Problems of adaptation by sheep to hot arid conditions

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INTRODUCTION

In the north-western Indian desert, although the rainfall is scanty, the atmospheric humidity is fairly high, and is comparable with that of places with higher rainfall in the semi-arid and sub-humid zones (Krishnan, 1968). The mean maximum temperature during summer is 40°C, though the highest temperatures recorded are in the range of 48 to 50°C (Krishnan, 1977). In fact, the hot deserts are characterised by extreme variations of diurnal and annual temperature conditions. Under these climatic conditions, the risk and uncertainty involved in the production of crop necessitates diversification of production decisions in favour of livestock production (Mann and Kana, 1977). However, lack of adequate feed resources, and inadequate and/or brackish water resources are the major reasons for the low productivity of livestock (Acharya et al., 1977). In working out suitable technology for improvement in sheep productivity, it is imperative to develop a bioenvironmental index for production-adaptability prediction. Management, the point of impact of man upon animal production, provides ample opportunities for minimising the restrictive effects of arid environments.

CONSEQUENCES AND ACCLIMATIZATION

One of the first noticeable responses of animals to thermal stress is the reduction in feed intake. Observations made on the grazing habits of sheep in tropical areas (Payne, 1966) revealed that the direct stress of hot climate caused serious curtailment of grazing by European breeds of sheep but their indigenous counterparts were less affected. Also, the animal tends to reduce consumption of hay, under thermal stress (Payne and Hancock, 1957). Depression in the efficiency of energy utilization for production processes under high temperature conditions is also reported (McDowell, 1972). Thermal stress has a depressing effect on the growth of lambs (McDowell, 1966), impairs scrotum and results in poor quality semen production (Rathore, 1969). During the hotter parts of the year (about 38°C) under semi-arid conditions, or marked deterioration in semen quality was observed in Rambouillet sheep, while the semen quality was reportedly better in Rambouillet crosses with Malpura or Chokla (Tiwari & Sahni, 1975). In the ewes, high ambient temperature shortens the duration of visible expression of estrus.
as well as decreases embryo survival (McDowell, 1972).

In a complex, closely integrated mechanism such as the animal body, it is inevitable that an alteration in activity of one part should have repercussions in other parts. These interrelationships need to be further studied.

ADAPTABILITY TO HEAT

According to Lee (1962) progressive adaptation to hot arid zone conditions is indicated by: a) decreased heat production; b) increased ease of heat loss; c) increased sensitivity of the heat regulating mechanism; d) reduction in the secondary disturbances brought about in the course of heat regulation; and e) increased tolerance of either a rise in body temperature or of the secondary consequences of regulation. Of these, the first two aspects have been studied in considerable detail.

A. Heat production

Normal heat production by sheep is about 1301/Kcal/day (Blaxter, 1962). Critical temperature, an ambient temperature at which the animal produces minimum metabolic heat, is also influenced by a multitude of factors including feeding level and fleece characteristics. Graham et al. (1959) reported that the critical temperature was 39-40°C for sheep fed 600 g of hay per day, 33°C for sheep fed 1200 g/day and 24 to 27°C for sheep fed 1800 g/day. Apparently, higher critical temperature under low level of feeding is advantageous to the animal under thermal stress. Reduced intake by a part of the adaptation process, sheep exposed to thermal environment, is

B. Heat loss

Although sweating in sheep has been confirmed (Riek et al., 1950; Brook and Short, 1960), the respiratory cooling by panting has been considered to be the main route of heat dissipation (Knapp and Robinson, 1954; Brockway et al., 1965). Most of these observations are, however, based on Merino or Merino types. In the field studies, Singh and Acharya (1977) found that under thermal stress (33.5°C under the sun) the Rambouillet pant while the Malpura do not, indicating that Indian Malpura sheep utilise cutaneous evaporative cooling for dissipating body heat more than the respiratory evaporative cooling, unlike the Rambouillet.

a) Panting

In open mouthed breathing, carbon dioxide is increasingly washed from the blood and may result in alkalosis which could lead ultimately to death (Hales and Webster, 1967). Respiratory water loss reaches as much as one third of the total water loss in sheep (Knapp and Robinson, 1954). Hot and humid conditions evoke higher respiratory frequency in the unshorn (7.8 cm fleece length) than in the shorn (0.5 cm fleece length) sheep while the hot and dry environment evoked higher respiratory frequency in the shorn than in the unshorn sheep (Klemm, 1962). High place or nutrition reduced the heat tolerances of sheep as indicated by higher respiratory frequency (Robinson and Lee, 1947; Riek et al., 1950; Blaxter et al., 1959).
b) **Cutaneous evaporative cooling**

Increased transudation of water through the skin followed by initiation of sweating promotes heat loss (Bligh, 1967). Brook and Short (1960) have reported that sheep exposed to 40°C (28.1 mm Hg vapour pressure) had a sweating rate of 32.1 g/m²/h. Higher sweating rates (including the transudation of moisture) for acclimatised Rambouillet, Chokla and Malpura ranging from 123 to 192 g/m²/h have also been recorded (Rai, 1976). The scrotum which plays a role in cooling the testis, may however, attain a sweating rate of 200 g/m²/h (Waites and Voglmayr, 1963). The site of evaporation and consequently the cooling efficiency of sweating in sheep with varying fleece conditions needs further investigations.

**PRACTICAL CONSIDERATIONS**

a) **Water**: Bailey *et al.* (1962) found that water consumption was doubled when ambient temperature increased from 12°C to 15°C. Water intake increased in proportion to salt intake at the rate of 3.4 litres of water per 100 g sodium chloride in the feed or water (Wilson, 1966). In desert conditions, the high ambient temperature during summer, scarcity of water and brackish nature of water, all add up to increased water requirement of sheep. Acclimatised sheep are, however, tolerant to these stresses. Saline water containing 1 per cent of sodium chloride is well tolerated by sheep (Ratan *et al*., 1971). Taneja (1973) reported that sheep could be watered once in 3 days without adverse effects. More and Sahni (1977) also did not find any adverse effect on the wool yield of sheep watered once in 72 h. Water deprivation, however, causes significant (P < 0.05) decline in the feed intake (Singh *et al*., 1976; Purohit *et al*., 1976). In dry and semi-arid areas an adequate water supply has to be an integral part of the overall production plan.

b) **Grazing**: Night grazing when the ambient temperature is low in the arid areas, is attractive but not free from handicaps. Apart from the annoying insects, the capability of the sheep to choose herbage during the hours of darkness is required to be considered. Further, preference of sheep for grazing intensively in the early morning and late afternoon point towards gearing managemental practices as much as possible to these periods. Sedentarization is desirable only in special conditions. Movement of the flock enables the sheep over the year to get up the available trace elements.

c) **Shelters**: Natural shades are ideal but when not available it is desirable to construct shelters for protection (against solar heating, though economics are usually involved in balancing the cost of shelters. For shelters to be profitable, they must improve the environmental conditions in a manner that can be measured in increased efficiency of performance.) The provision of shade for growing lambs is desirable under hot summer conditions. Simpson *et al.* (1959) found that sheltering during Kentucky summer improved the quality of semen. Bond *et al.* (1961) have confirmed that hay and straw are the best material to resist radiant heat. Roof type shades serve the desired purpose and should be preferred to the wall and roof types of
shades which act as heat traps (Lee, 1964).

In fact, change in the management system of exotic animals through grazing only in the coo'er hours and through their housing during the day in asbestos sheeted sheds with Kacha floor and with free air movement, availability of water throughout the day and the supplementary feeding green/dry fodder and concentrate during the evening after the animals return from grazing has shown tremendous improvement in the adult and young survival (155 per cent and 83 per cent, respectively) and the male and female fertility (C.S.W.R.I., 1974).

CONCLUSION

Management plays an important part in ameliorating the effect of hot climate. The constructive management measures are, provision of shade, diminishing the ground reflection, suitable shelters, restriction of feeding during hotter parts of the day, postponement of shearing to cooler season, and control of mating so that late pregnancy occurs in comparatively cooler season. But in the developing countries the approach has to be based on proper selection and breeding of animals so as to optimise the combination of heat tolerance and productivity. Also, research on the ecology of the sheep raised in the arid zones is of the utmost importance.

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REFERENCES


McDowell, R. E. 1966. Factors to consider in reducing the adverse effects of climate on animals performance. USDA. Info. ARS. 4-182, Washington, D.C.


