DEFINITION IN BEEF CATTLE IMPROVEMENT:

SUPPLEMENTARY NOTES - NORTHERN AUSTRALIA

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The economic objective of beef production in northern Australia is the same as elsewhere. The aim is a favourable relation of market value of product to costs of feed and other resources, where the unit of production comprises the lifetimes of a dam and her progeny, excluding her replacement. In an extensive, tropical, pastoral environment, the feed available alternates between seasons of super-abundance and of limitations of quality rather than quantity. There is a tendency to see the feed resource as "free". Yet the main costs are in provision of this feed, and its efficient utilization remains the main aim.

One relevant aspect is that the system of production should be economic in the long term. It should allow for sustenance of range-lands, and conservative reliance on damaging or possibly short-lived inputs (fertilizers, cultivation, pesticides). Such considerations of ecology and resource dependence influence breeding aims.

The primary animal characters which represent the objective for improvement, and are to a large extent selection criteria, are reproduction, growth, survival, and carcass value.

REPRODUCTION

Fertility is a function of two broad components:

a) Inherent neuro-endocrine, morphological, and behavioural factors which govern potential fertility, and

b) Adaptations to stresses such as parasites, heat, nutrition which affect realization of inherent capacity.

These adaptations are the same as those affecting growth and survival. In both components there is genetic variation, and their relative importance differs in different contexts. Some breeds appear to suffer mostly from short-comings in a), others in b).

In contrast to temperate situations, breed compositions of populations and their reactions to the environment are such that heritability estimates for female fertility in the range of 20-40% have been found. Repeatability is also such that over-mating of heifers and culling of non-calvers can eliminate sub-fertile breeders and yield acceptable phenotypic fertility of the mature herd. In practice, culling on calving performance varies in different herds from nominal to effective.

There are unresolved problems in screening of bulls for their own fertility, or selecting bulls to improve fertility of their male or female progeny. Promises of means of selecting for factors underlying fertility are emerging from research.

GROWTH

Selection experiments in which sires have been selected for high or low weight gain have shown good responses in growth of their progeny. Objective performance recording is a live topic in Queensland so, while its extent is still quite limited, it is beginning to apply pressures that cut across traditional sources of bulls.

While significant progress can immediately be made by any application of performance recording, there is going to be need for some refinement. A basic question is the phase of growth at which or during which weight or gain is measured. Rapid maturing (i.e. rapid approach towards mature, slaughter, or breeding weight) is the main criterion of efficiency. An animal that matures relatively rapidly early in life must *ipso facto* mature relatively slowly later. As an exaggerated example, an animal which has grown rapidly and reached 90% of its mature weight at a given age so that its growth is almost finished, must subsequently grow slower than one which has reached 70% and has 30% still to be realized. A simple model suggests that the turnover point where the rankings reverse may be in the neighbourhood of 60% of mature weight. Theoretically, if selection is for growth about this phase it is exclusively for mature size, earlier it is for rapid maturing, but later it is against early maturing.

Generally weight at a given age is preferred as a selection criterion to growth rate during a period post-weaning. This is largely because it has higher heritability, but in most phases it has a higher component of mature size. An increase in mature size may be acceptable or undesirable but in any case it is less desirable than maturing rate and its genetic variance may partly account for the higher heritability of weight.

Because of these considerations, there is need to build bridges between the implications of models of ideal growth and empirical features of the far from ideal growth displayed in the field. It is surprising that there are not firmer foundations for deciding the most efficient criteria of growth under different conditions, and the decisions are still rather arbitrary.

There is genetic variation in a range of adaptational factors with major impact on growth: tick resistance, helminth resistance or tolerance, disease resistance, heat tolerance, drought tolerance. On the other hand, inherent growth capacity, such as would be expressed in the absence of environmental stresses, is also a significant component of growth realized in the field. This is the component that makes Brahman x British derived cattle superior to the well-adapted Brahman under most conditions. The pressure applied to it when selecting simply for observed growth may be strong, weak, or even negative depending on the population and the environment (see below). Means of incorporating selection for it in a controlled discriminating way is a problem for research.

SURVIVAL

Survival at the various phases of the life cycle is an objective, but not a selection criterion except by the agency of Nature. The adaptational factors common to other aspects of performance are operative.

CARCASS VALUE

Well controlled research reveals genetic differences in fat/muscle ratio, distribution of fat, proportions of relatively valuable muscles and tenderness. A high growth rate is favourable to carcass quality and it is the main means of achieving efficiency, including carcass value. Residual variation in the latter, independent of growth rate, is of limited commercial significance. Differences in total body composition (reserves of fat and protein) may be relevant to overall efficiency in the dynamic situation of seasonal gains and losses of body weight.

BREEDING OBJECTIVES IN RELATION TO ENVIRONMENT

The objectives that can be defined for selection, and the results achieved by applying particular selection criteria, are strongly dependent on the environment in which performance is measured. This is true of either aspect of performance, growth or reproduction. Features of natural environments across northern Australia, and managerial difference even within regions, interact strongly with genotypes. Different breeds or crossbreds, or different individuals, when assessed for relative merit in growth rate or fertility, rank differently in different environments. The case for adhering strictly to selection in the target environment, and avoiding special treatment of candidates for selection, is particularly strong and is becoming more widely accepted.

In a typical field situation featuring stresses of heat, parasites, disease, and drought, the qualities of adaptation found in *Bos indicus* cattle are advantageous. In a more benign environment, the high eating capacity, growth potential and reproductive capacity of *Bos taurus* cattle can be expressed and are advantageous. Over a range of environments, the most desirable proportion of *B. indicus* characters increases as the level of stress increases. Defining a suitable animal thus in terms of percent zebu is a first approximation, to be built on by selection.

Similar principles of combining complementary characters apply within breeds or crossbred lines, but there are problems. Though they are not all well quantified, there are genetic correlations between characters. Adaptive characters are positively correlated with productivity realized in a typical field situation. They can be adopted as objectives or used as aids to selection. Rating for tick resistance, for instance, is already being applied to some extent.

However, there is a tendency for negative genetic correlations of adaptational characters with characters of *inherent* productivity (which in turn is a component of productivity realized in the field). The low maintenance requirement conferring drought tolerance is generally associated with reduced appetite and growth capacity under favourable conditions. The same low metabolism and heat production is one possible component of heat tolerance, so selecting for heat tolerance may reduce inherent productivity. Even parasite resistance, to the extent that it is conditioned by relative plane of nutrition, may under limiting conditions be achieved by reducing maintenance requirement and thereby reducing potential productivity.

So there are components of adaptation that are unfavourable to *inherent* productivity, though others (e.g. immunological in relation to parasite resistance, sweating rate, etc. in relation to heat tolerance) which are probably fairly free of complications. There is the possibility then of side-stepping or breaking unfavourable correlations. In particular, an

objective worth investigating is the capacity to turn metabolism up or down to exploit or withstand current seasonal conditions - a mild form of the versatility of a hibernating animal.

Selection for a performance character, e.g. growth, may change the characters determining it in various ways depending on the starting population and the environment, i.e. depending on what characters are most limiting. It may increase adaptation but decrease inherent productivity as a correlated response, or *vice versa*. Seasonal and year to year variations in environment may confound progress by changing the pressure on different characters. There is need for more discriminating selection applying pressure to an optimum mix of component characters.

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