CHALLENGES FOR BEEF PRODUCTION IN DEVELOPING COUNTRIES OF SOUTHERN AFRICA

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Introduction

Developing countries from southern Africa are confronted by many of the same socio-economic and beef production challenges. Furthermore, cattle are the most important livestock species in Africa The consequent similarities in climatic and agricultural conditions allows for many areas of similar interest and concern regarding beef cattle production.

The challenges discussed in this article relate to low beef production levels, the challenges posed by global warming, adaptation of genetic resources to the production environment, enteric methane production and low levels of performance recording.

CHALLENGES

Low production levels
The cattle sectors in these countries are highly dualistic with communal, subsistence or small scale farmers and large commercial farmers all co-existing. Whereas the off-take from the commercial sector is at an acceptable level, the off-take from the other sectors is still low in certain countries as a result of low fertility, high mortality, etc. A survey undertaken in South Africa demonstrated major differences in the different sectors regarding production levels (Table 1). These major discrepancies in production and throughput between the commercial, emerging and communal sectors are demonstrated in Table 1, and clearly indicate that aspects such as pre-weaning mortality, herd composition and calving percentage in the communal sector should be urgently addressed to improve production from this sector.

Table 1: Beef production information on the different sectors in South Africa

Trait	Commercial sector	Emerging sector	Communal sector
% Adult females in herd	52	49	25
Calving percentage	62	48	35
Pre-weaning mortality (%)	3.1	3.3	30.7
Post weaning mortality (%)	2.7	2.2	4.7
% Off-take	32	25	6

Although South Africa produces predominantly high-value grain fed beef, it is still a net importer of beef due to the low levels of production in the emerging and communal sectors. Except for Botswana and Namibia, all southern hemisphere African countries are net importers of beef.

Effect of global warming

Tropical and subtropical climates have both direct and indirect effects on livestock. Factors such as temperature, solar radiation, humidity and wind all have direct effects on animals, whereas factors such as digestibility of feed, intake, quality and quantity of grazing, pests and diseases, all have indirect effects on animals.

It is predicted that climate change will have a more extreme effect on the African continent than on any other continent. The anticipated global warming will change the southern hemisphere environments and vegetation of Africa. An increase of 2.5 °C is predicted for southern Africa, which is substantial.

One potential consequence of significant and permanent changes to the climate is altered patterns of diseases in animals. This may include (a) the emergence of new disease syndromes and (b) a change in the prevalence of existing diseases, particularly those spread by biting insects. Therefore animals will be exposed to different parasites and diseases as indicated from the predicted change in the distribution of, for example, Tsetse in Africa; putting an even greater pressure on production and the survival of livestock breeds. The OIE Scientific Commission has concluded that climatic changes are likely to be a factor in determining the spread of some diseases, especially those that are vector-borne. The two most mentioned emerging and re-emerging cattle diseases in a recent OIE survey were Bluetongue and Rift Valley fever.

In southern Africa Heartwater is considered to be the main tick-borne disease. Heartwater has a significant economic impact on livestock. Economic losses due to Heartwater are a result of the high mortality rate it causes, which ranges between 20 and 90% and the reduced productivity in both clinically ill and surviving/recovered animals which become chronic carriers of the disease.

Ambient temperature is the factor that has the largest direct effect on livestock production. Most livestock performs at their best at temperatures between 4 and 24°C. In the tropics and subtropics temperatures frequently rise above this comfort zone and it is therefore important that livestock are adapted to these higher temperatures. High temperatures and solar radiation decreases intake in order to reduce digestive heat production, and reduce grazing time (animals do not graze in hot midday hours), whereas sweating and water intake increases. Other factors involved in thermal comfort include the external coat of the animal (thickness, structure, thermo isolation, absorption and reflectivity) and body traits (shape, size and superficial area).

Nutrition stress has the largest indirect effect on the grazing animal in the tropics and subtropics. In these environments, natural pasture has both lower nutritional value and lower tiller density than in temperate regions. These tropical grasses (C4) have developed a different photosynthetic pathway to adapt to the climate. The C4 refers to a 4 carbon compound compared to a 3 carbon compound (C3) in temperate grasses. C4 plants have a higher photosynthetic rate, which results in high fibre content, low stem to leaf ratio, reduced digestibility and intake. Climate change will thus have the greatest impact on ruminant species.

As a result of global warming, livestock in the developing countries of southern Africa will need to adapt to higher ambient temperatures, lower nutritional value of the grass in some cases, and expansion of diseases, especially ticks and tick borne diseases. Under such challenges balancing genotypes with production environments will become a crucial element requiring the utilization of diverse genetic resources with appropriate genetic potentials for growth, milk production, resistance to disease and prolificacy. The question is how to measure adaptation and how to select for it.

Enteric methane production from beef cattle

Since 1980 scientific evidence of the effect human interference on the climate placed the question of climatic change and its environmental consequences on the world's political agenda. After various discussions, the Kyoto Protocol officially established goals for emission of greenhouse gas (GHG). for industrialized nations (UNFCCC, 2007). The document recognized that climate change is one of the greatest challenges of the present day and that actions should be taken to keep temperature increases to below 2°C.

Methane contributes 16% of total world gas emissions and is therefore the second most important GHG. Despite the highest concentration being carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have a heating potential 23 and 296 times higher than CO_2. Human-related activities producing methane include fossil fuel production, animal husbandry (enteric fermentation in livestock and manure management), rice cultivation, biomass burning, and waste management. It is estimated that more than 60 percent of global methane emissions are related to human activities. Enteric fermentation (animal digestive tract) is the main source being responsible for 28% of global CH_4 emissions.

In ruminants, CH_4 is produced by a specific group of bacteria called methanogenics, but may also be produced by protozoans. As CH_4 cannot be metabolized by the animal or microorganisms, part may be absorbed by the ruminal wall, enter in the blood stream and released through respiration. Most, however, is eliminated by eructation with CO_2. From a nutritional point of view, methane represents a loss of energy by the animal of between 6 and 10% which is not converted to a product (meat, milk, wool, etc). This increases production costs and reduces profit.

Some studies have shown that the use of tanninferous legumes exclusively or in combination with grasses in pastures for ruminant feeds, may reduce enteric methane emissions per unit of dry matter consumed without affecting production performance.

Most research is focusing on manipulating animal diet in an effort to inhibit a rumen environment favorable to methanogens. It was also found that increasing dietary oils could mitigate emissions from enteric fermentation.

Other options to combat enteric fermentation such as genetic engineering and the use of additives may be options, but further research and development is needed before such options can be employed.

Breeding objectives to reduce enteric methane production from beef cattle under extensive production systems can also play a significant role in addressing climate change. Variation between animals, between breeds, and across time, is reported, providing the potential for improvement through selection.

It is also reported that beef cattle with low residual feed intake produced up to 28% less methane than those with high residual feed intake. Residual feed intake is calculated as the difference between actual feed intake and the expected feed requirements for maintenance of body weight and a certain level of production. The lower methane production was attributed to differences in ruminal microbial population and these differences could be heritable.

Adaptation to production environments

Adaptability of an animal can be defined as the ability to survive and reproduce within a defined environment or the degree to which an organism, population or species can remain/become adapted to a wide range of environments. An improved understanding of the adaptation of livestock to their production environments is important, but adaptation is complex and thus difficult to measure. Extensive research has been conducted on the direct measurement of adaptation. This included direct measurements on the animal such as rectal body temperature, respiration rate, heart (pulse) rate, sweating rate (water loss), skin thickness and hair per cm^2. In addition, more sophisticated measurements investigated, included the heat tolerance test where the difference in body temperature was measured before and after exposure to extreme heat, and temperature change associated with exercising the animals.

Several proxy-indicators for adaptation are available and have also been used. These include reproductive traits such as fertility, survival, birth rate and peri-natal mortality; production traits such as growth rate, milk production, low mortality and longevity; and health traits such as faecal egg counts and number of external parasites.

Adaptation can also relate to either resistance or tolerance. Resistance means that animals do not get affected by unfavourable conditions, or they quickly get accustomed to them. Tolerance means that the animals stay affected but continue to live, with or without some degree of discomfort.

The Australian beef industry presents one of the best examples of production systems where adapted zebu breeds are utilized through crossbreeding with taurine cattle, resulting in genotypes and synthetic breeds that that cope better with the harsh environments, and which could be used commercially in some of the systems in developing countries.

Low levels of animal recording

Animal recording forms the backbone of any improvement program. If traits are not measured and recorded no improvement is possible. Performance recording in many developing countries is difficult since the breeding objective may include many traits, some of which can not be easily measured or quantified.

Opportunities for using the modern information technologies such as mobile phones to relay raw data to central data processing centers on a real time basis, exist, but are yet to be exploited. Other constraints include rigid rules on recording, even when such rules do not add much value. For example, in some countries, breed societies, which are more of exclusive clubs, actually hinder livestock recording, by not accepting own recorded farm data, and insisting on some form of inspection, and by-laws on breed standards and registration. By insisting that only officially registered animals can be officially recorded, the opportunity to exploit the huge genetic variation in the population is lost.

The ranking or scoring of animals for a trait rather than measuring the trait directly was investigated, even for traits that are easy to measure. It was concluded that if animals can be ranked reasonable accurately for a trait of economic value, direct measurements may not be necessary. It also appeared that ranking is more accurate than scoring. For example, by simply ranking animals on an ascending overall preference scale of 1-5 (least likeable to most likeable) much better traction can be achieved compared to rigidly insisting on recording many traits and not objectively and appropriately weighting them into a single index, especially for within herd ranking purposes. This may be of value in the emerging sector, as well in case of a breed such as the Nguni, where inspections still plays a significant role.

Conclusion

Challenges facing beef production in the developing countries of southern Africa include variable and low production levels, the effect of climate change, enteric methane production, adaptation of genetic resources and low levels of animal recording. In addition these countries face the implications of increasing populations, urbanization and economic development. These developments are expected to lead to a significant rise in demand for livestock products, referred to as the Livestock Revolution.

Ruminants are important to mankind since most of the world's biomass is rich in fibre. Only ruminants can convert this into high quality protein sources (i.e. meat and milk) for human consumption and this will need to be balanced against the concomitant production of methane.

Finally it is important to note that there are large differences between breeding cattle for the subtropics / tropics and temperate areas, the main difference being in trait definition. Cattle in subtropical and tropical environments are subjected to numerous stressors, e. g.: (a) parasites (tick and tick borne diseases, internal parasites, flies); (b) seasonally poor nutrition; (c) high temperatures or high daily temperature variation; (d) humidity (both high and low); and (e) temperament (exaggerated by extensive production systems).

In these cases management interventions may be possible, but they are difficult and expensive to implement, particularly in poorly adapted cattle. The best method of ameliorating the effects of these environmental stressors to improve productivity and animal welfare is to breed cattle that are productive in their presence, without the need of managerial interventions.