Beef cattle production will have to adapt to climate change

M M Scholtz, G M Pyoos-Daniels, F J Jordaan & J Hendriks
ARC Animal Production, Irene
GScholtz@arc.agric.za

Ambient temperature is the factor that has the greatest direct effect on livestock production. Most livestock perform at their best at temperatures between 4 and 24°C. In Southern Africa the temperature regularly rises above this comfort zone, so it is important that livestock are adapted to these higher temperatures. The maximum daytime temperature is not the biggest problem, but if the minimum night temperature does not fall below 20°C, un-adapted beef cattle will show signs of tropical degeneration.

High temperatures reduce feed intake so that the heat produced in the digestive system can be less. Furthermore, the grazing time is shortened because the animals do not graze during the hot hours of the day, while sweating and water intake increase. Other factors involved in thermal comfort include the skin and coat of the animal (thickness, structure, thermal insulation, absorption and reflection) and conformation (shape, size and skin surface area).

Nutritional stress has the greatest indirect effect on the grazing animal. In warmer regions, the natural grazing has both a lower nutritional value and leaf density than in moderate regions. As a result, climate change has the greatest impact on ruminant species. Furthermore, heat stress is a common cause of reproductive inefficiency in cattle.

Climate change projections indicate an increase in the average temperature of between 1.5 and 2°C, which will range from 0.5°C at sea level to as much as 3°C in the eastern parts of Namibia and the western parts of Botswana.

Bull fertility

The semen quality decreases when bulls are exposed to high ambient temperatures. The sperm concentration decreases, sperm motility decreases and the percentage of morphologically abnormal sperm increases. After a period of heat stress, the semen quality will be affected for about eight weeks, due to the length of the sperm development cycle. Heat stress of one day can therefore have an effect on bull fertility for up to eight weeks. It is important to note that the eight weeks it takes for resumption of normal semen production after bulls have been exposed to heat stress can have a major effect on conception figures where fixed summer mating seasons are applied.

But how can the farmer reduce the negative effect of heat stress on bull fertility?

The temptation is to suggest that the bulls should be kept cool before the mating season, but this is not practical in the case of extensive beef cattle farming. A more practical approach would be for the farmers to have the fertility of the bulls tested again after heat waves have occurred. Bulls whose semen quality has been adversely affected can then be replaced during the mating season. Another strategy is to apply multi-sire mating's in both stud and commercial herds. In the case of stud herds, parentage will then have to be confirmed. Another option is to use bulls of more heat-tolerant genotypes, such as the Boran, when high temperatures are predicted. For that, however, we need accurate predictions for heat stress spells.

Cow fertility

The fertility of cows is also affected by heat stress. A high maximum ambient temperature has a great impact on the conception of the cow as heat stress affects the development of the oocyte (egg). In contrast, the critical period for embryo survival is the first seven days after fertilization. Thus, both the ambient temperature and the nutritional status of the cow can have a significant effect on the survival of the embryo during this period.

It turns out that certain embryos have the ability to better withstand elevated temperatures through certain biochemical mechanisms where so-called heat shock proteins are produced. In vitro (in the laboratory) studies have shown that female embryos can possibly withstand heat stress better. Embryos of Zebu and indicus types, such as the Boran, have also been found to be less sensitive to heat stress than the *Bos taurus* types.

Effect of selection

Increased selection for production traits tends to lead to a reduction in survival (fitness) and adaptability. Highly selected animals are less able to allocate their body reserves (internal energy sources) away from production to resistance or tolerance to stress factors. Animals that have adapted to stressors in specific environments (such as heat, cold, salinity, drought, etc.) can help elucidate the routes to adaptation and assist in the development of adaptation strategies. Information from locally adapted animals, especially those from less developed countries, can be utilized in the changing production environments due to climate change, by replacing the breeds currently kept by farmers. The Boran can play a role in this regard.

Alternative breeding objectives

Climate-smart breeding objectives should aim to increase production efficiency and not just production. Unfortunately, selection for some of the traditional traits increases production, but does not necessarily increase the efficiency of production. In the case of beef cattle, the three components traits of cow efficiency are the weight of the calf, fertility and the cow weight (which is an indication of her feeding requirements). A selection index should therefore be compiled that increases the weight of the calf and fertility, while keeping cow weight constant.

Likewise, it is important to select for the correct post-weaning traits. There are two alternative post-weaning measures of efficiency that deserves attention. They are residual feed intake and risidual daily gain. Residual feed intake is improved by reducing feed intake without altering growth, and residual daily gain is improved by increasing growth without altering feed intake. Animals with a low residual feed intake (more efficient) also produce less methane and consume less feed than high residual feed intake animals. They also produce less heat and digest feed better, making them more adaptable to the effects of climate change.

It is also possible to increase the resistance or adaptation of beef cattle to climate change through within-breed selection. The possible traits or characteristics for which selection can be considered include:

- selection for a smaller frame size (so that the animal can get rid of heat more easily)
- change of hair and skin color (lighter hair color and darker skin pigmentation)
- enlargement of the ears and navel skin (sheath)
- larger skin area and longer limbs such as legs and
- the identification of genotypes responsible for heat shock proteins that make individuals more heat resistant. Certain breeds and animals within a breed carry genes that can handle heat better.

These proposed changes are going to be quite challenging, because how are we going to convince breeders, for example, to select for smaller animals with longer legs, while most breeders have actually concentrated on heavier and stockier animals. Similarly, longer navel skins and sheaths will now have to be preferred, while this has usually been discriminated against. Note: prolapse of the sheath should not be confused with a longer sheath and prolapse should still be discriminated against in the Boran.

With about four to six livestock generations before the full impact of climate change hits animal production, significant progress can be made within-breed selection to counteract the negative effects of climate change. However, it will require dedication from all and breeders and breed societies and collaboration with scientists.

The use of adapted genotypes

The greater part of the Southern African environment will increasingly become dependent on breeding programmes that make use of tropically adapted (indigenous) breeds or genotypes. Fortunately, there are a large number of different indigenous, composite and tropically adapted genotypes in Southern Africa, including the Boran. These breeds can survive in difficult conditions and show a low susceptibility to disease, with good adaptation to adverse environmental conditions.

Alternative production systems

The effective use of crossbreeding can help to counteract the negative effects of climate change. Indigenous and other tropically adapted breeds can handle higher temperatures more easily, but their production is usually lower. When these breeds are crossed with British or European breeds, the principle of hybrid vigour is utilized. In Southern Africa, crossbreeding with our locally adapted breeds can be used as mother lines to cross with exotic breeds. In this way the production potential of the offspring will be improved. The role of the Boran in crossbreeding should be properly investigated.