Chapter I

INTRODUCTION

History of animal breeding through ages reveals that cross-breeding among cattle has been one of the important tools in the improvement of livestock. Most of the important breeds of cattle of today came into existence by the combination of qualities of different types and breeds, engineered by some of the pioneers in cattle breeding.

It is an accepted fact that a major contributory factor to the low productivity of indigenous tropical cattle is the poor inherent productive capacity. Progress through selective breeding of indigenous cattle is too slow to register any significant impact on tropical dairy industry in the near future. The production responses of zebu cattle to improved nutrition and managerial practices are less than those of the exotic breeds. This indicates that many strains of existing Bos indicus cattle have a low gene frequency for high production. The zebu has evolved in an environment of recurring scourges of thirst, famine and disease. Hence, the ability to survive, not better productivity, was the main criterion for the selection enforced by nature. As such, the selection pressure on production, as rightly pointed out by Mahadevan (1966), would have been under such circumstances, low or absent altogether and might well have been negative if high production had a low survival value. Even in the present day, when problems of water supply, diseases and
feeding have been more or less taken care of, a sufficiently strong selection potential for better production is lacking because of various socio-economic reasons prevalent in some of the major tropical countries. The tropical dairy farmer is, therefore, left with only one choice if he wants to achieve a break through, the choice of increasing the frequency of genes for high dairy production from an external source. The source which strikes the mind spontaneously is the highly evolved B. taurus cattle, which have demonstrated possession of such genes to a desired level. Scientific opinion had swung away from all exotic stock in the direction of the improvement of indigenous stock in the nineteen twenties and thirties due to the set-back suffered in the form of disintegration due to diseases and poor management. But in forties and fifties the pendulum began to swing back in favour of exotic cattle and their crosses, thanks to the tremendous strides achieved in disease control and environmental and nutritional aspects of management. Thus, introduction of B. taurus genes has become a realistic proposition by which tropical dairy farming can hope to achieve a leap-forward.

Pure-breeding of temperate cattle in arid-subtropical regions is possible, as has been demonstrated in Israel. However, in countries like India, where the conditions are not so conducive yet, it seems that cross-breeding of indigenous stock, with a suitable B. taurus breed is likely to be a more reasonable approach. The nutritional and managemental atmosphere has improved remarkably, but not to the extent required for pure-
breeding of temperate cattle. Notwithstanding this, the economic considerations also pose problems which come in the way of import of high pedigree exotic stock in sufficiently large numbers. In view of this, cross-breeding and not pure-breeding of temperate cattle, has been suggested as the immediate answer to the problems posed by our dairy farming industry. This, if properly carried out, is expected to produce at least a better grade of dairy stock, if not the one matching the pure-bred taurean cattle.

An example of a similar effort is the outstanding case of Jamaica Hope evolved in Jamaica by crossing Jersey with Sahiwal. Military farms in India have registered a substantial increase in milk production by resorting to cross-breeding. But the outcome at many other centres in India has not been so promising. The failure of most such attempts could be attributed to poor nutritional and managemental status, small numbers of animals used in the particular cross-breeding programme, lack of proper culling, and failure to give proper attention to heat tolerance and disease resistance. In many of the projects, non-descript mongrel cattle were used as parent stock for cross-breeding. Their low standards and heterogeneity resulted in developing hap-hazard strains, the production standards in such instances being far below the expected projection targets.
It is with this background that the National Dairy Research Institute, Karnal, which was maintaining herds of pedigree zebu milch breeds like Tharparker, Sahiwal and Red Sindhi, adopted a cross-breeding programme using imported Brown Swiss semen from the United States of America. It has been noticed that the milk production of the milch cattle in this farm has remained more or less stagnant for several years around 2020 kg/305 days, in spite of selective breeding (Anon, 1966). The small year to year fluctuations have been attributed to environmental factors like feed and climate, thus indicating that the improvement by selective breeding in the herd has possibly approached the upper limit. It was felt that bulls with much better genetic constitution are required for further improvement. To find better zebu bulls than what the institute possesses at present, is difficult. As such, introduction of \textit{B. taurus} genes was recommended as a means of further progress. So, in the limited perspective of improving the performance of the institute herd and in the wider perspective of studying the performance of, and recommending a suitable zebu-taurus combination for country-wide consideration, this institute came forward with a systematic cross-breeding programme, involving pedigree Sahiwal cows and Brown Swiss sires. The information and experience available from various cross-breeding stations in this country were taken into account while planning the cross-breeding project at this institute.

In a sound cross-breeding programme, the abilities of a high-yielding and comparatively heat tolerant exotic breed
should be combined with those of a good producing zebu breed. In doing so, one can expect to evolve a new breed, in course of time, which possesses the good qualities of both. From that angle, a cross between Sahiwal and Brown Swiss is expected to be an ideal one. Brown Swiss has a reasonably high level of production, which compares favourably with any other western breed. As regards heat tolerance, it is ranked at the top among European breeds (Johnson and Bagadale, 1959). Sahiwal, the zebu counterpart, is the best dairy breed among zebu cattle (Williamson and Payne, 1959).

A subjective analysis of the results of such a crossing is possible, only after gaining experience over a number of years. But the evaluation of the first filial generation is important, as it should be able to guide in a certain objective manner to evaluate the fruitfulness of such an undertaking. Many types of investigations are possible, in the beginning itself, to predict the future performance of an animal, which could be of immense significance to the future of dairying in India. All such investigations can be classified into two categories. One is to assess the production traits of the animals and the other to study their physiological adaptability to the local conditions.

The dairy industry is primarily concerned with increasing the milk production of the cattle and therefore the first question that has to be asked is "How efficient the Sahiwal-Brown Swiss cross-bred is, in producing milk in a tropical environment?"
A farmer would like to know whether the cross-bred is capable of full expression of its genotype in terms of milk production in the climatic conditions prevalent. An animal which is capable of producing, in an apparently adverse environment, commensurate with the level expected of it as judged from pedigree and other genetic considerations, can be adjudged, to a very great extent, adaptable to the local environment.

Some workers like Sundaresan (1966a) propose that, in assessing individual animals for their worthiness for tropical dairy production, one need give attention to their level of production only. In other words their argument goes to say that the milk yield at a particular period is the net result of the physiologic adaptive mechanisms which have been brought into play to counter the adversities of climate and that if an animal is capable of producing at a desired level in an adverse tropical climate, it can be deemed fit for that region. This line of thought holds good if it is regarding a large population of individuals reared in a certain region for a sufficiently long period. Even in limited populations and studies of short durations the assessment of the productivity of an animal is of paramount importance. But the argument that evaluation of milk yield alone can give all relevant information regarding the adaptability of an animal does not hold good in cases of observations of short duration on a small population. Such an assumption, based on limited experimentation is not safe for drawing generalized conclusions applicable on a country-wide basis. The initial
success in production achieved in such experiments can be misleading. In a highly organised farm like the National Dairy Research Institute, where the nutritional and managemental standards are of reasonably good order, the physiological stress may not manifest itself on production levels to such a great extent as to be felt immediately. Improved managemental practises might serve as a temporary mask denying expression for the physiological strain, which would otherwise manifest itself sooner under field conditions, where managemental and nutritional standards cannot be expected to be of a high order. On the other hand, a critical analysis of the physiological status of the animal would reveal tendencies of many susceptibilities and weaknesses that would manifest in less ideal conditions, resulting in uneconomic production, if not a total derangement.

Environmental heat in tropical and sub-tropical regions presents at all levels of biological organisation a stress that brings into play, in the homeothermic animal like the dairy cattle, a complex of nervous, endocrine, humoral and motor functions. All these combine to restore a constant body temperature and to adjust body fluid and electrolyte balance, energy metabolism and behaviour to the needs concomitant with survival in the new environment. The well-being and healthy production of an animal under an adverse environment depends on the power of such homeostatic mechanisms to operate effectively, resulting in the maintenance of normal conditions. The sum-
total of all these mechanisms has been loosely termed as heat
tolerance. Lee (1953) defined heat tolerance as an animal's
ability to escape adverse consequences of direct operation of
hot conditions, i.e., it is the measure of its ability to
withstand heat when all other factors are constant.

While evaluating an animal for tropical production,
the interpretation of the reactions of an animal to meteorological
conditions is of immense informative value in distinguishing
the physiological differences existing between breeds and even
among individuals. A detailed physiological assessment in
association with the study of productive performance appears to
be more desirable in evaluating an animal for adaptability.

Bredy (1948), while justifying the cause of planned
animal climatological studies, has discussed the major agricul-
tural and economic reasons for such types of studies. These are:
(1) "how do the changed conditions affect the productivity,
health and longevity of the animals?", (2) "how wise is it to
import animals from different climatic regions?", and (3) "that
the farmer wishes to know before he spend his money on farm
shelters, the most desirable and economical hot and cold weather
shelter." These queries, closely linked with the economy of the
farmer, are pertinent under Indian set up, or for that matter
any set up. The answer to these lies in an accurate knowledge of
'the limits of endurance'. In other words, one must try to
obtain a sensitive assessment of the physiological adaptability
of an animal along with its productive performance for any
accurate assessment of its suitability for a particular climatic niche. The present study has, therefore, been planned so as to constitute two parts, the first one aimed at the evaluation of the productive performance of the cross-breds and the second one dealing with their physiological adaptability. The former gives a direct answer to the question the industry is primarily concerned with, subject to limitations mentioned earlier, and the latter could under-line the validity of whatever conclusions we arrive at, in the former case. The first one involving the actual study of the milk yield of the cross-breds could tell, subject to further confirmation from the physiological studies, whether the progress achieved has been adequate and whether the animals were producing at their optimal level without hinderance from environmental stresses. This could guide us in the proper direction and provide objectivity to the physiological studies. By no mean it should be mistaken as a fullfledged study of the genetic constitution for milk production. It has validity only in the form of a guide-line serving to lead us in the pathway of physiological adaptability studies aimed at evaluating the suitability of the cross-breds to a tropical environment.

The whole investigation was so designed and directed that the animals under the study were subjected to evaluation of adaptability from different angles, taking into account the primary and secondary changes in the physiological set-up on an animal as a sequel to environmental stresses. The study was
mainly directed towards assessing the efficiency of the homeostatic apparatus with emphasis on the homeothermic mechanisms, of the Sahiwal x Brown Swiss (F₁) cattle as compared to pure-bred Sahiwal stock. The validity of such a comparison was thought to be sound since Sahiwal, being indigenous stock, are supposed to be well adapted to the climatic conditions prevalent locally where they have been for generations. The comparative studies were adopted to reveal the behavioural deviation in the cross-breds from that the indigenous stock. The information would lead to the evaluation of the degree of favourable physiological set up inherited by the cross-breds from their, comparatively, more heat tolerant dams. As a part of the study of physiological adaptability of cross-breds, the beneficial effects of housing was also investigated. The objective was to find an answer to the question whether housing would reduce the stress on the animals to a significant degree.

The review of literature presented in the subsequent chapters reveals that almost all the studies on physiological adaptive responses of B. taurus x B. indicus crosses have been carried out in psychrometric chambers in which ambient temperature and humidity were adjusted to simulate tropical climate. While they give valuable basic information for prediction of the performance of these animals in a tropical climate, they may not find direct application in the field where other factors like radiation, rain, wind velocity, nutritive value of fodder, etc., may influence and produce a totally different physiological state.
in the animal. Therefore, it is important to have field studies to assess the adaptability of a particular breed of cattle to a certain climatic region.

The advent of field studies in India can be traced to the work of Minnisi (1946) and his co-workers. Studies involving water buffaloes are in progress at Mathura, organised by Roy and his co-workers. At Izatnagar, Mullick (1960) carried out field studies on hill cattle. At the National Dairy Research Institute, Rasdan (1965) conducted an extensive study of the heat tolerance and allied physiological functions of Tharparker cattle. But reports on field studies involving cross-bred cattle to assess their physiological adaptability to tropical conditions are scanty. Even though some field studies were planned to be organised on all India basis under the supervision of FAO experts, somehow these did not make much of a headway. Therefore, it was felt that a wide gap in the knowledge in this field is remaining unfilled and that it would be worthwhile to attempt to fill the same. As cross-breeding has been accepted as a National policy, such a study becomes an immediate necessity, the results of which could be of National importance.

The author agrees with Rasdan (1965) that Karnal is an ideal place for climatological field studies because of the wide range of climatic conditions available during different months of the year. Located in Haryana State, this place has formed a natural habitat for some of the finest zebu milch breeds like Sahiwal and Tharparkar. This place has a latitude of 29.7° and
longitude 77°. The elevation is 253 meters above mean sea level. The climograph of Karnal (fig. 1) clearly shows the extreme variation in climate during different seasons. Mercury passes 43°C during May–June – July. In December–January, temperature falls to the freezing point. In July–August the summer showers result in the climate being hot and sultry. During March–April and October–November the climate is pleasantly mild. This place experiences different shades of environmental conditions which can be approximated to climatic conditions prevalent in different climatic pockets in the country. India, though essentially a sub-tropical country, has different climates in different regions. South India is hot almost all round the year. Variation in climate is caused mainly by rainfall. The coastal strips of the peninsula experience heavy rains and, therefore, remain hot and humid, the central Deccan plateau being hot and arid. All of North India experiences extremes of summer and winter, with the exception of Himalayas and its foothills, which experience only mild and cold climate. Rainfall is heavy in the eastern states of Assam and Bengal; and, as one comes more and more to the west across the Indo-Gangetic plains, the rainfall gradually tapers off. In Rajasthan we come across arid or semi-arid climate. It will be highly exaggerated if it is stated that Karnal has a prototype of the climates of all such climatic zones in India. But it can be safely stated that the various seasons here, which are so wide apart in climatic conditions, can represent approximately, for purposes of adaptability studies, some of the major climatic zones in the country. Thus, the physiological well being of the cross-
breds in a particular season can be interpreted to mean the adaptability of those animals to an area having approximately the same climatic conditions during a major part of the year.

Thus the experiment was planned to assess the physiological adjustments produced in response to climatic variations in the Sahiwal x Brown Swiss cross-breds vis-a-vis in pure bred Sahiwals. The aim was to make out the subtle changes brought about by nervous and humoral reactions in response to the operation of various climatic stresses on them. These studies were expected to throw light on the physiological susceptibilities of the cross-breds. This would tell whether the cross-breds which apparently perform well with respect to growth and production in a comparatively protected environment with adequate nutrition, would maintain the same standards in the field conditions, where housing and managerial practices may not be so ideal. By doing so, the criminal wastage of time, money, skilled labour and, above all, the valuable pure-bred stock, which would happen in a faulty breeding programme, could be avoided. If, on the otherhand, the cross-bred generation is found to be in a sound physiological state in the face of an adverse environment, the future productivity is more or less safeguarded and the cross-breeding programme can be vouchsafe.

The present series of investigations produced some interesting results in this direction, which are discussed in detail in the following chapters.