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Ventilation Control in Intensive Pig Production

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Ventilation Control in Intensive Pig Production Units in South Africa

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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.

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.

Controlling ambient temperatures

The micro ambient temperature, which 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.

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.

Temperature increases occur when the temperature inside the building rises above the outside temperature due to heat emitted by the pigs.

Controlling humidity
Humidity plays an important part in the microclimate conditions inside piggeries. The idea 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.

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

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.

Air movement
Draughts cause the temperature to fall due to evaporative cooling, which is to say increases in both the lower critical and upper critical temperatures occur. The graphs in Figure 1 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.

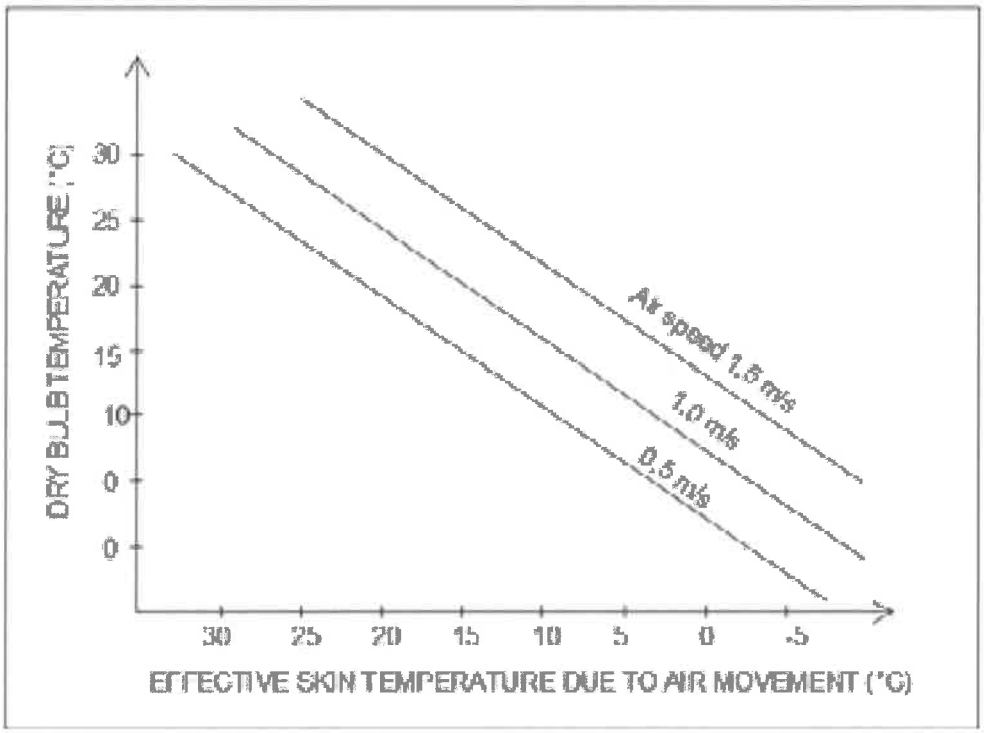

Figure 1: Approximate reductions in the dry bulb temperatures due to air movement at different speeds over the human skin

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.

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.

The mechanism of natural ventilation
There are two mechanisms involved in the natural ventilation of a building:

- 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 Δt.
- The height difference between the inlet and outlet points, Δh.
- The areas of the inlet and the outlet vents, A_1 and A_2.

The buildings as shown in the figure 2 below 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.

Requirements for effective natural ventilation
The design, layout and construction of buildings have to be accurate from the start

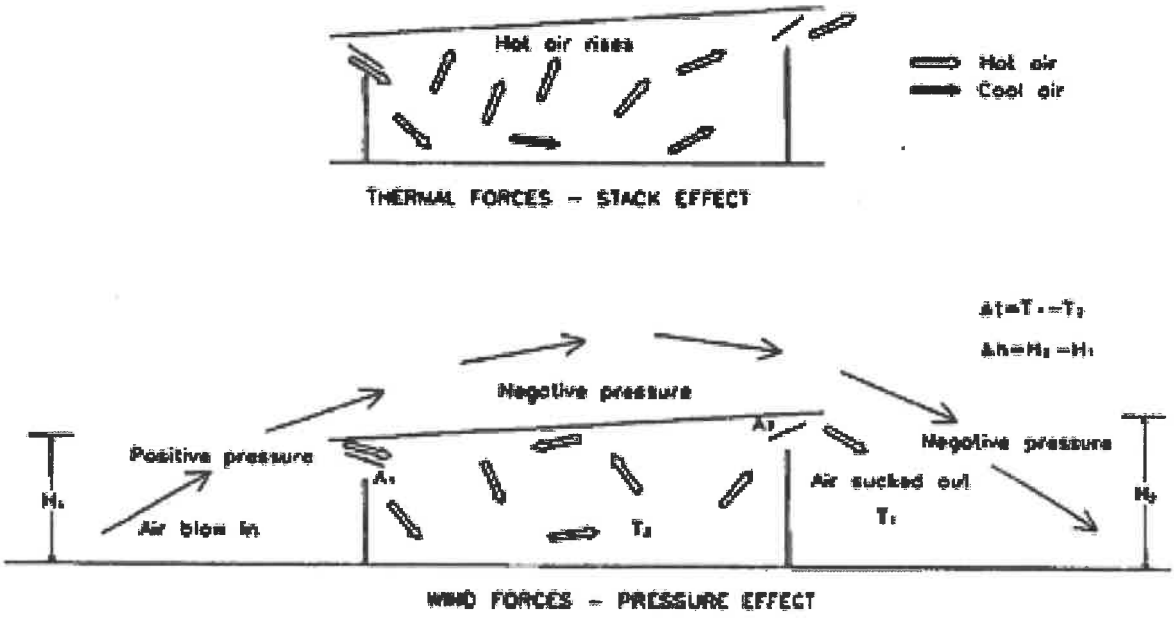

Figure 2: Two natural ventilation mechanisms

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.

Design, layout, and management of buildings

The design of buildings should adhere to the basic dimensions as shown in Figure 3. 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, 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.

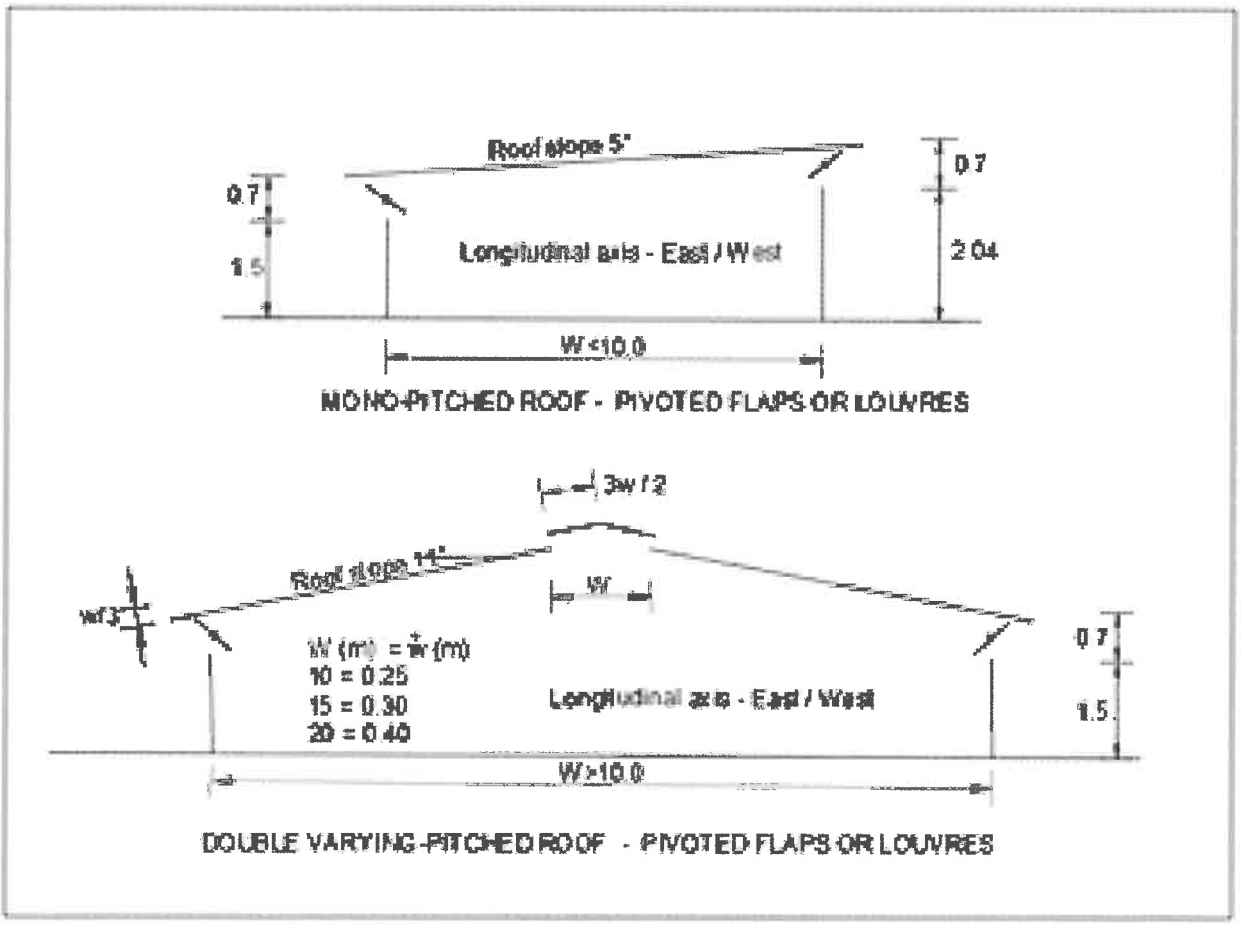

Figure 3: Main dimensions applicable to naturally ventilated piggeries

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.
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.

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.

A complete manual on housing for pigs are available at the ARC-NRE Agricultural Engineering campus. Contact Elmarie Stoltz at stoltze@arc.agric.za to order.

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