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OPTIMIZING THE ENVIRONMENT OF THE HOUSED ANIMAL

IRENILZA DE ALENCAR NÄÄS

State University of Campinas, Agric.Eng. College, P.O.Box 6011, Campinas SP- BRAZIL

SUMMARY

The increase in world's population associated to the lack of grazing areas for expansion of extensive animal production leads to search for optimizing space and consequently to the adequate use of life support systems. In the other hand, when increasing animal stoking densities or having animals housed under hot weather conditions, heat load inside the houses may reach undesirable values affecting production; while the emission of effluents and gases may drive sustainability into its limits. A main question raised nowadays is related to the future of animal protein commerce due to the new demands of consumers, including welfare of the animals. Animal housing must provide an interior environment that meets the animal’s thermal comfort needs, which is an important factor in producing high quality animal protein. This paper presents a review on environmental aspects of animal housing.

Keywords: environment, housed animals

INTRODUCTION

Animal production in Latin America, mainly in countries as Mexico, Brazil, Costa Rica and Peru, but also in some developed countries, has moved quite rapidly to a consolidated structure of fewer, larger farms. Driven by economies of scale arising from steady advances in technology, the trend shows no sign of slowing. This new structural concept features an increased concentration of large-scale livestock and specialty crop production in fewer, scattered pockets surrounding existing or emerging marketing and processing centres.

This trend is most advanced in the broiler industry. Intensive broiler farming refers to the movement toward more direct production and marketing relationships between producers and processing unit. Under industrialization, processors attempt to assure a stable supply of a consistent product while exploiting the economies of scale in new production and processing methods. As production shifts to bigger companies and clusters around processing plants, the result is a further concentration of production.

Although consolidation and industrialization have been long-standing trends, the recent acceleration in the growth and concentration of large farms presents significant challenges for natural resource management. These changes also have important social consequences. New forms of organization and control also present new opportunities and complexities for public agencies endeavoring to provide technical assistance in natural resource management to large-scale agricultural operations. However what is actually seen is that the initiative of private organizations to propose policies of natural resources protection and linking the producer’s attitude to the farmer’s product for added value (Thomas *et al.* 1996).

At the same time there is an increasing demand for good quality food in the global economy and it is proportional to the economic growth in the emerging countries, as referred by Thomas *et al.* (1996). The consumer’s need and ecological conscience has changed for a more demanding taste mainly in the largest world consumer markets such as the United States and Europe, as well as China (Holroyd 2000).

According to Holroyd (2000), the future of animal protein commerce depends mainly on an industry reacting towards the following concepts: honesty, availability of information, traceability, assurance of quality, and flexibility for change. For the retailer or fast food buyer, it is only possible to build up a business when quality is assured and continually being improved, when the final design is correct, and the product is always available in the right place at the right time. One of the important factors in producing high-quality animal protein is the environmental characteristics of the building housing the animals. This paper presents a review on environmental aspects of animal housing.

ANIMAL PRODUCTION ORGANISATIONAL CONCEPT

This new shift in the structure of animal production (farming) is tightening the industry's marketing links, creating a more integrated industry from farm to the markets and the worldwide consumers. One of the main characteristics in this emerging structure is a shift toward contract production and vertical integration.

Consumer economies are also changing in the global market and there are several countries emerging and as a result the people is these countries are adopting new diets. Poultry consumption is an example of this in the Americas. The expansion of fast food restaurants increased the consumption of grounded beef and processed poultry meat as well.

Larger producers are the most likely to benefit from contractual arrangements to produce specialised products for food companies in the worldwide market chains. The industry's new structure will link these farms more closely to the growing market for value-added food products. In the other hand smaller farmers may face a declining market for their generic production. At best, they may become residual suppliers to the specialty product market (Barkema & Drabenstott 1996).

Nevertheless consumers are quite aware of the health problems that the ingestion of unsafe food may bring to them and their families and associate these risks with animal housing and management, ingestion of drugs and ultimately the process and conservation of the product throughout the market chain. Safety is one of the most demanded quality in food products, and it is required mainly for assuring quality. It is important to meet the consumer's requirements for food safety, traceability, animal welfare and health control, employee welfare and health and reduction of risk

The questions that remain unanswered in most developing countries are:

- How to reach safe and sustainable animal production and, at the same time, meet their thermal comfort in an economical way?
- How to adapt trends and demands for improved human and animal welfare to on-going production animal and worker's welfare concepts to on-going production?

THERMAL ENVIRONMENT

Most problems related to animals housed in tropical climates are caused by high environmental temperatures. Building housing costs represent 50% of the initial investment in a livestock production facility. Structures are necessary for efficient production, because they provide means of modifying the interior environment and also protect against predators and against spread of disease. However, structures can generate thermal problems for the herd or flock when they are not adequately designed. Animal housing must provide an interior environment that meets the animal's thermal comfort needs. The thermoneutral dry bulb temperature for a wide range of small animals lies between 18°C and 20°C, and it extends between 12°C and 18°C, for animals at slaughter age. When the upper critical temperature is reached, the latent heat lost by evaporation is highly affected by relative humidity levels.

No matter the geographic location of business, the overall performance of the animal production depends on the herd or flock management as well as the nutrition, sanity control and building facilities.

The upper critical temperature is influenced by the ventilation rate, the presence of cooling devices, and the temperature of drinking water. The animal's thermoregulation response to heat stress is to use extra energy, leading to losses in productivity. Piglets are more sensitive to sudden weather changes up to 6-10 days after birth, when their thermoneutral environmental temperature is 26°C. The pig's thermoneutral environmental temperature drops gradually depending on the stage of growth. For instance, between 18 and 15°C in the growing and finishing period, while gestating sows have their comfort zone at 24°C. Research indicates that the best feed conversion is found at environmental temperatures ranging from 22 to 24°C for swine weighing 30 to 65 kg, and 17°C, for swine above 65 kg. Environmental temperatures between 16°C and 21°C, are adequate for animals housed in groups (Andriguetto *et al.* 1988).

Optimum poultry production requires a housing environment that provides adequate temperature and relative humidity. The combined effects of both variables are critical in determining the bird's ability to dissipate heat and avoid losses caused by heat stress. During the summer months in Southern Brazil for instance, losses reach around 10% of the total production. Environmental control of poultry houses is provided by using fans and evaporative coolers. The controllers used by producers are thermostats that regulate equipment operation based environmental temperature.

The success in Brazilian poultry and swine production is linked to variables such as economic feasibility, specialized labour force, productive and reproductive characteristics and adequate management, (Cartaapinco 1999a). Each variable has its own importance and needs to be evaluated in an interdisciplinary way. This labour intensive activity takes place mainly in the South and Southeastern regions and is in the hands of European immigrant families. They are efficient in growing swine and poultry associated to integration systems. With the grain production moving towards the West central region, this kind of farming activity is destined to disappear soon.

The use of mechanized operations for animal production is mainly divided in three categories: industry of animal feeding and processing; environmental and climatization and meat or dairy processing (Martins 1999). Within the intensive animal production systems the major gap in mechanization remains in the area of climatization. In poultry production, for instance where nearly 60% of the operations are mechanized, feeding and drinking systems are automated, as well as the process and distribution of diets. While for swine production the level of mechanization is smaller, there are larger producers that use automatic feeding and drinking. Depending on the size of the production, the level of mechanization varies from literally nothing to highly mechanized farms.

Milk yield decreases during hot months as well as its quality, in around 8% worldwide. Investment in the use of cooling devices and facilities are necessary to reduce losses. The same pattern is followed by egg production, which decreases in the order of 3-4% due to high temperatures in hot season.

The breeding used for industrial herd and flock production is mostly imported and hardly adapted to tropical climate conditions. Due to a long hot season, industrial animal production in Brazil is quite dependent on the use of climatization equipment in order to improve the animal's performance. Figure 1 shows the increase in milk yield and fat content when Holstein cows in semi confinement were exposed to cooling devices (Arcaro *et al.* 2000).

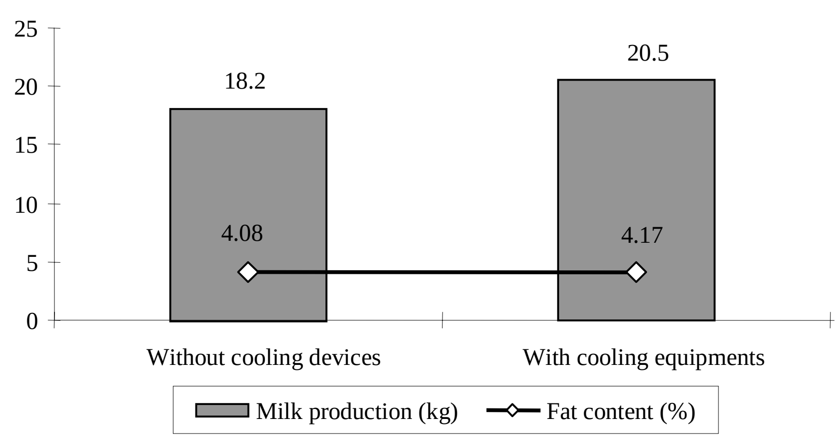

Figure1. Increase in milk yield and quality by the use of cooling equipment. Adapted from Arcaro *et al.* (2000).

Another weak point in the production, where the losses are high especially in the broiler industry is the waiting zone at the slaughter houses. Studies have shown that the use of cooling equipment such as fans, associated with a fogging system in the area where the loaded trucks wait with the caged birds, reduces the heat stress and consequently bird mortalities (Nääs *et al.*1998). The change in environmental conditions produced by the use of cooling equipment is illustrated in Figure 2.

In boar housing the use of fans was tested in a farm under tropical conditions and the results showed that the increase in wind speed near the animals influenced semen production three months after the exposure to heat stress, even though it did not influence the housing dry bulb temperature or relative humidity (reflected in the WBGT index), as shown in Figure 3 (Espelho 2001). It was concluded that the use of fans in boar housing improved semen production under tropical environment.

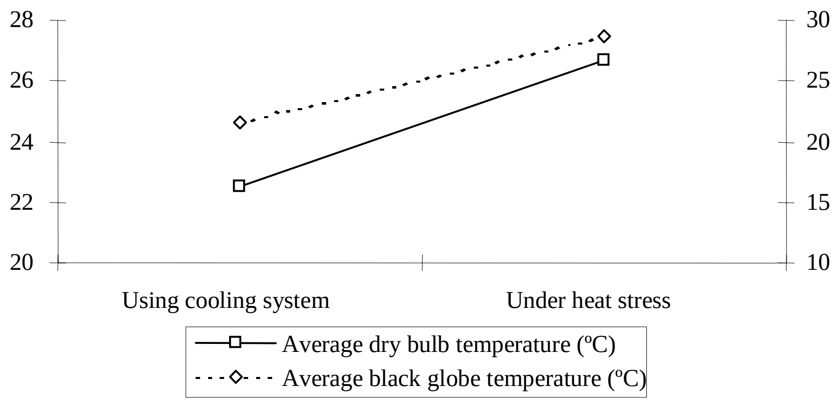

Figure 2. **Environmental response in poultry slaughter house waiting zone when using cooling devices**

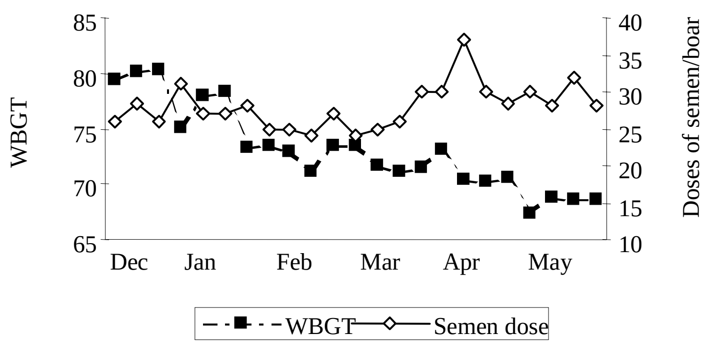

Figure 3. Dose of semen production as function of WBGT, from December to May

As an example, Brazilian dairy and meat industry is based upon three different segments: cooperatives, integration and independent producers. The type of integration that has occurred in dairy and poultry farming in Brazil is one where the producer is interactive with the industry demand. It involves two stages: the first sector manages reproduction and the production of young birds or animals and the second sector is responsible for growing animals to slaughter. The use of mechanized processes happens more clearly at the reproduction farms where more resources are invested.

The evolution of mechanization of animal production operation, such as feeding, handling and environmental control is shown in Figure 4. It is clear that broiler production is the most mechanized activity while swine and dairy production still have room to apply some mechanized operations, especially in changing the housing environment.

Even though in some cases the thermal comfort is reached by the intensive use of equipment and climatization devices, in most cases, it is still a matter of concepts and an adequate transfer of technology. A clear example of this was the adaptation of the tunnel ventilation concept for Brazilian poultry production. Studying the tunnel ventilation systems, with the increased stocking density (10 to 18 birds/m^2), under Brazilian conditions, Aradas *et al.* (2000) found that the use of the association of negative and positive pressure (auxiliary fan lines) inside the housing (G2) could lead to the improvement of the broiler thermal sensation, although dry temperature and relative humidity were slightly higher than in the tunnel ventilation that used only negative pressure (G1). Productive results are shown in Table 1.

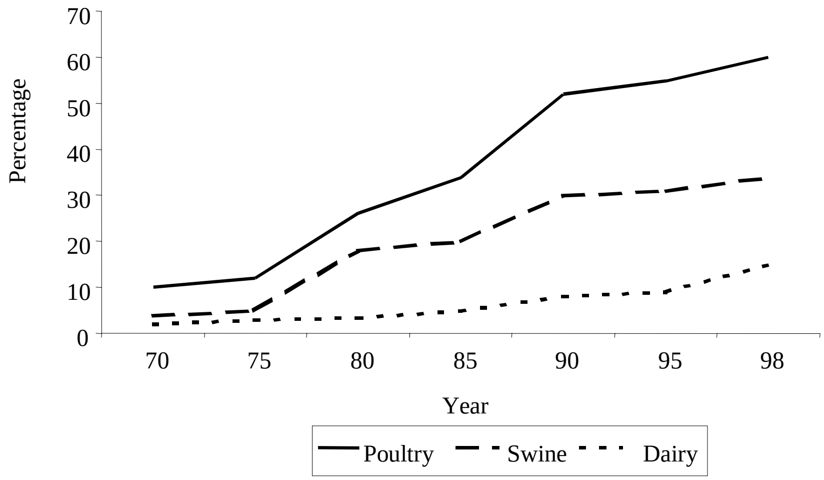

Figure 4. Use of mechanization in the process of animal production. Adapted from Cartaapinco (1999b) and Martins 1999).

Table 1. Results during summer for both treatments. Adapted from Aradas *et al.* (2000).

	Day 21	Day 28	Day 35	
Accumulated mortality in G1				3%
Accumulated gain in G1	0.76	1.20	1.66	
Accumulated mortality in G2				2.7 %
Accumulated gain in G2	0.74	1.22	1.68	

AERIAL ENVIRONMENT

Within today's principles of modern animal production, the limits are related towards both welfare and emissions. Hyslop (1974), Sainsbury (1981), and Curtis (1983) among others have found a strong correlation between change in air quality and the health of broilers raised in intensive housing. High environmental temperature associated to high relative humidity, presence of high ammonia concentration, dust and poor ventilation contribute to high pathogenic diseases (Castro, 1999). Same results are found for dairy cows and swine in various stages of growth.

Several authors have found that some species of fungus are associated to respiratory diseases in both man and animal (Andrade *et al.* 1966; Olenchock *et al.* 1983; Rylander 1986), especially in countries where the intensity and length of winter leads to animals being kept in houses with minimum ventilation so the heat is preserved (Lovett *et al.* 1971, Reece *et al.* 1972, Thiso *et al.* 1978, Sauter *et al.* 1981). Richard (1982) found that reducing the dust inside the housing decreases significantly the possibility of disease incidence for both animal and worker (Banhazi and Cargill, 1998; Banhazi and Cargill, 1999).

Miragliotta *et al.* (2000) compared the aerial environment in an adapted tunnel ventilation system for broiler with a high stocking density with open sided buildings oriented east-west. They found that the average ammonia emission rate on the 40^{th} day of production in the adapted tunnel (TVS) was higher than the Conventional Ventilation System (CVS), and in both systems it increased during the trial and was higher in the Eastern side in the TVS and in the Western side in the CVS (Figure 5).

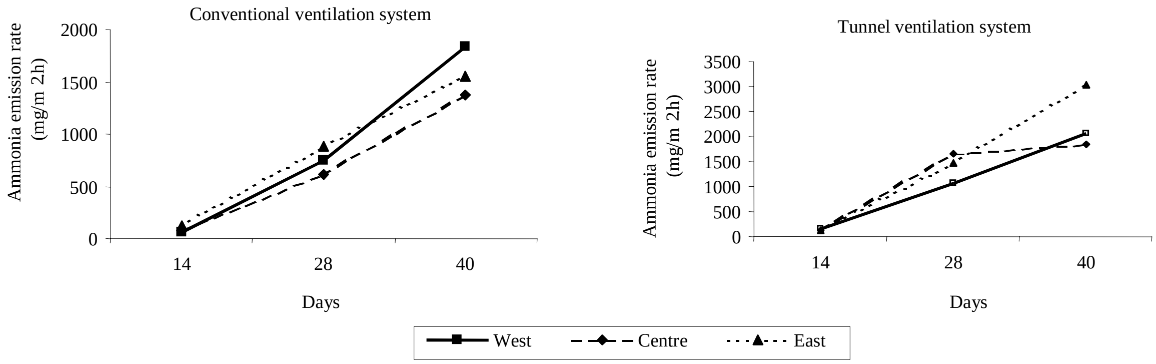

Figure 5. Ammonia emission rate in two ventilation systems

Some factors such as deep-litter pH and temperature influenced ammonia emission rate. In TVS, on the 40th day, pH and temperatures average values presented accumulated pattern. It was observed that pH became alkaline during the trial (6.17 to 8.88) and the temperature data oscillated between 27° and 31°C (Figure 6). In CVS, deep-litter pH and humidity were higher in the Eastern side but its temperature was higher in the central area, presenting differences of 1 to 2°C when compared to other sectors.

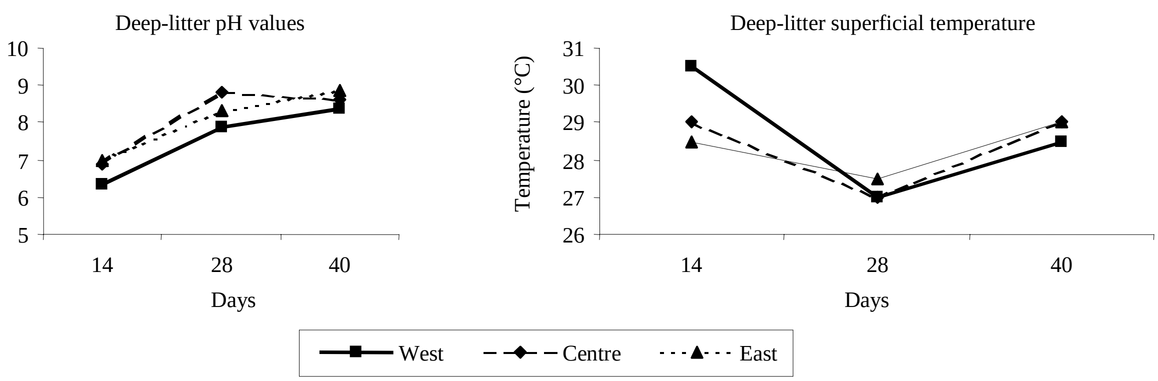

Figure 6. Average deep-litter pH and superficial temperature in tunnel ventilation system (TVS)

The measurement of air quality as well as the concepts that are related to air quality (such as pollution limits, effluent definition, and contamination criteria) vary substantially from one country to another. On the other hand, these concepts are influenced by the overall climate, as well as the management system used, the design of the building and the materials used and the diet. Time of confinement associated to type of animal, genetics, climate and the degree of mechanization in the process can determine the make-up of the effluent and the pollution that will arise as a result of it.

CONCLUSIONS

There is an urgent need to find a balanced solution that provides necessary welfare to housed animal without reducing profit. It seems possible to achieve good economical outcome by reducing the environmental heat load inside the houses by using simple techniques, such as appropriate use of fans and fogging. Optimizing the environment of the housed animal is a matter of balancing the thermodynamic principles achieving profit by using adequate equipment and management meeting welfare regulations and, as a main goal, meeting the consumer's needs.

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Email: irenilza@agr.unicamp.br