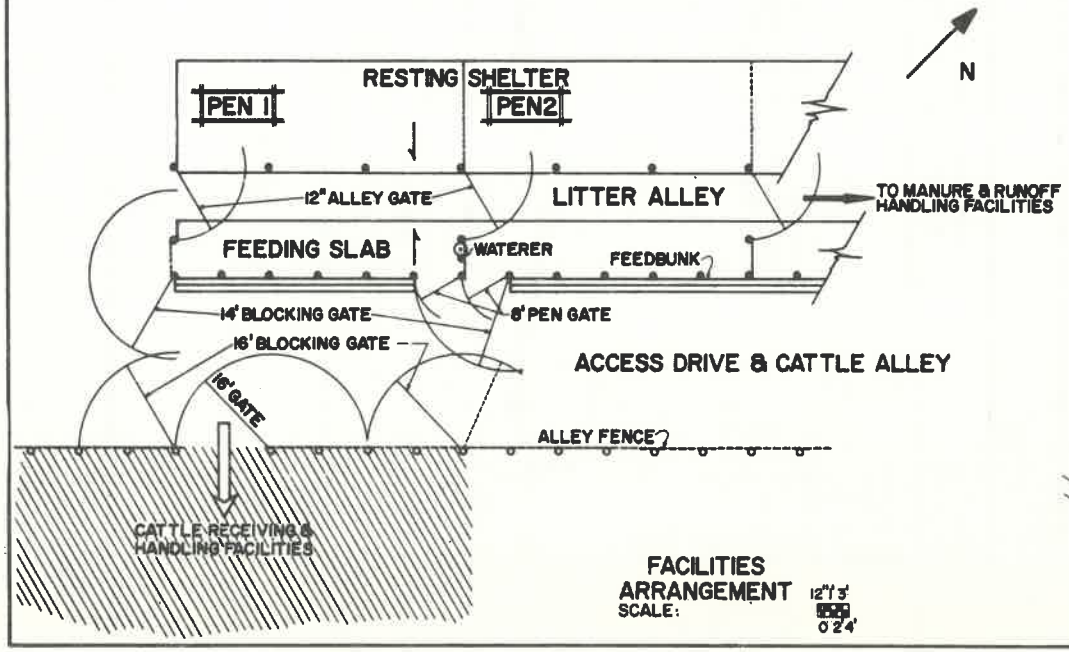


PLATE DETAIL
NOT TO SCALE



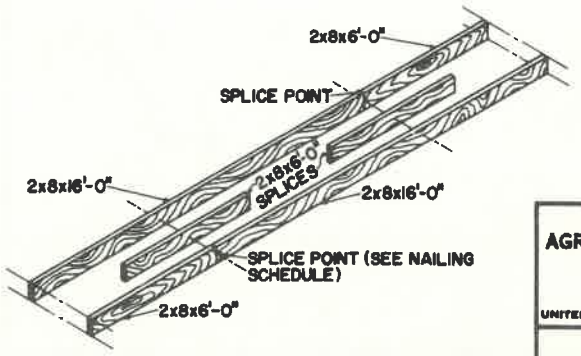
USE 12 HARDENED THREADED NAILS EACH GROUP
20D WITH LUMBER S4S, 50D WITH ROUGH LUMBER

SPLICED RAFTER NAILING SCHEDULE
NOT TO SCALE



ACCESS DRIVE & CATTLE ALLEY

FACILITIES ARRANGEMENT
SCALE: 12" 1' 3' 0 2' 4'



ALTERNATE RAFTER DESIGN
NOT TO SCALE

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
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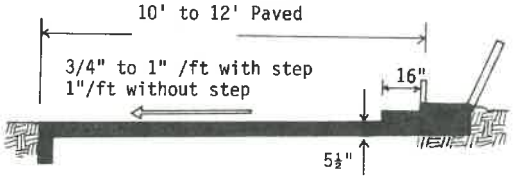
BEEF FEEDING PENS
COUNTER-SLOPED

VA.	'78	6297	SHEET 2 OF 2

BUNK APRONS for CATTLE

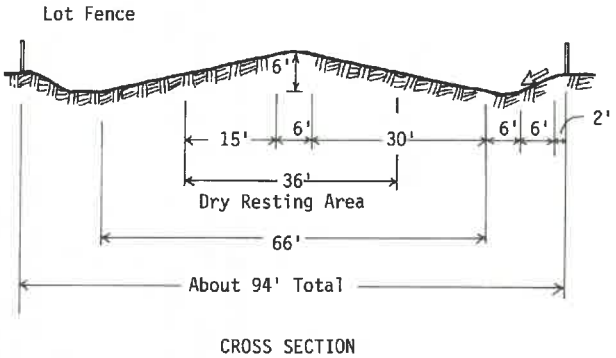
A step along the bunk, 5½" high (2 x 6 form) and 12" to 16" wide, helps reduce manure in the bunk, because cattle are not likely to back up the step.

Use 12' wide apron if the earth below it will be muddy or drifted with snow part of the year.

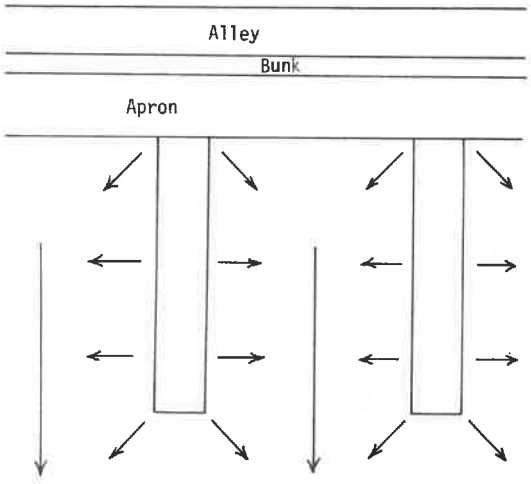


EARTH MOUNDS for CATTLE - Typical Dimensions

Access to mounds is from the paved bunk apron. If lots slope generally away from the mounds, the mounds are perpendicular. If the lots have a side slope, orient the mounds diagonally.

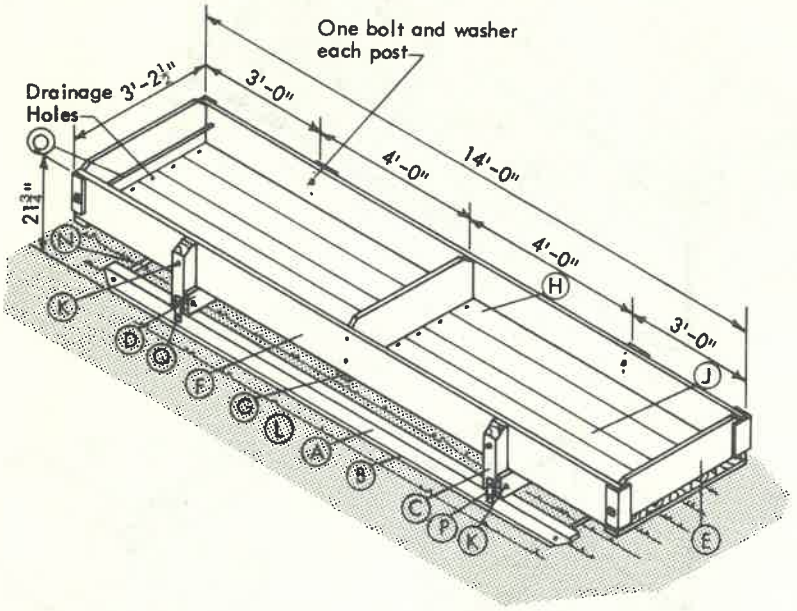


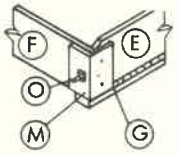
CROSS SECTION



OVERHEAD VIEW

LOT BUNK

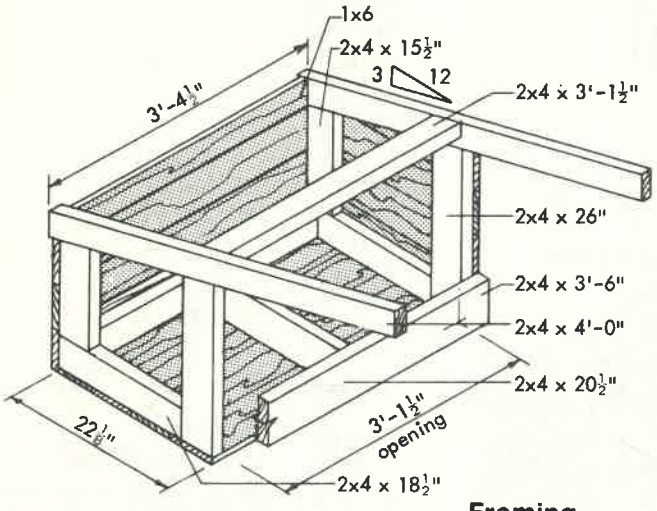




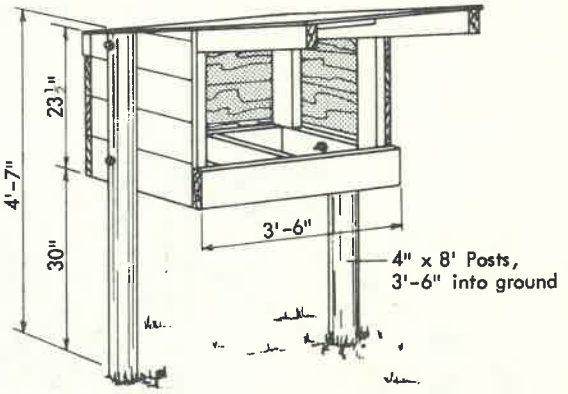
Corner Framing

CUTTING LIST

Item	No.	Description
A	2	4x4 x 12'-0"
B	2	2x4 x 12'-0"
C	4	4x4 x 16¾"
D	2	2x6 x 3'-8½"
E	3	2x12 x 34½"
F	2	2x12 x 14'-0"
G	3	2x4 x 37½"
H	4	2x8 x 14'-0"
J	1	2x6 x 14'-0"
K	8	½" x 6" bolts and washers
L	6	⅜" x 4" lag screw
M	4	2½" x 2½" x ¼" angle iron
N	2	1" x 3'-9½" pipe
O	2	½" x 3'-6" tie rod
P	2	3/16" x 1½" x 6" strap
Q	8	½" x 5" bolts and washers



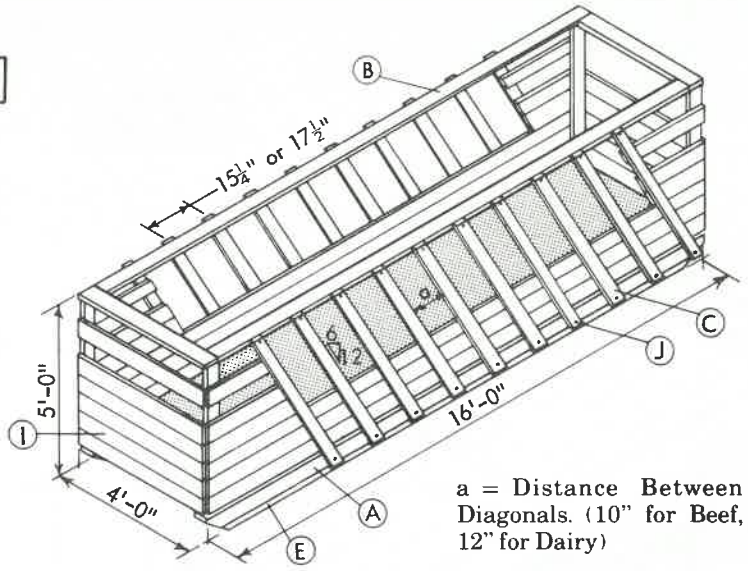
Framing



Stationary

MINERAL FEEDER

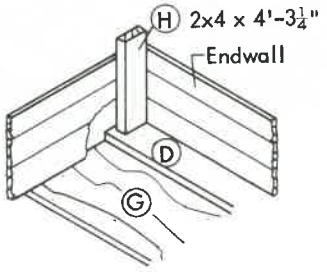
HAY and SILAGE FEEDER



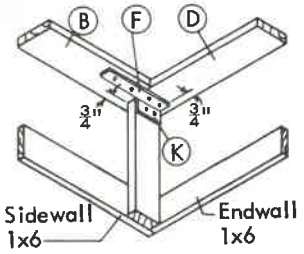
a = Distance Between Diagonals. (10" for Beef, 12" for Dairy)

CUTTING LIST

Item	No.	Description
A	2	4x4 x 16'-0"
B	2	2x6 x 15'-¾"
C	20	2x4 x 5'-9"
D	4	2x6 x 4'-0"
E	2	2x4 x 16'-0"
F	4	2½"x2½"x¼"x12" angle
G	2	¾" C-C ext. plywood
H	4	2x4 x 4'-3¼"
I	232	Ln. ft. 1x6
J	48	⅜" x 4" lag screw
K	24	½" x 2½" bolt



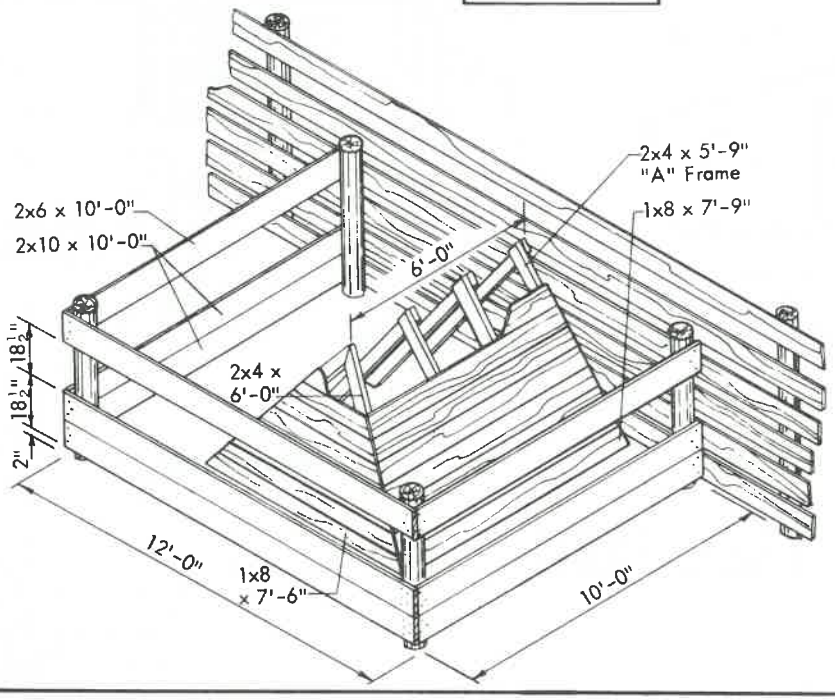
Bottom Corner

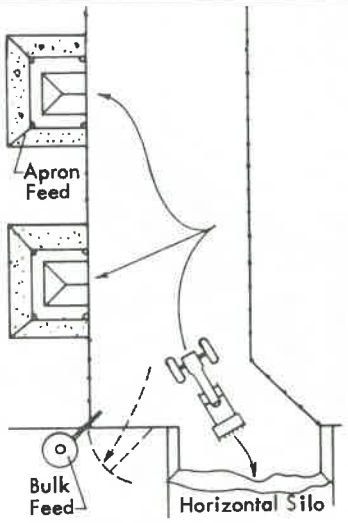


Top Corner

Corner Details

BOX FEEDER



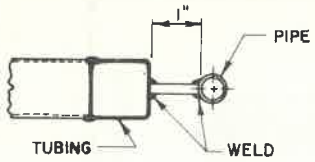


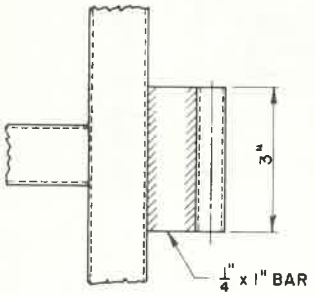
Use 2x8's to reduce throat height for calves. Consider installing a paved apron.

This type of feeding fence opening works well for silage or hay. Place feeder next to service alley.

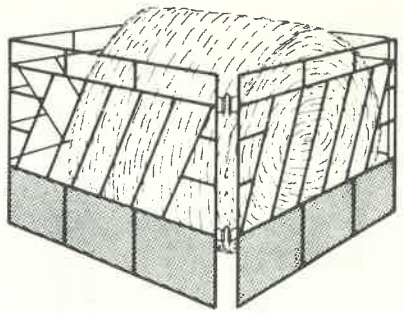
For feeding hay, the feeder may be against a barn wall under the hay mow door.

Bill Of Material (Per Panel)	8'	10'	12'		16'
1¼" x 16 Ga. (.065") Square Tubing	68'	83'	98'	113'	120'
18" x 20 Ga. (.0359") Sheet Steel	7'-11"	10'-1"	12'-3"	14'-5"	15'-6"
¼" x 1" Steel Bar	12"	12"	12"	12"	12"
½" Dia. Pipe	12"	12"	12"	12"	12"
½" Dia. Steel Bar	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"
APPROX. WEIGHT PER PANEL, Lbs.	93	113	134	155	164
Dimension					
A	8'-0"	10'-2"	12'-4"	14'-6"	15'-7"
B	2'-6"	3'-4"	4'-0"	4'-10"	5'-2"

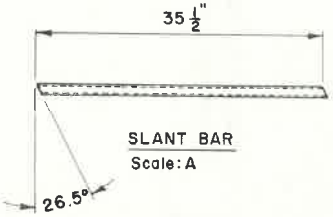




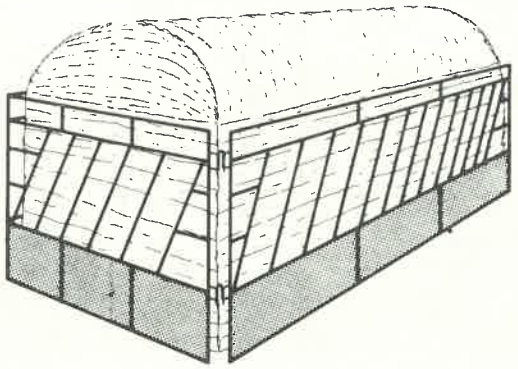
DETAIL "A"
Scale: B



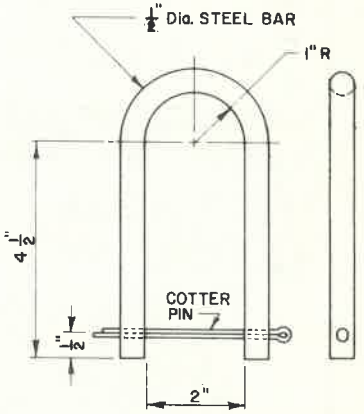
PERSPECTIVE



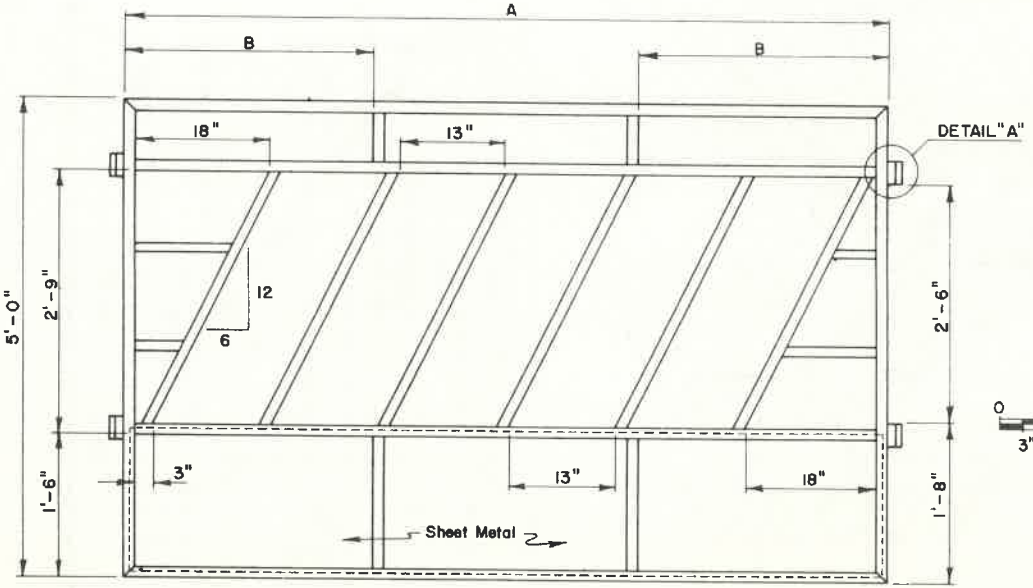
SLANT BAR
Scale: A



PERSPECTIVE



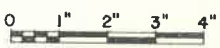
PANEL CONNECTOR PIN
Scale: B



FEEDER PANEL
Scale: A

Pinned Corner Connections Allow Panels To Collapse, Thus Providing Complete Hay Cleanup.

Scale: A



Scale: B

BASED ON: OKLA. STATE UNIV.
PLAN NO. OK-724-28

NOTE:
1½" Dia. x 16 Ga. (.065") Round Tubing May Be Substituted For The Square Tubing

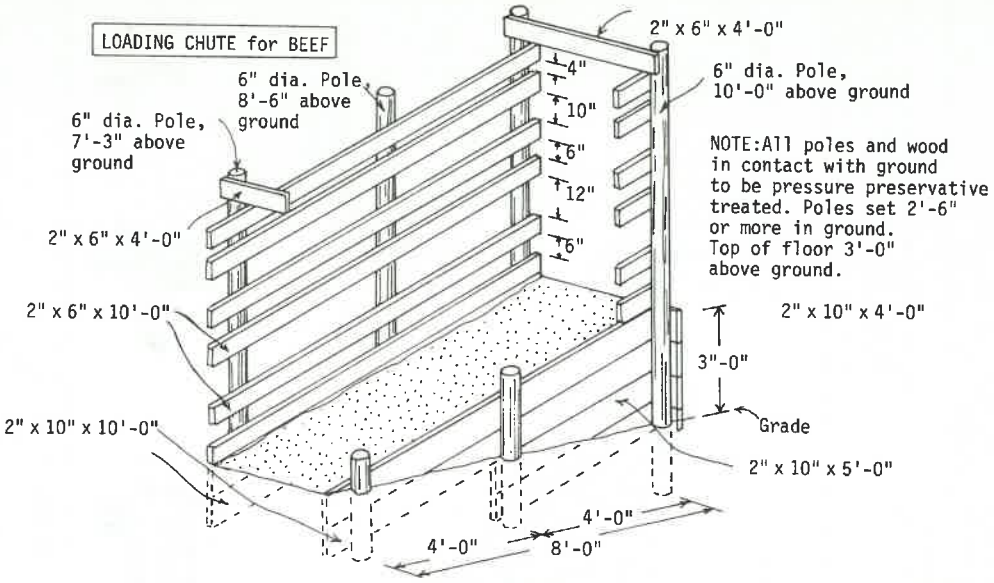
COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS

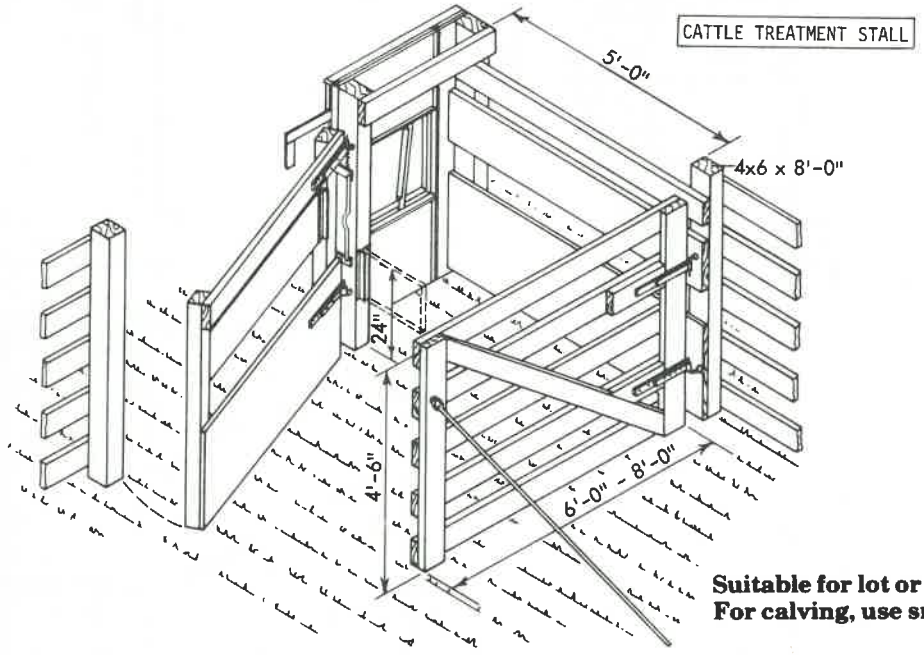
AND UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

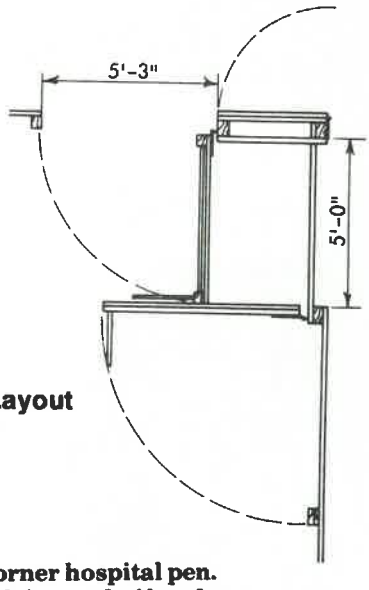
SLANT BAR FEEDER PANELS

OK. '76	6242	SHEET 1 OF 1

69

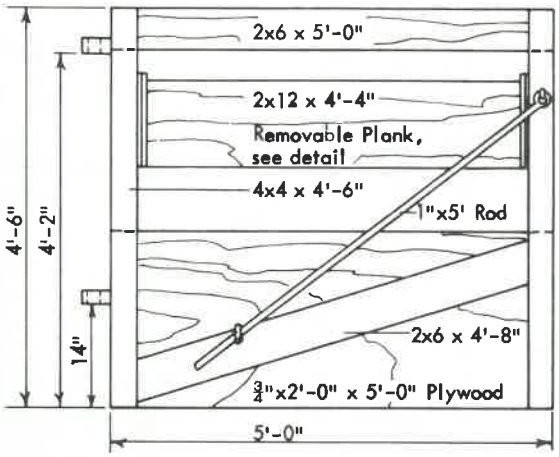




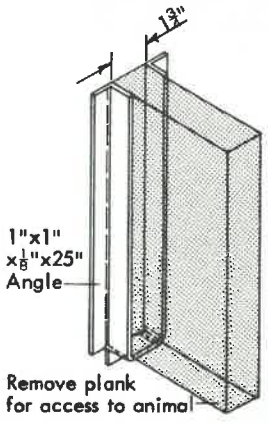


Layout

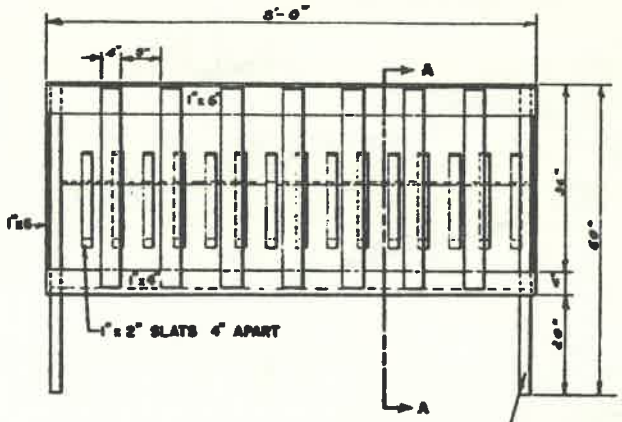
Suitable for lot or corner hospital pen.
For calving, use snub instead of headgate.



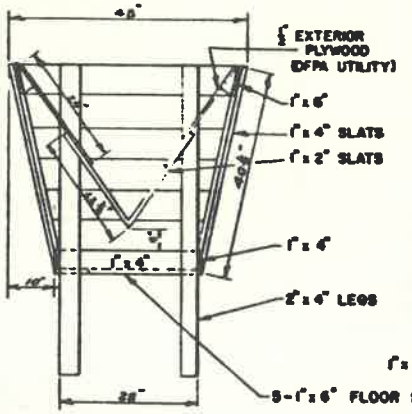
Gate Detail



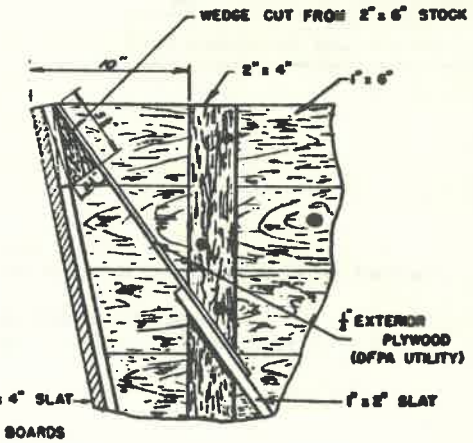
Removable Plank Detail



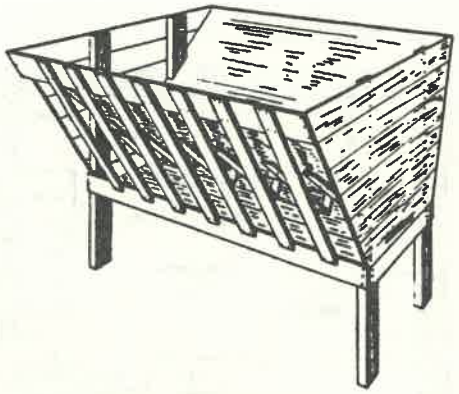
SIDE VIEW
DOUBLE FEEDER



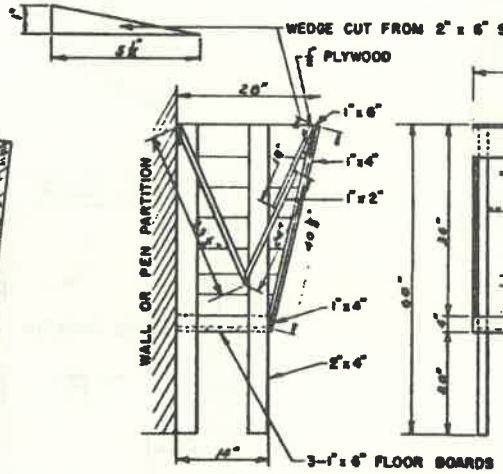
SECTION A-A



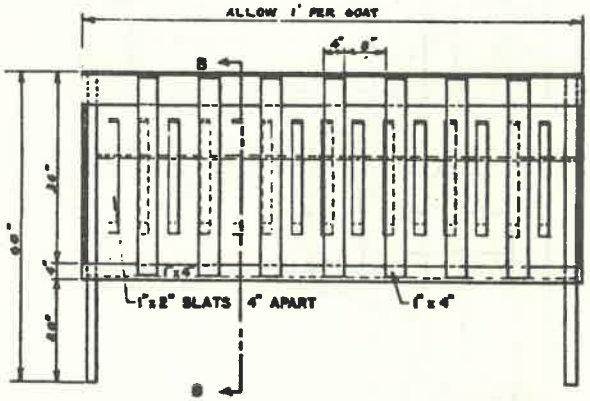
ENLARGED VIEW OF
CORNER DETAIL



PERSPECTIVE VIEW
OF
DOUBLE FEEDER



SECTION B-B

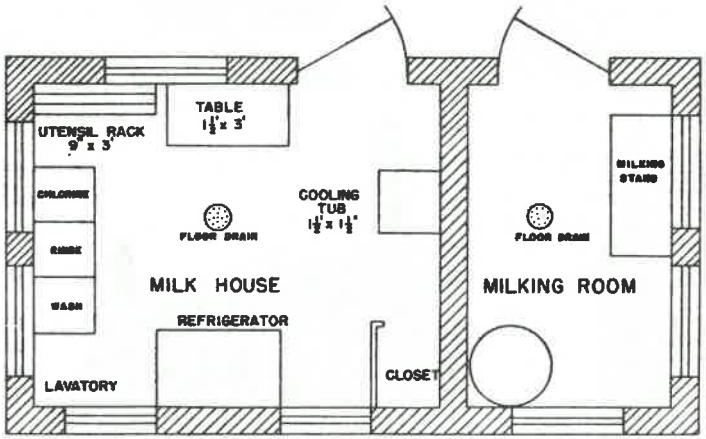


SIDE VIEW
SINGLE FEEDER

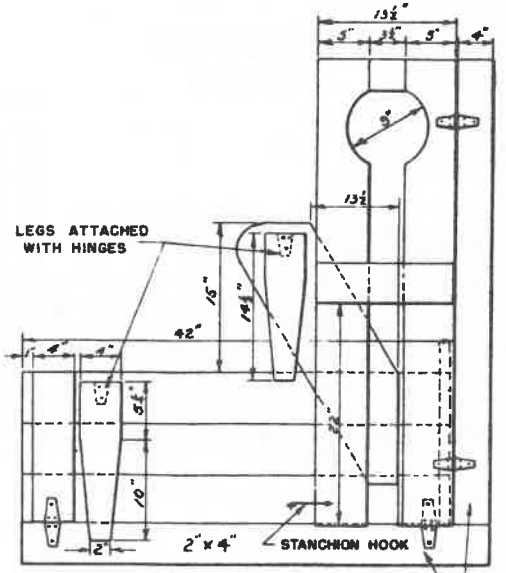
THE PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXTENSION SERVICE	
FEED RACKS FOR GOATS	
ORDER NO. 728-99	SHEET 1 OF 1

27/7/59

* Check with your state milk sanitation or health officials before starting construction

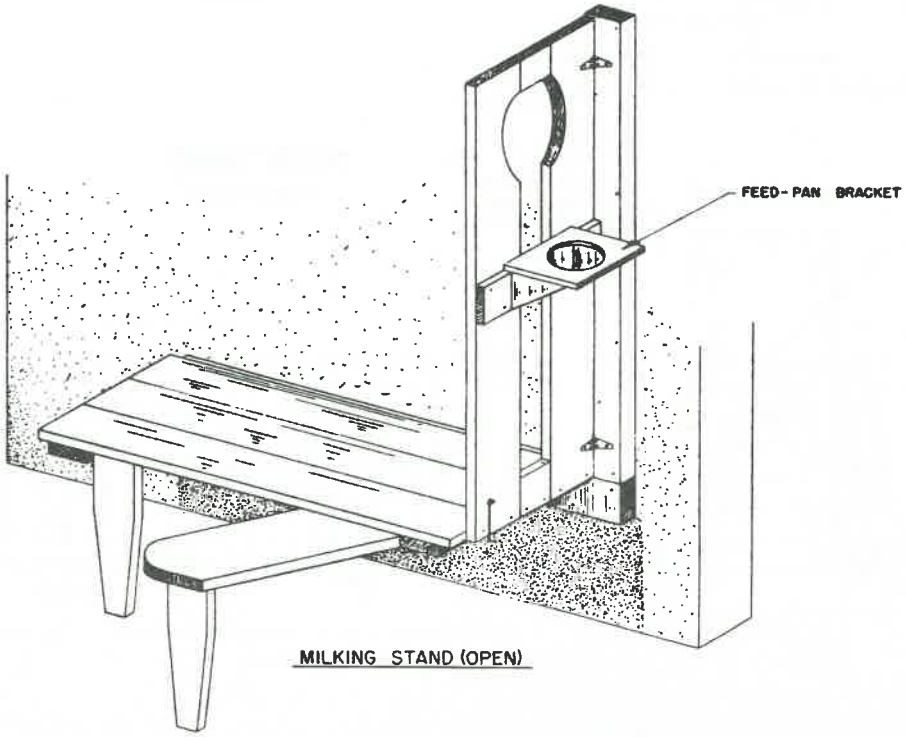


FLOOR PLAN



FRONT VIEW (FOLDED)

2" x 4"'s ATTACHED TO WALL



MILKING STAND (OPEN)

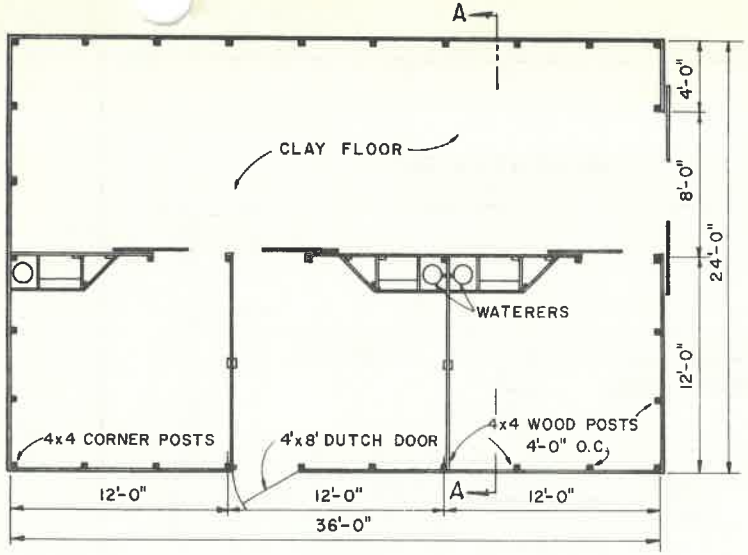
NOTE:

MILK HOUSE AND MILKING ROOM FLOORS TO BE OF SMOOTH CONCRETE.

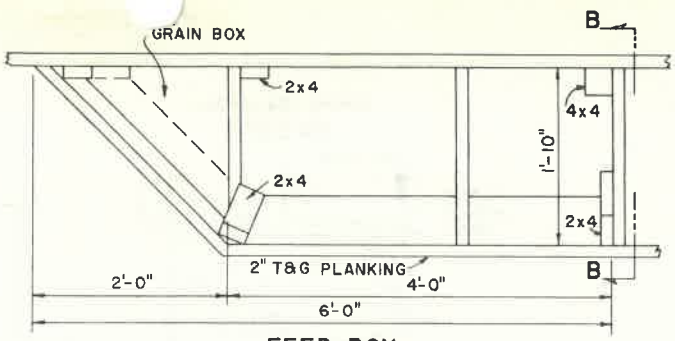
WALLS MAY BE OF BLOCK OR FRAME CONSTRUCTION

THE PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXTENSION SERVICE	
MILK HOUSE, MILKING ROOM, & MILKING STAND FOR GOATS	
ORDER NO. 728-100	SHEET 1 OF 1

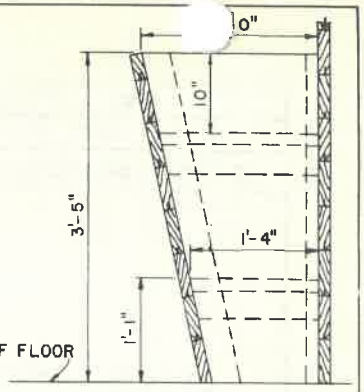
26/7/59



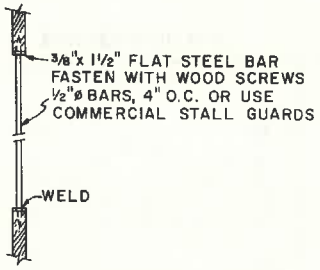
PLAN



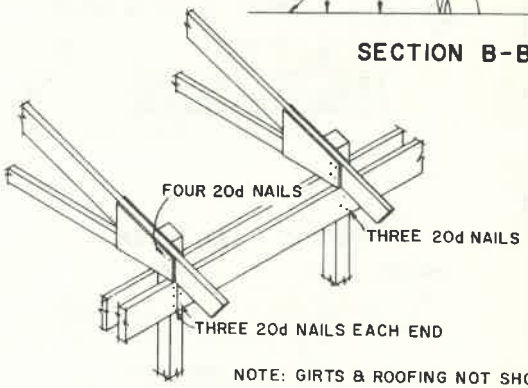
FEED BOX



SECTION B-B

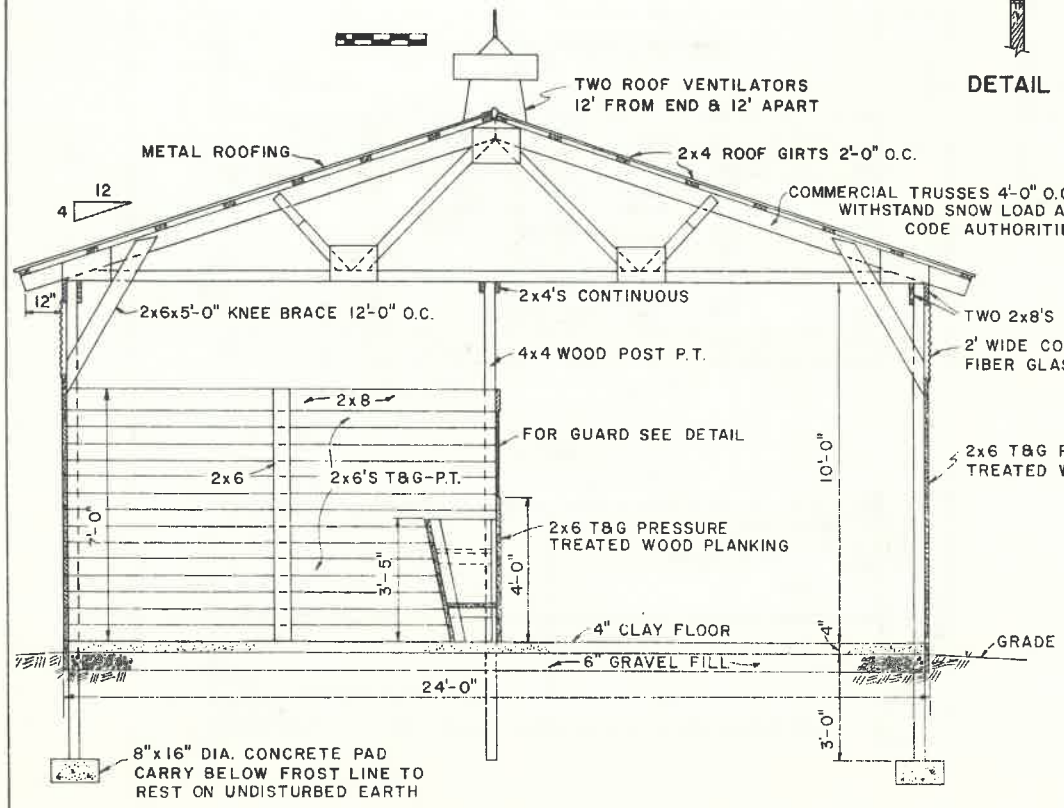


DETAIL OF STALL GUARD

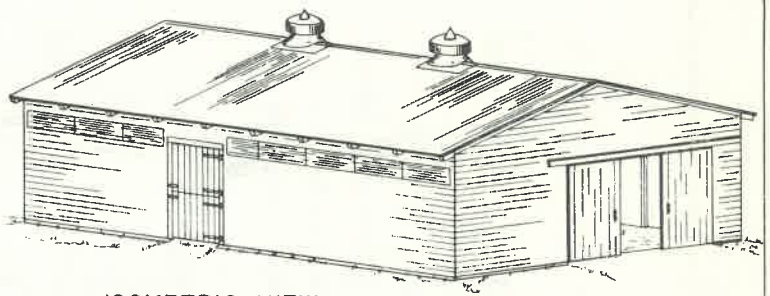


NOTE: GIRTS & ROOFING NOT SHOWN

ISOMETRIC VIEW



SECTION-A-A



ISOMETRIC VIEW

NOTE: CONSULT LOCAL HEALTH AND BUILDING CODE AUTHORITIES BEFORE STARTING CONSTRUCTION.

BASED ON: MICH. STATE UNIV. PLAN NO. 772-C1-14

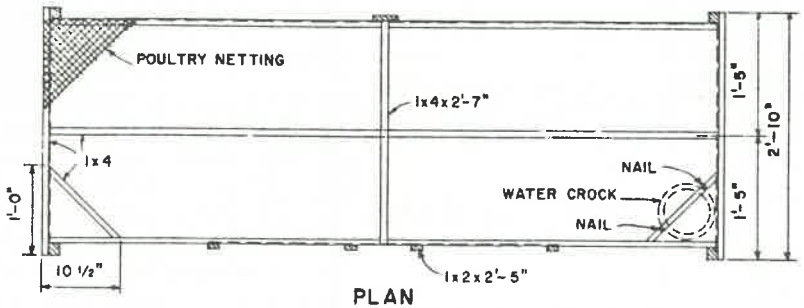
COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS

AND UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

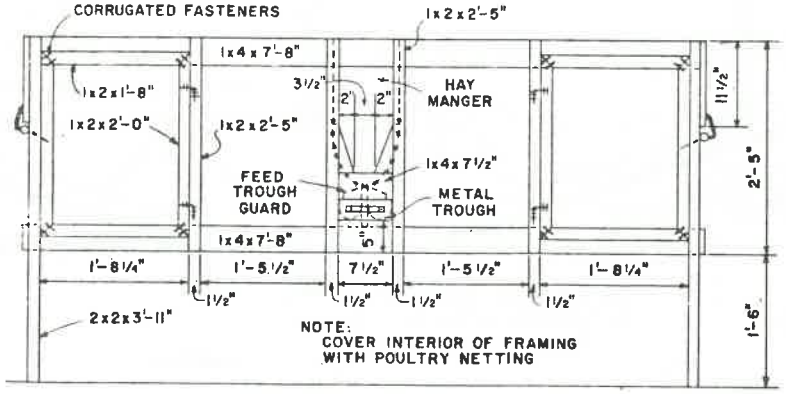
HORSE BARN

POST CONSTRUCTION

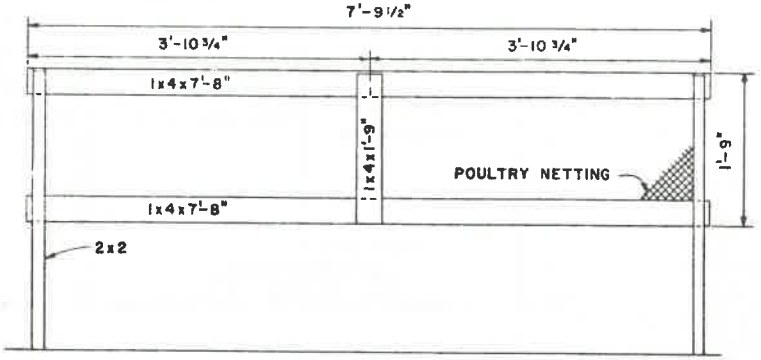
MICH. '77	6275	SHEET 1 OF 1



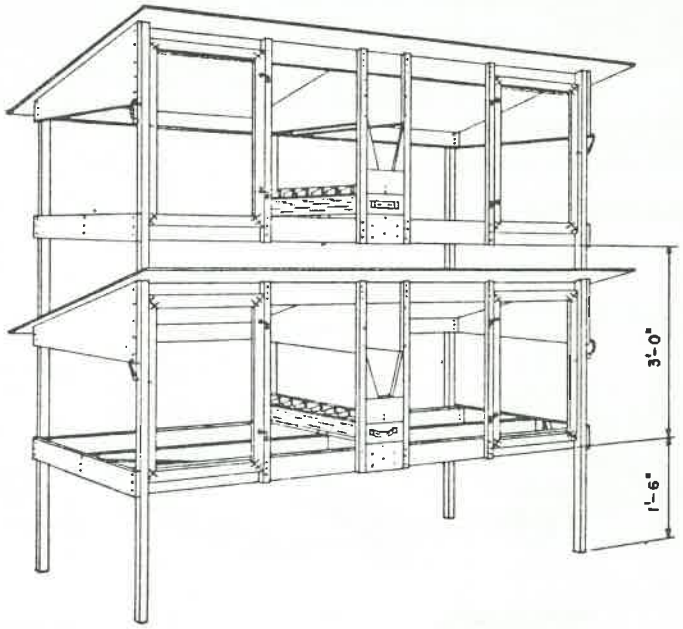
PLAN

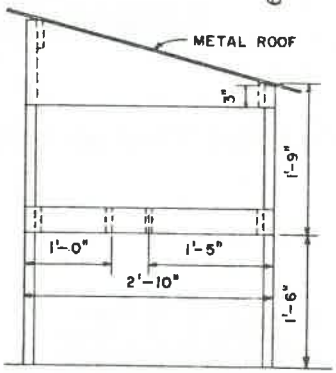


FRONT ELEVATION

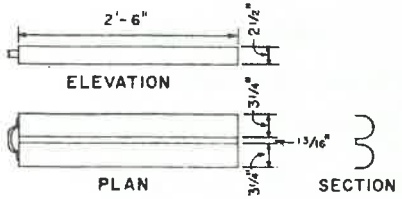


REAR ELEVATION

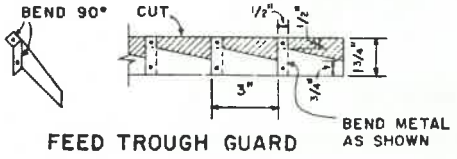




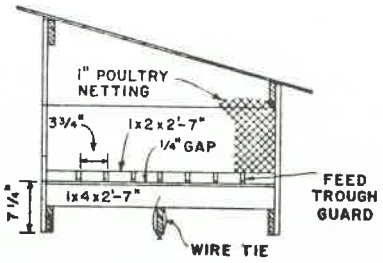
END ELEVATION



METAL FEED TROUGH



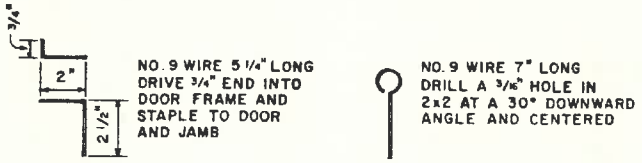
FEED TROUGH GUARD



SECTION
(TROUGH NOT SHOWN)

HUTCHES FOR RABBITS		
N.M. & CAL. '72	6137	
SHEET 1 OF 2		

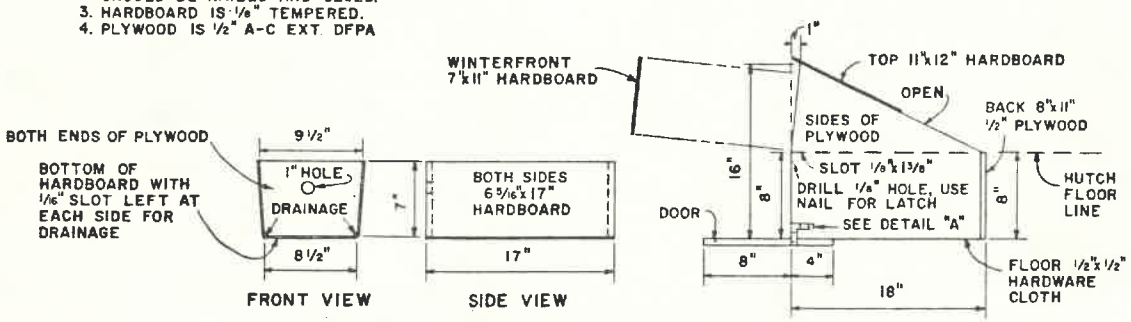
BASED ON CALIF. PLAN NO. OSA #210



DOOR HINGE

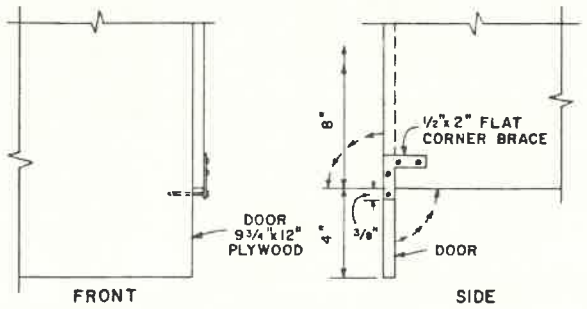
DOOR LATCH

NOTE:
1. COVER ALL EXPOSED "CHEWABLE EDGES" WITH METAL.
2. ALL PLYWOOD TO PLYWOOD JOINTS SHOULD BE NAILED AND GLUED.
3. HARDBOARD IS 1/8" TEMPERED.
4. PLYWOOD IS 1/2" A-C EXT. DFPA

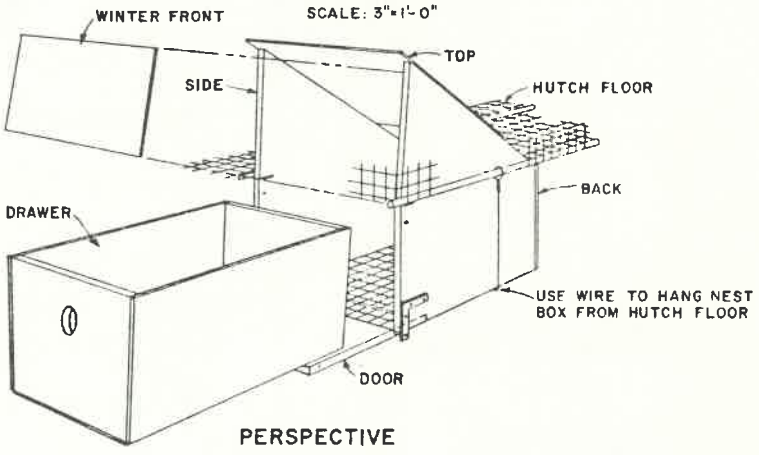


RABBIT NEST BOX DRAWER
SCALE: 1 1/2" = 1'-0"

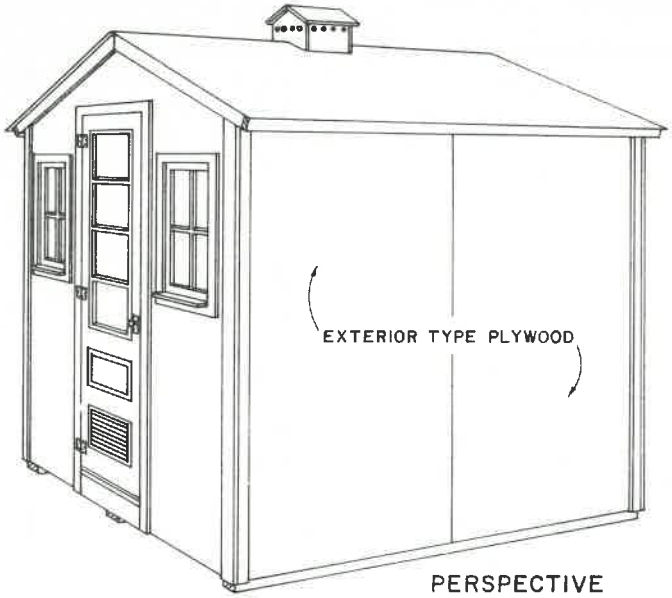
RABBIT NEST BOX-SIDE VIEW
SCALE 1 1/2" = 1'-0"



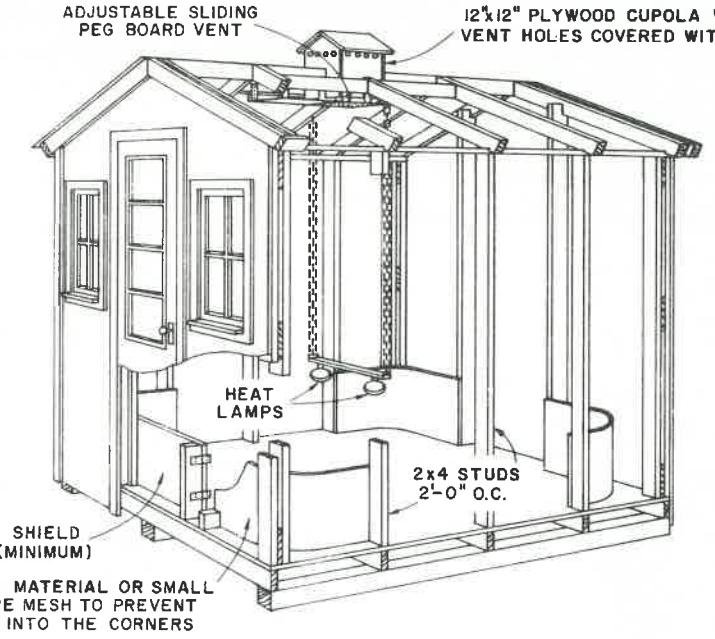
DETAIL "A"
SCALE: 3" = 1'-0"



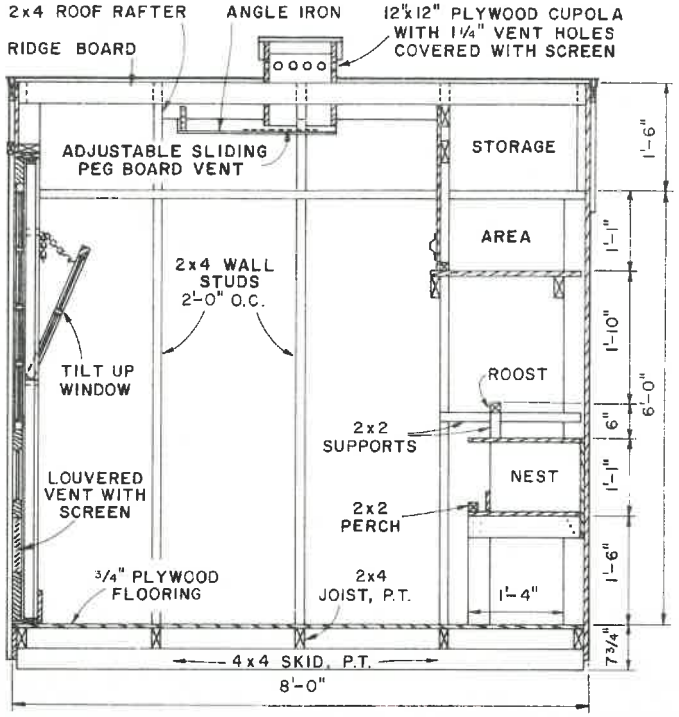
PERSPECTIVE
RABBIT NEST BOX



PERSPECTIVE
BROODFR HOUSE
LAYING HOUSE
CHICKEN HOUSE-BANTAMS
PIGEON HOUSE

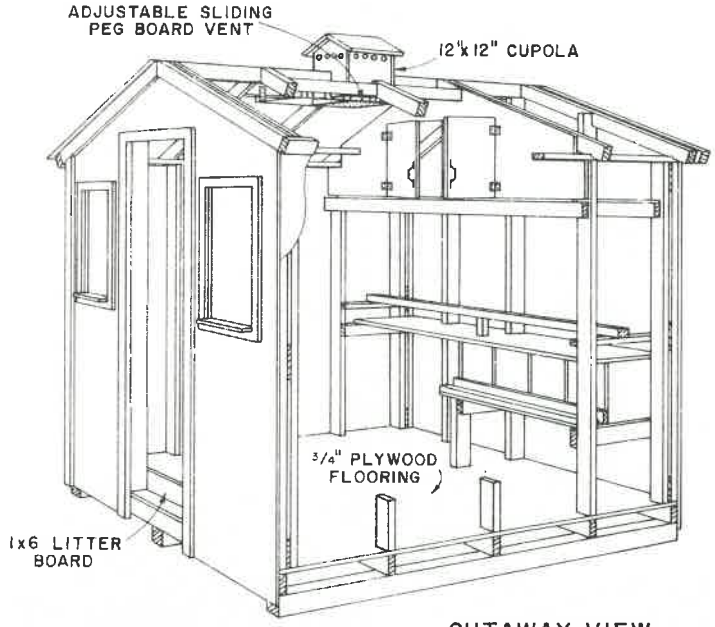


CUTAWAY VIEW
OF 8'x8' BROODER HOUSE



SECTION
LAYING HOUSE

NOTE:
P.T. = PRESSURE TREATED

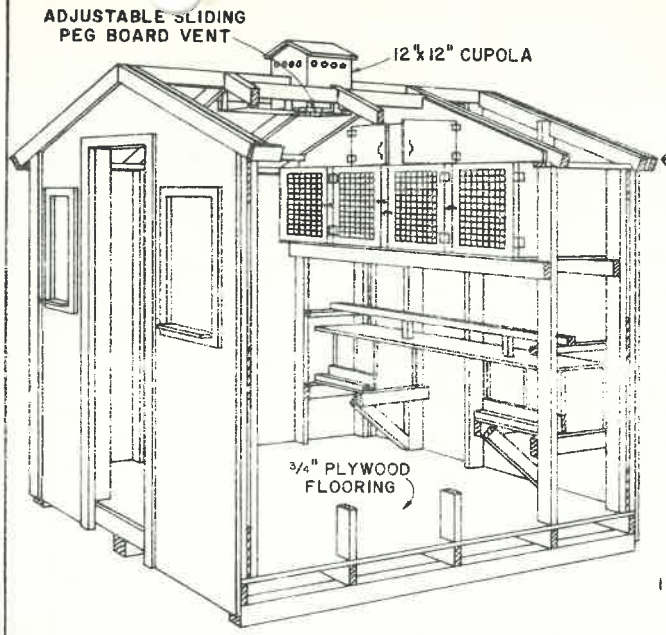


CUTAWAY VIEW
OF 8'x8' LAYING HOUSE

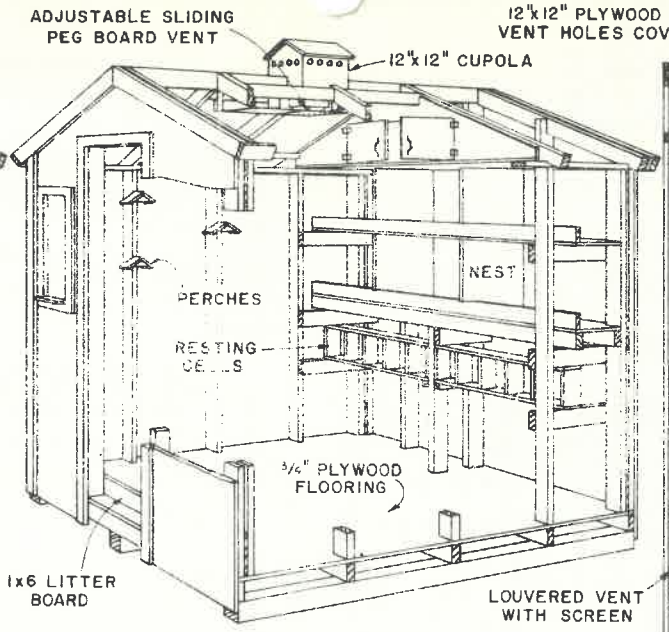
NOTE:
CAPACITY 15-20 HENS
4-NESTS
ROOST & STORAGE AREAS.

NOTE:
BASED ON: UNIV. OF WISCONSIN PLANS NO. WP 5702, 5703, 5704 AND 5705.
CONSULT LOCAL HEALTH AND BUILDING CODE AUTHORITIES BEFORE STARTING CONSTRUCTION.

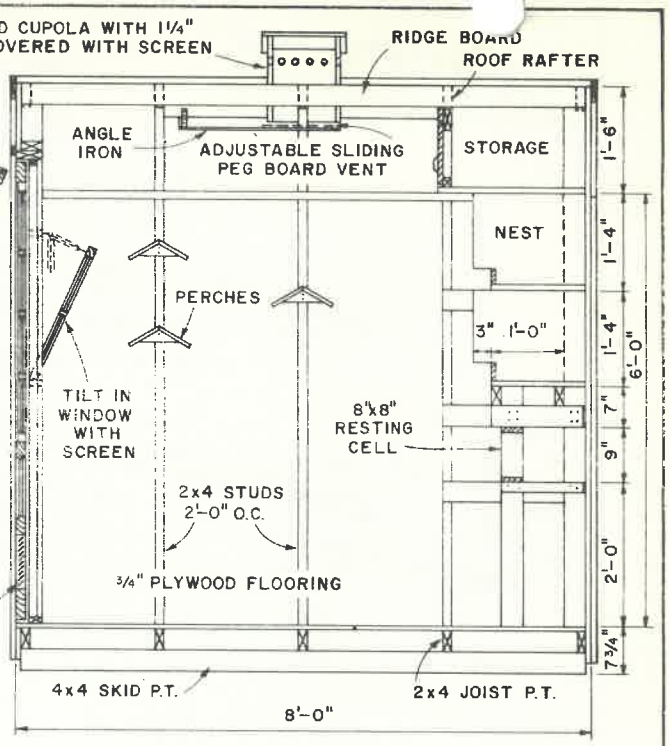
POULTRY & PIGEON HOUSES BROODERS-LAYERS-BANTAMS		
WISC '75	6232	SHEET 1 OF 2



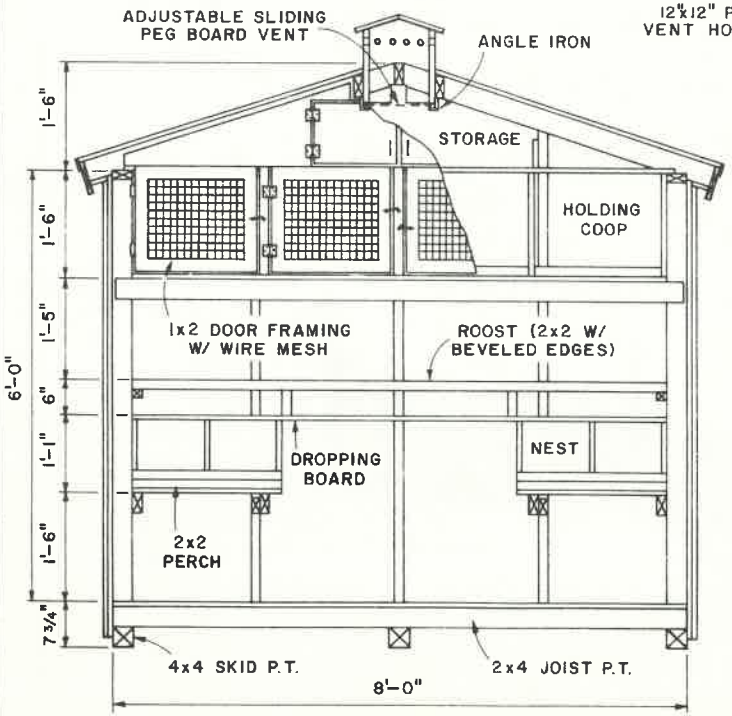
PERSPECTIVE
OF CHICKEN HOUSE-BANTAMS

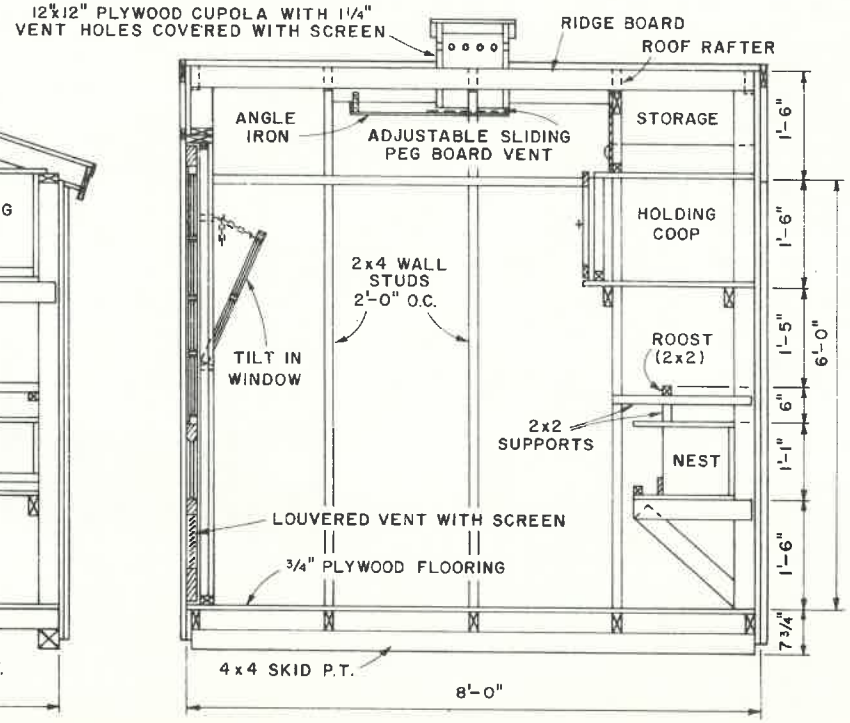


PERSPECTIVE
OF PIGEON HOUSE



SECTION
OF PIGEON HOUSE





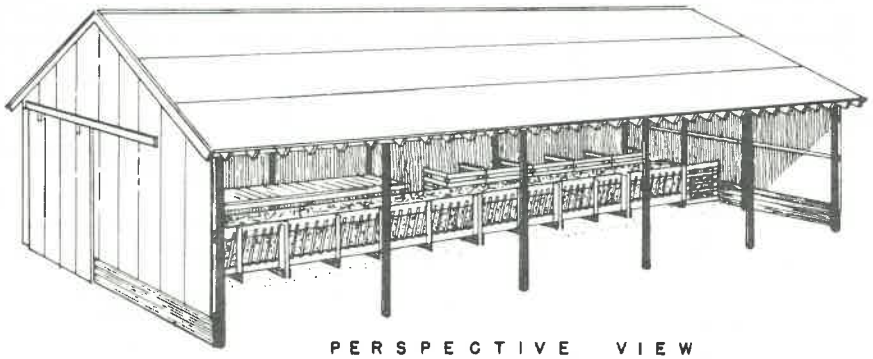
SECTIONS
OF CHICKEN HOUSE-BANTAMS

NOTE:
P.T. = PRESSURE TREATED.

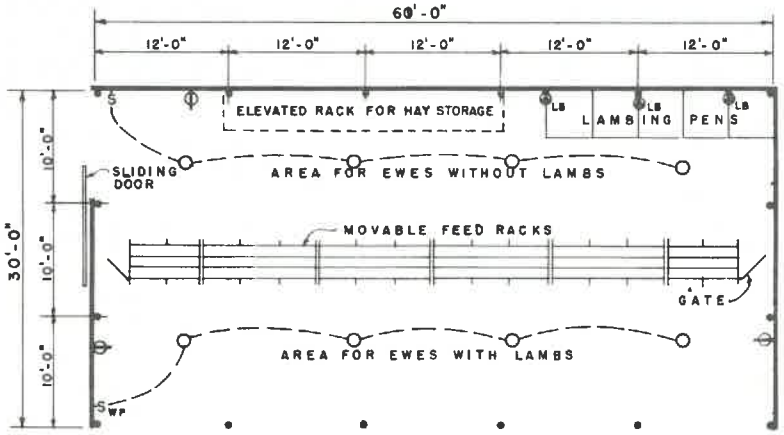
POULTRY & PIGEON HOUSES
BROODERS-LAYERS-BANTAMS

WISC. '75	6232	SHEET 2 OF 2

77



PERSPECTIVE VIEW

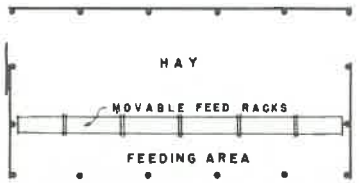


PLAN

NOTE: 1. CAPACITY 120 HEAD

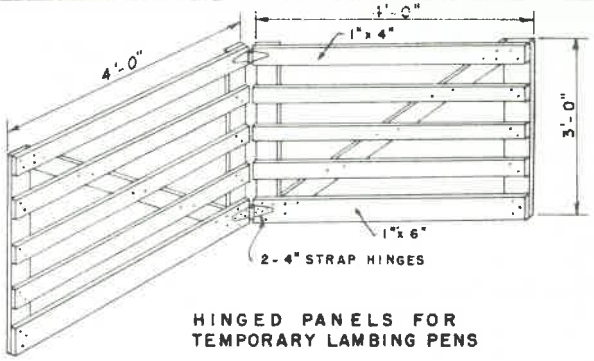
2. LENGTH OF BUILDING MAY BE VARIED IN UNITS OF 12 FEET.

3. USE OF THE BUILDING AS CATTLE & HAY BARN OR MACHINERY STORAGE IS ILLUSTRATED BY SMALL PLANS BELOW. COMPLETE PLANS FOR EITHER OF THESE TYPES OF BUILDINGS MAY BE OBTAINED---WHEN ORDERING, USE THE PLAN NUMBER INDICATED.

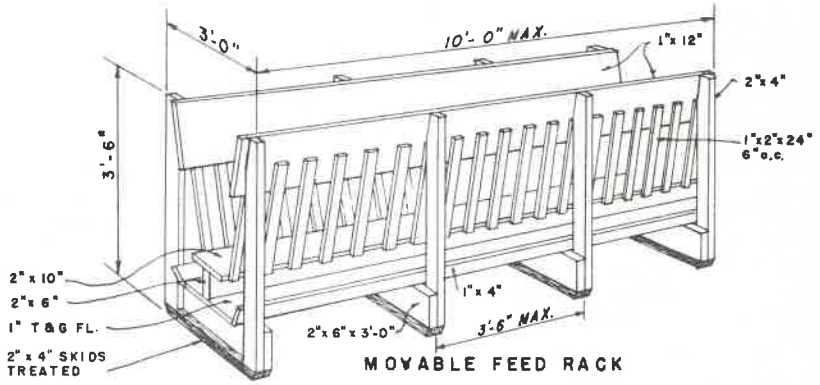


CATTLE & HAY BARN
CAPACITY 24 TO 32 HEAD

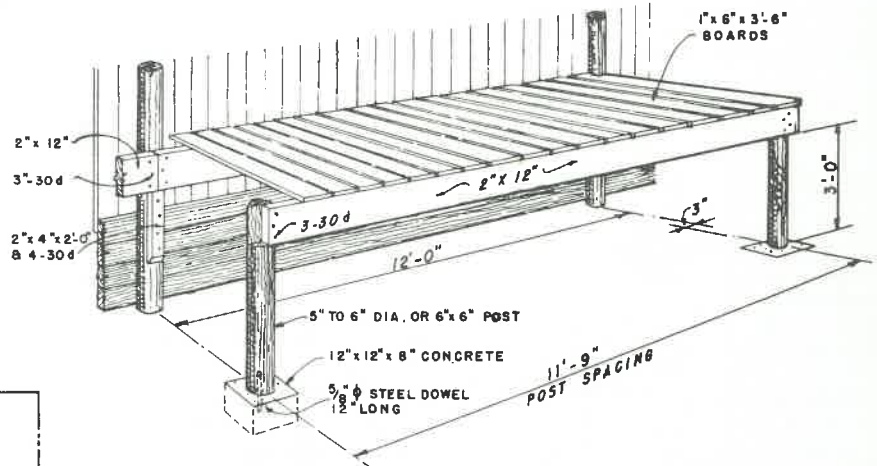
MACHINERY STORAGE



HINGED PANELS FOR
TEMPORARY LAMBING PENS



MOVABLE FEED RACK

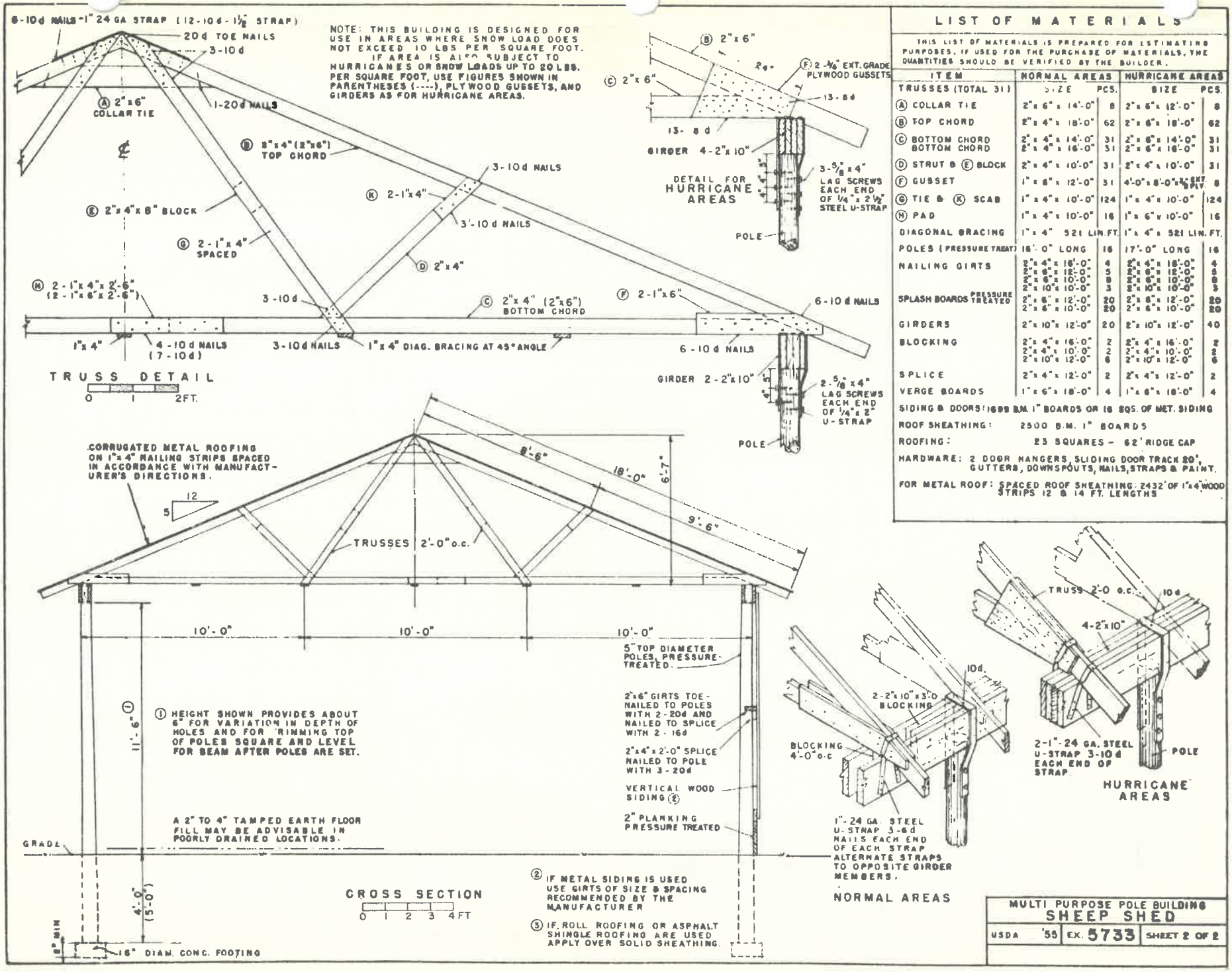


HAY STORAGE RACK

WIRING LEGEND
- ○ LIGHT OUTLET
- ⊛LB LAMB BROODER
- S SINGLE POLE SWITCH
- ⊖ DUPLEX OUTLET
- S_{WP} WEATHERPROOF SWITCH

BASED ON VIRGINIA PLAN No. K 1.25

MULTI PURPOSE POLE BUILDING SHEEP SHED			
USDA '55	EX. 5733	SHEET 1 OF 2	



LIST OF MATERIALS

THIS LIST OF MATERIALS IS PREPARED FOR ESTIMATING PURPOSES. IF USED FOR THE PURCHASE OF MATERIALS, THE QUANTITIES SHOULD BE VERIFIED BY THE BUILDER.

ITEM	NORMAL AREAS SIZE	PCS.	HURRICANE AREAS SIZE	PCS.
TRUSSES (TOTAL 31)				
Ⓐ COLLAR TIE	2"x 6"x 14'-0"	8	2"x 6"x 12'-0"	8
Ⓑ TOP CHORD	2"x 4"x 18'-0"	62	2"x 6"x 18'-0"	62
Ⓒ BOTTOM CHORD	2"x 4"x 14'-0"	31	2"x 6"x 14'-0"	31
BOTTOM CHORD	2"x 4"x 16'-0"	31	2"x 6"x 16'-0"	31
Ⓓ STRUT & Ⓔ BLOCK	2"x 4"x 10'-0"	31	2"x 4"x 10'-0"	31
Ⓕ GUSSET	1"x 8"x 12'-0"	31	4'-0"x 8'-0"x¼" EXT. PLY.	8
Ⓖ TIE & Ⓚ SCAB	1"x 4"x 10'-0"	124	1"x 4"x 10'-0"	124
Ⓗ PAD	1"x 4"x 10'-0"	16	1"x 6"x 10'-0"	16
DIAGONAL BRACING	1"x 4" 521 LIN.FT.		1"x 4"x 521 LIN. FT.	
POLES (PRESSURE TREAT)	16'-0" LONG	16	17'-0" LONG	16
NAILING GIRTS	2"x 4"x 16'-0"	4	2"x 4"x 16'-0"	4
	2"x 6"x 12'-0"	5	2"x 6"x 12'-0"	5
	2"x 6"x 10'-0"	8	2"x 6"x 10'-0"	8
	2"x 10"x 10'-0"	3	2"x 10"x 10'-0"	3
SPLASH BOARDS PRESSURE TREATED	2"x 6"x 12'-0"	20	2"x 6"x 12'-0"	20
	2"x 6"x 10'-0"	20	2"x 6"x 10'-0"	20
GIRDERS	2"x 10"x 12'-0"	20	2"x 10"x 12'-0"	40
BLOCKING	2"x 4"x 16'-0"	2	2"x 4"x 16'-0"	2
	2"x 4"x 10'-0"	2	2"x 4"x 10'-0"	2
	2"x 10"x 12'-0"	6	2"x 10"x 12'-0"	6
SPLICE	2"x 4"x 12'-0"	2	2"x 4"x 12'-0"	2
VERGE BOARDS	1"x 6"x 18'-0"	4	1"x 6"x 18'-0"	4

SIDING & DOORS: 1699 B.M. 1" BOARDS OR 16 SQS. OF MET. SIDING

ROOF SHEATHING: 2500 B.M. 1" BOARDS

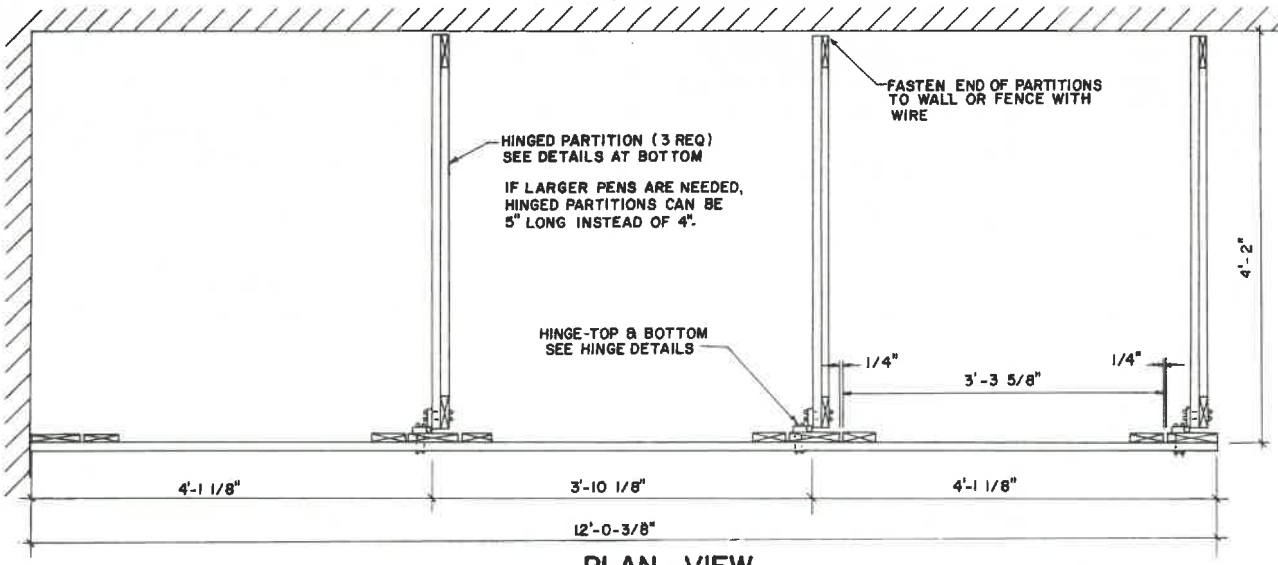
ROOFING: 23 SQUARES - 62' RIDGE CAP

HARDWARE: 2 DOOR HANGERS, SLIDING DOOR TRACK 20', GUTTERS, DOWNSPOUTS, NAILS, STRAPS & PAINT.

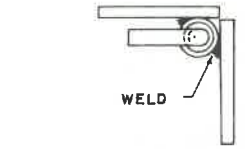
FOR METAL ROOF: SPACED ROOF SHEATHING: 2432' OF 1"x4" WOOD STRIPS 12 & 14 FT. LENGTHS

MULTI PURPOSE POLE BUILDING
SHEEP SHED

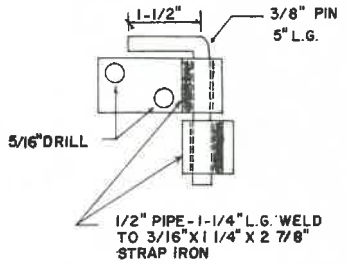
USDA '55 | EX. 5733 | SHEET 2 OF 2



PLAN VIEW

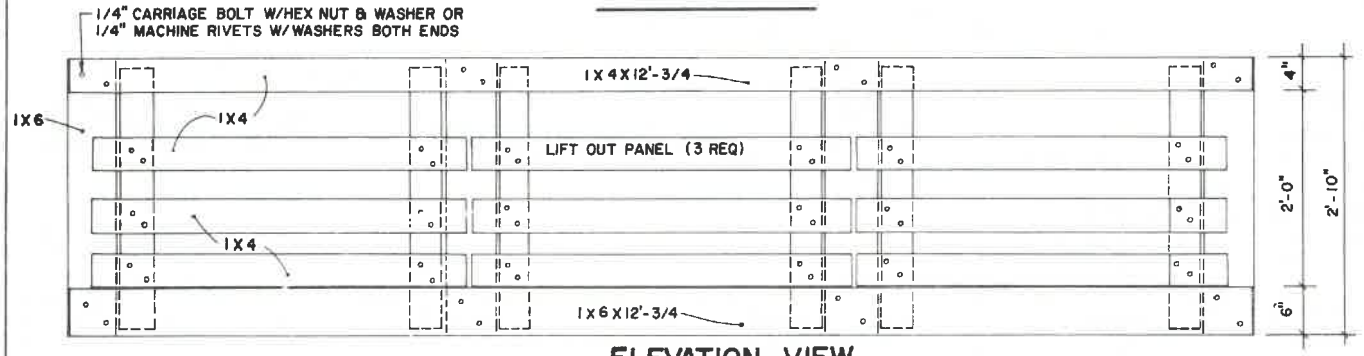


TOP VEIW



SIDE VIEW

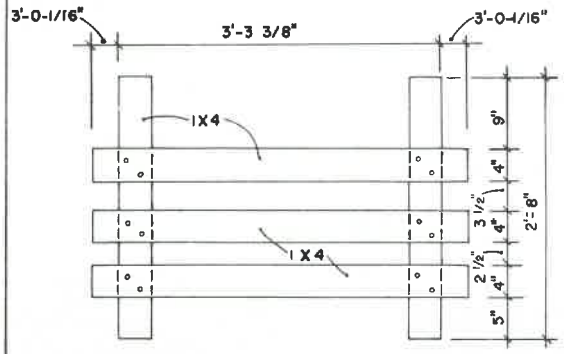
HINGE DETAILS



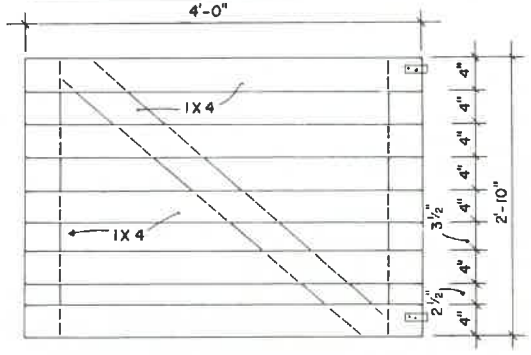
ELEVATION VIEW

NOTES

1. SIZES SHOWN ARE FOR FULL DIMENSION LUMBER
2. SURFACED LUMBER CAN BE USED OVERALL DIMENSIONS WILL BE THE SAME BUT SPACING BETWEEN SOME MEMBERS WILL BE DIFFERENT



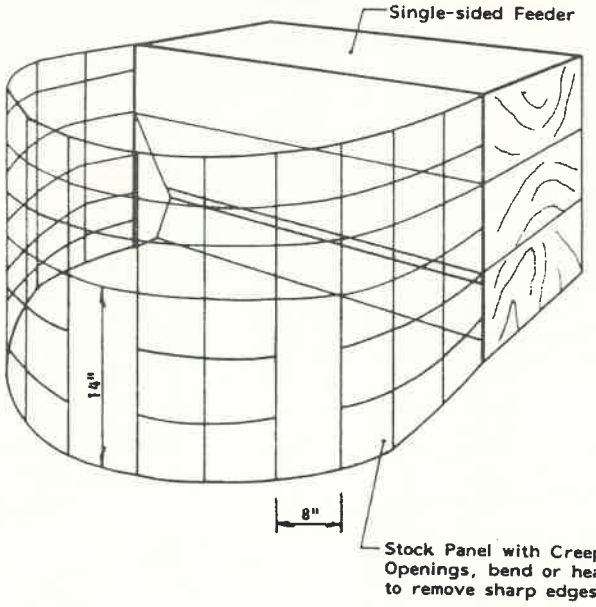
LIFT OUT PANEL DETAILS



PARTITION DETAILS

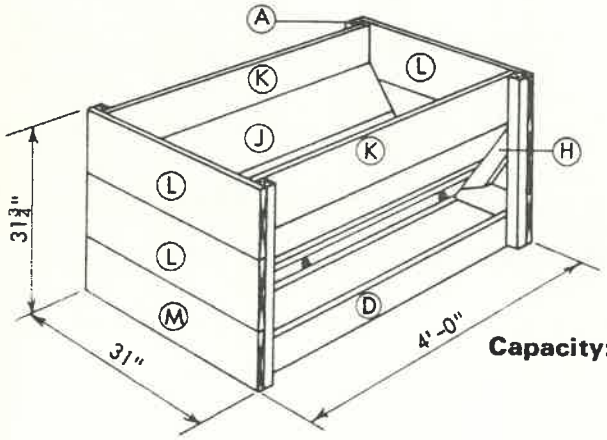
BASE ON: UNIV. OF WEST VIRGINIA PLAN SH-161

PORTABLE LAMBING UNIT		
W. V. '73	EX. 6304	SHEET 1 OF 1

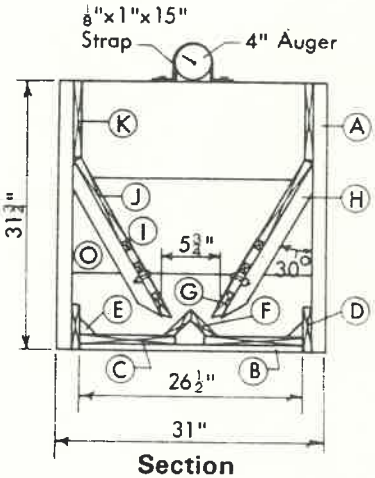


Sheep Creep Feeder

Stock Panel Creep Fence



Capacity: 4¾ Bu. Per 4' Length



Section

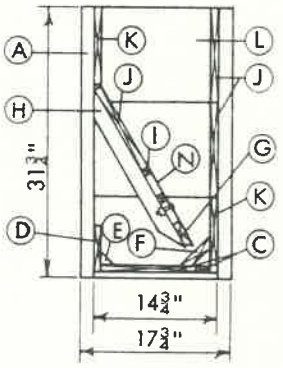
CUTTING LIST

Small Lamb Feeder

Item	No.	Description
A	4	2x2 x 32"
B	3	1x2 x 26-1/2"
C	2	1x12 x 4'-0"
D	2	1x6 x 4'-0"
E	2	2x2 x 4'-0" (ripped)
F	2	1x4 x 4'-0"
G	2	1x8 x 4'-0"
H	4	1x2 x 22"
I	2	1x1 x 4'-0"
J	2	1x12 x 4'-0"
K	2	1x10 x 4'-0"
L	4	1x12 x 31"
M	2	1x10 x 31"
N	2	10" x 22-gage x 4'-0"
O	4	3/8" x 1-1/2" carriage bolt

Single-Sided Option

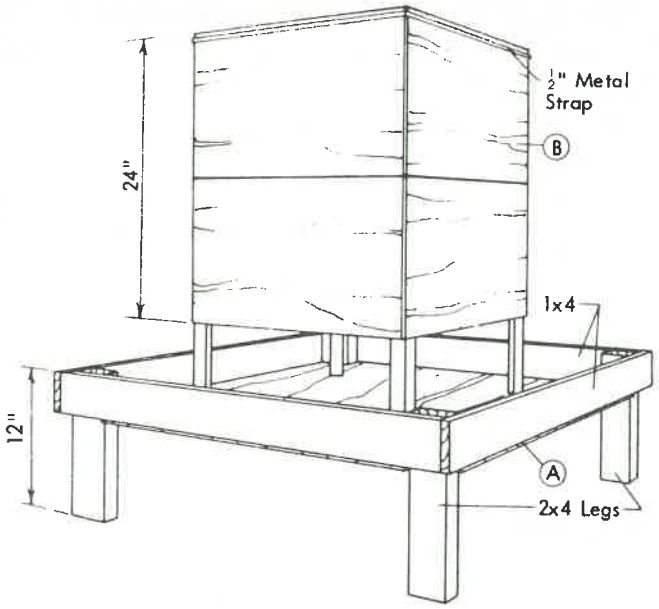
Item	No.	Description
A	4	2x2 x 32"
B	3	1x2 x 13-3/4"
C	1	1x2 x 4'-0" Floor
	1	1x12 x 4'-0" Floor
D	1	1x6 x 4'-0"
E	1	2x2 x 4'-0" ripped
F	1	1x4 x 4'-0"
G	1	1x8 x 4'-0"
H	2	1x2 x 22"
I	1	1x1 x 4'-0"
J	3	1x12 x 4'-0"
K	2	1x10 x 4'-0"
L	4	1x12 x 17-3/4"
M	2	1x10 x 17-3/4"
N	1	10" x 22-gage x 4'-0"
O	2	3/8" x 1-1/2" carriage bolt

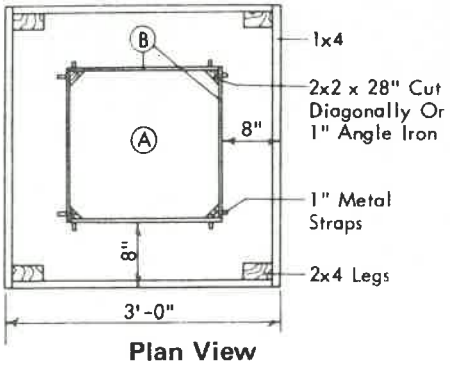


Single-Sided Option

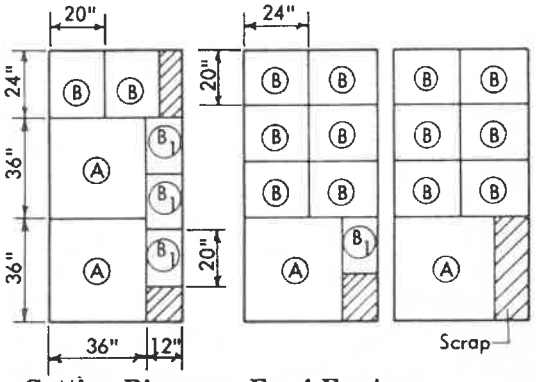
Self-feeders

Plywood Box Feeder





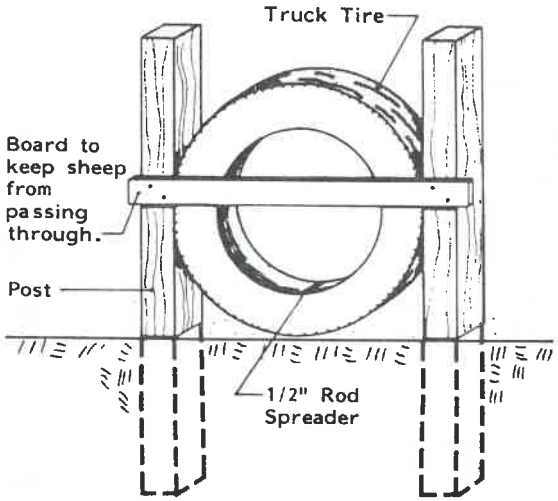
Plan View



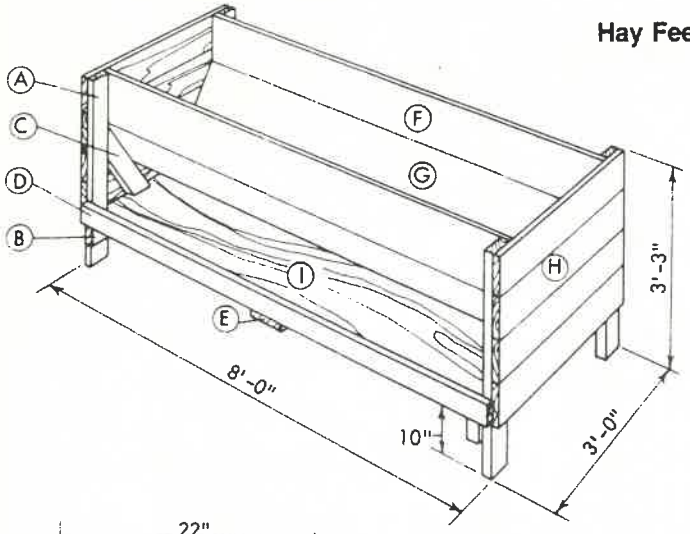
Cutting Diagrams For 4 Feeders

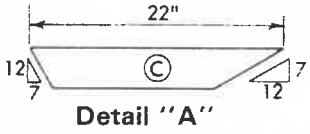
½" Plywood (4'x8' Sheets)
2 sides must be pieced with 2-12" x 20" pieces B_1

Tire Feeder



Hay Feeder

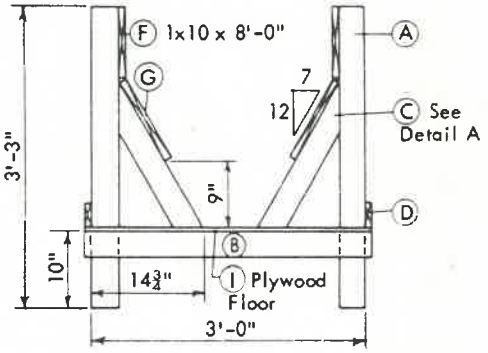




Detail "A"

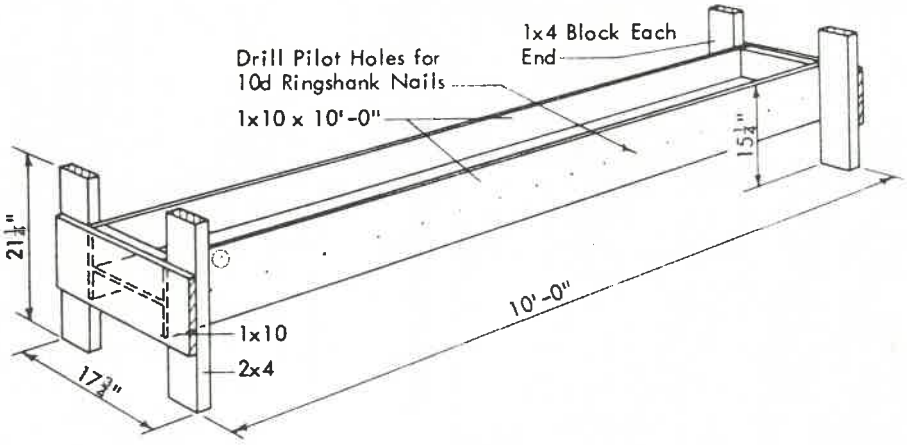
CUTTING LIST

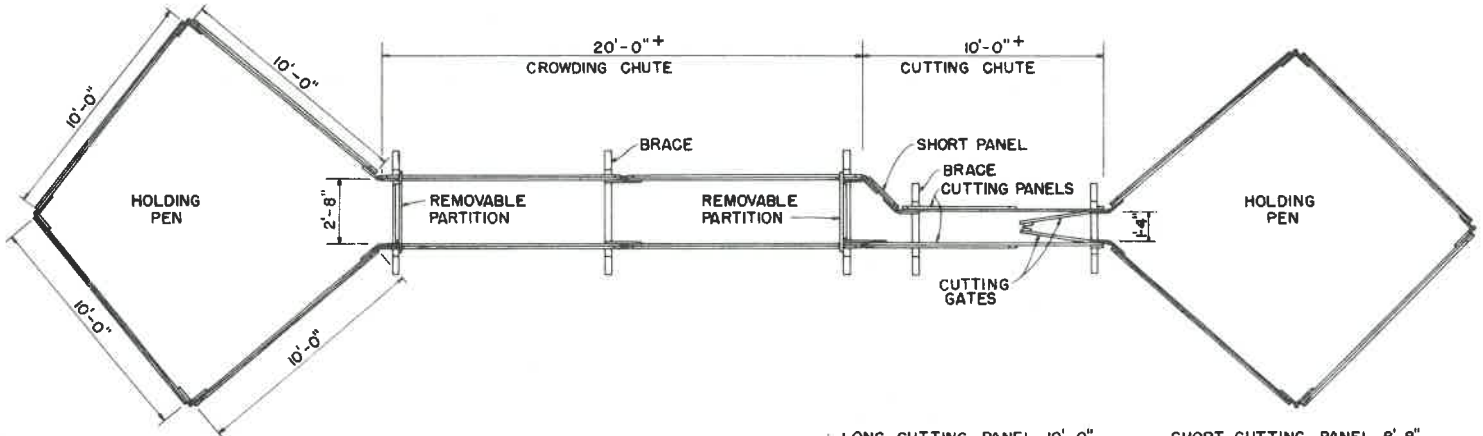
Item	No.	Item
A	4	2x4 x 3'-3"
B	2	2x4 x 3'-1-1/2"
C	4	2x4 x 22"
D	2	1x4 x 8'-0"
E	1	1x8 x 3'-1-1/2"
F	2	1x10 x 8'-0"
G	2	1x12 x 8'-0"
H	8	1x8 x 3'-0"
I	1	3'-0" x 8'-0" x 3/8" C-C ext. plywood

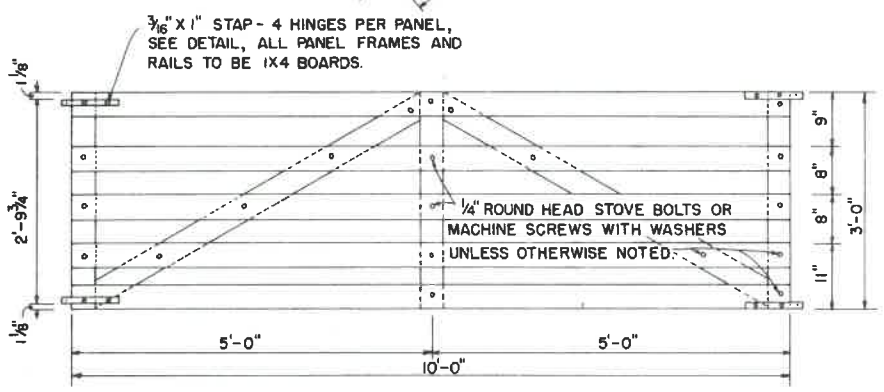


Grain Bunk

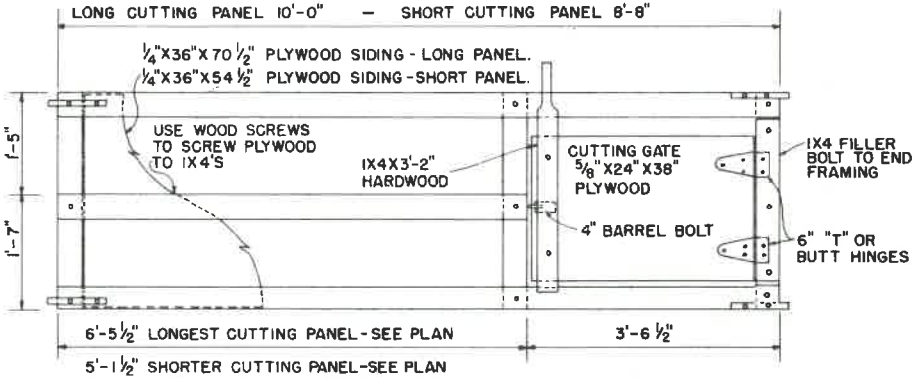
Grain for Ewes



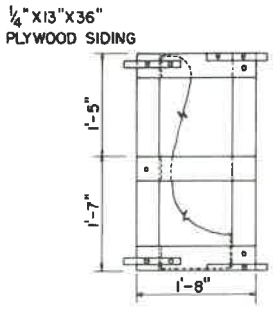




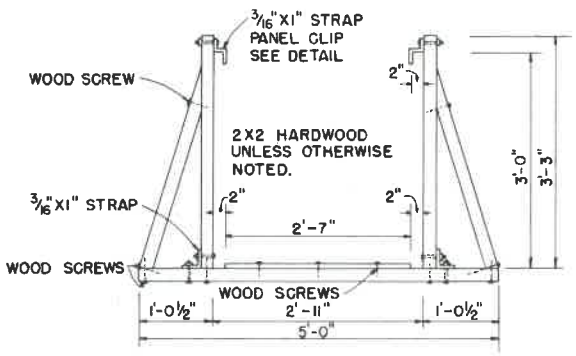
STANDARD PANEL - 12 REQUIRED



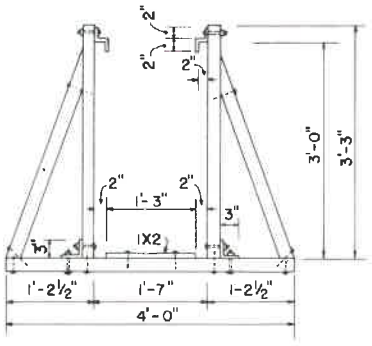
CUTTING PANELS - 1 EACH SIZE REQUIRED



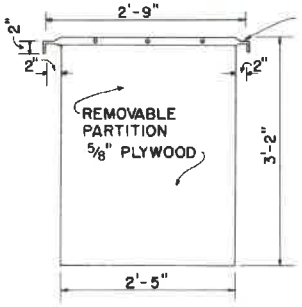
SHORT PANEL - 1 REQUIRED



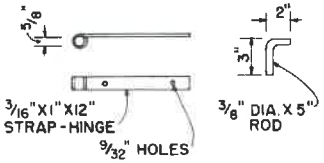
CROWDING CHUTE BRACE - 3 REQUIRED



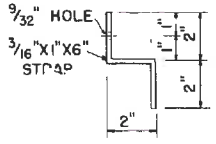
CUTTING CHUTE BRACE - 2 REQUIRED



REMOVABLE PARTIONS - 2 REQUIRED



HINGE & PIN DETAILS



PANEL CLIP DETAIL

MATERIALS:

78 PCS. 1X4X10'-0"
15 PCS. 1X4X12'-0"
5 PCS. 2X2X10'-0" HARDWOOD.
4 PCS. 2X2X12'-0" HARDWOOD.
1 SHEET 5/8" EXT. PLYWOOD.
2 SHEET 1/4" EXT. PLYWOOD.
1 PIECE 1X2X12'-0" HARDWOOD
3/16"X1"X76'-0" STRAP IRON
2 PR. 6" "T" OR BUTT HINGES
3/8" DIA. X12'-6" STEEL ROD
TWO-4" BARREL BOLTS
VARIOUS FASTENERS - SCREWS-BOLTS & WASHERS

BASED ON: W.VA. UNIV. PLAN NO. SH-152

PORTABLE HANDLING FACILITY FOR SHEEP		
W.VA. '75	6236	SHEET 1 OF 1

You can order these plans

S[illegible]erences

Available from Northeast Regional Agricultural Engineering Service (NRAES), Cornell University, 144 Riley-Robb Hall, Ithaca, NY 14853. (607) 256-7654

NRAES-1 *Pole and Post Building Construction* ($2.00)

NRAES-11 *High-Tensile Wire Fencing* ($1.00)

NRAES-15 *Planning Dairy Stall Barns* ($1.50)

NRAES-16 *Planning Farm Shops* ($2.50)

Available from Midwest Plan Service or from NRAES, 122 Davidson Hall, Iowa State University, Ames, Iowa 50011. (515) 294-4337

MWPS-8 *Swine Handbook* ($5.00)

MWPS-15 *Horse Handbook* ($4.00)

MWPS-3 *Sheep Handbook* ($5.00)

MWPS-6 *Beef Handbook* ($4.00)

MWPS-7 *Dairy Handbook* ($5.00)

MWPS-2 *Farmstead Planning Handbook* ($4.00)

MWPS-13 *Planning Grain-Feed Handling* ($4.00)

MWPS-14 *Private Water Systems* ($4.00)

MWPS-23 *Solar Livestock Housing Handbook* ($4.00)

MWPS-1 *Structures & Environment Handbook* ($15.00)

MWPS-18 *Livestock Waste Facilities Handbook* ($4.00)

MWPS-24 *Onsite Domestic Sewage* ($4.00)

Available from Cooperative Extension Service, Purdue University, CES Mailing Room, AGAD Bldg., West Lafayette, IN 47907.

Energy Management in Agriculture Series
Free to Indiana residents; $0.50 each to others:

AE-95 *Insulating Livestock and Other Farm Buildings*

AE-96 *Environmental Control for Confinement Livestock Buildings*

AE-99 *Solar Heating Systems for Confinement Livestock Buildings*

AE-101 *Energy Conservation in Swine Buildings*

AE-102 *Wind and Snow Control for the Farmstead*

AE-103 *Cooling Systems for Livestock*

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