Appropriate performance testing measures for indigenous cattle

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The importance of indigenous cattle breeds

Approximately 80% of the world's livestock population and 70% of livestock breeds reside in the 140+ developing countries of the world. In these countries, about 4000 or so livestock breeds are employed in primarily lower input production systems. All over the world there is a growing awareness of the importance of genetic biodiversity. *The theme of this paper is that animal production occurs in very diverse environments and has to satisfy very diverse human needs. Breeding goals and performance testing programmes should reflect this diversity. Secondly, to be effective, animal scientists should take greater cognisance of human needs and motives when planning interventions intended to promote genetic improvement of livestock.* These two factors also apply to the performance testing of indigenous cattle, which have a very specific niche in livestock production in South Africa.

The European breeds of domestic livestock have all been developed between latitudes 45 and 60 degrees North. These areas are characterised by high rainfall and mild temperatures. Pastures grow slowly, is high in protein content, very succulent, and low in crude fibre. Under these conditions, selection for increased voluntary feed intake, with the resultant gains in production per animal, is almost obligatory. The African environment, on the other hand, is characterised by high temperatures, erratic rainfall, fast-growing natural-curing hay type pastures that are high in crude fibre and low in protein content (Bonsma, 1980). The summer rainfall area of southern Africa is characterised by major seasonal changes in both the composition and the quantity of grazing. Typically cattle gain weight for 4 to 5 months during summer and lose 20 to 30% of their maximum summer weight during winter (Van Niekerk, 1989). According to Ramaboa (1993) livestock in Lebowa grows positively for only 5 months of the year, maintain weight for 3 months, and lose weight for 4 months. Under these conditions a large frame size is a distinct disadvantage. The small frame size of indigenous cattle is most likely a direct consequence of natural selection in this habitat.

With the exception of the Drakensberg area and the Cape Coastal Belt, many of the cattle farming areas are subject to sub-tropical temperatures. The primary effect of overheating, is loss of appetite. As a result, unadapted cattle in hot areas are characterised by stunted growth and a marked reduction in fertility. Pioneering work by Bonsma in South Africa (Bonsma, 1949) and later work in Texas, Africa and Australia have clearly demonstrated the superior ability of indigenous breeds to withstand heat stress. Thirdly, the continent has its own, locality-specific subsets of diseases, disease carriers and insect irritants.

Indigenous breeds have been subjected to natural selection for the ability to survive and reproduce in an environment characterised by the high temperatures, fluctuating feed supplies and local diseases of the continent for more than a thousand years. Zebu cattle has evolved special mechanisms to cope with food scarcity. They have a lower fasting metabolic rates than European beef cattle (in other words they require less energy and generate less surplus heat in the process of maintaining essential body functions; utilize poor quality roughage (e.g. dry grass) better than European breeds (e.g. Hunter *et al*., 1985) ; and have a superior urea recycling capacity, equivalent to having a built-in protein supplement on dry roughage (Vircoe *et al*., 1972). On the other hand zebus are less efficient on high energy diets in terms of growth rate relative to feed intake. Their voluntary feed intake per unit live-weight (appetite) is also lower.

The commercial value of indigenous cattle have become more apparent as the agricultural paradigm has shifted from maximum production per se to profitable, sustainable, and environmentally friendly production. Concepts such as "biological efficiency" has replaced the "bigger and more" approach of yesteryear. Furthermore, there is a growing appreciation of the need to conserve genetic diversity as insurance against unknown circumstances that may arise in future.

As long ago as 1947, the then SA Secretary for Agriculture appointed a committee under the chairmanship of the late Prof FN Bonsma to "make a survey of the nature and numbers of indigenous stock in this country and to report upon the desirability and means of preserving this stock". The committee's recommendations were (Bonsma *et al*., 1950) that "immediate steps be taken to arrest the deterioration of indigenous cattle in the 'native' reserves, consequent upon the infusion of exotic blood and the use of inferior sires; and that a pure-bred herd of not less than

500 Nguni breeding stock be established with a view to investigate the potential of the breed with regard to growth, production and reproduction, and to serve as the nucleus of Nguni stud cattle". This led to several government studs being established by the then Department of Bantu affairs in several regions. Unfortunately, whenever performance testing was applied to these herds, it was with a view to increase growth rate and size, thus directly detracting from the breed's value as a highly suitable dam line for beef production.

As a result of research by the Agricultural Research Council's Animal Improvement Institute, and its predecessor, the Animal and Dairy Science Research Institute, (e.g. Scholtz, 1988, Scholtz & Lombard, 1992) and substantiated by research at the Matopos Research Station in Zimbabwe (Moyo, 1992), the prejudice against indigenous cattle has been largely overcome in the commercial sector. In the communal sector there is still a strong preference for other than indigenous breeds, primarily as a result of (i) decades of 'improvement' programmes to upgrade Sanga cattle by top crossing them with non-Sanga bulls, and (ii) because of the lack of control over grazing by the individual owner, he/she cannot but ignore production per hectare in favour of the production per animal obtainable with the larger breeds.

What to improve and why

Performance testing is but one link in the chain of events that lead to genetic improvement. It is an important component, but it is not the first step required. Furthermore, the way it is applied, depends very much on the other steps involved. Figure 2.1 in Groen (2000) summarises the strategic approach to genetic improvement in an elegant manner. Broadly speaking genetic improvement strategies are about:

1. Stating the development objective – what do you want to achieve and why?
2. Identification of breeds that fit the development objective.
3. Choice of traits to be included in the breeding goal, estimation of relative importance of each trait (goal values), and definition of the breeding goal.
4. Establishing a programme to evaluate individual animals. Performance testing is a critically important component of this step.

The first two steps were particularly well applied in the creation of synthetic breeds (the great success story of livestock production in South Africa) to achieve very clearly defined development goals such as the Bonsmara, Dorper, Dohne Merino, Dormer and Afrino. The methodology was also fairly simple: identify the best cross or crosses and create a new breed.

Within breeds, step four has been remarkably successful, although it was sometimes based on no more than intuitive assumptions about the development objective. The past four decades has seen tremendous advances in the methodology of performance testing and breeding value estimation. Performance testing *per se* will therefore not be further discussed in this paper. Furthermore, over this period there has also been a deeper understanding by scientists of the economic realities of breed improvement; adoption by the stud industry of the principles of selection based upon objective measurement and quantitative analysis; and a major restructuring of the industry to promote genetic improvement over a broad front.

What is now required, is a similar refinement of the approaches to and methodologies used for defining development objectives and breeding goals, more specifically with regard to indigenous breeds, but equally important for non-indigenous and synthetic breeds. A key element of this paradigm change is multi-disciplinary teamwork with regard to a rigorous analysis of production systems, and the development of modelling and other methodologies for estimating goal values to be used when determining breeding goals.

Development objectives

The following observations about the South African situation are intended to stimulate the debate on development objectives and to relate this to a preferred production system.

In South Africa, the development objective for beef production could include one or more of the following elements: increased profitability from commercial beef cattle farming, a greater contribution to household food security in the communal areas, sustainable use of the natural grazing, and more efficient drought management. These goals imply that the production system should be matched to veld type and marketing system.

Analysing the production system

A thorough analysis of the production system is an absolute must before well motivated breeding goals can be defined. Because geneticists have tended to operate in relative isolation, this aspect has been somewhat neglected in South Africa. The absence of detailed descriptive and quantitative analyses of the different production systems found in the country, has led to relative conformity in the setting of breeding goals, and confusion on the best use of performance test data. Consider for example the impact of veld type and marketing policy on what would be the desired characteristics of a breed used for beef production.

Sweetveld remains sufficiently palatable and nutritious to support animals year-round. The calf crop can be either sold as weaners or grown out for 18 months to two years and sold as steers. It occurs primarily in the arid and semi-arid regions, and is usually characterised by a lower than average carrying capacity and higher than average drought risk. On sweetveld steers finish off much sooner than on sourveld. Drought risk determines the preferred maturity type. Where the rainfall is reliable, medium-framed cattle can be profitable on sweetveld. If rainfall is not so reliable, small-framed cattle will realise better economic returns over time.

Sourveld, in contrast, meet the requirements of productive animals only during the growing season. It occurs primarily in high rainfall areas, where it has a high carrying capacity in summer. In winter it becomes unpalatable and of an extremely low nutritive value. Relatively large framed, high growth rate weaners, raised during summer can be sold off to the feedlot industry. On sourveld it takes a long time to finish steers for the market. Small-framed, early maturing types are therefore preferred for steer production.

The feedlot industry prefer weaners to long weaners (calves that have to be raised beyond the usual 7-8 months to reach marketable weights, because of grazing conditions) since young animals grow faster than older ones. Weaner production should therefore preferably be practised where the risk of carrying young animals beyond 8 months is minimal.

In the case of communal farming, the benefits which most cattle owners derive from their livestock is very different from that of the commercial farmer. Domestic uses (milk, ceremonial, draught, meat for own consumption, insurance, investment, emergency cash) predominate over cash sales. Whereas production is usually defined in terms of quantity of animal products, such as meat or milk, the objectives of the small-scale communal farmer, and the lack of control the owner has on the management of his natural resource base, implies that productivity may be better defined in terms of reproductive ability, survival and longevity. Incidentally, the same characteristics are required in an ideal dam line for terminal crossing for either weaner production for the feedlot, or steer production for selling off the veld.

Breed choice

Once the development objective has been defined, and the production system which best utilises veld type, marketing institutions, tenure arrangements, and infrastructure, has been characterised; the breed or breeds which may achieve this objective and fit into the production system, needs to be identified. Some of the considerations are:

Is there a need for a new synthetic?

Pure breeding or crossbreeding? Pure breeding is easier to manage than crossbreeding. The same long-term selection objectives apply to both bull selection and cow selection. Rotational crossbreeding is extremely difficult to maintain. It usually breaks down into a system of changing the bull breed at irregular intervals, using them on a cow population of mixed origin. Terminal crossbreeding is easier to manage and provides an excellent opportunity to exploit sexual dimorphism (small females and large males) as a means of increasing profitability in meat production. Selection objectives in the dam line are totally different from what it would be in a straight-breeding system. Since indigenous breeds are particularly well suited for use as a dam line, breeding goals and performance testing should reflect this fact.

Breeding goal definition

This is the area that is probably the least developed in the South African breeding industry. Unfortunately, selection objectives are usually discussed in breed terms rather than production system terms. Greater differentiation is required in the formulation of breeding goals (and the associated performance testing programmes) both within and between breeds, to satisfy the dictates of different ecological regions and different production systems, even when these occur within the same ecological region. There is no universally applicable set of breeding goals, and although this is to some extent recognised by the stud breeding industry and geneticists alike, the ongoing debate on issues such as frame size, growth rate, reproductive ability, product characteristics and product quality, needs to be cast into a new mould, based on a more structured methodology. For a full discussion, with examples, see Groen (op cit).

Human needs and motives: Breed improvement in developing countries

Before embarking on a genetic improvement project in developing countries or developing communities, it is prudent to take cognisance of the evolution of development paradigms. Following the success of the Marshall Plan in Europe, development theory ascertained that economic growth, while it might enrich a certain class, would by a trickle-down process also improve the welfare of the poorer sections of the community. In an economic theory that capital accumulation was the key to economic growth, technology transfer was the fashion of the fifties and sixties. The problem was clearly seen and the solution obvious. Transfer technology to countries struggling with poverty and hunger and prosperity was assured. Outside Europe, the trickle-down theory generally failed to deliver the expected benefits even where satisfactory economic growth had occurred. The resultant rapid polarisation of income levels between rich and poor, raised the issue of equity. The basic needs concept was introduced, which became the integrated rural development approach. The World Bank in the seventies and eighties enthusiastically supported IRD projects, which typically consisted of synergistic interventions in agricultural extension, research, marketing, input supply, credit, rural roads, water supply infrastructure, and small-scale irrigation schemes (Bingswanger 1997). The complexity of coordination proved to be the Achilles' heel of integrated rural development as practised in the seventies and eighties. While the community may have been involved, it was involved in achieving objectives set by planners, and the modest gains made were seen as threatening the local leadership (Bingswanger op cit).

By now it was realised that development was a function of people and their behaviour, and much less a problem of technology. The technology transfer and economic growth theory were seen as a top-down, prescriptive form of development, and it was realised that the intended beneficiaries have a crucial role to play in the process of their own development, both in setting the agenda and in implementation. Also in the eighties, the importance of collective action by small groups (of the order of 5 to 10) became evident, and the concept of social energy was formulated. Social energy is defined as a function of ideas, ideals and friendship (Uphoff, 1995).

The focus on people spawned a whole new set of development approaches, collectively known as participatory development. Participatory development accepts that rural communities are knowledgeable, rational decision-makers in the context of their constraints and opportunities, and that interventions should not be planned on the basis of exogenous analysis, which may be unrelated to the local situation (Perret, 2000). A complementary development has been the gradual recognition of the critical important role of institutions (e.g. Eicher, 1999)

In summary, when planning interventions aimed at genetic improvement, keep in mind the key role of social energy, group formation, institution building and participation in setting the agenda by intended beneficiaries.

Concluding remarks

The challenges currently facing animal breeding scientists in South Africa are: (i) to become as effective change agents in animal improvement and performance testing in the developing sector as they have been in the traditional commercial sector; (ii) to fine-tune their expertise in defining development objectives and breeding goals, with regard to both the commercial and the developing sectors (iii) think more in terms of systems, and extend their academic network to include economists and social scientists.

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