A MODEL OF REASONS FOR BREED DIFFERENCES
IN GROWTH OF CATTLE IN THE TROPICS

J.E. FRISCH*

Summary

A model has been developed which describes the importance of, and the reasons for combining the productive features of the Bos taurus with the adaptive features of the Bos indicus to increase growth rate of cattle in tropical areas. The differences in field growth rates of various breeds have been partitioned into proportions due to environmental and genetic constraints. The relative importance of each component as it affects growth can be assessed and areas in which improvements in growth can be made are identified. This approach allows the definition of breed types which grow best in a particular environment and enables producers to make a rational choice of breeds best suited to their conditions.

I. INTRODUCTION

Growth rate of Bos taurus breeds is high in temperate areas but declines markedly in the tropics. The Bos indicus breeds are well adapted to the tropics in terms of survival but their growth rate is also low compared to temperate standards. This paper outlines the development of a model to explain the reasons for the low growth rates of both breed types under tropical conditions. It also explains the necessity of combining both the productive features of the Bos taurus breeds and the adaptive features of the Bos indicus breeds to increase growth rate over that of either parental breed.

II. METHODS AND MATERIALS

The model has been developed from results of experiments mainly at "Belmont" Rockhampton which have demonstrated the differential effect of environmental factors on the growth of different breed types. The environmental factors so far identified are cattle ticks (Boophilus microplus), gastro-intestinal helminths, high ambient temperatures and solar radiation, "pinkeye" disease, and the fluctuations in both quality and quantity of available forage. The Bos indicus breeds used were Brahman and Africander, the Bos taurus breed was Hereford x Shorthorn (HS) and the crosses between the two breed types were F2 and later generations of Africander x HS (AX) and Brahman x HS (BX).

III. RESULTS AND DISCUSSION

Figure 1 is a diagrammatic presentation of the model. Each block is composed of segments of liveweight attributable to each factor which together account for all the differences in liveweight between breeds. The lower segment represents the weight of each breed reared under field conditions (Frisch 1972). At 15 months of age the mean weights (kg) were: HS 272; Brahman 274; Africander 286; AX 306; BX 321. These results are characteristic of the ranking of the breeds at "Belmont" over several years (Kennedy and Chirchir 1971; Frisch unpublished). The weights reflect comparative growth rates of the breeds grazed together under conditions of a low level of control of endo- and ecto-

* CSIRO Division of Animal Genetics, Tropical Cattle Research Centre; Rockhampton, Qld.
parasites, no alteration of heat loads and where no animal was offered supplementary feed or treated for "pink eye".

FIGURE 1

A model of reasons for differences in growth of different breeds

Each other segment represents the depression in growth which can be attributed to environmental or genetic constraints. The differential reduction in liveweight caused by infestation with cattle ticks and gastrointestinal helminths has been analysed by Turner and Short (1972). The increases in gains in liveweight in 27 weeks due to tick control were: HS 27 kg; AX 10 kg; BX 3 kg. These differences account for about 40% of the difference between HS and BX in observed field growth rates. The differential breed responses to the presence of cattle ticks were accounted for by differences in the number of ticks which matured on each breed. The low numbers of ticks which mature on purebred Africanders and Brahman (Seifert unpublished) relative to the other breeds indicate that the effect of ticks on these two breeds is correspondingly less than the effect on the AX and BX.

The response to anthelmintic treatment for each breed was: HS 18 kg; AX 22 kg; BX 1 kg. These differences in helminth tolerance represent about 30% of the observed difference between HS and BX and more than the observed difference between AX and BX in liveweight under field conditions. Again, only limited data were available for the pure-bred Brahman and Africanders but at least for the Brahman, the affect
of helminths would be correspondingly lower than for the BX.

Turner (1962 and unpublished) has shown that differences in toler-
ance to high ambient temperatures and solar radiation accounted for a
further 15% of the difference in field liveweights between HS and BX.
Difference in heat tolerance of the Bos indicus based breeds is small
(Vercoe, Frisch and Moran 1972).

Differences in resistance to "pinkeye" are associated with a reduc-
tion in mean weight of eight kg in the HS, one kg in the AX and BX and
zero in the purebred Brahmons (Frisch 1975) and accounts for another 20%
of the difference between HS and BX in liveweight at 15 months.
Similarly, differences in ability to cope with fluctuating nutritional
conditions account for about another 10% of the difference between the
HS and BX (Vercoe and Frisch 1974).

Each of these environmental constraints acts to restrict the growth
of the different genotypes to varying degrees primarily through a
reduction in appetite (e.g., Seebeck, Springell and O'Kelly 1971; Vercoe,
Frisch and Moran 1972). Under field conditions where these constraints
are operating it would be expected that appetite and consequently growth
of the HS would be markedly depressed, that of the purebred Brahmons
would hardly be affected, whilst the AX would be more affected than the
BX. Despite the small effect of these environmental constraints on the
appetite of the Brahmons, under field conditions they grow only margin-
ally better than the HS and considerably slower than the AX and BX. In
the absence of the constraints the appetite of the Brahman is lower by
about 20% than that of the HS at the same liveweight (Frisch and Vercoe
1969) . This is the only factor so far identified which accounts for
their low growth rate. Under field conditions, growth rate of the HS is
low because environmental constraints restrict intake; growth rate of
the Brahman is low because its inherently low appetite restricts intake.

The BX has inherited an intrinsic appetite about midway between
that of the HS and the Brahman (Frisch and Vercoe 1969; Vercoe and
Frisch 1974 and unpublished). It has inherited from its Brahman parent
the ability to cope with environmental constraints and consequently,
appetite and growth are only marginally reduced in the presence of these
constraints. 'It is the combination of both productive features (inher-
ently high appetite and growth rate) and adaptive features (resistance
to environmental constraints) which confers on the BX the attributes
essential for high growth rate under tropical conditions. Neither
feature alone will give high field growth rates.

The AX is not quite as well adapted as the BX to conditions at
"Belmont". However, it has an inherent appetite greater than that of
the BX but less than that of the HS. In the absence of environmental
constraints the AX could be expected to grow more rapidly than the BX
but less rapidly than the HS, for inherent appetite then becomes the
major determinant of ranking on growth rate. Hence, under feedlot
conditions the Bos taurus breeds have higher growth rates than the Bos
indicus purebreds or crossbreds. Insufficient data were available for
the Africanders to include them in the model. However, available data
suggest that they would rank with the AX in the same way as the Brahman
ranks with the BX.

This type of analytical approach can be useful to the animal
breeder. Major constraints which limit growth in a particular environment and breeds which can cope with those constraints can be identified. It is then possible to predict the expected ranking for growth rates of diverse breed types in any particular environment. Breeds with complementary strengths can then be combined to produce the most desirable crossbred. This could largely eliminate the hit and miss approach common in comparisons of growth rate of crossbreds and the apparent contradictions caused by different rankings of breeds compared in different environments. The magnitude of each constraint as it affects particular breed types can also be assessed. It is then possible to determine where the greatest gains in improving growth rate can be made, e.g. improving adaptation would markedly improve the growth rate of the Brahman but have a small effect on the Brahman in which increasing inherent appetite could be expected to give the greatest improvement in growth.

The model can also be useful to the beef producer. A knowledge of environmental constraints and the ability of various breeds to cope with those constraints allows the beef producer to make a rational choice of breed type. He can decide whether he is prepared or can financially afford to alter the environment sufficiently to be able to achieve optimum growth from an unadapted breed or whether he would be financially better off to use a genotype able to cope with his existing environmental conditions. He can also assess financial gains likely to be obtained from instituting a particular management practice on his existing breed type, e.g. in areas of high tick burdens, dipping cattle of more than half Brahman content will decrease financial returns but dipping straight Bos taurus cattle will increase returns though not to the level from the undipped Brahman crossbreds. He also has the opportunity to explain the differences in growth between his own cattle and those of others reared under different management conditions. This may help remove some of the emotionalism attached to the choice of breeds and management practices.

IV. ACKNOWLEDGEMENTS

Thanks are due to colleagues at the Tropical Cattle Research Centre who contributed components and stimulated the development of the model.

V. REFERENCES