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# Combining revealed and stated preferences to define goat breeding objectives in Ethiopia

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ABSTRACT

In order to design a sound community-based genetic improvement program, identifying breeding objective traits and their relative importance is a prerequisite. The study aims to identify goat breeding objectives in three production systems of Ethiopia based on revealed and stated preference information. Market transaction surveys as well as choice experiments (CE) were conducted in three production systems of Ethiopia. Relationships between goats' attributes and prices were estimated by hedonic modeling, while economic values of traits included in the CE were estimated by conditional logit (CL) model. Part worth value of a trait which indicates the relative importance of a trait was calculated based on the implicit prices farmers were willing to pay (WTP) for an improvement of a trait. The hedonic regression results showed that body weight was a consistent determinant of goat price in all observed markets. While, attributes such as body condition, age and season had heterogeneous effect on market prices of goats. The CL analysis indicated that farmers living in harsh environments valued functional traits such as disease resistance more than performance traits. Based on revealed preferences and choice models, alternative breeding options, which are in line with farmers' trait preferences and market demands, were suggested. The suggested alternative trait combinations and their economic values could be used as an input for optimization of the breeding schemes after considering heritability, genetic and phenotypic correlations.



## 1. Introduction

In recent years, a paradigm shift was observed in livestock genetic improvement approaches by incorporating local communities and institutions into the design and implementation process of breeding programs in low-input agricultural systems. A considerable number of community-based breeding programs (CBBPs) were designed and implemented with some success but also shortcomings within the last two decades (Mueller et al., 2015). Understanding the breeding objectives of livestock keepers is a prerequisite to design sound CBBPs that consider farmers' priorities and trait preferences that are tailored by specific production systems and agro-ecologies (Valle Zárate and Markemann, 2010; Sölkner et al., 2008).

Choice experiment (CE) is one of the stated preference (SP) tools widely used for valuation of non-marketed goods and services (Hoyos, 2010; Hensher et al., 2005). The tool was mainly used in transportation industry (Train, 2009), environmental resource valuation (Hoyos, 2010) and health care services (Bekker-Grob et al., 2012). In the livestock sector, a number of researchers applied SP tools to identify trait preferences and estimate economic values for the traits in various parts of the world. For instance, some researchers employed CE to investigate producers' trait preferences and estimate economic values of the traits for cattle (Tada et al., 2013; Kassie et al., 2009; Ruto et al., 2008; Scarpa et al., 2003a), small ruminants (Duguma et al., 2011; Omondi et al., 2008a, 2008b) and pigs (Roessler et al., 2008; Scarpa et al., 2003b). These studies indicated that breed or trait preferences varied across production systems, agro-ecologies and different levels of market access. Other studies used revealed preferences (RP) tools by applying hedonic pricing to investigate attributes affecting market price of livestock (Terfa et al., 2013; Kassie et al., 2011; Barrett et al., 2003). These studies showed that selling prices of

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livestock were affected by attributes such as age, sex, body size, body condition and color as well as other factors including season, reason of buying and selling, buyers and sellers' occupations and market locations.

Despite the booming number of researches in SP and RP of livestock attributes, only limited information is available (Kassie et al., 2012; Scarpa et al., 2003a) in providing a comprehensive understanding of trait preferences from producers and market perspectives by combining both, SP and RP findings. Both approaches have their own advantages and disadvantages. RP represent the real market transactions, and take market and personal constraints into consideration and hence have high face validity (Louviere et al., 2000), but are limited in the number of attributes and attribute levels that can be included and possibly suffer from invariance and multicollinearity (Hensher et al., 2005; Louviere et al., 2000). SP allow evaluating utility functions of attributes, which are not directly valued through market transactions such as genetic attributes bundled within phenotype (Scarpa et al., 2003a), but they are criticized for being hypothetical and fail to consider real market and personal constraints (Louviere et al., 2000). Combining SP and RP information allow improving the strengths and reducing the weaknesses of each approach (Louviere et al., 2000). The combination of RP and SP can be either merging of the data generated from the same sample (Kassie et al., 2012; Hensher et al., 2005) or merging the SP and RP approaches from different samples but the same population (Kassie et al., 2012). For this study the latter approach was implemented, because it generated wide range of information on goat trait preferences by taking into account both hypothetical and real market conditions.

In livestock breeding programs, economic values of traits are usually derived by using profit equations or bio-economic models which consider cost and benefit components to measure effects of genetic changes on profitability of the enterprise (Nielsen et al., 2011). Such detailed economic data are hardly available in low input systems and these approaches overlook values of phenotypic appearances (Sölkner et al., 2008) and animal welfare issues (Nielsen et al., 2011). The SP approach is an alternative option to derive economic values of traits in such conditions (Nielsen and Amer, 2007). For instance, Tano et al. (2003) and Siddo et al. (2015) derived part worth values of traits (relative importance of traits) from a conjoint study, while Byrne et al. (2012) used choice experiments to drive part worth utility values of traits in the Irish sheep industry. In the present study, willingness to pay (WTP), which is the implicit price farmers are willing to pay for a unit increase in trait level, was used to derive part worth values. The objectives of the present research were to identify breeding objectives of goat producers in three largely differing production systems of Ethiopia based on revealed and stated preference information.

## 2. Materials and methods

### 2.1. Description of the study area

The study was conducted in Meta Robi, Abergele and Konso districts of Ethiopia representing three different agro-ecologies and production systems. While Meta Robi represents a highland area characterized by a mixed crop-livestock (HMCL) system with settled farmers, Abergele and Konso districts represent arid agro-pastoral (AAP) and semi-arid agro-pastoral (SAAP) systems, respectively, in which farmers periodically move with their livestock during periods of feed shortage. Climatic conditions and predominant goat breeds kept in the three study locations are given in Table 1.

### 2.2. Experimental design and data collection

#### 2.2.1. Revealed preference data

The market data collection was carried out in one rural livestock market of each district. Two enumerators were recruited and trained for market data collection at each market location. The information collected for each observed goat transaction included: selling price, goats' age (using dentation method), body weight (using hanging scale of 100 kg × 200 g), sex, coat color, body condition, reason for buying and selling, buyers and sellers occupations. The body condition grading was done based on three levels (poor, good and excellent). This grading system is the most commonly used method by the local market actors in the study areas. Market data of 796 goat transactions were collected from October 2013 to March 2014. From the total observed transactions, 40.7%, 34.8% and 24.5% were in AAP, HMCL and SAAP systems respectively.

#### 2.2.2. Stated preference data

For the CE, a preliminary list of preferred goat traits was extracted from detailed goat production system studies (Netsanet, 2014; Alubel, 2015) conducted in similar locations. Focus group discussions in each study area were conducted to select the most important goat traits and set levels for the selected traits (Table 2). Consequently, a total of eight desired traits and price levels (body size, disease resistance, libido, coat color, milk yield, mothering ability, twinning ability, kidding interval and price) were selected. The price levels were set based on quartiles of market prices of goats suggested by farmers during the group discussion.

By considering the total number of traits with two to four levels, the full factorial design can possibly generate a total of 648 ($3^4 \times 2^1 \times 4^1$) doe profiles for AAP and SAAP systems, and 432 ($3^3 \times 2^2 \times 4^1$) for HMCL systems. The variation of the factorial designs among production systems is due to differences in breeding doe trait preferences (Table 2). For instance, milk yield is considered important trait in AAP & SAAP systems but not in HMCL system, while mothering ability was important trait in HMCL system. Similarly, a total of 216 ($3^3 \times 2^1 \times 4^1$) buck profiles could be generated for each production system. However, choice tasks with such huge number of profiles would be time consuming and place a heavy burden to the respondents in terms of answering the questions. The fractional factorial design described by Kuhfeld (2010) was employed to limit the number of profiles, while ensuring the estimation of main effects independently. Accordingly, a randomized 36 goat profiles for each sex (18 choice sets) were generated by using *%MktEx* macro (Kuhfeld, 2010) in SAS, which were further blocked into two groups with nine choice sets each. Each choice set contained two goat profiles and an opt-out option,

**Table 1**
Climatic conditions, predominant goat breeds and production systems in the three study locations.

| Districts | Annual range of precipitation (mm) | Annual range of temperature (°C) | Goat breeds | Production systems |
|---|---|---|---|---|
| Meta Robi | 850–1100 | 15 and 32 °C | Central highland | Highland mixed crop livestock (HMCL) |
| Abergele | 300–496 | 21 and 41 °C | Abergele | Arid agro-pastoral (AAP) |
| Konso | 400–1000 | 12 and 33 °C | Woyito-Guji | Semi-arid agro-pastoral (SAAP) |