The role of pedigree recording in sustainable animal agriculture with special focus on indigenous breeds

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Abstract

The realities of global warming and climate change pose new challenges to livestock producers in terms of the harsh environments in which they will have to produce in future. The challenge for animal breeders is to maintain or improve the specific adaptation of their animals to the changing environmental conditions while improving the productivity and efficiency of their breeds. The recording of origin, parentage and ownership of animals is a fundamental and indispensable part of the conservation and genetic improvement of animal populations.

It has been well established that local and indigenous breeds are indispensable for global animal genetic diversity, providing the world with a greater range of options to meet future challenges in terms of animal production. Most indigenous and local breeds, however, are not part of formal animal recording programmes.

Some of the problems relating to this situation are discussed and examples of how various recording processes can be used to address these problems are given.

Keywords: pedigree recording, indigenous breeds, farm animal genetic bio-diversity, population statistics

1. Introduction

Livestock has played a very important role in the history and development of sub-equatorial Africa and it will undoubtedly continue to do so. This region harbours the full spectrum of livestock breeds - from highly productive modern and global breeds of cattle, sheep, pigs and horses, well adapted to the demands of modern production practices, to a rich complement of truly local and indigenous breeds of farm livestock which have sustained pastoral communities through many years.

The livestock industry in its entirety is faced by very real challenges:

- Land use for agriculture, and livestock production in particular, will have to be planned with greater discernment than before.
- The realities of global warming and climate change will pose new challenges to livestock producers in terms of the harsh environments in which they will have to produce.

The challenge then for animal breeders is to maintain or improve the specific adaptation of their animals to the changing environmental conditions while improving the productivity and efficiency of their breeds. It has been well established (FAO, 2007) that local and indigenous breeds greatly contribute to global animal genetic diversity, providing the world with a greater range of options to meet future challenges in terms of sustainable animal production.

2. Sub-equatorial Africa

Animal agriculture in sub-equatorial Africa can be typified as dualistic: On the one hand there is a 'commercial' sector focussed on the production of marketable commodities. On the other, there is a rather large 'informal' sector that does not participate in the 'normal' processes found in a typical production environment.

The dynamics of the commercial livestock industry indicate that purebred breeding and formal animal recording are vitally linked to the production sector. There is a healthy interdependence between these two segments. Cost effective and sustainable production in commercial herds and the constant improvement of the genetic components thereof, are to a large extent dependent on the genetic improvement of the relevant traits in the purebred herds – the source of their breeding material. The recording of origin, parentage and ownership of purebred animals, as performed by registering authorities and breeders' societies, is an indispensable part of this segment of the industry. The cost of animal recording - and animal improvement in general - is largely borne by the purebred breeders themselves, with government assistance in some cases.

Due to many factors the livestock owners and breeders in the informal sector of the livestock industry can be termed as resource-poor. To some extent they lack or have limited access to basic resources in the production process such as land, capital, knowledge and institutional support. In most instances livestock forms the backbone of the wealth and production of resource- poor farming communities. Invariably these livestock are well adapted, indigenous breeds with appropriate productive capabilities for the circumstances under which they are managed.

The biggest problems facing livestock production under resource-poor circumstances are rangeland management and the control of communal land. The cultural relationship between farmers and their livestock, which to a large extent dictates the eventual application of the production that may occur from these animals, is another factor - in many cases the perceived wealth in animal numbers seldom leads to financial emancipation. To some extent these factors are all interrelated and limit the ability of the farmer to be a productive and efficient producer, regardless of the eventual product. In terms of the possible future use of livestock from this sector, the almost total lack of formal identification and recording of the animals is a very big challenge.

The dilemma that faces the industry is rather intricate:

- Sub-equatorial Africa has a rich heritage of locally adapted indigenous breeds and landraces that have evolved under the harsh local conditions and are well suited to these conditions.
- These breeds possess special qualities – some of which may not yet have been recognised. Indeed, some of the owners and breeders of these breeds may not be aware of the potential value of these animals.
- The need for the sustainable conservation and utilisation of these populations is well established but not always well accepted. The concepts of biodiversity and conservation of indigenous breeds must become part of the policies and aid programmes not only of governments but also of the management ethos of the producers of these breeds.
- Breeders and owners of these local and indigenous breeds need to be made aware of the benefits of conserving and / or improving their livestock and these owners / breeders need to derive rewards commensurate to their efforts.
- Breed characterisation, improvement and conservation are costly processes. For instance: Proper identification and recording of animals is a basic requirement of any improvement or conservation project. All other actions like descriptive processes, genetic management etc. are dependent on proper identification and efficient recording. The identification of livestock will require resources like capital, labour, management, time and skill - from a farmer who can already be described as 'resource-poor'.
- Governments need to realise the importance of actions like basic animal identification and recording and the use of such information for the benefit of the owners and breeders and their broader communities. They need to get actively involved in programmes that support animal improvement in rural and developing communities.
- Established breeders and breeders' organisations need to reach out to breeders of local and indigenous breeds that are not yet participating in the formal processes of animal recording. Through active involvement, and by example, they need to demonstrate the rewards of the various processes of formal animal recording.

In the past, the ability to respond to environmental and market changes was achieved readily, even without the use of modern evaluation techniques. This was mainly because breeders had access to a larger gene pool spread over a number of diverse ecosystems. But these reservoirs of genetic insurance policies have, for many reasons - of which indiscriminate crossbreeding is not the least - dwindled noticeably over the past few decades.

In the absence of direct measures of genetic diversity, the identification, characterization and recording of indigenous breeds provide the best indication of total farm animal genetic diversity. In the short to

medium term, the management activities of previously unrecorded local and indigenous breeds will, to a large degree, determine the future role and contribution of any breed to farm animal genetic diversity and towards global food security.

Selection is the only practical tool at the disposal of animal breeders to face the challenges of changing environmental and consumer needs. Within breeds, selection response depends on five factors – variation in breeding worth, generation interval, intensity of selection, effective population size and the accuracy of selection, all of which depend heavily on the extent and accuracy of basic animal recording in the relevant populations. The first logical step in meeting the challenges is to embark on a formal process of census and recording of genealogical and distribution information to facilitate the evaluation of salient population structure parameters and to quantify and monitor in breeding in the breed and its sub-populations. The information gained in this way forms the basis of virtually all other efforts that are needed to ensure the future existence and application of the breed.

3. Possible use of pedigree information

Some examples of the use of formal recording processes in indigenous and local breeds exist in South Africa and may be used to demonstrate some of the benefits that can be derived from the use of these processes. Data pertaining to four indigenous beef cattle breeds is used for this purpose.

Summaries of the histories of the Afrikaner (AFR), Bonsmara (BON), Drakensberger (DRB) and Nguni (NGI) cattle breeders' societies and the basic characteristics and performance profiles of each of the breeds are well documented (FACT (2000); SA Stud Book (2004); ARC-AII (2001)).

The Afrikaner is one of South Africa's oldest recorded breeds. Formal recording of this breed commenced in 1907 and a breeders' society was established for this breed in 1912. The Afrikaner was once the most numerous cattle breed in South Africa.

Of all livestock breeds in South Africa (and possibly the world) the Bonsmara is probably the most widely researched and documented. While formal recording of animals in the breed commenced in the early 1940s the Bonsmara Cattle Breeders' Society was established only in 1964. The Bonsmara is currently the most numerous cattle breed in South Africa and has breeders and breeders' societies in several other countries.

Development of the Drakensberger breed of cattle probably started as early as 1800, but formal recording of the breed started with the establishment of a breeders' society for the breed in 1947.

The Nguni is, like the Afrikaner, one of South Africa's oldest cattle breeds, but formal recording commenced on a very limited scale only in the late 1940s. The Nguni Cattle Breeders' Society was established in 1986. The Nguni shows the highest increase in terms of numbers of formal breeders and formally recorded breeding animals in South Africa.

The comparative census statistics for the four breeds in July 2008 (NextGenSA, 2010) are shown in Table 1. The average recorded performances of the four breeds for 2007/2008 (ARC-API, 2009) are shown in Table 2.

Table 1. Census statistics for four beef cattle breeds, as in July 2008.

Breed	Registered herds	Perf. Rec. herds	Registered animals	Perf. Rec. animals
AFR	74	52	11 885	10 505
BON	350	332	99 642	97 235
DRB	73	71	13 538	13 355
NGI	441	95	53 265	19 307

The data in Table 1 provide some context for the comparison of the four breeds: The Bonsmara is numerically the biggest breed with almost 100 000 registered animals. The Nguni has the most breeders but shows the lowest participation in performance recording – only 22.3% of the herds with only 33.2% of animals participate in the South African National Beef Recording and Improvement Scheme. The levels of performance recording is very high and similar for the Bonsmara and the Drakensberger breeds and slightly lower for the Afrikaner.

Table 2. Average performance of animals of four beef cattle breeds, as in 2007/2008.

Breed	Birth weight (kg)	Weaning weight (kg)	Cow weight at weaning (kg)	Weaning weight ratio
AFR	31.3	195	478	43.2
BON	35.3	218	508	44.1
DRB	34.6	204	499	43.3
NGI	25.1	158	366	44.9

The average performances of the four breeds very much typify the breeds – the BON and DRB on average being medium-framed, medium-maturing breeds, the AFR is a small- to medium-framed early-maturing breed and the NGI is a small-framed early-maturing breed.

An analysis of the breeding structures (Robertson, 1953) of the four breeds was performed on the data of the progeny born in the 24-month period 1 July 2006 to 30 June 2008. An analysis of the breeding structure of a breed yields very pertinent information about the functional stratification and several population statistics of a breed and is dependant on pedigree and ownership data of the breed being analysed. The four breeds show very similar breeding structures with an average of 50.7% of the herds being classified as 'breeder herds' – herds supplying breeding animals to other herds. On average the 'breeder herds' bred 69.3% of the progeny that was recorded for these breeds. Compared to the same parameters for six other numerically significant beef breeds in South Africa, these statistics are of more or less the same magnitude. The four indigenous breeds, however, display less variation amongst them than the other breeds.

The number of active herds, the number of progeny born in the 24-month period and the average number of births recorded per herd per year for each of the four breeds are shown in Table 3.

The data in Table 3 serves to support the data in Table 1. The numbers of herds in Table 3, however, are slightly lower, as the data in Table 3 reflects only the number of herds that actually recorded births of qualifying progeny in the relevant period.

Table 3. Number of animals born, number of active herds and average number of births recorded per herd per year for four beef cattle breeds.

Breed	Number of animals born	Number of herds	Average births / year
AFR	4 999	52	48.07
BON	49 688	250	99.38
DRB	7 232	64	56.50
NGI	26 447	259	51.06

From this data it can be established that, on average, only 72% of all herds actually contribute to the breeding of animals in the breeds, with DRB-herds being above average (87.73%) and NGI-herds below average (58.7%) in this regard. The situation for the other six numerically significant beef breeds in South Africa in this respect is on average somewhat lower (66%) but variable – some breeds have levels of recording as high as that of the DRB and some have levels lower than that of the NGI.

The BON has an appreciably higher average herd size than the other three breeds. The average herd size for six other numerically significant beef cattle breeds in South Africa is of the same magnitude as that of the AFR, DRB and NGI breeds, except for one other breed, which has an even higher average number of births per year (127.57) than the BON. The size of breeding units within a breed has a significant effect on the rate and extent of genetic gain that can be achieved within a breed.

The effective number of herds supplying sires (H_s), grandsires (H_{ss}) and great-grandsires (H_{sss}) to the respective breeds (Robertson, 1953; Gutiérrez *et al.*, 2003), an indication of the levels of within-breed genetic diversity, is shown in Table 4.

The data in Table 4 indicates that the BON and NGI had the highest number of effective herds supplying sires to the breed and that the AFR and DRB had substantially lower H_s-values. The data is, however, skewed due to the differences in the number of progeny born for each of the breeds. If the H_s-value for each breed is weighted for the number of progeny born, it becomes clear that the AFR actually had the highest levels of genetic diversity (3.33 herds supplying sires per 1 000 calves born), followed by the DRB (2.07), the NGI (1.60) and the BON (1.06). These figures are slightly lower for the four indigenous breeds when compared to some numerically significant international beef cattle breeds in South Africa. This is probably to be expected if the worldwide genetic base of these breeds is taken into account.

Table 4. The effective number of herds supplying male ancestors for four beef cattle breeds.

Breed	H_s	H_{ss}	H_{sss}
AFR	16.64	11.14	15.04
BON	52.63	22.37	20.12
DRB	14.95	13.83	14.43
NGI	42.19	42.37	49.02

The standardised effective number of herds supplying male ancestors to a breed also serves as an indication of the average relatedness of male ancestors within a breed and may be used as an indicator of whether a more extensive analysis of the relationships within a breed needs to be performed – another analysis that depends on the pedigree and ownership data of a breed.

The average completeness of the pedigree information in the parental generation of the animals born in the period under investigation is shown in Table 5.

The average completeness of pedigrees of a breed also serves as an indication of the reliability of parameters that are calculated from the pedigree- and relationship data of the breed like inbreeding coefficients and breeding values and, in some cases, may indicate potential problems with the recording processes that are used for the breed or with the integrity of the database.

Table 5. Average completeness of pedigree information in the parental generation for four beef cattle breeds.

Breed	Average completeness of pedigrees (%)
AFR	99.95
BON	98.23
DRB	97.44
NGI	89.12

The data in Table 5 reflects the extent to which a breed has an 'open studbook' with an active upgrading programme. The data in Table 5 is comparable to that of the six other numerically significant beef cattle breeds in South Africa. Only one other breed has an appreciably lower value for the average completeness of its parental pedigrees (79.3%) – a recently introduced synthetic breed with an open studbook and a very active upgrading programme.

Several comprehensive analyses of the basic animal recording data of the Bonsmara breed were recently done as part of a publication commemorating 45 years of the breeders' society. The changes in the breeding structure of the breed over its history were described (Hunlun, 2009), a demographic description of the breed over time was given (Hunlun *et al.*, 2009) and the developmental history and evolution of the genetic variability of the breed were described (Van der Westhuizen, 2009). All these analyses depend largely on the recorded ownership and pedigree data of the breed.

4. Conclusive remarks

To be able to reach selection goals, modern techniques of animal- and performance recording and breeding value estimation should be employed and used judiciously. To safeguard populations against the detrimental effects of inbreeding and to help preserve genetic variation, a system of exchange of genetic material between sub-populations within breeds must be established. No efforts should be spared to increase the effective population size, both on a regional and on a global level.

Most of these factors are interrelated and have marked effects on each other and all of these actions require thorough recording of pedigree and ownership. Animal breeders today are in the fortunate position that excellent scientific and institutional support is readily accessible and affordable. There are no technical reasons that will prohibit breeders of local and indigenous breeds from positively meeting the challenges that face them and the broader livestock industry. The first steps towards this goal are animal identification and the recording of origin and descent.

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