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CHAPTER 8

# ENVIROMENTAL CONTROL FOR ANIMALS AND PLANTS—PHYSIOLOGICAL CONSIDERATIONS

*ANIMALS: Cattle, Sheep, Swine, Poultry; PLANTS: Environment and Plant Growth.*

THE control of environment for animals and plants is being studied more closely as efforts are made to attain greater efficiency and better quality in livestock production. This information is being compiled through the joint efforts of scientific research projects. This chapter is a product of some of the published results of the various studies in this field. It provides a concept of the physiological factors involved in controlling environments.

## PART I: ANIMALS

Important domestic animals are homeothermic, and it is reasonably assumed that for each species there exists one environment at which maximum productivity is associated with maximum production efficiency. If the temperature is increased above that of the ideal environment, the animal must decrease its fuel intake to maintain a constant body temperature, consequently reducing its productivity. If the temperature is decreased below that of the ideal environment, the animal must increase its fuel intake to maintain homeothermy, and this reduces its efficiency of production.

When genetic engineering becomes a practiced art, an ideal environment could be established for each species, according to age, weight, sex, kind of fuel, or any other variable. At present, data define broad environmental limits within which production may be said to be *maximum*, and production efficiency more or less uniform.

These limits are largely defined in terms of temperature and humidity. Future research, no doubt, will fully describe the effects of air movement, barometric pressure, air composition, etc., but, until most livestock are housed in controlled environments, the accumulation of such information will be rather slow.

Air temperature must be considered the major variable describing environment, since the animal's sensible heat dissipation is a function of temperature difference. Second in importance is humidity. All homeotherms are alike to the extent that a portion of the heat dissipated is in the form of vapor. When increasing ambient temperature approaches the animal's surface temperature, the burden of heat dissipation is shifted to insensible, or evaporative, heat loss. Thus, at higher ambient temperatures, high humidity may limit production. The interrelation of temperature and humidity have been studied to some extent for some species, but the results are far from complete.

Animals confined in a closed environment tend to alter the composition of the air by reducing the oxygen content, increasing the carbon dioxide and vapor content, and by adding ruminant gases, ammonia from feces and urine, and microscopic particles of dust from feed, bedding, etc. Experience has shown that, when operating at an environment designed to elicit *maximum productivity*, the addition of sufficient fresh air to remove water vapor and ammonia will prevent any detectable effects of carbon dioxide build-up, lung respiratory irritation due to dust particles, or harmful effects from methane.

The study of air movement has been insufficient to clearly define its effect in terms of temperature or humidity equivalents. Studies tend to show that *air movement* in excess of that required to remove stationary layers accumulated about animals is of doubtful benefit.

Heat production data under conditions of normal metabolic activity have been accumulated for domestic animals customarily confined in housing, i.e., dairy cattle, poultry and swine, but generally have not been accumulated for range animals, i.e., beef cattle and sheep.

Unlike heat production, animal productivity is only indirectly related to environment. Maximum productivity is a genetically inherited characteristic, but realization of the full potential is controlled by other factors. Some of these are:

1. Environmental, such as temperature or light.
2. Nutritional, such as feed composition or enzyme activity.
3. Pathological, such as microorganisms.
4. Psychological, such as fright or sexual stimulation.

In general, the physiological control systems will react to unfavorable conditions in such a manner as to insure survival of the animal at the expense of productivity.

### CATTLE

Because of their economic importance, dairy cattle have been the subject of much research regarding their physiological responses to environment. Fig. 1 illustrates the effect

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