17

Estimating the Worth of Traits of Indigenous Breeds of Cattle in Ethiopia

Girma T. Kassie[1], Awudu Abdulai[2] and Clemens Wollny[3]
[1]*International maize and Wheat Improvement Center (CIMMYT), Harare*
[2]*University of Kiel*
[3]*Bingen University of Applied Sciences, Bingen*
[1]*Zimbabwe*
[2,3]*Germany*

1. Introduction

Livestock in general and cattle in particular are indispensable components of rural livelihoods in Ethiopia. In semi-arid and arid parts of the country, the pastoral communities depend mainly on their livestock for their livelihoods (Little et al. 2001; Barrett et al. 2003; Ouma et al. 2007). In the more dominant mixed crop-livestock livelihood system, cattle serve in providing traction power, in generating cash, in buffering shocks, as sources of consumables, as sources of prestige, and as the main indicator of wealth. The vital importance of cattle in supporting rural livelihoods against the backdrop of negative effects of climate change and continuing erosion of animal genetic resources (AnGR) justify a thorough analysis of the preferred characteristics of cattle to guide conservation and improvement programs.

Accordingly, proper identification, valuation, and maintenance of different traits of animal genetic resources are necessary to make them available and relevant for future use without compromising their current utilization. The main challenge in this regard is that the economic implications of erosion of genetic diversity and consequently its conservation are not well understood. This is essentially so because the diversity of AnGRs has a quasi-public nature (Scarpa et al. 2003a) and this makes it inadequate to value it in ordinary markets using revealed preference techniques.

Both revealed and stated preference techniques have been employed to analyze the marketing or pricing of livestock in Africa. The revealed preference techniques mainly employ the hedonic pricing method. Previous studies that used this method are Andargachew and Brokken (1993), Fafchamps and Gavian (1997), Jabbar (1998), Barrett et al (2003) and Jabbar and Diedhiou (2003). These studies showed that, in general, weight, age, sex, body condition, body size, coat colour, reason of purchase, season, rainfall pattern, holidays, district location, breed type, market locations, and restrictions such as quarantines determine livestock prices observed in the market.

The stated preference approach has recently become important in analyzing the preferences and economic values of livestock attributes. The significance of this approach in valuing attributes has generated considerable interest and research in the area of AnGR in recent times. After the pioneering work by Sy et al (1997) in Canada, many authors have used stated preference approach to analyze economic values of livestock traits in different parts of the world. Tano et al (2003) analyzed the economic values of traits of indigenous breeds of cattle in West Africa focusing on trypanotolerance by employing conjoint ranking and ordered probit model. Using choice experiments (CE) and mixed logit model, Scarpa et al (2003a) quantified the economic values of different traits of a Creole (local) pig in Yucatan, Mexico. Scarpa et al (2003b) later employed the same method to estimate the values for the traits of indigenous cattle in Northern Kenya. Ouma et al (2007) employed choice experiments to elicit preferences and mixed logit and latent class models to determine the relative values of traits and heterogeneities in trait preferences in the pastoral areas of Northern Kenya and South-Western Ethiopia. Zander (2006) employed conjoint ranking and mixed and multinomial logit models to study the relative values of traits and preference heterogeneities of Borana cattle keeping pastoralists in Northern Kenya and Southern Ethiopia. Roessler et al (2008) employed choice experiments and multinomial logit model to investigate the relative economic weights of pig traits in Vietnam, while Ruto et al (2008) examined the relative values of cattle traits and preference heterogeneities in Northern Kenya using choice experiments and latent class modeling. Recently, Kassie et al (2009) applied the same methodology to estimate the implicit prices of traits of indigenous cows and sources of trait preference heterogeneity.

This study contributes to the scientific literature in two ways. First, it applies both revealed and stated preference methods to analyze the implicit prices of attributes of indigenous cattle. The econometric tools used are advanced and comprehensive in that they reliably represent and predict the reality of the rural markets in study area. Second, unlike most of the past studies whose unit of analysis was the household (see Tano et al. 2003; Zander 2006; Ouma et al. 2007; Ruto 2008), we analyze preferences of cattle buyers at the market level by sampling different representative markets and interviewing market agents who were mainly farmers. This entailed capturing preferences of farmers for different cattle traits during actual market transactions unlike conducting interviews at the farm level when some farmers are not even thinking of selling or buying animals. The remaining part of the paper is organized as follows; next, a description of the study area, and the data generation and management procedures are presented. These are followed by results and discussion. The final section contains conclusions and implications of the results.

2. The approach

2.1 The study area

The study was conducted in the *Danno* district of central Ethiopia, which is located 250 km west of the Ethiopian capital Addis Ababa. The district has an area of about 66,000 hectares, and had a human population of 83,000 in 2005/6. Livestock, particularly cattle, are an important asset of the community. Semi-subsistence crop-livestock mixed farming system is the mainstay of rural livelihoods for the district's human population. The most important livelihood objective of the average household is producing sufficient food for the family each year (Kassie 2007).

The study covered five markets. Four of the markets, namely, *Sayo, Menz, Danno-Roge* and *Awadi-Gulfa*, are situated within the *Danno* district. *Sayo*, the administrative and economic capital of the district, has two different cattle markets that operate on Wednesdays and Saturdays. *Menz* is a small market located at about 12 km north of *Sayo* and is operational on Tuesdays only. *Danno-Roge* is located at the northern tip of the district some 28 km far from *Sayo*. *Danno-Roge market days* are on Thursdays and, unlike in other markets, cows and calves are frequently exchanged. *Awadi-Gulfa* market is located 24 km northeast of *Sayo* and operates on Wednesdays. *Awadi* is mainly a market for male cattle brought from both within and outside the district. The fifth market is *Ijaji* that is located in neighboring *Cheliya* district, very close to the district's border with *Danno*, and it sets on Saturdays. *Ijaji* market was included only because *Danno* farmers mentioned it as a market they visit as frequently as those within the district. All types of cattle are brought to *Ijaji* market and it is the only fenced market of about 30m by 80m area. Comparatively, traders are more frequent in this market than in others. Animals are trekked to and from the markets throughout the year. All cattle markets are managed and run by male buyers and sellers with virtually no women around. All the markets set for half a day mostly in the afternoons.

2.2 Sampling and data generation

2.2.1 Revealed preference analysis

Data were generated through a survey in the five rural markets described above. The survey was conducted in four rounds every three months over a sample of 20 cattle buyers in each season from each of the five rural markets. Given that some of the buyers purchased two animals at a time, the final sample size was 411. The survey focused on the phenotypic traits of the animals, places the animals were brought from, price, and the characteristics of the buyers. The phenotypic characteristics were identified in the initial survey and included color, class, age and body size of the animal bought.

Data collection for each season[1] was carried out over two weeks simultaneously in all of the markets. Season one covers the period from end of February to beginning of March. This is immediately after the major crop harvest where crop prices are normally low and livestock prices are high. Most of the cattle keepers want to sell their animals during this period against the challenge of the imminent feed scarcity in the dry season that follows right away which is evident from Figure 1. Season two covers the period from late May to early June. This is a period when prices of cattle decline, as buyers - predominantly farmers, usually lack money or cash to purchase cattle. Moreover, since it is the beginning of the rainy season, farmers tend to focus on their cropping activities.

The third season spans from late August to early September, a period of serious feed shortage. Prices are normally expected to be low for the animals that are yet to regain weight they lost in the dry season and for those that are subjected to a restricted free grazing during the rainy season. As expected, this is the most favored period by buyers and the least preferred by sellers. The last round of data was collected in late November. This is the beginning of the crop harvest period for early maturing crop varieties and the declining prices of crops. The animals normally recover from the weight losses of the past seasons and farmers can then postpone their selling decisions, if the prices offered are not attractive enough.

---

[1] Season implies the periods in which the market level surveys were conducted.

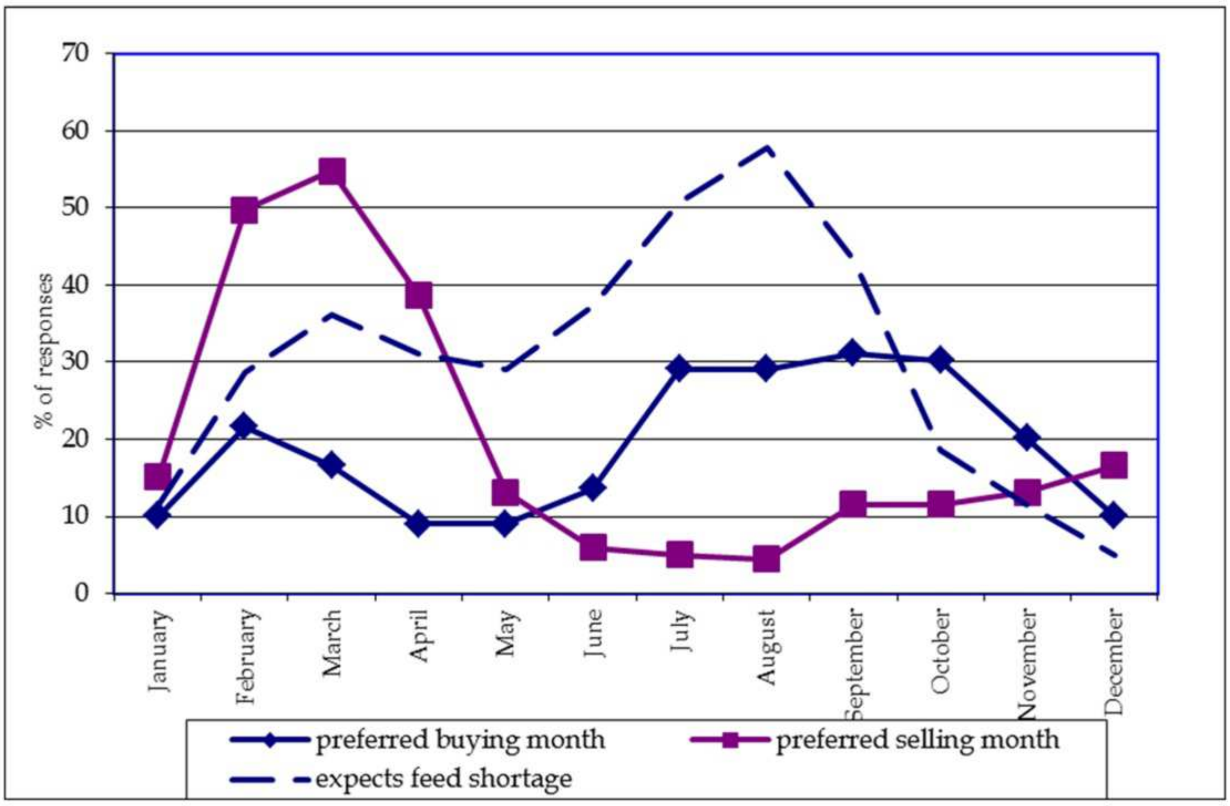


Fig. 1. Annual feed availability calendar and cattle selling and buying season preferences in *Danno*

An important observation in this study is the kind of classification farmers have for cattle and the influence of this classification on cattle prices. Male cattle which have ploughed for more than two seasons and which are sometimes castrated are called '*sangota*'. Non-castrated or intact younger male cattle with plowing experience of less than two seasons are called '*jibbota*'. A cow which has delivered more than once is called '*sa'a*'. Young female cattle that have delivered only a calf or none are called '*gorba*'. Very young female and male cattle with no parturition or plowing experience are called '*jabbota*'. We retain this classification in this paper but use the conventional terms ox for '*sangota*', bull for '*jibbota*', cow for '*sa'a*', heifer for '*gorba*', and calf for '*jabbota*'. It is worth noting that this classification somehow overlaps and might differ for the buyers and sellers. For instance, a younger cow for a seller might be a heifer for the buyer. The present study adopts the buyers' classification.

2.2.2 Stated preference analysis - Choice experiment

Choice experiment (CE) is a popular stated preference method which is used to elicit preferences for attributes of differentiated goods based on statistically efficient designs of attributes and attribute levels. CE surveys have already become routine in the fields of, *inter alia*, environmental (e.g., Rolfe et al. 2000; Campbell 2007), food and beverage (e.g., Rigby and Burton 2005; Mtimut and Albisu 2006), and plant genetic resources (e.g., Windle and Rolfe 2005; Birol et al. 2006) economics. Application of CE for the valuation of attributes of livestock is very recent and only a few studies (Scarpa et al. 2003a,b; Ouma et al. 2007; Roessler et al. 2008; Ruto et al. 2008, and Kassie et al. 2009) employed it.

The most important issues in designing a CE survey are attribute and attribute level determination, generation of statistically efficient and practically manageable experimental design, and management of the field interview. In this study, trait identification and trait level determination were done after a series of informal and focus group discussions both in the villages and in the markets where people of *Danno* district make a living and undertake cattle transactions. Respondents were asked to mention the attributes they consider when valuing the animals they keep or buy.

Seven traits were identified for cow CE and six traits for bull CE. Age was fixed at 3 years for cows based on the average of the figures indicated by farmers. This is in line with the fact that the average age of a cow at its first parturition is about 3.2 years in this part of the country (Ayalew and Rowlands 2004). For bulls, age was fixed at 4 years, as this is the age at which a bull would have ploughed for a year. The price levels used in the CE are averages of the minimum, average and maximums of the price distributions generated from respondents in the villages and markets for an ‘average’ cow and ‘average’ bull – average as perceived by respondents. Table 1 presents the traits and trait levels used in the choice experiments.

Variable	Levels	Reference level
Origin	*Danno* Nearby districts *Wellega* *Keffa*	Danno
Body size	Small Medium Big	Small
Fertility (Cows only)	A calf/ 2 years A calf/ year	A calf/2 years
Milk yield (Cows only)	1 liter/day 2 liter/day 3 liter/day	1 liter/day
Plowing potential (Bulls only)	Poor Good	Poor
Calf vigor	Poor Good	Poor
Disease resistance/ illness frequency	>2 times per year <2 times per year	>2 times per year
Price – cows	Low price = Birr[2] 500.00 Medium price = Birr 700.00 High Price= Birr 900.00	Birr 500.00
Price - bulls	Low price = Birr 800.00 Medium price = Birr 1000.00 High Price= Birr 1200.00	Birr 800.00

Table 1. Traits and levels included in the choice experiments

[2] Birr is the local currency in Ethiopia. One USD ≈ 8.8 Ethiopian Birr in 2007.

The traits and trait levels were statistically combined in an efficient way to generate the final profiles based on the attributes and attribute levels. The most comprehensive approach to generating statistically efficient design is with SAS algorithm. This was employed in this study as suggested by Kuhfeld (1997, 2005). In addition to orthogonality, statistically efficient designs are characterized with balanced distribution of attribute levels, balanced utility across alternatives, and minimum overlap of levels in a choice set (Huber and Zwerina 1996).

The design for cow traits generated 36 profiles classified into 18 choice sets (two profiles in each set) blocked into 3 so that each respondent could be presented with six choice sets. Similarly, the design for the bull traits CE generated 24 profiles categorized into 12 choice sets blocked into 2 so that each respondent receives six choice sets. In total, each respondent received 12 choice sets. Attributes and attribute levels were described with pictures and sketches which were carefully selected to clearly show the attributes and the differences in the levels of the attributes. The choice experiment was administered by three experienced researchers from the department of livestock improvement at *Bako* Agricultural Research Centre (BARC) and supervised by an agricultural economist.

Completed experiments were 195 for cows and 198 for bulls. Accordingly, the total number of cow choice sets responded to were 1170 and that of bulls were 1188 with three alternatives in each set. The third alternative was an opt-out option included for the purposes of avoiding forced choice and of generating theoretically sound taste parameter estimates. In each market, one or two well-known brokers were identified and briefed about the objectives of the study and the equal opportunity sampling procedure to be employed. Then broker(s) identified respondents from the different spots in the markets. This is a relatively isolated community and the five markets are virtually the only markets where cattle in the district are traded. The sample is therefore believed to be representative of the cattle buyers in *Danno* district.

3. Analytical framework

3.1 Combining revealed and stated preference approaches

Both revealed (RP) and stated (SP) preference analyses have advantages and disadvantages. According to Louviere et al (2003) and Hensher et al (2005) RP data represent the real world scenario, possess inherent relationships between attributes, embody market and personal constraints on the decision maker, have high reliability and face validity, have limitations on alternatives, attributes, and attribute levels, yield one observation per respondent at each observation point, and show attribute level invariance. on the other hand, SP data show virtual decision contexts, allow mapping of utility functions with technologies different from existing ones, can include existing and/or proposed and/or generic choice alternatives, cannot easily represent changes in market and personal constraints, seem to be reliable when respondents understand, are committed to and can respond to tasks, and usually yield multiple observations per respondent at each observation point. The advantages of these approaches can be harnessed and the disadvantages abated if employed systematically combined.

Combining of RP and SP data and analysis is a highly recommended approach (Louviere et al 2003; Bateman et al, 2003). It has also been indicated, however, to be difficult and sometimes impractical (Bateman et al, 2003). The combination can be in terms of merging the RP and SP data sets generated from the same sample or merging the approaches on different sample of the same population. The latter widens the scope of the investigation and generates sets of information that can complement each other. Accordingly, this study employed the two approaches on two different samples of the same population of livestock keepers and consumers in order to explain indigenous cattle trait preferences in the real and hypothetical scenarios.

3.2 Revealed preference analysis

Theoretically, the prices cattle sellers receive reflect the anticipated utility by the buyers and this utility is derived from the attributes of the product as cattle can be considered as quality (attribute) differentiated goods (Lancaster 1966; Rosen 1974). This paper focuses on the main phenotypic attributes that buyers check or verify by inspecting the animals during the bargaining period and purchase. The external features farmers look for and attach value to are age, color, body size, sex, and the place where the animals were brought from.

The different levels of the attributes that differentiate cattle are known to both buyers and sellers, albeit at different levels of detail. The levels considered in this analysis are those perceived by the buyers, despite the possibility of imperfect knowledge and differences in measurement. The buyers and sellers in the markets considered are mainly farmers who raise the cattle. In line with the household modeling literature, where goods are produced, consumed and sold by households, a hedonic model can be employed to value the attributes of the quality differentiated indivisible goods. Therefore, estimation of the relationship between the characteristics of the cattle and their prices can be made through hedonic price analysis.

Under competitive market conditions, implicit prices will normally be related to product attributes alone, without accounting for producer or supplier attributes. However, as widely documented in the literature, rural markets in developing countries, particularly in Sub-Saharan Africa, are rarely competitive (Barrett and Mutabatsere 2007). Several empirical studies have shown that prices are also related to the characteristics of buyers, season and market location (e.g., Oczkowski 1994; Jabbar and Diedhiou 2003). Hence, season, market location and education level of the buyer were included in the models estimated in this research. As mentioned above, cattle price discovery in the rural markets surveyed is done through a one-to-one bargaining with the help of brokers. Brokers are usually invited by buyers - mainly farmers, as they have much less market information about prices and tend to be price takers. Therefore, the bargaining power of the buyer is very important in influencing the price paid. No direct information was gathered on bargaining power, but education level was taken as a proxy to indicate strength in bargaining, under the assumption that higher education increases the bargaining skills of buyers.

Another important issue in estimating hedonic functions is the identification of the appropriate functional form and estimation procedure. The critics of Rosen (1974) model on identification emphasize on Rosen's formulation that attempts to obtain higher order approximations to the utility function by imposing homogeneity across individuals (Brown and Rosen, 1982; Epple, 1987; Bartik, 1987). Ekeland et al (2002) suggest a solution based on transformation models and instrumental variable models, however, their approach only allows for a single dimensional characteristic which must be observed. Ekeland et al (2002) in fact indicated that if the price is constructed to be non-linear (e.g., log transformation), its non-linear variation gives an added piece of information which can help to identify preference parameters. Similarly, Bajari and Benkard (2004) solve the identification problem by allowing each individual to have different utility parameters but relying on parametric restrictions on the utility function. Moreover, they generalize the Rosen's approach by allowing for imperfect competition, a discrete product space with discrete characteristics, and one product characteristic that is not observed by the econometrician.

In general, the functional form of the hedonic price equation is unknown (Haab and McConnel 2002). Parametric, semi-parametric and non-parametric estimation procedures have all been suggested and used in different applications (e.g., Anglin and Gencay, 1996; Parmeter et al. 2007). As this research focuses on the estimation of the relative weights of cattle attributes (first step hedonic analysis), the technical details of these alternative approaches are not of interest.

The estimation strategy adopted in this study is a simple linear model based on the suggestion by Cropper et al (1988) as well as Haab and McConnel (2002). Cropper et al (1988) employed Monte-Carlo simulation analysis to show that the linear and linear-quadratic functions give the smallest mean square error of the true marginal value of attributes. However, when some of the regressors are measured with error or if a proxy variable is used, then the linear function gives the most accurate estimate of the marginal attribute prices. Haab and McConnel (2002) also argue that when choosing a functional form and the set of explanatory variables, the researcher must bear in mind the almost inevitable conflict with collinearity. High collinearity makes the choice of a flexible functional form less attractive, since the interactive terms of a flexible functional form result in greater collinearity. Given these considerations, we begin with a restrictive basic linear model given by

$$\ln(price) = X\beta + \varepsilon \tag{1}$$

where X is the vector of independent variables including the constant term, characteristics of cattle and the socioeconomic variables considered, β is a vector of parameters to be estimated and ε is an independently and identically distributed (iid) error term.

The iid assumption for the error term implies that the conditional distribution of the errors given the matrix of explanatory variables has zero mean [$E\{\varepsilon\} = 0$], constant variance [$V\{\varepsilon\} = \sigma^2$], and zero covariance [$V\{\varepsilon\} = \sigma^2 I$, where I is the identity matrix]. These assumptions and hence the reliability of the estimates based on such assumptions hardly hold in analyzing survey data. We tested the basic model for specification error and heteroscedasticity. Ramsey's RESET test of the hypothesis of no omitted variables generated $F(3, 381)$ value of 1.54 which is much below the critical value of 2.60 at $\alpha = .05$ implying non-rejection of the null hypothesis. Both White and Breusch-Pagan tests rejected the hypothesis of homoskedasticity at the one percent level of significance, suggesting the presence of heteroscedastic error terms.

The data analysis employed in this study follows the approach used by Barrett *et al* (2003) in their study of the determinants of price and price variability in Northern Kenya. They applied the well-established concepts of structural heteroscedasticity and GARCH-M models to iteratively estimate price of cattle simultaneously accounting for price variability in the estimation.

Two equations are estimated simultaneously. The first equation regresses the conditional mean of the ln(price) on the independent variables discussed above and the standard deviation of the residual for each observation from the original OLS regression given by:

$$\ln(price) = X\beta + \sigma\gamma + \varepsilon \quad (2)$$

where σ is the conditional standard deviation of the natural log of price and γ is its coefficient.

The second equation is the regression of σ on selected exogenous variables (Z) in X.

$$\sigma = Z\lambda + \upsilon \quad (3)$$

where λ is the vector of parameter estimates and υ is an iid error term.

The estimation is conducted such that the predicted values of equation (3) will be substituted into equation (2) in each step until the parameters converge. This simultaneous estimation strategy is suitable for an analysis of price risk and the risk premiums relevant to cattle marketing (Barrett *et al.* 2003).

3.3 Stated choice analysis

Random utility theory (McFadden, 1974) formulates utility (U) as an additive function of deterministic and random components:

$$U_{njt} = X'_{njt}\beta_n + \varepsilon_{njt} \quad (4)$$

where, X_{njt} is a vector of attributes of alternatives and ε_{njt} is unexplained utility assumed to be independently and identically distributed (iid) across individuals, alternatives and choice sets with extreme value type I distribution. β_n is a conformable vector of the unknown weights the respondent assigns to the explanatory variables.

Given the stochastic component of utility is iid extreme value type I, the probability conditional on β_n (CP_{njt}) that the cattle buyer chooses alternative '*j*' out of '*m*' alternatives in a choice set '*t*' is a conditional logit (McFadden 1974):

$$\mathrm{CP}_{njt}(\beta_n) = \frac{\exp X'_{njt}\beta_n}{\sum_{l=1}^{m}\exp X'_{nlt}\beta_n} \quad (5)$$

However, this assumes homogeneous preference for traits across all respondents and the taste parameters of each individual (β_n) are known and completely explained by their means only.

Preference heterogeneity is, however, known to be common among cattle producers and consumers (e.g., Ouma et al. 2007, Kassie et al. 2009). A random parameters logit model which accounts for heterogeneity is therefore used here. In random parameters logit (RPL), the β_n's are specified to be random and normally distributed:

$$\beta_n \sim \mathrm{N}[\beta, \Sigma_\beta] \tag{6}$$

where β is the mean and Σ_β is the covariance of the distribution of β_n.

The random taste parameters (β_n) are unobserved and so the unconditional probability that a cattle buyer will choose alternative '*j*' is estimated by integrating the conditional probabilities over all values of each of the random taste coefficients weighted by its density function. That is

$$P_{njt} = \Pr[y_{nt} = j] = \int \frac{\exp(\mathrm{x}'_{\mathrm{njt}}\beta_{\mathrm{n}})}{\sum_{l=1}^{\mathrm{m}} \exp(\mathrm{x}'_{\mathrm{nlt}}\beta_{\mathrm{n}})} \phi(\beta_n \mid \beta, \Sigma_\beta) d\beta_n \tag{7}$$

where the integral is multidimensional and $\phi(\beta_n \mid \beta, \Sigma_\beta)$ is the multivariate normal density for β_n with mean β and variance Σ_β.

The maximum likelihood estimation then maximizes

$$\ln L_N = \sum_{n=1}^{N} \sum_{j=1}^{m} y_{njt} \ln P_{njt} \tag{8}$$

with respect to β and variance Σβ. This maximization cannot be solved; because, the integral (equation 7) has no closed form solution as its dimension is given by the number of components of β_n that are random, with non-zero variance. Simulated maximum likelihood estimation is, therefore, employed to estimate the unconditional choice probabilities (Train 2003; Cameron and Trivedi 2005). Following Cameron and Trivedi (2005), the integral (equation 7) is replaced by the average of R evaluations of the integrand at random draws of β_n from the N[β, Σ_β] distribution. The maximum simulated likelihood estimator then maximizes

$$\ln \hat{L}_N(\beta, \Sigma_\beta) = \sum_{n=1}^{N} \sum_{j=1}^{m} y_{njt} \ln \left[\frac{1}{R} \sum_{r=1}^{R} \frac{e^{x'_{njt} \beta_n^{(r)}}}{\sum_{l=1}^{m} e^{x'_{njt} \beta_n^{(r)}}} \right] \tag{9}$$

where y_{njt} is 1 if alternative *j* is chosen and 0 otherwise, and $\beta_n^{(r)}$, *r* = 1,2,…, R, are random draws from the density $\phi(\beta_n \mid \beta, \Sigma_\beta)$.

4. Results and discussion

4.1 Description of the sample population

Three data sets generated from two samples are used in this study. The revealed preference analysis is based on observations on 400 respondents and their 411 transactions. The sample size for the stated preference analysis is 200 but the valid numbers of observation were 195 for cows and 198 for bulls. The mean age of the respondents is about 36 years for all samples. The average number of male and female family members of households (2.73) is less than that of stated preference sample. Most of the respondents in both samples are either illiterate or have completed elementary school or less. The occupation of the respondents in the SP sample was found to be that nearly 89% of the respondents are either farmers (~47%) or farmer traders (~42%). About 8% of the respondents were full time traders and the remaining 2% were in other occupation such as small restaurant ownership and civil service (Table 2).

Variables	RP sample	SP sample	
		Cows	Bulls
Mean age of respondent	36.19	36.35	36.45
No. of make family size	2.73	3.39	3.40
No. of female family size	2.34	3.34	3.32
Literacy level (%)			
Illiterate	33.40	22.10	23.70
Reading and writing	9.80	9.20	9.10
Religious studies	2.60	2.60	2.50
Elementary school	41.40	51.80	51.00
Secondary school	10.50	13.80	12.60
Above secondary	2.30	0.50	1.00
Occupation (%)			
Farmer		46.70	47.00
Farmer trader		42.60	41.90
Trader		7.70	8.10
Other		3.10	3.00

Table 2. Some characteristics of the sample population

4.2 Revealed preference analysis

Both the mean and standard deviation equations have 411 observations and were found to be statistically significant. The mean equation has 27 parameters and R^2 value of 0.84, whereas, the standard deviation equation has 19 parameters and R^2 value of 0.41.

The estimations show that season, market location, class (age and sex based) of cattle, body size and age are important determinants of cattle prices in the rural markets of central Ethiopia (Table 3). Cattle prices in seasons one and two were found to be similar. However, the prices in season three were significantly lower than those in season one. Season three is the period when farmers would not have harvested their crops and their liquid assets are believed to be low. This implies that they could be forced to sell their cattle to generate cash with the market responding with lower price due to excess supply. Season three is, therefore, the least preferred period to sell cattle by farmers (see Figure 1). Average price in season four was found to be significantly higher than that of season 1. This is expected because during this season (season 4) the farmers can afford to postpone their cattle selling decisions if the prices are not acceptable, since they can easily rely on the recently harvested crop yield to meet subsistence and other needs.

Most of the coefficients of the market dummies were also found to be significantly different from zero, implying price differentials for cattle relative to *Danno*. The frequency of each class of animal is also decisive in this particular estimation. It is only at *Danno-Roge* market that the frequency of the bigger animals – oxen and cows – is less than that of *Sayo*. This clearly undermines the prices in *Danno-Roge* as compared to other markets and hence the negative coefficients. Cattle prices in *Menz* and *Awadi* markets are significantly higher than in *Sayo*. These markets have higher frequency of oxen and cow transactions as compared to others. In addition, *Awadi* is one of the routes out of the district to trek to secondary markets such as *Guder* and Ambo. Traders in *Menz* also trek their cattle to these secondary markets via *Awadi*.

	Modified SHM [ln(price)]		Modified SHM [St.dev. ln(price)]	
ln(price)	Coef.	St. Err.	Coef.	St. Err.
Constant	6.265*	0.079	0.540*	0.038
Season 2	0.017	0.016	0.004	0.018
Season 3	-0.032‡	0.019	0.018	0.019
Season 4	0.101*	0.017	0.033‡	0.018
Menz	0.118*	0.024	0.017	0.023
Awadi	0.088*	0.020	-0.025	0.021
Ijaji	0.008	0.025	-0.015	0.027
Roge	-0.063	0.040	0.095*	0.023
Ox	0.252*	0.053	-0.110*	0.018
Cow	-0.077	0.093	-0.255*	0.023
Heifer	-0.098*	0.037	0.061*	0.026
Bull	0.059†	0.027	-0.103*	0.025
Medium body size	0.028	0.020		
Big body size	0.174*	0.019		
Red coat color	0.036	0.026		
Black coat color	-0.091*	0.029		
White coat coloer	0.021	0.053		
Age	0.181*	0.029		
Age square	-0.011*	0.002		
Neighbor district	-0.036	0.031	-0.075*	0.034
Wellega	0.113‡	0.066	0.110	0.073
Keffa	-0.067	0.056	0.080	0.064
Read and write	-0.037	0.032	0.025	0.035
Elementary	-0.020	0.024	0.002	0.023
Secondary	0.067†	0.028	-0.009	0.031
Above second.	0.074	0.066	-0.054	0.058
Religious study	-0.078	0.050	0.028	0.055
St.dev. ln(price)	-0.155	0.267		

*, †, and ‡ significant at α = 0.01, α = 0.05, and α = 0.05, respectively.

Table 3. Modified SHM model parameter estimates

Farmers' classification of cattle into sex and functional categories was found to be important determinant of prices. For example, oxen have a price premium of about 25% over calves. This is the highest premium followed by that of bull. The heifers were found to have lower prices than the calves. Given the frequency of heifer and calf transactions, the fact that the calves include mainly male young cattle might have inflated the prices for calves over heifers. Coefficient for the cow dummy has the unexpected negative sign. Though the cow dummy coefficient is not statistically significant, the result generally shows that the relative value attached to female cattle is lower. This is essentially due to the fact that milk is not tradable in the district and female cattle are kept mainly for herd replacement purposes.

Body size was found to be very important determinant of cattle prices, with big size having a price premium of about 18% over small ones. This is a clear indication of the interests of cattle keepers/buyers of the area on larger body size, an observation also made by previous studies elsewhere on the topic (Jabbar and Diedhiou 2003; Barrett *et al.* 2003; Scarpa *et al.* 2003a). The most consistent variable in determining the price of cattle in these rural markets was age of the animal. The results show a strong quadratic relationship between age and price of cattle that at younger ages an increase in age increases the price of the animal and as the animals get older increase in age decreases price.

The coat color of cattle is also an attribute buyers normally consider in setting an animal's price. The results reveal that red and white colors attract similar prices (i.e. are equally preferred) as compared to mixed color, which is the base level. However, black coat color, relative to mixed color, has a significant price lowering effect on cattle. The coefficient for black coat color is not only statistically significant but also exhibits the highest value. Specifically, black coated cattle will attract a downward premium of about 9% as compared to mixed color coated cattle. This is attributed to the perception in the community that black coated animals are very susceptible to trypanosomosis that is prevalent in the area. It is an established fact that tsetse flies are attracted by a combination of blue and black colors (Barrass 1960; Roth 1967; Steverding and Troscianko 2004) which makes black-colored animals unsuitable for trypanosome prevalent areas.

Among the cattle origins, only *Wellega* appears to be marginally significant. Cattle from *Wellega* had a price premium of up to 11% above those from within *Danno* district. This is expected as the field surveys revealed that cattle from *Wellega* are considered to be bigger in size, disease free and therefore more marketable. Although statistically insignificant, the location *Keffa* has the expected negative sign as cattle from this zone are considered to be susceptible to diseases. Literacy related variables included as proxies for bargaining power did not significantly influence cattle price.

As expected, the coefficient of the conditional standard deviation of the natural log of price in the natural log price equation is negative, but is statistically insignificant. The negative sign implies the commonly observed phenomenon that as market prices grow more volatile, those who, nonetheless, opt to sell their animals in the markets are somewhat more desperate for cash and so are less able to hold out for a good price from traders (Barrett et al. 2003). The variability of the natural log of price is indicated to be influenced mainly by the age and functional classes of cattle as defined by marketers as well as season, market, and origin of the cattle.

4.3 Stated preference analysis

4.3.1 Cow trait preferences

Choosing a profile in the choice sets, as opposed to opting out, was found to be highly preferred by the respondents as indicated by the significant constant term (Table 4). Fertility, disease resistance, calf vigor, and milk yield were found to be highly significant (P<< 0.001) in influencing the choice of a cow. Body size, price and some locations were found to be statistically insignificant. The signs of all the taste parameters are as expected, except that of medium body size. The model in general is highly significant (P<< 0.001) at 29 degrees of freedom (Table 4).

The magnitude of the parameter estimates shows that fertility – or short calving interval – is more important than all the other attributes considered by cattle buyers. Disease resistance was also found to be more important than calf vigor, milk yield and the origin of the cow. Vigor of the calf was also identified to be very important in influencing cow choice. These findings conform to the basic objectives of rural life in this part of Ethiopia in general and with the specific purposes for which animals are kept.

The primary goal of majority of the households in this part of rural Ethiopia is to produce sufficient food for the family. Secondly, households aim at selling part of their produce to generate cash to pay for other costs of life including food, as food shortage is not uncommon. The main contribution of livestock towards achievement of these goals is through traction power generated from bulls and through livestock sales. Shorter calving interval implies more animals to sell over the lifespan of a breeding female, and higher total number of male calves over the same period, to replace the aging bulls as well as to sell. Disease resistance is so important not only because it assures the herd stays productive but also saves the scarce cash resources (treatment costs) of the rural people. A vigorous calf is described in the area as one that is fast growing, healthy and strong. The high value assigned to larger herd and the medication cost implications show the importance of calf vigor. The relative importance of these traits is comparable to the corresponding findings of studies elsewhere which analyzed preferences for cow traits (Tano et al. 2003; Ouma et al. 2007; Zander 2006) with apparent differences in the relative weights of the attributes.

Production of milk is important attribute of cows. However, the relative weight assigned to milk yield potential of cows in the study area is lower than those for other cattle traits. In *Danno* and the neighboring districts, milk is only produced for household consumption and selling milk is a social taboo that people would rather give it free. Some households milk their cows every other day as they do not have storage facilities, or cannot sell it. This is unlike the high importance attached to milk yield by the latent class of crop-livestock farmers in Kenya (Ouma et al. 2007). Given the fact that recent public livestock development efforts in the highlands of Ethiopia in general and in the study area in particular have focused on improving milk production from dairy cows, the relatively weight attached to milk production capacity of cows shows the considerable disparity between the official public livestock development agenda and rural livelihood objectives. Therefore, genetic improvement efforts targeted at rural settings need to consider the breeding goal of the community.

Variable	Structural Parameters		SD of the parameter distributions	
	Coefficient	St. Error	Coefficient	St. Error
Random parameters				
Medium body size	-0.42	0.30	0.21	1.62
Big body size	0.28	0.47	0.07	3.34
Fertility	1.80*	0.61	1.06‡	0.60
Milk yield	1.00*	0.33	0.60	0.37
Calf vigour	1.05*	0.29	0.11	1.88
Disease resistance	1.59*	0.51	1.45*	0.54
Medium price	-0.20	0.29	0.98	0.99
High price	-0.13	0.32	0.79	0.77
Non-random parameters				
Nearby districts	0.55‡	0.30		
Wellega zone	-0.47	0.32		
Keffa Zone	-0.27	0.29		
Constant	-2.98*	0.65		
Heterogeneity in mean parameters				
Big body*education	0.17‡	0.1		
Fertility* farmer trader	-0.29‡	0.16		
Fertility*family size	-0.09†	0.04		
Milk*trader	-0.51†	0.24		
Disease res.*farmer trader	-0.81†	0.35		
Disease res.*other occupant.	1.00‡	0.58		
High price*trader	-1.00‡	0.56		
High pr.*farmer trader	-0.31	0.30		
High Pr.*other occupant.	1.25‡	0.66		
N = 1170	LL = - 630.47		Pseudo R^2 = 0.51	
χ^2 (df=29)= 1309.80	LL_{base} = -1285.4		Adj. R^2 = 0.50	

*, †, and ‡ significant at α = 0.01, α = 0.05, and α = 0.05, respectively. LL is value of log-likelihood function, LL_{base} is value of the restricted (no coefficient) log likelihood function and χ^2 is chi-squared.

Table 4. Random Parameters logit model parameter estimates for cows

The origin cows are brought from is another important attribute cattle buyers consider, but this is not explicitly related to breed identity of the cows, although both livestock keepers and buyers implicitly recognize that cattle of a common origin share certain typical or characteristic features. People ask for the origin of the cow to judge its adaptability, in addition to examining some phenotypic characteristics which show considerable difference across locations. The regression results show that cows from immediate neighboring districts are preferred to those of the same district. Taste coefficients of Wellega and Keffa zones were found to be negative and statistically insignificant. The negative sign implies that cows from these areas, which are very far, are less preferred, *ceteris paribus*.

The three price levels were entered as categorical variables like all other traits with low price (Birr 500.00) fixed as reference level. The coefficients of the two price levels are statistically insignificant showing that the price levels used in the CE did not significantly influence the choices of alternatives. The respondents apparently considered the price levels too small for most of the profiles presented. Identification of traits (including price) and trait levels was completed four months before the CE survey. In the subsequent four months, the inflation that had been rampant in Ethiopia since May 2005 made the prices identified for the CE quite low.

4.3.2 Heterogeneity in cow trait preferences

This paper also examines preference heterogeneity based on the means and standard deviations of the random parameters, as well as the mean coefficients of the interaction terms. In line with Hensher *et al* (2005) and Train (2003), differential distributional assumptions were tried for random parameters. However, all random preference parameters were assumed to be normal based on the likelihood ratio test.

Preference heterogeneity was evident around the means of fertility and disease resistance. This implies that not all cattle buyers attach equal value to these cow attributes. The estimated means and standard deviations of each of the random taste parameters give information about the share of the population that places positive values or negative values on the respective attributes or attribute levels (Train, 2003). Considering attributes with statistically significant standard deviation estimates, 96% of the respondents prefer the fertility to be good (a calf per year), while 4% of the respondents prefer lower fertility (a calf/ 2 years). Similarly, 86% of the respondents indicated preference for higher disease resistance.

The sources of taste heterogeneity were further investigated by introducing interaction of the attributes and socioeconomic characteristics. As education level increases, the sensitivity towards body size increases. The relatively educated group of respondents is composed of non-farmers who intend to consume the animals than keeping them either for production or reproduction. Higher sensitivity for diseases resistance of cows was also observed among small restaurant owners as compared to farmers. This is essentially because these respondents cannot afford to keep sick animals or take them to clinics after purchase as the animals are to be slaughtered for immediate use. For buyers, other than this group, purchasing sick animals might not be that risky as there is always a one month guarantee with which they can return the cows for the seller in case they are seriously ill. These restaurant and inn owners are also quite sensitive to the high prices of cows as compared to farmers. This is clearly the result of the effective demand of these buyers that they have to purchase the animals to run their businesses and postponing their decisions in case of high prices is less likely.

The results also show that farmer traders are less interested in fertility of cows as compared to farmers. This is intuitive and implies that the marginal utility of fertility is lower for farmer-traders as they mainly intend to resell the animals. Similarly, as family size increases, interest in fertility of cows decreases. This shows that bigger family sizes are of well-established households with possibly less interest in increasing their herd size as compared to smaller families of young households that are expected to intend to increase their herd size. Traders, as compared to farmers, were also found to be less interested in milk yield of cows. This is in line with the peculiar culture of the community that discourages milk selling. Farmer-traders are less interested in disease resistance of the cows. This group of people purchases the cows essentially for reselling and hence is not expected to be interested in diseases resistance as much as farmers do. Traders and farmer-traders were uniformly found to be less interested in high price levels of cows as compared to farmers. These respondents are interested in increasing their marketing margins and are supposed to be keener on paying less than more. As farmers are less informed about the prices across markets, the sensitivity of traders and farmer traders is expected.

4.3.3 Bull trait preferences

Body size was found to be relatively less important trait in influencing bull type choices in these rural markets (Table 5). Negative sign of the medium body size level was, however, unexpected and this might possibly be due to the lack of sufficiently distinct level descriptions in the survey or the levels were too close to differentiate from respondents' perspective. The mixed crop-livestock production system depends very much on the traction power of bulls for all the activities from first plowing to threshing. Only bulls are used for plowing in this area, making traction power a crucial characteristic of a bull. That is essentially what the model results reflect (Table 5). Plowing suitability has the largest taste coefficient with the expected positive sign and high statistical significance, indicating that good plowing potential is a trait that respondents consider when purchasing bulls.

The rural community has multiple objectives in buying and keeping cattle in such a production system. The bulls are bought and kept at least for two purposes - traction and reproduction. The reproductive contribution of bulls is very important as there are no communal or village-owned bulls selected for this purpose. In particular, farmers normally do not take within-the-herd mating for granted and focus on traction suitability only. They usually inquire about the reproductive characteristics of the bull, for which is calf strength is taken as a proxy. The attribute's coefficient is highly significant. The more vigorous the offspring of a bull is, the higher the probability that it will be chosen on the premise that a higher utility can be derived. Disease resistance was also found to be positive and statistically significant, indicating preferences for healthy or disease tolerant animals. With limited resources to employ on medication and hygienic costs for their animals, rural livestock keepers are expected to be very interested in healthy animals.

The RPL estimation resulted in negative and statistically significant coefficients for nearby districts and *Keffa* zone. The negative signs of the coefficients indicate that bulls from both origins are less preferred to those from *Danno* and will result in less probability of choice for a bull. The differences in absolute magnitudes of the structural parameters of the location variables show that the probability of not selecting an animal will be higher if the origin is *Keffa* than neighboring districts. This is an exact reflection of the preference of farmers in *Danno*, as cattle from Keffa region are considered susceptible to trypanosomosis and less adapted to the local conditions at *Danno* district. This again implies that buyers generally give high value to the fact that they know the pedigree of the cattle they buy which could only be possible if the animals were raised in their proximity. Given the lack of accurate information and the uncertainties under which farmers make decisions, it is obvious that cattle buyers in this semi-subsistent farming system would prefer bulls from their own districts.

	Structural Parameters		SD of the parameter distributions	
Variables	Coefficient	St. Error	Coefficient	St. Error
Random parameters				
Medium Size	-0.254†	0.108	0.005	0.300
Big Size	0.836*	0.192	0.655	0.480
Ploughing	1.994*	0.218	1.357*	0.255
Calf strength	0.752*	0.084	0.006	0.300
Illness freq.	0.821*	0.124	0.003	0.307
Price 1 (birr 1000.00)	0.237	0.183	0.003	0.245
Price 2 (birr 1200.00)	-0.267‡	0.170	0.014	0.444
Non-random parameters				
Constant	-2.476*	0.226		
Nearby districts	-0.417‡	0.240		
Wellega zone	0.223	0.130		
Keffa zone	-0.634*	0.193		
N= 1188 LL = -792.9	LL base = -1305.15 Ps. R^2 = 0.392		χ^2= 1024.4, df=18	

*, †, and ‡ significant at $\alpha = 0.01$, $\alpha = 0.05$, and $\alpha = 0.05$, respectively. LL is value of log-likelihood function, LL_{base} is value of the restricted (no coefficient) log likelihood function and χ^2 is chi-squared.

Table 5. Random Parameters logit model parameter estimates for bulls

The results also show that both medium (Birr 1000.00) and high (Birr 1200.00) levels of price have no significantly different influence on choice as compared to small price level. These results appear realistic, given that the price levels used during the choice experiment were already low as stated above in relation to prevailing inflation and the low and medium levels of prices were nearly indifferent for the respondents. Even the high level of price was considered quite acceptable for almost all the hypothetical profiles presented in the choice sets.

4.3.4 Willingness to Pay (WTP) values for bull attributes

The marginal rate of substitution between the traits and the monetary coefficient provides estimates of the implicit prices for the traits. These implicit prices are also referred to as willingness to pay (WTP) or willingness to accept. The price volatility prevalent in the study area makes the absolute magnitude of the willingness to pay (WTP) values less important. In order to assess prioritization of traits by the buyers, only the relative magnitudes of the WTP weights should be used. The willingness to pay values computed for each attribute (**γ**) at the highest price (**p**) level show that changing the traction potential level from poor to good is valued 2.65, 2.42, and 2.39 times more than a comparable change in offspring vigor, illness frequency (implying disease resistance) and big body size, respectively (Table 6).

Trait	$WTP_{\gamma} = E(-\beta_{\gamma}/\beta_p)$	$SD = E(-\delta_{\gamma}/\beta_p)$	Min.	Max.
Medium Body	-0.954	0.018	-0.956	-0.951
Big body	3.134	2.382	1.698	4.842
Ploughing potential	7.476	4.550	-1.624	11.286
Calf strength	2.819	0.021	2.811	2.824
Illness freq.	3.078	0.013	3.070	3.084

Table 6. Willingness to pay for bull traits computed at the highest price level

5. Conclusion and recommendation

This study used both revealed and stated preference approaches to determine the values attached to the different features of indigenous cattle in central Ethiopia. A hedonic model was employed to examine the determinants of cattle prices in the primary rural markets. Transaction level data of cattle farmers and farmer-traders were used in the analyses. Data collected in rural markets to identify cattle price determinants result in estimates with standard errors that are mostly heteroscedastic. We employed SHM estimations to account for heteroscedastic errors. Based on Akaike, Bayesian and log-likelihood criteria of model selection, we found that the modified SHM formulation is very appropriate for examining price functions in such rural markets.

The empirical estimation showed that market place, seasonal differences, sex and function-based classification of cattle, body size, and age were very important factors influencing the market prices cattle sellers receive. The significance of the characteristics of animals in influencing prices paid for the animals reveals the importance of the preferences for traits in the decision-making process related to buying and selling of cattle. These preferences at the farmers and farmer-traders levels are the ones that matter most in shaping up the diversity of animals marketed at farm level. Furthermore, depending on the relative contribution of selling and purchasing of breeding cattle in herd dynamics, the same preferences are expected to have lasting and cumulative influence on the genetic diversity of cattle maintained at farm level. Phenotypic and genetic diversity in the existing cattle genetic resources provides the basis for selecting preferred attributes of breeding stock in the context of the livelihood objectives of the target community. Thus, the cattle breeding strategies and activities should duly consider the preferences expressed through the prices paid for animals in such markets, where the cattle keepers are the main sellers and buyers.

For the stated preference analysis the study employed choice experiments and random parameters logit to elicit and analyze cattle trait preferences of buyers in the semi-subsistence livelihood systems of rural central Ethiopia. The results of the cows CE revealed that in areas where livestock serve multitude of purposes and where the production and marketing system is semi-subsistence, cows have other functions more important than milk production. Fertility, disease resistance and strength of the calves they bear are as much or more important than milk. The breed concept which is very much associated in Ethiopia with the area where the animal is brought from (Ayalew and Rowlands 2004), was found to be less important as such and it appears that farmers are interested in obtaining animals from the district or locations close by. This is essentially because cattle buyers, who are mostly farmers, are more concerned about adaptability and therefore give high value to the fact that they know the pedigree of the cattle they buy.

The results of the CE for bulls indicate that cattle buyers assign high values for good traction potential, disease resistance, calf vigor, and for places of origin when choosing bulls in the market. The preferences cattle buyers have for these attributes do vary essentially due to differences in occupation, education and age. The primary objective of the rural community to produce sufficient food for the family for each year was manifested through the value assigned to traction potential which is more than twice that of disease resistance. These results are consistent with the basic reasons why animals are kept in the area, but appear to be incoherent with the government funded interventions of livestock development. An observation which needs to be emphasized is the consistency of the preferences of the cattle buyers in such a system characterized by lack of information in every aspect. Given the importance of livestock, bulls in particular, for the livelihoods of the communities in rural Ethiopia, such consistent valuation of the traits show that the objectives of the agrarian life are quite clear among the community – farmers, farmer traders, traders, and others – that production and marketing decisions are made on broader considerations than just milk and meat production.

On-going and planned cattle improvement programs for Ethiopian central highlands should take note of the significant livestock and socio-economic attributes that influence the production, marketing and utilization of cattle and cattle products. Current public policies on improvement of cattle production in central Ethiopian highlands promote use through crossbreeding of exotic dairy type breeds considered as improver genotypes mainly to increase milk production. The smallholder community in this part of Ethiopia depends on semi-subsistence agriculture and so livestock development interventions should focus on reproductive and adaptive traits that stabilize the herd structure, rather than focusing on traits that are only important for commercial purposes which are accorded low priority by the cattle keeping farmers. It can also be observed that improving these preferred traits of cows owned by smallholder farmers in the area has a better chance of addressing immediate livelihoods needs of the farmers than can introducing and testing new genotypes from outside.

6. References

Andargachew, K, & Brokken, R F. (1993). Intra-Annual Sheep Price Patterns and Factors Underlying Price Variations in the Central Highlands of Ethiopia. *Agricultural Economics*, Vol. 8, No. 2, pp. 125-138.

Anderson, S. (2003). Animal genetic resources and sustainable development, *Ecological Economics* Vol. 45, pp. 331 – 339.

Anglin, P M., & Gencay, R. (1996). Semi-parametric Estimation of a Hedonic Price Function. *Journal of Applied Econometrics* Vol. 11, pp. 633-648.

Ayalew, W.; van Dorland, A. & Rowlands, J. (2004). *Design, Execution and Analysis of the Livestock Breed Survey in Oromiya Regional State, Ethiopia.* Oromia Agricultural Development Bureau (OADB), Addis Ababa Ethiopia and the International Livestock Research Institute (ILRI), Nairobi, Kenya. 260pp.

Bajari, P. & Benkard, C. L. (2004). *Demand Estimation with Heterogeneous Consumers and Unobserved Product Characteristics: A Hedonic Approach.* Research Paper No. 1842, Stanford University.

Barrass, R. (1960). The settling of tsetse flies Glossina morsitans westwood (Diptera, Muscidae) on cloth screens. *Entomologia Experimentalis et Applicata,* Vol. 3, No. 1, pp. 59-67

Barret, C, & Mutambatsere, E. (2007). Agricultural Markets in Developing Countries. Entry in S. N. Durlauf and L. E. Blume, (Eds.), *The New Palgrave Dictionary of Economics*, 2nd Edition, Palgrave McMillan , London.

Barret, C.; Chabari, F.; Bailey, D.; Little, P. & Coppock D. (2003). Livestock Pricing in the Northern Kenyan Rangelands. *Journal of African Economies,* Vol. 12, No. 2, No. 127 – 155.

Bartik, T. J. (1987). The Estimation of Demand Parameters in Hedonic Price Models. *The Journal of Political Economy,* Vol. 95, No. 1, pp. 81-88.

Bateman, I., Carson, R., Day B., Hanemann M. *et al.* (2003). *Economic Valuation with Stated Preference Techniques*. Cheltenham: Edward Elgar.

Birol, E.; Smale, M, & Gyovai, A. (2006). Using Choice Experiment to estimate farmers' valuation of on Hungarian small farms. *Environmental and Resource Economics,* Vol. 34, pp. 439-469.

Brown, J. N., & Rosen, H. S. (1982). On the Estimation of Structural Hedonic Price Models. *Econometrica, Vol.* 50, No. 3 (May), pp. 765-68.

Cameron, A. C. & Trivedi, P. K. (2005). *Microeconometrics: Methods and Applications* Cambridge University Press.

Campbell, D. (2007). Willingness to pay for Rural Landscape Improvements: Combining Mixed Logit and random Effects Model. *Journal of Agricultural Economics, Vol.* 58, pp. 467-483.

Cropper, M. L.; Deck, L. B, & McConnel, K. E. (1988). On the Choice of Functional Form for Hedonic Price Functions. *The Review of Economics and Statistics,* Vol. 70, No. 4, pp. 668 – 675.

Drucker, A. G.; Gomez, V. & Anderson, S. (2001). The Economic Valuation of Farm Animal Genetic Resources: A Survey of Available Methods. *Ecological Economics*:36:1-18.

Ekeland, I.; Heckman, J. & Nesheim, L. (2002). Identification and Estimation of Hedonic Models. IFS Working Paper CWP07/02.

Epple, D. (1987). Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products. *The Journal of Political Economy,* Vol. 95, No. 1, pp. 59-80.

Fafchamps, M. & Gavian, S. (1997). The Determinants of Livestock Prices in Niger. *Journal of African Economies,* Vol. 6, No. 2, pp. 255-295.

Haab, T. C. & McConnel, K. E. (2002). *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation.* Edward Elgar, Cheltenham, UK, Northampton, MA, USA.

Hensher, D.; Rose, J. & Greene, W. (2005). *Applied Choice Analysis: A Primer*. Cambridge University Press.

Huber, J. & Zwerina, K. (1996). The Importance of utility Balance and Efficient Choice Designs. *Journal of Marketing Research,* Vol. 33, No. 307-317.

Jabbar, M. A. (1998). Buyer Preferences for Sheep and Goats in Southern Nigeria: A Hedonic Price Analysis. *Agricultural Economics, Vol.* 18, No. 1, pp. 21-30.

Jabbar, M. A. & Diedhiou, M. L. (2003). Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa? *Ecological Economics,* Vol. 45, pp. 461 – 472.

Kassie, G. T. (2007). *Economic Valuation of the Preferred Traits of Indigenous Cattle in Ethiopia.* Department of Food Economics and Consumption Studies, Christian-Albrechts University of Kiel, Germany. PhD Dissertation.

Kassie, G T.; Abdulai, A. & Wollny C. 2009. Valuing Traits of Indigenous Cows in Central Ethiopia. *Journal of Agricultural Economics,* Vol. 60, No. 2, pp. 386-401.

Kuhfeld, W. F. (1997). *Efficient Experimental Designs using Computerized Searches* Sawtooth Software Research Paper Series. SAS Institute, Inc.

Kuhfeld, W. F. (2005). *Marketing Research Methods in SAS: Experimental Design, Choice, Conjoint, and Graphical Techniques* (SAS Institute Inc., Cary, NC, USA, http://support.sas.com/techsup/technote/ts722.pdf)

Lancaster, K. (1966). A New Approach to Consumer Theory. *Journal of Political Economy,* Vol. 74, No. 132-57.

Little, P.; Smith, K.; Cellarius. B.; Coppock, D., & Barrett, C. (2001). Avoiding Disaster: Diversification and Risk Management among East African Herders. *Development and Change, Vol.* 32, No. 3, pp. 401 – 433.

Long, J. S. & Ervin, L. H. (2000). Using Heteroscedasticity Consistent Standard Errors in the Linear Regression Model. *The American Statistician,* Vol. 54, pp. 217 – 224.

Louviere, J.; Hensher, D. & J. Swait. (2000). *Stated Choice Methods and Analysis*. Cambridge: Cambridge University Press.

McFadden, D. (1974). Conditional Logit Analysis of Qualitative Choice Behavior. In Zarembka, P. (ed.) *Frontiers in Econometrics.* Academic Press, New York.

Mtimet, N. & Albisu, L. M. (2006). Spanish Wine Consumer Behavior: A Choice Experiment Approach. *Agribusiness,* Vol. 22, No. 3, pp. 343–362.

Oczkowski, E. (1994). A Hedonic Price Function for Australian Premium Table Wine. *Australian Journal of Agricultural Economics,* Vol. 38, No. 93 – 110.

Ouma, E.; Abdulai, A. & Drucker, A. (2007). Measuring Heterogeneous Preferences for Cattle Traits amongst Cattle Keeping Households in East Africa. *American Journal of Agricultural Economics,* Vol, 89, No. 4, pp. 1005-1019.

Parmeter, C. F.; Henderson, D. J. & Kumbhakar, S. C. (2007). Nonparametric Estimation of a Hedonic Price Function. *Journal of Applied Econometrics,* Vol. 22, pp. 695 – 699.

Rigby, D. & Burton, M. (2005). Preference heterogeneity and GM food in the UK. *European Review of Agricultural Economics,* Vol. 32, pp. 269-288.

Roessler, R.; Drucker, A.; Scarpa, R.; Markemann, A.; *et al*. (2008). Using choice experiments to assess smallholder farmers' preferences for pig breeding traits in different production systems in North-West Vietnam. *Ecological Economics, Vol.* 66, pp. 184-192

Rolfe, J.; Bennet, J. & Louviere, J. (2000). Choice modeling and its potential application to tropical rainforest preservation. *Ecological Economics, Vol.* 35, No. 2, pp. 289-302.

Roosen, J.; Fadlaoui, A. & Bertaglia, M. (2005). Economic Evaluation for Conservation of farm animal genetic resources. *Journal of Animal Breeding and Genetics,* Vol. 122, pp. 217-228.

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy,* Vol. 82, No. 1, pp. 34 -35.

Roth, H.H. (1967). *White and black rhinoceros in Rhodesia*. Oryx 9, 217-231.

Ruto, E.; Garrod, G. & Scarpa, R. (2008). Valuing animal genetic resources: a choice modeling application to indigenous cattle in Kenya *Agricultural Economics,* Vol. 38, No. 1, pp. 89-98.

Scarpa, R.; Drucker, A.; Anderson, S.; Ferraes-Ehuan, N.; Gomez, V.; Risoparion, C. & Rubio-Leonel O. (2003a). Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yacutan. *Ecological Economics,* Vol. 45, pp. 427-443.

Scarpa, R.; Kristjanson, P.; Ruto, E.; Radeny, M.; Drucker, A. & Rege, J. (2003b). Valuing Indigenous Farm Animal Genetic Resources in Kenya: A Comparison of Stated and Revealed Preference Estimates. *Ecological Economics,* Vol. 45, pp. 409-426.

Steverding, D. & Troscianko, T. (2004). On the role of blue shadows in the visual behavior of tsetse flies. *Proc. R. Soc. Lond. B (Suppl.),* Vol. 271, pp. S16–S17.

Sy, H. A.; Farminow, M. D.; Johnson, G. V. & Crow, G. (1997). Estimating the Values of Cattle Characteristics Using an Ordered *Probit* Model, *American Journal of Agricultural Economics,* Vol. 79, pp. 463-476.

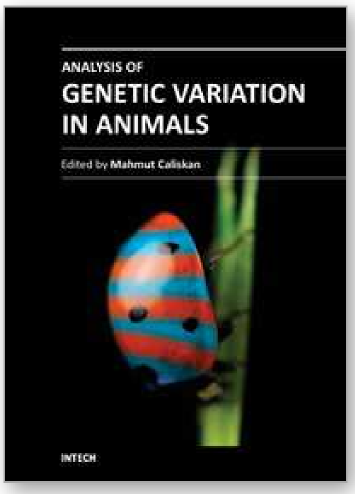
Tano, K.; Faminow, M. D.; Kamuanga, M. & Swallow, B. (2003). Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa. *Ecological Economics,* Vol. 45, pp. 393 –408.

Train, K. (2003). *Discrete Choice Methods with Simulation*. Cambridge University Press. Cambridge.

Verbeek, M. (2004). *A Guide to Modern Econometrics.* Second Edition. John Wiley and Sons Ltd, The Atrium, Southern Gate, Chichester, England.

Windle, J. & Rolfe, J. (2005). Diversification choices in agriculture: a Choice Modeling case study of sugarcane growers, *The Australian Journal of Agricultural and Resource Economics,* Vol. 49, No. 1, pp. 63-74.

Zander, K. K. (2006). *Modeling the Value of Farm Animal Genetic Resources – Facilitating Priority Setting for the Conservation of Cattle in East Africa.* PhD Dissertation; University of Bonn.



Analysis of Genetic Variation in Animals
Edited by Prof. Mahmut Caliskan

ISBN 978-953-51-0093-5
Hard cover, 360 pages
Publisher InTech
Published online 29, February, 2012
Published in print edition February, 2012