Environmental stressors such as parasites, poor nutrition and high heat and humidity affect the growth and reproductive performance of cattle grazed in tropical and sub-tropical areas. Beef CRC research shows that breeding cattle that are productive in their presence is the best approach.

**Stressors faced by cattle in the tropics and sub-tropics**

Cattle grazed at pasture in tropical and sub-tropical areas experience numerous environmental stressors that reduce the growth and reproductive performance of animals and decrease their beef quality. The stressors include parasites (cattle ticks, buffalo flies, gastrointestinal helminths or worms), seasonally poor nutrition, high heat and humidity and diseases, often transmitted by parasites.

The impact of each stressor on production and animal welfare is often multiplicative rather than additive, particularly when animals are already undergoing physiological stress such as lactation. Hence under highly stressful conditions, cattle deaths can occur due to the stressors. Under extensive production systems common in the tropics it is generally not possible to control the stressors through management strategies alone. Therefore the best method of reducing the impact of the stressors to improve productivity and animal welfare is to breed cattle that are productive in their presence, without the need for managerial interventions.

**Consider the impacts of productive and adaptive traits**

In every production environment, factors limit beef production, meaning no one breed is best in all environments. Comparative rankings of different cattle breed types for different characteristics in tropical environments are shown in Table 1. Any cattle breeding program designed for the tropics and sub-tropics must consider the impacts of both productive and adaptive traits, even though the adaptive traits (and some productive traits) are very difficult and/or expensive to measure. However the differing impacts of environmental stressors across the breed types indicates that genetic parameters and economic weightings for use in selection indexes must be specific for each breed type and environment.

**Table 1: Comparative rankings of different breed types for productive and adaptive traits in tropical environments (the more stars the higher the value for the trait)**

<table>
<thead>
<tr>
<th>Breed type</th>
<th>Temperate Bos taurus</th>
<th>Tropical Bos taurus Sanga</th>
<th>Bos indicus Brahman</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>British</td>
<td>Continental</td>
<td></td>
</tr>
<tr>
<td>Productive traits:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Fertility</td>
<td>★★</td>
<td>★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Mature size</td>
<td>★★★★</td>
<td>★★★★★</td>
<td>★★</td>
</tr>
<tr>
<td>Beef Quality</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Adaptive traits:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle ticks</td>
<td>★</td>
<td>★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Worms</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Eye disease</td>
<td>★★</td>
<td>★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Heat</td>
<td>★★</td>
<td>★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>Drought</td>
<td>★★</td>
<td>★★</td>
<td>★★★★★</td>
</tr>
</tbody>
</table>
Simultaneous Genetic Improvement of Productive and Adaptive Traits

For traits to be included in effective breeding programs, they must be under direct or indirect genetic control. Direct genetic control is assessed by estimating the heritability of traits. Indirect control is achieved through favourable or unfavourable associations (genetic correlations) between different traits.

Beef CRC and earlier research primarily from northern Australia indicates that all the key productive and adaptive traits are at least moderately heritable in tropically adapted cattle reared at pasture in tropical environments, meaning they will respond to genetic improvement through crossbreeding and within-breed selection programs. In addition, no major antagonistic relationships have been found that would preclude simultaneous genetic improvement of all the traits in tropical beef breeding objectives. Studies at Belmont Research Station near Rockhampton showed that resistance to parasites and productive attributes such as growth and reproduction are largely genetically (though not phenotypically) independent, meaning selection for parasite resistance will not genetically change productive attributes or vice versa. However resistance to heat stress and productive attributes are favourably correlated, particularly in breeds that are not as well adapted as the Brahman, meaning that selection for growth or reproduction will improve resistance to heat stress and vice versa.

Strategies to maximise adaptation and production in different environments

Based on extensive reviews of the scientific literature, the Beef CRC has developed a number of ‘rules of thumb’ to optimally match cattle ‘genotypes’ (breeds or sire lines) to their production and marketing environments. These ‘rules of thumb’ as they apply to crossbreeding systems include:

- Depending on the severity of the environment and the level of stressor challenge, 25% to 75% ‘adapted genes’ are required for optimal production. Only exceptionally stressful environments (rare in Australia) require 100% ‘adapted genes’.
- Adapted genes’ can be derived from Bos indicus and their derivatives as well as the tropically adapted taurine breeds, providing an opportunity to use heterosis from crossbreeding and to maximise productivity without reducing resistance to environmental stressors below levels acceptable for the production environment.
- For most tropical environments, optimal levels of productivity and adaptation will be achieved using a combination of multiple breed types (e.g. Bos indicus, tropically adapted taurine, British, Continental).
- The harsher and the wetter the environment, the greater the need for some Bos indicus content to ensure sufficient adaptation to parasites (mainly ticks and worms).

Summary

In breeds that are well adapted to their production environment, there are no major antagonistic relationships to preclude simultaneous genetic improvement of both productive and adaptive traits through selection to maximise herd profitability. The major constraint to such genetic improvement is the difficulty and expense of measuring the complete range of economically important productive and adaptive traits required to achieve a balanced breeding objective. This same constraint also applies to genomic selection using DNA-based technologies, which offers new opportunities for tropical beef producers. Until phenotypes for these traits become available, beef producers in the tropics can confidently select to improve productive attributes in their cattle, knowing they are unlikely to compromise adaptation of their herds.

The best method of reducing the impact of the stressors to improve productivity and animal welfare is to breed cattle that are productive in their presence, without the need for managerial interventions.

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