Farm Structures
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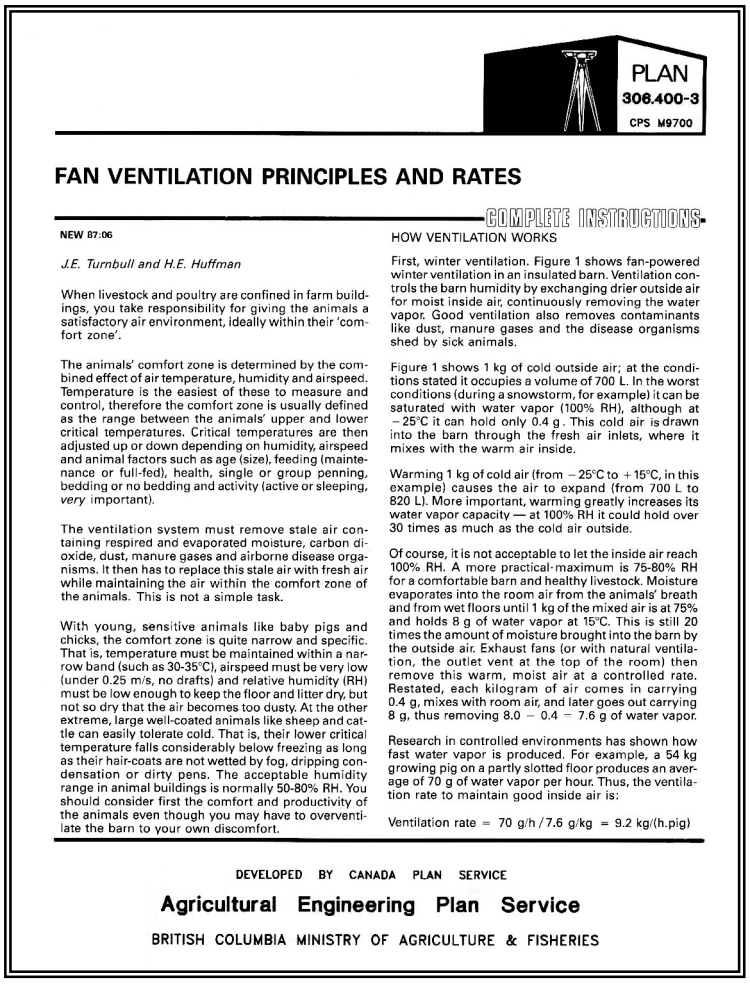
Fan Ventilation Principles and Rates



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FAN VENTILATION PRINCIPLES AND RATES

COMPLETE INSTRUCTIONS

NEW 87:06

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When livestock and poultry are confined in farm buildings, you take responsibility for giving the animals a satisfactory air environment, ideally within their 'comfort zone'.

The animals' comfort zone is determined by the combined effect of air temperature, humidity and airspeed. Temperature is the easiest of these to measure and control, therefore the comfort zone is usually defined as the range between the animals' upper and lower critical temperatures. Critical temperatures are then adjusted up or down depending on humidity, airspeed and animal factors such as age (size), feeding (maintenance or full-fed), health, single or group penning, bedding or no bedding and activity (active or sleeping, *very* important).

The ventilation system must remove stale air containing respired and evaporated moisture, carbon dioxide, dust, manure gases and airborne disease organisms. It then has to replace this stale air with fresh air while maintaining the air within the comfort zone of the animals. This is not a simple task.

With young, sensitive animals like baby pigs and chicks, the comfort zone is quite narrow and specific. That is, temperature must be maintained within a narrow band (such as 30-35°C), airspeed must be very low (under 0.25 m/s, no drafts) and relative humidity (RH) must be low enough to keep the floor and litter dry, but not so dry that the air becomes too dusty. At the other extreme, large well-coated animals like sheep and cattle can easily tolerate cold. That is, their lower critical temperature falls considerably below freezing as long as their hair-coats are not wetted by fog, dripping condensation or dirty pens. The acceptable humidity range in animal buildings is normally 50-80% RH. You should consider first the comfort and productivity of the animals even though you may have to overventilate the barn to your own discomfort.

HOW VENTILATION WORKS

First, winter ventilation. Figure 1 shows fan-powered winter ventilation in an insulated barn. Ventilation controls the barn humidity by exchanging drier outside air for moist inside air, continuously removing the water vapor. Good ventilation also removes contaminants like dust, manure gases and the disease organisms shed by sick animals.

Figure 1 shows 1 kg of cold outside air; at the conditions stated it occupies a volume of 700 L. In the worst conditions (during a snowstorm, for example) it can be saturated with water vapor (100% RH), although at −25°C it can hold only 0.4 g. This cold air is drawn into the barn through the fresh air inlets, where it mixes with the warm air inside.

Warming 1 kg of cold air (from −25°C to +15°C, in this example) causes the air to expand (from 700 L to 820 L). More important, warming greatly increases its water vapor capacity — at 100% RH it could hold over 30 times as much as the cold air outside.

Of course, it is not acceptable to let the inside air reach 100% RH. A more practical maximum is 75-80% RH for a comfortable barn and healthy livestock. Moisture evaporates into the room air from the animals' breath and from wet floors until 1 kg of the mixed air is at 75% and holds 8 g of water vapor at 15°C. This is still 20 times the amount of moisture brought into the barn by the outside air. Exhaust fans (or with natural ventilation, the outlet vent at the top of the room) then remove this warm, moist air at a controlled rate. Restated, each kilogram of air comes in carrying 0.4 g, mixes with room air, and later goes out carrying 8 g, thus removing 8.0 − 0.4 = 7.6 g of water vapor.

Research in controlled environments has shown how fast water vapor is produced. For example, a 54 kg growing pig on a partly slotted floor produces an average of 70 g of water vapor per hour. Thus, the ventilation rate to maintain good inside air is:

Ventilation rate = 70 g/h / 7.6 g/kg = 9.2 kg/(h.pig)

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This document describes the critical need for optimum ventilation design in confined livestock buildings to ensure an environment that is as comfortable as possible to housed animals. The importance of removing moisture, dust and detrimental gases without wasting heat and power is emphasized. Other specific topics covered include differences between summer and winter ventilation, the relationships between inlets, fans and air pressure, the effects of wind on ventilation; the importance of establishing air movement within buildings and recommended ventilation rates for various species of farm animals. To obtain a copy, contact:

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