Milking Parlour

On commercial farms where several cows are milked at the time, a milking parlour becomes a feasible investment. Several types of milking parlours are in use in dairy regions throughout the world. Figure 10.16 a, b, c and d, illustrate some of the most common types.

Any type of parlour should have a high quality concrete floor and metal railings for durability and ease of cleaning. Walls are not required, but if supplied they should at least be plastered masonry walls. The pit where the milker stands should have a floor level 900mm below that of the cattle stands for the most comfortable work position.

The number of stands is determined by the allowable milking time of the herd or time taken to the concentrate ration.

Abreast Parlour

The abreast parlour allows cows to enter and leave individually. The variation of this parlour shown here, in which the front of the stands can be opened so that the cows can proceed forward out of the parlour after milking has proved effective. The main drawback with the abreast parlour is the relatively long distance to walk between milking points, and cows obstructing the herdsman, since they share the same floor space.

The stands should be 1.0 to 1.1m wide when a bucket milking machine is used or when hand milking is practiced, while 0.7 to 0.8m is adequate when a pipeline milking system is installed. In both cases the width for the milker should be 0.6 to 0.8m. A two-level abreast parlour, in which the milker works at a lower level than the cows stand, is more difficult to construct and has no outstanding advantages over the single level type. The abreast parlour has been common in East Africa for herds of more than 40 cows, but its uses is decreasing and giving way to the double herringbone parlour.

Tandem Parlour

The tandem parlour also allows for individual care of the cows. It is used mostly for smaller commercial herds and in particular, for herds with high yielding cows. The main drawbacks with this type of parlour are its larger space requirement and more expensive construction when compared to other types of parlours; of similar capacity.

The parlour capacity in terms of cows milked per hour and labour efficiency can compare to that of a small herringbone parlour.

Figure 10.15 Milking parlour for a medium size herd.

Walk-through Parlour

In walk-through or chute parlours cows enter and leave in batches. They have been used mainly for small herds. Their narrow width can be an advantage where a parlour is to be fitted in an existing building, but it is inferior to other types in most other respects, however, it is cheaper to construct than a tandem parlour.

Herringbone Parlour

The herringbone parlour layout results in a compact working area and allows feeders to be fixed to the side walls. Four stands on each side of the pit, as shown in Figure 10.16c, is the minimum size of this type for high labour efficiency. If the herd has fewer than 80 cows, then a double-three parlour will keep the investment lower with only a small drop in labour efficiency. The popularity of the herringbone parlour is mainly due to its simplicity and its high capacity measured in numbers of cows milked per man-hour. (A man-hour is the equivalent of one man working for one hour). However, the risk of cows kicking the herdsman is greater in this type than in parlours where the herdsman stands alongside the cow.

Double 6, 8, 10 and even 12 stand parlours are used for very large herds. These larger parlours allow more cows to be milked per hour, but because of the need for more workers and the increased waiting time to allow all cows on one side to finish before they are released, the output per man-hour is usually less.

Grain Feeders

It is advantageous to equip milking parlours with grain feeders which allow each cow to be fed in ratio to her production. Since cows are more likely to enter the parlour when they expect to be feds some labour will be saved. Manual distribution of the concentrates with a measuring scoop is recommended except in the largest herds. Semi automatic and automatic systems are expensive to install and require spare parts and mechanics for their maintenance and these may not be available when needed.

Figure 10.16a Abreast parlour.

Figure 10.16c Walk through parlour.

Figure 10.16b Tandem parlour.

Figure 10.16d Herring-bone parlour.

Collecting Yard

The cows are normally assembled in a collecting yard (holding area) before milking. This may be a portion of the yard that is temporarily fenced off with chains. The collecting yard should have a minimum size of 1.1 to 2.0m per cow. Large horned cows and a low herd number will require the largest space per cow. Provision must be made for water for the cows awaiting their turn to enter the parlour. The area should slope away from the parlour 20 to 100mm/m. This not only improves drainage, but also encourages the cows to face the entrance.

The collecting yard should be paved for easy cleaning and to allow for sanitary conditions in the parlour. A roof is desirable for shade and to avoid wet cows entering the parlour in the rainy season and it will reduce the amount of rainwater that has to be stored in the manure pit.

Entrance and Exit

An entrance into the parlour that is straight (no turns) will ensure a smooth and convenient operation. Once trained, cows and heifers will walk readily into the parlour.

A single step of about 100mm will help to keep manure from being carried into the parlour.

An exit leading into an uncrowded area will facilitate animal flow. A straight exit is desirable but not as important as a straight entry. If exiting alleys are needed they should be narrow (700 to 900mm depending on cow size), to keep the cows from turning around.

Feeding Equipment

One advantage of loose housing of cattle is the opportunity to construct the feed trough in the fence allowing easy access for filling. The simplest type of manger consists of a low barrier with a rail fixed above. However, cattle have a tendency to throw feed forwards while eating, but a wall in front, as shown in Figure 10.18, will reduce this problem. The dimensions of the trough must be chosen to conform with the height, reach and required width of the feeding space for the animals to be fed, while providing enough volume for the amount of feed distributed at each feeding time. Figures 10.17, 10.18 and 10.19.

Although timber construction is simple to install, concrete should be considered because of its greater durability. When timber is used, the base should be well treated with wood preservative. However, the preservative should not be used on any surface which cattle can reach to lick as some preservative materials are toxic to animals. When concrete is used, it should be at least C20, or a nominal mix of 1:2:4; since a lower grade concrete would soon deteriorate due to chemical attack by feed stuffs and the cow's saliva. The cows will press against the barrier before and during the feeding so that the head rail must be firmly fixed to the vertical posts, which are immovably set in the ground.

A 2.5m wide concrete apron along the feed trough will reduce the accumulation of mud. A narrow step next to the trough will help to keep the trough free of manure as animals will not back up on to such a step. The bottom of the feed trough should be at a level 100 to 400mm above the level at which the cow is standing with her front feet.

A slightly more elaborate feed trough separates the cattle by vertical rails or tomb stone barriers, as shown in Figure 10.19, to reduce competition during eating. The tombstone barrier may also reduce fodder spillage because the cow has to lift her head before withdrawing it from the trough.

A simple roof constructed over the feed trough and the area where the cows stand to eat will serve as a shade and encourage daytime feeding in bright weather while serving to protect the feed from water damage in rainy periods.

Watering Equipment

Drinking water for cattle must be clean. Impurities may disturb the microbiological activities in the rumen. Table 10.7 shows the requirement of drinking water, but a hot environment may considerably increase it. In dairy cows the need for water will increase with milk yield.

	Calves	**Heifers**	**Mature Cows**
A Reach at ground level	550	650	700
B Reach at 300mm above ground level	700	850	900
C Throught height	350	500	600
D Height to the withers	1000	1200	1300
Width of feeding space:when all animals feed at once	350 - 500	500 - 650	650 - 750
feed always available	100	150	220

Level of feed trough bottom above level of stand	50 - 200	100 - 300	100 - 400

Figure 10.17 Dimension for feed trough design for cattle.

Figure 10.18a Perspective view of Timber Feed Trough.

Figure 10.18b Timber Trough.

Figure 10.18c Concrete Trough and a Step in front of the Trough.

Figure 10.18d Masonry Walls in the Trough.

Dimension	**Calves**	**Heifers**	**Mature Cows**
A	800 - 900	900 -1000	1000 - 1200
B	300	400	500
C	50 - 200	100 - 300	100 - 400
D	500 - 700	650- 850	700 - 900
E	300 - 550	400 - 650	450 - 700

Figure 10.19a Perspective view.

Figure 10.19b Section.

Figure 10.19c Alternative Design.

Dimension	**Calves**	**Heifers**	**Mature Cows**
A	850-950	1000- 1100	1100- 1200
B	350	450 - 500	550
C	50 - 200	100 - 300	100 - 400
D	500 - 700	650 - 850	700 - 900
E	300 - 550	400 - 650	450 - 700
F	150 - 250	150 - 450	500
G	130 - 150	170 - 200	200

Table 10. 7 *Drinking Water Requirement for Cattle*

	litre/day
Calves	10
Young stock, average	25 (8 - 12/100 kg body weight)
Heifers	35 - 45
Beef cows	30 - 45
Beef cattle	15 - 30
	(30 - 60 in hot environment)
Dry dairy cows	40 - 60
Milking cows	SO - 100

Water Troughs

The size of a water trough depends on whether the herd is taken for watering periodically or is given water on a continuous basis. If water is limited, the length of the trough should be such that all of the cows can drink at one time. A trough space of 60 to 70cm should be allowed for each cow. For free choice, the trough should be sized

for 2 to 3 cows at a time. One trough should be provided for each 50 animals. Figure 10.20a and b shows a well designed trough made of concrete. The length may be increased if necessary. A float valve installed on the water supply pipe will control the level automatically. A minimum flow rate of 5 to 8 litres per minute for each cow drinking at one time is desirable. To prevent contamination of the water trough with manure, the trough should preferably have a 300 to 400mm wide step along the front. The animals will readily step up to drink, but will not back up onto the raised area. An alternative is to make the sides facing the cattle sloping as shown in Figure 10.20c.

Young stock held in a loose housing system require one water trough for each 50 to 60 animals. A 60cm height is satisfactory. A minimum flow rate of 4 to 5 litres per minute for each animal drinking at one time is desirable.

Figure 10.20 Concrete water trough.

Automatic Drinkers

Automatic drinkers which are activated by the animals provide a hygienic means of supplying water for cows and young stock. Figure 10.21. When used in loose housing systems for cows the bowl should be placed at a height of 100cm and be protected by a raised area beneath it. (1m and 150 to 200mm heigh). One bowl should be provided

for each 10 to 15 cows.

A nipple drinker without bowl provides the most hygienic means of watering for young stock, but most nipples have limited flow rate and can therefore not be used for calves older than 6 months.

Feed Handling

The types and quantities of feed stuffs to be handled varies greatly from farm to farm.

Figure 10.21 Automatic Drinker.

Dry Hay or Forage

If an adequate supply of green forage can be grown throughout the year, then only temporary forage storage and space for chopping is required. On the other hand if a prolonged dry season makes it necessary to conserve dry forage, a storage method that will prevent spoilage is essential. A raised slatted floor with a thatched or corrugated steel roof will provide good protection for hay. A simple storage similar to the sunshade shown in Figure 10.4 will be adequate.

If the store is filled gradually, it may help to have some poles in the top of the shed on

which to spread hay for final drying before it is packed into the store. Loose hay weighs about 60 to 70 kg/m. Although requirements will vary greatly a rough guide is 3 to 5 kg of hay or other forage per animal per day of storage.

Silage

Good quality silage is an excellent feed for cattle. However, it is not practical for the small holder with only a few cows because it is difficult to make small quantities of silage without excessive spoilage.

Successful silage making starts with the right crop. The entire maize plant including the grain is ideal as it has enough starch and sugar to ferment well. In contrast many grasses and legumes do not ferment well unless a preservative such as molasses is added as the forage is put into the silo.

It takes a good silo to make good silage. The walls must be smooth, air-tight and for a horizontal silo the walls should slope about 1:4 so that the silage packs tighter as it settles. The forage to be made into silage should be at about 30 to 50% moisture content and must be chopped finely and then packed tightly into the silo. The freshly placed material must be covered and sealed with a plastic sheet. Failure at any step along the way spells disaster.

The large commercial farmer, with well constructed horizontal or tower silos and the equipment to fill them, has the chance to make excellent feed. However, good management is no less important, regardless of size.

Concentrates and Grains

Again the amount to be stored is highly variable. The method of storing is little different from food grains and suitable storage facilities are discussed in Chapter 9.

Manure Handling

Careful waste management is needed:

- to utilize the fertilizing qualities of the manure, urine and other wastes;
- to maintain good animal health through sanitary facilities;
- to avoid pollution of air and water and to provide good hygiene around the farmstead.

The method of disposal depends on the type of wastes being handled. Solids can be stacked and spread on fields at the optimum time of year, while liquids must be collected in a tank and may be spread from tank-wagons.

Manure from a livestock production unit may contain not only faeces and urine, but also straw or other litter materials, spillage from feeding, and water. If silage is produced on the farm, the runoff from the silos should be led to the urine collection tank. Depending on the wilt the amount of effluent can vary from zero to 0.1 m or more per tonne of silage but normal storage allowance is 0.05 m per tonne.

Manure is handled as solid when the dry matter content exceeds 25%. In this condition the manure can be stacked up to a height of 1.5 to 2 metres. This condition of the manure is only obtained when urine is drained away immediately and a prescribed amount of litter, like straw or sawdust, is used. The use of 1 to 2.5 kg of litter per cow per day will ensure that the manure can be handled as a solid. Manure with less than 20% solids has the consistency of thick slurry. It must be collected in a tank or pit but is too thick to handle effectively with pumps. It must be diluted with water to less than 15% solids before it can be pumped with a conventional centrifugal pump. If diluted in order to use irrigation equipment for spreading liquid manure, the solids must be below 4%.

The amount of manure as well as the composition varies depending upon factors such as feeding, milk yield, animal weight, position in the lactation period, and health of the animal. Cattle fed on 'wet' silages or grass produce more urine. Table 10.8 shows the manure production in relation to the weight of the animals.

To estimate the volume of manure and bedding, add the volume of manure from Table 10.8 to half the volume of bedding used. Heavy rains requires removal of liquid for stacked manure, within the storage period. Similarly the storage capacity must be increased by about 50% or a roof should be built over the storage when slurry or liquid manure.

Example

Find suitable dimensions for a slurry manure pit with access ramp given the following:

Animals: 5 dairy cows 500 kg

Storage period: 30 days

Maximum slope of access ramp: 15%

Storage capacity (V) needed (see Table 10.8);

V = 5 x 30 x 0.055 = 8.25m

Table 10.8 ***Manure Production in Cattle***

Weight of animal	**Faeces**	**Urine**	**Total Manure Storage capacity to be allow***	
kg	kg/day	kg/day	kg/day	m/day
Dairy cattle				
50	2.7	1.2	3.9	0.004
100	5.2	2.3	7.5	0.009
250	14	6	20	0.025
400	23	10	33	0.045
600	35	1 5	50	0.065
Beef cattle				
350	15	6	21	0.025
450	19	8	27	0.035
550	24	10	34	0.045

*** These values are for manure only - no bedding is including. Washing water used in the milking parlour may amount up to 300 litres/stall/milking. Usually 50 litres/head/day to allowed.**

(Normal variation can be as much as 20% of the tabled figures).

Assume the pit will be 0.5m deep and 5m long, see sketch

Total width (W) will then be:

$W = V / (l_1 + 0\ 5l_2)\ h$

$l_2 = h / 0.15 = 0.5 / 0.15 = 3.3m$

$l_1 = l - 1_2 = 5 - 3.3 = 1.7m$

$W = 8.25 / (1.7 \times 0.5 \times 3.3) \times 0.5 = 4.9m$

A pit 5 x 5 x 0.5m with a slope on the access ram of 15% is chosen.

Cattle Dips

Ticks continue to be one of the most harmful livestock pests in East Africa. As vectors of animal diseases ticks have been a great hindrance to livestock development especially in areas where breeds of cattle exotic to the environment have been

introduced.

At present the only effective method of control for most of these diseases is control of the vector ticks. Dipping or spraying with an acaricide is the mose efficient way of reducing the number of ticks.

Siting a Dip

The ground where a dip is to be built, and the area around should be slightly sloping and as hard as possible, but not so rocky that a hole for the dip cannot be dug. Laterite (murram) soil is ideal: The ground must:

- **support the structure of the dip;**
- **be well drained and not muddy in wet weather, and**
- **be resistant to erosion or gullying of cattle tracks.**

Cattle must not be hot or thirsty when they are dipped, so it is important to have a water trough inside the collecting yard fence.

Figure 10.22 Manure pit with access ramp.

Waste Disposal and Pollution

All dipping tanks need to be cleaned out from time to time and disposed of the accumulated sediment. It is normal for all the waste dip-wash to be thrown into a 'waste pit' that is dug close to the dip. In addition dipping tanks may crack with leakage of acaricide as a result.

The siting of the dip and the waste pit must therefore ensure that there is no risk of acaricide getting into drinking water supplies, either by overflowing or by percolating through the ground. The waste pit should be at least 50 metres from any river or stream, 100 metres from a spring or well, and considerably more than that if the subsoil is sandy or porous. Figure 10.23 shows a typical site layout and describes the features in the order that the cattle come to them.

Footbaths

Footbaths are provided to wash mud off the feet of the cattle to help keep the dip clean. At least two are recommended, each 4.5 metres long and 25 to 30cm deep, but in muddy areas it is desirable to have more. Up to 30 metres total length may sometimes be required. Figure 10.23.

The floor of the baths should be studded with hard stones set into the concrete to provide grip, and to splay the hoofs apart to loosen any mud between them.

The footbaths should be arranged in a cascade, so that clean water added continuously at the end near the dip, overflows from each bath into the one before it, with an overflow outlet to the side near the collecting pen. Floor level outlet pipes from each bath can be opened for cleaning.

If water supply is extremely limited, footbath water can be collected in settling tanks and reused later.

Jumping Place A narrow steep flight of short steps ensures:

- **that animals can grip and jump centrally into the dip,**
- **that their heads are lower than their rumps at take-off,**
- **that they jump one at a time, and**
- **that dip-wash splashing backwards returns to the dip.**

The lip of the jumping place experience extreme wear and should be reinforced with a length of 10cm diameter steel pip.

Figure 10.24 shows the jumping place 40cm above the dip-wash level. While such a height is desirable to give maximum immersion, there could be some danger to heavily pregnant cows if the water level was allowed to fall a further 40cm. (The dipping of

1,000 cattle without replensihment would lower the water level to 60cm below the jumping place).

Splash walls and ceiling are provided to catch the splash and prevent the loss of any acaricide. The ceiling will protect a galvanized roof from corrosion. The walls can be made of wood, but masonry is most durable.

Figure 10.23 Cattle dip layout.

Figure 10.24 Cattle dip.

The Dipping Tank

The dipping tank is designed to a size and shape to fit a jumping cow and allow her to climb out, while economizing as far as possible on the cost of construction and the recurrent cost of acaricide for refilling. A longer tank is needed if an operator standing on the side is to have a good chance of reimmersing the heads of the animals while they are swimming, and increased volume can slightly prolong the time until the dip must be cleaned out. In areas with cattle of the 'Ankole' type with very long horns, the diptank needs to be much wider at the top.

Poured reinforced concrete is the best material to use in constructing a dipping tank in

any type of soil although expensive if only a single tank is to be built, because of the cost of the form-work involved, the forms can be reused. If 5 tanks are built with one set of forms the cost per tank is less than the cost of building with other materials, such as concrete blocks or bricks. A reinforced concrete dipping tank is the only type with a good chance of surviving without cracking in unstable ground. In areas prone to earthquakes a one-piece tank is essential.

Catwalk and hand rails are provided to allow a person to walk between the splashwalls to rescue an animal in difficulty.

In addition to providing shade, a roof over the dipping tank reduces evaporation of the dip-wash, prevents dilution of the dip-wash by rain, and in many cases, collects rain water for storage in a tank for subsequent use in the dip.

Draining Race

The return of surplus dip-wash to the dipping tank depends on a smooth, watertight, sloping floor in the draining race.

A double race reduces the length and is slightly cheaper in materials, but a very long single race is preferable where large numbers of cattle are being dipped. Side-sloping

of the standing area towards a channel or gutter increases the back-flow rate. The total standing area of the draining race is the factor that limits the number of cattle that can be dipped per hour, and the size shown in the drawings should be taken as the minimum.

A silt trap allows settling of some of the mud and dung from the dip-wash flowing back to the tank from the draining race. The inlet and outlet should be arranged so that there is no direct cross-flow. Provision must be made to divert rain water away from the dip.

Cattle Spray Race

A spray race site requires the same features as a dip site and these have already been described. The only difference is that the dip tank has been changed for a spray race. The race consists of an approximately 6m long and 1m wide tunnel with masonry side walls and a concrete floor. A spray pipe system on a length of 3 to 3.5m in the tunnel having 25 to 30 nozzles place in the walls, ceiling and floor, discharge dip liquid at high pressure and expose the cattle passing through to a dense spray. The fluid is circulated by a centrifugal pump giving a flow of 800 litres per minute at 1.4 kg/ cm pressure. Power for the pump can be supplied by a 6 to 8 horsepower stationary engine, a tractor power take-off, or a 5-horse-power electric motor. The discharged fluid

collected on the floor of the tunnel and draining race is led to a sump and re-circulated. In addition to being cheaper to install than a dipping tank the spray race uses less liquid per animal and operates with a smaller quantity of wash, which can be freshly made up each day. Spraying is quicker than dipping and causes less disturbance to the animals. However, spray may not efficiently reach all parts of the body or penetrate a fur of long hair. The mechanical equipment used requires power, maintenance and spare parts and the nozzles tend to get clogged and damaged by horns.

Handspraying is an alternative method that can work well if carried out by an experienced person on an animal properly secured in a crush. The cost of the necessary eqyuipment is low, but the consumption of liquid is high as it is not re-circulated. The method is time consuming and therefore only practicable for small herds where there is no communal dip tank or spray race.

Click here to continue

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Pig Housing

Contents - **Previous** - **Next**

Pig farming is realtively unimportant in most regions of Africa, as in most tropical countries, except China and South-East Asia. However, pig production is increasing in many tropical countries as processed pork finds an increasing market and pig production yields a relatively rapid rate of return on the capital employed. Pigs are kept primarily for meat production, but the by-products, such as pigskin, bristles and manure are also of economic importance.

To some extent pigs compete with man for food, but they can also utilise by-products and wastes from human feeding.

Management Improvements

In many tropical countries pigs roam freely as scavengers or are raised in the back-yard where they depend on wastes for feed. Little attempt is made to obtain maximum In many tropical countries pigs roam freely as scavengers or are raised in the back-yard where they depend on wastes for feed. Little attempt is made to obtain maximum productivity. However, a few simple management practices can help to improve the

productivity and health of these pigs. They include:

1 Fenced paddocks with shade and water where:

- **a Pigs are protected from direct sun, which will cause sunburn, and sometimes sunstroke particularly with whiteskinned pigs.**
- **b Pigs can be fed supplementary feed secure from neighbouring pig.**
- **c Some basic measures to control disease and parasites are possible to reduce the often very high mortality rate and to improve the poor reproductive and growth performance and inferior quality of meat experienced in traditional pig production in the tropics. The paddock can be sub-divided into 4 to 6 smaller areas so that pigs can be moved from one enclosure to another at 2 week intervals.**
- **d Sows can be bred to selected sires.**

2 Simple semi-covered pens constructed of rough timber with a thatch roof and floor of concrete as shown in Figure 10.25. An earth floor can be used, but is more difficult to keep clean and sanitary. Several pens can be arranged in a row as required. The main disadvantage with this type of accommodation is the relatively high labour requirements for cleaning.

3 Wallows or sprinklers can be provided to alleviate heat stress. Being unable to sweat sufficiently pigs have a natural instinct to wallow to increase the evaporative cooling from the skin.

Figure 10.25 Smallholder's pigsty for one sow with litter or 4 to 5 fattening pigs.

While such improvements have the advantage of low investment in buildings and less need for balanced feed rations, they should only be regarded as first steps in raising the general level in present primitive systems.

The raising of pigs in confinement is gradually replacing the old methods because of lower production costs, improved feed efficiency and better control of disease and parasites. Thus, the confinement system is usually advisable in circumstances where:

- **good management is available;**
- **high-quality pigs ate introduced;**
- **farrowings occur at regular intervals throughout the year;**
- **land is scarce or not accessible all the year;**
- **balanced rations ate available;**
- **labour is expensive;**
- **parasite and disease control is necessary;**

- **the target is commercial production;**
- **herd size is reasonably large.**

Some systems keep only part of the herd in confinement. The order of priority for confinement housing for the different classes of animals is usually as follows:

- **1 Growing/finishing pigs (25-90 kg or more liveweight) for higher control daily gain, better feed conversions dna pasite control.**
- **2 Farrowing and lactating sows, to reduce pre-weaning mortality and for higher quality weaners.**
- **3 Gestating sows, to allow individual feeding and better control of stock.**

Management Systems in Intensive Commercial Pig Production

There is no standard type or system of housing for pigs. Instead, accommodation and equipment are chooser to suit the type of management system adopted. However, there are certain similar principles and practices in most systems. These originate from the fact that most pig units will contain pigs of different ages and classes as show in Figure 10.26.

Farrowing-Suckling Pens

In small and medium scale intensive pig production units a combined farrowing, suckling and rearing pen is normally used. The sow is brought to this pen one week before farrowing and stays there together with her litter for 5 to 8 weeks when the piglets are weaned by removing the sow. The sow is often confined in a farrowing crate a few days before, and up to a week after birth to reduce piglet mortality caused by overlaying or trampling. Systems 1 and II in Figure 10.27.

Early weaning after a suckling period of 5 to 6 weeks or even less can only be recommended where management and housing is of good standard.

The piglets remain in the farrowing pen after weaning and until they are 12 to 14 weeks of age or weigh 25 to 30 kg.

Group keeping of farrowing-suckling sows that have given birth within a 2 to 3 week interval is possible, but is unusual in intensive production. However, there are few acceptance problems and the litters cross-suckle and mix freely. The pen should have at least 6m deep litter bedding per sow, with an additional creep area of 1m.

In a large scale unit, which has a separate farrowing house, sometimes either of the following two alternative systems ate practiced instead of the system described above:

The first alternative (System III in Figure 10.27) is similar to the system already described, but the piglets are moved two weeks after weaning to a weaner pen where they may remain either until they are 12 to 14 weeks of age (25 to 30 kg) or until 18 to 20 weeks of age (45 to 55 kg). Note that the piglets should always remain in the farrowing/ suckling pen for a further 1 to 2 weeks after the sow has been removed so that they are not subjected to any new environmental or disease stress at the same time as they are weaned. The weaning pens can contain one litter or up to 30 to 40 pigs. The pigs are often fed 'ad libitum'.

Figure 10.26 Flow Chart of the life cycle or pigs.

In the second alternative showing (System IV in Figure 10.27) the sow is placed in a farrowing crate in a small pen one week prior to birth. Two weeks after farrowing the sow and the litter are moved to a larger suckling pen. The piglets may remain in this pen until 12 to 14 weeks of age or be transferred to weaner accommodation two weeks after weaning.

Dry Sow Pens

After weaning a sow will normally come on heat within 5 to 7 days and then at 3 week intervals until successful mating. The average weaning to conception interval can vary

between 8-20 days depending on management. In the period until pregnancy has been ascertained the sow is best kept in a pen or stall in close proximity to the boar pen.

Gestating sows are kept in yards or pens in groups of up to 10 to 12 sows, that will farrow within a 2 to 3 week interval. They can also be kept in individual pens confined in stalls or tethered in stalls.

Weaner and Fattening Pens

The weaners, whether they come from a farrowing pen or a weaner pen, will at 12 to 14 weeks of age be sufficiently hardened to go to a growing/finishing pen. Finishing can be accomplished either in one stage in a growing/ finishing pen from 25 kg to 90 kg - systems 1 and IV in Figure 10.27 or in two stages so that the pigs are kept in a smaller growing pen until they weigh 50 to 60 kg and are then moved to a larger finishing pen where they remain until they reach marketable weight. System II in Figure 10.27. In large scale production the pigs are arranged into groups of equal size and sex when moved into the growing/finishing pen. Although finishing pigs are sometimes kept in groups of 30 or more, pigs in a group of 9 to 12, or even less, show better growth performance in intensive systems. An alternative, where growing and finishing are carried out in the same facility, is to start about 12 pigs in the pen and later, during the finishing period, reduce the number to 9 by taking out the biggest or smallest pigs from

each pen.

Figure 10.27 Flow chart of four different management systems in the pig production.

Replacement Pens

In intensive systems a sow will, on average, produce 3 to 6 litters before she is culled because of infertility, low productivity or age. Young breeding stock should be separated from the rest of the litter at about 3 months of age, since they should be less intensively fed than the fattening pigs. Gilts are first covered when they are 7 to 9 months of age or weight 105 to 120 kg. After mating they can either be kept in the same pen up to 1 week before farrowing, or kept in the gestating sow accommodation, but in a separate group.

Boars in the tropics are usually quiet if run with other boars or with pregnant sows, but may develop vicious habits if shut up alone.

Determining the Number of Pens and Stalls Required in a Pig Unit

One objective in planning a pig unit is to balance the accommodation between the various ages and numbers of pigs. Ideally, each pen should be fully occupied at all times, allowing only for a cleaning and sanitation period of about 7 days between

successive groups.

In the following example the number of different pens required in a 14-sow herd, where 8 week weaning is practised, will be determined.

I Determine the farrowing interval and number of farrowings per year.

Average weaning to conception interval	20 days
Gestation	114 days
Suckling period (7 x 8 weeks)	56 days
Farrowing interval	190 days

Number of farrowings per sow and year 365 / 190 = 1.9

2 Determine the number of farrowing pens.

The piglets remain in the farrowing pen until 12 weeks of age.

Before farrowing	7 days

Suckling period	56 days
Rearing of weaners	28 days
Cleaning and sanitation of pen	7 days
Occupation per cycle	98 days

Thus one farrowing pen can be used for: 365 / 98 = 3 7 farrowings per year.

A 14 sow herd with an average of 1.9 farrowings per sow and year requires (14 x 19) / 3.7 = 7 farrowing pens.

3 Determine the number of servicing/ gestating pens.

Average weaning to conception interval	20 days
Gestation period less 7 days in farrowing pen	107 days
Cleaning and sanitation of pen	7 days
Occupancy per cycle	134 days

Thus one place in the servicing/gestation accommodation can be used for: 365/ 134 = 2.7 farrowings per year.

With a total of 27 farrowings a year

27/2.7 = 10 places would be required.

4 Determine the number of places for replacement stock.

Presume the sows on average get 5 litters, then 20 percent of all litters will be from gilts.

Rearing of breeding stock (12 to 35 weeks)	168 days
Gestation less 7 days in farrowing pen	107 days
Cleaning and sanitation of pen	7 days
Occupancy per cycle	282 days

About 30% more animals are separated than the required number of gilts thus the required number of places in the 14 sow herd will be

(14 x l.9 x 0.2 x 1.3 x 282) / 365 = 6 places

5 Determine the number of places in the growing/finishing accommodation:

One stage finishing:	
Fattening of pigs 12 to 27 weeks of age, (25-90 kg)	105 days
Extra period for last pig in the pen to reach marketable weight	21 days
Cleaning and sanitation of pen	7 days
Occupancy per cycle	133 days

Assuming that 8 pigs per litter will survive to 12 weeks of age the number of places required in the finishing accommodation will be:

(14 x 1.9 x 8 x 133) / 365 = 78

That is 8 pens with 10 pigs in each or 10 pens if each litter should be kept together.

Two stage growing/finishing unit:

Growing pigs 12 to 20 weeks of age will occupy a growing pen for 63 days including 7 days for cleaning.

(14 x 1.9 x 8 x 63) / 365 = 37 places is required in the unit.

Finishing pigs 20 to 27 weeks of age will occupy a finishing pen for 70 days including 14 days emptying period and 7 days for cleaning. (The empyting period will be shorter if the pigs are sorted for size while being transferred from the growing to the finishing pens.

(14 x 19 x 8 x 70) / 365 = 41 places is required in the unit

From the above example it will be appreciated that the number of pens of various kinds required in a pig unit is based on a number of factors. It is, therefore, not possible to lay down hard and fast rules about the relative number of pens and stalls. However, a guide line to the requirement of pens in herds with average or good management and performance in tropical conditions is given in Appendix VI.

Space Requirement

In intensive pig production systems all pigs should be raised on concrete floors to provide for a clean and sanitary environment. In semi-intensive systems a concrete

floor is only used in the pens for finishing pigs and perhaps in the farrowing pens, whereas an earth floor or deep litter bedding is used in other pens and yards. Litter may or may not be used on a concrete floor, but its use is desirable, particularly in farrowing pens.

Because of the cost of a concrete floor there is a tendency to reduce the floor area allowed per animal. However, too high stocking densities will contribute to retarding performance, increasing mortality, health and fertility problems and a high frequency of abnormal behaviour thus endangering the welfare of the animals. Increasing the stocking density must be accompanied by an increased standard of management and efficiency of ventilation and cooling. In particular, to aid in cooling, finishing pigs kept in a warm tropical climate should be allowed more space in their resting area than is normally recommended for pigs in temperate climates. Table 10.9 lists the recommended space allowance per animal at various stocking densities. The figures listed for high stocking density should only be used in design of pig units in cool areas and where the management level is expected to be above average.

The dimensions of a pen for fattening pigs are largely given by the minimum trough length required per pig at the end of their stay in the pen. See Table 10.10. However, the width of a pen with low stocking density can be larger than the required trough length. This will reduce the depth to 2.0 to 2.4m, and thus the risk of having the pigs

create a manure are within the pen.

Furthermore, the flexibility in the use of the pen will increase and the extra trough space allow additional animals to be accommodated temporarily or when the level of management improves.

Sometimes finishing pens are deliberately overstocked. The motive for this is that all pigs in the pen will not reach marketable weight at the same time and the space left by those pigs sent for slaughter can be utilized by the remainder. Such over-stocking should only be practiced in very well managed finishing units.

General Requirements for Pig Housing

A good location for a pig unit meets the following requirements: easy access to a good all-weather road; welldrained ground; and sufficient distance from residential areas to avoid creating a nuisance from odour and flies.

An east-west orientation is usually preferable to minimize exposure to the sun. Breezes across the building in summer weather are highly desirable. A prevailing wind during hot weather can sometimes justify a slight deviation from the east-west orientation. Ground cover, such as bushes and grass, can reduce reflected heat

considerably, and the building should be located where it can most benefit from surrounding vegetation.

A fairly light well drained soil is preferable, and usually the highest part of the site should be selected for construction.

Pig houses should be simple, open sided structures as maximum ventilation is needed. A building for open confine merit is therefore essentially a roof carried on poles. The roof supporting poles are placed in the corners of the pens where they will cause least inconvenience. A free span trussed roof design would be an advantage but is more expensive.

In some circumstances it may be preferable to have solid gable ends and one tight side to give protection from wind or low temperatures, at least for part of the year. If such walls are needed they can often be temporary and be removed during hot weather to allow maximum ventilation. Permanent walls must be provided with large openings to ensure sufficient air circulation in hot weather. If there is not sufficient wind to create a draught in hot weather, ceiling fans can considerably improve the environment.

The main purpose of the building is to provide shade, and therefore the radiant heat from the sun should be reduced as much as possible. In climates where a clear sky

predominates, a high building of 3m, or more, under the eaves gives more efficient shade than a low building. A wide roof overhang is necessary to ensure shade and to protect the animals from rain. A shaded ventilation opening along the ridge will provide an escape for the hot air accumulating under the roof. If made from a hard material the roof can be painted white to reduce the intensity of solar radiation. Some materials such as aluminium reflect heat well as long as they are not too oxidized. A layer of thatch (5cm) attached by wire netting beneath a galvanised steel roof will improve the microclimate in the pens. A roof of thatch is excellent in hot climates, particularly in non-confined systems, but cannot always be used because of fire hazard and because it is attractive to birds and rodents. A pig house with two rows of pens and a central feeding alley would require a ridge height of 5 to 6 metres if covered with thatch.

Table 10.9 ***Dimensions and Area of Various Types of Pig Pens***

	Units	Stocking density		
		Low	Medium	High
A. Farrowing/ suckling pen.				
Resting area, if weaner				

pens are not used	m	10.0	7.5	6.0
Resting area, if weaner pens are used	m	8.0	6.0	5.0
Manure alley width	m	1.7	1.5	1.3
Farrowing pen (System IV)	m:	-	4.5	4.0
Farrowing crate, length excl. trough	m	2.0	2.0	2.0
width depending on size of sow	m	0.65 - 0.75	0.6 - 0.7	0.55 - 0.65
free space behind the crate	m	0.4	0.35	0.3
Piglet creep (incl. in resting area)	m	2.0	1.5	1.0
B. Boar pen				
1. Pen with yard				
Resting are (shaded)	m	6	5	4.5
Yard area (paved)	m	12	10	08
2. Pen without yard	m	9	8	7
C. Gestating sow pens				
1. Loose in groups of 5 - 10 sows				

Resting area (shaded)	m	2.0	1.5	1.1
Yard area (paved)	m	3.5	3.0	2.5
Feeding stalls, depth x width	m	2.0 x 0.6	1.8 x 0.55	1.7 x 0.5
2. Individual stalls with access to manure alley, length of stalls excl. trough	m	2.2	2.1	2.0
width of stalls	m	0.65 - 0.75	0.60 - 0.70	0.55 - 0.65
width of manure alley	m	1.5	1.4	1.3
3. Confined in individual stalls				
length x width of stalls	m	2.2 x 0.70	2.1 x 0.65	2.0 x 0.60
D. Weaner pen (to 25 kg or 12 wks)				
Resting area excluding trough	m/pig	0.35	0.30	0.25
Manure alley width	m	1.0	1.0	1.0
0E. Growing pen (to 40 kg or 17 wks)				
Resting are excluding trough	m/pig	0.5	0.45	0.40
Manure alley width	m	1.1	1.1	1.1

E. Finishing pen, resting area excl. trough

For porkers to 60 kg or 21 wks	m/pig	0.70	0.60	0.50
For beaconers to 90 kg or 27 wks	m/pig	0.90	0.75	0.60
For heavy hog to 120 kg or 33 wks	m/pig	1.0	0.85	0.70
Manure alley width	m	1.2 - 1.4	1.2 - 1.3	1.2

The pen partitions and the 1 metre wall surrounding the building, which serves to reduce heat reflected from the surrounding ground, can be made of concrete blocks or burnt clay bricks for durability or perhaps soil-cement blocks, plastered for ease of cleaning. Regular white washing may improve the sanitary conditions in the pens.

Doors have to be tight fitting and any other openings in the lower part of the wall surrounding the building should be avoided to exclude rats. Apart from stealing feed and spreading disease, large rats can kill piglets.

For all types of confinement housing a properly constructed easily cleaned concrete floor is required. Eighty to 100 mm of concrete on a consolidated gravel base is sufficient to provide a good floor. A stiff mix of 1:2:4 or 1:3:5 concrete finished with a wood float will give a durable non-slip floor. The pen floors should slope 2 to 3% toward the manure alley and the floor in the manure alley 3 to 5% towards the drains.

Click here to continue

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Housing for a Small Scale Pig Unit

Contents - Previous - Next

For units with 2 to 15 sows, specialized buildings for the various stages of production may not be practical or desirable. For the smallest units of 2 to 6 sows a kind of universal pen which is about 2.7m wide and 2.8-3.0m deep (including feed through) which can be used for:

I sow and her litter, or
2 litter of weaned piglets, or
3 to 4 gestating sows, or
9 growing/finishing pigs of up to 90 kg live weight, or
1 boar

This type of pen shown in Figure 10.28, provides a high degree of flexibility but usually does not allow as efficient a use of the building space as the more specialized pens.

When used for farrowing, the pen should be adapted with guard rails 25cm above floor level and 25 from the wall to protect the piglets from being crushed as shown in Figure 10.28b. However, confinement farrowing is one of the most efficient ways of reducing piglet losses. An arrangement with fixed or removable rails, which divide the pen, as shown in Figure 10.28c, will offer some degree of confinement.

In some climates it may be desirable to give sows with litter access to exercise yards. However, for the relatively short suckling period (6 to 8 weeks), it is usually considered best to keep the sows confined in pens with their litters.

A creep for the piglets is arranged in one corner of the pen. It is recommended that a temporary ceiling (e.g. wire netting covered with straw) 50 to 60cm above the floor in the creep area be constructed to prevent draughts and to keep warmer temperatures for the piglets during their first weeks of life. Where electricity is available, heating with an infra-red lamp may be used instead. Piglets are fed in the creep area out of reach of the sow.

Figure 10.29 shows a single row pig unit for 2 sows and fattening pigs, and Figure 10.30

a double row pig unit for 4 sows having a central feeding alley. The semi-covered manure alleys are arranged along the outside walls separated from the resting area of the pen. This arrangement will allow rain water to help flush away the waste to the drain channel and on to the manure store which has to have extra capacity for this water. However, in the 4 sow unit the furrowing pens have fully covered manure alleys for increased protection of the piglets.

The roof may be equipped with gutters so that rain water can be drained away separately or be collected for use as drinking water for the pigs.

A single tubular steel or round timber rail 20cm above the outside, rear wall (1m high) is desirable to increase security without interfering with ventilation.

Both buildings shown in Figures 10.29 and 10.30 can be extended to accommodate 2 to 4 more sows by adding 2 pens for fattening pigs at one end every time a farrowing pen is added at the other end.

Table 10. 10 ***Minimum Trough Length and Height of Partitions in Various Types of Pig Pens***

		Minimum	Minimum

		trough length m/pig	height of pen partitions m
Sow in farrowing pen		0.7	1.0
Loose dry sows in pens		0.5	1.0
Stall for dry sows		0.5	1.0
Boars		0.6	1.2
Piglets	10 kg	0.14 - 0.15	0.6
Piglets	15 kg	0.16 - 0.17	0.7
Pigs	25 kg	0.18- 0.20	0.8
Pigs	40 kg	0.22 - 0.24	0.9
Pigs	60 kg	0.25 - 0.27	0.9
Pigs	90 kg	0.30 - 0.32	0.9
Pigs	120 kg	0.35 - 0.37	1.0

Figure 10.28 Universal pen.

Figure 10.29 Single row pig unit for 2 sows and fatteners.

Figure 10.30 Double row pig unit for 4 sows and fatteners.

Housing for the Medium Scale Pig Unit

In pig units for more than six to eight sows it becomes feasible to construct specialised pens for the various production stages, but these can still be accommodated under the same roof. A larger production volume can be accommodated by extending the unit shown in Figure 10.31 up to about 15 sows. A further increase should then be accomplished by building an additional separate unit of this type with up to 15 sows, as too many animals in one building is a potential health hazard.

Housing for the Large Scale Pig Unit

In large scale units special provisions must be made for efficient health control. This means: not too many animals in one building; animals of approximately the same age housed together; using an all-in-all-out system with thorough cleaning and disinfection of every house between each batch of pigs; placing the buildings 15 to 20m apart and surrounding the entire site with a secure fence.

Specialised pens in separate houses for the various stages in the production is normally feasible in units for more than 20 to 30 sows. Each type of pen can be designed with dimensions for the most efficient use of the building space, as they don't have to fit in a layout with other types.

Farrowing House

The type of farrowing pen shown in Figure 10.32 offers a relatively high degree of confinement in that the sow is restrained in a farrowing crate during farrowing. Five to ten days after farrowing the crate is removed or opened, to free the sow, as indicated in the figure. A slightly askew arrangement of the farrowing crate will allow for a longer trough for the piglets in the front of the pen, but is more complicated to construct.

A reduction in space requirement can be accomplished by putting the sow in a farrowing pen, consisting merely of a farrowing crate with 0.5 and l.0m wide creep areas on either side, one week prior to farrowing. Two weeks after farrowing the sow and piglets must be transferred to a suckling pen equipped like the pen shown in Figure 10.28b but with the dimensions 2.3m wide, by 2.35m deep and with a 1.4m wide manure alley.

Figure 10.31 Pig unit for 10 sows and fatteners.

Figure 10.32 Farrowing pens with crates for confinement of the sow during birth.

Housing for Growing/Finishing Pigs

Growing/Finishing pens 2.8m wide by 1.9 to 2.2m deep and with a 1.2m manure alley can accommodate the following number of pigs, according to their weight:

up to 40 kg - 12 pigs
40 - 90 kg - 9 pigs
over 90 kg - 7 pigs

Where it is very hot it is preferable to reduce the number of pigs per pen below the numbers given here. The manure alley must be well drained, preferably by a covered drain, but an open drain will also serve provided that it is outside of the pen to prevent urine from flowing from one pen to another. Bedding in the pens is preferable for the animals' comfort and to reduce stress, as the bedding will provide them with something to do. Controlled feeding is important to ensure the best possible feed conversion.

Housing for Gestating Sows

Gestating sows are usually the last group in a pig herd to be considered for confinement housing. However, there are obvious advantages which could have a great influence on the production efficiency when sows are confined and controlled during gestation.

As their litters are weaned, sows can be returned to the gestating sow structure and placed in one of the pens arranged on either side of the boar pens for easy management of sows in heat. After mating and the three week control period, the sows should be re-grouped according to the actual farrowing dates.

The type of accommodation shown in Figure 10.33a will always have four sows per group as the gates in the manure alley are used to enclose the sows in their stalls while cleaning the pen. The stalls, which are used for both feeding and resting, should be 0.60 to 0.75m wide, depending on size of the sows.

With the type shown in Figure 10.33b, the numbers in the groups can vary according to the size of the herd and farrowing pattern, but sows in one group should be in about the same farrowing period (within about 10 to 15 days of each other).

The feeding stalls should be 50cm wide, and a bar should be installed which can be lowered after all the sows have entered the stalls. This arrangement will prevent sows

from backing out of their assigned stall, and biting and stealing feed from other sows. When all the sows have finished eating, the bar is lifted and they can leave the feeding stalls.

Behind the feeding stalls there is a manure alley with gates across and which can close the opening of the resting area in order to confine the sow while cleaning out the manure alley. The width of the manure alley can be increased from 1.5 to 2.5m if desired, so that cleaning out can be earned out by a tractor mounted scraper.

In both types of pens, exercise yards when considered feasible, can be arranged behind the building.

Figure 10.33a Groups of four sows in resting and feeding stalls and with access to a manure alley.

Figure 10.33b Groups of five sows with access to feeding stalls and a headed resting area, where they are enclosed during cleaning.

Figure 10.34 Layout of a 50 sow unit.

Special Arrangements for Warm Climates

Many of the principles that have been discussed above apply equally well to both hot and temperate climates and are basic requirements for the housing of pigs. The open type of confinement system has its limitations, but applied in many warm areas leads to a major improvement in production.

The complete control of the environment in animal houses is generally far too expensive to be feasible, in particular when considered in connection with nonconfined systems. However, provisions for shade, proper roof colour and material and controlled air movements, which have already been discussed, can be both practical and economic.

A spray or a wallow can considerably reduce heat stress in pigs. A wallow can be anything from a water filled hole in the earth to a concrete trough. While wallows are effective and need not be expensive, they tend to become unsanitary if not regularly cleaned.

From a hygienic point of view sprinklers which spray water on to the pigs, are preferable, but water consumption can be up to four times as high as for a wallow. Water consumption is about 20 litres per pig per day for 10 hours continuous spraying, compared with 5 litres per pig per day using a wallow. However, a spray system can be operated intermittently by a timer which can limit use to about 2 litres per pig per day.

The spray should be directed on to the pigs and not into the air. The spray system can be effectively used with all categories of pigs, except very young piglets. A sprinkler in the manure alley of the farrowing pen, operated from the time the litter is about two weeks old, may help the sow to maintain her feed intake. Hosing pigs once or twice a day is a great deal less effective than a spraying system.

Feed Troughs and Feed Storage

Efficient pig production requires a reliable supply of water and feed for a balanced diet. A large range of feedstuffs, including by-products and crop surpluses, may be used provided they are incorporated into a balanced diet. The requirements for feed change as the pigs grow and depend on the stage of production in sows. Table 10.11 shows the requirement where the feeding is based on a mix of meal feeds and can be used to estimate the required storage capacity for supply between deliveries.

Table 10.1 1 ***Feed and Water Requirement for Pigs***

Animal	Feed Intake (meal feed) kg/pig	Drinking Water Requirement litre/day

Sow in farrowing pen		5 - 7	22 - 27
Gestating sow		2 - 3	12 - 17
Boar		2.5 - 3.50	10
Piglet	10 kg	0.60	1.0
Piglet	15 kg	0.75	1.5
Pigs	25 kg	1.10	2.5
Pigs	40 kg	1.70	4.0
Pigs	60 kg	2.30	5.5
Pigs	90 kg	2.90	7.0
Pigs	120 kg	3.10	7.0

A wide variety of feeding equipment is available for pig operations. The easiest to clean and sanitize are made from concrete, metal or glazed burnt clay. Concrete troughs are commonly used and can be pre-fabricated using a metal mould. The trough is often placed in the front wall of the pen as shown in Figure 10.35d, e and f. Although such an arrangement makes for a more difficult construction than to have the trough inside the pen it is usually preferred due to easier feeding and it also prevents the pigs

from stepping into the trough.

The wall above the trough can be made either solid or open and can be either vertical or sloping inwards to the pen.

An open front improves ventilation in the pen but it is more expensive than a close-boarded wooden front as galvanised steel pipes have to be used for durability. In particular a sow confined in a stall of a farrowing crate will feel more comfortable if she is able to see in front of her. A sloping front will more effectively discourage pigs from stepping into the trough but it is more complicated and expensive to construct.

Two piglet feeders for use in the creep area are shown in Figure 10.36. The same types can be used for growing pigs up to 40 to 50 kg, but the dimensions will need to be increased. Metal is preferred, although a feeder made of wood can be satisfactory if cleaned regularly and thoroughly.

Watering Equipment

The requirement of drinking water is shown in Table 10.11. It is preferable to mix mealfeed with 1.5 to 2.1 litres of water per kg feed. The rest of the water can be given in the trough between feedings or in special drinkers. Clean water must be available to

the pigs at all times, including the piglets in a farrowing pen.

Automatic drinkers are the most hygienic and can be used where piped water is available. There are two types, one which is placed above the feed trough and sprays into the trough when pushed by the pigs and the other type, which is operated by the pigs biting around it. This latter type is often placed in the manure alley or in the pen close to the manure alley to prevent the pigs from getting the resting area wet.

Manure Handling

The pig pens must be cleaned once or twice per day. Provided suffcient bedding is used and the urine is drained away separately to a urine storage tank the solids may have a consistency, which allows it to be stacked on a concrete slab. Where little or no bedding is used or the urine is not separated, a manure storage slab of the type shown in Figure 10.22 can be used. Table 10.12 shows the manure production.

[**Figure 10.35 Feeding equipment.**]

[**Figure 10.36 Piglet feeders.**]

Poultry Housing

Poultry, including chickens, turkeys, ducks and geese, offers one of the best sources of animal protein, both meat and eggs, at a cost most people can afford. Chickens are the most widely raised and are suitable even for the small holder who keeps a few birds that largely forage for themselves and require minimum protection at night. At the other extreme, commercial farms may have highly mechanized systems housing thousands of birds supplying eggs and meat to the city market. In between are farm operations in a wide range of sizes with varying types of housing and management systems proportionate to the available level of investment and supply of skilled labor.

No single system of housing is best for all circumstances nor even for one situation. Some compromise will invariably have to be made.

The needs of chickens and later other classes of poultry will be discussed and a number of housing systems will be described along with the principal advantages and disadvantages of each.

General Housing Requirements for Chickens

Proper planning of housing facilities for a flock of laying hens requires knowledge of management and environmental needs in the various stages of the life of the chicken. A typical life cycle is illustrated in Figure 10.37.

The laying period may be up to 16 months, but in flocks held for commercial egg production the hens are normally culled after a laying period of 11 to 12 months or when the production has dropped to a point where the number of eggs collected per day is about 65% of the number of hens in the flock. It is true that the hens will come in to production again after a couple of month's moulting period, but the production is not as high and the egg quality is generally not quite as good as in the first laying period. Where prices of poultry meat are reasonable, it is usually more economic to cull all the hens after one year's egg production.

Table 10.12 ***Manure Production for Pigs***

	Wet soild Manure	Urine	Total	Storage requirement for slurry
	kg/day	kg/day	kg/day	m per day of storage
Dry sow and boar	2.0 - 2.5	4 - 5	6.0 - 7.5	0.011 or 0.013 per sow in the herd
Sow with litter	2.5 - 3.0	8 - 10	10 -13	0.018
Farrowing pigs - 45 kg	0.8 - 1.0	2.5	3.3 - 3.5	0.004 or 0.006 per growing/finishing pig

Finishing pigs 45 - 90 kg	1.5 - 2.0	4 - 5	5.5 - 8.0	0.008

Figure 10.37 Typical life cycle of a laying hen.

Site Selection

The best site is one that is well-drained, elevated but fairly level, and has an adequate supply of drinking water nearby.

Regardless of the type or size of the housing system, the site for construction should be selected to provide adequate ventilation, but be protected from strong winds. An area under cultivation, producing low growing crops, will be slightly cooler than an area of bare ground. High trees can provide shade while at the same time actually increasing ground level breezes. Bushes planted at one windward corner and also at the diagonally opposite corner will induce air currents within the building to make existing bmise the heat from direct solar radiation.

Since all buildings used for poultry housing tend to produce odours, they should be located well downwind from nearby dwellings. If there are several poultry buildings in a group it is desirable to have them separated 10 to 15m in order to minimize the possibility of the spread of disease.

Brooding buildings should be isolated from other poultry buildings by 30 metres or more and be selfcontained in respect of feed supplies and storage of equipment. If the same person cares for both layers and growing birds, a disinfectant foot bath at the entrance to the brooding area is an added precaution. All buildings should be constructed on well-drained sites where drives and paths between buildings will not become muddy even during the rainy season.

Environmental Requirements

The effects of temperature and humidity on the birds make it apparent that in most areas of East and Southeast Africa the principal environmental concern is to keep the flock as cool as possible. Shade, good ventilation with natural breezes, freedom from roof radiation and the indirect radiation from bare ground are all important. Only in a few high altitude areas does protection from wind and low temperatures become a significant consideration.

Humidity seems important in only two respects. Very low humidity causes objectionably dusty conditions and high humidity combined with temperatures above 27C seems to interfere with the physiological cooling mechanism and increases the possibility of death.

Day old chicks require a temperature of 33 to 35. This temperature is maintained for a week and is then gradually lowered to the ambient temperature by the end of 5 weeks.

In addition to providing a good environment, the housing should offer protection from predators and theft as well as the exclusion of rodents and birds. These latter two not only carry disease, but they can consume enough feed to make a significant economic difference.

The effect of light on egg production has been discussed earlier. Additional hours of light can be achieved by installing one 40W electric light bulb per 15m floor space in a position about 2.2m above floor level.

More important than the hours of light, however, is the maintenance of the lighting schedule, since any sudden change in the length of the photo-period is likely to result in a significant drop in production. Fourteen hours of light throughout the laying period is optimum.

A schedule with gradually decreasing hours of light may be used in windowless houses for maturing pullets. This postpones laying, but results in larger eggs being produced from the start of laying.

In warm climates near the Equator, houses are open for natural ventilation, however, and the day length is close to 12 hours throughout the year. The result is that pullets start to lay at 14 to 18 weeks of age and egg size, which is small at first, gradually increases during the first 3 months.

Broiler houses are often lighted 24 hours per day to encourage maximum feed consumption and rate of gain.

Proper design and management of the poultry house can effectively contribute to the prevention of disease in the flock. In general it is best if the litter is dry but not too dusty. If no litter is used, the floor and wall surfaces should be designed so that they can be easily cleaned between flocks and stay reasonably clean during use.

Construction Details

In most hot climates there will be many more days when a cooling breeze is needed rather than protection from a chilling wind. A wall construction consisting of a solid base, which protects from indirect radiation from the ground, and an open space covered with mesh above it, is therefore preferred for all four walls in most types of chicken houses. A hessian or reed curtain that can be dropped on the windward side will offer extra protection and, if installed on the east and west, it may also protect

from direct sunshine. An arrangement where the top end of the hessian is fixed to the wall plate and the bottom end attached to a gum pole around which it can be rolled when not in use, will provide for smooth operation. In high altitude areas off-cuts may be used on the gable ends, but 15 to 20mm spaces should be left between them to improve the ventilation. The width of the building should not exceed 9m for efficient cross ventilation.

Lower Wall Design up to 1000mm of solid walls can be made of any available masonry units. Bag washing will give a smooth easily cleaned finish, but adobe blocks will require the extra protection of plastering to prevent the birds from destroying the wall by pecking.

The Upper Wall Design to the total height of the wall, including the solid base should be about 2m. Gum poles treated with wood preservative and set 500mm deep in concrete are a practical means of supporting the roof and upper wall structure. Eighteen millimetre wire mesh is small enough to keep out rodents and birds. A tight fitting door is essential.

The floor in a poultry house may consist of gravel or well drained soil, but concrete is desirable because it is easily cleaned, durable and considerably more rat proof. A concrete floor should be 80 to 100mm thick and be made of a stiff mix, 1:2:4 or 1:3:5

concrete, placed on a firm base at least 150mm above ground level and given a smooth finish with a steel trowel.

Table 10.13 ***Recommended Minimum Floor, Feed and Water Space for Chickens***

	Floor Space Stocking density		**Feeder Space**		**Water Space**
	Low	**High**	**Trough**	**Tube**	
	birds/ m	**birds/ m**	**birds/ m**	**birds/ m**	**birds/ m**
Chicks and Pullets					
1 - 4 weeks of age	15 - 20	25 - 30	40	40	150
5 - 10 weeks of age	8 - 11	12 - 15	15 - 20	25	75
11 - 15 weeks of age	5-6	7-8	9- 10	12	50
16 - weeks of age	3 - 4	5 - 7	7 - 8	10	40
Breeders	3 - 4	5 - 6	6 - 8	9	1 5
Layers	6 - 7	8	10 - 20		

Semi-intensive					
House-run					
house	3	4 - 5			
run	0.04 - 0.08	0.10 - 0.13			
Straw-yard					
house	3	4 - 5			
yard	1.5	2.5			
Fold system	2	2			
Intensive					
Deep litter floor	3 - 4	5 - 7			
Wire floor	7 - 8	9 - 10			
Combination floor	5 -6	7 - 8			
Cages, incl. alleys	8 - 12	15 - 25	7 - 10		

Roof structure with a free span is desirable to avoid any inconvenience caused by roof supporting poles inside the building. Corrugated steel sheets are the first choice for roofing material because they are much easier to keep clean than thatch. Insulation

under the metal roofing will improve the environment in the house. However, a thatched roof may result in even better conditions and can be used on narrow buildings. The roof overhang should be 500mm, or more, in order to give adequate protection from sun and rain. A ventilation opening along the ridge is usually supplied in layer houses, but not in brooding houses.

Housing Systems for Layers

The pullets are transferred from the rearing to the laying accommodation at 17 to 18 weeks of age and start laying when they are 20 to 24 weeks old. At the time of transfer they should be grouped according to size and stage of maturity.

There are five major systems used in housing of layers: Semi-intensive; deep litter; slatted or wire floor; a combination of slatted floor and deep litter; and cage or battery system.

Having considered the factors that affect the comfort, protection, efficiency and production of the birds, it is also important to design a system that is labor efficient, reasonable in investment and easy to manage. How well each of the systems fills the needs of both the chickens and the people supervising the operation should be the determining factor in the selection of an appropriate system for a specific situation.

Click here to continue

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Semi-intensive Systems

Contents - Previous - Next

Semi-intensive systems are commonly used by small scale producers and are characterized by having one or more pens in which the birds can forage on natural vegetation and insects to supplement the feed supplied. It is desirable to provide at least two runs for alternating use to avoid build up of disease and parasites. Each run should allow at least 10 to 15m per hen and be fenced, but a free-range allowing 40 to 80m per hen will be required where the hens are expected to obtain a substantial part of their diet by foraging. A small, simple house, which allows 0.3 to 0.4m per bird, and which has a thatched roof a littered earth floor and slatted or chicken wire walls on at least three side will provide protection from inclement weather, from predators at night and offer shade in the daytime. The shelter should be large enough to enter to

collect eggs and be equipped with nextboxes, feeders, drinkers and perches. For convenience the house should be situated so that access to each of the runs can be provided with small outlet doors or 'popholes'.

Figure 10.38 shows another type of shelter for roosting and laying, which can be used in combination with daytime foraging by the hens. The legs of this structure have rat guards and ant protection and may be equipped with skids or wheels to make the whole unit easily movable between runs. Feed and water are provided in troughs outside the house.

This system is low in cost, but growth of the birds and egg production are likely to be less than with systems offering closer confinement and better feed. Losses may be encountered by birds of prey and from failure to find eggs laid in bushy areas. The poultry run requires a considerable amount of fencing.

A fold unit is a house and run combined, having part of it covered with chicken wire and the remainder with solid walls. The unit should allow 0.5m per bird and must be moved each day over an area of grassland. A unit 6 by 1.5m will take 16 to 18 birds and can normally be handled by one man. For larger flocks several such units will be used. Portable units are generally more expensive than permanent houses and may decay quickly because of the contact with the ground. The hens have reasonable protection

against birds of prey and inclement weather, and parasites, if the unit is not returned to the same area within 30 days.

In areas where grassland is limited a yard deeply littered with straw and allowing only 0.4 to 0.7m per bird will provide for an outdoor exercise area. This system is similar to the deep litter system, but requires more space, a considerable amount of litter for the yard and the fresh green food has to be carried to the birds.

Figure 10.38 Poultry shelter for 50 layers.

Figure 10.39 Fold unit for /8 layers.

Deep Litter System

Deep litter houses, Figure 10.40, confine the birds in a building that offers good protection with a reasonable investment. If well designed with low masonry walls set on a concrete floor and wire mesh completing the upper part of the walls, the building will exclude rats and birds.

The principal advantages of this system are easy access for feeding, watering and egg gathering, good protection and reasonable investment. The principal disadvantage is the need for high quality litter. If this is produced by the owner, it is of little

significance, but if it must be purchased, it becomes an economic factor. In either case, the litter and manure must be removed periodically.

The deep litter house can be designed up to 9m in width and any length that is needed. Approximately 4 to 5 birds/ m of floor area is a satisfactory density.

Slatted or Wire Floor System

Figure 10.40 Deep litter house for 130 layers (or 350 broilers). Note the solid wall facing the prevailing wind.

A small house of this type with slatted floor is shown in Figure 10.41. Alternatively wire mesh can be used for the floor. It is built on treated wooden piers 0.8 to 1m above the ground. Ventilation and manure removal are both facilitated, no litter is required and bird density can be 6 to 8 per m. Feeding, watering and egg gathering are all efficiently handled from the outside. Either a double pitch thatch roof or a single pitch corrugated steel roof may be installed with the eaves about 1.5m above the floor. If the latter is used, some insulation under the roof is desirable. The feed troughs should be equipped with hinged covers and rat guards should be installed at the top of each pier. The width of this type of building should be limited to about 2m to allow easy removal of manure and adequate wall space for feed and nests. The building should be

oriented east and west and may be of any length. However, if it is more than 5m long, nests will need to be put on the sides and all remaining wall space on either side used for feeders in order to allow the required 100mm/bird. See Table 10.13.

If using a slatted floor' made sufficiently strong for a person to walk on, then a wider building is feasible as feeders can be placed completely inside where the chickens have access to both sides of the trough. The floor is sectioned for easy removal during cleaning out of manure.

This type of houses is said to be cooler than other types, but the building cost is high and management is more complicated.

Figure 10.41 Slatted floor house for 50 layers.

Combination of Slatted Floor and Deep Litter

A combination deep litter, slatted floor house, offers some advantages over a simple deep litter house, but with some increase in investment. Figure 10.42 shows a house of this type for the small producer.

Approximately l/2 of the floor area is covered with small gum pole slats or with wire mesh. This area is raised above the concrete floor 0.5m or more so that cleaning under

the slatted portion may be done from the outside. Waterers and feeders are placed on the slatted area. This type of house is limited in width to 3 to 4m so that feeders and waterers can be handled from the litter area and manure beneath the slatted area can be easily removed from the outside without moving the slats or disturbing the birds. Although this system entails added expense for materials and labour to install the slats, the bird density can be increased to 5 to 7 per m, so there is little difference in the cost per bird. This system saves on litter, increases litter life, reduces contact between birds and manure, and allows manure removal without disturbing the hens. Ventilation is improved due to the slatted floor. Perhaps the biggest disadvantage is the limited width for convenient operation and the need for some litter.

In medium to large scale houses of this type the slatted floor must be made removable in sections and at least part of it made strong enough to walk on. An increased building cost and a more complicated management will result, however. The house shown in Figure 10.43 has slats over 2/3 of the floor area. This is generally considered maximum for this type of house and allows for a stocking density of up to 8 birds per m. Automatic tube feeders are placed on the slatted floor. One such feeder, with a bottom diameter of 0.6m can serve for 60 to 75 birds, depending on size of breed. The water troughs are suspended from the ceiling. The nestboxes are doubled by arranging them back-toback and have one end resting on the slatted floor and the other suspended from the ceiling. Egg collection can be facilitated by the use of a trolley,

which is supported on a rail just below the ceiling. Cleaning out between batches can be done by a tractor shovel, if all furnishings and part of the end walls are made removable.

Figure 10.42 Poultry house fot 40 layers half deep litter/ half slatted floor.

Figure 10.43 Poultry house with l/3 deep litter and 2/3 slatted floor for 1100 to 1200 layers.

Cage or Battery Systems

Cage management of layers in very large, well insulated, windowless buildings has become the standard practice in much of Europe and the colder parts of the United States. With complete mechanization of feed, water, egg collection, manure removal and environmental control, two to three people can care for thousands of birds.

It should be noted that a very large investment is made in order to obtain labour efficiency and ideal environmental conditions. East and South-East Africa has relatively low labour costs and a mild climate making a mechanized cage system in an insulated building unnecessary and impractical.

Nevertheless, there are much simpler cage systems that may work very well for

commercial growers in this region. These consist of rows of stair-step cages in long narrow shelters. Figure 10.44. The thatch roof or insulated metal roof shelter can be completely open on the sides with perhaps some hessian curtains in areas where cold winds are experienced. The buildings should be oriented east and west and designed to provide shade for the cages near the ends.

A 3.4 metre width will allow for four cages without overlap and an alley of about 0.9 metre. While a concrete floor makes cleaning easy, smooth hard soil is less expensive and quite satisfactory. A little loose sand or other litter spread on the soil before the manure collects will make manure removal easier. The building posts should be treated with wood preservative and be sturdy enough to support the cages. Rat guards should be installed on the posts at a height of 0.8 to 1 m. A central alley, raised 20cm and cast of concrete is easily cleaned and keeps manure from encroaching on the work area. Feeding and egg collecting are easily done by hand while watering may be either by hand or with an automatic system. It is important that the watering trough be carefully adjusted so that all birds receive water. The simplest method of supplying water automatically or by hand at one end is to slope the entire building and row of cages 10mm/3m of length.

The trough can then be attached parallel with the cages. Water must run the total length of the trough and it is inevitable that some will be wasted. Consequently a good

water supply is essential.

Even though feed is distributed by hand, feed stores should be built convenient to each building to reduce carrying to a minimum. Eggs can be collected directly on to the "flats" that are stacked on a cart which is pushed down the alley. The cart can be made self-guiding by means of side rollers that follow along the edge of the feed troughs or the raised central alley.

Cage types that are equipped with pans to catch the manure are not advocated because they restrict ventilation. Previously used cages should be considered only if they are of a suitable design, and have been carefully inspected for condition prior to purchasing.

Figure 10.44 Cage compartment and various arrangements of cage tiers in open-side houses.

Table 10.14 Recommended Minimum Dimensions of Cages for Laying Hens

Layers per	Cage Area[1]	Width	Depth	Height		Floor
cage	per bird			front	back	slope

No.	cm	mm	mm	mm	mm	%
1	1100- 1300	250	450	500	400	11 - 15
2	700-900	360	450	500	400	11 - 15
3	600-750	450	450	500	400	11-15
4	550 - 650	530	450	500	400	11 - 15
5	500 - 600	600	450	500	400	11 - 15
20	800 - 900	2000	850	650	500	15 - 20

[1] Depending on the size of the breed

Click here to continue

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Summary

Contents - Previous - Next

The housing systems for layers that have been described should meet the needs of most situations encountered in East and South-East Africa. In the few cases where much colder weather occurs, the buildings described should be built with one or more tight walls. However, it must be emphasized that chickens tolerate cold weather better than wet, sticky, foul smelling litter resulting from inadequate ventilation. If the temperature falls below freezing it is essential that the chickens have a continuous supply of free flowing water (not ice) and that eggs are collected frequently enough to avoid freezing.

Planning for Continuous Production

The producer who can supply his market with either eggs or meat on a regular and uniform basis will undoubtedly find his produce in demand at the best market prices. Planning the poultry housing system has much to do with uniform production.

A programme for 1,000 layers is diagrammed in Figure 10.45. A larger or smaller operation can be designed with the same number of buildings, but of a different size.

It is assumed that the brooder house is large enough for brooding only and that pullets

will be transferred to a laying house for growing to laying age. New chicks are started every 13 weeks, brooded 7 to 8 weeks, and then transferred to the laying house. After approximately 11 weeks they will start a laying period of 52 weeks, after which they are sold and the house cleaned and rested for two weeks before the cycle is renewed. Five laying houses are required. At any one time four will have layers in full production and the fifth will either be housing growing pullets or be empty for cleaning. Each house is on a 65 week cycle: 11 weeks growers, 52 weeks layers, 2 weeks cleaning. The brooder house is on a 13 week cycle: 7 to 8 weeks brooding, 5 to 6 weeks cleaning and resting. A suggested housing layout is shown in Figure 10.46.

Housing for Breeders

Breeders must be housed in one of the floor systems since cocks need to run with the hens. One cock per 5 to l0 hens is sufficient. Special emphasis is placed on disease control, so frequently a partially or completely slatted floor design is preferred.

Few commercial producers will breed their own replacements, but will instead buy day-old chicks from a commercial hatchery.

However, most chicks of indigenous breeds are produced by natural incubation at small scale farms. A hen sitting on some 8 to 10 eggs, needs little feed and even less

attention, but a cool, clean nest at ground level that is enclosed to protect the hen and later the chicks from insect pests, vermin and predators, and a supply of feed and clean water may improve the breeding result.

Brooders

Naturally hatched chicks are reared and protected by the broody hen and can be left undisturbed as long as their yard is protected from predators, is of good sanitary standard and has a supply of feed and water.

Artificially incubated chicks must be started under gas or oil-fired brooders to compensate for the absence of a natural mother and to keep them warm without their crowding together. If electricity is available a 250W infrared ray lamp is a more reliable and comfortable solution, but is also more expensive.

A cheap, simple but still efficient brooding arrangement that will serve for about 100 chicks is shown on Figure 10.47. The hover, which prevents the heat from escaping and protects the chicks from draught, is made from a halved oil drum and is equipped underneath with two heaters, e.g. kerosene storm lanterns protected by netting. The hover is suspended by chains from the roof structure and its height over the floor is adjusted according to the required temperature.

A similar but larger brooder for 400 to 500 chicks has a hover made from two 3m long corrugated roofing sheets, is equipped with 6 heaters and has a proportionally larger area enclosed by the 60cm wall and is supplied with 10 water founts and 10 feed troughs.

Figure 10.45 Production flow when starting chicks every three months.

Figure 10.46 Layout of buildings for 1000 layers and brooder house for replacements.

Figure 10.47 Brooding arrangement for approximately 100 chicks.

Housing for Pullets and Broilers

In the past, poultry meat has been derived chiefly from culled layers. This is still the main source of poultry meat in most developing countries, although there is an increasing shift to rearing chickens specifically for meat. Broilers, the common term for meat birds, are fastgrowing strains which reach market weight of 1.6 kg in 8 to 12 weeks. The commercial production of poultry meat is now based primarily on broilers.

In a semi-intensive system the growing pullets may obtain part of their food by scavenging for forage, seed, etc. A fenced yard allowing 5 to 8m per bird is preferable to open land. At least part of the yard should have shade cover and a simple building

in which the birds can be enclosed at night will be required. The building should allow 0.2m per bird, have good ventilation, perches for roosting and offer protection against predators and inclement weather. The birds should be moved at regular intervals to a different yard in order to avoid a build-up of worm infestation.

There is little difference in the rearing of chicks to become pullet replacements for the laying flock or broilers for market. The same environment and housing are suitable, so they will be considered together.

Brooding and rearing are floor-managed operations. It is common practice to keep broilers or pullets in the same house from the time they are one day old, first on newspapers or thinly spread litter, and later, on deep litter. When broilers are marketed at 8 to 10 weeks of age, or pullets are transferred to the laying house at 16 to 18 weeks of age, the litter is removed so that the house can be thoroughly cleaned and disinfected. Therefore, the house should be designed and built to allow for easy and efficient cleaning. Pullets and broilers are not grown together because of the different length growing periods and differing schedules for artificial lighting.

Chicks are started in a brooder, which may be of the type discussed in the previous section and remain there for six to eight weeks. During this time it is desirable to conserve heat and to prevent draughts, and in this, the building design can be an

important factor. A method that is widely used in the United States called "end room" brooding works well and seems adaptable to warm climates as well. By taking advantage of the fact that chicks up to 4 weeks old require only 1/3 to 1/2 as much floor space as they will need later on, one end and enough of the adjacent sides are closed in tightly to provide 0.05m of floor space per chick to be brooded. Off-cuts, with low thermal capacity, are ideal for enclosing the wall. A hessian curtain makes the fourth (inside) wall to complete the temporary enclosure. The baby chicks can then be confined in the space around the brooder in the enclosed end of the house. See Figure 10.48.

The balance of the walls are covered with 18 to 25mm wire mesh. At the end of the brooding period the brooder is raised to the ceiling for storage, the Hessian curtain is lifted and the chicks are allowed into the balance of the house which should provide from 0.08m/bird for broilers to 0. 17m/ bird for pullets.

Depending on the maximum temperatures expected, it may be necessary to provide some ventilator openings in the tight walls. An adjustable gable-end ventilator is particularly desirable as the roof will not have a ridge vent due to the brooding operation.

If cool, breezy weather is expected, one or more of the screened sides may be

equipped with Hessian curtains.

Equipment and Stores

In addition to what has already been described, any chicken house will require equipment such as waterers, feeders and a feed store and perhaps perches for roosting. Houses for floor managed layers or breeders will require nestboxes. A store for eggs may be required in any laying house. Feeders and waterers should be in sufficient numbers for easy access (particularly important for young chicks), be long enough for each bird to have its place and have sufficient holding capacity. The Tables 10.13 and 10.15 provide some information for their design. Most chickens in intensive production are fed water and mash on a free choice basis.

Note: The cumulative feed consumption in pullets from one day to the point of laying at 20 to 24 weeks is 1012 kg. The rearing of one broiler from one day old to marketable weight (2 kg live weight) at 9-12 weeks of age requires 4 to 6 kg feed.

Feeders

Either trough or tube feeders are used for day-old chicks, growing birds and layers, but their size must be selected to suit the birds to be fed. The number of feeders should be

such that the distance to the nearest feeder should not exceed 2m from any point in the house. A trough should not be too wide, be easily cleaned and have a design that prevents the hens from leaving their droppings in it.

Figure 10.48 A closed end brooder and growing house.

Table 10.15 ***Feed and Water Requirement for Pullets and Broilers Relative to Their Age and for Layers Relative to Their Weight and Egg Production.***

Chickens	**Feed Requirements kg/week bird**		**Water Requirement l/ day per bird**
	Pullets	**Broilers**	
Rearing birds			
1 - 4 weeks of age	0.07 - 0.20	0.10 - 0.40	0.05 - 0.15
5 - 8 weeks of age	0.26 - 0.36	0.50 - 0.90	0.16 - 0.25
9-12 weeks of age	0.40-0.49	1.00-1.10	0.20-0.35
13 - 20 weeks of age	0.51 - 0.78	-	0.25 - 0.40

Egg production: No. of eggs/year

Layers	100	200	300	
Light breed	0.54	0.65	0.78	0.25-0.35
Medium breed	0.69	0.82	0.94	0.27-0.40
Heavy breed	0.84	0.96	1.10	0.30-0.45

Figure 10.49a shows a good type of trough that can be made by the farmer. If used outside in a run the trough should be sheltered by a roof. Small trough feeders for chicks are used on the floor, but the larger ones are usually mounted on a stand to prevent the chickens from kicking litter into them and have perches where they can stand while eating, see figure 10.49b. The tube feeders, as shown in Figure 10.49c, are suspended from the ceiling and are easily adjusted for height (0.3m above ground is recommended for mature birds).

Drinkers

An ordinary 10 or 15 litre bucket serves very well as drinker for layers. If it is sunk into the floor or ground so that only about 10 centimetres are out it may be used for chicks as well. Another arrangement for chicks consists of a shallow bowl supplied with water from an upside down bottle, as shown in Figure 10.62. Water fountains of the type shown in Figure 10.49d are available in sizes for all ages. Like feeders they are used on

the floor for small chicks and on stands for older birds. The number of drinkers should be such that all chickens have access to one within a distance of 3m.

Automatic drinking nipples may be used for layers in cages. There should be at least one nipple per every two hens. It is desirable that every hen have access to two nipples as clogging of a nipple is not always readily detected.

Figure 10.49a Trough

Figure 10.49b Trough on a stand

Figure 10.49c Tube feeder

Figure 10.49d Woter fount

Nest Boxes

Layers and breeders, except those managed in cage systems, should have access to nestboxes in which they can lay their eggs. The nests can be such that they can be used by one or more birds at a time. Single nests commonly have the dimensions 250 to 300mm wide, 300 to 380mm deep and 300 to 350mm high, have a 100mm litter retaining board across the bottom of the opening and have a perch 150 to 200mm in

front of the entrance. Communal nests should have a space allowance of at least 0.09m per bird. The top of the nest should be steeply sloped to prevent birds from roosting there. One nest should be supplied for every five birds in the flock. Figure 10.50 shows a twotiered nestbox arrangement. The bottom row of nests should be 450 to 600mm off the floor.

Perches

Chickens have a natural instinct to roost in trees at night. To provide for this perches are commonly installed in chicken houses from 6 to 8 weeks of age and after, in particular in semi-intensive systems. Perches for young birds should have a diameter of about 35mm and provide

0.1 to 0.15m space per bird, while those for adult birds should be about 5Omm diameter and provide 0.2 to 0.3m space. The perches should be fixed to solid stands, be 0.6 to 1.0m above the floor, be 0.35 to 0.4m apart and preferably be placed lengthwise at the centre of the house. A deck about 200mm underneath to collect manure is desirable.

Feed Stores

Grain stores are discussed in Chapter 9. The feed stores for a small flock would be very much like those shown for food grains. For the commercial flock, the type of store depends on how the feed is handled. If it is purchased in bag lots, then a masonry building with an iron roof that is secure against rodents and birds is most suitable. If feed is delivered in bulk, then one or more overhead bins from which the feed is removed by gravity will be convenient and safe.

The size of the store required depends entirely on the frequency and size of deliveries, but can be estimated as 0.0035m floor area per bird in the flock where feed is purchased in bags. If part of the grain is produced on the farm, then some long term storage of the type shown in Chapter 9 will be required.

Figure 10.50 A battery of single laying nests for 50 lo 60 hens.

Figure 10.51 Perches.

Manure Handling

A layer is estimated to produce on average 0.15 to 0.20 kg manure per day and a broiler 0.08 to 0.12 kg manure per day. In deep litter systems the litter used may more than double these amounts. Poultry manure is commonly allowed to accumulate in

the house, under a wire or slatted floor or as deep litter for quite extended periods, but may alternatively be cleaned out regularly and stored in a concrete pond. It is an excellent form of fertiliser. Processed poultry manure has successfully been fed to cattle, sheep and fish as a portion of their total ration.

Egg Handling

Eggs are an excellent source of animal protein and are usually less expensive than meat. If properly handled under sanitary conditions they store well for short periods and reach the consumer in good condition. However, eggs are perishable and possible carriers of salmonella, a serious food poison, thus the need for clean conditions and refrigeration cannot be overemphasized. The following list includes several recommended practices and facilities:

- **1 Clean nest and floor litter will minimize the number of dirty eggs.**
- **2 The egg handling and storage building should be screened, free of rodents and other vermin.**
- **3 The water supply should be potable and ample.**
- **4 Lavatory and toilet facilities should be available.**

Egg Cooling for large commercial laying operations requires approximately 0.25m of

cool store per 1000 layers and day of storage. For smaller flocks the store will need to be proportionately larger.

Figure 10.52 shows an Evaporative Charcoal Cooler for small farms. A store measuring, e.g. 100 x 100cm is covered by a water tray from which cloth strips or "wicks" drip water down into side frames. The frames consist of a 5 cm layer of broken charcoal sandwiched between 1.25cm chiken wire mesh. A hinged and latched door is constructed similarly to the sides. The action of water evaporating from the charcoal cools the interior of the box.

Other methods for short term storage of eggs at the small poultry unit include underground cellars, storage in lime water and storage after dipping in waterglass.

For longer periods of storage a refrigeration system and a well insulated room is required to maintain a storage temperature of 5 to 10C. To allow storage for 6 to 7 months a temperature of -1.5 to 0C will be required. The refrigeration capacity necessary is approximately 200W for 5000 layers, or 3400W for 10,000 layers. Other capacities would be proportionate. Custom designed systems with generous size evaporators should be installed. Room air conditioners do not allow desirable humidity in a storage. The evaporator is too small and operates at a low temperature, thus removing too much moisture from the air.

Figure 10.52 Evaporative cooler for eggs, milk and other food stuffs. Where electricity is available a fan controlled air flow will make a more efficient operation.

Duck Housing

Although ducks are kept for both meat and egg production, commercially there is much more demand for meat than eggs.

On the other hand egg production does provide a valuable contribution to the family income and diet for the small scale farmer. Ducks lay more and larger eggs than indigenous chicken. Raising ducks is encouraged in African countries because they are hardy and easy to raise and manage.

They can feed to a large extent on grass, vegetables and grains produced on the farm. Housing is also quite simple and inexpensive. Small scale farmers would, for these reasons, benefit from keeping ducks instead of hens, which are more prone to disease and malnutrition.

Brooding and Rearing

Brooding is similar to chickens and the same temperatures are used, 35C for the first week and then reduced 3C weekly until normal air temperature is reached.

Ducklings grow very rapidly, and floor and trough space on deep litter should be provided according to Table 10. 16.

Table 10.16 Recommended Minimum Floor and Feed Space for Ducks

	Floor Space		**Feed trough space**
	m/bird	**birds/m**	**birds/m**
1- 2 weeks	0.05	20	14
3-4 weeks	0.1	10	11
4 - 7 weeks	0.2	5	9
7 weeks to market	0.3	3 - 4	8
Mature birds	0.3 -0.4	2.5 - 3	7 - 8

Refers to deep litter; on wire mesh Door the stocking can be doubled.

Litter materials include straw, sawdust, shavings and sand. The large quantity of water that ducks drink produces wet manure that causes problems with almost any form of

litter. A wire mesh floor therefore is a desirable alternative. The 12.5mm mesh of 8 gauge wire is suitable.

Fresh air is important and ducklings can be let out in fine weather after a few days. They should, however, not be allowed to get wet before the feathering is completed on their backs at about six weeks of age. Ducklings should also be shaded during hot weather to prevent sunstroke.

Housing

Housing for ducks can be very simple. See Figure 10.53. The house should be situated on a well drained, preferably elevated area.

The floor should be raised at least 15cm above the surrounding ground level to help keep it dry. Ducks tend to be dirty and plenty of clean litter must be used in floor type housing.

Although a concrete floor can be installed for easy cleaning, it is not necessary. If part of the floor is of wire mesh and the ducks have to cross it on their way to the nestboxes, their feet will be cleaned so they do not make the nests and eggs dirty.

Solid walls 60cm high are adequate. They may be made from any material as long as it

keeps the ducks in and predators, like dogs, snakes, rats and wild birds out. The space between the wall and the-roof is covered with wire netting not larger than 25mm mesh. Total wall heigh does not need to exceed 150-200cm.

Figure 10.53 Duck house for 25 ducks.

Roof made of thatch is a fully adequate and inexpensive roof covering for a duck house. Metal sheets can also be used, but insulation should be installed under the sheets.

Nest boxes 30cm wide, 40cm deep, and 30cm high should be provided for each four ducks. The front should be l5cm high. The nestboxes are placed either on the floor or 30 cm off the floor against a side or rear wall. Although nesting boxes off the floor release more floor space, the ducks may lay their eggs under the boxes.

Run and Fencing should provide a minimum of 1 m per bird, but 2 to 3m or more, will keep the ducks cleaner and give more space for grazing. On open range pasture the ducks should be allowed 20m/bird.

Feed and Water Equipment

Duck feeders need to be somewhat wider than chicken feeders to allow for the

"shovelling" eating habits. For the first two weeks the food is preferably given as crumbs or wet mash. Later the food is best given as pellets. The required trough space is included in Table 10.16. Adult ducks normally consume about 0.2 kg feed per day, but some ducks in full lay may require up to 0.3 kg per day.

Ducks of all ages drink large quantities of water. Waterers must be designed to allow easy access for the birds and easy cleaning for the caretaker.

Ducks like to swim so if possible they should have access to a stream or pond. Contrary to common belief there seems to be little benefit in providing for swimming except that with water available the ducks are able to keep themselves cleaner and somewhat higher fertility of the eggs may result.

Geese Housing

Geese are foragers and can be allowed to graze on succulent grass as early as three weeks of age. Because of this there should be more encouragement for the development of the meat production from geese in East and South-East Africa.

Unless there is a large number of geese, natural hatching will take place. A goose will sit on 10 to 1 5 eggs. The sitting goose should be allowed to use her regular nesting

place for incubating the eggs.

Rearing of goslings is relatively easy if proper care and attention is given. The goose should be confined to a clean coop for the first 10 days while the goslings have access to a small run. Chick mash can be fed for the first 3 to 4 weeks along with succulent grass. After 3 weeks of age the goslings will graze, but supplementary feed must be given if the value of the grazing is poor.

Geese are selective grazers and will quickly return to grass newly grown after recent grazing. If the geese are herded, a much wider range of grazing is possible.

Housing for geese is very simple, if any is required at all. In tropical areas geese appear to be quite content left outside at all times of the year. However, there is often danger of theft and attack by predators, so the geese should be herded into a shelter at night for protection. The shelter can be simple and cheap as long as it serves this purpose.

A wooden framework surrounded by wire mesh is quite adequate. Wooden rails or bamboo can also be used in place of the wire mesh. The same materials can be used for the roof as a waterproof roof is not necessary. There is no need for a floor, but the ground should be elevated to avoid flooding.

Turkeys Housing

In recent years there has been a steady increase in turkey production. The main demand is still at Christmas and New Year, but the better hotels and restaurants require supplies throughout the year. The demand is only for turkey meat. All the eggs produced are used for incubation by hatcheries.

The production of turkeys should be confined to commercial enterprises. Chickens carry diseases that affect turkeys so they should not be grown together by the small farmer.

Brooding and rearing methods for turkey poults are similar to those for chickens, but the brooding temperature is higher. The recommended temperature for the first week is 35 to 38C, after which it can be reduced 4C per week until ambient temperature is reached.

Adequate floor space in the brooder house is important as the turkey poults grow rapidly. Table 10.17 provides information on space requirements.

At about 10 weeks of age, turkeys are put out on range in a fenced enclosure. In the interest of disease control, it is essential to use clean land that has not carried poultry,

turkeys, sheep or pigs for at least two years. Approximately 20m of pasture should be allowed for each bird.

A range shelter with 20m of floor area is suitable for 100 poults up to marketing age. Dry, compact soil is adequate for a floor. The frame should be made of light material covered with wire mesh so that the shelter can be moved to clean range each year. The roof, which should be watertight, can be made of thatch or metal sheets. Perches, made from rails 5 x 5cm or round rails 5cm in diameter, should be installed 60cm from the ground and 60cm apart allowing 30 to 40cm of length per bird.

The turkey breeder flock can be confined in a deep litter house similar to the one shown in Figure 10.40 for chickens. Recommended floor, feed and water space for turkeys is given in Table 10.17. Approximately 23 kg of feed is required to produce a 6.4 kg turkey at 24 weeks of age. Adult birds require 0.12 to 0.3 kg per day depending on the size of the breed.

Early mortality in turkey poults due to lack of drinking or feeding is a constant problem and can only be prevented by good management and reliable equipment. Young poults must be coaxed to eat by making sure they have plenty of feeding places and can easily see the food. The same applies to water.

Table 10.17 ***Recommended Floor, Feed and Water Space for Turkeys***

	Brooding	**Growing**	**Breeding**
	0 - 6 weeks	**6 - 12 weeks**	
Floor Space	0.1 m	0.4 - 0.6m	0 7 - 0.9m
Roosting Space		30 - 38cm	30 - 38cm
Nests	-	-	60 x 150cm
(for 20 - 25 hens)			
Feeders 4 - 8cm	10cm	12cm	
Water 2cm	3cm	4cm	

It is important to keep turkeys from being frightened by people, animals or machines. When alarmed, turkeys have a tendency to stampede, pile up and smother.

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Sheep and goat housing

Contents - Previous - Next

Sheep and goats are important sources of milk and meat. Both readily adapt to a wide range of climates and available feed supplies. They also have similar housing requirements and will therefore be treated together.

Management Systems

Depending primarily on the availability and use of land, three systems of production are practiced:

- **1 Subsistance, in which a few animals are tethered during the day and put into a protective shelter at night.**
- **2 Extensive, in which the flock/herd grazes over large areas of marginal land unsuited to agriculture. The flock is usually shut into a yard at night. Both these systems are practiced extensively in East Africa.**
- **3 Intensive, in which the animals are confined to yards and shelters and feed is brought to the flock. This system offers the greatest protection for the flock from both predators and parasites. Although it may make the best use of limited land**

resources, this system also increase labour and the capital investment required for facilities.

Housing

Housing in tropical and semi-tropical regions should be kept to a minimum except for the more intensive systems of production. In the arid tropics no protection other than natural shade is required. In humid climates a simple thatched shelter will provide shade and protection from excessive rain. Sheep and goats do not tolerate mud well; therefore yards and shelters should be built only on well drained ground.

Figure 10.54 shows a sheep/goat house for 100 animals. Unless predators are a serious problem, gum poles can be substituted for the brick walls. If thatching is difficult to obtain, a lower pitch roof of galvanized steel is feasible, but some insulation under the roof is desirable.

Where housing facilities are provided, it will be necessary to have in addition to water, feed troughs and permanent partitions, provision for temporary panels to help divide and handle the flock when necessary to carry on such operations as disease treatment, docking, shearing, milking and lambing.

In temperate climates and at high altitudes a more substantial structure may be needed. An open-front building facing north provides wind protection and a maximum of sunshine. A rammed earth floor with a slope of 1:50 toward the open front is recommended. A concrete apron sloped 1:25 and extending from 1.2m inside to 2.4m outside will help maintain clean conditions in the barn.

Figure 10.54 Sheep/goat house for 100 animals. In warm climate will gumpole rails instead of the masonry walls prowide for better ventilation.

Table 10.18 ***Recommended Floor and Trough Space for Sheep/ Goats in intensive Production Related to Live Weight***

	Weight	Floor Space			Trough Space
		Solid Floor	Slatted Floor	Open Yard	
	kg	m/animal	m/animal	m/animal	m/animal
Ewe/ Doe	35	0.8	0.7	2	0.35
Ewe/ Doe	50	1.1	0.9	2.5	0.40
Ewe/ Doe	70	1.4	1.1	3	0.45
Lamb/ Kid		0.4 - 0.5	0.3 - 0.4	-	0.25 - 0.30

Ram/ Buck		3.0	2.5	-	0.5

Slats shall be 70 to 100mm wide, 25 to 30mm thick and laid with 25mm spaces. Individual lambing pens should be 1.5m depending on the weight of the ewe and number of lambs expected.

A feed trough should be 0.3 to 0.4m deep front to back and have a 0.5 to 0.6m high front wall facing the feed alley

In areas of high rainfall it may be desirable to keep the animals off the ground. Stilted houses with a slatted floor which is raised 1 to 1.5m above the ground to facilitate cleaning and the collection of dung and urine are shown in Figures 10.55 and 10.56.

Milking can be facilitated by providing a platform along the feeding fence where the animals can stand while being milked from behind. Such a platform should be 0.8m deep and elevated 0.35 to 0.5m above the floor where the milker stands.

Parasite Control

A dipping tank and crush are essential in the layout for a large flock or for a community facility for the use of many small holders. A typical dipping tank is shown in

Figure 10.57. In areas where the Bont tick is a problem, simple walk-through tanks or footbaths may be needed. Figure 10.58 shows plans for a footbath.

Figure 10.55 House for 2 to 4 sheep-goats in intensive dairy production.

Figure 10.56 House for 12 to 18 sheep-goads in intensive dairy production.

Figure 10.57 Sheep dipping tank.

Rabbit housing

There are few, if any, countries where domestic rabbits are not kept for meat and pelts. It is widely recognised that a few rabbits can be kept for a low cost, but yet produce a fair quantity of wholesome and tasty meat. However, to raise rabbits successfully one must begin with healthy animals, provide a good hutch, clean and nutritious feed and take good care of the rabbits.

Management Systems

Rabbits like other domestic animals, may be bred and reared at various intensities. Table 10.19 shows some production characteristics related to this. Rabbits can be

mated at almost any time and when mating is successful the doe will kindle 30 to 32 days later. The doe should be checked for pregnancy 10 days after mating and, if necessary, re-mated. A shortened interval between kindling and mating will obviously result in increasing number of litters per doe and year. Commercial producers aim at getting at least 6 litters per year with 7 kids weaned per litter, i.e. 42 kids per doe each year. However, with intensive production the breeding doe may have to be replaced every one to 1.5 years, while in a semi-intensive system, she may last for 3 years. Replacement does can be bred for the first time at 5 months of age.

A balanced diet fed in adequate amounts, good sanitation, disease control, appropriate housing and equipment and good care are all important factors when aiming at lower mortality and higher daily gain.

The mortality in a well managed rabbit unit should be below 20% from birth to slaughter among the young and below 20% annually among the adults, but presently many extensive producers in East and South East Africa experience mortality of up to three times that.

[**Figure 10.58 Footbath and drain crush for sheep/goats.**]

Table 10.19 Management Practices and Production Efficiency Related to the Intensity in

the Rabbit Production

	Feed Time between kindling and mating		
	Extensive Greens8 - 10 weeks	**Semi-intensive Greens/ concentrates 4 - 6 weeks (or remating 1 - 2 days after weaning**	**Intensive Concentrates 1 - 2 weeks**
Age of young at weaning	8 - 10 weeks	6 - 8 weeks	4 - 5 weeks
Number of litters per doe, year	3 - 4	5 - 6	8 - 10
Number of young weaned per doe, year	10 - 20	30 - 40	50 - 65
Age of young at slaughter	20 - 30 wks.	12 - 15 wks.	10 - 13 wks.
Daily grain during fattening	10 - 15g.	20 - 30g	25 - 30g
Production of cold dressed	15 -25 kg	40 - 60 kg	75 - 100 kg

meat per doe, year			

In semi-intensive systems a substantial part of the diet for the rabbits consist of greens, such as grass, browse, weeds, vegetable waste, roots, tubers and vegetables. This usually necessitates longer breeding intervals and results in lower daily gain than intensive systems where the rabbits are fed with only rabbit pellets or chicken mash. However, since the feeding cost will be lower equally large profit for the farmer may result.

Hutches While there are a great many types of hutches, there are certain essential features that any well designed hutch should provide:

- **1 Enough space for the size of the rabbit,**
- **2 fresh air and light, but exclusion of direct rays of the sun,**
- **3 protection from wind and rain,**
- **4 sanitary conditions and ease of cleaning,**
- **5 sound but cheap construction; which is free of details that could injure the animals,**
- **6 convenience of handling,**
- **7 a cage for each adult rabbit.**

Space Requirement

Each adult rabbit must have its own cage or compartment. Since domestic rabbits vary in weight from 2 to 7 kilos, depending on breed, the size of cage may be determined by allowing 1200 to 1500cm of clear floor space per kilo of adult weight. This means that a cage for a medium breed buck should be minimum 80cm square. However, cages for females should allow extra space for the nestbox and the litter, hence 80 by 115cm should be regarded as minimum for a medium breed doe.

Young rabbits reared for meat can be kept in groups of up to 20 to 30 animals until they reach four months of age. The weaned young kept in one group should be about the same age and weight. Such colony pens should allow 900 to 1200cm floor space per kilo of live weight.

The cages should not be deeper than 70 to 80cm for ease of reaching a rabbit at the back of the cage. The floor to ceiling height of the cages should be minimum 45 to 60cm and it is desirable to have the floor of the cages 80 to 100cm off the ground to handle the rabbits comfortably.

Hutch Modules

Any size rabbit unit is conveniently made up from two doe or four doe modules. The number of cages required in each of these modules is shown in Table 10.20.

The small scale producer may only have one such module, covered with its own roof, placed directly on the cages as shown in Figure 10.59 and 10.60; while the medium to large scale producer may have several modules placed under a separate roof on posts or in a shed, as shown in Figure 10.61.

Construction Details

Proper ventilation of the rabbitry is essential. The walls, roof and door of the hutch can be covered with chicken wire netting (37mm mesh) or made up of wood or bamboo placed 20mm apart.

In high altitude areas with lower temperatures it may be desirable to have a solid wall in the direction facing the prevailing wind. Temporary protection for strong winds, low temperatures and rain can be provided with curtains of Hessian, reeds, grass, plastics, etc. The roof of the rabbit unit should be leak-proof and can be made of thatch or metal sheets with some insulation underneath.

Ease of management depends to a great extent on the construction of the floor. It may

be solid, perforated, or semi-solid. Each has its advantages and disadvantages:

A solid floor can be made from wood, plywood or different kinds of boards. It allows bedding to be used, eliminates draughts through the floor and causes less trouble from hock sores, but is difficult to clean. The use of a solid floor will permit the hutches to be stacked in two or three tiers with the bottom row 30cm off the ground, and this may save some building space. However, a solid floor in the hutch frequently lead to outbreak of coccidiosis, a disease causing diarrhoea, loss of appetite and often death, because of build-up of manure in corners of the cage and contamination of feed and water.

A perforated floor is self-cleaning as manure and urine pass through to the ground and this assists in disease control, but if not properly constructed it may injure the animals. It can be made of woven or welded wire of not less than 16 gauge. Suitable mesh sizes are 12mm for small and medium breeds and 18mm for large breeds. Chicken wire can be used, but its thin wires may cause sore hocks and the urine can corrode the wire to failure within a year. The wire netting is streched over a wooden frame, trimmed flush with the bottom edge, and stapled every 5cm. Where it is fastened to posts the wire edges should be turned down to avoid injury to the rabbits. Self cleaning floor is usually recommended.

Table 10.20 ***Number of hutches Required in 2 and 4 Doe Modules Depending on the Intensity of Feeding and Breeding***

	Cage for Buck	**Cages for Does**	**Cages for fattening weaners**	**Total number of cages per module**
2 doe modules				
Extensive production	1	2	(1)	3 (or 4)
Semi-intensive production	1	2	1	4
Intensive production	1	2	2	5
4 doe modules				
Semi intensive production	1	4	3	8
Intensive production	1	4	4 (to 5)	9 (or 10)

Note: The cages for fattening weaners allow space for one litter

Figure 10.59 Rabbit unit for 2 does, 1 buck and fatteners.

Figure 10.60 Plan view of rabbit housing module for 4 does, 1 buck and fatteners.

Kindling boxes are permanently installed with access from each cage for a doe. The kindling boxes have outside doors to facilitate cleaning. The cross section is similar to the one shown in Figure 10.59.

Equipment and Store

Drinkers

A doe with litter may require up to 5 litres of water per day if fed only rabbit pellets or chicken mash. Rabbits receiving fresh greens daily will require less water, but all rabbits should have access to clean drinking water at all times.

An automatic waterer can be made from a large bottle and a small tin can. Figure 10.62a. Fasten the bottle to the inside of the hutch so that the lip of the bottle is about 1cm below the rim of the can. Fill the can and the bottle with water and replace the bottle. As the rabbit drinks from the can, the water will be replaced from the bottle.

Alternatively a nipple drinker made from a bottle, a pierced rubber cork and a piece of

6 to 8mm steel pipe as shown in Figure 10.62b, can be used. This allows the bottle to be placed outside the cage for easier refilling and there is less risk of contamination of the water as the rabbits drink by licking the nipple.

Figure 10.61 Rabbit house for 16 to 18 does, 2 to 4 bucks and approximately 100 fatteners. Note that hay racks have been installed between the cages for fatteners.

Feeders

Heavy earthenware pots, about 8cm deep and 10 to 15cm diameter make good dishes for feeding grain, pellets and mash because they are not easily tipped over. Tin cans, free of sharp edges, or open sections of bamboo nailed to a small board can also be used. However, rabbits like to scratch out feed with their feet and to avoid this a feed hopper which is tied to the side of the hutch, can be made from an empty 5 litres oil tin as shown in Figure 10.63c. A 6 by 12cm flap is cut 6cm from the bottom and strengthened with a piece of timber and then bent inwards. The top of the tin is removed and the edges bent net against the inside of the tin.

A manger made out of a piece of wire mesh, 40 by 40cm, can be fixed to the door of the cage for feeding greens or hay. This allows the rabbit to pull forage into the cage as it feeds. Greens should not be put on the cage floor as it increases the risk of disease.

The remains of greens left on the floor must be removed every day.

Nests

Does like to kindle in a private place. A nestbox should be placed in the doe's cage 5 to 7 days before birth. A box for medium sized breeds should be about 30cm wide, 40 to 50cm long and 20 to 30cm high. A lid is sometimes supplied as some does prefer the nestbox to be dark and in cold weather the lid will conserve some heat for the kids. Straw or grass lining of the box is generally not necessary but will provide extra protection in cold weather. The box can be made of plywood, hardboard, wooden planks or even bamboo, but whatever is used it must be easily cleaned.

Feed Storage he storage requirement for feed to all categories of animals in a rabbit unit can be determined by multiplying the following figures with the number of does in the unit and the number of days in the storage period:

- **in intensive production each doe-unit requires 1.3 to 1.8 kg pellets or mash per day.**
- **in semi-intensive production each doe-unit requires 0.3 to 0.5 kg pellets or mash per day. No storage is required for greens as they should be fed fresh every day, but if hay is used instead of greens each doe-unit will require 0.1 to 0.15 kg per**

day.

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Slaughterslabs and slaughterhouses

Contents - Previous - Next

In rural areas of developing countries the slaughter of animals for meat consumption is often carried out under less than ideal conditions. Where there are no facilities, slaughtering is likely to take place under a convenient tree where an animal can be hoisted for skinning and evisceration. Meat produced under such conditions lacks veterinary inspection, is often contaminated and must be considered a hazard to human health.

Most countries will have a meat control act providing meat inspection aimed at the control of meatborne diseases and the protection of the consumer from meat of

inferior quality or that has not been hygienically slaughtered and handled. The act may state minimum requirements for the design and operation of slaughtering facilities and must Therefore be carefully studied before any construction commences. While only basic design requirements are discussed here, the throughput and sanitary conditions of a slaughterhouse also depend greatly on equipment, manpower and work organization. It is advisable therefore to seek the advice of specialists whenever a slaughtering facility is to be planned, especially if the required killing capacity is more than a few animals per day or other facilities such as meat processing are to be included at the same location.

Gantry Hoist

In areas where population density is low and relatively few animals are slaughtered, a simple and inexpensive slaughtering facility is desirable. As animals must be hoisted immediately after stunning to assure proper bleeding and then remain in a hanging position during the dressing operation to ensure sanitary conditions, a first step in improving facilities is to build a wooden or steel gantry hoist. While a single gallow should be at least 3.7m above floor level, two levels of suspension are desirable; 4.5m for bleeding of cattle and 3.5m for the dressing operations. Sheep and goats can be suspended from a rail at a 2m height at the side of the gantry hoist.

Although a mobile gantry hoist that can be easily transported and reassembled is feasible in the first stage towards improved slaughtering, a permanently installed facility will normally be the minimum requirement as that allows for the construction of a concrete floor and a metal roof. The roof gives protection from sun and rain and allows slaughter to take place in all weather.

Figure 10.62 Homemade feeder, waterer and kindlingbox.

Whether temporary or permanent, the site should be fenced to prevent access to stray animals and unauthorized persons. In particular dogs and jackals must be prevented access to offal and condemned meat. These products may contain the parasite causing hydatid disease and infected dogs are a very common means for disseminating the disease to man.

Slaughterslabs

After an initial installation of a gantry hoist, concrete slab and metal roof, the facility can be gradually converted to an economical, low through-put slaughterslab. There should be floor rings to hold animals, skinning cradles for cattle and small stock, rails for hanging the carcasses and an adequate and convenient water supply.

Satisfactory waste disposal is a requirement from the start. The slab can be surrounded by wall 1.5m high and partitions can be installed between clean and dirty operations areas. A lairage should be constructed for both cattle and small animals. Drinking water should be available for the animals at all times.

Paving the area immediately surrounding the slaughterslab with either concrete or bitumen will improve both sanitary and working conditions. An extended overhead rail will allow the carcass to be moved from one operation to the next until it reaches the despatch area. Improved sanitation and management are possible by using separate bays for cattle and small stock. However, this is a design feature that must be considered at the very onset when the floor slab is poured.

Slaughterhouses

In areas where a large number of animals are slaughtered a fully equipped slaughterhouse should be provided, i.e. a large slaughter hall where animals are stunned, bled, slaughtered, flayed and dressed in successive operations. In such a system live animals enter one end of the building and emerge as dressed carcasses at the other. Capacity can be increased by using more than one bay for each kind of animal. A freezing room is normally included in a slautherhouse, but only the largest factory abattoirs will have facilities for the processing and large-scale storage of meat,

and the utilization of inedible byproducts.

Figure 10.63 Gantry' Hoist and layout of fenced area. (By courtesy of Dr. 1. Mann).

Figure 10.64 Slaughter of 20 cattle and 40 to 50 shep goats / goats per day (By courtesy of Ministry of Local Government, Kenya).

Figure 10.65 Slaughterhouse for slaughter of 40 cattle and 40 to 60sheep/goats per day .(By courtesy of Ministry of Local Government, Kenya).

Pig Slaughter

Out of consideration for the Muslim population, pigs should be handled separately in a slaughterhouse designed and used only for that purpose. Reasons other than religious also make it desirable to separate pig slaughtering. The steam from the scalding vats creates adverse conditions for setting of meat and the scurf accummulated from scraping pig carcasses is heavily contaminated with meat spoilage organisms. Pig slaughterhouse designs follow the same basic pattern as those for cattle, with provision for the separation of clean and dirty activities. The gallows and rails need to be 3.9m above floor level in the bleeding area and 2.5m in the slaughterhall. A water boiler to supply the scaldingvat with water of about 80C will be

required.

Poultry Slaughter

Most poultry for local meat supply in rural areas is slaughtered singly or in small batches as the need arises and it is often carried out in the kitchen.

Only in areas where poultry is produced on a medium to large scale for supply of meat to an urban area, will the construction of a slaughterhouse for poultry be feasible.

General Recommendations for Design and Construction

The site for a slaughter facility should be on ground that is higher than its surroundings to facilitate drainage. An adequate water supply must be available nearby to allow the slaughtering operations to be carried out under sanitary conditions. An all weather road will ensure timely dispatch of the meat throughout the year. All trees and bushes within 20m of the fenced area should be cleared to detract birds, insects, etc.

In tropical countries slaughterhouses should be as open to the air as possible and the building designed so that even a light breeze will produce a ventilating draught. The openings should not be glazed, but should, along with grills in the roof ridging, be screened to prevent the entry of insects. The grills will allow the warm air to escape

and cooler air to be drawn in through the windows.

For sanitary reasons, floors and walls should be easily cleaned, impervious to water and rodent-proof. Concrete floors should be finished smoothly, but not to the extent of being slippery, and sloped towards the open drains along the walls. Concrete blocks or stone building blocks are preferred for wall construction. All joints should be smoothly finished and wall and floor junctions will be much easier to keep clean if they are finished with a cove.

Figure 10.66 Pig slaughterhouse for 20 to 30 animals per day.

The meat must not come into contact with any wooden surfaces or equipment. Steel is prone to rust and stainless steel is generally very expensive. Hence concrete could be used wherever practicable and in particular for such items as troughs for intestines, offal, and for work benches. If wood is used for doors, a galvanized steel sheet should be fixed to the bottom of the door on the outside for protection against rodents. The layout should be designed to permit expansion without basic alterations to the original structure or suspension of operations. See figure 10.68.

Lairage

A lairage with a capacity of 11/2 days kill should adjoin the slaughterhouse. Here the animals are allowed to rest and recover from stress before slaughter, thereby improving the setting quality of the meat. Each pen in the lairage should hold about 15 cattle allowing at least 2.3m for each animal. At least 0.6m should be allowed for small animals. While the lairage should be an integral part of the slaughterhouse complex, it should be separated by at least 10m and connected by a long, straight cattle race 75cm wide at the top, narrowing to 45cm at the bottom, to prevent the cattle from turning around. The lairage should provide shade and clean drinking water and a hard, impervious, well-drained floor sloping toward open drains. A separate area where animals showing signs of sickness or fatigue can be detained for control, is desirable. A holding pasture where the animals are allowed to graze until 24 hours before slaughter should be available. A clean lairage ensures that the animals will enter the slaughtering area as free as possible from contamination.

Water Supply

Obtaining an adequate supply of potable water will often be the greatest problem to overcome when constructing a slaughterhouse in a rural area. The following minimum quantities should be available for each animal slaughtered:

1000 litres - cattle

100 litres - small animals
450 litres - pigs

Water from wells is best, but in many cases it will be necessary to use water from lakes and rivers. Should the quantity of potable water be insufficient, it may be necessary to install a dual water system, the potable water being used for carcass and edible offal, and non-potable water for watering stock, washing skins, cleaning, etc.

If a water tower is required, the simplest procedure is to purchase a prefabricated steel tank of the correct size. If, on the other hand, an underground tank is installed, it can be made of reinforced concrete. In the event that it is impossible to provide a supply of potable water, it is preferable to use a 'dry' slaughtering method, ensuring that no water comes in contact with the meat. However, the dry kill method should be used only when a maximum of two animals per day are killed. Water will still be needed for washing floors, walls, etc.

Figure 10.67 Slaughterhouse for Poultry.

Figure 10.68 Slaughterhouse with essential facilities.

Disposal of Blood

The large quantities of blood collected from the bleeding area should not be allowed to enter the main drainage system and cause pollution, and must not be mixed with water. Therefore, all the effluent from the stunning and bleeding area should be collected separately and led to an underground tank situated outside the building. The tank should be built with a tight-fitting, removable cover and be so constructed that the liquid can seep through the sides into the surrounding soil. the blood will eventually decompose and it should be necessary to clean the tank only occasionally.

To avoid objectional odours, the tank should be equipped with a screened ventilation pipe. In tropical areas the air in the pipe and the upper part of the tank will be warmed sufficiently during the day to cause circulation and air renewal in the tank.

The blood tank will operate satisfactorily only if the ground water level is below the level of the tank and the surrounding soil is pervious to water.

Removal of Manure and Condemned Meat

The carcass should be dressed out rapidly and the offal inspected and taken to a separate room where it can be cut up and the stomach and guts opened, cleared of manure and flushed with water. The manure is taken to a manure pit outside the building, while the rinsing water is directed into the main drainage system.

Suspected or condemned material is taken to the room set aside for this purpose. At the end of the day it is disposed of, together with inedible offal, in two concrete pits outside the building. The pits should be equipped with airtight locable covers.

Most of the material will slowly decompose and it will not be necessary to empty the pits. Incineration is not recommended as efficient incinerators are expensive both to buy and to operate and simple incinerators do not work satisfactorily and burn out quickly.

Drains

As running water is used during slaughtering and floors are flushed clean, the floors should be sloped so that water and effluent run into open drains placed along the walls. All these drains should be connected by a central drain to a grease and solids trap. From this trap the remaining effluent is led either into an evaporation pan where bacterial action will break down most of the effluent in 20 to 30 days, or alternatively, into a sub-surface seepage field, designed with a series of herringbone patterned trenches filled with stones.

Soakage pits not less than 6m deep and 1.8m in diameter and covered with a concrete top are satisfactory for only the smallest units.

Open drains are recommended for the effluent from the slaughterhouse for the following reasons:

- **a it is often difficult to obtain the right type of piping in rural areas, whereas open drains can be cast as the floor is installed;**
- **b the quantity of water available is sometimes insufficient to ensure that a system using closed pipes is adequately flushed and clogged pipes may result;**
- **c it is often difficult to obtain sufficient slope to allow the flushing action to take place by gravity so that automatic pumps would need to be installed - an expensive and impractical measure for a small slaughter operation.**

To prevent rodents from entering, a screen should be fitted to the open drain where it passes through the slaughterhouse wall in such a way that it can be easily removed for cleaning.

Cooling, Chilling and Freezing Rooms

As soon as the carcasses have been dressed they should be removed from the slaughterhall to avoid prolonged exposure to its atmosphere and thereby reduce the development of microflora in and on the meat. Most meat in the tropics is distributed, still warm, for consumption the same day it is slaughtered. Hence a cooling room will

normally not be required. The meat is instead transferred directly to a dispatch area. This practice implies that the work must start sufficiently early, and the slaughterslab, or slaughterhouse must have capacity such that the slaughtering operations can be finished by about 10 o'clock in the morning.

It is desirable to have a freezing room in all but the smallest slaughterhouses. The freezer can be used to sterilize measled meat, since some types of meat parasites are destroyed by the low temperature. It also makes it possible to help to balance the supply of meat to the demand. Refrigeration units are expensive and a chill room where meat can be ripened and tenderized can be justified only where there is a demand for meat treated in such a way.

Further reading

Agricultural Information Centre, Livestock *Development Technical Handbook,* Nairobi, Agricultural Information Centre.

Attfield H.D., *Raising Rabbits,* Mt. Rainer M.D., Volunteers in Technical Assistance, VITA, 1977.

Chakroff M., *Freshwater Fish Pond Culture and Management*, Mt. Rainer M.D.,

Volunteers in Technical Assistance, VITA, 1978.

Crees H.J.S., Nissen-Petersen E., Githari J.K., *Cattle Tick Control,* Ministry of Livestock Development, 1977, Nairobi.

Department of Agriculture, Rabbit Keeping, Lusaka, Rural Information Service, Ministry of Agriculture and Water Development.

Devendra C., Fuller M.F., *Pig Production in the Tropics,* Oxford University Press, 1979.

Devendra C., McLeroy G.B., *Goat and Sheep Production in the Tropics*, Intermediate Tropical Agriculture Series, London, Longman Group Ltd., 1982.

Ensminger M.E., The Stockman's Handbook, Animal Agriculture Series, 5th Edn. Danville, 111., The Interstate Printers & Publishers, Inc., 1978.

Eriksen P.J., Slaughterhouse and Slaughterslab Design and Construction, FAO Animal Production and Health Paper no.9, Rome, Food and Agriculture Organization of the United Nations, 1978.

Eusebio J.A., Pig *Production in the Tropics*, Intermediate Tropical Agriculture Series, Harlow, Essex, Longman Group Ltd., 1980.

Francis P., *Poultry Production in the Tropics,* Intermediate Tropical Agriculture Series, London, Longman Group Ltd., 1984.

Hafez E.S.E., *The Behavior of Domestic Animals,* 3rd Edn, Baltimore, The Williams and Wilkins Co., 1975.

Hall J.M., Sansoucy R., *Open Yard Housing for Young Cattle*, FAO Animal Production and Health Paper, no. 16, Rome, Food and Agriculture Organization of the United Nations, 1981.

Kilgour R., Dalton C., *Livestock Behaviour, a Practical Guide,* London, Granada Publishing Ltd., 1984.

Mann I., Bees are Wealth; *A Handy Guide to Bee-keeping in East Africa,* Nairobi, East African Literature Bureau, 1976.

Midwest Plan Service, Small Farms-Livestock Buildings and Equipment, Ames, lowa, Midwest Plan Service, 1984.

Midwest Plan Service, *Structure and Environment Handbook,* Ames, lowa, Midwest Plan Service, 1983.

Ministry of Agriculture and Water Development, *Dairy Buildings and Equipment,* Lusaka, Ministry of Agriculture and Water Development, 1982.

Ministry of Agriculture and Water Development, *Tick Control by Spraying - Dipping,* Lusaka, Ministry of Agriculture and Water Development, 1982.

Ngugi J.B.M., Chicken Production; *Main Breeds, Breeding & Management,* Nairobi, Kenya Literature Bureau, 1980.

Nissen-Petersen E., Svantesson F., *Manual of Construction of Cattle Dips,* Nairobi; Veterinary Department, Kenya, 1977.

Noton N.H., *Farm Buildings,* Reading, UK, College of Estate Management, 1982.

Oluyemi J.A., Roberts F.A., *Poultry Production in Warm Wet Climates*, London, The Macmillan Press Ltd., 1979.

Payne W.J.A., *Cattle Production in the Tropics*, Vol. 1, Tropical Agriculture Series, London, Longman Group Ltd., 1970.

Price C.J., Reed J.E., *Poultry Husbandry 11, Notes for Students of Animal Husbandry,* Rome, Food and Agricultural Organization of the United Nations, 1971.

Whitaker J.H., *Agricultural Buildings and Structures*, Reston V.A., Reston Publishing Company, 1979.

Williamson G., Payne W.J.A., *An Introduction to Animal Husbandry in the Tropics*, 3rd edn., Tropical Agriculture Series, London, Longman Group Ltd., 1978.

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Chapter 11 Sundry farm buildings

Contents - Previous - Next

Farm workshop facilities

A workshop provides a focal point at the farmstead for the repair and maintenance of machines, implements and structures. It also provides a place where tools can be stored in an orderly manner, a store for supplies and spare parts, and a shelter where

work can be carried out during inclement weather. A facility of this type should be available on every farm. The size and design of a workshop, however, should be commensurate with the size of the farm and the work to be done in the shop.

The small holder may be adequately served with a tool storage cupboard that can be locked for security and a workbench with a simple homemade vice for holding tools while they are being sharpened or fitted with new handles. From this simple beginning a more complete facility may gradually evolve as the farm operation grows and more equipment is required. Since repair tools and supplies represent a considerable investment, most farmers will want to store them in a secure place. Many small scale farmers will not require a separate store for this purpose, but if stored together with hand tools and small implements, the number of items may motivate the farmer to build a storeroom by enclosing part of the workshop with solid walls. Figure 11.1 shows a simple work shelter and store suitable for repair work and the storage of small implements. Note that the doors to the store may be designed with racks and hooks to hold supplies and tools. Fuels and other combustible materials should not be stored with the tools. A simple work bench and vice can also be housed under the shelter.

At the other extreme, a large ranch or commercial farm may need a separate building with extensive equipment for maintaining the farm machinery, tractors and vehicles. A

farmer may also use his workshop to do routine repairs and preventive maintenance during the off season, to build or modify some of the equipment used on the farm and to prefabricate building elements to be used in construction projects.

The workshop facilities should be cost effective. That is, enough savings should be realized from timely maintenance, repairs and construction projects to pay for the cost of the building and the necessary tools and equipment. Although it is difficult to put a monetary value on timeliness, there is no question that being able to make emergency repairs is important. Some farm operations (planting, spraying, milking) are more sensitive than others to prolonged interruptions, and having facilities to complete repairs on the farm can reduce delays to a minimum.

Other factors, apart from the farm size, which will influence the extent of the workshop facilities are the number and diversity of machines, the availability of service from dealers, and the interest and mechanical skill exhibited by the farmer and farm labourers. If necessary, a skilled mechanic may be employed. Without qualified personnel to use the shop it becomes questionable in value and may even contribute to more frequent breakdowns and additional expense due to careless work.

The workshop should be located close to the work centre of the farm and convenient to the farm home on ground that is well drained and sufficiently level to allow easy

maneuvering of equipment. Where electric power is available, proximity to the power source should be considered.

In tropical climates the workshop may be a simple pole structure with a non-flammable roof. Unless dust is a problem, it may be feasible to leave the sides open to provide good light and ventilation. Heavy-gauge wire netting can be used to make the area more secure without reducing light or ventilation. A pole structure of this sort can be enclosed with offcuts or corrugated steel at a later time, but if this is done, there must be provision for several good-sized windows. While a simple earth floor is often satisfactory, concrete offers the advantages of an easily cleaned, level surface. To do a clean repair job, a clean work area is essential and this is particularly important when lubricated mechanisms are reassembled. The level surface is helpful in some assembly or alignment operations.

Figure 11.1 Small farm workshop with a secure storeroom.

The following additional features are important for a safe and efficient shop:

- **1 Sufficient room for the largest machine that may need repair, including workspace around it. If the machine is large, truss roof construction may be needed to provide the required space without intermediate supports.**

- **2 An entrance that is both wide enough and high enough for the largest equipment that the shop has been designed to accommodate. If the building is enclosed with either solid walls or wire netting, a second door is essential for safety in case of fire.**
- **3 Some means of lifting and supporting heavy loads. When the roof span is 3m or less, a timber beam is often adequate. For larger spans or very heavy loads a truss will be required. Alternatively, a portable hoist can be used.**
- **4 Electric lighting and electrical service for power tools.**
- **5 A water supply for both convenience and safety.**
- **6 One or more fire extinguishers of a type suitable for fuel fires. Two or three buckets of dry sand are a possible substitute or supplement for a fire extinguisher.**
- **7 Storage cabinets for tools, supplies and spare parts. Sturdy doors can be locked for security and also provide space to hang tools and display small supplies for easy access.**
- **8 A heavy workbench attached to the wall or otherwise firmly supported. It should be 1 m high, up to 800mm deep and at least 3m long and equipped with a large vice. There must be sufficient clear space around it to maneuver workpieces and, if attached to a solid wall, ample window openings above it to provide light.**

Equipment needed in the workshop will depend on the type and extent of work to be done. Generally this means those tools required to perform day-to-day maintenance

on machines and to carry out general repair work and small construction jobs required on farm buildings and equipment. However, any shop, regardless of size, will need some simple woodworking tools, some means of sharpening field tools, and wrenches (spanners) of various types and sizes. If the shop equipment includes a welder, it should be located, in the interest of safety, away from the woodworking area and preferably near the main door where it can conveniently be used inside or outside the building.

Flammable materials such as sawdust, shavings and oily rags must never be allowed to accumulate in the workshop since they represent a fire hazard, and fuels should be stored in a separate area. Generally good order and cleanliness in the shop makes for efficient work, convenience and safety.

Machinery and implement storage

On many small-scale farms in Africa all cultivation and transport operations on the term are done manually. The few small-sized hand tools and implements used in such farming can normally be stored in any multipurpose store at the farmstead. The store needs only to be secure for protection of the equipment from theft and vandalism, and dry so as to avoid deterioration of the metal and wooden parts. The tools will last

longer if they are cleaned and working surfaces are greased prior to storage. The tools may be hung on rails or hooks on the wall or from the ceiling for order and convenience and to protect them from dampness penetrating an earth floor in the store.

Implements such as ploughs, harrows and cultivators are damaged little by rust when left outdoors. If they are properly cleaned prior to storage and metal surfaces, particularly all threaded parts used for adjustments, are greased, then a little rust is not likely to harm performance enough to justify the cost of a storage structure. A fenced compound can offer adequate protection against theft during storage. Although implements containing wooden parts are more susceptible to decay, those parts can usually be replaced at low cost.

Tractors and other complex machines will function better when needed if they have been stored under cover and given a complete off-season check-up. An adequate storage structure for these machines is likely to be economically feasible.

For most purposes a narrow open-side shed with a welldrained, raised earth or gravel floor will be adequate for machinery storage. The sides of the building can be partly or wholly enclosed with netting or solid walls when security conditions make it necessary. The building must be high enough to accommodate the highest machine. A smooth, level floor makes it easier to attach and detach tractor-mounted equipment or to move other machines. The space required can be determined by obtaining the dimensions of all the machines and implements to be stored. Then, using graph paper, the outline of the machines can be sketched onto a plan view, allowing additional space for maneuvering. Any roof-supporting posts inside the building or in the open sides must be marked on the drawing, since they will restrict the way the floor space can be utilized. Since many machines can not be easily moved, it is desirable to arrange the stored machines so that shifting is unnecessary.

Figure 11.2 Narrow open-side implement shed.

Fire resistant construction is desirable where tractors, cars and other powered machines are stored. A pole structure with an earth floor, sheet metal walls, timber trusses and metal, asbestos-cement or sisal-cement roofing will offer adequate fire resistance.

Machinery stores and farm workshops are constructed in much the same way and are usually placed close together for convenience. In fact, they may be housed in one building with a workshop section at one end and machinery and implement storage in the balance of the building.

Fuel and chemical storage

Many materials that are used on farms fall into the category of "hazardous materials", since they are either highly flammable or poisonous. The type and quantities of these materials requiring storage will vary from one farm or one cooperative store to the next and only a few basic requirements for safe storage will be considered here. Other materials frequently used on farms such as fertilizers and cement also have special storage requirements mainly because they are hydroscopic, i.e., they tend to pick up moisture from the atmosphere.

Storage of Hazardous Products

- **Hazardous materials stored on farms normally include the following:**
- **Highly flammable materials such as engine fuels and oils, such as petrol, diesel, kerosene and lubricating oils.**
- **Gases such as butane, propane and acetylene. Oxygen promotes the combustion of other materials and must be handled carefully.**
- **Paints containing flammable solvents, cellulose thinner or alcohol.**
- **Poisonous materials such as herbicides, insecticides, rat poison and sheep and cattle dips.**
- **Acids and alkalies such as detergents, cleaning liquids, lye and quicklime (CaO).**

- **Medicines such as veterinary drugs and supplies. Some drugs may require refrigeration.**
- **Wood preservatives and corrosion inhibiting paints.**

Hazardous materials should always be stored in a separate location containing only those materials. If the quantities are larger, flammable and poisonous materials should be stored in separate rooms. Ideally each type of material should have its own storage space, that is, its own shelf in a cupboard or a storage room, or its own room in a cooperative or merchant store.

Quantities of flammable products greater than about 3 litres of cellulose thinner, 10 litres of petrol, 20 litres of kerosene, 50 litres of diesel fuel should be stored in a separate building at least 15m from any other building. For this purpose a pole building with steel netting walls offers shade and security.

Any store for hazardous products must be well ventilated so that explosive or toxic fumes can not accumulate. Ventilation openings should be provided at both low and high levels or alternatively the door can be covered with netting. The store, including the ventilation openings, should be vermin proof to prevent rodents from breaking open packages. It must be possible to lock the store to prevent the theft of expensive materials and keep unauthorized persons, in particular children, from accidentally

coming into contact with the hazardous materials.

Some chemicals are harmful to the skin. Therefore washing facilities should be available nearby for immediate use. Stores for hazardous materials should never have a drain in the floor as any spillage or washdown water containing the materials must be prevented from entering any watercourse or drinking water source. It is frequently recommended that the floor and lower part of the walls including the door sill be constructed of concrete to form a reservoir to contain any accidental spills. This type of store must be clearly marked with an appropriate warning notice.

Figure 11.3 Cabinet for the storage of chemicals.

Storage of Fertilizers and Other Non-hazardous Materials

Some fertilizers are hydroscopic and easily pick up moisture from humid air or from the ground. This causes them to become lumpy and to deteriorate. Cement, although not very hydroscopic, will deteriorate if exposed to damp conditions. Other materials may be adversely affected by prolonged exposure to high storage temperatures and therefore must be shaded. Fertilizers and cement are normally sold in plastic lined bags offering some degree of protection. They should be handled and stored so that the bags are not punctured or otherwise damaged. In addition the storage conditions

should be as dry as possible. Bags should be placed on a raised platform in the store. This will allow ventilation and prevent ground moisture from penebating from below. The pile should be protected from rain by a roof or some other type of watertight cover. Fertilizer can be very corrosive to metals and should not be stored close to machinery or tools.

Greenhouses

A greenhouse is a structure using natural light within which optimum conditions may be achieved for the propagation and growing of horticultural crops, for plant research, or for isolating plants from disease or insects. While in the tropical areas of Africa there are only limited applications, there are a few situations in which a greenhouse can be justified because of the optimum growing conditions required for a high value crop or a research project.

There is a wide range in the cost of various greenhouse designs and a careful assessment to relate the requirements for a given enterprise to the cost of the house is important. For example, a greenhouse used for year long flower production can justify the cost of glass, while a house used for a month or two for starting vegetable plants can only justify a polythene covering.

Site and Support Facilities

Greenhouses should be located in open areas with no shading from trees or buildings and with access to roads. The land should be nearly level and well drained with a fall of 1 in 100 to l in 200 being ideal. If possible, the site should be sheltered from excessive winds. However, normal air movement is essential for natural ventilation systems and to prevent locally stagnant conditions.

Good soil is essential, deep, medium-textured loam being ideal. Soils which are less than ideal should be worth improving. Very heavy soils are not usually satisfactory.

A good, clean water supply is of paramount importance. A full crop system may require up to 8,400m per hectare (840// m) in a single year and the source of water must be able to supply all that will be required.

Electricity will be required if ventilation is to be mechanized and if stationary machinery is to be used in the greenhouse.

Design Parameters

Light

It is important that the crops being grown in a greenhouse receive the optimum amount of light, not only when the skies are clear (direct light), but also when it is cloudy (diffuse light).

The shape and construction of the house should be such that it will allow the best possible entry of light. The two shapes coming closest to the ideal are: a the single-span semicircular section covered with clear polythene film, Figure 11.4. b the mansard profile, a framed structure in which the sides and two roof sections are sloped in such a way that a semicircular cross section is approximated, Figure 11.5.

The size and cross section of all the load bearing members have a pronounced effect on light transmission.

The gutters of multi-span roofs produce considerable shade, and likewise, in wide-span houses, the heavier roof trusses tend to cause more shading. Thus open trusses with narrow-section members are desirable.

Light colors and reflective surfaces improve light transmission. In spite of a good design for natural light, artificial lighting may be needed for the production of photo-period sensitive plants.

Orientation

Within the latitudes found in the tropics it is desirable to orient the ridge of greenhouses north and south to reduce the overall shading by the framing members. This is true for all types of frames including multi-span houses.

Size

While multi-span blocks of 3.2m each are least expensive to build, wider spans will allow somewhat better light transmission. Furthermore, the general management in wider houses (movement of machines, optimum cropping layouts, etc.) may justify the extra cost. As a general rule the cost is lowest when the length is four to five times the span width. This is particularly true with wide-span houses.

Height

The height of a greenhouse should be sufficient for the operation of machinery and the comfort of the workers. An increase in height improves natural ventilation during still conditions and the desired plant climate is more easily obtained. However, with very high roofs, maintenance becomes more difficult. Gutter heights of 2.8 to 3.0m are recommended for multi-span houses to allow machines to move freely. In single-span

houses, eave height should be at least 2m to allow for unrestricted work space.

Materials

Greenhouses are generally built of steel, aluminium or wood and are glazed with good quality glass, clear polythene sheet, or fibreglass-reinforced polyester panels.

Steel must be galvanized after fabrication as any welding or drilling breaks the galvanized layer. Steel is cheaper than aluminium and is ideal for the main roof frame.

Aluminium is very resistant to corrosion and is easily formed into complex sections. While it is expensive, it is most suitable for glazing bars. It cannot be economically welded and bolted construction is used.

Wood is less suitable for the lightweight construction and the high moisture conditions found in greenhouses, therefore only top grade timber of the most decayresistant species which has been treated with a waterbourne type of wood preservative should be used.

Figure 11.4 Semicircular greenhouse frame.

Figure 11.5 Mansard and gable greenhouse frames.

Glass is expensive, but it is the most durable covering and transmits the most light (90%). However, the gradual build-up of dirt and algae along with surface etching eventually causes a reduction in light transmission. The minimum width of glass ordinarily used is 610mm. Also common is the 730mm width. Both of these are 4mm thick and weigh 2.8 kg/m.

Polythene sheet is increasingly being used to cover relatively low cost structures. It has light transmitting qualities similar to glass but the material has to be replaced periodically as it deteriorates under the influence of ultraviolet light. However, the cost is much lower than glass and the roof framing can be much lighter, resulting in good economy.

Fibreglass reinforced polyester panels are more impact resistant than glass and more durable than polythene sheet. Light transmission is about 85% but drops off appreciably unless the surface is cleaned and resurfaced with acrylic sealer every 4 to 5 years. It is intermediate in cost between glass and polythene.

Ventilation

In tropical regions ventilation is likely to be the most important environmental control feature of the greenhouse. The exchange of air inside the building with air from the

outside is used to lower temperature, reduce humidity, and to maintain a supply of carbon dioxide for photosynthesis. This is accomplished by natural means with vents and doors or by mechanical means with fans. A comprehensive discussion of ventilation is found in Chapter 7.

The ventilation rate is usually expressed as the cubic metres per second of airflow per square metre of floor area. To obtain a reasonable heat rise of less than 4C in a glass-clad house, the airflow rate in the tropics should be 0.04 to 0.05m/s and m of floor area.

Polythene-clad houses do not become as hot due to the transparency of the plastic to longwave radiation which is transmitted back out of the house. Thus the ventilation rate for a polythene-clad house can be reduced to 0.03 to 0.04m/ s and m. This further reduces the cost of a polythene-covered house.

Adequate natural ventilation is often provided by large doors at each end even though this may amount to only 3 to 7% of the floor area. These large doors not only aid in ventilation but also allow easy access to the greenhouse.

Cooling

Evaporative cooling can be used in greenhouses where ventilation alone is insufficient to maintain the required temperatures. Figure 11.6 shows the temperature reductions possible with evaporative cooling. Evaporative cooling is discussed in detail in Chapter 7.

Figure 11.6 Limits of evaporative cooling.

Shading

Shading is used to reduce light transmission and heat gain when necessary. In glass houses shading may be done simply by applying water-based whitewash to the inside of the roof to cut down light transmission. When the weather conditions are steady and reliable, whitewash is cheap and effective and easily washed off when the need is past. Whitewash as a shade seems particularly appropriate for shading in tropical areas.

Further reading

Iowa State University, *Planning and Equipping a Service Center for Your Farm,* Ames, Iowa, Cooperative Extension Service Iowa State University, 1980.

Noton N.H., *Farm Buildings, Reading*, U.K., College of Estate Management, 1982.

Virhammar K., *Plastic Greenhouses for Warm Climates,* FAO Agricultural Services Bulletin 48, Rome, Food and Agriculture Organization of the United Nations, 1982.

Whitaker J.H., *Agricultural Buildings and Structures,* Reston, Va., Reston Publishing Co., 1979.

Food and Agriculture Organization, Agricultural Machinery Workshops: *Design, Equipment and Management,* FAO Agricultural Development Paper No.66, Rome, Food and Agriculture Organization of the United Nations, 1960.

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Chapter 12 Farm dwellings

Contents - Previous - Next

The traditional life style of the farming communities of tropical Africa is undergoing many changes. People are becoming better educated, coming into contact with other cultures and technologies, and are gradually losing their knowledge of the traditional crafts and agricultural methods that were practiced by their ancestors. This is encouraging a change from the traditional way of life to a more modern, in some respects, westernized, mode of living with a desire for appropriate dwellings.

Planning the design and construction of a farm dwelling requires decisions with which the farm family must live for a long time, perhaps a lifetime. These decisions are likely to be highly personal because of individual preferences, financial situation, family size, location and other circumstances. There are a number of factors to be considered and questions to be answered before building a home.

This chapter presents information relating to space requirements together with ideas for planning farm dwellings. It leaves a great deal of opportunity for designs to evolve through the cooperation of the farm family, craftsmen and perhaps engineers and architects. The planning will involve careful evaluation of factors such as traditional family culture and social life, climate, government regulations, available materials and the skills of local craftsmen. The planning process will result in unique designs that may differ greatly from one area to another. However, only if the planning process aims at producing designs which within a cultural and environmental context are

general in terms of layout, materials, construction and details, will they contribute to develop an indigenous building tradition that pursues the native architectural heritage.

Helpful information related to the planning of farm homes will be found in several other chapters including: Chapter 3-Materials, 5-Building Construction, 7-Climate and Environment, 8-Functional Planning, and 14-Water and Sanitation.

Space requirements

In planning a farm home, adequate space must be allowed for each of the daily activities. This is not so much related to total space as it is to such things as door widths and heights, corridor widths, adequate space for a bed or a table and chairs, clearance for a door to swing open, etc. It is essential that these dimensions be checked in every design as very minimal changes can often make a considerable difference in convenience. Figure 12.1 as well as several figures in Section "Functional Requirements for different rooms and spaces" provide a guide to space requirements.

Family cultural and social requirements

Various tribes and ethnic groups with different cultural and religious bac kground have

developed distinctive customs and social requirements. An analysis of the farm family's daily life, including present requirements and future plans, will help in selecting the important factors for designing an appropriate dwelling house.

A number of questions relevant to a farm home design are listed as follows:

***Family size*: How many persons will live in the house initially and in the future? What are the family relationships - age, sex, marital status?**

***Sleeping:* Are separate bedrooms and/ or houses needed for the husband and wife (wives)? Where do small children sleep - in parents room, separate room nearby? Where do the older children sleep - separate room, separate house? Are children of different sexes separated?**

Figure 12.1 Critical human space requirements.

***Cooking/eating:* Is cooking done inside or outside the house or in a separate structure? Are cooking and eating done in the same area? Is there a separation between women and men, children or visitors during eating? What kind of water resources are available?**

***Store:* How much food is stored, where? What type of storage conditions are required?**

What other items need to be stored - fuel, water, implements?

Resting/conversation: **What kind of room is required for resting and conversation - outside, verandah or separate shelter, - inside, kitchen or living room? Are men, women and children separated during these activities?**

Special requirements of farm dwellings

The farm family accustomed to working with nature, has different needs in a dwelling than a family in the urban area. Although many of the basic requirements are the same for both rural and urban homes, additional factors must be considered in designing the rural dwelling. They include the following:

- **A well-drained site, but suitable for a well, and when necessary either a latrine or a septic tank and drainage field. A home should never be built on a flood plain.**
- **The relation of the dwelling to other farm buildings that will allow a view of the access road and the farmstead. See Chapter 8 Section: Farmstead Planning.**
- **The correct orientation of the house to give protection against sun, rain, odour and dust while providing for ventilation, a view and easy access. An east-west orientation to provide the most shading is a general rule. However, it may sometimes be desirable to modify this to take advantage of a prevailing wind for**

better ventilation or to have more sun penetration into the house in cool highland areas.

Figure 12.2 Orientation of a farm dwelling.

- **A design which will allow building the house in stages according to the availability of finances.**
- **Flexibility in the arrangement of rooms to allow for alternative use and future expansion.**
- **A kitchen large enough to allow for space-consuming activities such as cutting meat after slaughter, preparation of homegrown vegetables, etc.**
- **A separate entrance from the backyard into the kitchen area. A small verandah at the rear of the home where some of the kitchen work can be done and perhaps farm clothes can be stored.**
- **A verandah large enough to allow for activities such as eating, resting, visiting, etc. The veranda, along with windows and ventilation openings, may need to be protected against insects with mosquito netting.**
- **A separate office for larger farms, while a storage cupboard and the dining table will be sufficient for small farms.**
- **A place to store dirty farm clothes and shoes combined with washing facilities, if possible.**

- **A room for guests if it is likely to be needed.**

Categories of farmhouses

Farming communities may be grouped according to the type of agriculture practiced in the area: subsistence, emergent or commercial. The size of the home, materials used and the method of construction will be influenced by the type of agriculture and the resulting income. The dwelling may range from a self-built structure using local, natural materials and costing little or nothing, to a contractor-built house using mostly commercial building materials and requiring a considerable income to finance. Table 12.1 summarizes various factors relative to housing for the three categories of farm families.

The improvement in layout, design, construction and building materials may allow further development of the farm dwelling and will help to extend the life span of the dwelling house and make life more comfortable. Table 12.2 summarizes some of the improvements to be expected.

Function and communication schemes

Good communications play an important role in the successful management of a farm business. Close supervision and control will help to maximize profits and keep losses to a minimum. Therefore, easy access to the ongoing farm activities is imperative. A functionally placed dwelling will serve as a communication center within the farmstead and will aid the farmer in supervising the farm operation. Figure 12.3 graphically shows the dwelling as the center of operations for the farmstead.

Human environment and the traditional social life strongly influence the functional arrangement of rooms within a dwelling. In Figure 12.4, an attempt is made to show functional communication between rooms with the essential connection to each other.

Traditional house design in East Africa may combine functional and communication requirements in one large multi-purpose house with one or several rooms, or in several small one-room single-purpose houses. Three traditional plans are shown followed by four contemporary plans with varying degrees of privacy and security.

Table 12.1 ***Summary of Factors Relative to Farm Dwellings***

	Substance Farmer		Emergent Farmer	Commercial Farmer
	Village Farmer	Single Farmer		

Agricultural method used:	Traditional	Traditional	Traditional/Modern	Modern
Agricultural products for:	Self-	Self-	Self	
	consumption	consumption	consumption/	Sale
			Sale	
Income:	Nil - low	Nil - low	Low	Medium
			medium	-high
Dwelling situated at:	Village	Plot	Plot/farm	Farm
Design used:	Traditional	Traditional	Traditional/	Modern
			Modern	
Building materials used:	Local	Local	Local mainly,	Industrial
	only	only	few industrial	products
			products	mainly,
				few local

Expected life span of dwelling	5-30 years	5-30 years	30-50 years	50-150 years or more

Figure 12.3 Farmstead functional scheme.

Figure 12.4 Dwelling house functional scheme.

Multi-purpose House with One Room

Figure 12.5 shows this type of house which is very economical in use of buildings materials and has good security because of only one entrance. Its disadvantages are a lack of privacy and a health hazard because cooking, eating, sleeping, meeting and even keeping of animals are done in the same room.

Figure 12.5 Multi-purpose house with one room (Mijikenda house - Kenya).

Multi-purpose House with Several Rooms

In terms of building materials, this type of house, shown in Figure 12.6, is less economical than the previous one. The security is good and the individual privacy has improved because of separation of the rooms. Health standards are still not good

because of cooking, food storage, sleeping and keeping animals under the same roof.

Figure 12.6 Multi-purpose house with several rooms (Maasai- Tanzania).

Table 12.2 ***Summary of Improvements in Farm Dwellings***

Further	**Subsistence**	**Emergent**	**Commercial**
Improvements	**Farmer**	**Farmer**	**Farmer**
In layout:	separation of animal shelters and dwelling	accounting for further expansion	functional and flexible farm dwellings
	nearby water resource	trees for break windbreak and farm use	future extension
	trees for wind break		
	facilities like garden, pit latrine etc.	facilities such as garden, latrine, etc.	carport

In design:	improvement of traditional design (minimum floor space, minimum room height, etc.)	design to allow building in stages	functional design (may consult architect)
In construction:	proper drainage of surface water	further training of basic knowledge in	consult/employ contractor, experienced foreman, etc.
	raised floor		
	strong foundation	construction	
	efficient roof slope		
	good roof overhang		
In building material:	improvement of local building materials, e.g. treatment of wood,	use of appropriate or improved building materials, e.g. soil cement,	use of suitable, well-tested material according to the

	surface treatment of walls, etc.	fibre- reinforced roofing, etc.	manufacturer's recommendation

Single-purpose Houses with One Room

This type, shown in Figure 12.7, is uneconomical in terms of building material and may not provide satisfactory security in some areas. However, privacy is very good and the separation of the houses will keep the health hazard to a minimum. Further expansion is possible and modification in use is simple.

Figure 12.7 One-room, single-purpose houses (Mesakin house- Sudan).

Further development of the traditional multi-purpose house with several rooms has lead to a more contemporary design, influenced by western culture and industrial building materials. These designs combine the advantages of privacy, security and improved health conditions without excessive expense for building materials or skilled craftsmen.

Considering the arrangement and communication between rooms, these houses can be divided into four main types, each of which can be easily varied.

External-access. Type

All rooms have their entrances from outside. Security depends on several expensive outside doors. The lack of internal connection between rooms is often a disadvantage from the functional point of view, but the resulting separation can be advantageous in situations such as an extended family or a change of owner. See Figure 12.8.

Courtyard Type

This type, shown in Figure 12.9, resembles the previous design but the rooms have their entrances from an enclosed yard, which improves the security and privacy of the house.

Figure 12.8 External-access type.

Figure 12.9 Courtyard type.

Corridor Type

All rooms have an entrance from a corridor running through the house as shown in Figure 12.10. This type provides good security and privacy. A long corridor, however, often tends to be dark and may be thought of as wasted space.

Figure 12.10 Corridor type.

Central-room Type

Instead of a corridor, a central room such as the meeting or dining room provides access to the other rooms as shown in Figure 12.11. Security is very good in this type of house, but the central room must be large enough to allow space for both circulation and the furnishings for its primary purpose.

Figure 12.11 Central-room type.

Functional requirements for different rooms and spaces

Farm families have different needs for rooms and space depending on their daily activities, way of life and financial resources. The following recommendations cover the basic needs for a subsistence farm family and range on up to the high standards of an affluent commercial farmer. Accordingly, a design should be chosen which will best fill the needs for each farm family.

Sleeping

One of the most obvious purposes of a house is to provide shelter for comfortable sleeping. The sleeping rooms need to be clean, well-ventilated, dry and well-lit by day.

The minimum floor area for a bedroom should ordinarily not be less than 9m with a minimum floor area of 3m for each person accommodated. In hot humid climates cross ventilation is essential, while in highland areas it may be difficult to have both adequate ventilation and at the same time protection against the cold nights. The protection of windows and ventilation holes with insect mesh is recommended in mosquito infested areas.

Meeting and Rest

An important part of African daily life is a place to meet to talk with family and friends or simply to sit down to rest. To a large extent, this activity takes place outdoors in the shade of a tree, a separate shelter or a verandah. In order to function well, this outdoor space should not be less than the recommendation given in Figure 12.13.

There should also be some indoor space such as a living room for similar activities during the evening and inclement weather. A room with a minimum floor space of 12 to 15m, furnished with chairs and tables will ordinarily be sufficient. Although not an ideal solution, this room can be used for sleeping by children or older boys. If the room is to be more elaborately furnished, an increase in floor space of up to 25 to 30m may be needed. Cupboards, book shelves, a TV, fireplace and other amenities may be included.

Figure 12.12 Recommended sleeping spaces.

Figure 12.13 Minimum space for outdoor meeting/rest.

Figure12.14 Recommended indoor space for meeting/rest.

Taking Meals

Traditionally meals are taken either indoors or outdoors utilizing the same space as for meeting and resting. Dining can be a strictly private matter (out of sight of neighbours) and even in separate groups (men, women, children). In contrast, other families may eat together as a group with no particular desire for privacy. Depending on the culture, in one home it may not be appropriate to have a separate dining room, while in another this facility will be appreciated.

Figure 12.15 Space for taking meals indoors.

Figure 12.16 Working levels for food preparation and cooking.

Figure 12.17 Recommended arrangements for cooking.

Preparing and Cooking Food

Again, cultural and tribal customs may determine whether food is prepared and cooked inside or outside of the house. In areas where nights are cold, it may be desirable to cook inside to conserve the warmth, while in warm humid areas it is preferable to cook outside the dwelling. In either case, the cooking area should be kept clean and raised above the ground for basic hygienic conditions.

Outdoor cooking facilities in a separate shelter or on a small verandah need to be protected from sun, rain, dust and animals. Food preparation and cooking done inside the house require good ventilation, enough openings for lighting and nearby access to the backyard.

Figure 12.18 Storage of food and kitchen equipment.

Figure 12.19 Storage for clothing and bedding.

Storage

In a farm dwelling, space is needed to store foodstuff, kitchen equipment (pots, pans, dishes), clothing and bedding, fuel (firewood, charcoal), and perhaps some small farm tools (hoes, spades, pangas). The small things like foodstuff, kitchen equipment and textiles may be stored in the rooms for cooking, sleeping and meeting. Larger items

need a separate store which can be another room in the house or part of an out-building. Kerosene should be stored outside of the house.

Kitchen utensils and foodstuff kept in pots or containers should be raised off the ground for storage. They may be either hung from the roof, placed on racks or shelves or in kitchen cabinets. For larger quantities of grain or produce, a separate store will be needed.

Clothing and bedding and small personal belongings should be stored in a clean, dry place, well-protected from dust. Boxes and built-in shelves are adequate and inexpensive. Cupboards are more convenient and more dust proof but are somewhat more expensive.

Recommendations for space for separate storerooms for foodstuff and larger items such as fuel and equipment are given in Figure 12.20.

Figure 12.20 Recommended spaces for separate storerooms.

Washing

Personal washing (ablution) and washing of dishes and clothes is done either inside or outside the dwelling, depending on the availability and source of water (stream, lake,

well, piped). If washing is done inside the house, it is important to take care of the waste water.

Well-drained surfaces and a properly constructed soak away will avoid muddy areas and breeding places for mosquitos. Easily cleaned, waterproof materials should be used inside the house. Floors should slope towards a drain leading to a soakaway.

For washing dishes and clothes outside, an easily cleaned, hard surface of at least 3m will be necessary. An open shelter and a work bench are recommended improvements. Clothes washing inside the house is usually done in the bath or a separate utility room, while dishes are washed in a kitchen sink or in a basin.

Personal washing, if not done in a nearby stream or lake, can be done in a simple shelter constructed near the home. A drain and soakaway are essential. Section Aqua Privies in Chapter 14 discusses and illustrates a combination bathhouse and privy. Personal washing done inside the house requires a well-ventilated room finished with waterproof and easily cleaned materials. If piped water is available, a flush toilet is a desirable amenity. A septic tank and drainage field will be necessary with a flush toilet. Figure 12.21 shows space requirements and facility arrangements for various combinations ranging from a simple washroom to complete bath and toilet facilities.

Figure 12.21 Recommended space for indoor toilet and bathing facilities.

Reading and Writing

Education of the rural population is increasing steadily and places to read and write are becoming more essential for the farm home, especially for children going to school. While the sleeping room may provide the best place in terms of privacy, the meeting room and verandah are possible but less appropriate places for intensive studying. The farmer also needs a place to store documents and records and attend to the farm business. The dining table in combination with a cupboard is sufficient for the small farmer, while on a large farm, a separate office of about 9m of floor space may be required. Good natural lighting as well as artificial lighting are essential wherever reading and writing are done.

Entrance

The traditional African house has an entrance protected from wind, rain and sun by a roof overhang which also provides privacy for the family. In a low cost farm dwelling the entrance may be combined with the verandah or the main meeting and resting room and is often used for additional storage space for equipment, farm clothing, bicycle, etc. A larger more modern farm dwelling should have at least two entrances,

one at the front of the house where visitors are received and another near the kitchen or utility room which can be used for coming and going in the performance of daily work around the home and farmstead.

Improvement of existing dwellings

In many cases, improvements can be made to existing homes similar to those shown in Figure 12.22 at little or no cost. For example, separating the animals from the dwelling and installing a well designed latrine should improve sanitary conditions. Developing a nearby water supply of adequate quantity and good quality will make the women's life easier. A mud stove will save fire wood and contribute to forest resource conservation. However, the waste heat from a traditional fireplace may be needed for warming the home in cool climates.

Another improvement desirable in many rural homes is additional backfilling with soil to raise the floor level to 10 to 15 cm above the outside ground level. Unfortunately this will sometimes make ceiling and door heights undesirably low. Cut-off drains will also help to prevent surface water from entering the home. Although it may be difficult to install in an existing house, a waterproof foundation will be helpful in preventing moisture from penetrating the floor and lower walls.

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Contemporary farm dwellings

Contents - Previous - Next

For the farm family that choses to use one of the expandable systems shown in Figures 12.23 and 12.24, a number of local materials are suitable. A foundation of stone or brick masonry or concrete is desirable, but then adobe blocks, mud and poles or stabilized soil blocks are suitable for the walls. While corrugated steel makes a clean, leakproof and durable roof, where it is available, thatch is less expensive and perfectly satisfactory. Thatch will require a roof slope of approximately 450 and the frame should be build high enough to allow the eaves to be a minimum of 2m above the ground. An overhang in the verandah areas will require support as shown in the figures.

When resources allow, the same designs shown in Figure 12.23 and 12.24 may be built

with concrete foundations and floors, along with durable masonry walls of brick, concrete blocks and other available material. The temperature extremes typical of corrugated roofs can be reduced with the installation of insulated ceilings. The final result will be a secure, easily cleaned and durable home. Although considerably more expensive than dwellings made completely of local materials, this type of construction should be feasible for the emerging farmer who is producing some crops or animals for the commercial market.

Figure 12.22 Traditional homes for sleeping or sleeping and cooking.

Figure 12.23 Improved Farm Dwelling design based on a design by Malawi Government/UNDP/UNCHS: Rural Housing Project.

Figure 12.24 Improved farm dwelling design, Ministry of Agriculture and Water Development, Zambia.

Further reading

Andersen K.B., African Traditional Architecture, *A Study of the Housing and Settlement Patterns of Rural Kenya,* Nairobi, Oxford University Press, 1977.

Enzmann J., *Farm Dwellings,* Lusaka, Ministry of Agriculture and Water Development, 1984.

Kaszner O., *Guidelines for Room Types in Low-cost Housing*. with Reference to the Highland Climatic Region, Nairobi, Housing Research and Development Unit - University of Nairobi, 1977.

Neufert E., Architect's Data - *Handbook of Building Types*, 2nd edition., London, Granada Publishing Ltd., 1980.

Olesen F., *Low-income House Types for Kenya, a Selection of House Types with Estimated Construction Cost Prices, Suitable for the Low-income Group*, Nairobi, Housing Research and Development Unit - University of Nairobi, 1979.

Schreckenbach H., Abankwa J.G. K., *Construction Technology for a Tropical Developing Country,* Eschborn, German Agency for Technical Co-operation (GTZ), 1982.

Svard C., Rural *Low-cost Houses. Advice Concerning Design and Choice of Materials for Rural Housing in Tanzania,* Technical Pamphlet no. 3, Dar es Salaam, National Housing and Building Research Unit, 1980.

Chapter 13 External facilities

This chapter deals with rural structures which are only indirectly related to buildings, but which are of great importance to the farmer. These include roads, farmstead courts, minor river crossings, fencing and animal handling yards.

Introduction to simple road designs

Rural access roads range from the simplest earth roads to bituminous surfaced highways. However, earth roads are normally the only type that can be justified for access to farmsteads. These roads, designated as unimproved earth roads, are generally suitable solely for light traffic, up to some dozen or so vehicles per day, and they often become impassable in the wet season. Heavy lorries, which sometimes need to have access to farmsteads, should only be allowed on this type of road after an adequately long dry spell. There is no need for actual structural design of unimproved roads, but there are some principles, which if followed, will produce a reasonably good road for the small investment that they justify.

Road Location

Some roads are built entirely new, but more often a sequence of communication routes evolves as the area develops. This may start with a footpath, which later turns into a track and, by gradual improvement becomes an earth road which is passable throughout most of the year. It is therefore advantageous to choose a road line at an early stage in the planning which will allow for gradual improvement of the road without having to make long and costly diversions.

A survey to determine the best location for a road line starts by identifying areas through which the road must pass, for example, a gap between hills, the best location for a river crossing, and points to be linked by the road. Places to be avoided include soft ground, steep slopes, and big rocks. In large scale road projects the terrain is viewed from aerial photographs, but for smaller projects this is too costly and instead an overview of the proposed road line must be obtained from adjacent hills. Such an overview provides valuable information on natural drainage, but should always be supplemented by a detailed examination on foot.

Once the points through which the road must pass have been established, the road line is laid out to run as directly as possible between them. When possible, roads should be located on sandy soils in well-drained locations, avoiding wet and low lying areas prone to flooding. To take full advantage of natural drainage, it is practical to locate the road along the backbone of a watershed if it roughly parallels the road line.

By doing so, the best possible drainage away from the road will be achieved and expensive bridge, culvert or drift construction may be avoided. However, an attempt to avoid all the difficult spots may result in a longer road and the additional cost of the construction and maintenance should always be weighed against the cost for a road built in a more direct line.

Gradients

A steep gradient not only slows down traffic and limits the load a draught animal can pull, but it also complicates the road construction and increases the cost since care must be taken to avoid erosion from storm water flowing on and along the side of the road. A gradient can be expressed in three ways:

- **a units of rise relative to units of horizontal distance, (e.g. 1:40)**
- **b percentage, (e.g. 2.5%) and**
- **c angle to the horizontal (e.g. 126').**

The recommended gradient standards for unimproved roads differ in different countries, but generally, for roads used mainly by motor vehicles, the gradient should not exceed 1 in 17 in flat or rolling terrain, 1 in 13 in hilly terrain, or 1 in 11 in mountainous terrain. In exceptional cases it may be necessary to have steeper

gradients, but their maximum length should then be limited. In hilly terrain 1 in 11 can be allowed over a maximum of 500m and in mountainous terrain 1 in 9 over a maximum of 150m. Roads frequently used by draught animals should have a gradient not exceeding 1 in 20 or in exceptional cases a maximum of 1 in 10 over short distances. Pack animals can manage steeper gradients: 1 in 10 with a maximum of 1 in 8. The ability of lorries to ascend steep gradients in wet conditions will improve if the surface is gravelled, but that is expensive.

Curves

A straight road is the shortest distance between two points, but as noted earlier, this may not be the most economical line for a durable, easily constructed road which is passible throughout the year. Long gentle curves are preferred since there is better visibility and less speed reduction necessary than on a sharp corner. The minimum radius for a horizontal curve is 15m but 30m or more is preferable. Banked curves are seldom a consideration when building earth roads since the speeds are generally low. Sharp ridges which may diminish visibility or require cutting can almost always be avoided.

Slopes

Only occasionally will an unimproved road require embankments or cuttings, but where it cannot be avoided, the side slopes should not exceed 1 in 1 on well-drained soils. In wet soil it should not exceed 1 in 3, i.e. one unit rise in three units of horizontal distance.

These are maximum values and should only be used where the depth of the cut or fill is so large that to reduce the slope would be too expensive.

Camber

The camber is the slope of the road surface to the sides designed to shed water into the side drains. A simple earth track has no camber and no side drains. But all other roads should have a camber of 5 to 7% from the middle of the road, thus shedding water into both side drains. In deep cuts (where the road is dug into a hill side) or on sharp curves, the camber is designed to drain water from the whole surface inwards toward the cut or to the inside of the curve.

Cross Section of a Simple Earth Track

The simplest earth track is obtained by merely clearing vegetation and stones from the natural soil surface. It may run between fields within a farm, from the main road to a

farmstead or between small villages where the traffic volume is very low. Earth tracks are based on single lane traffic in one pair of wheel tracks, but vegetation should have been cleared wide enough to allow for two small cars to meet. The road surface should be level with the surrounding terrain so that water can pass across it in any direction. If the tracks deepen, they should be filled in so that any water running down a slope will be able to pass across the road at any point, thus preventing water from accumulating in the tracks and causing erosion or lower bearing capacity. Where the road is running with a gradient, low gentle humps across the track will direct water flowing along the road into the surrounding terrain. In wet spots or in areas with high rainfall, it may be impossible to maintain the simple earth track in a passable condition. The cheapest way to increase the carrying capacity in such areas is to raise the level of the road and camber it as described in the next section.

Cross Section of an Upgraded Earth Road

These roads may be used to connect rural market centres and villages where the traffic volume is 10 to 20 vehicles per day including some heavy lorries in the dry season. Generally the only affordable surface material is the soil found on the line of the road or in its immediate surroundings. The bearing capacity of the road depends on the type of soil and the prevailing climatic conditions. The road is constructed by digging out soil from the sides and throwing it on the road until the cross section illustrated in

Figure 13.2 is obtained. The 30cm difference in level between the road surface and the bottom of the side drains, combined with the camber of the road surface, will ensure a much drier roadway with higher carrying capacity than the simple earth track.

Wet spots soon turn into mud if the traffic is frequent, making the road impassable if wet weather continues. Gravelling reduces the risk of mud forming, but a 50 to 70mm layer of gravel may more than double the cost of the road. It is usually far cheaper to further raise the level of the roadway. Up to a point, depending on the type of soil, the higher it is raised, the drier it will be. Only if mud still tends to form in wet spots will gravelling be necessary and then only in those spots.

Figure 13.1 Cross section of a simple earth track.

Figure 13.2 Cross section of an upgraded earth road.

Figure 13.3 Road due to incorrect construction and maintenance.

Erosion of earth roads

Soil is eroded from a road by traffic, wind and water. Depending on soil conditions, climate and volume of traffic, soil erosion may cause considerable deterioration of the

road and increase the cost of maintenance. While erosion from wind and traffic is normally of minor importance, that caused by run-off water from heavy rains can, if uncontrolled by proper drainage and maintenance, cause deterioration, beyond what is worth repairing in only a few years.

Properly installed drainage and road maintenance go hand in hand to insure the durability and carrying capacity of an earth road. If deep tracks are allowed to form, water will accumulate in them and since most roads have at least a slight gradient, the water begins to flow. As the volume of water increases either through intensity of rainfall or inadequate side drains, its speed and eroding action will increase. Side drains, if not properly installed, will also erode.

It is obvious then that drainage of earth roads is of primary importance. It is essential to remove rain water that falls on the road itself and to prevent that which falls on adjacent land from washing over the road. As far as possible natural drainage should be used to achieve these goals, but an engineered drainage system may be required to adequately protect the road. Rain water that falls on the road is shed from the curved surface (camber) into shallow side drains and diverted from there through mitre drains into the bush. Where necessary, catchwater drains should be constructed which collect water flowing towards the upper side of the road allowing it to be directed across the road and back into its natural channel in a controlled way.

Side Drains

When side drains are dug, care should be taken to make them shallow but wide. Water in thin layers flows slowly without causing much erosion and the grass that will gradually grow in the drain will further slow the flow. Gradients not steeper than 1 to 250 are unlikely to cause erosion in ordinary soils. Where steeper grades are necessary, the drains should be emptied onto surrounding land at frequent intervals. Where a side drain has a very steep gradient, additional measures in the form of checks or gabions may be necessary. These checks will silt and form steps, thus decreasing the gradient and slowing the flow.

Figure 13.4 Scour checks will slow down the water flow in side drains with steep gradient.

Mitre Drains

Mitre drains are used along high level roads to prevent build-up of water in the side drains. Depending on the gradient, mitre drains should be spaced 20 to 250m apart, using the closer intervals where rainfall is heavy, the soil is prone to erosion, or the gradient is steep. The mitre drain should block off the water flow in the side drain with a bolster block at an angle of about 30 degrees and lead the water well away from the

road with a wide, shallow channel having a gradient of 1 in 125. The water is discharged 30 to 40m away from the road over as large an area of land as possible to prevent erosion. Figure 13.5 shows the use of mitre drains.

Figure 13.5 Mitre drains.

Diversion Banks

Simple earth roads having no side drains should have diversion banks at 30 to 250m intervals to divert water flowing along the tracks. Natural bumps in the road can sometimes be used as diversion banks if they can be improved to a suitable shape. These banks 30cm high and about 12m in length along the road should have a smooth contour allowing vehicles to pass easily at moderate speeds. The bank is connected to a mitre drain which feeds the water on to the adjacent land.

Catchwater Drains

Where a road is constructed along the lower part of a slope or cut into a hillside, a catchwater drain will divert the excessive flow of water down the hill and across the road line. Wherever possible, it should be constructed on the upper side of and at least 3m from the edge of the road and be separate from the side drain. This

construction prevents the side drain from being overloaded with water from the slope. The water in the catchwater drain must be lead off across the road line back to its natural channel in a controlled manner. Wherever possible a natural waterway crossing the road should be used. If a controlled lead-off cannot be easily arranged, then it is better that no catchwater drain be used since water collected by it and flowing uncontrolled across the road will cause serious erosion and form gullies.

Road construction

When the land has been surveyed and the most feasible road line has been found, the centre line of the road is set out with pegs inserted at 15 to 20m intervals and tall enough to be clearly visible. Additional pegs may be installed to mark the width of the roadway, side drains and the area to be cleared.

Stumping and Clearing

To construct a simple earth road, trees and rocks must be cleared from the road line and well back from the road so that sun and wind can dry the road surface. In heavily wooded country, trees should be cleared from the road way a distance equal to the height of the tree cover or even one and a half times that height on roads with north-south orientation. Wider clearing ensures visibility through bends and road safety in

areas densely populated with wild animals.

Tree stumps can be removed by digging them out, burning them or by dragging them away with draught animals or a tractor. Rocks are either dug out and removed, buried, or broken down to ground level with a sledge hammer or by the hot-cold (fire-water) treatment. All holes are then filled and compacted and any bumps leveled. Stumps and rocks should be cleared well outside the roadway since the verges are likely to be used when vehicles meet. Any stones that cannot be removed and lie beside the roadway should be clearly and permanently marked with paint or a tall white peg. The final step in constructing a simple earth track is the building of diversion banks at suitable intervals.

If the objective is to construct a high-level earth road, the work will continue with the construction of side drains.

Construction of Side Drains

Using wooden pegs and string as a guideline, the edge of the road should be established 1.8 to 2.0m from the center line. On roads with no cross-fall, side drains are dug out of either side to a depth of 150mm and half the width of the roadway All soil thus dug out is thrown on to the road and spread to form an even road surface

with correct camber.

It would be advantageous to excavate the side drains in several steps, allowing some traffic to pass on the road between each step, as some unevenness of the surface can be corrected in later steps when the high and low spots become visible.

The side drains are then shaped with a gentle slope of 1 :150 away from the road. The verge and back edge of the drain are shaped with a slope of about 3:1, thus avoiding the need for meeting bays, since vehicles can use the verge when meeting.

On sections of the road with steep cross-fall, the side drain on the upper side of the road is started at a depth of about 1 50mm and then dug slightly sloping away from the road into the hill. Where the cross-fall is steeper than 1 in 30, no drain is required on the lower side of the road and the road level and camber is then formed with material only from the upper side drain.

Mitre drains should be installed without delay, especially when working in wet areas. Boning rods may be used in uneven terrain to give the mitre drains an even gradient of 1 in 125. Later, on slopes where it is found necessary, catchwater drains may be installed to drain off surface water and divert it away from the road. Much of this water is often flowing down foot paths and cattle tracks and if small diversion banks

are installed on these to divert the water into the bush well away from the road, the catchwater drain may become unnecessary.

Road Maintenance

The most important maintenance job on any type of earth road is to ensure that all drains work properly and that additional drains are installed wherever it becomes necessary. Secondly, rutted wheel tracks should be filled in with soil from outside the road bed. If the road surface becomes badly deteriorated it will be necessary to resurface the road by adding more soil from the side drains. Never remove earth from the road surface since this will lower the road level and make efficient drainage difficult or even impossible. Soil should be taken from the side drains so that they are made wider rather than deeper. On cross-falls, soil should be taken only from the upper side drain. During the first years after construction it may be necessary to control shoots from tree roots. When vehicles start using the road, bumps (other than diversion banks) and holes will soon become apparent. These holes and any other uneveness should be repaired promptly by filling.

Minor river crossings

Where the road crosses a natural water way, a splash, drift, culvert or bridge should be

built. Even if the waterway only carries water occasionally during the rainy season some kind of structure is necessary to keep the water that flows across the road from scouring and forming a gully. It is cheaper to build a splash or drift than a culvert. Bridge construction requires complex design calculations and is generally the most expensive alternative. The problem can often be simplified by choosing a road line closer to the watershed line or at an alternative crossing where conditions permit a splash or drift to be constructed rather than a more expensive structure.

Splashes and Drifts

Splashes and drifts are the same type of construction but their sizes differ. Splashes are associated with small local run-offs whereas drifts are built where a road crosses a stream or riverbed. Splashes are frequently used where water collected by a catch-water drain is directed across the road. Information given for drifts in the following paragraphs also applies to splashes.

A drift is best suited for a crossing where the river banks are relatively low and gently sloping and the stream is shallow. Concrete is the best material for surfacing the crossing, but in many cases is too expensive. Stone and gravel are used to surface most drifts, but if the flow of water is rapid the surface may soon be eroded. In some cases grass can be planted for stabilization or the flow can be slowed by widening the water

course.

Figure 13.6 Sections of a splash or drift.

A drift should allow motor vehicles to pass at a reasonable speed during the dry season when there is little or no water. It should also be designed to allow traffic to pass during flood conditions, perhaps with the exception of a few hours or a day when the water flow reaches its highest level. However, such flows should not cause any major damage to the drift. For safety reasons a drift should be designed nearly perpendicular to the flow of water and the road approaching and crossing the drift should be straight for 20 to 30m on each side.

To maintain a uniform depth throughout its length, a drift must be constructed with a level roadway across the stream. While the dimensions of a drift are largely determined by the stream width and flow, a long level section will spread the flow and reduce the water depth and velocity to a minimum. For small splashes needing only a short level area, a minimum of 2 to 3m should still be allowed to avoid interfering with traffic flow during periods of no water.

The gradient of the road leading down to the drift should not be steeper than 1 in 20 and should preferably be gravelled for 1 5 to 20m on either side of the stream to avoid

having mud form from the water that is carried up the slopes by passing vehicles. Where the road has to be cut into the river banks to decrease the gradient, run-off water on the road surface and in the side drains should be led away with diversion banks and mitre drains immediately before the road goes into the cut.

The edges of the drift must be stabilized with concrete blocks, big stones or gabions (stones wrapped in wire netting). The top edge on the upstream side of the drift should be laid level with the bed of the stream to prevent turbulence in the water flow and subsequent scouring and washing away of the road material. For the same reason the downstream edge should be level with the road surface and if a free fall is created, the river bed may be strengthened with an apron of flat stones to prevent undermiming.

Finally, the edges of the roadway should be clearly marked with stones or stakes which have been painted white. Depth markers are also desirable. They may be painted white up to the maximum safe depth and red above that to serve as a warning.

Embanked Drifts

Motor vehicles and other road traffic can tolerate shallow water better than deep water even if the flow is more rapid. In some cases the depth of water can be

decreased by raising the roadway on an embankment. In streams with a low gradient (flat country) the water tends to bulk up in a deep, slow flow. An embankment drift with a free fall on the down-stream side will cause a rapid but shallow flow over the embankment. The increased water speed may, however, require the road surface to be concreted to avoid scouring. The edge of an embanked drift facing up-stream will normally have to be constructed in concrete or masonry work and be designed as a dam. The structure should preferably be carried down to a solid base in the bottom of the riverbed to avoid undermining.

Figure 13.7a An embarkment drift in a stream with deep water flow because of slight gradient will create a shallow rapid flow across the top of the drift.

Figure 13.7b An embarkment drift in a narrow. deep water course, can spread the flow to make it more shallow.

Figure 13.7c Cross section of an embanked drift.

Culverts

Culverts are best suited for streams with steep banks, since their construction requires some difference in height between the level of the road surface and the bed of the

stream. Culvert construction consists of the following:

- **1 The actual culvert (one or more pipes) which carries the water under the road.**
- **2 The embankment, which carries the road across the water course.**
- **3 Wing walls, which protect the embankment from flood water and direct the flow into the culvert.**
- **4 The apron at the discharge end, which presents erosion of the stream bed.**

Culverts may also be combined with embanked drifts. The normal water flow is carried by the culvert, but large flows of storm water are allowed to flow over the top of the embankment.

Concrete pipes, 400 to 900mm in diameter, are often used for culverts. The diameter and number of pipes is determined by the expected water flow. Alternatively corrugated steel pipes or masonry work in burnt bricks, concrete blocks or stone may form the culvert. Temporary structures may be constructed with logs, which are notched and fitted together. The bottom of the culvert should be laid on or slightly above the bed of the stream to avoid silting. Regular maintenance to clear the culvert of any silt or debris is essential.

Where concrete pipes have been used for a culvert, the embankment must provide for

a soil cover above the pipe to a depth at least equal to the diameter of the pipe in order to sufficiently protect the pipes from the load of heavy vehicles. The beams in the ceiling of a square shaped culvert with masonry walls may be designed to carry the load of vehicles, thus reducing the need to spread the load in the embankment by a soil cover.

Many culvert installations have failed because the embankment has not been sufficiently protected by wing walls and have thus been washed away. In some cases the embankment can be built adequately strong with materials found at the site, but in most cases the extra protection of concrete work or a masonry wall is required. Water will tend to bulk up in front of the culvert and the height of the walls must allow for this. Wing walls, built with an angle, will guide the water flow into the culvert and reduce the bulking tendency. Since any culvert construction is likely to be overtopped by an extreme storm flow or because the pipe is blocked, provision should always be made for a controlled overflow through emergency spillways.

Simple Bridges

The ideal site for a bridge is where the river is narrow and the banks are solid. The bridge should be designed to interfere as little as possible with the natural flow of water. The highest level which the river is known to have reached is determined and

the bridge designed to give at least 0.5m clearance above that level. A bridge includes the following:

Abutments, the structures provided to strengthen the stream banks and adequately support the shore end of the road-bearing beams. They can be constructed of concrete, masonry work (stone, brick, concrete blocks) or timber. The lower part of the abutments will normally require wing walls to protect them from the action of the stream.

Intermediate supports installed where the stream is too wide to be bridged in a single span. Timber trestles, masonry piers and reinforced concrete columns are the most common types of support. Intermediate supports must be designed to withstand the combined loads of the weight of the bridge and vehicles moving on it, plus the action of the flowing water and any debris floating in the water.

Road-bearing beams that carry the weight of the roadway and traffic between abutments and any intermediate supports. Simple bridges have road-bearing beams consisting of round or sawn timber or universal steel beams spaced about 600mm center-to-center across the roadway. For example, a bridge 3.0m wide requires 6 beams and a bridge 3.6m wide, 7 beams etc. The beams are usually designed as simple beams supported at the ends.

Figure 13.8 Culvert.

Decking or flooring, which make up the road surface on the bridge. Where poles or other rough materials have been used for decking a smoother surface can be obtained by putting planks along the bridge for the wheel tracks. The decking should be strong enough to spread the load from one wheel over at least two road-bearing beams. Wooden decking should never be covered with soil, since that will increase decay and disguise any weakness in the bridge.

Curbs made from poles or pieces of timber should be secured to the edges of the decking. Curbs will reduce the risk of vehicles slipping over the edge and will also, if positioned over the outer road-bearing beams and well secured to them, contribute to the strength of the bridge.

Rails along the edges of the bridge for safety.

The bridge must be designed to carry the weight of the members of the bridge (dead load) and the weight of any traffic moving across it (moving load). In order to simplify calculations, the moving load is often converted to an equivalent live load by multiplying it by 2. When a heavy lorry moves across the bridge, the bridge will carry concentrated loads from the wheels with spacings equal to the wheelbase and tread-

width. In a bridge of short span the largest bending moment in the road-bearing beams will occur when the back wheels which carry the greatest weight are at the centre of the span and will be determined by half the weight on one wheel, since the decking is designed to distribute the load to at least two beams. In a bridge of longer span where both front and rear wheels may be on the span at the same time, the maximum bending moment will occur when the centre of the wheel base is a short distance from the centre of the span. In addition to bending, shear may have to be considered in short spans, and deflection for long spans. Where bridges are constructed with rough materials under unfavourable conditions a larger factor of safety should be used.

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Vehicle access to farmsteads

Contents - Previous - Next

Although the types of vehicles found around any farm building depend on the scale of the farm operation, increasingly there is likely to be a need to allow for larger vehicles used for delivering supplies or collecting produce. On smaller farms this may be limited to pick-ups, light vans and tractors, but on larger farms and around village or co-operative buildings the vehicles may be up to the maximum sizes allowed on roads.

Vehicle Dimensions

The overall width and height of vehicles are of importance when designing door openings, gateways etc., and when clearing vegetation for roads and driveways. The minimum requirement is an opening which is 0.6m wider and 0.5m taller than the vehicle to allow for maneuvering, uneven ground surface, deflection of lintels, etc. Big lorries will thus require a minimum opening having a height of 4.8m and a width of 3.2m provided there is straight access to the opening. If the free space in front of the opening is limited (e.g. smaller than 1.2 times the overall length of the vehicle), a wider opening will be required.

Figure 13.9 Simple bridge construction using round timbers, (carrying capacity for moving loads up to 10 tonnes).

High vehicles should be prevented from moving too close to buildings with roof

overhangs or other projections which are less than 5m above ground level. Vehicles with lift bodies may require a clear height of 7m or more.

Drives near the corners of buildings require an allowance for the vehicle to swing out on the curve, so that the centre of the turning circle is at the corner of the building or preferably out away from the corner.

The space required for a U-turn is an area with a width equal to the outer turning diameter and a length equal to the outer turning diameter plus one vehicle length.

Planning Space for Vehicles in Farm Drives and Courts

Drives and farm courts are part of the internal transport system on a farmstead. They indicate where the vehicles are expected to move or be parked. A single entrance drive is usually desirable for traffic control so vehicles can be readily observed from the house and farmstead.

Figure 13.10a Space requirements for tractor movements around a building.

Figure 13.10b Space requirements for tractor movements in and out of buildings.

The turn-off from the main road to the entrance drive should be located at the top of a

hill or far enough from the top for safe visibility. Visibility must not be obstructed by trees, banks, signs, etc. A gate located in the entrance drive should be at least 10m and preferably 20m from the main road to permit cars and lorries to stop off the road while the gate is being opened.

The farmstead court is usually an extension of the entrance drive which provides space for parking and maneuvering machines and lorries. Proper parking space discourages visitors from blocking farm vehicles and directs them to the house or office. The safety of drivers, farm workers and children should be of prime concern in the overall scheme.

When planning the layout of farmstead buildings, the drives and courts should be designed to accommodate the type and size of vehicles used in the farm operation in an effective circulation system.

When a vehicle moves through a turn, the rear wheels track with a reduced radius. The road or drive therefore needs to be wider at curves. Articulated vehicles may almost pivot around the centre of the turning circle in a sharp turn or U-turn.

Table 13.1 ***Dimensions and Outer Turning Diameters for Some Common Types of Vehicles and Vehicle Combinations***

Type	Overall Dimensions (m)			Outer Turning
	Width	Height	Length	Diameter (m)
Saloon Car	1.8	1.5	4.0	11.0
Pick-up	1.8	1.6	4.8	11.5
Light Delivery Van	2.1	2.4	6.0	12.0
Two-Axle Lorry	2.6	3.4	10.0	23.5
Three-Axle Lorry	2.6	3.9	12.0	25.0
Articulated Lorry	2.6	4.6	15.0	24.0
Lorry with Trailer	2.6	4.6	22.0	26.0
Tractor	2.3	2.8	4.3	10.0
Tractor with Trailer	2.4	2.8	12.0	13.0
Tractor with Two Trailers	2.4	2.8	20.0	15.0

Gravelling of the most frequently used areas will improve the drainage and keep the surface of the drives firm and durable throughout the year. Extra parking space for

storage of machines and supplies can be stabilized by sodding.

Heavy vehicle traffic close to retaining walls, tanks and similar structures should be barred within a distance equal to or greater than the height of the wall or structure.

Figure 13.11 Protect retaining walls from heavily loaded vehicles causing shearing of soil.

Fencing

The two main objectives of fencing on a farm are security and improved livestock management, but fences may also be used as wind breaks, to provide privacy and to improve appearance. The type of fence chosen for a specific situation will be determined by the objective or the combination of objectives for which it is built.

Security

Fencing is often used to protect property and growing crops from theft and damage by people or animals. Where the objective is solely the demarcation of boundaries very simple structures may be sufficient. On the other hand, fences, which are designed to stop intruders from entering, must be high, dense, sturdy and be topped with spikes or

barbs. As secure fences can be quite expensive, their use is limited to enclosing particularly valuable property. The three most widely used types of fences for this purpose are:

- **1 Round or square vertical bars of wood or steel secured to horizontal rails and fixed to posts set 2 to 3m apart. These are very difficult to climb.**
- **2 Chain link (diamond mesh) netting, about 2m high and fixed to posts set 3m apart. In both types, stays may be used for extra strength and a barbed wire top added for extra security.**
- **3 Thorny hedges.**

Fencing is also used for protection around ponds, along steep slopes or in other hazardous locations.

Improved Livestock Management

Herding has been the traditional method of controlling livestock movements during grazing. Fencing was only done to exclude the animals from certain areas such as homesteads and cultivated fields and to safeguard them at night.

With "extensive" livestock production, fencing is likely to be so costly that herding

must continue to be practiced. However, it is not uncommon to enclose the land with a boundary fence. With "intensive" livestock production, it is often feasible to sub-divide the land. The greater number of paddocks allows for flexibility in stocking and division of the livestock into different classes or age groups. It is seldom economical to sub-divide the land beyond what is necessary for efficient grazing practice.

In Africa some of the worst livestock diseases are tickborne and fencing can play an important roll in breaking the disease cycle by maintaining a disease-free condition once enough ticks have been eradicated by spraying or dipping the livestock regularly. Fencing also helps to limit the spread of other infectious diseases and to reduce problems with parasites. Fencing will also prevent improved animals from being bred by animals from outside the farm.

In intensive dairy production the animals are often grouped according to production to allow for more efficient feeding of concentrates and for improved management practices. The various groups of animals are kept separate by fences and other structures, such as feed racks.

Types of fences

Any type of structure which forms an effective barrier to livestock movements or which

restricts human movements can be termed a fence. The following types are the most common on farms.

Wire Fences such as:

- **Plain wire fences.**
- **Barbed wire fences.**
- **Suspension fences.**
- **Wire netting fences.**
- **Electric fences.**

Other Types of Fences such as:

- **Post and Rail Fences.**
- **Hedges.**
- **Log fences.**
- **Walls.**

Wire Fences

Types of Wire

Plain or barbed-wire fences are best suited for fencing of large areas. Plain wire is cheaper than barbed wire, but requires a higher standard of assembly and of construction for posts since the wires must be permanently strained to be effective. The thinner but stronger high-tensile steel wire is cheaper than plain wire but more difficult to install. Fencing wire is galvanised for corrosion protection. However, great thermal variations may crack the protective cover. The salt air in coastal districts or applications below ground level also reduce the effectiveness of the galvanizing. Barbed wire will generally rust faster than plain wire. High tension wire will keep its tension longer than plain or barbed wire, but will rust faster than plain wire once the galvanizing is broken. Barbed wire may cause serious injury to animals resulting in lower pelt value. The most justifiable use of barbed wire is as a top wire above other types of fences to discourage stock from leaning over the fence and breaking it down.

Even though fencing wire should be strained to be effective, care should be taken not to over-strain it. The elasticity of the wire will cause it to return to its original position after being stretched by the impact of animals or by temperature changes, provided the yield point stress has not been exceeded. Furthermore it will be difficult to maintain a very high tension value over several years. Generally the elasticity will not be damaged and the fence will retain resilience and tension if the wires are stressed to about 30% of the yield point, or about l500N for common types of fencing wire.

Wire Applications for Various Animals

It is recommended that 4 to 5 lines of barbed wire or 5 to 7 lines of plain wire be used in a cattle fence. However, on large ranges with low stocking density, 2 to 4 and 3 to 5 lines respectively may be adequate. The top wire should be at least 1.2m above ground level.

Fencing for poultry runs should be about 2m high. A thin gauged, hexagonal, relatively open mesh is adequate to control adult birds, but often smaller mesh netting, dug 20 to 30cm into the ground and with a total height of about one meter, is fitted at the bottom of the fence to prevent young birds from escaping and predators from entering the run.

Barbed or plain wire can be used for pig fencing, but due to the small spacing of the wires required, in most cases it will be more economical to use a heavy gauge woven wire fence or a chain link (diamond mesh) fence. It is recommended that a mesh smaller than 15cm be used although 20cm mesh can be satisfactory for adult pigs in large runs. Where sows with litters are to be fenced, smaller mesh must be used at the bottom. The height of the fence should be at least 90cm. Unless the pigs noses are ringed it is difficult to make a fence pig-proof, but it will help to dig the bottom of the fence about 25cm into the ground. This will however, increase the maintenance cost

due to rusting of the wires. Alternatively, a single line of barbed wire can be fixed at the bottom of the fence, just above the ground.

Barbed wire is not considered suitable for sheep since it tears their fleece. A good sheep fence needs to be 90 to 110cm high depending on the breed. It can consist of either 6 to 10 lines of plain wire or woven fencing, 80 to 90cm high, and one or two barbed wires at the top to make up the height. However, sheep fences in small paddocks or yards may be built at least 2m high to keep out predators. The mesh should be 15 to 30cm. The larger mesh will prevent the sheep from getting their heads caught if they attempt to reach through, but may not be sufficiently dense for lambs and for breeds having a special liking for getting through fences. For plain wire fences, batten and wire spacing seem to be more important than tension in the wires. Wires spaced 15cm apart require battens at every second metre, whereas wires at 10cm can have battens spaced 2.5 metres.

Fencing Posts

Equally important as the wires in a fence are the posts which hold them up. Strainer posts and corner posts need to be strong and faced firmly in position, since the stability of the fence and retention of tension in the wires depend on them. Intermediate posts, battens and wires may be replaced as necessary.

Naturally durable and termite resistant hardwood or less durable wood treated with a preservative should be used for strainer and corner posts. Note that some wood preservatives may cause the wires to deteriorate quickly, especially in the atmosphere of coastal areas. Knots are potential sources for weakness. Sometimes galvanized steel or concrete posts are used, but they are generally more expensive than wooden posts. Concrete posts, although easily broken, are long lasting, fire and termite resistant and can be made at the farm using a simple mould. A concrete mixture 1:2:2 reinforced with four 6mm steel bars wired together at 50cm intervals is satisfactory. Strainer posts should be 20 x 20cm thick at ground level and other posts 15 x 15cm.

Wooden posts may be set in dug or bored holes and fixed firmly with tamped soil. Alternatively they may be driven into the soil or into under-sized bored guide holes. Driven posts are generally 1.5 times as firm as posts rammed into over-sized holes, and will withstand greater lifting forces. A hand driver can be made from a 900mm length of 200mm steel pipe. The top end is closed with a steel plate while handles are welded to the bottom end. The total weight should be about 15 kg for a one-man driver and about 30 kg for a driver operated by two men. Driven posts should be pointed before they are given a preservative treatment.

Intermediate posts should be set 40 to 60cm deep whereas strainer, corner and end posts requiring greater rigidity should be set up to 80cm deep. Metal strainer posts

should always be set in concrete, and wooden posts are sometimes set in concrete for extra rigidity.

Live posts consisting of trees growing on the fence line or specially planted posts are cheap and long lasting. Suitable species can also act as shade trees and provide browse. Live posts should be planted some time before they are to be used to give adequate time for rooting. It can be difficult to establish live posts in arid areas.

Battens (droppers) are used to compensate for sag in the wires where the distance between intermediate posts is necessarily long and also to keep stock from pushing between the wires. Wood battens should have a diameter of 25 to 40mm and will last longer if treated with a preservative. Alternatively, wire lashings may be used to maintain the distance between the wires or extra wires can be supplied to decrease the spacing, thus reducing the need for battens.

Stapling is the most common method of fixing the wires to the posts. Alternatively they may be secured with 2mm galvanized mild steel ties. However, it is difficult to make such a tie secure against sliding on the post. When stapling, the wire should be loosely stapled to the intermediate posts. Staples driven too far will bend and hammer out the wire, thus creating a weak spot. Splitting of the posts can be lessened if the staples are driven diagonally into the grain.

Wire Fence Construction

The length of fencing required per hectare will vary greatly with the form and size of the fields. Square fields have the lowest fencing cost per unit area, and the larger the fields the lower the fencing length per hectare. Fence lines should be as long, straight and unbroken as possible, since corner posts and gate posts require bracing and thus add to the cost.

When the fence line has been laid out, the ground area over which the wires will be stretched should be cleared. Next the strainer assemblies are installed. These will take the whole strain of the stretching of the wires and it is therefore most important that they are firmly set and wellbraced. Normally strainer assemblies are located next to corner and gate posts, but on long straight stretches of fence, additional strainers should be installed at up to 200m intervals if the ground is even, or at the top and bottom of each slope in hilly terrain.

Three types of strainer assemblies in general use are shown in Figure 13.12a, b and c. The double horizontal stay strainer assembly is extremely rigid in all types of soil, but for most purposes the single horizontal-stay assembly will be sufficient. On firm but easily dug soil the traditional assembly with a diagonal stay will be adequate and the cheapest in terms of material.

Corner posts should have a diameter of at least 150mm and be braced in the direction of both fencing lines. Corner posts, where the fence angle is less than 45, will be sufficiently rigid if braced with a single diagonal stay or diagonal tie-back.

Figure 13.1 2a Double horizontal stay.

Figure 13.1 2b Single horizontal stay.

Figure 13.1 2c Traditional strainer with diagonal stay.

Intermediate posts having a diameter of 75 to 125mm should be set exactly in line to avoid any horizontal forces due to strain in the wires. Where there is a pronounced low spot in the fence line, one or two of the intermediate posts in the low area may require extra security against uplift by being driven deeper or set in concrete. For a plain-wire cattle fence no battens are required if the intermediate posts are spaced no more than 3.5 to 5m. but the posts can be set up to 15m apart if battens are used at 3.5 to 4m intervals. Woven wire fence requires intermediate posts every 4 to 5m and chicken wire every 2m.

The wire or wire netting is then attached to the posts. Starting with the bottom wire, it is first secured to a strainer post, then stretched using a tackle-block stretcher,

chaintype stretcher or, for single plain or barbed wires, a simple wooden lever. When the wire has been stretched tight enough it is secured to the next strainer post by wrapping and stapling. The wire should be on the inside of all posts, and taken one turn around any corner post. After the fence-stretcher has been released the wires are loosely fastened to the intermediate posts and finally battens are fixed as necessary.

When the fence is erected all bits of wire, nails and staples should be collected to avoid "hardware disease" caused by the animals eating the scrap metal.

Suspension Fences

A suspension fence can be cheaper than a conventional plain or barbed wire fence since the number of posts is reduced. It will however require one or two more wires than the corresponding conventional fence. For its effectiveness it relies on the strain in its high-tensile wires, which causes them to vibrate when an animal nudges the fence. If an animal charges against the fence with a force that would seriously damage a conventional fence, the suspension fence heals over and returns undamaged to its original position after the animal has retreated or passed over. Strainer assemblies are set as for conventional fences, but intermediate posts may be spaced up to 40m where the fence line and contours permit. Wood or wire battens, which must not touch the ground, are spaced about 4.5m apart.

Electric Fence

An electric fence can be made from either plain or barbed wire. It can be simple in design, since it need not be a physical barrier to the animals, but instead relies on an electrical pulse sufficient to shock, but not kill. The wires are stretched between insulators at the strainer posts with intermediate posts spaced 12 to 15m for cattle or 7 to 12m for sheep and pigs. Battens are not needed. Barbed wire is often preferred since the barbs will penetrate the fur of animals and make good contact with the skin. However, plain wire is satisfactory in most cases. As the hot wires must be insulated from the ground, they are fastened to the posts with insulators and should not come into direct contact with weeds, grass or the posts. The most common type of energizer (controller) operates by charging a capacitor with electrical energy and then discharging it to the fence in the form of a pulse of high voltage. It can be powered from the mains or a battery. Solar recharging units are also available for battery-powered energizers.

Temporary electric fences are often used for strip grazing within a permanently fenced field. These consist of a single hot wire at a level about three-fourths the height of the cattle. Two hot wires are provided for sheep and pigs.

Electric fences rely on the soil to conduct the current back to the earth (ground)

terminal on the energizer, but soil is a poor conductor under dry conditions. Therefore, in the dry season an electric fence may be ineffective since an animal may not get a shock because of insufficient current flow. Adding earth-return wires from the energizer to the fence will make it effective during dry conditions. This is also the typical arrangement for permanent electric fences which have two hot wires and one or two neutral wires spread between them.

A single hot wire can also be used to increase the animal's respect for a conventional fence and to protect it from damage. The line can be carried on insulators in the fence or on outriggers. The recommended height is 60cm for cattle and 25cm for sheep.

Other Types of Fences

Post and Rail Fences

Post and rail fences consist of wooden posts with wooden or split bamboo rails attached to them. They are mainly used to fence areas where the stocking density is very high, as in collecting yards and handling areas. They are also used in farmstead areas because of their attractive appearance and because they are easily crossed by humans. Their main advantage is that animals are unlikely to be injured by them, but to be effective as physical barriers for stock, they must be strong and properly

constructed.

Figure 13.13 Post and rail fences for cattle.

The posts should have a diameter of at least 125mm, be firmly fixed in holes 500 to 800mm deep and not more than 3 to 4m apart. Three to four 100mm rails are then fixed to the posts. Where post and rail fences are used in animal handling yards or other similarly crowded situations, for extra strength the rails should be joined only on posts, but not all rails on the same post. In a four-rail fence for cattle the rails are usually spaced about 125mm, 175mm, 225mm, and 275mm from the ground upwards. With 100mm rails, the top rail will be 1200mm above ground level.

Single wooden rails are sometimes used at the top of barbed-wire fences where the stocking density on the pastures is high. The rail will increase the visibility of the fence and protect the wires from damage by animals leaning over the fence, without any risk of injury to the animals.

Hedges

Live fences have the advantage of low capital cost if planting material is available at the farm, but require labour for planting. In the humid tropics most species used for

hedging grow quickly and may require cutting twice a year. Therefore, the maintenance work can require more labour than is available on the farm in spite of underemployment during part of the year. For a hedge to be stockproof it may be necessary to include one or more barbed wires in the fencing line. Although hedges require more space than fences and encourage weeds and vermin, they may preserve wild life, act as wind breaks and be an attractive feature in the landscape.

Log Fences

Where land is being cleared, thorn bushes or the waste from tree felling can be laid in a line to make a stock-proof fence that will last for some years. Piled logs and wooden palisades can also be used for fencing, but are quite wasteful of material. Log fences, unfortunately, are very susceptible to attack by termites and in humid areas, by rot as well.

Walls

Stone walls are an attractive alternative in localities where wood is scarce and stones are plentiful. Construction is labour intensive, but maintenance cost is low. They may be constructed with stones placed in mortar as described in chapter 5 or by simply piling stones loosely in a wall 0.7 to 1.2m wide at the base. Adobe or stabilised soil

blocks can also be used for low cost wall construction especially in very dry areas.

Fencing accessories

These include various structures such as gates, stiles and grids which allow people and/ or vehicles to pass a fencing line, but still restrain animals. The purpose of wheel splashes is mainly to restrict the spread of diseases.

Wire Gates

Although a wire gate itself is inexpensive, the strainer assemblies required for the gate posts in a wire fence should be included in the total cost. Normal width for a gate where vehicles are to pass is 3.3m, but may be up to 5m if traffic is frequent.

Figure 13.14 Wire gate.

Pole and Chain Gate

This is less tedious to open and shut than the wire gate and is also quite inexpensive. This gate and the wire gate do not impose a lateral load on the gate posts other than the strain of the fence.

Field Gates

These gates are constructed with wood or metal frames with a face of open boards, netting or wire. Since a gate will put a sideways bending moment on the post when the gate is open, this post must be extra strong and firmly installed. The gate can be made self-closing by arranging the hinges so that the centre of gravity is lowest when the gate is closed. Gates wider than 3.5m should be given extra support with a wire running from an extended gate post down to the free end of the gate as shown in Figure 13.16b.

Stiles

Stiles provide easy passage Over a fence for humans without breaking the fence line. The stile shown in Figure 13.17 can be easily moved.

Man Pass

There are several methods to make passages through a fence line for humans. The one illustrated in figure 13.18a has an opening protected by doors which are permanently fixed in a half open position so that cattle are restrained. The strain in the fencing lines is transferred overhead with a tie rod. The posts should be strong enough to resist the

bending load from the strain in the wires.

Another type consists simply of an opening 250 to 300mm wide, just enough to let a man pass but too narrow for cattle.

Cattle Guards

A cattle guard is a grid in the roadway which serves as an alternative to a gate. It eliminates frequent opening and closing of a gate, but is more expensive to construct. The cattle guard may be made of pressure treated wood, but steel or concrete are best for use in places where wood is likely to be attacked by pests. The minimum length (in the roadway) is 1.5m but 2.4m is recommended, to discourage animals from jumping across. The load bearing members should be made of a minimum of 200mm round timber, or larger if heavy lorries are to pass. The grid can be of 50 by 125mm sawn timber or 100mm round poles spaced 100mm apart. The width of the cattle guard is ordinarily 3 to 4m. The narrower width is satisfactory if sloping ends are used as shown in Figure 13.19.

Figure 13.15 Pole and chain gate.

Figure 13.16a

Figure 13.16b

Figure 13.17 Stile.

Figure 13.18a

Figure 13.18 Two types of man pass.

Figure 13.19 Cattle guard.

Wheel Splashes

The purpose of a wheel splash is to disinfect the wheels of vehicles moving into the farm area, thereby limiting the spread of diseases and parasites. They are relatively expensive to construct and maintain, and to be effective they must be kept filled at all times with a disinfecting liquid. A wheel splash is a shallow basin made of waterproof concrete with 2m long entrance and exit ramps sloping 1:8. The centre section of the splash containing the disinfecting liquid should be long enough to allow the largest wheel of a tractor to make at least one full turn before reaching the other ramp (4 to 6m).

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Animal handling facilities

Contents - Previous - Next

Animals which are handled constantly, are normally very quiet and can be managed easily with very limited facilities. Larger herds with less individual handling of the animals and new management practices such as artificial insemination, castration, inoculation, dehorning and weighing will increase the need for handling yards. A simple handling yard will include a holding pen, a forcing pen, a race, a crush with a head restraint and a loading ramp. A more complete handling yard may also include drafting facilities and several holding pens for the sorted animals. A dipping tank or spray race can also be included. The size and complexity of the yard depends largely on the number of animals to be handled at any one time.

Handling facilities can be built of inexpensive materials, but should be of such standard that jobs are easily carried out. All fences in the handling yard should look

strong and be strong and clearly visible to the animals to prevent bruising. Post and rail fences fit these needs best. Wire fences are suitable only for receiving yards where the animals are held prior to entering the main yard.

Main Yard

The handling yard should be situated centrally to the grazing paddocks in a village and must be on a site with good drainage. Shade and drinking water should be available. The site should also be accessible to lorries throughout the year.

The fences of the holding and forcing yards should be at least 1.65m high if large active zebu cattle are to be retained. Posts 150 to 200mm in diameter should be set at least 0.8m into the ground and spaced not more than 2.5m apart. Four 150mm or five 100mm rails are attached to the inside of the posts with slightly larger spacing at the top of the fence.

Table 13.2 ***Space Requirement for Holding and Forcing Pens***

Animal	Holding Yard	Forcing Yard
Category	m/ Animal	m/ Animal

Cattle		
100-300 kg	1.3	0.6
300-550 kg	1.6	1.0
> 550 kg	2.0	1.2
Sheep		
Dry Ewes	0.5	
Ewes with Lambs	1.0	

Holding yards for sheep can have lower fences, but they need smaller rail spacing, especially if lambs are to be handled.

Figure 13.20 Simple cattle yard.

Figure 13.21 Alternative sections for cattle race.

Cattle Races and Crushes

Quick operations such as branding, spraying and giving injections only need a race to

position the cattle. More specialised work such as ear marking, dehorning, castration, foot trimming, weighing, artificial insemination, pregnancy testing and veterinary operations requires a crush to firmly restrain an animal. The crush is best located as an extension of the race. Moving cattle into the race is often a slow process, but once a few animals have entered, others will readily follow. The race should therefore be long enough to hold three animals waiting to enter the crush or be at least 6m long. Post and rail fences of the same type as for the holding yard are used for the race, but the height should be increased to 1.8m. Where round timbers are used for rails, they should be arranged so that the thick end of the pole faces the front of the race to minimize the risk of animals injuring themselves on projecting butt-ends. The rails should be joined on posts for extra strength. It is important that the width of the race be correct so that animals can move easily but cannot turn around, i.e. 500 to 700mm between rails depending on the size of the cattle. Cattle with very large horns are a problem.

The only real answer is to build a race with sloping sides and reduce the height of the fence.

It is desirable for the entire length of the race and crush to be floored with concrete. A solid wall about 600mm high at the bottom of the fences will reduce the risk of leg injury if the cattle should slip. Such walls are especially necessary in races with sloping

sides.

A simple crush need only consist of a head bail at the end of the race and a side opening gate in the last panel of the race. To improve access to the side of the animal, the gate can be split horizontally in halves so that the top half can be opened while the bottom half restrains the animal. It will also be advantageous to have a sliding gate or tail bar at the entrance of the crush to hold back animals and give easier access to the rear of the animal in the crush. The animals should not have to back up to leave the crush. This can be solved by having a side gate which opens at the front of the crush or the head bail constructed in a gate or a head bail constructed so that it can be opened wide enough for the animal to walk through. The head bail should fix the head of the animal with vertical bars since horizontal bars may cause choking of the animal should it collapse or slip. Dehorning however will require that the head be restrained both vertically and horizontally. In such cases a bar at the top and a chain in a quick release at the bottom will adequately hold the head.

Figure 1 3.22a Cattle crush.

Figure 13.22b Head bail.

Figure 13.22c Sliding gate.

Loading Ramps

A loading ramp is necessary to load stock into lorries for transport to market or transfer to other grazing areas. Figure 13.23 shows typical dimensions for a cattle loading ramp. Note that the ramp floor has cross battens every 20cm to prevent slipping. The catwalk along the outside is convenient for workers who are urging the animals along. A height of 1. 1 m is a little low for articulated lorries and a little high for most two-axle lorries. However, it should be adequate for either. A ramp slope of approximately 30cm/m is suggested.

Figure 13.23 Loading ramp.

Sorting Alley

A sorting alley will be useful in a handling yard where large herds must be drafted into several different groups on a frequent basis. A sorting alley is basically a race with side gates which can be swung into the race, thereby directing the animals into holding yards, one for each class of animals. The yards can be located on one or both sides of the race.

Sales Yard

Auctioning of animals has the advantage of establishing the market price on animals of the same quality. This will encourage farmers to market better animals and buyers will get access to a central market instead of going around to many different farms (producers).

The auction system demands both good management and a well prepared sales yard. Figure 13.24a shows the principles of a sales yard for approximately 500 cattle and 350 sheep and goats. The yard is calculated for 40 cattle/ sheep in each pen or 1.3m/cattle and 0.25m/sheep or goat.

Management

Cattle shall be registered and marked before sorted into size and sex. Each category will then be sold in groups or individually. Note that if sold one by one a maximum of 250-300 cattle can be sold during a day.

A monthly auction will create a widespread interest and buyers and sellers may come from a large area. Normally a market will establish itself near the auction area which should be considered when choosing the site.

The auction should start with the largest cattle first and taken in groups to the

collecting point from where 12-15 cattle at a time walk into the auction ring. When sold the cattle shall go to respective buyers pen.

Because of the heavy wear and tear, maintenance has to be done regularly. Especially the gates are weak points.

Access to water in each pen is a necessity especially when dairy cattle are sold.

Figure 13.24a Sales yard.

Figure 13.24b Auction ring in sales yard.

Further reading

Road Construction

de Veen J.J., *The Rural Access Roads Programme,* Geneva, International Labour Organization, 1980.

Hindson J., (rev. Howe J., Hathway G.), *Earth Roads, Their Construction and Maintenance,* London, Intermediate Technology Ltd., 1983.

Longland F., (ea. Stern P.), *Field Engineering, An Introduction to Development Work and Construction in Rural Areas,* London, Intermediate Technology Ltd., 1983.

Fencing

Ker A.D.R., et al., *Agriculture in East Africa,* London, Edward Arnold Ltd., 1979.

Leighton J., *Guide to Fencing*, Supplement to the New Zealand Farmer, April 27, 1978.

Midwest Plan Service, *Beef Housing and Equipment Handbook,* Ames, Iowa, Midwest Plan Service, 1975.

Pattison R.J., *Cattle Handling Facilities,* FAO Informal Technical Report No. 27 UNDP/FAO/ETH 72 006, 1974.

Chapter 14 Rural water supply and sanitation

Water, along with food, is one of the essentials of life. Perhaps because of its importance and scarcity in many locations the use of water is encompassed with very strong cultural/social precepts in most societies. Hence the success of projects aiming

at improved water supply and quality must be performed with the full participation of the village population, in particular the women as they are the main users of water. While relatively small quantities will sustain human life, much more is needed for cooking, personal hygiene, laundry and cleaning. Water for a sanitary system is desirable but not essential if it is scarce. Water is also required for livestock and perhaps for irrigating crops.

Types of water for the farmstead: a Clean water for use in the home b Reasonably clean water for livestock c Water for irrigation

Water requirements - quantity and quality

Quantity for Domestic Use

When determining the volume of clean water for domestic use, the location and convenience is a significant factor as shown in Table 14.1.

Table 14.1 ***Domestic Water Consumption per Person***

- **Water source several km away 2 - 4l per day**
- **Water source up to 1 km away 4 - 8l per day**

- **Water next to house 10 - 20l per day**
- **Water in home for wc, tap and shower 60 - 100l per day**
- **Water in home for wc, bath, kitchen and laundry 100 - 250l per day**

The range of consumption given in Table 14.1 has a factor of over 100. It seems obvious that people adapt their needs to the supply. At the low extreme the bare minimum is used for cooking and drinking while at the other extreme water is used with abandon. Under conditions of shortage, much lower quality water may be used for personal hygiene and for washing clothes. The suggestions that follow will hopefully improve both the supply and the quality of water.

Quantity for Livestock

Table 14.2 gives the estimated water requirements for various classes of livestock. From this the total requirements can be determined.

Table 14.2 ***Water Requirements for Livestock***

Type and Number	Daily needs litres	Total for each type

upgraded dairy cow.......	x 70 =	....
upgraded beef cows	x 50 =	....
local cattle	x 20 =	....
sheep	x 5	....
goats....................	x 3 =	....
poultry, dipping, biogas etc........................		....

If water for dipping livestock is to be drawn from the same source, then 3 litres per head of livestock per week must be added to the estimated amount needed.

Fish can be raised in the reservoir without any additional volume of water. Chickens, pigeons and turkeys can live on used water from the house, but ducks and geese need about 1 litre of fresh water daily per bird.

For the production of biogas, a weekly consumption of about 100 litres must be included in the total requirement of water for livestock.

Quality of Water

Water from a protected well is nearly always free from harmful bacteria although it may contain dissolved salts that make it less than desirable for drinking. A protected well is located up grade from sources of pollution such as animal yards and privies. Twenty metres is an adequate distance in areas with fairly heavy type soils, while double that distance is necessary for light soils and even more in areas with limestone formations. "Protected" also implies a well head that extends high enough above the ground level to prevent anything from washing or blowing into the well mouth and narrow enough to discourage the users from standing on it. The other essential feature is a concrete apron sloping away from the well on all sides. A sanitary means of lifting the water is also necessary.

Water from roof catchments is generally safe for drinking and other domestic purposes. The dust and bird droppings that accumulate on the roof during dry times are usually carried away at the start of the first rain and should be diverted away from the storage tank. A paved catchment to collect water for domestic use must be fenced to restrict animals and people. It should also be allowed to clean itself before the water is saved. Water that is stored for a week or more in a catchment tank will generally be free of any harmful bacteria such as those causing cholera, typhoid and diarrhea in children as these bacteria cannot live for long outside the human body.

Streams and ponds, whether artificial or natural, are very likely to be contaminated

and should be used for domestic purposes only as a last resort.

When the only water available is turbid (cloudy) and suspected of being polluted, it should be filtered through a well-designed sand filter. Even then, the safety of the water for drinking is questionable and boiling or other purification is recommended for complete safety.

Water storage

Long term storage of drinking water does not give rise to problems as long as the tank is always properly cleaned before the start of the rains, and the top of the tank is covered with fine wire mesh (mosquito nets), to prevent small animals from crowing in the tank.

The use of chemicals, cooking or biological treatment of the water might be necessary, in order that good quality drinking water is obtained.

Catchment Areas

The success of rain catchment depends on two things:

- **1 rainfall, and**
- **2 adequate area and character of the catchment surface.**

The type of surface determines both the quality and quantity of water saved.

The catchment area can be divided into:

Total run-off areas such as a hard roof surface or a protected paved area which allows the catching of nearly all the rain that falls on it. If surface dust and impurities are flushed away first, the water collected should be good for domestic use.

Partial run-off areas are hard surfaces such as rocky outcroppings, roads, and compounds which allow the catching of up to half the rain falling on the area. The water obviously will not be as clean, but if stored properly should be satisfactory for livestock requirements.

Other surfaces, even though the soil may be quite loose or covered with vegetation, may have considerable run-off during hard rains. Water from these sources is likely to carry a considerable amount of sediment into the storage, making the water suitable only for crop irrigation.

If wells are dug close to surface water storages they can provide high quality water.

Roof Catchments

The advantage of roof catchment systems is that even light rain showers will supply clean water and the total run-off is easily stored in a tank situated next to the house.

Types of Storage for Roof Catchments

Granary Basket Tank (UNICEF design) is type of tank uses a granary basket of woven sticks as a built-in framework for a cement-mortar plastered tank. The cost of the framework is only the labor of cutting and weaving sticks into an open-weave basket.

To improve strength and allow the construction of larger tanks, the outside of the basket can be covered with a layer of chicken wire after which barbed wire is wrapped with a 150mm spacing before the basket is plastered inside and out. A rich mortar of about 1:3 portand cement to sand should be used and mixed with just enough water to make the plaster easy to apply.

Without wire reinforcement the tank size should not exceed a diameter of 1.5m and a depth of 2m. If it is reinforced with barbed wire it should not exceed a diameter of 2.5m and a depth of 2m. A cover is desirable and can be made of mortar reinforced with chicken wire.

Figure 14.1 Reinforced mortar tank (Courtesy of Erik Nissen-Petersen).

Large cement jar is tank is a large bag with framework made of cloth or sacks and stuffed with sawdust, sand or rice hulls. Mortar is then plastered on to the bag, chicken wire and barbed wire are tied on to the plaster and another layer of plaster applied. The bag is removed from the inside of the jar after 24 hours, and plaster is applied to the inside to make it waterproof. The bag can be used for many water jars making the cost per tank minimal. A 1:3 portland cement to sand mortar is essential. The same size restrictions apply as for the granary basket tank. In both this tank and the granary basket tank the curved sides contribute to the strength and life of the tank. A cover is desirable.

Concrete ring tank sections can be used to form water tanks of about 2,000 litres capacity. The small tank volumes are suitable for rain catchment from small roofs scattered on a compound and for areas with relatively even annual distribution of rainfall. A reinforced concrete cover should be installed. These tanks are particularly suitable where a form can be obtained for community use. With the casting done on site, expensive transportation is avoided.

Figure 14.2 Concrete ring tank (Courtesy of Erik NissenPetersen).

Concrete block tank must have steel reinforcing incorporated into the walls. Two barbed wires laid completely around the tank and imbedded in the mortar between each course of blocks is adequate. The blocks must be of good quality to be relatively impermeable and keep leakage and evaporation to a minimum.

The site for a tank of this size must be on firm ground with a reinforced concrete base. If the original ground is sloping, it is necessary to dig out the high area but not fill in the low side.

Corrugated galvanised steel tank is the quickest and easiest way of providing a roof catchment storage is to buy and install a corrugated steel tank. The steel sheets are rather easily damaged, but if they are handled carefully and protected from corrosion by coating both the inside and outside with bitumen and then installed on a concrete base, they make a very good storage.

Table 14.3 ***Storage Tank Selection and Sizes***

Type	Range of capacity (litres)	Relative cost	Notes
Waterjar	< 1,000	Low	No reinforcement needed, filled sack

			used as form
Waterjar	< 5,000	Low	Reinforced, sack form
Granary basket tank	< 10,000	Low	Woven stick form, reinforced with chickenwire and barbed wire
Precaste	2-3,000	Med	Simple to install
Concrete rings			Less expensive if cast at site
Concrete block	< 20,000	Med	Requires good base and reinforcing
Corrugated Steel	> 1,000	High	Simple to build, needs good base and corrosion protection.

Figure 14.3 Roof catchment (Courtesy of Erik NissenPetersen).

Partial Run-off Catchments

In areas with heavy rainfall during relatively short periods the run-off can be considerably high if the ground level catchment areas are well sloped and hard surfaced, as much as 3/4 of the annual rainfall may be collected, but where there is little slope and a permeable surface, only about 1/4 can be saved. To compensate for a gentle slope, a soft surface, or the need for additional water, the catchment area can be extended or covered with a hard surface material.

For a small group of farmers a compound catchment tank can be enough, while for communal use, dammed reservoirs are more suitable.

Storage Requirements

If a dependable, continuous source of water is available, no storage facilities are required. However, with an intermittent supply, storage is essential! The theoretical size of the storage required is determined by multiplying the total daily needs, such as the family, livestock and irrigation, by the number of days expected to be without rain. However, it is the amount of water that is available for storage that is likely to be the limiting factor. Water used during the accumulation period must be subtracted from the total.

Figure 4.4 illustrates a method for determining the maximum storage capacity possible using the following procedure:

- **1 Plot the mean monthly rainfall for the area.**
- **2 Calculate the amount of rainfall that can be collected each month. This is determined by the amount of rain that falls and the area of the roof. (For a rectangular roof the area is the length of the roof times the width between the eaves). Thus the amount of water collected each month is the product of the amount of rainfall and the area of the roof.**
- **3 Starting with the first month after the dry season in which there is a chance to accumulate water in the tank, plot the amount of water that can be collected each month without regard to amounts used. In the example, the first month is November.**
- **4 Draw a line from zero on the left to the highest point on the right, making sure the line never goes above the amount of water accumulated to date. The slope of the line represents the average number of litres that can be used daily.**
- **5 Finally, the maximum difference in litres between the water usage line and the water accumulation line indicates the theoretical size of the storage tank required, which in the example is a little over 16,000 litres. It must be pointed out that these calculations are based on average rainfall records. There will be dry years when the tank will not come close to filling and others when water runs to**

waste from an overflowing tank.

Figure 14.4 Estimating storage tank size.

Calculation of Tank and Reservoir Volumes

Roof Catchment Tank

One of the strongest and least expensive tank shapes for a roof catchment is cylindrical with a diameter greater than its height. The height is usually determined by the distance between the surface of the tank foundation and the lowest point of the gutters.

The formula for calculating the volume of a cylindrical tank using inside dimensions is as follows:

$V = \pi \times r^2 \times h \times 1000$ where:

V = volume, l
r = radius, m
h = height, m

Example:

V=3.14 x 2.252 x 2.0 x 1000=31,800l

Figure 14.5 Capacity of a cylindrical tank.

Table 14.4 ***Cylindrical Tank Capacities in 1,000 litres (Inside dimensions)***

Diameter	**Heights**			
(m)	1 m	2m	3m	4m
1.0	785	1.570	2.356	3.142
1.5	1.767	3.534	5.300	7.068
2.0	3.141	6.283	9.425	12.566
2.5	4.910	9.817	14.726	19.635
3.0	7.070	14.137	21.206	28.275
3.5	9.621	19.242	28.863	38.485
4.0	12.566	25.132	37.700	50.265

Catchment Tank for the Compound

Where a storage tank must be dug into a relatively level area of ground, an approximate half-sphere shape is easiest. The volume of a half sphere can be found by using its radius in the following formula:

$V= 2/3 \times \pi \times r^3 \times 1000$ where:

V = volume, 1
r = radius of half sphere, m

Example:

$V=2/3 \times \pi \times 2.13^3 \times 1000$
V = 20,250 l

Dammed Reservoir

Water that drains from the compound or a large area may be stored in a pond or reservoir behind a dam. Estimating the water behind a dam is difficult because of the uneven topography below the water level. Two formulas that will help to make a

rough estimate are as follows:

Figure 14.6 Half sphere tank.

For a long narrow pond, perhaps a dammed-up stream:

V=(1 x w x d/8) x 1000 where:

V = Volume, l
l = length of pond, m
w = width of pond at dam, m
d = depth of pond at dam, m

For a circular shaped pond that has an area in the middle that is quite uniform in depth, the volume is determined in two steps and the results are combined.

$V_1 = \pi \times r^2 \times d$ where:

V_1 = volume in uniform depth area, m

r = radius of the area of uniform depth, m

d = depth of the uniform area, m

V_2 = 1/2 x w x d x c where:

V_2 = volume of sloping edges of pond, m
w = width of sloping edges, m
d = depth, m
c = circumference or length of sloping edge, m
(3 x the diameter is a good approximation)

$V_t = (V_1 + V_2) \times 1{,}000$ where:

V_t = total volume, l

Figure 14.7 Volume in a circular reservoir.

Example:

Assume a pond that is roughly 26m in diameter with a uniform depth of 2m in the center, an area estimated to have a radius of 10m. The approximate volume can be found using the previously described method.

$V_1 = \pi \times 10 \times 10 \times 2 = 629m$

$V_2 = 1/2 \times 3 \times 2 \times 70 = 210m$

$V_t = (629 + 210) \times 1{,}000 = 839{,}000$ l

Contents - Previous - Next

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Wells

Contents - Previous - Next

A properly constructed and protected well can be an excellent source for domestic water needs. The terms borehole, dug well and tube well describe the manner in which water is reached. A borehole well is drilled with a cable or rotary drill. It will have a small diameter and can be 200 metres or more in depth. A dug well is a hole dug with a diameter large enough to allow a man to work, usually to a maximum

depth of about 30 metres. A tube well is a perforated pipe with a pointed end which is either hammered or jetted into the ground.

When a well is less than 7m deep it is called a shallow well, and when more than 7m deep, a deep well. An earth well is unlined, a masonry well is lined with concrete blocks or stone, and a sinking well casing is constructed and sunk in stages from the ground level as the well is being excavated.

Location of Well Site

Water may often be found in one of the following locations:

- **1 Near a pond or reservoir**
- **2 In the foothills near mountains and especially near green trees or holes dug by animals**
- **3 In areas of green vegetation during drought**
- **4 Near existing wells or waterholes**
- **5 In sandy river beds, especially upstream from bed rock, where temporary wells may be dug**

Types of Well Casings

There are several methods of constructing well casings, the one chosen depending on purpose, soil structure, water source and local skills.

Oil barrel well are used to form this inexpensive well casing. The barrels are perforated to allow the entry of water. The life of this casing will be shorter than with other materials and the residue in the barrels may pollute the water so that it is unfit for domestic use.

Ferrocement well is a type of earth wall well that is excavated to a straight and smooth surface which is then plastered with a layer of mortar, reinforced with chicken wire, and finally plastered a second time.

A well head is built above ground level to limit the risk of children and animals falling into the well. To prevent contamination of the well a concrete apron, sloping away from the well head, is constructed on the surrounding ground.

Figure 14.8 Ferrocement well (Courtesy of Erik Nissen Petersen).

Sinking wells are so named because the casing is sunk into place. The method works well in sandy soils. Figures 14.9 and 14.10 show casings that can be sunk into place.

Concrete ring well is a method that requires either a steel casing ring mould for casting

the concrete rings on site or for precast rings to be purchased and transported from factory to construction site. Both alternatives are expensive for a single well, but feasible when a number of wells are being constructed in a local area. The rings, measuring 0.9m in diameter and 0.5m in height are stacked upon each other in an excavated well hole, or they can be used for sinking wells or a combination of both procedures.

Figure 14.9 Concrete ring well (sinking well).

Concrete block well is a less expensive alternative to concrete rings is the use of concrete blocks shaped in a wooden form. These blocks are stacked on a concrete foundation ring which can be cast in a wooden form, or more cheaply, in a ditch in the soil at the construction site.

With either type of casing, by digging soil out from under the bottom of the casing, the whole structure will be allowed to settle. When the top of the well casing has reached the surface of the surrounding soil another section is added to the top. Thereafter digging is repeated until another section can be added on to the well at ground level, and so on until a satisfactory depth has been reached. The blocks must be tied together with vertical reinforcing rods to ensure that the casing sinks as a single unit.

Figure 14.10a Concrete block well (sinking well).

Figure 14.10b Section of foundation and reinforcement (Courtesy of Erik Nissen-Petersen).

Lifts for Wells

The simplest means of lifting water from dug wells such as a rope and calabash or a bucket and windlass have been used for centuries and unfortunately they continue to be used today in many parts of the world. The objection to their use is that too often they are a source of pollution both because the top of the well is open and because the water vessel is frequently set down on a badly polluted surface. An improved variation of these methods has a bucket with a hose attached to the bottom and to an outlet at the wellhead as shown in Figure 14.11. When the bucket is lifted water is discharged from the outlet while the top of the well remains covered.

Figure 14.1 1 Bucket lift in closed well (Courtesy of Erik Nissen-Petersen).

Pumps

A pump is the most convenient and sanitary means of lifting water from a well or any

other low level water supply. Pumps may be hand or power operated, designed to lift only or to lift and discharge against pressure and to lift from either shallow or deep wells.

As mentioned earlier, shallow wells are those in which the low water level is 7m or less below the pump. In deep wells the water level may drop well below the 7m mark. The maximum suction lift for shallow-well pumps of any type is reduced about 1m per 1000m of site elevation.

Hand Pumps

The simplest hand pump, often referred to as a pitcher pump, is satisfactory for use on wells or cisterns in which the water never needs to be lifted more than about 6m. A cross section of a pitcher pump is shown in Figure 14. 12. If these pumps are maintained in good condition, they are easily primed and will hold their prime from one use to the next. However, if the valves leak, the pump will need to be primed each time it is used. This is not only a nuisance but can be a source of pollution from the priming water.

Water from deep wells is lifted with a similar plunger type pump in which the cylinder, including the plunger and valves, is supported on the discharge pipe deep enough in

the well to be submerged in water at all times. The pump handle is connected to the plunger by means of a long rod. While this type of pump is self-priming due to the cylinder being submerged in the water, it must nevertheless be maintained in good condition to work effectively. Figure 14.13 illustrates a deep-well pump. Both of these pumps allow the well top to be completely covered for maximum protection against pollution.

Occasionally it is necessary to use a hand pump to force water above the level of the pump. Models are available that are designed with a packing around the lift rod and a pipe connection at the point of discharge enabling them to force water to a tank higher than the pump. An even more sophisticated model is equipped with a small "differential" cylinder that causes the pump to discharge on both the "up" and "down" strokes.

Power Driven Pumps

There are a number of pumps on the market from which to select for a particular application. They all have characteristics which influence their suitability for a specific water supply as well as the volume and pressure required.

Centrifugal pumps are simple (only one moving part), durable, and relatively

inexpensive for a given capacity. However, they are suitable only for low lifts of 3 to 4m and are prone to losing their prime unless the suction pipe is equipped with a good foot valve (check valve). Neither will they discharge against a very high head (pressure).

There are several designs of centrifugal pumps that further influence one's choice. The impeller may be an open type with a relatively large clearance between it and the casing or it may be a closed type with very close clearances. The open type will tolerate sand or silt in the water much better than the closed-impeller type. (Figure 14.14 and 14.15).

A centrifugal pump may have an integral electric motor or petrol-powered engine which the manufacturer will have sized correctly, or it may have a belt drive. In the latter case, great care must be taken to drive the pump at a suitable speed and with a motor or engine of adequate power.

Figure 14.12 Shallow-well handpump.

As with the propeller fans described in Chapter 7, centrifugal pumps have volume, pressure and power requirement characteristics that vary with speed as follows:

- **a Volume changes directly with the speed.**

- **b Maximum pressure changes directly as the square of the change in speed.**
- **c Power required changes directly as the cube of the change in speed.**

This means that if a pump was designed to run at 2,000rpm and be operated by a 1,000W motor, and the motor pulley is exchanged for one that is 11/2 times the original diameter, the pump will then turn at 3,000rpm. The corresponding changes in volume, maximum pressure and power required will be:

- **Volume = 1 1/2 times as much**
- **Maximum pressure $(1\ 1/2)^2$ = 2.25 times as great**
- **Power $(11/2)^3$ = 3.375 times as great**

Figure 14.13 Deep-well handpump.

Figure 14.14 Open impeller.

Figure14.15 Closed impeller.

Consequently, the motor will be badly overloaded and may be damaged.

Jet pumps are centrifugal pumps for a shallow that may have a jet (ejector) built into

the pump housing. This will improve both the lifting and discharge efficiency. These pumps are suitable for lifts of up to about 6m.

A deep-well jet pump will have the ejector installed below the low-water level in the well. Two pipes of different dimensions connect it to the pump which may be located at the top of the well or even some distance to one side. The smaller of the two pipes carries water to the ejector, while the larger one delivers water to the pump housing where most is discharged but some is returned to the ejector. These deep-well jet pumps are suitable for wells in which the water level drops to 30m. The correct ejector for maximum efficiency is chosen on the basis of the lowest expected water level in the well. (Figure 14.16).

Deep-well turbine pumps are multi-stage centrifugal type and may be driven either by a long vertical shaft from a drive head at the top of the well or by a submersible motor below the pump in the well. The shaft-driven units are large expensive pumps designed to supply large volumes of water for irrigation or community use.

The submersible pump, on the other hand, is available in a range of sizes and is an efficient, trouble-free design for medium-sized installations. Obviously it is a major operation to remove the pump from the well if something goes wrong. It should be noted that the motor is installed below the pump so that if the water level is reduced

to the pump level, the motor will still be submerged in water which is essential for cooling.

Reciprocating pumps are available for both shallow wells and deep-wells. They are capable of delivering water at quite high pressures. The shallow-well type is usually reasonable in cost, but the deep-well type tends to be expensive and it must be installed over the top of the well.

Diaphragm pumps have a piston and cylinder thatare replaced with a diaphragm. As there are no sliding parts to wear, these pumps are suitable for pumping muddy water or high moisture slurries such as the waste from a biogas generator. See Figure 14.17. These pumps may be either hand or power operated.

Figure 14.16 Deep-well jet.

Figure 14.17 Diaphragm pump.

Hydraulic rams require no electricity or human power to operate, relying instead on the energy from flowing water. A minimum flow of 10 litres per minute with a head of at least one metre is required. As water flows through the ram, the waste valve alternately opens and closes. Each time it closes water is forced up the delivery pipe by

the inertia developed in the flowing water which is abruptly stopped when the waste valve closes. Small quantities of water are thus lifted well above the original source. A ram can be useful for pumping domestic or livestock water to a storage.

Commercial rams are available in a number of sizes that can pass supply-flow rates from 10 to 400 litres per minute and can discharge to maximum heights of 100 to 150m. Although a ram will operate at as little as 1 metre of head, larger heads will increase discharge rates considerably, e.g. increasing supply head from 1 to 10m can increase delivery by up to 20 times. It is necessary to know the flow rate of the water supply and the head which is possible before purchasing a ram. The first cost is substantial, but maintenance is low, life is long and operating cost is nil, so if the natural conditions are available, a hydraulic ram can be a very good investment.

Choosing a Pump

Five main factors must be considered when selecting a pump:

- **1 the total water required per day;**
- **2 the maximum rate of flow desired;**
- **3 the maximum flow from the water source;**
- **4 the vertical distance the water must be lifted to the pump;**

- **5 the total head against which the pump must operate.**

The terms head and pressure are used interchangeably. The unit of measure of pressure is the pascal (Pa) while the unit of measure of head is the metre (m). One metre of water column = 9.8 kPa. Head is frequently used in discussing pump installations because there will be vertical distances from water level to pump and pump to point of discharge. Pipe friction tables are often given in terms of loss of head per unit of pipe length.

The daily water requirement influences pump size in that it is desirable for the pump to operate not more than 25% of the time.

The maximum rate of flow is determined by totaling suitable flow rates from all of the discharge openings that may be operating at one time. If the source of water is a dug well, pond or stream, undoubtedly the desired flow rate can be used in choosing a pump. However, if the source is a borehole or driven well with very low storage capacity, there is no alternative but to choose a pump that does not have a capacity in excess of the flow rate of the well.

The vertical distance between low water level and the location of the pump is the primary factor in the type of pump chosen, although the total head is also significant.

Total head is made up of: a lifting head from well to pump, b vertical discharge head from pump to point of use, c working head or pressure at the point of use, and d friction losses due to flow through pipe and fittings.

Pump Storage Tanks

Regardless of the type of pump chosen, it must either discharge into a tank or have an open pipe discharge into an irrigation channel. Operating any of the centrifugal pumps against a closed line results in overheating and damaged shaft seals. Operating a reciprocating pump against a closed line will result in a stalled motor or the physical breaking of some part in the pump.

Figure 14.18 Hydraulic ram.

Hydropneumatic Systems

These systems consist of an enclosed tank combined with an automatic pressure switch which turns the pump motor on when tank pressure drops to a preset level. As the tank is approximately half full of air, several litres of water can be pumped into the tank before the air is compressed and the stock cut-off pressure is reached. The amount of water pumped into the tank can then be used as required before the pump

needs to operate again. There are several advantages to the hydropneumatic system:

- **a the tank can be located in any convenient place**
- **b optimum discharge pressure is available at all times**
- **c the system is completely automatic**
- **d the tank may be relatively small**

Table 14.5 ***Pump Applications***

Type of Pump	Vertical distance Pump to Water	Quantity Water Required	Operating Pressures	Applications
Centrifugal	up to 4m	large	low	stock or irrigation
Shallow-well jet	up to 6m	med	med	domestic or stock
Deep-well jet	6 - 30m	med	med	domestic or stock
Shaft-driven deep-well turbine	4 - 40m	large	low to high	irrigation

Submersible deep-well turbine	6 - 40m	med	med	domestic, stock, irrigation
Reciprocating				
Shallow well	up to 7m	low to med	med	domestic, stock
Deep well	6 -40m	med	med to high	domestic, stock
Diaphragm	up to 5m	med	low	slurries
Hydraulic ram	(-1m)	small	med	domestic,

As air is soluble in water, a small continuous supply of air is required to prevent the tank from becoming waterlogged. Each type of pressure pump discussed will have an air volume control suitable to its mode of operation to provide the necessary supply of air. Alternatively, tanks may be equipped with rubber air bags or foam plastic floats for permanent air retention.

The operation of a pressure tank is in accord with the universal gas law which states that:

$P_1V_1/T_1 = P_2V_2/T_2$ where:

P = absolute pressure, Pa
V = volume, l
T = absolute temperature, K

Although it is the water charge and discharge that is of interest, it is the pressure and volume of air that must be considered. The operation of the tank is essentially an isothermal process (constant temperature) although as fresh water is pumped into the tank the temperature is likely to change a little. The tank should be approximately half full at the cut-in pressure for the best operation. Water system problems are shown later.

Gravity System

A second system for storing pumped water is a gravity tank with the pump operation controlled either manually or by a float switch. The tank must be elevated above the highest point of water use, frequently on the roof of the building where the water is used. The tank is usually appreciably larger than a pressure tank. This is an advantage in that, in case of a power failure or pump breakdown, there will be a larger reserve of water available for use. However, the need to support a large tank on the roof

requires strong structural support that will add to the cost of the installation. Finally, water pressure is seldom very high and may be barely adequate near the level of the tank.

Pipe Flow

If the rate of water flow in a pipe system remains constant, the equation of continuity of flow applies; that is:

Q = A x V where:

Q = flow (m/s)
A = cross-section area (m)
V = velocity (m/s)

If the area of the pipe is cut in half, the velocity of flow will be doubled and so on. The velocity is not uniform across a cross section of the pipe because of the friction affect of the pipe walls, but average velocity is used for calculations.

Friction loss in pipes occurs when water flows through a pipe. The amount of loss is principally related to pipe size, velocity of flow and the roughness of the interior pipe surface and to a lesser extent temperature. The friction is proportional to the square

of the velocity, so the resistance, which is small at low velocities, builds up quickly as the velocity increases.

Roughness in pipes can change with age. Galvanized steel pipes may form rust or scale with age, thus increasing the roughness and friction and reducing the rate of flow. A smooth pipe such as plastic has less friction effect than a rough surface such as concrete.

The length is directly proportional to the friction head in pipes. Figure 14.20 gives the loss of head for both smooth and rough pipes of several sizes and for a range of flow rates.

Other Losses that can occur is when water flow in a pipe is interrupted such as by going through fittings, or from one pipe size to another, there will be a friction loss. This results from turbulence in the flow, which uses up energy, and so more energy must be used to produce a higher pressure at the start of the pipe lines. As friction loss is proportional to the square of the velocity of flow, it can be ignored at low velocities such as in drainage pipes. However, it can be significant in high-pressure irrigation lines or water-supply systems, especially if there are a large number of fittings. Adding 10% to the friction loss of the pipes to allow for all the miscellaneous fitting losses, is a common procedure.

Water System Problem

Example:

It is necessary to design the water system for domestic and stock watering for a family of five who keep 3 Zebu cows, and 10 goats. The water will be pumped from a dug well that is 3m below and 5m away from where the pump will be located. The pump will need to discharge into the storage tank at a minimum of 300kPa of pressure. The discharge from the tank between cut-out and cut-in pressure should be approximately '/ 12 of daily water consumption so that the pump will operate no more than 12 times per day. Water will be discharged from the tank a distance of 50m to a single tap and the head loss at a flow of 11/ s should not exceed 10% of the average pressure. The pump dealer has advised that his pumps are approximately 75% efficient in terms of power demand and the electric motors are 85% efficient.

Figure 14.19 Hydropneumatic water sistem.

Determine the following:

- **1 Total daily water consumption (maximum flow 11/ s);**
- **2 A suitable type and capacity of pump;**

- **3 A suction pipe sized to have a friction head of 8% or less of the suction head;**
- **4 An adequate tank size;**
- **5 A suitable discharge pipe size;**
- **6 A motor size capable of driving the pump.**

1 From Table 14.1, a single water tap supply indicates 1020 l/day per person. Choose 20 litres.

From Table 14.3 local cattle require 20 l/ day and goats 3 l/day.

5 people x 20 = 1001
3 cows x 20 = 601
10 goats x 3 = 301

Total daily needs 1901 at 1l/s maximum flow

2 The lift from well to pump is low (3m) and the water demand is low. Choose a shallow-well jet pump with a 1.21/ s capacity. The extra capacity will allow for some loss of capacity due to wear over the life of the pump.

3 Calculate the loss of head per metre of suction pipe.

3m x 8% = 0.24m/8m of pipe = 0.03m/m. From Figure 14.20, the intersection of 1.2l/s and 0.03m/m head loss is 38mm plastic pipe. Choose a 38mm P.V.C. suction line.

4 Tank size. 190/12 = 16ldischarge/cycle. Choose a pressure range of 200 to 300kPa; atmospheric pressure equals l00kPa.

$P_1V_1/T_1 = P_2V_2/T_2$ but assume $T_1 = T_2$

$V_2 = V_1 + 16$ as P_1 drops to P_2

$400 \times V_1 = 300 \times (V_1 + 16)$

$100 \times V_1 = 4800$

$V_1 = 48l$

$V_2 = V_1 + 16 = 48 + 16 = 64l$

V_2 = should be about 1/2 of the tank size

Approximate tank size = 2 x 64 = 128l .

Figure 14.20 Friction losses in pipes.

5 Average pressure at tank is (200 + 300)/2 = 250kPa 1 m of head = 9.8kPa, therefore 250kPa = 25.5m of head 25.5 x 10% = 2.55. Which gives:

2.55/50m = 0.5m/m allowable loss at 11/s flow.

From Figure 14.20, 20mm PVC pipe is small but 25mm PVC pipe is satisfactory.

6 Power to lift water from the well and overcome all head at a flow rate of 11/s is as follows:

Total head = 3 + 0.24 + (300/9.8) + 2.55 = 36.4m of head

1l water = 1 kg mass and gravitational force

= l kg x 9.8m/s^2

Force required = 1 kg x 9.8 m/s^2 = 9.8N

Work done = 9.8N x 36.4m = 357Nm

Since this amount of work is done each second,

Power = work/sec = 357Nm/s or watts (W)

356/0.75 pump efficiency = 475W input required by pump

475/0.85 motor efficiency = 560W input to motor

560/220V = 2.5 amp running current, which gives:

2.5 x 2 = 5 amp starting current.

Summary of Requirements

- **1 Total daily water consumption: 1901 at 1l/s**
- **2 Jet pump with minimum capacity of 1.21/ s at 36m total head**
- **3 38mm suction pipe (PVC)**
- **4 Tank size: approximately 128 litres**
- **5 25mm discharge pipe (PVC)**
- **6 Motor of 560W minimum input**

Water System Design Features

1 Even if the home water system consists of only one tap near the house, a complementary drainage system is essential. A pit that is one metre square and a half metre deep and filled with stones or gravel should be constructed under the tap to carry off leakage and spillage without creating a muddy area.

2 Perhaps the second step in the development of a rural home water system is a solar water heater. This can be as simple as a black 208 litre oil drum installed on the roof that is refilled periodically from the tap or it can be connected permanently by a branch pipe from the watersupply line. A combination of a check valve in the supply line to the water heater and a pressure safety valve at the tank is advisable. The check valve will prevent warm water from draining back into the cold water line at a time of low pressure, but a safety valve is absolutely essential when the check valve is used to prevent excessive pressure build-up from hot water.

3 If an extensive home water system is planned, complete with toilet, shower and sinks, it is prudent to plan a good drainage system at the same time.

Soakaways are necessary for disposing of shower and sink water unless the water must be saved for irrigation or stock watering in which case a collection tank should be constructed. Waste from a toilet is best treated in a septic tank and the effluent allowed to soak away in a pit or drainage field. These systems will be discussed later.

4 Pipe materials for cold water may be either plastic (PVC or high density polythene) or galvanized steel. The steel is more expensive and difficult to work with, but it is not easily damaged. Galvanized pipe has a relatively short life when exposed to acid water, but lasts very well when the water is neutral or slightly alkaline.

5 Twenty to 25mm pipe should be used as a main supply line, but 13mm will be adequate for branches to sinks, shower and water closet. Each branch should have a shut off valve to facilitate repair work.

6 Tropical areas are normally an ideal place in which to make use of solar water heating. Two square metres of properly positioned collector area should heat 20 litres or more to 45-50C on most sunny days. Solar heaters are discussed in greater detail in Chapter 7.

Contents - Previous - Next