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Journal homepage: www.Sjournals.com**Review article****Genetic improvement and utilization of indigenous cattle breeds for beef production in Zimbabwe: past, present and future prospects****N. Assan***Zimbabwe Open University, Faculty of Science and Technology, Department of Agriculture Management*

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ABSTRACT

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Indigenous cattle breeds constitute an important reservoir of genetic material which developing nations have failed to give adequate recognition. Changes in economic situation, the changing consumer preference and therefore the need for change in production methods to comply with these are the major forces dictating the future of indigenous cattle breeding. Genetic improvement programs for indigenous cattle in developing countries have lagged behind chiefly because the infrastructural element necessary for planned breeding programs such as performance recording and artificial insemination centers are unavailable. The traditional methods of livestock husbandry practices in most of these countries is based on subsistence farming characterized by low input system and majority of the livestock owners are peasant farmers, making it impossible to establish planned indigenous cattle breeding schemes as is done in developed countries.

It now seems clear that without a thorough understanding of the small cattle production sector's goals and strategies and without their participation, indigenous cattle genetic improvement programs are unlikely to be successful. Indigenous cattle genetic improvement must be based on empirically sound research if efforts are to be successful, more often than not previous projects implementation have been based on incorrect assumption about the behavior and goals of smallholder cattle sector. This may mean the evaluation of indigenous cattle breeds performance must be approached systematically, but is expensive and requires considerable professional dedication at national level. Unfortunately at least one

of these prerequisites is often lacking, and as a result few accurate data on indigenous cattle performance are as yet available to introduce suitable genetic improvement strategies. An open nucleus breeding scheme for indigenous cattle breeds should be advocated. This may be attractive particularly in smallholder cattle sector with small populations where within herd selection programs are ineffective. There can be little doubt that the opportunities for indigenous cattle breeding are great if local breeders are willing to accept the challenge of a changing beef industry and realize the necessity for having to be competitive. The specific strategy for genetic improvement of indigenous cattle proposed by this review is based on open nucleus breeding scheme where performance testing and progeny testing are applied as tools for selection.

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1. Introduction

Livestock production faces specific challenges as a result of rise in human population numbers, urbanization and economic development (Delgado, 2005). Livestock industry in Zimbabwe contributes an estimated 15- 20% of value of total agricultural output occupying an important position in the national economy (Agrisystems, 2000). Between 1970 to 1980, cattle holding in Zimbabwe were that communal farmers owned 70% of beef cattle, with remainder on commercial (CSO, 1994). The off take of beef cattle calculated as the number of cattle sold or slaughtered as a proportion of total holdings, was 1-3% for communal sector and 15- 24% for commercial sector (Mhlanga, 2000). It is estimated that Zimbabwe could carry 6.5 million head of cattle on a sustained basis and given the application of known technology, annual production could reach over 900 00 head (Zimbabwe Herd Breeders Association, 1991).

The majority of the indigenous cattle are in the smallholder sector which is characterized by low input subsistence farming of which contribution to human livelihoods is the major factor. In the traditional cattle system animals serve as household asset with multiple functions, giving rise to a variety of output including draught power, milk, meat, hides and manure in addition to providing a source of capital to be drawn on as required.

There are three indigenous cattle breeds in Zimbabwe which belong to the Sanga type of African cattle, namely the Tuli, Nguni and Mashona . They are pseudo zebu, meaning that they are humped. Few of the indigenous livestock breeds have been introduced in modern genetic improvement programs that aim to serve the larger farming population in Sub Saharan Africa (Bosso et al 2009), however plans to implement genetic improvement programs which utilize adapted genotypes of indigenous livestock is the only way to secure a sustainable beef supply base for local population. Indigenous cattle are well adapted to semi arid tropical conditions, with a high degree of heat tolerance and are partly resistant to many of the disease prevailing in the semi arid areas. Not to mention their ability to survive long periods of feed and water shortage. The role indigenous cattle can play in Zimbabwe livestock revolution is not always recognized. Pure breeding of the indigenous cattle is the only viable production strategy because of adverse climatic and nutritional conditions in semi arid areas. This article is attempting to raise issues pertaining to genetic improvement and utilization of indigenous cattle breeds for beef production in Zimbabwe looking at the past, present situation and the future prospects of cattle production.

2. Indigenous cattle breeds history and description

2.1. Mashona

Mashona cattle originated from the Shona people of eastern Zimbabwe and are the most numerous (Mhlanga, 2000). They are bred in a wide spreading territory covering most of the eastern half of Zimbabwe and an adjoining region of Mozambique that is free of the tsetse fly. The Mashona cattle are Sanga type. Following the

decimation in the Shona herds caused by the cattle plague of 1896- 1906 and the East Coast fever epidemic of 1900-1906 larger number of mainly Angonis cows were mated with Mashona bulls.

The breed is reared for meat production and it is said they make docile working animals. A herd book was established in 1954, after a decade of selection for beef and polled characteristics (hornless). The breed is usually black or red and most are now polled. The general conformation is neat and compact and the bone structure is fine. The tail is long and touches the ground. The mature weight of the breed ranges from 275 to 350 kg. Small experimental herds now exist at Makoholi Research Station in Masvingo.

2.2. Tuli cattle

The Tuli cattle are descendants of the Sanga cattle brought into Southern Africa by migrating tribes ca. 700 AD. Eventually these Sangas, the true indigenous cattle of the region, came to occupy most of the country south of the Zambezi. With the passing of centuries, as these Sanga cattle adapted by natural selection to various ecological regions to which they were subjected, subtle differences developed in the population and these became the basis of several breeds.

In 1942, while working in the lowveld regions of Southern Zimbabwe, Mr Len Harvey noticed that there appeared to be distinct type of yellow Sanga cattle amongst the ordinary mixed native stock. These cattle seemed better adapted to the harsh local conditions and were superior to other stock. As a result of these observations the government then decided to purchase some of these cattle to see if they could be improved and whether they could breed true to type. In 1945 Tuli Breeding Station was established with the basic idea to assist in improving stock in the outlying areas of Zimbabwe. The commercial cattle farmers soon realized the potential of the breed and for many years breeding stock was sold to them. The formation of the Tuli breeding Society took place in 1961. In 1979 the Tuli experimental herd was moved to Matopos Research Station and as expected, adapted very well to its new environment. Tuli cattle were imported into South Africa in the 1970's and affiliated to South Africa Stud Book. The numerous imports have resulted in the establishment of an active, ever increasing breeding population in South Africa. The genetic diversity of the Tuli breed in South Africa has been maintained by frequent importation of superior male and female breeding stock from Zimbabwe.

The Tuli commonest type is the yellow (or golden-brown) type they also occur in red, and white and other colors. They are large cattle, with males maturing at 770 to 820 kgs and females at 500 to 550 kgs (Mason and Maule, 1960). The largest herds were found at Matopos Research Station and Grasslands Research Station in Zimbabwe.

2.3. Nguni cattle

Nguni cattle of Zimbabwe forms part of the Sanga group of cattle which includes most of the type indigenous to East, Central and Southern Africa (Faulkner and Epstein, 1957). Nguni cattle are mainly found in the west Zimbabwe belonging to the Ndebele people. This breed forms part of the Sanga group of cattle which include most of the types indigenous to East, Central and Southern Africa (Vorster, 1964). Sanga cattle are characterized by well developed neck hump and are thought to have originated from the interbreeding of the humpless (*Bos taurus*) and humped zebu (*Bos indicus* in the horn of Africa many centuries ago (Epstein 1971). The Nkone are an off shoot of the Nguni cattle of the Zulu people of South Africa and were brought to Zimbabwe by Mzilikazi and his followers in 1822 (Moyo, 1991).

The Nguni cattle are medium sized bone animal and other attributes include a short haired glossy coat and well pigmented skin. Numerous coat color patterns are recognized by the Ndebele, however the Nguni Cattle Society only recognized red and white combinations in five basic categories. Red and white cattle where the local name 'Inkone' was derived formed the royal herd of Mzilikazi

3. Factors influencing cattle production

3.1. Agroecological regions

Zimbabwe occupies 39 00km² within the tropics but temperatures in the main are modified by altitude which vary from about 300m in the Zambezi (mean annual temperature 26⁰ C) and Limpopo Valleys to the north and south, respectively, to over 1800 m above sea level in the highlands (mean annual temperature 18⁰ C) of the eastern border. Abroad watershed (altitude 1200 to 1500m) extends diagonally across the country north-east to

south –west. Heat stress is seldom a problem in cattle production. Rainfall is the dominant feature of climate. It is seasonal, occurring mainly during summer from November to March. The amount of rain decreases from east to west, and on the watershed from north to south. Variability (CV) increases from 20 to 25 per cent about the mean in higher rainfall areas, to 45 or 50 per cent over much of the low-altitude area in the south and south-east. Savanna woodland with a variety of associated perennial and annual grasses occupies the major portion of Zimbabwe and consists of different types depending on local soil, climate and other factors.

The characteristics outlined above have been used to define agro-ecological or natural regions and appropriate farming systems (Table 1). Generally these agro-ecological zones are indicative of relative agricultural potential, which in terms of beef production represent successively increased variability. About 80 per cent of Zimbabwe (natural regions II, IV, V) is ecologically suited to semi-intensive animal production with beef cattle in the dominant role.

Table 1

Distribution of land in Zimbabwe according to natural regions, agricultural capability and rainfall (Vincent and Thomas, 1960)

Natural region	Agricultural capability	Mean annual rainfall, mm	Percentage of total area
I	Specialized, diverse	Over 1000	1,8
II	Intensive	750 to 1000	15,0
III	Semi-intensive	650 to 800	18,7
IV	Semi-intensive	450 to 650	37,8
V	Extensive	Under 450	26,7

3.2. Subsistence and commercial cattle production

Subsistence and commercial production is the one basic nature of the division in livestock industry in Zimbabwe. The communal and commercial livestock sectors occupies 50 and 36% of the agricultural land area, respectively (CSO, 2000). However this scenario has changed due to the land reform program, as a result there is a need for a census on the actual livestock numbers before establishing any meaningful selection programs. Land in communal areas in 2000 was shared among 800000 families of whom 60- 70 percent collectively owned 3.4 million cattle. It is assumed that the cattle population has drastically reduced since the 1992 drought (Van Rooyen, 2007).

Low input, small-scale cattle production remains a primary land use option in communal areas over most of southern Africa (Behnke, 1985; Cousins, 1994; Shackleton et al., 2002). Under circumstances of variable macro-economic policy, labour market and changing environmental regimes, people adopt multiple livelihood strategies (Chambers, 1997; Cousins, 1999). Such strategies include livestock production in communal areas (Tapson, 1991; Scoones, 1992; Shackleton et al., 1999), and the harvesting of natural resources (e.g. Dovie et al., 2002; Shackleton et al., 2002). The multi-purpose nature of livestock production and hence multiple benefits in communal rangelands has been noted to yield high economic returns (Barrett, 1992; Scoones, 1992). Economic values could be higher than those for commercial ranches that rely on single purpose production, such as for beef (Behnke, 1985; Barrett, 1992). Low returns of livestock production in communal areas could be attributed to (i) insufficient empirical case studies (Dahlberg, 1995), (ii) the use of conventional and sometimes inappropriate economic models to measure production and financial returns (Cousins, 1999), and (iii) failure to consider all uses (Beinart, 1992).

Conservative stocking rates of large-scale ranches geared to commercial beef production (aimed at large gains per head rather than per unit area) in Zimbabwe were believed to be the main reason for these lower densities. In Zimbabwe, livestock pressure was 6 TLU per km² or below the recommended rate of 8 to 14 TLU per km² (Mombeshora and Maclaurin, 1989). Livestock ownership by smallholder farmers created much higher densities. Scoones (1993) showed that long-term livestock densities of smallholder communities in semi-arid Zimbabwe ranged from 20 to 30 TLU per km².

4. Review of past animal breeding research on indigenous cattle

The high productivity of indigenous cattle in Southern Africa has been recognized and various workers have come to the conclusion that indigenous cattle should form the basis of improvement programs in the region (Vorster 1964; Animal Production Unit, 1981; Thorpe et al., 1981; Tawonezvi, 1984; Ward and Dlodlo, 1986). However the production potential of indigenous cattle has not been fully exploited partly due to lack of publicity. Information on expected response to selective improvement within breeds is also limited (Maule, 1973). Although selection of beef cattle for growth, particularly weaning weight is common in commercial herds in Zimbabwe, relatively little is known about genetic potential for improvement of virtually all breeds in use. Exploitation of genetic variation for growth within indigenous cattle breeds and other breeds in Zimbabwe and choice of selection criteria will depend on the magnitude of genetic parameters for growth traits (Vorster, 1994). There was need to estimate genetic parameters necessary for the development of improvement program in indigenous cattle and to evaluate the response to selection applied for over a longer period (Tawonezvi, 1986).

By 1934 a number of farms in the Rhodes Estate now Matopos Research Station had become an experimental station with indigenous cattle as the main subject for investigation. In the 1940's the government established herds for all three indigenous breeds (Mashona, Tuli and Nguni) for improvement, multiplication and conservation local cattle genetic material (Ward 1978). At that time there were only two registered Nguni pure breeders in Zimbabwe (Matopos Research Station and Anglesea Farm), however the Nguni breed and breed society is well established in South Africa. In 1945-47 animal research staff was strengthened to conduct meaningful research on broader and long term basis.

In the breed evaluation study at Matopos the Nguni was noted for its ease of calving (Moyo, 1990). As with other indigenous breeds, the Nguni performed well and was among the best cow genotype for weight of calf at 18 months produced per cow mated (Tawonezvi, 1986). Tawonezvi (1987) selection was highly effective in increasing body weight from birth to 18 months of age in Nkone cattle, in agreement with similar studies elsewhere (Gaskins, 1974; Nwakalor et al., 1976; Kennedy and Henderson, 1977; Alenda, 1980; Zollinger and Neilson, 1984). The genetic improvement observed in this study was generally higher than the annual gains reported in the literature. However it has been acknowledge that estimates of genetic parameters for Sanga cattle in sub tropical environment are scarce (Khombe, 1994) particularly from reasonably large data sets using the current commonly adopted mixed model and REML (Restricted Maximum Likelihood) procedures described by Henderson (1984) fitting an animal model (Beffa, 2005), however where such analysis are available old analytical methods used tend to be inadequate (Tawonezvi, 1986; Kars et al 1994). Genetic parameters are specific for a particular population (Khan and Akhtar, 1995; Rodriguez-Almeida et. al., 1997)) and hence the need for specific estimates in this case for the local Nguni cattle breed of Zimbabwe for the development of sound breeding programmes and prediction of breeding values and Nsoso et al (2004) suggested that in order to design optimal breeding programs breed specific parameters should be used. Examples of genetic improvement programs show that the potential to significantly improve breeds in terms of productivity do exist in Sub Saharan Africa (Ebanga et al 2000).

5. Context of cattle industry and marketing

The cattle industry in Zimbabwe has faced a lot of challenges over the last 12 years. Before the full scale land reform program started in 2000, the livestock sector had a dual structure (large scale commercial and small scale subsistence). Large scale commercial farmers in natural Regions IV and V concentrated on cattle ranching. Supported by well developed infrastructure and services and services they supplied cattle products to export markets such as European Union. As a result of poor management and limited access to inputs and services, small scale farmers could not comply with those market requirements and remained subsistence oriented. However, now the breakdown of the commercial since the land reform gives small scale farmers a new chance to venture into commercial cattle production in order to fill the gap in the demand for cattle products within the country. Hence the need to facilitate genetic improvement programs for indigenous cattle breeds and developing simple breeding procedures involving farmers at grassroots level as a long term strategy.

Unitary marketing was characteristic of purchase, storage and distribution to trade of Zimbabwe's major agricultural commodities. One of these statutory organizations, the Cold Storage Commission (CSC) was established in 1983 and had far reaching benefits on the cattle industry. Cold Storage Commission slaughtered the bulk of the slaughter stock for domestic and export markets. CSC offered farmers a guaranteed market throughout the year, with differential and seasonal prices being used to even out supply from the farmers. As a wholly Government owned company CSC has to operate commercially and was no longer obliged to buy all cattle offered

to it unless it made business sense. Zimbabwean had access to a cattle finance scheme operated by the CSC with Government backing. Under these arrangements the CSC provided credit to farmers willing to purchase cattle for finishing and breeding. The share of the CSC has declined with removal of its monopoly from about 90% in 1985-87 to just over 60% in 1994 and possibly than 50% in 1996. Presently due to economic meltdown CSC is failing to provide all these services and Zimbabwe is no longer exporting beef to the European Union.

5.1. State Services

In the absence of major disease outbreaks both number of cattle and value of production steadily increased after the first decade of the century, until the mid 1970's when they were disrupted by war. Veterinary control measures have since been restored. The key role of the veterinary Department in the control of disease is equaled in its role in the control of standards of meat hygiene by inspection in abattoirs. Meat grading is also a state function and in recent years has been based on objective classification.

5.2. Proposed indigenous cattle improvement and selection procedures

No serious attempt has been made to resuscitate the national selection programs to continue improving the beef traits in indigenous cattle in Zimbabwe. A breed may contribute to commercial production as a straightbred (Dickerson, 1969). Relative efficiency of this breeding system has been studied for cattle (Wilton and Morris, 1976; Notter et al., 1979). Dickerson et al; Cundiff et al., 1986) have discussed use of additive and non additive variation by pure breeding. Pure breeding is the easiest breeding system to manage, however it does not provide for use of heterosis. Also, extent that some breeds are more adapted for use in breeding herds whereas others excel in carcass merit. Pure breeding does not provide trade off between matching germ plasma to production resources and market requirements

Institutional herds in Zimbabwe have an important role since these may be the only herds where genetic improvement of indigenous cattle can be carried out. There should be a deliberate move to subject most segments of the indigenous cattle to selection for productivity. Considering the impressive results that have been achieved by selection by our neighbors (South Africa) on the same breeds, there should be good prospects for improvement by selection in Zimbabwe. Genetic improvement per generation from selection would depend on the variability of the traits considered, the heritability and the intensity of selection. As to heritability for weaning weight, recent studies based on sufficient data on Tuli and Nguni cattle in Zimbabwe have been reported to fall within the same range as those in the temperate breeds.

The two major selection procedures used in cattle are performance testing and progeny testing. Performance testing is used for traits of high heritability and easily measured in both sexes, e.g. growth rate. Progeny testing is applicable to traits that have low heritability or measurable in only one sex (e.g. milk) or after slaughter (e.g. carcass quality). If an animal is to be used widely for breeding as in artificial insemination and adequate information is available, progeny testing gives an accurate estimate of breeding value. The animal relative information is often used as an aid to selection particularly in choosing young males for progeny testing. The information that is most valuable is that of the sire and dam. The additional gain in accuracy by using information from ancestors' further back in the pedigree is relative small. Progeny testing and performance testing may operate within individual herds, among a group of cooperating farmers, or nationally.

5.3. Testing stations

Animals from different herds are assembled in testing stations and measured under a uniform environment. The influence of the herd environment is therefore minimized and population under comparison is vastly increased. This may be suitable for the Zimbabwean situation where a large number of small herds from communal areas are involved because individual farmers have no capacity to carry out proper within herd comparison. Government institutions may act as testing stations which can be used either for performance testing or for progeny testing e.g. growth rate.

The purpose for performance testing is to increase the average performance of the National herd for its important economic traits. With the help of meaningful information to objectively determine the genetic variation amongst animals as accurately as possible for identification so that selection can be carried out purposefully. It also assists in evaluation of management practices and facilitates the selection of animals. For scientists and breeders beef performance testing create an opportunity to discuss issues of mutual interest. The evaluation and recording the change in traits of economic importance amongst breeds over the years may be done through

performance testing, as a result that such information may be supplied to the beef industry for future planning. Research results and information in this practice has shown exceptional improvement in several characteristics by applying the basic principles of beef performance testing as an aid in selection.

5.4. Progeny testing schemes

Progeny testing is used only to a limited extent in beef cattle because for improvement of growth traits., the performance test is cheaper, quicker and can be applied to many bulls. However progeny testing of beef bulls may be carried out when they are to be used in artificial insemination for traits such as calving ease and carcass quality. Bulls to be progeny tested are first selected on the basis of a performance test and then mated to cows in commercial herds. Information is collected on dystocia, calf mortality, liveweight gain, carcass weight and carcass quality. In such tests, where the performance test precedes the progeny test, over 80-90 percent of the genetic gain in growth rate is attributable to performance test (Allen and Kilkenney, 1980).

6. Open Nucleus Breeding Scheme (ONBS) concept as an option for cattle improvement

The concept is based on the principle that in each herd there is a small number of genetically very superior animals which if brought together will form a nucleus whose average genetic merit is far greater than that in any of the contributing herds (Nicol, 1976). This is a cooperative group breeding scheme first developed in New Zealand for sheep.. Small scale producers with the assistance of animal production specialists (breeders) may select best performing females from participating small scale cattle producers and send them to the nucleus herd.. In this case the nucleus herd could be established at government research stations such as Matopos Research Station, Makoholi and Grasslands Research Stations which are public institutions. Here, after further recording the best young males and females are retained for breeding in the nucleus herd. Other selected young males from the nucleus will be used in cooperating/ participating villages as replacement sires. This cycle of recording and selection is continued over years. The nucleus is always kept open to the highly productive selected females from the participating small cattle producers so there is a two way flow of stock and genes. The maximum rate of gain is achieved when the nucleus has 5-10% of the nucleus female replacement come from the contributing small cattle producers' herds. All nucleus born young calves not needed for replacements in the nucleus are used in the contributing herds (Rae, 1977). The theory of open nucleus breeding schemes should be able to obtain a greater rate of improvement (15- 25%) than an individual small cattle producer because of high selection intensity. Since the nucleus breeding scheme shifts the onus of operating the breeding program from the small scale farmer to the nucleus herd, it seems an attractive method for the tropics because of limitation of infrastructure

7. Objectives of the open nucleus breeding method

The effects of genetic improvement in performance components on cattle product value will depend considerably upon the production and marketing system (Dickerson, 1970). The lack of production and marketing adaptations to improved genetic potential for cattle performance (meat) would sharply limit economic benefits from and thus the incentives for genetic improvement (Dickerson, 1980). The choice of a cattle breeding strategy will focus on development of both the small scale cattle farmers and their cattle in their own environment/communities. Bench marking of the role of Mashona, Tuli and Nguni indigenous cattle genotypes taking into account the limitation of genetic progress in small scale cattle production sector which is as a result of single sire herds, inbreeding due to small population and lack of records. However any breeding progress should be done without compromising adaptation to environmental stressors.

8. Principles underlying operation of cattle open nucleus scheme (ONBS)

Mutetwa and Makuza, (1996) recommended an open nucleus breeding scheme for small ruminants. A nucleus or group breeding scheme is being used in some countries, particularly in New Zealand for sheep. It is particularly attractive for small populations where within flock selection program are ineffective. In each small scale producer herd there is a small number of genetically superior animals, which if brought together will form a nucleus whose average genetic merit is far greater than that of any of the contributing cattle herd. Group of small

scale cattle producers agree to pool their high performing animals. The larger the number of cattle in participating herd the more successful the program is likely to be since sampling should produce genetically superior foundation stock containing a wide degree of genetic variability. Initial screening process to form an elite group is the most important step.

8.1. The purpose of ONBS

The most important purpose of the scheme is to increase the average performance of the local cattle herds for their important economic traits. With the help of meaningful information to objectively determine the genetic variation amongst indigenous cattle breeds as accurately as possible for identification so that selection can be carried out purposefully. The scheme would assist to evaluate management practices and facilitate the selection of animals. In addition evaluation and record the change in important economic traits amongst local cattle breeds over the years is possible so that it can supply the industry with meaningful information for future planning.

8.2. Potential value of ONBS

Initial screening of goats from cooperating small scale producers gives a genetic lift in establishing the nucleus cattle herd. Faster rate of genetic change is possible because of the increased population which results in high selection intensity. In terms of cost on genetic improvement would be low on regional basis. There shorter generation turnover therefore economic benefits are obtained sooner. Due to the set up of public institutions which harbors' the nucleus herd it is possible to measure traits more difficult to measure in the field. It is possible and more effective to concentrate scientific and technical expertise in a research station set up. The concentration of expertise makes it possible to use modern expensive technologies i.e. multiple ovulation and embryo transfer (MOET) and to develop new technology. The institution keeping the nucleus herd may be used as a base for research and center for training field personnel. Setting up such a facility does not suffer from as much infrastructure constraints because previous cattle structures are present.

8.3. Shortcomings of ONBS

Complex ownership patterns and multiple uses of cattle in Zimbabwe may affect the number of cattle supply of breeding stock and males available from small scale farmers. However, the other concern is the genotype*environment interaction. This only occur when the management of the nucleus herd becomes very much better than the communal areas herd management then the superiority of the young males may not be achieved in the communal herds. Possible solution to genotype*environment interaction is to site the testing station to be representative of all cooperating small scale farmers cattle as far as is practicable. On the other hand management and feeding need to be improved or be adequate in order to maintain good reproductive rates. Strict hygiene control is vital in large herds to reduce the risk of losses from diseases. In some areas nucleus schemes might not be feasible because of the costs involved in establishing a cattle breeding herd. Returns are long term therefore it may be difficult to convince poor smallholder farmers to contribute to the nucleus herd. The most difficult component may be the choice of selection objectives for several small scale cattle producers; however there is need to link selection objectives to market trends in long term. The risk of concentrating best animals in one risk (De Jong 1996)

8.4. ONBS ideal structure

Optimum operating structures for open nucleus scheme have been sought by several workers and reported results of analyses of varying situations (Jackson and Turner, 1972; Rae, 1974; Clarke, 1975; James, 1977). In general these were consistent in showing that the ultimate rate of response to selection was greatest when about 10% of the population was in the nucleus, about half the nucleus dam requirements were introduced from the base, and surplus nucleus born females were used for breeding in the base. However maxima were not very sharp and operating conditions could be varied considerably without greatly reducing response. Participating small scale cattle farmers' benefit from a coordinated policy shared facilities and from the improvements achieved Open nucleus breeding scheme on theoretical grounds is as follows:

- a) Ten percent of the female replacement should be in the nucleus herd.
- b) Fifty percent of the female's replacement should come from the base cattle herds.
- c) All surplus females born in the nucleus flock should be used for breeding in other cattle herds

d) Once the nucleus herd is assembled an efficient system of recording and selection is implemented including selection of young males on pedigree information and progeny testing

e) The best males are kept for breeding in the herd while other selected males are given to the participating small scale farmers.

f) The nucleus may remain open and dam replacements and sires in the nucleus originated from which are then compared with those in the nucleus. Matopos Research Station, Makoholi Research Station and Grasslands Research Stations could act as open nucleus breeding centers for local genetic resource provided links are established with the local small scale cattle farmers.

8.5. Successful ONBS depends on

Knowledge of the cattle related market; perhaps more than any other thing, this is a must. It is futile to spend time and money producing cattle for which there is no market. Successful schemes first they develop the market by finding out what is needed and then produce for that need (market). Recognize what you have, in this case indigenous cattle types (Mashona, Tuli and Nguni) managed by small scale cattle farmers. Promote your program through sometimes awareness campaign amongst small scale producers. There is a need for market research which goes in line with the targeted cattle market development.

9. Traits to target for selection and their impact on efficiency of production in indigenous cattle

Before one considers intervention aimed at improvement of performance of indigenous cattle breeds in communal areas it is necessary to know both the limitation imposed by the production environment and the genetic potential of the stock available in terms of all important economic traits.

1. Fitness traits (survivability and reproduction or fertility).

High reproductive performance ranks very high as a factor affecting meat production. Reproductive performance is an indicator of environmental compatibility (Casey and Van Niekerk 1989). Effective reproduction is necessary and is doubly important for meat production. High rates of reproduction and low post natal mortality are most important requirements for meat producing animals.

2. Growth

Weight or growth rate (pre-weaning and post weaning) is a direct component of meat production and thus need to be considered in a selection program. Rapid growth rate of meat animals is frequently stated to be desirable; since it is expected to result in greater weight of meat at a given age and per unit of food consumed hence greater efficiency and profitability. In fact these advantages may not be realized in all circumstances and optimum genetic potential for growth rate depends on many variables. Selection for rapid growth to normal slaughter weight or age generally results in increased weights at birth and maturity and later attainment of a given degree of maturity and lead to a decrease in reproductive performance (Taylor, 1970).

3. Efficiency of feed use (feed conversion).

4. Carcass composition and quality

5. Dam efficiency and mothering ability

The above mentioned traits may be tested in various phases of the open nucleus breeding scheme. It is essential to note the multiple functions of cattle in the communal areas, which are as follows: food supplies-meat and milk, cultural needs, provide manure and meeting the financial needs small scale farmers. Cattle production by small scale producers is characterized by low plane of nutrition and high incidence of diseases resulting in low production. About 60% of the national herd is owned by small scale cattle producers (Homann et al., 2007) and the Mashona cattle are the most numerous (CSO, 2000). The local cattle have the ability to cope with an adverse condition (Mason and Maule, 1960). With this in mind interventions are desirable to increase genetic potential of important production traits to link with the current cattle market development thrust.

9.1. Way forward

It is clear that improvement of indigenous cattle and their utilization can play an important role in resuscitating the cattle industry which can translate into national food security and income growth for small scale cattle producers while in future providing options for local and regional market development. Indigenous cattle represent a genetic resource which should not only be conserved for future use, but should also be fully exploited for short term benefits. Different breeding methods are employed to exploit the different kinds of genetic variance

in the total genetic improvement of beef production. Selection within indigenous cattle breeds is the only viable production strategy because of adverse climatic and nutritional condition. This will ensure that conservation and utilization of indigenous cattle breeds in Zimbabwe is ensured. Indiscriminate crossing of indigenous cattle with larger breeds may not be the solution it only compound the eroding of the indigenous cattle genetic diversity. The meat production potential is still poorly developed within the indigenous cattle however there is a need to improve the potential to a satisfactory level, without sacrificing adaptational qualities. This may be accomplished through improvement by selection within the indigenous cattle herds. The low genetic potential for meat of indigenous cattle, although such cattle are usually well integrated with the available feed resources some genetic improvement will usually be necessary if improved feeding is to be fully exploited. The type of production strategy to be followed will depend primarily on the environment and level of management taking into account low input subsistence smallholder farming and emerging farmers after land reform are operating on a noncommercial level. In small scale cattle production field recording is almost negligible and virtually no information on the performance potential of animals in their native environments is available.

Integrated national performance recoding centres are sort for genetic improvement of indigenous cattle breeds. The centers need to adopt new technologies and improved genetic evaluation systems. An open nucleus breeding scheme may present possible advantages taking into account the small holder cattle sector which has small individual populations where within herd selection may not be effective. Open nucleus breeding scheme combined with progeny testing may accelerate genetic progress. A sire and cow evaluation program where animals are ranked on their estimated breeding values and sire summaries published twice a year may be established. This entails a huge investment on the part of the government on performance recording of data to cater for the vast small cattle sector. The future of the cattle industry is vested in the small holder sector which requires a collaborative approach to improvement of management in the communal areas. One of the setbacks in this venture is the lack of trained animal breeders in Zimbabwe, however all animal scientists and veterinarians need to work together to improve the spectrum of the basic animal husbandry issues such as feeding, grazing, general management and disease control in communal areas. Measurement of targeted traits in a performance testing program to identify superior animal should be emphasized. In particular, use tested high performance young bulls and heifers from outstanding dams and sires.

10. Impact of new technologies in indigenous cattle improvement

Animal breeding is presently in what can be called the hi-tech computer era and is steadily, albeit slowly, moving into the hi-tech biological era. The approaching era with the possibility of creating different forms of transgenic livestock, has already caused great excitement and anticipation. This has to be taken into account into in our endeavor to improve indigenous cattle. The advent of DNA technology adds a new dimension to the ability to evaluate and select within indigenous cattle breeds. Such technology allows for the direct selection of a gene or genes combinations of importance to breeding program. Also linkages between the gene and the trait can be established, laboratory identification can be used in selection process. In the case of polygenic genes the laboratory selection would have to be incorporated in the normal breeding value predictions. The increased accuracy in selection, especially in combination with modern reproductive techniques such as AI, MOET (Multiple Ovulation and Embryo Transfer) embryo splitting and nuclear transplanted can lead to dramatic increase in selection response. The availability of frozen semen means that in establishing an open nucleus breeding herd may readily use a wide range of foundation cattle including those from small scale cattle producers and also foreign such as the Tuli and Nguni in South Africa, in order to obtain as favorable a starting point as possible in the breeding programs.

11. Integrating conservation of indigenous cattle breeds

The introduction of exotic breeds and other social and economic pressure have exposed locally adapted indigenous cattle breeds to the risk of extinction and could lead to loss of potentially valuable genetic resource (Rege and Gibson, 2003). There is need for a comprehensive policy for conservation and breeding of indigenous cattle.

Conservation strategies should include:

1. Setting up a national performance recording scheme for sheep and goats from all farming sectors of Zimbabwe. This will enable breed characterization and evaluations.
2. Revamping of breed societies and encouraging of keeping of performance records of the farm animals.
3. Maintenance and/or use of live animals. Selection within the breed should be the only method of improvement to make them more commercially viable for example at government research stations. Representative samples of animals should be chosen from many flocks in preference to the conservation of a single flock, even if relatively large.

Preservation of the indigenous breeds' gene resources in haploid form as frozen semen and oocytes, in diploid form as frozen embryos and single genes preservation is advocated.

12. Conclusion

Indigenous cattle in Zimbabwe as a potential animal genetic resource demands greatly for their improvement for increased productivity and wide use of these animals can be expected to increase overall meat productivity and consequently national offtake as what the South African have achieved on the same indigenous cattle breeds. Targeting of the indigenous cattle in genetic improvement needs an objective and efficient breeding organization which takes into account the technical constraints of the smallholder farmer production setup and the breeding methods and programs existing in the breed population. Genetic potential of indigenous cattle breeds in communal areas is low yet hardly exploited because the common objective has been to meet the limited meat household requirements.

It will be interesting to see the cattle industry become better organized to exploit resources in the formation of smallholder cattle farmers' cooperative open nucleus breeding groups for successful exploitation of selection pressure for improvement of Mashona, Tuli and Nguni cattle breeds. There is a large variation in the genetic background of cattle population in the communal areas of Zimbabwe as far as their beef potential is concerned. This arises primarily from a differing emphasis placed by different smallholder farmers in the past on the production of beef, which in turn has influenced breeding aims. However selection within breeds aimed at meeting the requirements of existing variables and unstable environmental situation may be a difficult task. In the process of indigenous cattle genetic improvement should avoid narrowing animal genetic resource base. There is need to maintain a breeding strategy which sustain a broad range of genetic resource, possible to provide genetic insurance against future challenges and shocks

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