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Determination of economic weights for breeding traits in indigenous Nguni cattle under *in-situ* conservation

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ABSTRACT

This study was conducted to determine the economic weights of most preferred traits in young breeding Nguni bulls and first parity cows. Fifty-four farmers from low-input cattle production enterprises participated in the choice experiment. Sixteen individual animal profiles were formulated from four traits of three levels each using a fractional orthogonal design of SPSS 14.0 (2005). 120 pair-wise choices were deduced for each breeding animal class. A total of 6480 (54×120) observations were obtained for each class of the animals. Data was subjected to multinomial logit (MNL) models using econometric software NLOGIT 4.0.1 Version (2007). All computed economic values for bull traits were significant ($p < 0.05$). The economic weights of bull traits were poor body condition score (-0.99 ± 0.095), good body condition score (0.45 ± 0.073), over-conditioned (base level), low tick infestation (0.57 ± 0.103), medium tick infestation (0.58 ± 0.084), high tick infestation (base level), high aggression and mating behavior (4.41 ± 0.095), average aggression and mating behavior (2.53 ± 0.094), and low aggression and mating behavior (base level). The economic weights of first parity cow traits were poor body condition score (-0.06 ± 0.055), good body condition score (1.08 ± 0.061), over-conditioned (base level), low tick infestation (1.50 ± 0.059), medium tick infestation (0.83 ± 0.067), high tick infestation (base level), age at first calving of ≤27 months (2.37 ± 0.068), age at first calving of 27–36 months (1.30 ± 0.076), and age at first calving of >36 months (base level). Farmers were willing to pay R37,939 (US$4864) for a bull with high aggression and mating behavior score and R17,185 (US$2203) for a first parity cow of less than 27 months old. Enterprise ownership and demographics factors of the farmers were significant in determining economic weights within trait levels. Economic weights were high for reproductive efficiency of the breeding animals followed by the high adaptive characteristics. The choice experiment procedure can be the tool for determining importance of animal characteristics under low-input production systems. It is recommended to make use of the economic weights of preferential traits in designing selection models.

1. Introduction

Diversity of an indigenous genetic resource is a key component for a low-input production system to overcome destabilizing factors of uncertainty over future production environments such as climate change, diseases and changing market demands (Ruto et al., 2008; Kassie et al., 2010; Zander, 2011). The indigenous Nguni cattle breed in South Africa is an example of Animal Genetic Resources (AnGR) currently under *in-situ* conservation in the communal and small-scale farming enterprises of the Eastern Cape Province (Muchenje et al., 2008; Tada et al., 2012). The majority of the farmers in these sectors (67%) perceived the low-input *in-situ* conservation as profitable because the indigenous breed possesses traits of economic

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and socio-cultural importance (Tada et al., 2012). Informed decisions on sustainable conservation of this genetic resource could be made easier if information on the economic value of traits and breeding objectives were available.

The development of breeding objectives has long involved quantification of the levels of economical benefit associated with genetic traits expressed by farmed livestock (Amer, 2007). The breeding objectives determine optimal herd size and direction of genetic changes in production traits. Thus, they considerably influence the need of economic weights of production traits in selection. The economic weights of traits for beef cattle are often disregarded under low-input production systems probably due to the difficulty of measuring and valuing them as reported by Roeleveld (1996). The development and application of adequate tools to economically characterize the traits was therefore important. A review of potential AnGR valuation methods by Roosen et al. (2005) highlighted the potential role of non-market valuation methodologies in developing countries. This follows the premise that many of the benefits derived from the existence of well adapted indigenous breeds are not transacted in any market (Ruto et al., 2008). An indirect stated preference approach, the choice experiment (CE) (Louviere et al., 2000) ,can therefore be used to investigate farmers' preferences over cattle traits in livestock selection markets.

Some applications of CEs show that such methodologies reveal useful estimates of the values that are placed on the market, non-market, and potential breed attributes (Scarpa et al., 2003; Tano et al., 2003; Ruto et al., 2008). The contribution of preferred traits in the breeding objective is the basis for determination of their economic weights. The need to include economic weights of traits in a selection model for low-input animal production environments is recognized (Hazell et al., 2007; Zander, 2011). This has not yet been implemented for Nguni cattle and many other indigenous breeds in the developing countries where performance recording systems are minimal. The objective of the study was, therefore, to determine the economic weights of most preferred traits of young breeding Nguni animals by farmers in the low-input production enterprises using a CE approach. It was hypothesized that the contribution of animal traits to the market value of the breeding animal from different enterprise types and farmers of different demographic factors were the same.

2. Materials and methods

2.1. Study area

The study was conducted in the Eastern Cape Province of South Africa with representative farmers (75%) from communal and small-scale Nguni cattle enterprises. The enterprises were the beneficiaries of Nguni Cattle Restoration Program that was enacted in 2004 (Raats et al., 2004). The Eastern Cape Province is the second largest Province with an area of 169,580 km², representing 13.9% of South Africa's total land mass (Acocks, 1988). The climate varies according to the distance from the Indian Ocean. The coastal areas enjoy mild temperate conditions ranging between 14 and 23 °C, while the inland areas experience slightly more extreme conditions with temperatures of 5–35 °C. Inland mountainous areas experience winter snows and summer rainfalls.

2.2. The rationale of choice experiment and its design

Wurzinger et al. (2006) reported that choice experiments are important for identifying selection criteria in traditional production systems where literacy level is low and recording practices are not in place. The breeding goal is generally described as a linear function of traits to be improved as described by Hazel (1943); each of these traits is multiplied by its economic weight (EW) expressing the value of a unit change in the trait while keeping the other traits in the breeding goal constant. Due to the complexity and diversity of the low-input production systems, the lack of good records and good estimates of inputs and outputs, a simplified CE procedure was deemed appropriate to derive EWs of most preferred traits of young breeding Nguni cattle. Choice experiment permits the analysis of farmer's preferences in terms of the benefits that they expect to attain from different genetically determined traits. Hypothetical profiles were described in terms of trait levels. Traits were identified by farmers during a preliminary survey and these are easily recorded at farm level with minimum literacy. The three most important traits identified for, and price ranges of the young breeding Nguni, i.e. first parity cow and 2–3 year old bull, are presented in Table 1. When policy makers promote cattle with desired traits, farmers are likely to conserve the breed and at the same time generate income (Zander, 2011). With four traits of three levels each in both classes of animals, there were 64 (4^3) possible Nguni cattle profiles in a full factorial design. These were reduced to a manageable size of 16 profiles using a balanced orthogonal i.e. fractional factorial design (SPSS 14.0, 2005). The design ensures the identification of the main effects with a minimum number of profile combinations. A choice set with uncorrelated attributes was then generated. Descriptive cards in Xhosa (vernacular) with pictorial illustrations were used.

2.3. Data collection

Data were collected in the form of an in-person survey instrument. Fifty-four respondents representing low-input Nguni cattle conservation enterprises were conveniently sampled. The criteria involved selecting a representative who is literate and willing to implement cattle recording system. Respondents were first exposed to interactive discussions on the value of animal records, traits of economic importance and recording. The demographic data of the respondents were also gathered. Age, education level, gender and ownership pattern have been identified as key demographic parameters affecting selection of animal traits and their pricing under the South African environment (Madzimure, 2011). After a cheap talk script, respondents were introduced to the type of choice task required i.e. a full set of 120 pair-wise choices from 16 individual animal profiles. The respondents were tasked to hypothetically