MANUAL ON HOUSING FOR PIGS

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Thanks and acknowledgement to the National Department of Agriculture and the nine Provincial Departments of Agriculture which made it possible to revise the Manual on Pig Housing.

Photograph acknowledgements: Meintjies Pig Farm, Northern Natal
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1. INTRODUCTION

Pig production in South Africa is characterized by large intensive production units representing high capital investment. Currently, more than 25% of intensive units have between 200 and 1 000 sows.

While planning and creating facilities for intensive pig production units, a compromise must be found between the maximum production performance of the pigs and efficient management and labour on the one hand, and the cost of supplying these on the other hand.

For efficient planning and management of intensive production units, it is of the utmost importance to know what the environmental requirements of the pigs are. Investment in pig production entails creating indoors environmental conditions that differ completely from the prevailing conditions outdoors.

There is a worldwide tendency, which has also become evident in South Africa, to increase the size of intensive pig production units, while the numbers of breeders are dwindling. While the consumption of pork in South Africa is still relatively low compared with other types of meat, such as beef, chicken and mutton, it is keeping in step with the population growth.

The importance of housing in the production of pork is often ignored. Ineffective housing more often than not is the main cause of less successful enterprises.
CHAPTER 2

2. BIOLOGICAL FEATURES OF PIGS

The pig is a homeothermic or warm-blooded animal. It has the ability to maintain a stable body temperature under limited fluctuating ambient temperatures.

A newborn piglet’s body temperature drops 2 °C to 8 °C during the first 20 minutes after birth because of a poorly developed heat regulation mechanism. However, it may return to normal levels after one to ten days, depending on the ambient temperature. The piglet’s thin coat, which is 1.5 mg/cm² of hair, as well as body fat of only 1.4%, forms a poor insulation mechanism against cold. As the piglet gets older, the percentage of body fat increases, thereby increasing its natural insulation against cold.

Because it does not have effective sweat glands, a pig is not properly protected against high temperatures. Pigs try to cool themselves by breathing more rapidly, spilling water from the drinking troughs or water bowls and by urinating on the floor. Providing shallow water troughs or fine overhead water sprinklers will help to improve heat loss by means of evaporation from the wetted body surface.

As a pig gets bigger, or as its live body weight increases, the maximum critical temperature falls from about 34 °C at birth to 25 °C at 45 kg, and to between 17 °C and 22 °C at 100 kg body weight. The maximum critical temperature is that temperature whereby heat production by the animal’s body, that is its metabolic rate, increases as the ambient temperature drops in order to try to maintain its normal body temperature of 39 °C. With further drops in the temperature, the minimum critical temperature is reached, that is the stage of maximum metabolic rate or heat production.

![Figure 2.1: Indication of the neutral temperature zone suitable to pigs](image)
Between the boundaries of maximum and minimum temperatures, the thermal neutral zone prevails. At temperatures below the minimum critical temperature, the body will not be able to produce sufficient heat to make up for heat loss. Death because of hypothermia (too little heat) will occur. Heating above the critical maximum boundary, that is where the metabolic rate is too low, will cause an increase in body temperature and death due to hyperthermia or heat stress.

Piglets are very prone to hypoglycaemia, or low blood glucose content, during the first seven days after birth. It commonly occurs due to a lack of feed because the sow suffers from agalactia (no milk flow). The lower the ambient temperature, the sooner this fatal condition steps in. Heat stress due to too high temperatures is an important contributing factor to agalactia. Other clinical symptoms of hyperthermia in sows are an increased body temperature (up to 42 °C), rapid pulse, immobility and diminished appetite.
CHAPTER 3

3. THE PIG AND ITS ENVIRONMENT

The environment for pig production may be subdivided into three sections, namely the thermal, the social and the chemical environment. All three environments, but especially the thermal, have a particular influence on the production performance of pigs.

3.1 Influence of the thermal environment on pig production

The thermal, or climatologic environment, is determined by air temperature, humidity, radiant heat and air movement.

With growing pigs, the purpose of optimum temperature environments is primarily to ensure optimum health status, maximum growth rate, high efficiency of feed utilization and the production of ideal carcass quality.

Rapid decreases in the growth rate and the efficiency of feed utilization occur if the air temperature increases to a higher level than the optimum (which is 21 °C for maximum growth rate). At air temperatures of 37 °C and higher, weight loss and even death may set in.

High temperatures very often have a more detrimental effect on production performance than low temperatures. Depending on the live body weight of a pig, an increase of 11 °C above the optimum of 21 °C may cause a decrease in the growth rate of between 30% and 70%. There will be a decrease in the growth rate of between 26% and 35% if the air temperature decreases 11 °C below the optimum. For a high growth rate, constant temperature conditions are better than temperature changes over extended periods.

The heavier the pig, the bigger the negative influence of high temperatures on its performance. At temperatures higher than 30 °C, a pig is extremely vulnerable to heat stress, bodily exhaustion and sunstroke.

Research results have shown that deviations from the optimum temperature may suppress the pig’s appetite and therefore also its feed intake. It is calculated that an additional 0,3 g feed per kilogram body weight is required for every 1,0 °C that the temperature decreases to below the effective critical temperature.

Exposure of pigs to too high or too low ambient temperatures also has an influence on their body composition. For example, exposure to extreme temperatures may change the size and activity of various organs. Protein deposit, that is muscle development, is highest at ambient temperatures of 15 °C to 23 °C. Both higher and lower temperatures result in greater fat deposits in baconer carcasses.

Ambient temperatures have a great influence on the performance of breeding pigs. High environmental temperatures have an obvious influence on the fertility of gilts, among other things. Pregnant sows are more prone to heat stress than non-pregnant
sows. Exposure of pregnant sows to high environmental temperatures of between 32 °C and 37 °C and a relative humidity of 50%, especially during the first few days after servicing, drastically increase embryo deaths, while the sow’s appetite and live weight will also decrease. White sows and sows with no pigmentation that are sunburnt as a result of exposure to direct sunlight, show high resistance to natural mating during oestrus, with a resulting negative influence on productivity. High temperatures also have a negative influence on working boars. It greatly reduces the libido, or sex drive, as well as the semen concentration, thus causing lower fertility.

3.2 **The social and structural environment of a pig**

As in the case with other animals, pigs have a hierarchy of domination and submission within the group. If this order is disturbed by removing pigs from or adding pigs to the group, the hierarchy will be re-arranged with accompanying fighting and stress.

The social domination hierarchy is established even before the litter is weaned. During the first days after birth, a specific weaning hierarchy is formed. This happens when the stronger piglets take possession of the front nipples, which contain the most milk. Disturbance of this order retards the growth and development of the piglets.

3.2.1 **Grouping**

Pigs grow larger when they are housed in groups instead of individually. However, if the total floor surface for pigs with a live body weight of 60 kg and more is smaller than 0.5 m² per pig, the growth rate may be lower. A large number of pigs on a limited floor surface in the same pen will result in diminished growth rates and feed utilization, cannibalism (such as tail biting), dung and urine soiling of the pens and heat stress.

The ideal group size is determined primarily by the size and weight of the pigs, environmental conditions, feeding and pen changing practices. Grouping and large groups are not advisable with the use of hayless and/or slatted floors. Grouping of eight to 12 pigs per pen during the growth stages of 45 kg to 115 kg live body weight apparently has good growth and feed utilization results (refer to Chapter 5). Pigs with a live body weight of less than 45 kg may be grouped together in larger numbers, provided that the social hierarchy can be established early.

3.2.2 **Changing pens**

Changing pens means transferring a litter or group of pigs from one type of pen to another, from birth to weaning or slaughter stage.

When changing pens in large intensive units, it is important to handle the pigs with care. It is therefore essential to create favourable conditions while planning and arranging pens, passages and troughs to ensure that they do not suffer any discomfort or undue stress.

The major objective of changing pens is to ensure the economical utilization of the available housing, especially for growers and finishers. By changing pens, a saving
of up to 36% of the floor surface for sleeping space may be achieved. The saving is possible because pigs require floor space of varying sizes, as they grow bigger. If they are kept in the same pen from birth to marketing, floor space is wasted. If pens are changed only twice, there already is a saving of 31%. When changing pens, the following needs to be kept in mind:

- It has a stressful influence on pigs because the unfamiliar surroundings of the new pen could debilitate the growth rate, as well as feed utilization.
- It may promote the spreading of disease.
- More than two pen changes are not advised because the saving on floor space does not merit the negative influence the changing of pens has on the growth rate and feed utilization.
- Pen changing is only beneficial if the production unit is large enough to regularly supply the quantity and size pig to utilize the floor space.
- Because the pigs are handled regularly and the pens have to be disinfected, pen changing requires more labour costs.
- Management is more demanding.

With single pen systems, the litter is housed in a single pen from birth or weaning to slaughter stage. Pigs housed in a single pen system show about 2% better growth rate and 13% more efficient feed utilization than pigs that change pens in the normal fashion. Also, there are fewer cases of tail biting and cannibalism, while pens need not to be disinfected as often. The system also requires less labour.

The disadvantage of the single pen system is that it makes specific demands regarding the planning and erection of the building. Because of the various different sizes of pigs and the fluctuating number of piglets per litter, pens cannot be used optimally. This increases the housing costs.

Compared to other aspects, such as the climate in the building, transport methods, removal of manure and run-off, health and hygiene, pen changing is relatively unimportant. The larger and more intensive the pig production unit becomes, the more desirable it is to provide separate housing for each of the different life stages of the pigs. Pen changing then becomes an essential activity in the production system.

### 3.3 The chemical environment

The different reactions that take place inside the buildings of intensified pig production units may change the composition of the air through pollution to such an extent that harmful gases appear, such as carbon dioxide (CO₂), methane gas (CH₄), ammonia (NH₃), and hydrogen sulphide (H₂S).

Temperatures higher than 33 °C and a high relative humidity of ± 100%, ammonia levels higher than 89 ppm and carbon dioxide concentrations higher than 0.7%, lower the growth rate, the utilization of feed and the health standard of pigs housed under such conditions.

Efficient ventilation is therefore essential to create the optimum temperature and other climate conditions, and to ensure an unpolluted air environment for the pigs (refer to Chapter 4).
CHAPTER 4

4. VENTILATION CONTROL IN INTENSIVE PIG PRODUCTION UNITS

Intensive pig production facilities require ventilation systems to regulate the moisture and heat produced by the pigs, as well as air pollution produced by dung, feed and the pigs themselves.

South Africa’s climate is more moderate than that of some overseas countries. For that reason, natural ventilation has been used here for decades with excellent results, provided that proper design considerations have been taken into account. Mechanical ventilation (air and temperature conditioning) is indeed used, especially for piglets that are weaned early at 21 days. However, the installation cost is very high. Buildings with natural ventilation are more economical in terms of fixed and running costs. Such buildings will still only function effectively if the principles of natural ventilation are strictly adhered to.

4.1 Objectives of ventilation

The objective of ventilation is the control of the ambient temperature and humidity, the provision of fresh air, the removal of harmful gases and the movement of air.

4.1.1 Controlling ambient temperatures

The micro ambient temperature, that is the temperature surrounding each pig, can be controlled effectively by means of ventilation. Pigs that are herded together in a building create heat. The heat may be applied to good effect during cold conditions, but during warm conditions, it must be removed by means of effective ventilation.

Heat derived from sunbeams causes an increase in the conduction and radiation heat inside the building. Figure 4 indicates the expected increase in solar heat inside an uninsulated piggery with a maximum height of 3,0 m in South Africa.

Ventilation means replacing the air inside a building with fresh air from outside. Controlled ventilation is to control the rate at which the air is replaced, depending on the environmental conditions outside the building, such as temperature and wind speed.

Figure 4.2 illustrates the interrelationship between temperature increase, insulation and various ventilation rates.

Temperature increases occur when the temperature inside the building rises above the outside temperature due to heat emitted by the pigs.
The graphs in Figures 4.1 and 4.2 illustrate the following:

- The ability of pigs to create heat and increase the temperature of the ambient micro environment.
- The relative increase of solar heat inside the piggery.
- The relative effect of total insulation, partial insulation (roof) and no insulation.
- The important role of ventilation to curtail temperature increases during warm conditions.
Temperatures inside buildings can be controlled effectively with the use of natural ventilation, provided that the design of the building, as well as the layout and construction are done properly.

4.1.2 **Controlling humidity**

Humidity plays an important part in the microclimate conditions inside piggeries. The ideal is to keep pigs in a relative humidity range of between 45% and 75%. Relative humidity values of more than 80% and less than 40% should be avoided. This may be brought about randomly by means of natural ventilation, or by means of controlled ventilation and proper management.

4.1.3 **Supplying fresh air**

Fresh air is best for pigs. Ventilation supplies fresh air rich in oxygen.

4.1.4 **Removing harmful gases**

Harmful gases should be removed for the sake of the pig’s health. The building should be managed in such a way that it requires the minimum amount of air changes to regulate the temperature. At the same time, it has to be ensured that gases, dust particles and pathogens are removed effectively.

4.1.5 **Air movement**

Draughts cause the temperature to fall due to evaporative cooling, that is to say increases in both the lower critical and upper critical temperatures occur. The graphs in Figure 4.3 give approximate indications of how the effective temperatures on the skin surface are lowered due to air movement. Draughts should be avoided. Air movement should be limited to the minimum during winter. During summer however air movement should be used to cool the environment by means of judicious ventilation control.

![Figure 4.3: Approximate reductions in the dry bulb temperatures due to air movement at different speeds over the human skin](image-url)
4.1.6 **Light**

Artificial lighting is not usually required in piggeries. Translucent flaps or shutters usually allow enough daylight to enter the building. Even solid flaps will allow enough daylight into the building when they are opened and closed for ventilation purposes.

4.2 **Ventilation control**

An important facet of production management in a pig production unit is proper ventilation control. Inadequate ventilation could have the following results:

- More deaths
- Poor health
- Lowered production performance
- Unsatisfactory working conditions
- Increased maintenance costs for buildings and equipment

In most parts of South Africa, the climate conditions are such that natural ventilation is adequate.

4.2.1 **The mechanism of natural ventilation**

There are two mechanisms involved in the natural ventilation of a building (see Figure 4.4):

- Thermal forces or the stack effect
- Wind forces or the wind pressure effect

The **stack effect** occurs when warm air inside the building rises and gets replaced with cold air lower down. It depends on the following:

- The temperature difference between the air inside and the air outside the building, namely $\Delta t$.
- The height difference between the inlet and outlet points, $\Delta h$.
- The areas of the inlet and the outlet vents, $A_1$ and $A_2$.

The buildings in Figure 4.4 are designed in such a way that, when the flaps are fully opened, the stack effect will ensure sufficient air replacement to provide oxygen and remove gases. It may even cause the temperature in the building to drop notably, although there is little airflow.

The **wind effect** develops due to pressure differences generated when the wind blows over the building. The pressure forces effect air movement or natural ventilation through the building.
4.2.2 Requirements for effective natural ventilation

The design, layout and construction of buildings have to be accurate from the start in order to facilitate ventilation. The following basic principles apply:

- Fresh air has to come from a lower level.
- Stale air has to be extracted from a higher level.
- Roofs with flat gradients are completely subject to suction during windy conditions. This aids the extraction of stale air.
- Airflow is directly linked to the size of the vents and is determined by the area of the smallest vent.
- The further apart the vents, the less the airflow will be.
- Practical observations have shown that wind directions may deviate up to 50° from a line perpendicular to the longitudinal axis of the building, without significantly influencing the suction force.
- The windbreak effect of an object extends to approximately six times its height on the down-wind side. This should be kept in mind to ensure maximum ventilation in summer. It may also be used to soften the effect of cold winter winds.

4.2.3 Design, layout and management of buildings

The design of buildings should adhere to the basic dimensions as shown in Figure 4.5. This is to ensure optimum ventilation regulation. The following should also be kept in mind:

- Use economical materials
- Use good quality concrete
- Apply damp proofing to the floors and insulate the floors with no-fines concrete (Appendix A), especially in wet areas.
- Insulate the roof where high temperatures can be expected.

For effective natural ventilation, buildings should be positioned in such a way to make optimum use of prevailing winds and topography, while at the same time minimizing heat increases due to radiation. The ideal is to place the longitudinal axis of the building in an east-west direction. However, the directions of prevailing summer winds should be the determining factor. The longitudinal axis is therefore placed rectangular to this direction. The low side of a flat-roofed building should be placed in an up-wind direction. Best results are obtained if the gradient of the building site also lies in this direction. In cases of any doubt, professional advice should be sought.

**Figure 4.5: Main dimensions applicable to naturally ventilated piggeries**

The following are important points to consider when planning the layout of buildings:

- Buildings must be spaced at least 18 m apart to ensure effective air movement between the buildings and to combat the spread of disease.
- There should be no obstructions in the way of warm winds.
- If the land falls in the direction of prevailing warm winds, smaller spaces between the buildings may be considered.
- Obstructions to cold winds however are advisable.
- If the ground falls in another direction than the prevailing warm winds, that is downhill, bigger spaces between buildings should be considered.
4.2.4 **Ventilation control**

The ventilation of a modern piggery entails the following:

- Meticulous control of ventilation vents.
- Monitoring of the temperature and relative humidity in the building.
- Meticulous removal of dust, gases and pathogenies by means of sufficient air replacement.
- Keeping of performance records.
- Supplying heat to piglets.

4.2.5 **Mechanical ventilation**

The principle of mechanically ventilating pig housing facilities is described in Appendix B.
CHAPTER 5

5. HOUSING REQUIREMENTS OF PIGS

Intensive pig housing represents the largest capital outlay of pig-breeding. Planning, not only of efficient buildings, but also of economical buildings, is therefore extremely important. The main aim of pig-breeding should be to produce the maximum amount of quality meat in the shortest possible time.

The efficiency of pig housing in intensive housing units is strongly influenced by especially temperature control and ventilation (as discussed in the previous chapter). Experiments have clearly shown that space, the length of feeding troughs and the comfort and facilities of pens, play an important role in optimum pig production.

Pigs have different environmental and climate requirements during different stages of growth. In order to reach their full potential, boars and sows especially need special attention as far as prevention of high ambient temperatures and other stress factors are concerned.

The housing requirements of different pigs at different growth stages will be discussed separately in this chapter. Special attention will be paid to required floor space, feed and water supply and the treatment of manure. The common layout for a 100-sow production unit is shown in Figure 10.1

5.1 The boar and boar pen

One boar is required for every 15 to 20 sows. The boar should be kept separately in a pen with a minimum floor area of 7.0 m². However, if the pen is to be used for servicing purposes, a minimum floor area of 9.3 m² is required, with the shortest side not shorter than 2.1 m. This is necessary so that the boar may easily turn around in his pen.

The floor in the boar pen should be non-slippery and equipped with bedding. If the pen is used for servicing, the floor should be free of slats and other obstructions. The floor is cast with a fall towards the sides to enable urine to drain towards a shallow manure channel on the side of the service passage or along the side of the building. The channel in turn drains to the main manure channel.

All non-solid gates should be designed with vertical spacers to prevent the boars from climbing up against the gates. The spacers are usually made of round iron pipes, with a 20 mm diameter, spaced vertically, no further apart than 75 mm. The height of the gate should correspond with the height of the surrounding wall, that is 1 400 mm.

Bedding in the sleeping area of the boar pen will prevent the sides of the hooves and false hooves from chafing against the concrete when the boar gets up from a lying position. It will also prevent the development of bedsores on the shoulders of heavy boars.
The feed trough has to be placed in such a way that wood shavings on the floor are not eaten with the feed. Each boar requires a trough of between 460 mm and 600 mm long, 150 mm to 200 mm high and 500 mm wide. The condition of the boar is important because he cannot be allowed to become too heavy for the sow.

A boar needs about 10 to 15 litres of drinking water per day. High quality drinking nipples (12 mm in diameter) with a flow rate of at least 2 litre/min are commonly used. If the drinking nipple is placed at a 90° angle with the vertical, the height from the floor has to be between 550 mm and 650 mm. If it is placed at an angle of 45°, the required height is 650 mm to 750 mm.

Because pigs are in the habit of defecating where they drink water, their water has to be placed in the dunging area. To prevent the feed from getting wet or soiled by urine or faeces, the feeding trough has to be placed as far away as possible from the dunging area and the drinking nipple.

The boar pen has to be cool, well ventilated and free of draughts. If possible, the temperature in the pen should never go higher than 22 °C for long periods. Boars that are exposed to temperatures of higher than 32 °C may become infertile for up to six weeks thereafter. Sufficient roof insulation is essential for proper temperature control.

If there are problems in keeping the boars cool due to high ambient temperatures, they may be sprinkled with water, or moistened with water in some other way. Pigs do not sweat and cooling is brought about through evaporation. For this reason, sprinklers are preferable to moistening because moistening only cools the air, while sprinkling wets the pig and causes the skin to cool through evaporation.

5.2 The sow and sow pen

In an intensive pig production system provision is made for five single sow pens per boar, because the sow has to stay there for five weeks and a sow/boar ratio of 1:20 has to be maintained.

It is important to bring the boar into contact with the sow as often as possible. The boar is therefore allowed to pass through the feeding passage, about 1,5 m wide, in front of the sow pens (Figure 5.1A). To manage even more contact between the boar and sows, or in cases where there are no feeding passages, partitionings made of iron pipes 20 mm in diameter, spaced 75 mm vertically, are placed over the slatted floor area between the adjoining boar and sow pens (Figure 5.1B). The reason for placing the partitioning over the slatted or dunging area is that pigs tend to defecate while communicating with pigs in adjoining pens.
Alternatively, the sow may be placed in a pen directly next to the boar right after she weaned her litter. The pens are divided by a pipe partitioning. A direct connecting gate may be placed between the pens (Figures 5.2A and 5.2C). The gate is opened and closed from the service passage. The boar is allowed access to the sow twice daily by simply opening the gate. This avoids unnecessary moving of the sow from her place to the boar and back, and makes it easier to manage the boar’s oestrus identification problems. The arrangement as mentioned above also has a calming effect especially on the boars. As soon as the sow has been served and does not want to stay with the boar any longer, she is moved to an individual pen close to the boar pen. If it is confirmed after three weeks that conception has taken place, she is moved to a crate partition or to group housing where she remains until her 12th week of pregnancy.

An alternative is to follow the same construction as in Figure 5.2A, but to leave out the gates that link the boar pen with adjoining pens. All movement from and to the boar pen then takes place via the passage.

For individual feeding, the sows are placed in pens of about 1.8 m² adjacent to the boar pen. The sows are kept in the same building as the boar. For this reason, the same temperature and ventilation requirements apply as those for the boar. Temperatures of between 9 °C and 22 °C are acceptable, with an optimum of 16 °C. The relative humidity should be between 40% and 70%.
Slatted floors, with a width of one third of the length of the sow pen, are frequently used. The slats keep the sows relatively dry and clean, and facilitate management of the system significantly. A drinking nipple with a 12 mm diameter is placed 550 mm to 650 mm high at an angle of 90°, or 650 mm to 750 mm high at an angle of 45° above the slatted floor. The estimated water requirements of a non-pregnant sow is five litres per day and the required water flow rate two litres per minute. The feeding trough measurements are the same as those for boars.

The sow and boar stable has to make provision for pens adjacent to the boar pens where gilts can be placed in groups of four. The boars that are placed next to the gilts should preferably be older boars that are more relaxed and have more experience. Hand servicing should be supervised and requires a lot of patience because it may take a while.

Figure 5.2A: Sow and boar – House 2

Figure 5.2B: Cross-section of sow and boar pens – House 2

Figure 5.2C: Cross-section of boar pen – House 2
5.3 Dry sow and dry sow housing

For a period of about one month after weaning her litter, and for about two weeks before she farrows, the housing, feeding and management of the dry sow go through a critical phase. Dry or pregnant sows may be housed in crates, in groups or in tethers.

5.3.1 Pregnant sows housed in crates

The crates that house the sows are about 600 mm wide, with a minimum length of 2 000 mm and a height of 1 000 mm above floor level. The height of the bottom railing has to be between 150 mm and 225 mm above floor level to allow the sow to lie down comfortably and to allow enough room for her legs. It is important to close the crate at the top with steel rods to prevent the sow from turning around and jumping out. About 50 crates are required for a 100-sow unit. It is advisable not to keep gilts in crates. If they are, they should preferably not be put next to older sows, but rather next to boars.

Slatted floors at the back of the sow keep the crate dry and allow for easy management. The slatted floors have to extend 300 mm behind the crates to prevent the sow from defecating in the passage when standing against the back of the crate. The quality of the slats is important because sharp edges will seriously damage the hind legs and hooves of the sows. The gaps between the slats should be 25 mm. A water pipe, 20 mm in diameter, can be used to determine the space. The floor underneath the crate should have a slope of 1:100 in the direction of the slats and link up with the slats evenly, without a step. No-fines concrete floors (Appendix A) are recommended for insulation against cold. The building where the dry sows are housed must be draught-free to maintain an optimum temperature of between 15 °C and 16 °C for maximum conception and survival of embryos. Roof insulation will also be extremely beneficial for temperature control and is strongly advised.

Sunken or above-ground feeding troughs may be used. Trough measurements for dry sows are as follows:

- Length: 460 mm to 600 mm
- Height: 150 mm to 200 mm
- Width: 300 mm to 500 mm

In the case of sunken troughs, a crate length of 1 800 mm will be sufficient. To eliminate unnecessary excitement among the sows during feeding time, tipping-bowls may be fixed to a common railing per section, which serves as a hinge. The troughs are filled while the sows are still busy with the previous meal. At feeding time, all the bowls are swivelled from a common point and all the sows are fed simultaneously. The bowls need to be swivelled away from the sows to prevent the feed from spilling on them. This feeding system may also be used in the boar and sow house.

Water can be supplied by means of a flushing system in a continuous feeding trough or by means of drinking nipples with a diameter of 12 mm. The approximate drinking water requirements of dry sows are 10 to 18 litres/day/sow and the flow rate at which
water should be provided per nipple should be about two litres/min. Nipples that are placed at an angle of 90° with the vertical have to be 550 mm to 650 mm above ground level, and nipples at an angle of 45°, 650 mm to 750 mm above ground level. Drinking nipples are often placed above the feeding troughs to ensure that water spills only into the trough.

5.3.2 Pregnant sows housed in groups

Research has shown that sows that are housed in groups of four to five significantly increased the number of litters per year. Pens have the advantage that sows that are in heat again can be noticed much easier. However, the sows have to be fed individually to prevent fighting. A feeding trough with individual partitions for each sow can be used for this purpose.
Where possible, sows with the same body weight and condition have to be grouped in the same pen with a floor area of 3.9 m² to 4.9 m² per sow. The area includes a sleeping area of 1.3 m² to 1.8 m², a dunging passage of 1.3 m² to 1.8 m² and an individual eating space of 1.3 m² per sow. The height of the pen wall must be 1 200 mm. A gate 1 200 mm high and 750 mm wide, consisting of mild steel rods with a diameter of 12 mm and spaced about 50 mm vertically, must be provided.

Group housing can also be done semi-intensively by merely placing a roof over the pens and keeping the sides open. This layout requires less material and construction costs, but could possibly create problems regarding the regulation of temperature and ventilation. Instead of using wall partitions between pens, vertical trellis partitions consisting of mild steel pipes 20 mm thick, or else mild steel 12 mm in diameter, spaced 50 mm to 75 mm vertically, can be used.

Where slatted floors are used, the slats should cover one third of the length of the pen, and the drinking nipples should be installed above the slatted floor to prevent water from spilling on the floor. Use can also be made of a shallow manure channel with a flushing system (refer to paragraph 8.3.5).

5.3.3 Pregnant sows in tethers

The sow’s movements are restricted by means of a belt around her body, just behind the front legs, or around the neck. The belt is fastened to the floor with a short chain, about 300 mm behind the feeding trough. The crate areas are 600 mm wide, 800 mm to 1 000 mm above floor level and about 1 000 mm to 1 300 mm long.

The tether requires little material, but the cost of the belt implies that the cost of the system as a whole is more or less the same as that of a conventional crate. Handling and accessibility are easier with a tether, because the crate is open at the back. It also simplifies testing for pregnancy in large intensive units.

Care should be taken that the tether does not chafe or strangle the sow when she lies down too far away from the point where the chain is fastened to the floor. The length of the chain should be adjustable according to the height and condition of the sow. The tether should also not interfere with the freedom of the sow to get up or lie down.

5.4 Farrowing pens

5.4.1 General

The most important considerations regarding housing during farrowing and the first seven to ten days thereafter, are to supply optimum temperatures to the sow and her litter and to limit deaths among the piglets through trampling or overlying.

Approximately 30 farrowing pens, 1.8 m to 2.0 m by 2.2 m to 2.5 m big, are required for a 100-sow unit. A large variety of farrowing pens is commonly used. Very good results are obtained by using the two alternative Holderness type pens as shown in Figures 5.4A and 5.4B. The sloped sides, which force the piglets to defecate on the slatted floor, are typical of these pens. Because the system requires more material and
due to construction and other practical problems, it is not very popular. Figures 5.5A and 5.5B show a farrowing pen with parallel sides, which is easier to construct and which requires less floor space per pen. The measurements indicated allow for a large enough pen to keep the sow and her litter there until they are weaned at five weeks. The height of the partitioning between adjoining farrowing pens is between 500 mm and 600 mm.

Figure 5.4A: Farrowing pen (Holderness type)

Figure 5.4B: Cross-section of Holderness type farrowing pen

Figure 5.5A: Farrowing pen (rectangular layout)
Sows should be placed in disinfected farrowing pens one week before farrowing to allow time for adjustment to the new surroundings. The sow or gilt is washed and treated for scabby skin, not less than two days before she farrows.

The floor of the farrowing pen has a gradient of 1:50 in the direction of the manure channel. The floor ends in a manure channel or is linked to slatted or perforated floors to direct all urine away from the sow. When any kind of perforated floor is used, care should be taken that the sow’s nipples cannot be damaged. Expanded metal is not recommended. No-fines concrete is strongly recommended as flooring material (see Appendix A). If possible, the level where the sow lies should be 25 mm higher than the level where the piglets move around. It allows the piglets greater access to the sow’s nipples. To a certain extent, it also prevents the piglets from creeping underneath the sow where she can squash them.

To create more pleasant working conditions for labourers and to facilitate the removal of manure, farrowing pens are placed over slats. Placing the pens on a perforated sheet over a shallow manure channel (see Figure 5.5B) underneath the sow, requires more labour. It is also more difficult to clean this system. The spaces between standard concrete slats are, however, too large for piglets because their feet get stuck. A grid floor consisting of flat (6 mm × 20 mm) and round (10 mm diameter) mild steel rods welded alternately onto a framework should rather be used. The spaces between the rods should be maximum 10 mm across in the direction of the farrowing crate to prevent the sow from slipping. Concrete and plastic slats may also be used. The vertical partitions between adjoining farrowing pens, usually round mild steel rods 8 mm in diameter, vertically spaced 50 mm apart and 500 mm high, should be removable to allow for repairs to the grid floor.

The temperature requirements of the sow that is between 10° and 22 °C must be observed. Daily variations may not exceed 4 °C to 5 °C. As mentioned before, the optimum temperature for piglets in the creeping pen is between 27 °C and 32 °C. The temperature requirement of newborn pigs are, however, between 32 °C and 37 °C. Cold will lower the resistance of piglets against disease. Piglets kept at 21 °C are five times more prone to serious bouts of diarrhoea than those kept at 35 °C. “Cold” piglets need more feed than “warm” piglets, but eat less.
5.4.2 The farrowing crate

The farrowing crate is made of steel pipes or round steel rods. The measurements are extremely important to ensure that the sow is comfortable. The crate has to be designed in such a way to allow enough free space behind her for easy farrowing, and to prevent the piglets from being overlaid. Enough walking space for the piglets should be allowed behind the sow. The construction of the crate is vertical from the top (about 950 mm above floor level) to a height of 400 mm above the floor. This part of the crate is between 450 mm and 500 mm wide. After this, the crate widens to 700 mm or 850 mm at a height of 200 mm or 250 mm above the floor. The narrow part at the top prevents the sow from falling when she lies down, and gives the piglets a chance to get out of the way when she lies down. The wide part at the bottom of the crate ensures that the sow lies down comfortably and that the piglets have easy access to her nipples. The length of the crate is about 2 500 mm and includes the feeding trough in the front part. If the crate is fitted with vertical partitions, the partitions at the front should be 80 mm from the floor to keep the sow’s head from getting stuck. Partitions further to the back must be 150 mm to 200 mm above the floor. The distance between the partitions at the front of the crate can be 200 mm to 250 mm, and at the back 270 mm and 320 mm. A plan for a typical farrowing crate is given in Figure 5.6.

5.4.3 The creeping area

A creeping pen of 600 mm by 600 mm with bedding must be provided for the piglets. Wood shavings are preferred for the bedding, but if hay is used, care should be taken that it is not set alight by the heater. A roof over the creeping pen is essential to prevent draughts and to keep the heat inside. A vertical overhang along the roof of the creeping pen improves the recycling of warm air. The optimum temperature in the creeping pen is 27 °C to 32 °C. It is important to provide heat for at least the first five days after birth. After that, the piglets will be able to produce enough body heat for the creeping area, except during very cold weather conditions.

In order to keep piglets healthy and alive, they should be kept warm. To ensure that the sow has enough milk for her litter, she has to be kept cool. Every possible effort should be made to obtain an average of 10,5 live born piglets per litter.
Temperature fluctuations of more than 5 °C in the creeping area must be avoided. A light in the creeping area provides heat, attracts the litter and helps in this way that the piglets are not squashed to death by the sow. Gas heaters are often used, especially where electricity is not available. Infrared lamps are very economical as far as the consumption of electricity is concerned, because only the sow and piglets are heated. However, the floor remains cold.

Electricity of around 300 W to 500 W is required for every creeping pen. Underfloor heating may also be installed in the creeping area. The advantage of underfloor
heating is that the floor surface is also heated, meaning that the piglets are heated from underneath. With the use of infrared lamps or heaters, the floor often remains cold. The disadvantage of underfloor heating is that it takes a while to get warm, especially when cold weather unexpectedly sets in. A heating method, which is increasingly becoming popular, is the use of heated rubber mats in the creeping area. The efficiency of these mats is very high, while the electricity consumption remains low compared to other heating methods.

It is preferable not to place the creeping pen too close to the sow, because the heat may cause her discomfort and stress. If the creeping pen is indeed placed close to the sow, sufficient insulation should be provided between the pens. Generally, the creeping pen is positioned in front of the sow away from her nipples. An additional heating lamp behind the sow will reduce the mortality of the newborn pigs. The piglets must be able to easily find the heated creeping area after birth.

5.4.4 Water supply

A drinking nipple with a diameter of 12 mm is placed at a height of 500 mm to 600 mm (if the nipple is at an angle of 90° with the vertical), or a height of 600 mm to 700 mm (for a nipple at an angle of 45°), above or next to the sow’s feeding trough. The lactating sow needs about 18 to 23 litres of water per day at an average flow rate of two litres/min. The piglets get a drinking nipple or water trough in the dunging area. The drinking water requirements of piglets are in the region of 0.70 to 1.0 litres/day. A nipple with a 6 mm diameter should be used for the piglets. If the nipple forms an angle of 90° with the vertical, it should be installed at a height of 100 mm, and if the angle is 45°, at a height of 150 mm. To limit the mortality of piglets due to dehydration, the drinking nipple can be set up to continuously drip somewhat.

5.4.5 Feed supply

It is preferable to equip the litter with a creep feeder. A small, simple self-feeder 100 mm high, 150 mm wide and 250 mm long, which is filled twice or three times a day, is sufficient to prevent the feed from becoming stale and mouldy. The feeder can also be equipped with hooks and hooked over the dividing wall between adjoining pens to prevent the piglets from shoving it around. The self-feeder is placed approximately halfway between the creeping pen and the slatted floor, against the dividing wall. Milk powder strewn on the floor will encourage the piglets to eat.

The sow gets a concrete trough 460 mm to 600 mm long, 150 mm to 200 mm high and 300 mm to 500 mm wide at the front of the farrowing crate. As mentioned before, the drinking nipple is often placed above the feeding trough.

5.5 Weaners and weaner housing

For many years, it was customary in South Africa to wean pigs at the age of 35 days (five weeks). Worldwide, and locally, the tendency to wean pigs at an earlier age, for instance at the age of three weeks, is becoming more and more popular. This section focuses on housing for pigs weaned at 35 days, with two litters grouped together, all-in-all-out pens, housing for early-weaned pigs and flat deck housing.
5.5.1 **Housing for weaning at 35 days, with two litters combined**

When the method of weaning at 35 days is followed, and two litters, that is about 20 piglets, are put together, a pen 8.0 m² in size (0.3 m² to 0.5 m² per pig) will be required. The pen walls are about 600 mm high. The piglets remain in these pens until they are 70 days old (ten weeks), whereafter they are moved to grower pens.

A total of about 14 weaner pens are required for a 100-sow unit, taking into account that each sow weans on average 2.3 litters per year, and that each litter contains an average of ten piglets. The pens are housed in one building, in two rows of seven pens each, with a centre feeding passage 1.0 m to 1.6 m wide (Figures 5.7 to 5.9). If a portion of the slatted floor is placed over a flushing channel, it simplifies the cleaning of the pens, while also increasing the hygiene. Communication between pigs in adjoining pens takes place through communication railings. The railing is placed in the dunging area and is made of steel rods, 10 mm in diameter, spaced 75 mm vertically and 600 mm high.

To supply the piglets with about one to three litres of drinking water per day, a drinking nipple of 6 mm in diameter is placed 250 mm to 400 mm above floor level at an angle of 90°, or 300 mm to 450 mm above floor level at an angle of 45°, against the communication railing. This will ensure that urine and manure from the piglets land on the slatted floor.

To keep the cost of materials as low as possible and to create cleaner conditions, the two rows of pens can be placed back-to-back. The walking and feeding passages are then combined with the outer walls of the building with two manure channels against each other in the middle of the building. However, this layout means that the building will be wider.

For the supply of feed, a movable self-feeder can be used to adjust the size of the pen, as the piglets grow bigger. However, automatic feeding becomes more difficult with the use of the movable self-feeder. If a feeding trough is used to supply feed to the piglets, the required length for the trough is 150 mm to 170 mm per pig, the height is 100 mm and the width 150 mm. Gates are not provided, because weaners can be picked out of the pen by hand. Provision has to be made for bedding in the lie area, and also for a removable screen, because piglets require proper regulation of environmental conditions up to the age of ten weeks, with temperature needs of between 17 °C and 25 °C. Draughts should be avoided. Each pen is cleaned when the pigs are removed, but true effective sterilising is not possible because the pens are in the same building.
Figure 5.7A: Weaner house 1

Figure 5.7B: Cross-section of weaner house 1

Figure 5.8A: Weaner house 2
5.5.2 All-in-all-out pens

These pens are designed in such a way to accommodate all the litters of the sows that give birth in the same week in an enclosed section of the building when they are being weaned. The piglets then remain in this part of the building until they are transferred to a grower unit. All piglets enter the unit during the same week and leave the unit during the same week. That part of the building, which has been occupied by the group, can then be disinfected properly.
In a 100-sow unit, not more than five sows should farrow per week. The building is then designed in such a way that each section contains six weaner pens. Each litter occupies a pen, while the weakest piglets from the five litters are grouped in the sixth pen. After the piglets have been weaned at five weeks, they remain in this part of the building for another five weeks, until they are ten weeks old. All piglets are moved to the grower pens at five weeks. A week is allowed for sterilising and cleaning that part of the building. If a pen is occupied for five weeks and cleaned for one week, a building with six sets of pens, each containing six pens, therefore altogether 36 pens, is required.

5.5.3 **Housing for early weaning**

When piglets are weaned at the age of three weeks (21 days), the regulation of temperature and ventilation is even more important than when they are weaned at five or six weeks. The temperature requirements of piglets weaned at three weeks are between 25 °C and 29 °C. In order to obtain optimum temperatures of this kind, it will be necessary to regulate the temperature of the building, or else make provision by installing a heated creeping area.

Management plays an important role in achieving success and knowledge of housing and feeding methods is vital. The all-in-all-out system should be applied and there has to be enough pens to allow a cleaning period of seven days (one week). The piglets are housed here for 21 days and are therefore six weeks old when they are transferred to another type of housing. The piglet should weigh about 12 kg at this stage, while its temperature requirements may still be as high as 23 °C. The kind of heating, and especially the kind of floor used, are important issues.

Not more than 24 piglets, at 0,25 m² per pig, should be kept in one pen. It is important to remember that a pipe diameter of 20 mm will allow enough water pressure to share water points between pens, thus saving the cost of one pipe length. A self-feeder is optional, but a floor-feeding trough is better because it allows the caretaker to see the piglets more often.

Research on piglets that have been weaned at 21 days has shown the following:

- Early weaning (21 days) means that sows spend 61 days less to wean five litters, which means that she can have 2,54 litters per year instead of 2,34, as is the case with sows that wean their litters at 35 days.
- Creeper feed intake per piglet weaned at 21 days up to the age of eight weeks is 14,1 kg compared to 10,7 kg per piglet weaned at 35 days.
- Sows that wean at 21 days show an increase in weight of 66,4 kg over five cycles, compared to an increase of 52,3 kg in sows that wean at 35 days.
- Groups of pigs that wean early produce 20% more piglets aged eight weeks.

5.5.4 **Flat deck housing**

In larger units where piglets remain in the same pen system until they are nine to ten weeks old, flat deck housing is preferable. The pens are also often used for piglets that are weaned at three weeks.
If the litters are separated, 14 pens will be required for a 100-sow unit, and if they are kept together, 20 pens will be required. The pens consist of a pre-fabricated steel frame with a trellis fence 600 mm high. A floor area of 0,2 m² to 0,4 m² is allowed per piglet with a weight of up to 35 kg. The floor should be covered with high quality plastic, woven mesh or perforated steel plate. However, the surface of the area near the feeding trough has to be solid. Care should be taken to ensure that metal slatted floors do not rust easily. The partitions between the pens should be of a kind that will allow the piglets to communicate with one another while drinking and dunging on the perforated part of the floor. The pen is installed over a flushing channel to help with cleaning and the removal of manure.

Because the decks are on top of the floor, special care should be taken to ensure that there are no draughts from underneath. Roof insulation is essential and roof and side ventilation must be regulated. Temperature regulation for decks is not difficult. The temperature should be kept between 17 °C and 25 °C.

If possible, and for better results, piglets from the same litter should be kept together (about ten piglets). The mixing of different litters may cause stress, which in turn could cause a drop of as much as 13% in the growth rate.

Flat deck housing allows for better control, easier management and treatment of the piglets and inhibits the spreading of disease. An all-in-all-out system is maintained to enable the disinfection and cleaning of pens. A disadvantage of the system is that the pens are rather expensive. The high cost of replacing worn pens is the major reason why this system is seldom used in new units.

5.6 Grower and finishing pens

Pigs are normally moved from the weaner to the grower pens. The piglet should weigh about 30 kg at this stage and should have temperature requirements ranging between 12 °C and 18 °C.

Depending on the stage at which the pig is marketed, it will remain in the grower house until it reaches a weight of between 60 kg and 110 kg. Nowadays, ad lib feeding is commonly used for grower purposes. This also is the only difference between the grower and finishing houses. In the latter kind, feed intake is limited. This does not only save on the consumption of feed, but by regulating the growth of the pig at this stage, better grading and market prices can be ensured.

It has been scientifically proven that pen sizes based on floor space per pig have an influence on the growth potential of pigs. Although small differences do occur, the average norm is about 0,8 m² per 45 kg; 0,95 m² for up to 90 kg and 1,0 m² to 1,3 m² for up to 110 kg live body weight.

While planning the grower and finishing houses the design should take into consideration that about two thirds of the waste generated by the production unit will come from these two buildings. For the handling of manure inside the building, the use of slatted floors over a manure channel is recommended. Wide concrete slats of between 100 mm and 120 mm, spaced 20 mm apart, are commonly used. The outside of a 12 mm water pipe may be used to determine the size of the spaces. High quality
plastic slats may also be used.

Where two litters of more or less 20 piglets are grouped together from the weaning stage, the group is transferred to the grower pen in its entirety. If the norm for a 100-sow unit applies, as mentioned before, about 20 grower pens are required, each designed to house 20 pigs with a live body weight of between 30 kg and 65 kg. These pens are housed in the same building. After this, each group of 20 pigs is separated into two groups. After the gilts have been taken out of the group, the remaining eight or ten pigs go to the finishing pens where they are kept until they are marketed. Double the number of pens is required for the finishing house. These should be housed in two identical buildings. The pens may be grouped together intensively, completely inside a building, or semi-intensively, with open sides and covered by a roof. The latter method requires less material but factors such as the location, ambient temperatures and the breeder's preferences should be considered. For more cost saving, manure can be removed by means of a shallow flushing channel instead of slatted floors (refer to paragraph 8.3.5).

The layout inside the building consists of two rows of pens with a feeding passage in the middle (see Figures 5.10 to 5.14). The alternative is to build two rows of pens back-to-back with a feeding passage on the outside of each row of pens. The layout for grower and finishing pens, as well as the dimensions, is identical. The only difference is the feeding method used and the number of pigs housed in a pen. A self-feeder is used for growers, while finishers use a feeding trough allowing 300 mm per pig, with a height of 150 mm to 200 mm and a width of 300 mm. The self-feeder has to be installed properly to prevent spilling of feed. Rationed and ad lib feeding requires different feeding trough dimensions per pig. The recommended dimensions are as shown in Table 5.1.

Table 5.1: Recommended trough dimensions

<table>
<thead>
<tr>
<th>Pig weight (kg)</th>
<th>Rationing Trough space (mm)</th>
<th>Ad lib feeding Trough space (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>60</td>
<td>240</td>
<td>60</td>
</tr>
<tr>
<td>90</td>
<td>280</td>
<td>70</td>
</tr>
<tr>
<td>120</td>
<td>300</td>
<td>75</td>
</tr>
</tbody>
</table>

Growers and finishers require about five to ten litres of drinking water per day at a flow rate of 600 ml to 750 ml per minute. Drinking nipples at an angle of 90° with the vertical are installed above the slatted section at a height of 450 mm to 550 mm for growers and at 550 mm to 650 mm for finishing pigs. For a nipple at an angle of 45°, the required height is 550 mm to 650 mm for growers and 650 mm to 750 mm for finishers.

In pens with a feeding passage in the middle, it is essential to ensure that the gates on either sides of the passage are not directly opposite one another. If the gates are directly opposite one another, the pigs will communicate across the passage and soil the whole pen.
In most regions, housing which is open at the front can be used for finishers, because they are now able to resist low temperatures for some time without any detrimental effects. However, controlling the ventilation in the building is very important. A pig with a body weight of 54 kg produces 80 W sensible heat. Therefore, 100 pigs with the same weight will produce 8 kW heat. Sufficient ventilation must be available to remove the body heat and to replace the “old” air with fresh air. With proper ventilation control, it is possible to regulate the temperature inside the building if the temperature outside is lower than the temperature required by the pigs. Furthermore, ventilation prevents the build-up of harmful gases, as well as breathing problems. Roof insulation is recommended to prevent radiation heat from the roof. Asbestos roofs do not insulate as effectively as is commonly believed. Asbestos tends to become black after a while which causes the roof to absorb heat which is then radiated into the building. White paint on blackened asbestos roofs will lower the temperature inside the building.
Figure 5.11B: Cross-section of grower house 2

Figure 5.12A: Grower house 3

Figure 5.12B: Cross-section of grower house 3

Figure 5.13A: Finishing house 1
The handling of waste in grower and finishing houses is the same. Two methods are used, namely the clean flushing system and dry manure handling system.

- **The flushing system**

  A single or double row of slatted floors over a flushing channel is often used. In housing with a feeding passage in the middle, the flushing channel is usually placed parallel to the outside wall, while a trellis partition is installed across the width of one flushing channel, usually one metre wide, between adjoining pens. The purpose of these partitions is to enable pigs to communicate with others next door. The partition consists of iron rods 12 mm in diameter, spaced 75 mm vertically, with a height the same as that of the wall, which is between 1,0 m and 1,2 m.
Pens that are built back-to-back, with two feeding passages along the outer walls, have slatted floors in the middle of the building on either side of the border between the pens. Partitions between the pens are installed at the joint dividing wall, also by means of trellises. Channels without any gradients underneath the slatted floors are flushed clean by means of a syphon-flushing tank. All floors are built with a slope of 1:50 in the direction of the slatted floors.

- **Dry manure handling**

  The handling of dry manure is only possible with pens that adjoin the long side of the building and have a central feeding passage in the middle. Pens are built with a slope of 1:50 towards the side of the outer wall. A gap is left in the outer wall through which the manure is transported outside. A concrete channel is built along each long side of the building and manure and urine are scraped out of the pens into the channels. The latter are in turn scraped after the pens have been cleaned every day.

  The pens can be cleaned by means of a high pressure water-hose, provided there is enough pressure, and the channels flushed with clean water. In these pens, drinking nipples are fixed to the outer wall of the pen. Trellis partitions of one metre wide can be installed against the back wall between adjoining pens for communication purposes.
CHAPTER 6

6. CALCULATING THE HOUSING REQUIREMENTS FOR A PRODUCTION UNIT OF 100 SOWS IN A GIVEN MANAGEMENT SYSTEM

6.1 Introduction

Before calculating the housing requirements for a certain production unit, the following questions have to be answered:

- What size should the unit be?
- Are weaners, porkers, baconers or slaughter animals produced?
- What is the desired efficiency level, for instance, the age at which animals are to be marketed or the productivity level of sows?
- Which management system will be used?

An optimum management system will be assumed in determining the housing requirements and certain other assumptions are made, as given below. The following housing requirements are also based on these grounds. With each type of housing the management system and calculation method are discussed briefly.

6.1.1 Assumptions

- Size of the unit: 100 productive sows, excluding gilts.
- Weaning is at 35 days.
- Sows produce 2,3 litters per year.
- Ten live piglets are born per litter.
- The mortality rate among piglets from birth to marketing is 10%.
- At the age of approximately 120 days, 20% of the piglets weighing between 60 kg to 70 kg live body weight will be marketed as porkers.
- At the age of approximately 180 days, 80% of the pigs with a live body weight of between 90 kg and 100 kg will be marketed as baconers.
- Select eight gilts per month aged 100 days, that is 96 gilts per year.
- At the age of 160 days, a final selection of the best four gilts from each group of eight will be made.
- Sows give birth at an average rate of four to six piglets per week.
- If gilts are bought, they should be acquired at a rate of five per week over 22 weeks.
- The ratio between boars and sows should be 1:20.

PLEASE NOTE: If any of these assumptions are changed, the housing requirements will change accordingly.

6.2 Facilities for working boars

- Seven single boar pens are needed. Five are for working boars and two for young boars (Figures 5.1 and 5.2).
- **Management system**

  The boar remains in his pen. The sow is brought to him for servicing, or the gate between the adjoining boar and sow pens is opened. The boar is only allowed into the passage when he has to identify a sow on heat.

6.3 **Facilities for weaning sows**

- **Management system**

  After the sow has weaned her litter, she is kept in a single sow pen near the pen of the boar that has to service her, for at least 35 days, or in a group pen designed for weaning sows.

- **Pen occupation period**

  At 2.3 litters per sow per year, it means that a sow occupies a single sow pen for
  \[35 \times 2.3 = 81\text{ days per year}.\]

- **Needed**

  One sow pen is therefore sufficient for:
  \[365 \div 81 = 4.51\text{ sows}\]

  100 sows therefore need:
  \[100 \div 4.51 = 22.2\text{ pens, approximately 22 pens}\]

- **Recommendations**

  Rather make provision for 25 single sow pens (Figures 5.1 and 5.2), that is five sow pens per working boar pen, or alternatively, 30 single sow pens, six per boar pen.

6.4 **Facilities for pregnant sows**

- **Management system**

  After the sow has weaned her litter, she is kept in a single sow pen near the boar pen for at least 35 days. After this, the pregnant sow is moved to the facilities for pregnant sows. The pregnant sows are therefore kept here from ±28 days into their pregnancy until seven days before farrowing.

- **Pen occupation period**

  A sow occupies a standing place in the building for pregnant sows for: \[114 - 28 - 7 = 79\text{ days after each litter that she weans}\]

  That is, a sow occupies a standing place for:
  \[79 \times 2.3 = 181.7\text{ days per year}\]
• **Needed**

One standing place is sufficient for:

\[ \frac{365}{182} = 2.01 \text{ sows per year} \]

That is, for 100 sows:

\[ \frac{100}{2.01} = 49.8 \text{ or 50 standing places are required} \]

Refer to Figures 5.3A and 5.3B regarding the physical layout of the pens.

6.5 **Facilities for gilts**

• **Management system**

Eight gilts aged 100 days should be selected each month. At 160 days, the best four gilts are finally selected from the group and the rest are marketed. From the age of ±180 days, the gilts are brought into contact with a working boar, but they are not serviced until the age of 211 days (±100 kg). Gilts are housed in groups of four at the age of 100 days.

• **Pen occupation period**

A. Period from age 100 to 160 days:

Select eight gilts per month = 96 gilts per year

Pen occupation period:

\[ 160 - 100 = 60 \text{ days} \]

Number of groups per pen per year

\[ \frac{365}{60} = 6.1 \text{ or 6 groups} \]

B. Period from age 160 to 250 days:

Select four from each group of eight gilts per year, that is \( 4 \times 12 = 48 \) gilts

Pen occupation period:

\[ 250 - 160 = 90 \text{ days} \]

Number of groups per year

\[ \frac{365}{90} = 4.1 \text{ or 4 groups} \]

• **Needed**

A. Number of groups per year = 48 ÷ 4 = 12 groups

Number of pens required = 24 ÷ 6 = 4 pens

| PLEASE NOTE: | From the age of 100 to 160 days, the gilts are kept in finishing pens. That is to say, provision has to be made for four additional finishing pens. |
B. Number of groups per year = 48 \div 4 = 12 groups
Number of pens required = 12 \div 4 = 3 pens

PLEASE NOTE: From the age of 160 days, the gilts are kept in the servicing house. Provision has to be made for two to three gilt pens, each of which can house four gilts, plus two pens, each of which can house a young boar in the servicing house.

- Housing is done in one building as shown in Figures 5.1 and 5.2.

6.6 Facilities for farrowing

- Management system

The sow has to be cleaned and disinfected in an area for this purpose a week before she is to farrow. She is then placed in the farrowing crate. The sow and her litter remain in the crate until the piglets are ±35 days old, after which the litter is moved to the weaner pens and the sow to the servicing facilities. The crate is then thoroughly cleaned and disinfected during a rest period of four days.

- Pen occupation period

<table>
<thead>
<tr>
<th>Duration</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before farrowing</td>
<td>7</td>
</tr>
<tr>
<td>Sow and litter</td>
<td>35</td>
</tr>
<tr>
<td>Cleaning and sanitizing</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
</tr>
</tbody>
</table>

- Needed

Make provision for 100 \times 2,3 = 230 litters per year
One crate is sufficient for 365 \div 46 = 7,9 litters per day
Therefore, 230 litters need 230 \div 7,9 = 29,1 crates

PLEASE NOTE: Provide 30 farrowing crates in total.

- Figures 5.4A and 5.4B and Figures 5.5A and 5.5B show a plan for farrowing pens.

6.7 Facilities for weaned piglets from the age of 35 days to 70 days

- Management system

On weaning day, the piglets are put in groups of 20 according to live body weight and moved to the weaner pens where they remain until they are 70 days old. At 70 days, the piglets are transferred to the grower pens. However, all weak piglets are regrouped and kept in the weaner pens until they weigh approximately 20 kg. After a pen has been vacated, a rest period of seven days is allowed for cleaning and sterilizing the pen before the next group of piglets is let in.
• **Pen occupation period**

For the age group of 35 days to 70 days = 35 days
Cleaning and sterilizing = 7 days
Total = 42 days

• **Needed**

<table>
<thead>
<tr>
<th>Description</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of sows</td>
<td>= 100</td>
</tr>
<tr>
<td>Number of litters/sow/year</td>
<td>= 2,3</td>
</tr>
<tr>
<td>Total number of litters</td>
<td>= 230</td>
</tr>
<tr>
<td>Number of piglets/litter</td>
<td>= 10</td>
</tr>
<tr>
<td>Total number of piglets</td>
<td>= 2 300</td>
</tr>
<tr>
<td>Minus 10% deaths</td>
<td>= 230</td>
</tr>
<tr>
<td>Number of piglets weaned</td>
<td>= 2 070</td>
</tr>
<tr>
<td>Number of groups of 20</td>
<td>= 2 070 ÷ 20</td>
</tr>
<tr>
<td></td>
<td>= 103,5 or 104 groups</td>
</tr>
</tbody>
</table>

Number of groups of 20 per pen per year:

365 ÷ 42 = 8,7 groups per year

Number of weaning pens required:

103,5 ÷ 8,7 = 11,2 pens

**PLEASE NOTE:** Make provision for 14 weaner pens because weak piglets are kept in weaner pens for longer than 35 days.

• **Feeding system**

Ad lib, creeper pellets are supplied in a self-feeder (which does not spill).

• Refer to Figures 5.7A and 5.7B, Figures 5.8A and 5.8B and Figures 5.9A and 5.9B for general weaner housing.

6.8 **Facilities for growers**

• **Management system**

Piglets are moved from the weaner to the grower pens at age 70 days. Groups are not mixed again at this stage. Only the small and weak piglets are removed from each group and kept in the weaner pens for a longer period.

• **Alternative**

Producers are free to group the piglets at 70 days according to live body weight in two sub-groups and to house them in groups of ± 10.
• **Pen occupation period**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the period from 70 days to 120 days old</td>
<td>50 days</td>
</tr>
<tr>
<td>Cleaning and sterilizing</td>
<td>7 days</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57 days</strong></td>
</tr>
</tbody>
</table>

• **Needed**

Facilities to house ±20 piglets per group, that is:

\[ 2070 \div 20 = 103.5 \text{ or } 104 \text{ groups} \]

Number of groups per pen per year is:

\[ 365 \div 57 = 6.4 \text{ groups} \]

Number of grower pens needed:

\[ 104 \div 6.4 = 16.3 \text{ pens} \]

**PLEASE NOTE:** Make provision for 18 instead of 16.3 grower pens.

• **Alternative**

If the piglets are put in groups of 10, then 36 grower pens will be needed.

• **Feeding system**

Ad lib, growth meal is provided in self-feeders up to the age of 20 days. Spilling should be limited to the absolute minimum.

• **Refer to Figures 5.10A and 5.10B, Figures 5.11A and 5.11B and Figures 5.12A and 5.12B for general information on grower housing.**

6.9 **Facilities for finishers**

• **Management system**

Piglets are kept in their relevant groups of ±20 up to the age of 120 days. After they have been weighed at the age of 120 days, the piglets are put in groups of ±10 according to their weight and moved to finishing pens. If the little boars are not castrated, the groups should not be made up according to weight, but according to sex. The groups of finishers will therefore consist of eight to ten per group, depending on the percentage of pigs that is marketed at the growth stage of 45 kg.

• **Needed**

Facilities to house \[104 \times 2 = 208\] groups of eight to ten piglets each per year.

Number of groups per finishing pen per year:

\[ 365 \div 67 = 5.4 \text{ groups per pen} \]
Number of finishing pens required:
\[ 208 \div 5.4 = 38.5 \text{ pens} \]

**PLEASE NOTE:** Make provision for 42 finishing pens plus the four pens needed for gilts as discussed, therefore a total of 46 finishing pens.

- **Feeding system**

  From the age of 120 days up to the age of marketing, limited feed is given in troughs.

  - Figures 5.13A and 5.13B and Figures 5.14A and 5.14B show plans for general finisher housing.

6.10 **Additional needs**

Besides the needs mentioned above, provision also has to be made for the following:

- Storing space for hay, bags, fodder, feed mixing, etc.
- Office and other facilities
- Workshop
- A foot dip or washing area where the pigs can be scrubbed and disinfected and where their feet can be treated.
- Washing and toilet facilities for workers.

6.11 **Special equipment**

- **Drinking water nipples:** 12 mm nipples for large pigs, 178 per 100-sow unit
  6 mm nipples for piglets, 44 per 100-sow unit

- **Farrowing crates:** 30 per 100-sow unit

- **Shallow feeding bowls for piglets from the age of seven days to 35 days in the farrowing area,** that is 30 per 100-sow unit.
  
  **Measurements:**
  - Depth – 60 mm
  - Length – 300 mm
  - Width – 150 mm

- **Self-feeders for weaner pens:** 14 per 100-sow unit

**PLEASE NOTE:** Self-feeders serve as dividing wall between the sleep area and the feeding passage.

- **Covers over sleeping area for weaner pens:** 14 per 100-sow unit

- **Self-feeders for grower pens:** 18 per 100-sow unit
• Reliable scales: For finishers – one scale
  For growers – one scale

• High-pressure pump for water hose: One pump

• Infrared heaters: 30 per 100-sow unit

• Feed trolleys: 6 trolleys

• Garden hose: 1 per building

• Foot dip for visitors at entrance to the unit

PLEASE NOTE: Effective production and management not only depend on optimal housing, but also on a breeding policy scientifically planned in advance, and the keeping of an effective record system.

Table 6.1: Housing requirements for a 100-sow unit if some of the production assumptions mentioned are changed

<table>
<thead>
<tr>
<th>Type of pen</th>
<th>Standard</th>
<th>Alternative 1 (Change 1)</th>
<th>Alternative 2 (Change 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Needs as calculated in the preceding discussion.</td>
<td>Litters are housed separately until they are marketed.</td>
<td>Sows have only two litters per year and 20% of the young die before weaning. Piglets divided into groups of 20.</td>
</tr>
<tr>
<td>Boar pens</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Sow pens</td>
<td>24</td>
<td>24</td>
<td>20*</td>
</tr>
<tr>
<td>Gilt pens</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Standing places for pregnant sows</td>
<td>50</td>
<td>50</td>
<td>56*</td>
</tr>
<tr>
<td>Farrowing crates</td>
<td>30</td>
<td>30</td>
<td>26*</td>
</tr>
<tr>
<td>Follow-up pens</td>
<td>14</td>
<td>28*</td>
<td>10*</td>
</tr>
<tr>
<td>Grower pens</td>
<td>18</td>
<td>36*</td>
<td>14*</td>
</tr>
<tr>
<td>Finishing pens</td>
<td>42</td>
<td>46*</td>
<td>32*</td>
</tr>
</tbody>
</table>

*Deviations from the norm
CHAPTER 7

7. HEALTH ASPECTS IN INTENSIVE PIG PRODUCTION UNITS

7.1 General

Diseases in pigs can be divided into two categories:

- Specific infections and/or contagious diseases brought into the unit, or already present in a latent form.
- Secondary health problems, which develop or are promoted by environmental factors, and therefore more dependent on management and housing.

The following factors are important in any intensive pig production unit.

7.1.1 Quarantine facilities

This is necessary for the housing of animals brought into the unit from outside. Simple pens some distance from the main unit are usually adequate. They have a variety of functions, namely:

- Isolation and observation
- Adapting to climate
- Preventative health management, such as immunisation, medication, de-worming and treatment against scab.
- Controlled exposure to organisms present in the herd.

A period of four to six weeks in quarantine is usually sufficient.

7.1.2 Security fencing and visitors

Nobody should be able or allowed to enter and walk around a pig production unit at will. Facilities should be of such a nature that visitors are compelled to first announce themselves at a clearly designated office where they may be provided with protective clothing and water boots. The risk of spreading disease will be limited, or hopefully eliminated, in this way.

7.1.3 Transport

It is preferable that no delivery vehicle should drive around inside the security fence. Provision has to be made, for instance in the case of feed deliveries, to deposit deliveries in storage tanks which are placed on the border of the fence.

If vehicles have to enter the area, it is important to provide a dip-tank filled with disinfectant to drive through. Shoes also have to be disinfected.
7.1.4 **Storage facilities**

This applies to especially feed and bedding. Tanks or silos for the storage of feed should be scrutinized to ensure that both the cover and the joints are watertight. Damp feed with resulting mouldiness can cause great stock losses. Facilities for storing bedding are essential, as damp or soiled bedding can cause health problems.

7.1.5 **Water supply**

Depending on the source and the extent of the contamination of the water, provisions for the purification of water have to be made, especially for the farrowing and weaner houses. It may sometimes also be necessary to use water for dosing individual groups in specific buildings as treatment against certain diseases.

7.1.6 **Insulation**

Maintaining optimal temperatures is always important, especially in the farrowing, weaning and servicing areas. Roof insulation has to be considered for this purpose.

7.1.7 **Subdividing of buildings and health**

This is specifically important in the case of breathing ailments, a problem which tends to increase as the size of the unit increases. On principle, the all-in-all-out system should be considered for the farrowing stage, and for four to six weeks thereafter. Please consult a veterinary advisor in this regard.

7.1.8 **Drainage and health**

It is advisable to drain all pens individually, that is to ensure that the flow-off of one pen does not flow into another pen.

7.1.9 **Foot dip**

This should be built at a convenient spot close to the servicing and dry sow buildings. A place to wash and dip the sows before they are transferred to the farrowing house should also be provided.

7.1.10 **Cooling**

Fridge facilities are essential for storing vaccines and medicines, as well as material for laboratory research.

7.1.11 **Destroying dead animals**

The carcasses should preferably be buried. They should not be dumped on the dung-heap where they are exposed to flies which in turn will spread disease (refer to paragraph 8.4).
7.1.12 **Herd immunity**

Pens should be made available for young breeding animals where they can be grouped together for an immunisation programme before they mate. This initiation is becoming increasingly more important, especially with the current trend to house a large percentage of the breeding herd individually.

7.1.13 **Conclusion**

To conclude, the breeder should remember that control of the environment has become more critical in modern housing, and that serious stock losses can occur if control of the climate is inadequate. The positioning of doors and windows in relation to the time of day, the temperature and prevailing wind and climatic conditions for the time of year, are aspects that should be considered.

In older type housing, the animals could choose where they wanted to lie, something which has become impossible in modern housing designs.

The foregoing information has shown that pig housing is an intricate subject, which necessitates close liaison with available consulting services, such as agricultural engineers, animal experts and veterinarians.
CHAPTER 8

8. THE HANDLING OF WASTE IN INTENSIVE PIG PRODUCTION UNITS

When a factory complex is built, a strategy is always devised to handle its waste or by-products in such a way that it can be put to use, or to treat it in such a way that it does not become a nuisance. The same principle should apply when planning and building a pig production unit, because the removal of manure forms an integral part of the activities in such a unit. Steps should be taken to combat problems associated with waste products. At the same time, the national and provincial health regulations have to be obeyed, while useful applications of the waste material should be investigated.

8.1 The value of waste

The amount of waste produced by a 100-sow production unit has the same pollution potential as a town with 2800 inhabitants. A 100-sow unit which markets say 20 piglets per sow per year, will produce about 1710 tons of undiluted waste per year. Add to this, the above-mentioned waste of washing water, and the total annual waste production of a 100-sow unit could exceed 6000 tons.

The undiluted daily excrement as percentage of the pig’s body weight is on average 7.2%. Therefore, a pig which weighs 60 kg will produce on average 4.3 kg undiluted manure per day. It is difficult to determine the real net value of the waste, because it differs from region to region. It also depends on the demand for waste products and the availability of nearby farmlands where its nutritional value for plants can be put to proper use. To illustrate its value, it can be mentioned that the net annual income from manure produced by a 100-sow unit, with due consideration to losses during application and whether it is applied correctly, is the same as the income derived from the sale of 100 baconers. Table 8.1 shows the approximate amounts of manure and liquid manure produced by pigs during the various production stages.

8.2 Positioning of new units

The following considerations are important, regardless of which method is used, to handle manure:

- The prevailing wind direction in relation to residences.
- The proximity of water sources that can be polluted by the flow-off from the unit.
- The availability of a suitable site for erecting a manure handling system.
- The gradient of the site, which should be flat enough for a building, but steep enough to ensure proper drainage.
- The availability of sufficient water encourages proper cleaning.
Table 8.1: Expected amount of dung and urine, as well as the total amount of liquid manure produced per pig during the various production stages

<table>
<thead>
<tr>
<th>Production stage</th>
<th>Manure and urine per pig per day (litre)</th>
<th>Total storage space needed for liquid manure per pig per day (litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant sow</td>
<td>11,5</td>
<td>16,1</td>
</tr>
<tr>
<td>Lactating sow weaning at 5-6 weeks Piglets</td>
<td>20,5</td>
<td>28,7</td>
</tr>
<tr>
<td>4 kg to 11 kg (3-4 weeks)</td>
<td>1,1</td>
<td>1,5</td>
</tr>
<tr>
<td>11 kg to 22 kg (6-9 weeks)</td>
<td>2,3</td>
<td>3,5</td>
</tr>
<tr>
<td>Growers</td>
<td>3,4 to 5,1</td>
<td>4,8 to 7,4</td>
</tr>
<tr>
<td>22 kg to 57 kg (9-16 weeks)</td>
<td>7,4 to 9,1</td>
<td>10,4 to 12,7</td>
</tr>
<tr>
<td>57 kg to 91 kg (16-22 weeks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average for growers (22 kg to 91 kg)</td>
<td>7,0</td>
<td>9,8</td>
</tr>
<tr>
<td>Dry feeding</td>
<td>12,0</td>
<td>16,8</td>
</tr>
<tr>
<td>Wet feeding</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.3 Methods for handling waste

8.3.1 Handling of solid manure

The handling of solid manure, that is to say manure and bedding, requires a lot of labour. The following are usually needed:

- Solid concrete floors inside the building where bedding can be placed. The floor should have enough of a slope (1:50 to 1:100) to allow the drainage of urine to one side of the building. An opening is usually provided in the outer walls of the buildings to allow urine and spilled drinking water to drain into a canal parallel to the long side of the building.

- There should be a large enough concrete floor outside the building where the mixture of manure and bedding can be scattered for long-term storage or composting. Provision should also be made to catch the drainage in a storage tank from where it can be applied directly to farmlands.

- Front-end loaders or other machinery to transport, mix and turn the manure.

- Different types of scrapers pulled by a chain or cable, or mounted to a tractor.

Storage of the manure should be done without causing a nuisance. There should also be possibilities for partial or full treatment while the manure is being stored.

The solid manure, which is usually mixed with some bedding, can be stacked in wind-rows. It should be constructed and positioned to allow water to drain from the wind-row, without collecting effluent water. Treatment of solid manure, which is being stored for long periods, is essential to avoid the nuisance of stench and flies. The cheapest method to treat manure is by means of composting. This is a process through which the organic material is converted to a stable humus by aerobic bacteria. Aerobic bacteria need oxygen to survive, and oxygen has to be provided in the form of air, or else anaerobic wasting will take place, resulting in bad smells and the development of harmful gases. The most common method to aerate the material is to regularly turn the wind-row, or to blow air mechanically through the wind-row by means of a centrifugal fan.
8.3.2 Handling of liquid manure

Liquid manure is a combination of all the excreta of the pigs and the water coming form leaking drinking nipples, flushing water for floors and water used for flushing other areas. The handling of liquid manure is preferred for one or more of the following reasons:

- It is less labour intensive than the handling of solid manure.
- No bedding material is needed.
- Flies do not breed in liquid manure.
- Slatted floors limit direct contact between animals and their manure, and in this way, contact with pathogens is limited.
- Wasted manure water from lagoons can be recycled for cleaning purposes. In this way, fresh water can be saved.
- Aerated and odourless liquid manure with a low viscosity can be recycled as flushing water, thus also saving water.

Liquid manure can be handled by:

- Deep storage channels under slatted floors, which are seldom emptied.
- Shallow channels under slatted floors, which are regularly flushed clean.
- Open channels, which are flushed clean regularly.
- Wide concrete alleys, which are regularly flushed clean.

Auxiliary facilities include the following:

- Flushing tanks of different designs
- Pumps, agitators and pipes
- Equipment for separating solids
- A lagoon to accumulate liquid manure before application to farmlands

8.3.3 Slatted floors

The development of slatted floors, whether covering part of the pen or the whole pen, has made the handling of liquid manure possible. Slatted floors leave the pens dry and relatively clean and require less labour.

Concrete slats are the most common and durable kind, but they also are the heaviest, demanding sturdy support. The recommended spacing between concrete slats for all buildings in a piggery, excluding the farrowing pens, is 20 mm for slats with a width of between 75 mm and 100 mm. Wooden slats disintegrate, bend and are chewed by the pigs, leading to uneven spacing between the slats. These are not recommended. Round metal rods, alternated with flat rods, are preferred for using in farrowing houses. Spacings of 10 mm are recommended. This is to prevent the feet of piglets from slipping through the rods and getting stuck. High quality plastic slats may also be used. They come in separate slabs, which are fitted into each other, making replacement easier. Examples of the kinds of slats most often used in piggeries are shown in Figure 8.1.
Figure 8.1: Examples of slats

Slatted floors with collecting channels underneath are very expensive. When selecting a floor plan, the habits of the animals have to be taken into consideration to avoid contact between the animal and his manure. This can be done as follows:

- Feeding places have to be far away from the manure accumulation areas to prevent contamination of the feed.
- Drinking places must be put over the slatted area because animals tend to urinate while they drink.
- The partitions that enable animals in adjoining pens to communicate have to be placed over the slatted area because pigs defecate and urinate while communicating.

Pigs such as growers and finishers are usually messy, but dry sows are not. In the case of growers and finishers, which also by far produce most of the manure in a piggery, it is recommended to cover the total floor area, or at least two thirds of the floor, with slats (refer to Figures 5.10 to 5.14). For gilt, dry sow, boar and weaner pens, a slatted area over a one-meter wide channel will be sufficient. Expanded metal floors are not recommended because they may damage the feet and nipples of the animals. Untreated aluminium bars are also not recommended because of possible corrosion damage.

8.3.4 Deep channel storage systems

The deep manure channel (about 1.0 m deep) underneath slatted floors serves as a storage tank with a storage capacity of between one and three months. The channel is
first filled with water up to a depth of about 70 mm to prevent flies from breeding in
the initially semi-solid manure. Manure from the slatted floors, plus the urine and
spilled drinking water fill the channel. The manure slurry should not be allowed to
get deeper than 200 mm underneath the slats. The manure and slurry volume can be
assumed to be about 1.5 m³ to 2.0 m³ per month per sow unit, that is 10 pigs of 60 kg
each.

To make proper use of the deep channel storage volume, unnecessary dilution of the
slurry, by for instance leaking drinking nipples, should be avoided. A serious
disadvantage of the system is that solids tend to build up on the bottom of the
channel. This leads to the build-up of toxic gases and gases with an unpleasant odour,
which may have a negative influence on the performance of the animals. When large
volumes of slurry are moved, for instance, when manure is being dumped, toxic and
suffocating gases may be released. These include sulphuretted hydrogen (H₂S),
methane (CH₄) and carbon monoxide (CO), caused by the anaerobic decomposing of
organic material. A sudden release of a large volume of toxic gases can even cause
the animals to die. For this reason, buildings have to be ventilated properly,
especially when the deep channel is being emptied. It has become obvious from
experience that the deep channel storage system is not recommended for Southern
Africa.

8.3.5 **Shallow channel and open channel manure removal systems**

Shallow channel and open channel systems are very common in piggeries. The
shallow channel system, with flushing underneath the slatted floor, is recommended
for all buildings. There is no build-up of toxic gases or gases with an unpleasant
odour, because the diluted slurry, which is created in this way, can be flushed to a
tank outside the building. The width of the manure channel is usually standardised on
between 800 mm and 1 200 mm to correspond with the standard width of concrete
slats.

The main disadvantage of flushing open channels and shallow channels is that they
require large amounts of water. The amount of fresh water used can, however, be
drastically cut by re-using the slurry, or by using aerated manure with a low flood
resistance as flushing medium.

Channel dividers are needed on wide channels to prevent the flushing water from
flowing around solid manure, especially at the bottom end of the building where flow
rates decrease in any case. Channels with a width of up to 1,0 m do not need dividers,
but one or more dividers are necessary for channels of 1,0 m to 3,0 m wide (see
Figure 8.2).
Experience has shown that when a slope of one to two percent is used together with a smooth channel floor, the channel should not be less than 40 m long. This will ensure that the flushing water moves fast enough to clean effectively. The length of the building can, however, be doubled by using a centrally situated cross-channel for receiving the flushing water from the bottom of each building.

When a slope of one to two percent is used, a channel floor with built-in cross-lips, as shown in Figure 8.4, will maintain a liquid level, which will prevent manure from getting stuck to the concrete. Local experience has taught that channels of up to 80 m long can be flushed effectively if they have built-in cross-lips (see Figure 8.4).
If the building has a horizontal channel with no slope, a cross-lip of 150 mm across the discharge end of the flat channel floor will at all times maintain a corresponding water level in the channel. This water will prevent manure from sticking to the dry concrete floor between flushings (see Figure 8.5). A low water level can also be obtained by installing a weir at the discharge end. Good results can be obtained by building 300 mm deep channels absolutely level without any cross-lips over a distance of 35 m. Construction of these channels is also much easier.

A possible alternative is to use the open channel system in grower and finisher buildings. A potential problem is the spreading of disease and the transmission of antibiotics. The open channel system allows animal’s direct contact with the flushing water and is therefore not recommended for working sows and working sow units. When the animals lie in the open channel while it is being flushed, their skins get wet, offering a cheap and simple way of evaporation cooling. In this way, the summer performance of animals can be improved.

Open concrete channels of one meter wide, 50 mm to 100 mm deep, with a slope of one to two percent on the long side of the building, drain towards a cross channel alongside the building and from there to a lagoon (see Figure 8.6).
8.3.6 **Flush systems**

Flush systems for manure removal are classified as:

- Flush tanks with a sluice gate or valve discharge
- Tipping tanks
- Siphon tanks, above the ground or at ground level
- High volume pumps
- Continuous operating systems

The flushing tank with sluice gate or valve discharge is the most popular system because it is simple and easy to conduct. Details about flush tank designs are shown in Figures 8.7, 8.8 and 8.9.
The advantages of a flush tank are as follows:

- Building costs are low because the tank can be placed at ground level against one wall joined to the end wall of the building.
- A simple and inexpensive sluice gate may be used.
- The tank may be filled by means of an inexpensive low-powered pump.
- To prevent the tank from accidentally overflowing, a floater-control inlet may be installed as illustrated in Figure 8.9.
- Because of the large flushing volume, usually about 3,0 m³ per flushing, only one flushing per day or one every two days will be necessary.
The disadvantages of a flush tank with a sluice gate discharge are that:

- Although greasing will help, it is difficult to prevent the sluice gate from leaking when it is in use.
- Steel sluice gates with mechanical linkage are subject to corrosion.
- Manual labour is required to open the sluice gate for flushing.

A possible disadvantage of the flush tank with pipe discharge is that if the diameter of the pipe is too small, the discharge will be too slow to remove solid manure from the channel floor, especially at the bottom end of long buildings. This disadvantage can be overcome by means of built-in cross-lips, which will maintain a minimum liquid level in the channel (see Figure 8.4).

Tipping tanks are mainly used for small volume flushings, as at farrowing houses. Experience has shown that large tipping tanks are expensive to build and service. A typical tipping tank is shown in Figure 8.10.

The advantages of tipping tanks are that:

- The basin can be filled by means of an inexpensive low-power pump or tap.
- An automatic flushing action

The disadvantages are that:

- The size is almost limited to a content volume of 380 to 570 litres because more expensive bearings and axles are required to handle large volumes.
- Strenuous labour conditions are required for regular maintenance of bearings and
• Corrosion of metal construction materials can occur.
• It is impractical for long buildings due to the small volume discharge; the maximum recommended building length is 24 m.
• Open tank construction does not allow for a controlled release of flushing water in order to limit the flushing time to ten seconds.

8.4 Disposal of disease-infected carcasses

In the case of animals, which died because of notifiable diseases or is thought to have died because of one, the untouched carcasses must be disposed of by means of burning or incineration. If none of these are possible the relevant carcasses must be disposed of by burying them at least 1.8 m deep (in caustic lime, if possible), especially in case of large animals and rabid animals, or animals thought to have been infected by rabies. The carcasses of small animals or the remains of burnt or incinerated carcasses must be buried at least 1.2 m deep.

Where manure is handled in solid form, another method is allowed, namely, to dispose carcasses suspected to have been contaminated in hot straw or manure heaps. The carcass decomposes quickly, within two to three days, because of the heat and bacterial activity. A danger to this method of carcass destruction is that pathogens can be spread by flies and other insects.

8.5 Structures and equipment for the handling of manure

8.5.1 Anaerobic storage lagoons

The purpose of a biologically active anaerobic lagoon is to serve as an odourless long-term reservoir for liquid manure. A lagoon system allows for great flexibility regarding timing for application to fields to relieve moisture stress in crops. The need for plant nutrients can be satisfied partially, depending on the time of application. Great savings can be made on repeated transport of liquid manure and applications to farmlands, because a lagoon only needs to be emptied once or twice per year, provided it has been designed and managed properly. Furthermore, lagoon water can be recirculated as flushing medium in handling systems for liquid manure, thereby saving on the use of fresh water.

Biologically active lagoons work better during summer than in winter. If the water temperature of a lagoon falls below 10 °C to 13 °C, the anaerobic conversion of organic material into methane gas and carbon dioxide will not take place on a practical scale.

It is not possible, however, for a biologically active anaerobic single or double lagoon, even during summer, to achieve the degree of purification to produce lagoon effluent clean enough to allow direct delivery into a public water body. In order to prevent pollution to streams, lagoons cannot be allowed to overflow, unless there is a protective stretch of grass of at least 100 m wide.

Problems experienced with improperly designed and mismanaged lagoons include bad odours, rapid slurry forming and the build-up of heavy metals in the lagoon...
8.5.1.1 **Single or double lagoons**

A second lagoon, smaller than the primary anaerobic lagoon, is generally recommended for intensive pig units which recirculate the lagoon liquid for channel flushing where pigs have direct access to flushing water. It is believed that the second lagoon will provide a certain degree of protection against disease-carrying organisms carried over from the first lagoon.

A second lagoon has the following advantages:

- When the primary lagoon is desludged from time to time, liquid manure inflow may continue into the second lagoon.
- Lagoon liquid from the secondary lagoon may be used to irrigate pastures, since toxic copper will concentrate in the slurry of the primary lagoon.

A secondary lagoon does not have to be of specific size, since the occurrence of bad odours will depend on the size of the primary lagoon.

8.5.1.2 **Design considerations for anaerobic lagoons**

**Location**

For the sake of convenience, the lagoon has to be adjacent to the piggery, or as close to it as is practically possible. It is also done to keep the cost of channels and pipes conveying the liquid manure to the lagoons as low as possible. Lagoons have to be at least 300 m from residential areas at a place where prevailing winds will carry bad odours away from houses.

**Soil and foundation**

Lagoons should be located on soils of low permeability, which seal quickly.

**Retention time**

Normal liquid manure and flushing water storage capacity should be enough for at least 90 days. In dry regions with high evaporation rates, the retention time may be longer than 200 days.

A lagoon has to be at least 2,0 m deep, but preferably even deeper. The lagoon can be deeper than 6,0 m to keep the surface area as small as possible in order to minimize bad odours, to keep evaporation losses and salt build-up as low as possible, to encourage mixing due to rising gases, to reduce land area requirements and to minimize temperature variations during winter time. A minimum of 0,6 m freeboard above the design water surface should be provided for.

**Lagoon volume, odour and nitrogen losses**

Anaerobic lagoons function well over a wide range of input loads up to a given
lagoon volume. Volume, rather than surface area, is the basis for anaerobic lagoon design. The possibility of bad odours and sludge build-up decreases as the lagoon capacity increases, but nitrogen losses will then increase. The criteria for the size of a lagoon, for reasons of minimizing bad odours and for reasons of conserving nitrogen, are therefore not compatible. If odour control is the main aim, for instance near residential areas, the lagoon volume per unit of body weight should be as large as possible. If nitrogen conservation is the main aim, the lagoon volume should be small.

Criteria for the size of an anaerobic single lagoon without removal of solids prior to loading are shown in Table 8.2.

Table 8.2: Sizing criteria for anaerobic single lagoons

<table>
<thead>
<tr>
<th>Lagoon volume m(^3) per kg body mass</th>
<th>N conservation</th>
<th>Average</th>
<th>Control of bad odours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>0,06</td>
<td>0,12</td>
<td>0,19</td>
</tr>
</tbody>
</table>

Local experience has taught that a volume of 0,07 m\(^3\)/kg body mass will be sufficient for single lagoons in piggeries without creating undue problems with bad odours, provided bedding is left out of it. With this value as guideline for South Africa, the recommended lagoon volume for a 100-sow unit = 1 000 standard pigs of 60 kg each
\[
= 60 000 \text{ kg body mass} \\
= 4 200 \text{ m}^3 \text{ or more.}
\]

**Sludge build-up**

Cellulose matter, such as straw, sawdust or woodchips, is not degraded by anaerobic bacteria as rapidly as fat, proteins or soluble carbohydrates. Bedding material and undigested cellulose may result in rapid sludge build-up, especially in overloaded lagoons. The expected lifespan (in years) of unseparated manure as inflow until the lagoon is half-filled with slurry is shown in Table 8.3.

Table 8.3: Expected lifespan of lagoon (in years)

<table>
<thead>
<tr>
<th>Year</th>
<th>Small, N conservation</th>
<th>Average</th>
<th>Large, odour control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>6,1</td>
<td>12,2</td>
<td>12,9</td>
</tr>
</tbody>
</table>

The removal of bedding and undigested cellulose from the lagoon inflow by means of screening or sedimentation is essential. It ensures a long, useful lagoon lifespan and prevents overloading of the available lagoon volume, which may result in bad odours.

**Embankment**

The minimum top width should be 1,5 m. The side slope on the dry side of the embankment should not be steeper than 2:1. The side slope of the wet side above the
design water level should be constructed in such a way as to meet the requirements for soil stability. Expert advice should be obtained. The top of the embankment after compacting should be at least 600 mm higher than the maximum design water level. Where overflow is allowed, an overflow with a minimum capacity of one and a half times the maximum daily inflow rate, 300 mm above the maximum design level, may be installed to protect the wall against overflowing due to rain showers or when the overflow regulation system is not working. When the wall has reached the desired height, it should be covered with topsoil, planted with grass and fenced off.

**Inlet and outlet**

The inlet and outlet of double lagoon systems should be located at opposite sides to prevent short-circuiting and under-utilisation of lagoon volumes by active bacteria. The inlet pipe of a lagoon should preferably discharge below the water surface level. The inlet, outlet and general construction of a lagoon system are illustrated in Figure 8.11.

![Figure 8.11: Double lagoon system](image)

Buried PVC or polyethylene piping may be used to convey manure to the lagoon because it will not be affected by the highly corrosive nature of manure. PVC or polyethylene pipes are also most suitable for recycling lagoon water. Pipes of 160 mm in diameter must be buried 300 mm to 600 mm underground to prevent damage and deterioration.
Pipes connecting two lagoons (double lagoon system) should be at least 100 mm in diameter. A disadvantage of pipes is that they can easily become blocked. For this reason, open concrete channels are often rather used to convey manure and water to the lagoon. The measurements of the channels depend on the volume of liquid manure that has to be conveyed. A disadvantage of open channels, which are not properly managed, is that canal flow can be impeded due to grass and weed growth over the sides of the channel.

Various configurations can be used to prevent floating solids from ending up in the second lagoon. Three of these are illustrated in Figures 8.12, 8.13 and 8.14. The inlet shown in Figure 8.12 should be about 300 mm below the outlet. The cleaning process can then easily be conducted from the outlet point at the second lagoon. The structure in Figure 8.13 uses a T-piece to prevent solids from entering. The bottom part of the “T” should be 300 mm beneath the water surface and the T-piece should be within 1,0 m from the wall for cleaning purposes. The third type consists of an impregnated timber baffle, nailed to an impregnated pole, which has been driven into the bank. The pipe slope of the latter two types should be about 1:1 00.

Figure 8.12: Lagoon overflow pipe with reversed slope

Figure 8.13: Overflow pipe with T-inlet baffle
Salinity

A large lagoon surface increases the evaporation rate and consequently also the salt content. When lagoon water is recycled to flush out the manure, the salt accumulates faster. A moderate increase in salinity stimulates biological activity. By allowing the salt concentration to increase beyond an electric conductivity value of between 800 mS/m and 1 000 mS/m (or between 8 mmhos/cm and 10 mmhos/cm), the bacterial activity decreases, bad odours get worse and rapid slurry accumulation is encouraged. In this way, the lifespan of the lagoon is shortened. The relation between biological activity and salt content in an anaerobic lagoon is shown in Figure 8.15.
**Start-up and operation**

A new lagoon has to be filled with water at least halfway to its design volume before manure is added. The water may be obtained from nearby pools, streams or tanks. Liquid manure should be added slowly at first and increased over a period of two to four months until the loading rate level for which it has been designed has been reached. It is preferable to start in warm weather rather than at the beginning of a cold season.

Anaerobic lagoons should be filled with manure at least once a day. Intermittent addition of manure with longer intervals can cause as bad an odour as when the pool is completely overloaded.

In areas where evaporation is high, the inflow should contain sufficient diluting water to maintain an electric conductivity of below 1 000 mS/m (or 10 mmhos/cm). Hydraulic flushing systems, which use fresh water usually, supply ample dilution. Where lagoon supernatant is recirculated to flush out the manure, dilution water must be added. The amount can be determined by measuring the conductivity.

Electric pumping systems should be adequately earthed to prevent electrostatic charges, which contribute to the build-up of salt deposits in pipes and pumps. This again lowers the pump efficiency, especially when the salt content of the lagoon has reached a critical level.

The pH of an anaerobic lagoon should be maintained between 6,8 and 7,8. Because the first phase of the anaerobic decomposition is acid forming, the pH can be reduced below 6,5 when the lagoon is overloaded or when the action of the methane forming bacteria is slowed down by disinfectants or antibiotics, causing bad odours. If the pH should drop below 6,8 hydrated lime should be added to the surface of the lagoon at a rate of 1,0 kg per 200 m² per day until a pH level of 7 has been reached.

A lagoon has to be pumped or emptied in such a way as to retain half of its volume (volume and not depth). Lagoons should never be pumped dry because a certain amount of bacteria should remain to degrade incoming manure. In dry climates, lagoons have to be partially refilled with fresh water after having been emptied to decrease the concentration of total inorganic dissolved solids.

**Removal of sludge**

Sludge has to be removed when the displacement effect of the slurry has reduced the liquid volume to below the required level for a stable bacterial population. Sludge build-up which takes up about half of the total lagoon volume, is possibly the maximum level allowed before bad odours occur.

The solid content of lagoon sludge usually varies between four and 10%, which represents a semi-liquid consistency. Concentrations of more than 20% in solid parts are, however, possible in well-compacted sludge.
A feasible method to remove sludge is to empty the lagoon first and to then dredge it clean by means of a dragline. If the lagoon bottom is solid, a tractor with a front-end loader or scraper blade may be used. This method is quite expensive.

A more practical method is to partially empty the lagoon, to agitate the sludge, and then to pump the slurry mixture in a liquid manure spreader.

A third alternative is to agitate the whole of the lagoon contents, without emptying it first, and to then pump the diluted sludge mixture through a large-bore sprinkler irrigation system onto the farm-land. A long-shaft propeller agitator or a liquid manure chopper agitator may be suitable.

Phosphorus, copper and zinc are concentrated in lagoon sludge. The sludge layer contains:

- 20% to 40% of the nitrogen
- 60% to 80% of the phosphorus
- 10% to 30% of the potassium
- 60% to 80% of the copper
- 70% to 90% of the zinc of the total lagoon constituents

When the dredged-out sludge is applied to farmlands, the high copper and zinc contents should be kept in mind. The direct distribution of metal rich sludge on pastures should be avoided to prevent sensitive animals such as sheep or calves from contracting copper poisoning. A soil and irrigation expert should be consulted.

8.5.2 Manure storage tanks and agitators

An alternative method of storing manure is the use of a concrete manure tank (Figure 8.16). Depending on the specific situation, a single or double manure tank system or a manure tank together with a lagoon may be used. In any case, the manure tank will serve as a reservoir for liquid manure coming from the pigpens. The volume of the tank is calculated according to the duration the liquid manure is to be stored (usually no longer than seven days).

If a small number of pigs (up to 750 at an average weight of 90 kg each) are kept, a single or double manure tank system may be used. In cases where liquid manure is not going to be used for irrigation, but simply pumped over the soil or into a liquid manure tanker, a single manure tank with agitator will be sufficient. If irrigation is to be applied, however, most of the solid parts will first have to be separated from the water. The site layout and type of separator (paragraph 8.5.3) will confirm whether liquid manure can be conveyed straight from the unit over the manure separator into the manure tank, or whether it should first flow into a storage tank with an agitator before it is pumped over the manure separator to the second tank. Alternatively, liquid manure, separated or unseparated, can be collected into a manure tank and then pumped to a lagoon.

The function of the agitator or agitators (depending on the measurements of the tank) is to bring the water and solid parts into suspension before these are being pumped. It is essential to prevent the manure tank from silting up and/or the pump from not
operating effectively. Depending on the volume of the manure tank and the diameter of the area covered by the agitator, it may be necessary to use two agitators with a communal propeller motor. An old differentiating shaft or right-angled propelling may be used for operating the agitators. A three-phased 2.0 kW to 3.0 kW electrical motor operates the agitator by means of V-belts and universal joints.

Figure 8.16: Single manure storage tank and agitator
As mentioned before, the volume of the manure tank depends directly on the period the manure and liquid manure have to be stored before being pumped out. The maximum depth required for proper functioning of the tank and agitators is 3,0 m. However, a freeboard depth of at least 500 mm has to be allowed. The sidewalls and bottom of the tank should be at least 230 mm thick and constructed of reinforced concrete or a double brick wall in order to ensure sturdiness and stability. All metal parts of the agitators should be painted with paint that will protect the steel against corrosion.

Liquid manure can be carried to the manure tank by means of underground pipelines or open concrete channels. Make use of submersible pumps, centrifugal pumps with open or half-open impellers, which are suitable to pump separated or unseparated liquid manure effectively.

8.5.3 **Structures and equipment for separating solid manure**

For practical reasons, it is strongly recommended that bedding and undigested cellulose are removed from pig excreta prior to storing liquid manure in a lagoon, or prior to applying it to farmlands by sprinkler.

Non-mechanical structures such as small settling ponds, or barriers across a natural depression made of railway sleepers or straight wooden beams or bales of hay, can be used effectively and require almost no maintenance. Where sleeper or beam constructions are erected, it is advisable to leave gaps of about 25 mm through which liquid can seep. Examples of sleeper walls across a man-made settling basin and across a natural depression are shown in Figure 8.17.

Mechanical equipment that does not require much supervision and maintenance includes the static horizontal bar or wedge-wire screens, certain types of vibrating screens and the rotatory brush screen. The solid parts that are removed are usually dry enough to be handled by scrapers. Collected solids may be processed further by composting.

The static horizontal bar, or wedge-wire screen, has the advantage that it has no moving parts and that variations in flow rate do not seriously affect the performance. Though the initial costs are high, it is inexpensive to operate. It is one of the most popular devices for screening liquid pig manure (Figure 8.18).

Screen openings of between 0,5 mm to 1,0 mm are usually the best for handling pig slurry. A loading rate of about 12,5 ℓ/s or 750 ℓ/min per metre of screen width is recommended. A manual or automatic pump is used to load the screen.

Vibrating screens (Figure 8.19) are available as circular or rectangular models made of woven fabric or stainless steel mesh. Mesh sizes can be ordered to suit different types of slurry. Power is supplied by one or two three-phased vibrator motors with a total rating of 0,25 kW to 0,4 W.

As in the case of static inclined bar screens, vibrating screens are relatively simple to install and operate. However, the maintenance cost on some of the models may be high.
Figure 8.17: Sleeper wall across man-made settling pond

Figure 8.18: Static horizontal bar or wedge-wire screen

Both the static and the vibrating screens are best suited for diluted slurry. With thick slurry, both screens tend to become overloaded, with the result that less slurry flows through and that solids are wet. Thick slurry can still be diluted.
A problem often encountered with wedge-wire and vibrating screens is the build-up of bacterial slime, which causes the openings between the wires to become blocked. A successful method to combat the problem is to wash the screens with a chlorine-free slimicide. The process takes about ten minutes. Chlorine attacks stainless steel, especially on welding seams.

A third and popular type of mechanical manure separator is the roller brush separator. It is a circular drum consisting of a steel screen with openings of between 0.5 mm and 0.1 mm, mounted at an angle and slowly rotated by an electric motor. Liquid manure and solids flow from the unit over the separator. The water falls through the screen openings, while the solids slowly move out as the drum rotates.

### 8.5.4 Pumps for handling liquid manure

Pumps for handling manure slurry are classified as follows:

<table>
<thead>
<tr>
<th>Pumps suitable mainly for low viscosity manure slurry and lagoon supernatant:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Open vane and semi-enclosed surface mounted impeller pumps</td>
</tr>
<tr>
<td>• Submersible centrifugal pumps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pumps suitable mainly for high viscosity semi-liquid manure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Helical scroll and stator pumps</td>
</tr>
<tr>
<td>• Auger pumps</td>
</tr>
</tbody>
</table>

### 8.5.5 Manure spreaders and sprinklers and the use and application of manure

There is a difference between solid manure spreaders and distribution equipment for liquid manure. Solid manure spreaders with rear delivery or side delivery offer a practical method to distribute solid manure evenly over farmlands. The disadvantage of this type of spreader is that it requires high labour costs. Soil compaction by wheels, as well as traction problems on wet soil, is a common occurrence.
Liquid manure slurry is handled with tank spreaders. The liquid manure can be applied by:

- Ejection over a deflection plate
- Sideways ejection, which is suitable for sloping terrain
- Slurry injectors which are drawn behind the tanker

All liquid manure tankers have the same disadvantages than the solid manure spreaders.

The most common method to distribute diluted slurry is by means of a pipeline and big gun sprinklers. Where solid manure has been separated, ordinary irrigation sprinklers can be used. Pipes can either be laid on the surface or buried.

Animal manure can be applied and utilized in the following ways:

- Farmland application – manure as a source of essential plant nutrients and organic material
- Composting of excreted solids and manure
- Incorporation into animal feed rations
- Utilisation in aquaculture
- Production of biogas
CHAPTER 9

9. TRANSPORTATION OF PIGS

Large sums of money are lost every year due to bruising and especially deaths during the loading, unloading and transportation of pigs. It is therefore essential that pigs reach their destination as healthily and as speedily as possible, and with the least amount of stress. To achieve this goal, it is important to be informed about the various aspects, which may influence the loading, unloading and transportation of pigs.

9.1 Animal behaviour

Because of a pig’s wide visual field and poor observation of depth of field, it is extremely sensitive to changes in the brightness of light. For this reason, contrasts between light and darkness, such as shadows at loading and unloading facilities, should be avoided.

Loading ramps should be positioned north/south to prevent pigs from looking into the sun while they are loaded. This also implies that loading should be done early or late in the day.

Curved loading ramp passages with solid walls are more effective than straight ones. The reason for this is that pigs only notice the vehicle after they have advanced far onto the loading ramp.

9.2 Stress

Some pigs are genetically predisposed to stress, which poses one of the biggest problems in the transportation of pigs. Pigs that show signs of stress during transportation should be allowed to rest, otherwise they may die. Symptoms of stress are suddenly lying down, panting, trembling and red blotches on the skin. However, some pigs have genetically engineered low stress levels.

Exhaust fumes of diesel vehicles have a detrimental effect on pigs.

Stress due to high ambient temperatures is one of the main causes of death during transportation. Pigs should not be transported if the ambient temperature is higher than 26.5°C. If it cannot be avoided, the pigs should be cooled by means of a sprinkler system. The graph below (Figure 9.1) illustrates the combined influence of temperature and humidity on porcine stress.
Figure 9.1: Influence of temperature and humidity on porcine stress

It is obvious that pigs should under no circumstance be transported when the combined influence of temperature and humidity registers a reading in the region of “dangerous” or “emergency”. Furthermore, the truck should be well ventilated on hot days. Stopping should be limited to the absolute minimum. Any vehicle can break down, however, and it is therefore important to make provision for shade. A roll of shade cloth kept on the vehicle at all times will save a lot of money in the long run.

9.3 Loading facilities

Pigs should be loaded in such a way as to prevent injuries.

Use a ramp not steeper than 25° (slope of 1:2.2) and as near as possible to the level of the truck to enable the pigs to safely step up and down. Steps of 100 mm × 300 mm work better than a relatively steep ramp.

The rails on the ramp must be high and strong enough to prevent a pig from breaking through. There should also be no gaps between the rails of the ramp and those of the vehicle.

9.4 Floor construction of the vehicle

A floor area of between 0.2 m² and 0.3 m² should be allowed for porkers, and between 0.3 m² and 0.4 m² for baconers.

The floor should be solid, impenetrable and slip-free, while allowing for proper drainage. The use of grids on the floor reduces the number of deaths, but increases the number that will lie down. In other words, the possibility of bruising increases because those that lie down can be trampled.

The use of diagonal partitions will reduce the number of deaths during transportation. It has the advantage that the recommended floor area per pig is still allowed, even when the vehicle is not carrying a full load.

With the use of double-deck vehicles the height between the decks should be at least 0.75 to 1.0 m. Proper ventilation and escape outlets for all gases should be provided.
The rails or panels should not cause bruising, injuries or fractures. The height of the rails must prevent pigs from falling or jumping out. A height of about 1.0 m is recommended for rails.

Pigs kept in confinement are not used to exercise and should not be chased up the loading ramp, because it will increase their heartbeat. Pigs are then inclined to lie down to allow the heart rate to return to safe levels.

Never throw water on a pig that has collapsed. It may experience shock and die. Rather wet the area around the pig and allow it to cool through evaporation.

Also never use an electric prod on pigs. The shock will increase the heartbeat, which may give the pig a heart attack and cause him to die.

The driver of the vehicle should be trained to handle the pigs with care. He should be able to drive properly, to pull away smoothly and to slowly drive around corners.

Pigs seldom fight during transportation. In any case, pigs that are familiar with one another should be kept together at the abattoir. This will minimise down-gradings due to injuries caused by fighting. Prime cuts are always the first to be bruised during fights.

Be patient and use common sense when transporting pigs.
CHAPTER 10

10. **PROPOSED LAYOUT OF BUILDINGS FOR A 100-SOW PRODUCTION UNIT**

10.1 **General considerations**

The layout of piggeries should be planned in such a way that it facilitates the supervision and management of the various breeding and growth stages. The proposed layout (Figure 10.1) includes the most important basic principles. Though these can be adapted to the specific needs of individual breeding farms, it is advisable to stick to them as closely as possible.

The following should be kept in mind:

- In most regions in South Africa, a north-facing building is advisable for maximum utilisation of air and heat. A north-facing position will also facilitate natural ventilation – a practical consideration in our warm climate. Buildings with flat roofs should be positioned with the low side of the roof towards the north. If it is not possible, a deviation of 45° towards the east or west of due north will nonetheless ensure good natural ventilation. The situation could be different in other areas due to prevailing wind directions.
- The site should be well-drained with slopes of between 2,0% and 4,0%.
- The prevailing winds should be studied for purposes of controlling bad odours. Care should especially be taken to ensure that the smell does not become a nuisance to neighbouring houses and properties. Waste treatment installations should be at least 100 m to 300 m away from neighbouring properties.
- The layout of buildings should be such that it allows for a logical flow of pigs during all the different growth and breeding stages. The positioning of facilities on the other hand should also accommodate these requirements.
- Sufficient clean water is essential.
- Reliable electricity supply, especially to the farrowing pens, is essential. If the electricity supply is not reliable, alternative methods to heat the creeper pens should be investigated.
- The easy movement of pigs between buildings and pens should be possible.
- The distribution of feed should be simple and efficient.

10.2 **Disease control**

Because of the management importance of disease control, the layout of the piggery should be designed with this in mind. Visiting pig breeders, sales representatives and delivery vehicles, which move from one piggery to the next, pose the greatest danger in the spreading of disease. To eliminate infection through these sources, the following precautions can be built into the layout:

- The piggery should be surrounded by a security fence. Admission should only be possible through the office of the manager or through the main gate, which is always locked.
• Feed is delivered from outside into the feed silo, which is built into the fence, or into feed tanks, which are filled from outside by means of an air-pressure or an auger pump.
• Pigs are moved into or out of the piggery by means of a loading ramp opposite the finishing building. Vehicles should load and unload from outside the security fence. A sterilising foot dip should possibly be placed in the passage prior to the loading ramp to allow incoming animals to first walk through the bath on their way to the quarantine quarters or housing facilities.
• Visitors should park outside the fence near the office. They should enter the reception area through a separate entrance from where they can communicate with the manager over a counter. A bathroom with wash, shower and toilet facilities should lead from the reception area. Visitors should be supplied with sterilised overalls, boots and headgear. A sterilising foot dip should be installed at the back door of the bathroom. The back door should be locked to limit visitors to the reception area until they are allowed into the unit.

10.3 Layout of buildings

The layout of buildings should be such to allow for a logical flow from the top to the bottom of the piggery unit. While there is a continuous flow of sows between the dry sow quarters, the service quarters and the farrowing quarters, the buildings are placed downhill in this order. The following two buildings, that are the weaner and grower pens, are placed on the same terrace close to each other. From the grower building a separate fenced passage leads to a point between the finishing buildings lower down.

10.4 Supervision

The office should be situated directly opposite the buildings where the service and farrowing pens are because they require the most supervision. Most of the buildings, as well as the feed and herding passages, should be visible from the office.

10.5 Feed and herding passages

The fenced passages, which run along the ends of the buildings, can be used to distribute feed to all the buildings, or to herd the pigs from one building to the next, as necessary. Gates that are long enough to close off the passage are installed where needed. The gates are left open against the passage wall when they are not in use.

10.6 Choice of building

The building plans provide for alternative types of buildings for weaners and growers. Small changes to the size and arrangement of the layout are inevitable, depending on the choice of building plans, but the sequence of the buildings should not be changed.

10.7 Distance between buildings

Because the buildings depend on natural ventilation, the distance between the buildings should be made larger. The distances can also give added protection in the case of fire. With proper planning of the gardens in the open areas, the usually boring
surroundings can be made attractive.

10.8 **Workshop/machinery parking**

A workshop can be placed in the bottom corner of the unit where there is enough space to park and turn machinery.

10.9 **Manure handling and storage system**

It is suggested that these facilities are put outside the unit. All down-flow channels and pipes work with gravity and lead to the waste handling system. An entrance gate for operators should be provided in the fence close-by.

10.10 **Future expansion**

Provision for future expansions is imperative, even if the possibilities seem remote. Provision has been made for an additional 100-sow unit in the plan layout (Figure 10.1). The road for tractors and trailers around the 100-sow unit is necessary to eliminate problems with turning. The road is adapted as indicated for the second unit. Further expansion can be done either on the other side of the second unit or on the other side of the road opposite the side fence of the office, or even above the existing unit.
Figure 10.1: Proposed building layout for a 100-sow unit
APPENDIX A

NO-FINES CONCRETE FLOORS

No-fines concrete is concrete composed of only coarse aggregate, cement and water. No-fine aggregate or sand is used. Furthermore, the cement and water mixture is sufficient to coat the stone particles, so that they stick together at the points of contact. The spaces that are created between the stones are then equally distributed. To differentiate between no-fines and normal concrete, the latter is called dense concrete.

No-fines concrete is much lighter than dense concrete (about 1 500 kg/m³ compared to 2 400 kg/m³ for normal concrete with stone and sand) and much weaker. Even so, it is strong enough for all types of floors, except those that are subject to heavy concentrated loads, or reinforced suspended floors.

Another advantage of no-fines concrete is that it is easy to mix and lay. Because it forms a coarse surface, the top surface adheres strongly. Because this type of floor dries quickly, a suitable covering can be laid within a few days of the end of the damp-curing period.

Finally, no-fines concrete floors are economical. Not only is the cement content low, but the foundations also do not need the usual layer of coarse granular material or damp-proofing membranes.

**Proportions**

One bag of cement to 0.3 m³ of stone is recommended for all types of floors. This mixture only requires 3.3 bags of cement per cubic metre no-fines concrete.

**Mixing water**

The quantity of water needed for the mixing process is critical and should be managed carefully. Just enough water should be used with the cement to form a paste or slurry of such consistency that it will coat the stones evenly. If it is too wet, the paste will run down into the voids in the bottom layers of stone, thus not only defeating the object, but also weakening those parts of the no-fines concrete from which the paste has run down. With the right amount of water, the paste will not run down, but will be stymied where the stones touch. The layer of paste between the stones then dries up and gives the concrete its strength.

Usually about 20 litres of water is needed per bag of cement, but slightly more will be needed if the stone is porous or rough-surfaced, or smaller than usual.

**Stone**

The stone should be clean, hard and durable. The stones should be of the same size, if possible. The recommended size for floors is 20 mm stone.

Round or cubic stones are best and elongated, flat stones should be avoided.
The quantity of stone should be measured in a measuring box. Where possible, the right amount of stone for one bag of cement should be used to avoid having to split bags of cement.

**Mixing**

If mixing is done by machine, it is best to wet the stones first with half the water. Thereafter, the cement and the rest of the water can be added and mixed until the stone is evenly covered with the paste.

For manual mixing, it is suggested that the cement and water are first mixed in a separate container. This mixture is then poured over the stone and the two mixed thoroughly on a non-porous mixing surface.

**Placing**

A layer of no-fines concrete of between 75 mm and 100 mm thick is required. It should be laid in panels. Rakes are useful for levelling no-fines concrete. Heavy shovelling is not necessary. It should only be compacted enough to bring the stone particles tightly together. A light roller can be used in some places.

**Toppings for no-fines concrete floors**

The topping should be selected to satisfy all requirements. With most domestic and other applications with light wear of the topping, a 20 mm topping of cement-sand mortar will be adequate with a mixture of 130 litres sand on one bag of cement. In all other cases, a topping of medium or strong concrete made with 9,5 mm stone should be provided, the thickness being chosen to suit the duty, within a range of 40 mm to 50 mm thick.

**Damp curing of no-fines concrete**

Because no-fines concrete dries out very easily, special care should be taken to keep the concrete wet, so that the cement has time to harden.

The topping should also be thoroughly damp-cured to develop resistance to wear. By damp curing the topping, the no-fines concrete underneath is also damp-cured. At air temperatures above 15° C, no-fines concrete and other toppings should be kept wet for at least five days. At lower temperatures, longer periods are required.
APPENDIX B

MECHANICAL VENTILATION

Artificial ventilation can be obtained by means of extractor fans, which are installed in the ridge of the roof. Fresh air is sucked in through controlled openings on the sides of the buildings. Low airflow is thus created, which is beneficial for, among others, flat decks and other types of weaner housing. Pre-heated air can be let in through the ceiling by means of another system.

Another form of mechanical ventilation is by blowing fresh air into the building by means of fans installed in the roof, while stale air is allowed to escape through controlled openings in the sidewalls of the building. This type of system is also intended to bring about a slow airflow rate. Once again, the air can be pre-heated to obtain temperature-controlled buildings, especially for weaners.

Where buildings are ventilated entirely mechanically, it is essential to install a warning system to inform the manager of power failures and other defects. A stand-by generator is of the utmost importance. An alternative use of mechanical ventilation is to install it in combination with natural ventilation to allow for switching from one system to another in extreme weather and climate conditions. Table B1 gives guidelines for the ventilation rate for different types of pigs.

<table>
<thead>
<tr>
<th>Type of pig</th>
<th>Minimum ventilation Winter (m³/s per sow)</th>
<th>Maximum ventilation Winter (m³/s per sow)</th>
<th>Ventilation Summer (m³/s per sow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow and litter</td>
<td>0,0095</td>
<td>0,037</td>
<td>0,24</td>
</tr>
<tr>
<td>Growers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-18 kg</td>
<td>0,00095</td>
<td>0,0071</td>
<td>0,017</td>
</tr>
<tr>
<td>18-45 kg</td>
<td>0,0024</td>
<td>0,0095</td>
<td>0,023</td>
</tr>
<tr>
<td>45-68 kg</td>
<td>0,0033</td>
<td>0,012</td>
<td>0,034</td>
</tr>
<tr>
<td>68-96 kg</td>
<td>0,0047</td>
<td>0,017</td>
<td>0,047</td>
</tr>
<tr>
<td>Gilts, sows and boars</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91-114 kg</td>
<td>0,0047</td>
<td>0,017</td>
<td>0,057</td>
</tr>
<tr>
<td>114-136 kg</td>
<td>0,0057</td>
<td>0,019</td>
<td>0,085</td>
</tr>
<tr>
<td>136-227 kg</td>
<td>0,0071</td>
<td>0,021</td>
<td>0,12</td>
</tr>
</tbody>
</table>
The following illustrations, Figures B2, B3 and B4 show the placing of fans and the ventilation effect it causes.

Because of high building costs, buildings with natural ventilation are more economical in terms of both fixed and running costs. If it is at all possible, natural ventilation should get preference in buildings, provided that the principles as mentioned above are strictly adhered to. Mechanical ventilation may, however, be used with good results, provided it is done with discretion, and then only in exceptional cases, such as early weaner housing.
Figure B3: Mechanical ventilation (side extraction)

Figure B4: Mechanical ventilation (blowing in)
LITERATURE REFERENCES


