Modelling the Value of the Borana cattle in Ethiopia – An Approach to Justify its Conservation

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Abstract

The Borana cattle have their origin in Southern Ethiopia where they are guarded by the Borana-Oromyfa clans because of their unique traits that make them suitable for the harsh environment in the lowlands. Borana cattle are also the main source of the livestock-keepers' income and the local people's cultural identity is formed on the husbandry of these animals. Nowadays the existence of this breed and hence its cultural heritage is threatened due to genetic erosion and dwindling number of pure Borana animals. This depletion has many driving factors such as population pressure, ecological changes, natural catastrophes and adverse economic conditions, and provides justification for conservation initiatives that preserve the irreversible loss of the Borana genes. The preservation of animal genetic resources (AnGR) is crucial for future use and enhancement of global biodiversity, globally as well as locally, but financial aid for conservation purposes is scarce. Economic valuation of these genetic resources would justify that they are 'valuable' and hence deserve priority in funding. Thus this study seeks to quantify the total economic value of the Borana cattle to the Ethiopian livestock-keepers and to show why it should be conserved. A discrete-choice ranking approach is used to estimate the livestock-keepers' willingness to pay (WTP) for different attributes of cattle. This permits assessment of relative preferences for different attributes of the Borana cattle that can be used as an indicator to enhance its conservation. Furthermore, a random parameter logit model as an extension of the multinomial logit model with individual characteristics is applied, revealing heterogeneity in livestock-keepers' preferences or utilities for cattle. Particular emphasis will be put on variance in utility among livestock-keepers in different production systems, showing which group of livestock-keepers could be eventually targeted in conservation initiatives for the Borana cattle.

Key words: Ethiopian Borana Cattle, AnGRs, Stated Choice Preference, Choice Ranking, Random Parameter Model

1. Introduction

The Borana cattle is the predominant traditional[1] breed on the semiarid Southern Borana plateau of Ethiopia where it is been kept due to its outstanding attributes that make it suitable for husbandry in the lowlands. The Borana plateau is nowadays constantly in crisis due to pressure on the common rangelands, high population growth rates, and increased privatisation for both cultivation and grazing land (Coppock 1994; Hogg 1997). Apart from these factors, crossbreeding among other local breeds also negatively effect the population of the pure Borana cattle.

The Borana breed as well as any other traditional breed contains the genetic potential for new breeds tolerant or resistant to biotic and abiotic stress factors. These breeds will remain an essential aspect of sustainable animal production and food security for the growing world population. Maintaining genetic variation is crucial for improving livestock and responding to changes in climate, disease or consumer preferences and "existing AnGR represent a massive past investment which, if managed appropriately, can provide insurance against unknown global future" (Rege and Gibson, 2003, p.322). A loss in animal genetic diversity may weaken the chances of future generations to respond adequately to increasing food demand, potential environmental changes, diseases, and other challenges and catastrophes we cannot foresee (Koehler-Rollefson, 2002).

Until now, the economic, ecological, and cultural value of the Borana breed has not been quantified and thus a statement of whether the breed is "worth" of receiving conservation priority cannot be determined. Assessing the genetic potential of the Borana breed requires finding an economic value of the breed *per se* as well as of its unique attributes that makes it superior (or probably inferior) to other local breeds and their crosses. This value should be

[1] Traditional breed is also referred to as local, indigenous or old breeds. Traditional breeds have developed over time in traditional societies without herd books and scientific interventions.

derived from the point of view of local livestock-keepers because they are eventually enabled to conserve the Borana breed *in-situ*[2] in the first place. Therefore a stated choice method as applied in this study is deemed to be an appropriate approach to measure relative utility of the Borana breed for the local livestock-keepers.

Nowadays the Borana breed is still widely spread among the Borana people but this existing type is an admixture[3], and from the phenotypic perspective clearly different from the pure Borana breed. The aims of conservation initiatives must focus on the preservation of the pure Borana type only[4].

This paper is organised as follows: the introductory chapter gives an overview of the research objectives, the need to value the Borana cattle, as well as of the current situation of the Borana culture and its breed. The second chapter discusses the conceptual framework upon which the stated choice method and the applied choice experiment are based. The third chapter details the sampling strategy as well as results of the socio-economic household survey. The fourth chapter outlines the experimental design and procedure and provides the results of the choice experiment. Those include the outcomes of the welfare analysis from which a number of conclusions and policy implications are derived.

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[2] There are basically two different types of conservation methods. In-situ (also referred to as on-farm) conservation is defined by the Convention On Biological Diversity (CBD) as the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties (CBD, 1992). *Ex-situ* preservation involves the conservation of plants or animals in a situation removed from their normal habitat.

[3] There are currently three subtypes of the Borana breed: Kenyan Borana, Orma Borana and Ethiopian Borana (Simianer *et al*., 2003; Hanotte *et al*., 2000), whereby only the Orma and the Ethiopian Borana are existing on the Borana plateau. The Ethiopian Borana subtype is considered to the original pure one, as stated by interviewees.

[4] In the course of this study, when simply referring to “Borana”, we are talking about the existing type whereas the term “pure Borana” refers to the large-framed original Borana whose existence is in jeopardy.

1.1. Objectives and Purposes

This paper attempts to elaborate on the following objectives:

- Valuing cattle attributes that livestock-keepers particularly associate with the Borana breed,
- Revealing livestock-keepers' willingness to pay (WTP) for these attributes,
- Identifying heterogeneity in livestock-keepers' socio-economic characteristics with respect to their preferences about cattle attributes,
- Deriving consumer surplus (CS) associated with purchasing Borana cattle, as well as net benefits of Borana cattle kept in different production systems, an thereby
- Differentiating among types of livestock-keepers for determining potential participants who can be best targeted for conservation initiatives.

1.2. Why value and conserve the Borana breed?

Deciding over a conservation initiative for the pure Borana breed[5] depends broadly on two factors: the value of the breed to those who are guarding and using the breed (the consumers or in this case the local livestock-keepers) and the degree of threat leading to a depletion of the pureness of the Borana genetic resources. A high value of the Borana breed as well as many threatening factors can be seen as justification for launching an *in-situ* conservation programme for the Borana.

This section will cast some light on the subsisting threats Borana animals have to deal with in the course of the clash over scarce natural resources on the Borana plateau. Further, the benefits of the Borana breed as well as benefits from conservation programmes that may

[5] The aim of a conservation programme for Borana cattle would be to maintain the pure type of Borana, which is distinct from the majority of the currently existing Borana in the lowlands of Ethiopia. The existing Borana is an intermediate type between the small Ayuna and the large-framed Qorti (see section 3.2 for details). In the context of this study, we simply refer to "Borana" when referring to the existing intermediate type. In the context of conservation programmes we talk about "pure Borana" i.e. the large-framed *Qorti* type.

eventually be carried out based on the estimated values of Borana cattle attributes will be detailed.

Threat to the pure Borana cattle

The depletion of a breed, even if the breed in question is not yet recognised as being endangered, provides justification for conservation efforts if its loss results in a worsening condition for the livestock-keepers. There are various underlying causes for the genetic erosion of this important breed in this region (Coppock, 1994; Reda, 2001; Alemayehu and Drucker, 2002). The most important ones include: changes of ecological characteristics due to bush encroachment and recurrent droughts; poor herd management; difficulties in access to markets and civil strife (Alemayehu and Drucker, 2002). Bush encroachment due to population pressure often leads to diminishing availability of good pasture and hence to a decline in cattle carrying capacity per unit grazing area. After frequent droughts, pure Borana cattle are often replaced with other breeds that are readily available or cheaper. These include the smaller Guji cattle or Small East African Zebus which are often bought for restocking.

Despite this threat of genetic erosion, the pastoral communities in Ethiopia have continued to maintain Borana cattle in their herds. Most literature tends to attribute this trend to the traditional characteristics, organisational structures and indigenous knowledge of the communities keeping the Borana cattle (Rege and Gibson, 2003).

Benefits of the pure Borana cattle

Until now biodiversity is frequently linked to plant diversity and wildlife diversity, leaving out the issue of farm animal (genetic) diversity. Farm animals, unlike wildlife, do not have a “lobby”; do not have a strong bequest and existence value that drive governments and private stakeholders to get involved into conservation initiatives. People in developed countries might care about the well-being and existence of e.g. rhinos or elephants, but not about local breeds of farm animals. An economic valuation of farm animals can counteract the missing awareness towards the conservation of farm animal genetic resources.

The Borana cattle was chosen as case study because this breed is perceived as superior to other breeds in many ways, as came to light in a pilot study that was conducted prior to the choice experiment survey (see chapter 3.1). The maintenance of the pure Borana cattle is expected to have the following benefits:

- Contribution to the preservation of the global diversity,
- Securing livestock-keepers' livelihoods that almost fully depend on Borana cattle,
- Preserving the cultural heritage of the Borana-Oromyfa clans and enhancing their cultural distinctiveness by securing continuous traditional livelihoods with cattle production; keeping browsers like goats and camels do not go hand in hand with the Borana traditional way of life.
- Securing the equilibrium between culture and economic improvement through incentives. Maintaining the culture must be economically feasible for the Borana clans.
- Facilitating to find opportunities in order to diverse livestock-keepers' sources of income through the participation in conservation initiatives and resulting compensation payments.

1.3. The Borana Plateau, and its People and Cattle

The Borana plateau or zone occupies a total land area of about 95,000 square kilometres and its altitude ranges from 1,600 meters above sea level (ASL) in the northeast to about 1,000 meters ASL in the extreme south of Ethiopia (Kamara, 2000). The climate on the Borana plateau is semi-arid, with average annual rainfall ranging between 350 mm and 900 mm. The plateau is divided into four ecological zones based on soil types, natural vegetation, primary productivity, and duration of growing seasons. These include the savannah in the north, which has potential for carrying relatively higher numbers of livestock, the bush land with high shrub cover in the central zone, the medium-potential grassland in the east, and the volcanic areas in the west (Kamara, 2000). A particular feature on the plateau is the permanent supply of water by nine deep well complexes and a number of dispersed springs. The deep wells (*tula* wells) are perhaps the most fundamental feature that has shaped the Borana society (Helland, 1980), constituting a vital source without which keeping cattle in the Borana ranges would be impossible in the dry season (Helland, 2000). *Tula* wells are old, usually much deeper than normal well complexes and require massive excavation with shafts sunk into rock. The *tula* wells comprise the most reliable source of water, never drying up even in the course of severe droughts (Coppock, 1994). The nine deep wells underlie a strong social organisation controlling construction, access, usage and maintenance of the wells (Helland, 2000).

The Borana plateau is largely occupied by the Borana people, and natural resources are largely communal, although individual crop cultivation and private enclosures appear to be increasing in recent decades (Kamara, 2004, p26). Other ethnic groups on the plateau include the Somali, the Gari, the Gabra and the Guji[6]. The most recent census on the plateau recorded a total population of 480,000 inhabitants, with an annual population growth rate estimated at 2.5-3 % (Homann *et al.,* in press). Urban agglomerations can be found at Negelle, Yabello and Moyale towns, whereas the open grazing areas occupied by livestock-keepers have no permanent encampments. An important link to urban markets is the tarmac road from Addis Ababa to Nairobi which crosses the plateau (Homann *et al.,* in press).

Over 90% of the livestock-keepers' cash income is derived from livestock sales as other alternatives for income generation are very few mainly due to the lack of infrastructure (Homann *et al.,* in press). The Borana cattle, which are commonly found in Kenya and

[6] The local breeds of cattle kept in the plateau are named after the ethnic group which introduced them. There are therefore Borana cattle, *Arsi* cattle, Guji cattle, *Konso* cattle etc.

Ethiopia, have their origin on the Borana plateau. As already indicated in the introductory section, three Borana subtypes are known; two of them, the Ethiopian and the Orma Borana, in the research area on the Borana plateau. The local livestock-keepers gave these two subtypes different terms, but the distinction is basically the same than commonly found in literature and also based on the phenotypic makeup of the subtypes. The two subtypes are the traditional large-framed *Qorti* and the smaller *Ayuna*. Both sub-types have evolved through human selection along with adaptation to environmental changes but nowadays animals of both sub-types can hardly be identified. The *Qorti* type is what is referred to in literature as Ethiopian Borana, whereby the smaller *Ayuna* resembles the Orma Borana. To avoid complications, we refer to Orma and Ethiopian Borana throughout this paper.

The predominant Borana type that nowadays counts for the majority of cattle in the Borana lowlands are of an intermediate type between Orma and Ethiopian Borana. However, an investigation of the phenotypic makeup of most of the cattle found on the Borana plateau revealed that they were in fact admixtures of different local breeds and the livestock-keepers also admitted that the animals differ from the Borana they used to know 10 years ago, despite the fact that their breed name is unchanged.

There is also an improved type of the Borana cattle, mainly found in the highlands of central Kenya from where it has recently been exported to other countries such as USA, Australia and South Africa. This improved Borana type is for meat purpose and well suitable for crossbreeding with other highly productive breeds such as Hereford, Charolais and Angus. In the highlands of Ethiopia, on a governmental ranch (*Abernossa* ranch), improved crossbreeds between Borana cattle from the Borana lowlands and Holstein-Friesian[7] cattle are being kept and continuously improved. Every year these crosses are distributed to local livestock-keepers

[7] Holstein-Friesian cattle can be considered an “exotic” breed, i.e. a high productive breed that emerged through intensive selection and that have been imported from Western countries.

in the highlands in order to upgrade their herds in terms of productivity and therefore support their income generation. On the other hand, the governmental ranch near Yabello on the Borana plateau (*Did Tuyura* ranch) aims to conserve the pure Borana cattle. The ranch was established in 1987 when it received some of the best Borana animals[8] from Borana livestock-keepers and owing to these animals initiated a breeding programme. Since then the ranch has been given out breeding bulls to the five districts (*woradas*[9]) on the plateau in an annual regularity. The breeding bulls are then further distributed to some communally selected livestock-keepers within the *woradas* for the purpose of upgrading their herds in terms of productivity and body size of the animals. The number of Borana cattle given out to each *worada* depends on its population size. The Yabello district, for instance, obtained 18 bulls in 2003 but only six bulls in 2004. In total, 61 bulls were distributed in 2003, and 45 in 2004. The *Did Tuyura* ranch constitutes a first attempt to conserve the large-framed pure Ethiopian Borana breed (the *Qorti* type to express it in the local term) but it cannot fulfil the high demand of the livestock-keepers that clearly exceeds the supply of these few bulls for the entire Borana plateau. Moreover, hitherto, the ranch only facilitates the upgrading of the local peoples' Borana cattle as it distributes only breeding bulls and no cows. The usual strategy for a conservation programme under FAO recommendations requires the conservation of cows and bulls. As a safe minimum standard (SMS), it is recommended to maintain at least an effective population size of 1000 female animals (e.g., see Drucker, in press; and Zander *et al*., forthcoming).

[8] The selection of the "best" Borana animals entering the ranch was based on phenotypic characteristics. However, one cannot infer from the phenotypic make-up to the genotype of an animal and hence the pureness of these Borana cattle entering the conservation programme in the first place was never confirmed. Determining the genotype of a breed requires a molecular genetic analysis (see Hanotte *et al*., 2000).

[9] The five *woradas* are: Tatalde, Dire, Moyale, Arero, and Yabello.

2. Theory and Methodology

2.1. The Demand for Cattle

Most of the functions (e.g. traction power), outputs (e.g. manure, milk for self-sufficiency) and services (e.g. dowry, status of wealth) that come along with the keeping of cattle are not traded in the markets. Consequently, non-market valuation methods such as the applied stated choice method are suitable to determine the values of the benefits of certain cattle breeds and in particular of the Borana breed. These non-market values or benefits can be determined mainly by the consumption and production preferences of livestock-keepers as these benefits primarily accrue to them. Therefore, this study seeks to assess the total value of the Borana cattle (non-market and market-values) to the local livestock-keepers by identifying their preferences about cattle breeds and determining the implicit values these livestock-keepers attach to cattle and their attributes. In order to measure the implicit values of cattle and their attributes, a choice ranking experiment has been used, as will be detailed in the following chapter sections. This method is most appropriate in valuation of a good, such as cattle, which encompass multiple attributes, since this method allows for derivation of benefit value of each attribute. To strengthen this point, Scarpa *et al.* (2003) compared the results of a choice experiment, aiming to value cattle breeds in Kenya, with those derived from a revealed preference method (in this case an hedonic analysis of market transaction data for cattle in Kenya) and conclude that both approaches provide similar results.

2.2. Multinomial logit model specifications

Unlike other stated preference methods, such as the contingent valuation method (CV), the choice experiment (CE) and the choice ranking (CR) enables estimation of not only the value of the environmental good as a whole (i.e. the value of the cattle per se), but also the implicit marginal values of its attributes (Hanley et al., 1998; Bateman et al., 2003). Both methods are based on Lancaster's characteristics theory of consumer choice (Lancaster, 1966), stating that consumers derive utility not from the good per se but from the bundle of attributes and magnitude (levels) of the attributes they provide. The methods are further based on the random utility theory (RUM) (McFadden, 1973), which illustrate that utility for a consumer derived from a good consists of two decomposed parts; an observable part and an unobservable part (see Equation 1). The unobservable part ε_{nj} describes other factors or attributes of a good apart from the stated attributes but which are also influencing consumer's choice. The term ε_{nj} is treated by the analyst as random. Only the observed part V_{nj} is known by the analyst up to some parameters (Train, 2003). The random utility model (RUM) is based on the composite utility function as follows:

$$U_{nj} = V_{nj}(X_{nj}) + \varepsilon_{nj} \tag{1}$$

Where U_{nj} is the total utility that individual n obtains from choosing the alternative j from a finite set *C*. The observable part V_{nj}, which is a function of a vector, X_{nj}, consisting of choice-specific attributes as well as individual specific characteristics. The random error term ε_{nj} is assumed to be independent of X_{nj} and follows some predetermined distribution[10]. The distribution is also called Gumbel and type I extreme value (Train, 2003).

[10] It is assumed that the random error terms are independently and identically distributes (iid) (Train, 2003), i.e. iid implies that the variances associated with the component of a random utility expression describing each alternative (capturing all unobserved influences on the choice) are identical, and that these unobserved effects are not correlated between all pairs of alternatives (Louviere et al., 2000). According to Train (2003) the key assumption lies in the independence of the error terms, i.e. that the unobserved portion of utility for one alternative is unrelated to the unobserved portion of utility for another alternative. Under independence, the error for one alternative provides no information to the researcher about the error for another alternative. Stated equivalently, the analyst has specified *Vnj* sufficiently that the remaining, unobserved portion of utility is essentially "white noise." In case these logit assumptions are violated one option is to use a different model, such as a random parameter logit model or a latent class model.

RUMs are most commonly estimated using the method of maximum likelihood estimation (MLE), i.e. the coefficients show the relationship between the probabilities of selecting one option with its attributes that are most likely to occur given the choices one can observe the respondents actually making (Sandefur et al., 1996). Option i will be chosen over j if:

$$V_{ni}(X_{ni}) + \varepsilon_{ni} > V_{nj}(X_{nj}) + \varepsilon_{nj}; \forall \ i \neq j, \forall \ \mathrm{j} \in C. \tag{2}$$

The probability that this is the case will be given by

$$\pi_n(i) = \Pr ob\{V_{ni} + \varepsilon_{ni} \geq V_{nj} + \varepsilon_{nj}; \forall i \neq j, \forall j \in C \ \} \tag{3}$$

By assuming a linear functional form for $V_{nj}(X_{nj})$ and an iid distribution for the error components in Equation 3 a discrete choice model, known as multinomial logit model[11] (McFadden, 1973) can be constructed:

$$\Pr ob_{ni} = \frac{\exp(\beta' x_{ni})}{\sum_J \exp(\beta' x_{nj})} \tag{4}$$

X is a vector of independent variables upon which utility is assumed to depend, and β is a vector of parameters to be estimated, and then $\Pr ob_{ni}$ gives the probability of choosing alternative i out of j alternatives for decision maker n (Bateman et al., 2002). The vector β is usually assumed to equal 1 so that the $\beta' s$ can be identified. It is noteworthy that McFadden (1974) demonstrated that the log-likelihood function with these choice probabilities is globally concave in parameters β, which helps in the numerical maximization procedures (Train, 2003). The $\beta' s$ can also include a series of alternative specific constant term (ASC) that capture the effects in utility from any attributes not included in X_{nj}.

[11] In this study, the dependent variable takes four values (animal A, animal B, animal C, no animal), and hence a multi-nominal logit (MNL) model is required (Bateman et al., 2002). If the dependent variable only takes on two values (e.g. A or B) then we talk of a binary logit model (Bateman et al., 2002). MNL models are applied when there is a single decision among two ore more alternatives (Green, 2003).

MNL model and welfare indicators for cattle

For policy analysis, the researcher is often interested in measuring the change in consumer surplus that is associated with a particular policy. For instance, a change in the attributes of cattle can have an impact on consumer surplus that is important to assess. Deprivation of the level of tick tolerance of cattle harms livestock-keepers in their income generation due to early death of animals or lower productivity. As a result livestock-keepers are no longer able to keep this type of cattle and that leads to dwindling numbers of a certain breed and dwindling genetic resources as a biodiversity asset. Measuring this harm in monetary terms is a central element of setting up policy implications against the loss of genetic resources.

The probabilities of an individual choosing any given option can then be estimated owing to those coefficients showing the relationship between the probabilities of selecting one option (see Equation 3). These probabilities can be used to derive the inclusive value index of the underlying utility associated with various choice options. With one attribute being price the marginal utility of money[12] can be calculated. Hence, for any utility change induced by a change in animal attributes, one can calculate the money payment that would induce the same utility change. This money payment is the individual's WTP for getting one desirable cattle attribute. The marginal utility of money can be estimated from the MNL model through the calculations of part-worth (Rolfe *et al*., 2000):

$$W = -\left(\frac{\beta_{attribute}}{\beta_{monetary\,variable}} \right) \qquad (5)$$

[12] Also referred to as marginal rate of substitution (between income change and the attribute in question)

2.3. Accounting for livestock-keeper's heterogeneity

Though the simplicity in constructing and analysing such a basic MNL model has proven very useful, the behavioural restrictions it imposes on the data have increasingly troubled applied econometricians (McFadden, 1973). One of the limiting implications of the standard model is that it imposes homogeneity with respect to individual preferences. Failing to account for preference heterogeneity, when it is warranted, leads to biased utility parameter estimates (Green 1997). Such biased estimates have been shown to produce misleading predictions of the main variables of interest such as participation probabilities, market shares as well as marginal and total welfare measures (Breffle and Morey, 2000).

The choice model in Equation 4 assumes homogeneity of preferences which follows from the assumption that the deterministic component of the utility function is invariant across individuals (i.e. $\beta_n X_i = \beta X_i$). This further implies that the variance of the error term is assumed to be the same for all individuals and that there is no correlation across occasions for a given respondent (this implication follows from the *iid* assumption). In practical econometric terms this translates into the inability of identifying and estimating the coefficients of individual characteristics in the indirect utility function since terms that do not vary across alternatives fall out of the probability (Green, 1997, p.914). Hence, even if such individual characteristics are directly included in the vector X_{ni} their effect on the probability of choosing a particular option $\pi_n(i)$ cannot be assessed. Hence, alternative conditional logit models with interacted individual characteristics, such as the RPL models[13,14], are preferred (Kontoleon *et al*., 2002).

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[13] Apart from the RPL model there are two other models that account for consumer heterogeneity: the covariance heterogeneity model and latent class model. However, both models are considered in this study.

[14] The term mixed model is often used synonymously.

The RPL model allows all choice-specific parameters to vary randomly across individuals. That is, β in Equation 4 becomes β_n. This is accomplished by assuming that β_n is drawn from a joint density function, the parameters of which (mean and standard deviation) are recovered by simulation (see Train 2003). Recent applications of RPL models have shown that they outperform conditional logit approaches both in terms of overall fit as well as in the accuracy of their welfare measure estimates. (e.g. Kontoleon *et al.*, 2002; Scarpa *et al.*, 2004) although some have cautioned that while the RPL models explicitly account for preference heterogeneity, they are not well-suited to explaining the sources of heterogeneity (e.g. Boxall and Adamowicz, 1999).

The specification of the RPL model is based on the MNL model with some modifications, whereby variations in tastes that are related to observed attributes of the decision making respondents are captured through specification of the explanatory variables and/or the mixing distribution. The RPL probability can be derived from utility-maximizing behaviour in several ways that are formally equivalent but provide different interpretations. The two basic approaches are variation in the error term and secondly variation based on random coefficients. The most straightforward derivation, and most widely used in recent applications is the latter approach (Train, 2003) and it is also applied in this study and its specification is as follows:

The decision maker faces a choice among *J* alternatives. The utility of person *n* from alternative j is specified as

$$U_{nj} = ß_n X_{nj} + \varepsilon_{nj} \quad (6)$$

where X_{nj} are observed variables that relate to the alternative and decision maker, β_n is a vector of coefficients of these variables for person *n* representing that person's tastes, and ε_{nj} is a random term that is *iid* extreme value. The coefficients vary over decision makers in the population with density *f (β)*. This density is a function of parameters θ that are normally[15] distributed with a mean b and covariance W of the $\beta's$ in the population. Then $\varphi(ß/b,W)$ is the normal density with mean b and covariance W, whereby b and W have to be estimated.

The analyst does not know β_n and therefore cannot condition on β (Train, 2003). The unconditional choice probability is therefore the integral of $L_{ni}(ß_n)$ over all possible variables of β_n. If utility is linear in β , then: the choice probability under a normal density is:

$$P_{ni} = \int \frac{\exp(ß' x_{ni})}{\sum_j \exp(ß' x_{nj})} \varphi(ß/b,W)\partial\beta \qquad (7)$$

Accounting for preference heterogeneity supports policy decisions for possible conservation initiatives. The aim is to understand who makes which choice, how different types or segments of individuals are affected by their choice making. That eventually permits targeting of those livestock-keepers who are most “willing” and most suitable for participating in an *in-situ* conservation programme for the pure Borana.

[15] The coefficients can take on any other distribution, such as lognormal, uniform, triangular (Train 2003). The analyst can freely choose it. The lognormal distribution is useful when the coefficient is known to have the same sign for every decision maker, such as a price coefficient that is known to be negative for everyone (Train, 1998). However in this study the normal distribution was chosen for all parameters that vary randomly across individuals.

3. Sampling and household survey

The results of this study are derived from a survey conducted on the Borana plateau in Ethiopia where 246 households were randomly[16] sampled. The southern part of the plateau, made up of four peasant associations (PAs[17]), was targeted for this field research due to the importance of Borana cattle in this area. The field research lasted for four months, covering October 2003 to January 2004.

Apart from the choice experiment, a semi-structured questionnaire was used to capture household data. Additionally, participatory rapid appraisals, participant observation and interviews of key informants were employed to gather much of the qualitative data which facilitated interpretation of the quantitative data.

3.1. Results of pilot study

As already indicated in the introduction, the Borana breed is perceived as superior due to various outstanding attribute expressions. Table 1 highlights the main attributes that are important for the quality of cattle, as stated by village elderly in the course of focus groups and in-depth interviews. The table also attempts to rank the three predominant breeds (Borana, Guji and Gari) with respect to the performance of the different traits.

[Table 1 here]

The ranking reveals clear advantages for the Borana breed, particularly with respect to tolerance to water shortage, fertility, tick tolerance and cultural value. Some other attributes such as the ability to cover long distances due to large body size, milk yield and traction

[16] "Randomly" means that every household in a PA had an equal chance of being selected from a list for the sample as every other household. Lists of all households in any given peasant association were provided by the village chiefs.

[17] The *PA*s were created under the Land Reform Proclamation Act (1975), as a means to organise the livestock-keepers in territorial units.

suitability are perceived as excellent equally for Borana and Gari cattle. The Guji breed was in any cases considered performing not as well as Borana and Gari.

3.2. Socio-economic differences among Borana pastoralists in Ethiopia

The results of the household survey that was carried out simultaneously with the CE are emphasised in Table 2. The household characteristics are of importance for revealing whether the differences among livestock-keepers have any impact on the choice for one animal or the other.

[Table 2 here]

4. Experimental procedure and empirical results

4.1. Design of choice sets and experiment procedure

A choice experiment (CE) is a ‘structured method of data generation’ (Hanley *et al*., 1998), as it relies on carefully designed tasks or “experiments” to reveal the factors that influence choice. Several profiles were created, and in this study referred to as animal profiles. Each animal profile represents one animal[18] in terms of its attributes and levels of these attributes. A certain combination of different animal profiles (referred to as choice set) was presented to livestock-keepers on the Borana plateau and they were asked repeatedly which animal profile they prefer among all given profiles in a choice set.

In this study a choice ranking (CR) approach was preferred over a simple CE. In a CR approach, a sample of individuals is required to rank a discrete choice set of alternatives from their most to their least preferred. However, the model specifications are the same, only the experiment design and the data entering and coding differ between the CE and a CR approaches. The advantage of a CR over a CE approach is that it provides more “choices” per

[18] The animal profiles were different for cows and bulls.

respondent and therefore a greater set of information. Respondents are asked to make a full ranking between four options (Animal A, B, C or the “no-buy” option), i.e. each respondent has to make three choices in each choice set (in a simple CE it is only one choice per choice set).

Each animal profile contains seven attributes and its levels, whereby the profiles for cows and bulls vary in two attributes, namely offspring (for bulls) and calving (for cows), and traction suitability (for bulls) and milk quantity (for cows). The remaining five attributes are the same for both sexes with price being adjusted for cows and bulls, based on authentic market prices. The finally chosen attributes and levels for the animal profiles are as follows:

1) Big body size vs. small body size
2) Tick tolerance vs. no tolerance
3) Watering frequency: each day, after 2 days, after 3 days
4) Market price: 90, 120, 150 Euros for bulls and 40,60, 80 Euros for cows
5) Horn shape and size: short and straight, long and straight, long and curved
6) Traction suitability vs. unsuitability (bulls)

   Milk quantity: 0-2 litres, 2-4 litres, more than 4 litres (cows)
7) Strong offspring vs. weak offspring (bulls)

   One calve every year vs. one calve every two years (cows)

32 of those animal profiles were designed using SPSS partial factorial[19] orthogonal design, which guaranteed the identification of all taste parameters during estimation (Kuhfeld, 2003). The sets were further optimised by accounting for minimum level overlap within the animal profiles as well as for no overlap of animal profiles within one choice set. The 32 animal

[19] In a factorial design each level of each attribute is combined with every level of all other attributes (Louviere *et al.*, 2000)

profiles were then randomly[20] blocked into three. A combination of three animal profiles (animal A, animal B, animal C) as well as a forth option, a so-called opt-out option[21] can be considered a choice set. The choice sets for cows and bulls differ due to two different sex specific attributes. Four choice sets for cows and three choice sets for bulls were presented to each respondent. Hence, each individual did seven full rankings and thereby made 7*3=21 choices[22]. 246 respondents account for a total amount of 5166 (21*346) choices. An example of the choice sets for cows and bulls can be found in the Appendix.

4.2. Coding and opt-out options

The basic MNL model assumes that the choice between these options is only a function of an alternative specific constant (ASC) and the attribute of the alternatives. The attributes that had two levels were effects coded with -1 for the non-expression of the attribute and 1 for the presence of the attribute. Only price was coded as a numerical value with three levels and adjusted for males and females. The ASC is not choice specific but equals 1 when either animal A, B or C was chose and 0 when opted for the "no buy" option. The dependent variable "choice" is a discrete variable that equals 1 when an animal profile is chosen and 0 if it is not.

The introduction of an opt-out alternative (i.e. livestock-keepers chose this options when they did not approve any of the presented animal profiles but chose to keep the money instead) was necessary for the estimated welfare measures results to be consistent with demand theory. Bateman *et al.* (2003) make the point that "it is necessary to include a status quo option in the choice set in order to achieve welfare measures that are consistent with demand theory. This

[20] The animal profiles were blocked randomly but in a second stage the sets were approved while accounting for minimum overlap of the same profiles within one set and for the maximum level diversity among the profiles of one set.

[21] The opt-out option is the same than not buying any of the presented animals but keeping the money.

[22] The four alternatives in a choice set (animal A, animal B, animal C, "no-buy") give rise to three choices.

is, because, if a status quo alternative is not included in the choice set, respondents are effectively being "forced" to choose one of the alternatives presented, which they may not desire at all and that is inconsistent with demand theory (Bateman et al., 2003; Adamowicz and Boxall, 2001, Bennett and Blamey, 2001). If for some respondents the most preferred option is the current baseline situation, then any model based on a design in which the baseline is not present will yield inaccurate estimates of consumer welfare.

In this study, the "no-buy" option is considered as baseline or status quo profile and hence coded with all attributes being zero. There are two exceptions for the status quo profile, relevant for those three attributes with three levels[23] (watering frequency, horn shape and size and milk yield). For milk yield, the statue quo is "2-4 litres", for horn shape and size "short and curves" and for watering frequency "watering every 2nd day". The use of these status quo attributes allows the estimation of absolute values (Rolfe *et al*., 2000).

4.3. Results of the basic MNL model

After accounting for missing data or data, where respondents did not reply to the full set of choices, the sample size was reduced from 249 to 246 individuals. These individuals provided data for 2952 choices. The models were analysed using LIMDEP 8.0 NLOGIT 3.0 (Greene, 2003).

Different model specifications were compared according to higher log-likelihood value criterion. The model is specified so that the probability of selecting a particular animal profile as first, second or third choice is a function of attributes of the alternatives and of the alternative specific constant (ASC; see chapter 4.1). The MNL model is used to estimate the attribute values for the entire population represented by the sample and to test whether or not the demand for each attribute is significant and finally to compare the implied, relative values

[23] Including all three levels of these attributes would result in a collinearity problem and the estimation of the MNL model would be infeasible.

of attributes. Testing the significance of attributes for the choice decision is done by applying the *Swait-Louviere* log likelihood test (Louviere *et al*., 2000) for comparing models with different number of variables. The test statistic is asymptotically distributed as χ^2 and is expressed as:

$$\chi^2 = -2(LL_1 - LL_2) \qquad (6)$$

where LL_x refers to the log likelihood statistics for the different models with different set of variables. The highest value of the log-likelihood function is found for the specification with all attributes entering the model in a strict linear distribution. Further, the log-likelihood test revealed that for cows three attributes have no significant impact on choosing one animal over the other: the attributes “horn size” “milk yield of 0-2 litres a day” and “milk yield of more than 4 litres a day”. In other words, the livestock-keepers see no utility difference from cows that have “long and curved” horns or the status quo “short und curved” horns, but they assign different utilities for cows with “short and curved” horns and “short and straight” horns, i.e. the shape of the horns has significant impact on the choice. Further, livestock-keepers seem not to consider milk yield of “0-2 litres” or “>4 litres” compared to the status quo of “2-4 litres” as an important driving factor for their choice. These three variables were hence dropped from the model. For the bulls model, all variables explaining the animals were significant and kept in the model.

The results of the estimated MNL coefficients for cow and bulls are presented in Table 3.

[Table 3 here]

All of the cattle attributes are statistically significant at 1% level and any single attribute increases the probability that an animal is selected, other things remaining equal. Since the underlying sample is statistical, these parameters represent preference estimates of livestock-keepers about cattle. The overall fit of the model as measured by McFadden’s ρ^2 is reasonable by conventional standards used to describe probabilistic discrete choice models[24] (Ben-Akiva and Lerman, 1985). Furthermore, the IIA[25] property of this model is tested using a procedure suggested by Hausman and McFadden (1994) and contained within LIMDEP 8.0 NLOGIT 3.0. It was found that the IIA property is not violated implying that the multinomial logit estimates do not hold any bias that could have resulted from inclusion of the "no-buy" option.

Investigation of the results for cows and bulls reveals that the findings of the study are strikingly in line with those as expected. The demand for the ability to stay without water for three days is positive compared to the status quo of "watering once in 2 days" and, on the other hand, the demand for an animal that needs watering every day compared to once in two days is negative. That is due to the harsh environment on the Borana plateau and its scarcity of water, particularly in the dry season.

The results of the MNL model further demonstrate that livestock-keepers derive positive utility from cattle that have a strong progeny (i.e. strong offspring for males and an annual calving rate for females), that are tolerant to ticks and that have a large frame (variable "body size"). For female animals the attribute "yielding more than 4 litres milk per day" shows a positive coefficient compared to the status quo attribute of "2-4 litres milk yield per day". Finally, livestock-keepers consider traction suitability as an important attribute for males and assign a positive utility to it.

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[24] The ρ^2 value in multinomial logit models is similar to R^2 in conventional analysis, except that significance occurs at lower levels. Hensher and Johnson (1981) comment that values of ρ^2 between 0.2 and 0.4 are considered to be extremely good fits.

[25] The main selection probability axiom used in basic MNL model is known as IIA axiom. The IIA axiom states that the ratio of the probabilities of choosing one alternative over another is unaffected by the presence or absence of and additional alternatives in the choice set. Hausman and Mc Fadden (1984) developed a test that can be applied to detect IIA violations (Louviere et al., 2000).

4.4. Welfare analysis

The results of the part-worth between a change in the monetary variable (in this case market price of the chosen animal) and each attribute for cows and bulls can be observed in Table 4.

[Table 4 here]

Livestock-keepers are willing to pay 9 Euros additionally to the market price for a cow that has the ability to stay three days without watering instead of only two days (that is the status quo), in case of purchasing a bull with this attribute they are willing to pay 7 Euros more per animal. On the other hand, switching to an animal that requires water supply every day instead of once in two days results in a negative utility to the livestock-keeper and thus in a cost of 26 Euros per cow, and a cost of 36 Euros per male respectively. The WTP for a cow (bull) with high tick tolerance (instead of poor tolerance) equals 13 Euros (20 Euros) per animal, and the WTP for a cow (bull) with a large frame amounts to 4 Euros (7 Euros) per animal. The most important attribute for cows seems to be the ability to have one calve every year instead of every two years, that is worth 12 Euros per animal. Being suitable for traction seems to be the most desirable attribute for bulls, i.e. the WTP for one bull that is well suitable equals 37 Euros. The fact that a cow (bull) has long horns is unfavourable, i.e. the cost for this attribute equals 5 Euros for cows and 13 for bulls.

4.5. Interactions with socio-economic characteristics

For cows as well as for bulls a number of socio-economic variables were tested and it came to light that “age of head of household”, “level of education of head of household”, “size of household”, “ethical affection”, “religion”, “size of cattle herd”, and “income from cattle products” have no impact on the livestock-keepers preferences for different cattle attributes, although some of them had a general impact on choosing one animal or picking the opt-out option. Household with many members, for instance, were more likely to select one of the presented animals rather than choosing the “no-buy” option. This finding can be explained by the fact that all household members are engaged in the cattle husbandry and the more labour one household can supply the more cattle it can herd. Further, respondents who did not have any school experience (and who were mainly illiterate) were also more likely to choose one of the three animals than respondents who received at least primary education. This reflects an on-going trend in the Borana traditional society. Educated livestock-keepers nowadays tend to send all their children to school and therefore sell the majority of their cattle in order to pay the school fees.

However, the parameter "being a pastoralist"[26] has a significant impact on the livestock-keepers' preferences about some cattle attributes, and the final model only included the parameter "pastoralist" as only socio-economic characteristic in the RPL model. In this RPL model, the estimated standard deviations of coefficients are highly significant, indicating that parameters do indeed vary in the population. n the cow model, the derived standard deviations of parameter distributions show significance for the four attributes "calve", "tick", "wat_1" and "big". The parameter price was set as fixed value in order to avoid negative values for price. In the cow's model, the parameters for "milk" and "horns" did not show significance in the basic MNL model and hence were not considered in the RPL model. For bulls, all parameters seem to have significant impact n the respondents' choice (see results of MNL) and thus all were included in the RPL model. The parameters "traction", "wat_1", "offspring"

[26] Two production systems are common in the research area (see Table 2), namely pure pastoralism (true for 17.1% of respondents) and agro-pastoralism (true for 81.3% of respondents). Both systems are appropriate for the arid/semi-arid conditions in Southern Ethiopia. Pastoralism is a grass-based system, meaning that more than 90% of dry matter fed to animals comes from rangelands, pastures, annual forages and purchased feeds and less than 10% from crops. The system's annual average stocking production rates are less than 10 livestock units (LU) per ha agricultural land. Agro-pastoral systems are mixed farming systems with more than 10% of the dry matter fed to animals coming from crop by-products and stubble or more than 10% of the total value of production comes from non-livestock farming activities (i.e. another source of income besides livestock).

and “tick” were set as random, all exhibiting significant standard deviations. The price and the other parameters remained fixed (i.e. these characteristics do not vary among respondents).

The detailed tables, matrices and codes can be requested form the authors, they are not presented here as it would be beyond the scope of this paper. Using the *Swait-Louviere* log-likelihood test it could be seen that the RPL model outperforms the MNL model with respect to the model fit. Hence, allowing the parameters to vary, indicate that the explanatory power of the RPL is considerably greater than with basic MNL.

The RPL with this particular parameter about production system reveals three crucial points:

- Agro-pastoralists are indifferent about the body size of cows and bulls
- Pastoralists do not place importance on the traction suitability of bulls
- Pastoralists consider the ability to withstand water shortage for three days for bulls less important than agro-pastoralists

The RPL implies that even about 38% of the pastoralists place a negative coefficient on traction suitability in bulls. It is also noteworthy that more than the half (59%) of agro-pastoralists place a negative coefficient on big bulls and even 61% on large-framed cows. The latter fact could have negative consequence on the conservation of the Ethiopian Borana, that is, in comparison to other breeds and Borana subtypes large-framed.

Consumer heterogeneity among different production systems:

The implied heterogeneity among pastoralists’ and agro-pastoralists’ utility for cattle gave rise to model separate models, one including respondents who are pastoralists and one including respondents who live on agro-pastoralism in order to reveal differences in the WTP among the two groups. This section details the difference in WTP indicators among the two groups and also analyses the total utility that each group expects from keeping cattle.

Pastoralists assign more value or utility to cows that give one calve every year rather than every two years; i.e. the pastoralists’ WTP for this attribute exceeds the agro-pastoralists’ WTP for it by 3 Euros per cow. A similar situation applies for the attribute “tick tolerance”. For pastoralists, this attribute has a 4 Euros greater value per animal than for agro-pastoralists.

Agro-pastoralists prefer bulls that are suitable for traction and their WTP for this attribute is 52 Euros higher than the pastoralists’ WTP for this attribute, because there WTP amounts zero (the attribute does not show significance). On the other hand, pastoralists derive higher benefits from big bulls, as this attribute is not significantly valuable to agro-pastoralists.

Table 5 and 6 exhibit all WTP indicators.

5. Conclusions and implications for conservation

There are various governmental and non-profit organisation situated in the Borana zone and international institutions operating from Addis Ababa and frequently sending out researchers to this area. Until now none of them has set up conservation programmes for the pure (Ethiopian) Borana with participation of local live-keepers, although at some organisations the plan to follow this up is on their agenda, as came to light during expert interviews. The awareness of the current threat of ANGR erosion faced by the Borana and for taking action in the conservation process is already imminent and expressed not only by these organisations but also by the local livestock-keepers but the economic foundation of conservation programmes is still lacking. The results of this study shade light on the economic importance of conserving the pure Borana and may eventually facilitate a decision for initiating a conservation programme.

The relevance of cattle and its particular attributes as a means of food security, source of income and of cultural identity, was pointed out by conducting a choice experiment investigating livestock-keepers' preferences regarding different cattle attributes and the magnitude of their WTP for them. The choice experiment was performed across a sample of 246 livestock-keepers on the Borana plateau in Ethiopia. The WTP analysis shows that livestock-keepers allocate a great value to the following attributes (the figures in parentheses indicate the WTP for one animal in Euros):

- Requirement of watering only once in 3 days (9 for cows; 7 for bulls),
- Being tick tolerant (13 for cows; 20 for bulls)
- Being of large frame (4 for cows, 7 for bulls)
- Producing strong offspring (12 for bulls)
- Calving once a year (12 for cows)

Other cattle attributes, on the other hand, are not of importance in the marginal areas of the Ethiopian Borana zone. One of these attributes is the milk quantity, a production factor that is very important in the Western world. Neither a lower nor a higher milk yield than the status quo of 2-4 litres per day seems to have significant impact on the choice for cows.

Interesting differences have been found between two important groups of livestock-keepers: those whose livelihood almost fully depends on livestock production (=pastoralists) and those who also do crop cultivation for generating income (=agro-pastoralist). Pastoralists prefer cattle that are not necessary suitable for traction. Further, pastoralists derive higher benefits from large-framed animals (cows and bulls) than agro-pastoralists, for whose the body size is not an important purchasing factor.

These findings implicate that pastoralists may be better “targets” for participating in conservation programmes because they place a higher value to attributes that are well known for the Ethiopian Borana than agro-pastoralists and hence do not need compensation payments for keeping Borana cattle. These livestock-keepers will be therefore most likely to continue to maintain the Ethiopian Borana and they will also be the least costly to incorporate into a conservation programme.

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Appendix

Table 1: Livestock-keepers preference ranking of attributes among local breeds

Attribute	Measured through	Ranking* Borana	Guji	Gari
High tolerance to environmental extremes such as droughts	Watering frequency	**1**	2	2
Ability to cover long distances	Body size	2	3	**1**
High level of tick tolerance	Tick tolerance	**1**	2	2
Great cultural value	Horns size and shape; Body size	**1**	3	2
Insurance for emergency cases (ability to fetch high prices at market)	Market price	2	3	**1**
Good mothering ability and high fertility	Calving frequency	**1**	2	3
High milk yield and good udder condition	Milk quantity	**1**	2	**1**
Traction suitability	Traction suitability; Body size; Horn size and shape	**1**	2	**1**
Strong mating activity and strong offspring	Offspring strength	**1**	2	**1**

*1= the best performance, 3 = worst performance

Table 2: Socio-economic characteristics across Ethiopian respondents

Sex (in %)		
Male	93.5	
Female	6.5	
Age (in years)		
Mean	45.3	
St. Deviation	15.7	
Household size (in head)		
Mean	6.0	
St. Deviation	2.6	
Number of children under 15 yrs. (in head)		
Mean	3.2	
St. Deviation	1.8	
Aba Ola (village chief) (in %)		
Yes	10.6	
No	89.4	
Highest level of education (in %)		
	Head of HH	*Children*
Illiterate	86.6	54.1
Can write and read	9.8	39.4
Completed primary school	0.8	2.4
Secondary school	2.8	3.3
Completed secondary school	0.0	0.8
Household income from cattle products (in Euros)		
Mean	73.4	
St. Deviation	183.0	

Number of animals (in head)						
	Cattle	*Cows*	*Bulls*	*Calves*	*Goats*	*Camels*
Mean	17.7	9.2	2.5	6.1	4.3	1.2
St. Deviation	16.1	10.6	2.8	5.1	5.2	2.4
Production system (in %)						
Crop production	1.6					
Agro-pastoralist	81.3					
Pastoralist	17.1					
Movement (in %)						
	Cattle	*Family*				
Sedentary	13.8	88.2				
Transhumant	30.5	11.4				
Nomadic	55.7	0.4				

Table 3: MNL results for bulls and cows

	Cows		***Bulls***	
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
Price	-0.029	0.0000	-0.013	0.0000
Traction suitability			0.491	0.0000
Watering every day	-0.767	0.0000	-0.614	0.0000
Watering once in 3 days	0.261	0.0000	0.093	0.0309
Tick tolerance	0.384	0.0000	0.268	0.0000
Big body size	0.111	0.0012	0.088	0.0105
Short and straight horns	Not significant		-0.171	0.0067
Long horns	-0.0143	0.0000	-0.120	0.0000
Strong offspring			0.163	0.0000
1 calve every year	0.355	0.0000		
Log likelihood	-2350.4		-1795.1	
ρ^2	0.27		0.25	

Table 4: WTP indicators for the pooled model (including whole sample size)

	Cows		***Bulls***	
Variable	**Coefficient (rounded)**	**p-value**	**Coefficient (rounded)**	**p-value**
Watering every day	-26	0.0000	-36	0.0000
Watering once in 3 days	9	0.0000	7	0.0271
Tick tolerance	13	0.0000	20	0.0000
Big body size	4	0.0012	7	0.0106
Strong offspring			12	0.0000
1 calve every year	12	0.0171		0.0000
Short and straight horns	Not significant		-9	0.0090
Long horns	-5	0.0000	-13	0.0000
Traction suitability			37	0.0000
Wald statistic	681.2 (0.0000)		295.4 (0.0000)	

Table 5: WTP indicators for pastoralists

	Cows		*Bulls*	
Variable	**Coefficient (rounded)**	**p-value**	**Coefficient (rounded)**	**p-value**
Watering every day	-27	0.0000	-67	0.0000
Watering once in 3 days	8	0.0000	Not significant	
Tick tolerance	14	0.0000	26	0.0000
Big body size	4	0.0021	8	0.0188
Strong offspring			17	0.0000
1 calve every year	13	0.0000		
Short and straight horns	Not significant		-9	0.0511
Long horns	-5	0.0000	-16	0.0007
Traction suitability			Not significant	
Wald statistic	526.3 (0.0000)		207.5 (0.0000)	

Table 6: WTP indicators for agro-pastoralists

	Cows		*Bulls*	
Variable	**Coefficient (rounded)**	**p-value**	**Coefficient (rounded)**	**p-value**
Watering every day	-21	0.0000	-45	0.0000
Watering once in 3 days	13	0.0000	38	0.0000
Tick tolerance	10	0.0000	29	0.0000
Big body size	Not significant		Not significant	
Strong offspring			16	0.0065
1 calve every year	10	0.0000		0.0000
Short and straight horns	Not significant		Not significant	
Long horns	-6	0.0027	Not significant	
Traction suitability			38	0.0000
Wald statistic	168.5 (0.0000)		79.5 (0.0000)	

Figure 1: Example for choice set for cows

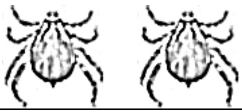
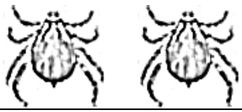
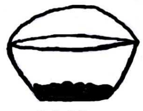
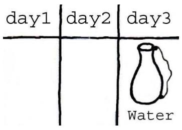
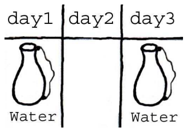
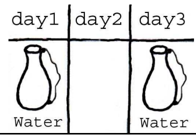
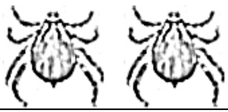
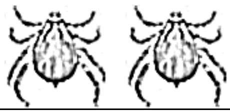
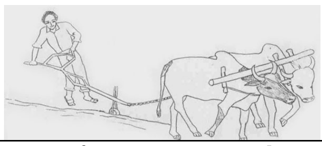
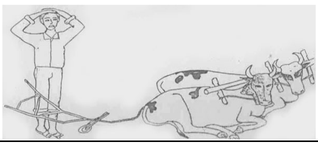
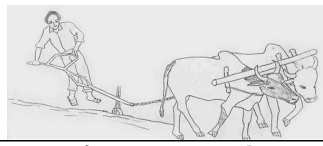
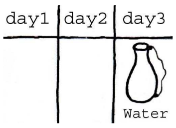
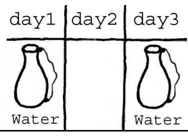
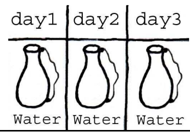
Card 7	Card 26	Card 19	No animal
Female cattle, age 5 years			**Not buying animal but keeping the money**
Calving frequency : **once a year**	Calving frequency : **once in 2 years**	Calving frequency : **once a year**	
Body size: **big frame**	Body size: **small frame**	Body size: **small frame**	
Tick tolerance: **poor** 	Tick tolerance: **good** 	Tick tolerance: **poor** 	
Milk yield: **2-4 litres** 	Milk yield: **more than 4 litres** 	Milk yield: **0-2 litres** 	
Watering frequency: **once in 3 days** 	Watering frequency: **once in 2 days** 	Watering frequency: **once in 2 days** 	
Horns: **short and straight** 	Horns: **short and curved** 	Horns: **long and curved** 	
Price: **800 Birr**	Price: **800 Birr**	Price: **600 Birr**	

Figure 2: Example for choice set for bulls

Card 13	Card 20	Card 25	No animal
Male cattle, age 5 years			**Not buying animal but keeping the money**
Progeny: **weak calves**	Progeny: **weak calves**	Progeny: **strong calves**	
Body size: **big frame**	Body size: **small frame**	Body size: **small frame**	
Tick tolerance: **good** 	Tick tolerance: **poor** 	Tick tolerance: **poor** 	
Traction: **suitable** 	Traction: **unsuitable** 	Traction: **suitable** 	
Watering frequency: **once in 3 days** 	Watering frequency: **once in 2 days** 	Watering frequency: **once a day** 	
Horns: **short and straight** 	Horns: **long and curved** 	Horns: **short and straight** 	
Price: **900 Birr**	Price: **900 Birr**	Price: **1200 Birr**	