Summary of Thesis

by

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Studies on the adaptability of Sahiwal Brown Swiss cross-bred cattle to tropical conditions.
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SUMMARY

There can be little dispute that increased milk production is the first step for a sound and balanced development of dairying. It is also generally accepted that the quickest way of doing this is by cross-breeding indigenous zebu cattle with exotic breeds of cattle. The programme of crossing Sahiwal, one of the important milch breeds of India, with Brown Swiss sires, and eventually evolving a new breed, undertaken at National Dairy Research Institute, Karnal, is a major step in this direction. However, previous experience cautions the danger of later disintegration of the cross-bred stock mainly due to their failure to orient themselves to the eco-system prevalent in this country. A systematic study was, therefore, undertaken to investigate the physiological sturdiness of these animals in comparison to the native zebu. The study revealed the strength and weaknesses of the cross-breeds with respect to adaptability and helped in formulating recommendations on manegmental procedures to impart relative comfort to the animals. It also helped in bringing to light certain interesting aspects of animal reaction to environmental heat stress. Further, the data collected from certain animal reactions were utilized to evolve a modified heat tolerance index for tropics. This is an improvement on the existing ones in many respects. The major findings of the study are listed below briefly.

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The study consisted of two parts. The first one, aimed at studying the productive performance of Sahiwal-Brown Swiss cows, consisted of a comparative study involving thirty cross-bred and thirty contemporary Sahiwal primipara. The cows were selected in pairs, one from each breed on the basis of similarity of date of calving. The thirty cross-bred (F₁) cows had an average 305 days lactation yield of 3124 ± 141 kg as compared to 1884 ± 107 kg for the Sahiwal counterparts. This represents a 65 percent difference in milk yield over those of Sahiwal. The dams of the cross-bred cows were having an average first lactation yield of 1824 ± 101 kg. Thus, the cross-bred progeny yielded about 70 percent more than their dams in the first lactation. A lactation yield above 3000 kg is remarkable in the beginning stages and promises ample scope for development on sound economic basis. But a rough comparison with the yield of their dams and the pure-bred Brown Swiss daughters born to their sires indicated that the production achieved is not completely satisfactory. This could be due to their difficulty in adjusting to the climatic and other environmental factors and, if of serious nature, could bring about degeneration of the cross-breds at a later stage. The second part of the study was undertaken to assess the nature and extent of the susceptibility of the cross-bred animals to climatic stress, if any. This was done in comparison to the parental zebu breed, Sahiwal, as it is considered to be well adapted to the local conditions, being native. Twelve Sahiwal and twelve cross-bred bull calves above one and a half years of age were selected for the study.
They were picked up in quadruplets, a pair from each breed, all the four being of similar age. The experiment was planned as a $2 \times 2 \times n$ factorial randomised block design in which there were two breeds, two shelter conditions and 'n' number of periods depending on the frequency at which a certain parameter was estimated. The two housing conditions were: (i) sheltered and (ii) unsheltered. The sheltered animals remained inside a shed throughout, whereas the unsheltered ones were tethered in the open.

The observations made on the experimental animals consisted of primary and secondary reactions in response to environmental stress. Maximum and minimum ambient temperature and absolute humidity, both inside and outside the sheds, were recorded. This part of the study lasted throughout the year 1968. The results obtained and the conclusions drawn therefrom have been presented in chapters IV to VII. The results and conclusions reported in different chapters have been co-ordinated for drawing comprehensive conclusions in chapter VIII, under general discussion and conclusions. The major findings and recommendations based on them are listed below:

1. It was observed that the cross-breds, in spite of a significantly lower feed intake, maintained relative growth rate equal to their Sahiwal counterparts. This was indicative of thriftiness and the capacity to use feed nutrients effectively, reducing the heat production and wastage on the part of the crossbreds. This has been interpreted as a contd......
means, the crossbreds avail, for maintaining homeothermy under hot environmental conditions.

2. The cross-breds were found to reduce feed intake during day time and resort to a switch over to night time feeding to a greater degree than the Sahiwals. This day to night shift in their feeding regime started at a much earlier date than the Sahiwals when the ambient temperature was not very high. It was, evidently, indicative of a lower critical temperature of the cross-breds. But this need not affect the production performance of those animals as they can eat during the night time and compensate for the diminished feed intake during the day.

3. The cross-breds were found to possess a higher yearly average respiratory rate, a lower rate of heart-beat and a similar rectal temperature as in case of the Sahiwals. The higher average respiratory rate has been mainly due to polypnoea caused by the thermal panting during summer. The slower pulse rate was attributed to larger body size. The fact that the cross-breds maintained a similar rectal temperature during the experimental period, and that even during summer their rectal temperature was similar to that of Sahiwals, indicates that the crossbreds managed to maintain homeothermy under conditions of climatic stress.

4. A study of body fluid distribution revealed that the cross-breds equalled pure-bred Sahiwals with respect to plasma volume. However, the Sahiwals were found to possess a higher percentage of ECF volume than the cross-breds. This has been contd.....
considered as a better sign of adaptability in them. Both the breeds were found to react in a similar way to the seasonal changes and to different shelter conditions.

5. An investigation into the behaviour of electrolytes and alkali reserve revealed many interesting aspects of secondary animal reactions to environmental stress. The crossbreds were found to possess, on an average, 14 percent more plasma bicarbonate. This was mainly due to a higher (20 percent more than Sahiwal) plasma bicarbonate level of the crossbreds during 'cold' and 'Mild' seasons. During the 'Hot' season there was only a 25 percent drop in plasma bicarbonate level in Sahiwal as compared to a 50 percent drop registered by the crossbreds. This, once again, brought to light the susceptibility of the respiratory apparatus of the crossbreds to thermal stress. During the 'Hot-humid' season, when humidity was also raised, the Sahiwall which relied upon increased surface evaporation for thermolysis found difficulty in evaporative cooling and, consequently, increased their respiratory activity. This was reflected in the plasma bicarbonate showing a further reduction of 21 percent in this breed. On the other hand, the crossbreds did not show any further reduction. This indirectly brings to light the basic difference in their thermolytic mechanisms. While the Sahiwal relied on surface evaporation to a greater extent for thermolysis, it was the respiratory apparatus on which the crossbreds draw upon mainly.

6. The study of serum sodium, serum potassium and blood chloride focussed attention, though in an indirect way, on contd......
certain fundamental differences in the electrolyte response to thermal stress. These inferences were further strengthened by other observations with regard to respiratory rate, plasma bicarbonate, body water distribution and body weight. During the 'Hot' season, serum sodium and potassium levels were greatly reduced. It was also observed that bicarbonate level was reduced to a greater extent in the crossbreds. On the other hand, blood chlorides revealed an opposite trend. The Sahiwals showed lower levels of chloride during the 'Hot' season. From this it was inferred that sodium and potassium were excreted in the form of bicarbonates to a greater degree in crossbreds in order to equilibrate the greater loss of carbon dioxide through hyperventilation for the purpose of preserving acid-base balance. On the other hand, the main pressure on the Sahiwals was from evaporative water loss from the surface without a parallel salt loss and not from hypotension of carbon dioxide. Therefore, they might have excreted sodium and potassium through urine, mainly in the form of chlorides.

7. The crossbreds were found to possess a significantly lower serum alkaline phosphatase activity. This, indirectly, indicated a better production potential on their part.

8. The provision of a thick-walled brick structure was found to be beneficial in reducing the maximum temperature and raising the minimum temperature inside the shed. This also cut off radiational stress almost completely. However, the average ambient temperature was always higher inside the

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shed. These aspects of the immediate climatic environment had an effect on the animals' reactions also. Thus, respiratory rate and rectal temperature, which are known to be affected by diurnal changes in ambient temperature and solar radiation were markedly increased in the unsheltered animals during summer. The increased respiratory rate, in turn, resulted in reduced plasma bicarbonate, serum sodium and serum potassium. The unsheltered animals had significantly lower levels of the same compared to the sheltered ones. On the other hand, dry matter and TDN intakes and serum cholesterol, which are known to be related to the level of thyroid activity, seemed to be affected by the average ambient temperature rather than the transient maximum temperature or solar radiation. Thus, the sheltered animals showed signs of greater thyroid depression in that they showed relatively lesser feed and TDN intakes and higher serum cholesterol levels.

9. The study also helped in providing some interesting clues regarding the nature of animal reaction to thermal stress which could form the basis for further study. They are briefly listed below:

a) The day to night shift in feed intake has been noticed to a greater extent, not during the hottest period of the year but during the 'border-line' months. The average ambient temperature during these months was quite low, but the maximum temperature was high enough to cause reduction in feed intake during the day time. On the other hand, the overall reduction in feed intake was maximum during the peak summer...
This indicated that, there might be two mechanisms which control the feeding regime; the first one which is transient in nature and quick acting appears to be neural. This might be responsible for the day to night shift in feed intake. On the other hand, the mechanism which causes general depression in feed intake appears to be humoral in nature, most probably the hypothalamus-pituitary-thyroid system, as has been indicated by other experiments. This appears to be more slow to start and stop its functioning, and also appears to supersede the former mechanism. This aspect needs a detailed study to have a more direct evidence on the possible neurohumoral mechanism that may be involved.

b) The investigation revealed a reduction in plasma volume, an increase in ECF volume, a lowering of plasma bicarbonate, a reduction of sodium and potassium and an increase in blood chloride during the 'Hot' season. These changes appeared to stem from two primary reactions of the animals to thermal stress, namely, increased respiration rate and surface evaporation. The present study revealed a highly increased respiratory activity during the 'Hot' season. During the 'Hot-humid' season the bicarbonate level was further depressed, plasma volume also decreased, ECF volume showed a still further expansion, serum potassium level decreased further and blood chloride level increased over the 'Hot' season values. But, serum sodium alone showed a significant increase. The higher rate of pulmonary ventilation which triggered the changes in other parameters was operative during the 'Hot-humid' season also. But when the already contd.....
sodium-deficient animals overbreathed it might have led to a conflict between the two regulatory functions of the kidney. It appears probable that the regulation of acid-base balance was sacrificed for a more vital need, the conservation of sodium. This might have taken place most likely through the agency of the sodium conserving hormone of the adrenal cortex - aldosterone. This aldosterone activity might have resulted in increased serum sodium level leading to further reduction in serum potassium. Chlorides might have been passively reabsorbed along with sodium and this increase in sodium chloride might have caused an expansion of ECF volume.

c) Observations so far made on changes in heart rates, when exposed to thermal stress, have been conflicting. The present study indicated that, the difference in cardiac response to thermal stress could be attributed to a difference in the behaviour of blood volume under thermal stress. Thus, when plasma volume expanded under thermal stress, it had a superimposed bradycardial effect over the actual tachycardial effect of elevated temperature. On the other hand, when blood volume was found to be reduced as in the present study, it resulted in a tachycardial effect over and above the direct action of elevated temperature. It was also found that by taking 'waking time' observations of heart rate alone confusions arising from the effect of feeding and excitement could be avoided.

10. The data on physiological reactions were effectively put to use to formulate a modified heat tolerance coefficient contd........
for the tropics as follows:

* Dairysearch Heat Tolerance Index

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\frac{.5 x_1 + .2 y_1 + .3 z_1}{x + y + z}
\]

where \(x\), \(y\) and \(z\) are the normal values of rectal temperature, respiratory rate and pulse rate. \(X_1\), \(Y_1\) and \(Z_1\) are the mean observed values of rectal temperature, respiratory rate and pulse rate taken before and after exposure to sun on a clueless summer day for six hours. This is an improvement over many of the existing indices.

11. On the basis of the observations, it was concluded that the Sahiwal were more adapted to the environmental conditions prevalent at this research station, mainly due to their superior surface evaporation and smaller body size. But the crossbreds showed the remarkable quality of retrieving this situation by a thrifty utilisation of nutrient energy, day to night shift in feed intake, increased respiratory activity and maintenance of more alkali reserve during the relatively comfortable seasons. The fact that the rectal temperature of the crossbreds was similar to that of Sahiwal throughout the year and under different shelter conditions indicated that the crossbreds succeeded in preserving homeothermy to a similar extent. Thus, even though, their homeothermic mechanisms were different from those of Sahiwal, and perhaps less commendable, they achieved the same results with regard to thermal adjustments indicating that the crossbreds could face the thermally

* Tentative name given to the modified index.

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adverse climate in the tropics successfully. Their greater reliance on mechanisms other than surface evaporation is suggestive of the fact that they may perform better in hot-humid areas than pure-bred Sahiwal.

Based on these results, certain simple and effective managemental procedures could be recommended for the cross-bred animals under the tropical and subtropical conditions.

Providing shelter during the day time and turning them out during the nights in the hot season could prove very effective. The same objective could be achieved by providing shaded courtyards attached to the cowsheds in which animals are loosely housed with freedom for seeking shade or sun according to their will. However, during winter this might not be economical if the animals exposed to cold winds in the outside start consuming more for the purpose of maintenance of body temperature. In the present study, however, the animals did not show any such tendency. From the economic point of view, a study involving assessment of milk production, feed intake and cost of production under different shelter conditions would be necessary.

Further, for imparting thermal comfort to the animals it appears advisable to feed them roughages in the evening, allowing them to continue to eat during the nights. This would, incidentally, mean a higher heat production on account of...
of normal fermentation during the cooler hours, thereby causing less problems for homeothermy. This could be achieved easily by providing managers in the courtyard.

It is hoped that the findings and conclusions obtained from this investigation will serve the dairy husbandryman in a useful way and help him in using cross-bred animals for profitable production, by orienting his management practices suitably.