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Assessment of Farmer Preferences for Cattle Traits in Smallholder Cattle Production Systems of Kenya and Ethiopia

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Abstract

The urgent need to improve livestock productivity in sub–Saharan Africa in order to keep pace with expected increases in demand for meat and milk is very topical. Breed improvement provides key entry points for increasing productivity in cattle populations. However, there are tendencies for genetic improvement programs to focus on single, market driven traits such as milk or meat production in isolation of environmental constraints and broader livestock system functions which cattle perform in developing countries. This potentially leads to genotypes that are not well adapted to the environment and not capable of performing the multiple roles that cattle assume in smallholder systems. In developing countries, many important functions of livestock are embedded in non-tradeable traits that are neither captured in economic analysis nor considered in livestock improvement programs. This study employs Participatory Rural Appraisal (PRA) ranking techniques and conjoint analysis to evaluate preferences of cattle keepers in pastoral and agro-pastoral systems of selected sites in Kenya and Ethiopia for various cattle traits. These systems are characterized by low input management and prevalence of various cattle diseases. Trypanosomosis is a serious disease constraint in Ghibe valley of Ethiopia and some of the pastoral areas in Kenya. The results indicate that farmer preferences for cattle traits are influenced by various factors including production system characteristics, infrastructural constraints and environmental conditions, especially in relation to disease prevalence and availability of cattle feeds. In the crop-livestock systems of Ghibe valley in Ethiopia, preferred cattle traits include trypanotolerance, reproductive potential and fitness to traction. Milk production is a less important trait. On the other hand, in the pastoral and agro-pastoral systems of Kenya, important traits include trypanotolerance, reproductive potential, coat colour and watering needs.

Keywords: Cattle production system, trait preferences, choice experiment, Kenya, Ethiopia

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2. Background and Aim of the Study

There is an urgent need to improve livestock productivity in sub–Saharan Africa in order to keep pace with expected increases in demand for livestock products. In sub-Saharan Africa, demand for meat and milk has almost doubled over the past two decades; In Eastern Africa the same trend has been observed. For instance, milk consumption in the region increased from 1.5 million metric tons in 1975 to 3.2 million metric tons in 1995, while meat consumption rose from 0.5 million metric tons to 0.9 million metric tons (Ehui et al*.,* 2002) in the same period. Further projections indicate that total consumption of meat and milk in eastern Africa will more than double between 1997 and 2020 to reach 1.9 and 7.3 million metric tons respectively, by 2020. Unfortunately, livestock productivity in sub-Saharan Africa remains very low compared to other parts of the world because producers are beset by several technical, institutional and infrastructural constraints related to feeding, animal health and genotype. The severity of these constraints varies by the various systems under which cattle production takes place. The production systems are determined by agro-ecology and commonly differ in exhibiting various stress factors, such as water shortages, disease and parasites as well as temperature extremes. The constraints faced by livestock producers would need to be overcome or minimized in order for improved livestock productivity to be realized.

Animal diseases, especially those caused by parasites, impose severe constraints on animal production in sub-Saharan Africa. Trypanosomosis is one of the major constraints to livestock productivity, with forty six million cattle at constant risk of infection (FAO, 1991; Kristjanson et al, 1999). The annual cost of trypanosomosis in terms of foregone milk and meat production is estimated at US$1.3 billion (ibid.). These are colossal amounts that could be invested in alternative development efforts such as improvement of dilapidated physical infrastructures of sub-Saharan Africa. Control of trypanosomosis currently relies largely on the use of chemotherapeutic drugs, tsetse vector control or an integrated control approach combining several strategies. In most cases, such control remains costly and only partially effective. The control of trypanosomosis using trypanocidal drugs to treat or prevent the disease is limited by drug costs and availability, and by the development of drug-resistance in target parasites. Attempts to develop an effective vaccine have so far been unsuccessful and immediate prospects are not promising.

Breed improvement, through genetic control provides key entry points for increasing productivity in cattle populations especially those susceptible to trypanosomosis. The advantage of genetic control over other methods of control is that genetic changes are cumulate and permanent, and there are no recurring costs to the end users. However, there are tendencies for breed improvement programs to focus on single, market driven traits such as milk or meat production in isolation of broader livestock system functions and constraints. This potentially leads to genotypes not well adapted to the environment and not capable of performing the multiple roles that livestock assume in livestock systems of developing countries. In developing countries, many important functions of livestock are embedded in traits that are not traded in the market. These include functions and products such as traction, manure, form of security (insurance), dowry payment and use in traditional ceremonies. This study aims to assess farmer preferences for cattle traits by deriving economic values for cattle traits in selected production systems in Kenya and Ethiopia, focusing particular attention on farmer preferences for trypanotolerance, relative to other traits which could be introduced through breeding programs that utilize resistant genotypes.

3. Data Sources

The data used in this paper is part of an on-going collaborative livestock project between three institutions*, ETH, ZIL and ILRI being conducted in Kenya and Ethiopia. The analysis presented is based on primary data collected through farmer group discussions conducted between February and March 2004 in selected sites in Kenya and Ethiopia, and a cross-sectional household level survey conducted on a sample of one hundred cattle keeping households in Kajiado district in Kenya using choice experiments in August 2004. The sampled households were randomly selected from seven sub-locations of Magadi division, Kajiado district. The farmer group discussions were held as part of a pilot study to identify existing cattle production systems to be used in targeting research areas for the household level survey. In addition, the farmer group discussions were important in identifying cattle traits preferred by farmers. These traits were then used in the choice experiment survey.

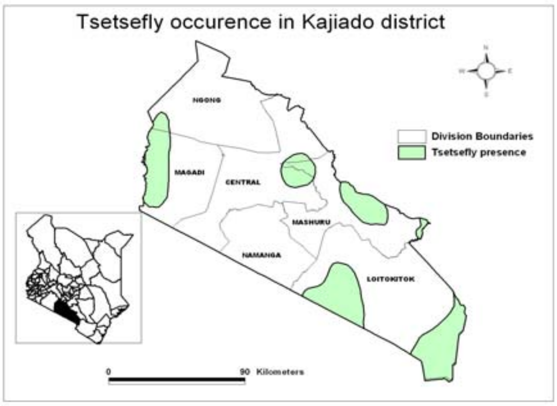
4. Study Area

Since the study focuses on farmer preferences for cattle traits paying particular attention to trypanotolerance as a trait, tsetse challenge areas have been identified and contrasted with non-tsetse challenge areas. Given that the presence of tsetse flies is a rudimentary indicator of tsetse challenge, spatial mappings of tsetse fly distribution in Kenya and Ethiopia has been done as an initial attempt at targeting research areas with tsetse challenge. Data on cattle densities in Kenya at the division level has also been overlayed to assess areas at risk of trypanosomosis. Two tsetse challenge districts with different cattle production systems have been randomly selected in Kenya to capture variations in cattle trait preference structure across three production systems; pastoral, agro-pastoral and crop-livestock. These systems are characterized by low input management and prevalence of various cattle diseases. In Ethiopia, various sites in Ghibe valley, where crop-livestock system is practised have been selected for the study. Farmer group discussions were held in various sites in two districts, Narok and Kajiado in Kenya and Ghibe valley in Ethiopia. Data collection for the household level, choice-experiment survey is still on-going; consequently the choice experiment survey results presented in this paper is based on findings from only one division in one district in Kenya, that is, Magadi division of Kajiado district.

4.1 Kajiado District

Kajiado district lies in the south-western part of Kenya (Figure 1). Most of the district lies in the semi-arid and arid zones, and only 8 percent of its land has some potential for cropping.

Figure 1: Tsetse fly distribution in Kajiado district



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Mean annual rainfall ranges from 300 to 800mm, and open grasslands predominate with small areas of bush and woodland. Livestock and wildlife coexist in much of the area with several major national parks bordering or falling within the district. Human population in Kajiado has increased significantly over the last 20 years, from 149,000 in 1979 to 260,000 in 1989 and 406, 054 in 1999 (Government of Kenya, 2001). The area has historically been dominated by the Maasai pastoralists. Per capita cattle ownership has declined from 3.2 Tropical Livestock Unit (TLU)[†] in 1997 to 2.1 TLU in 1998 (*ibid).* This decline has been attributed to several factors including increasing human population pressure, several severe droughts, diversification of the Maasai economy and land tenure changes including sub-division of group ranches (Scarpa et al, 2003). The one hundred sampled households for the choice experiment survey were randomly selected from seven sub-locations in Magadi division of Kajiado district. In Magadi division, pastoral systems dominate; however, agricultural production is also practiced in some parts of Ngurumani sub-location, Magadi division.

5. Methods

A variety of Participatory Rural Appraisal (PRA) tools were used during the farmer group discussions, including scoring and ranking techniques, timeline and trend analysis, seasonal calendar analysis as well as community institutional maps. Farmers were asked to indicate their objectives of cattle keeping and then asked to identify the cattle traits or attributes that they prefer in cattle, based on their prevailing local and environmental conditions. Pairwise ranking technique for the attributes was then applied. The identified attributes were then used in the construction of the choice experiment.

5.1 Conceptual Framework of Choice Experiment

The conceptual framework for choice experiments arises from the consumer theory developed by Lancaster (1966) which postulates that preferences for goods are a function of the attributes or characteristics possessed by the good rather than the good *per se*. An important implication of this theory is that overall utility of a good can be decomposed into separate utilities for its constituent characteristics or attributes. In terms of the utility function, this translates into using the characteristics of goods as the arguments of the function. For cattle breeding, this permits the analysis of farmer preferences in terms of the benefits they perceive to result from various cattle traits. Lancaster's model may be defined more precisely as follows: A consumer maximizes an ordinal preference function for characteristics, $U(z)$ where z is a vector of characteristics $1,\dots\dots\dots,r,$ possessed by a single good or combination of goods subject to the budget constraint $px \leq K,$ where p is a vector of prices for each of these goods and K is income. Goods, x, are transformed into characteristics, z, through the relation $z = Bx,$ where B is a $r \times n$ matrix which transforms the n goods into r characteristics.

Choice experiments and hedonic price analysis are alternative empirical applications to the Lancaster consumer theory. The strength of both hedonic pricing and choice experiment techniques is the ability to decompose revealed preference data, that is, price of goods in case of hedonics and choice of goods profiles by individuals in case of choice experiments, into marginal values or *part worth* estimates. However, the use of hedonic pricing is not practical when market transactions data is poor as is the case in Africa. In the rural areas in Africa, most cattle transactions do not take place in formal markets where transactions are transparent and easily recorded. Rather, transactions usually take the form of private agreements between buyers and sellers using cash or barter. Secondly, many cattle are never traded or sold, but stay within the

[†] 1 TLU equivalent to a 250 Kg animal

farm household or are passed on to other households through traditional practices such as dowry payments. In addition, market prices may be highly distorted due to the presence of intermediaries. Consequently, price data is likely to be incomplete and can suffer from substantial measurement errors. In choice experiments, since preferences are measured directly, and then related to utility, the results are less likely to be adversely affected by traits that are not priced or transactions that do not occur through organized markets. Consequently, choice experiment technique was used in this study.

5.2 Experimental Design

Attributes for cows and bulls were identified during the farmer group discussions. For instance, in the crop-livestock systems of Ghibe valley in Ethiopia, important cattle traits include trypanotolerance, reproductive potential and fitness to traction. Milk production is a less important trait (Ouma et al, 2004). A total of eight preferred traits were identified for cows in the Kenyan sites. These were then used to design the choice experiment, with each trait having two to three levels. Table 1 presents the various traits and their levels for cows.

Table 1: Traits and Trait Levels for Cows Used in the Choice Experiments

Traits	Levels
Trypanotolerance	1. Tolerant
	2. Susceptible
Milk yield	1. 1-2 litres per day
	2. 2-4 litres per day
Reproductive performance	1. 1 calf per year
	2. 1 calf every 2 years
Feeding requirements	1. Need to use supplementary purchased feed rations
	2. No need for supplementary purchased feed rations
Purchase price at 24 months	1. Less than KSh 15,000
	2. KSh 15,000 – 20,000
	3. Greater than KSh 20,000
Watering frequency	1. Once a day
	2. Twice a day
	3. More than twice per day
Coat colour	1. Light-colored
	2. Dark-colored
Liveweight at 24 months	1. Less than 250 Kg
	2. 250-300Kg-cows
	3. Greater than 300 Kg

Cards with pictorial representations of the differences in the levels of traits were used to demonstrate each cattle profile to survey respondents. The administration of the choice experiment was conducted in the following manner. Each respondent was first introduced to the type of choice task required and then he/she was presented with twelve sets of pair-wise choices for cows drawn from an orthogonal design. Each choice task required the respondent to choose one animal profile he would prefer to buy for rearing from the two profiles presented for each choice task. If neither of the profiles was found satisfactory, the respondent could choose the "zero" option and state that he preferred neither. An example of one choice task is presented in the appendix.

5.3. Analytical Techniques and Data Analysis

In choice experiments, we assume that a sampled individual q (q=1,…,Q) faces a choice amongst *I* alternatives in each of *T* choice situations. Individual *q* is assumed to consider the full set of offered alternatives in a choice situation *t* and has to choose the alternative with the highest utility. The (relative) utility associated with each alternative *i* as evaluated by each individual *q* in choice situation *t* is represented in a discrete choice model by a utility function of the general form:

$$U_{itq} = \beta_q X_{itq} + e_{itq} \tag{1}$$

Where; X_{itq} is a vector of explanatory variables that are observed by the analyst and include attributes of the alternatives, socio-economic characteristics of the respondent and descriptors of the decision context and the choice task itself in choice situation *t*. β_q and e_{itq} are parameters to be estimated and error terms respectively. In cases such as this, where an economic agent chooses from among a set of multiple choices, multiple choice models have been employed to model choice behaviour. Multinomial logit and conditional logit models have been used in this study to model choice behaviour.

Supposing observed choice *Y* has values 0, 1, …., *m* and X_i includes individual *q*'s characteristics while Z_i are the choice specific characteristics, the multinomial logit model to assess the effect of X_i on the probability that choice *Y* has trait *j*, can be presented thus (Greene, 1997);

$$\text{Prob}(Y_i = j) = \frac{e^{\beta_j' x}}{\sum_{k=0}^{m} e^{\beta_k' x_i}}, j = 0, 1, ...m \tag{2}$$

The independent variable X_i does not vary across choice alternatives but varies across individuals. On the other hand, independent variables Z_i varies across households as well as choice alternatives. Therefore, to assess the impact of Z_i (choice-specific attributes) on *Y*, the appropriate model to use is the conditional logit model, presented below for a total of J alternatives:

$$\text{Prob}(Y_i \mid x_i = j) = \frac{e^{\beta' z_{ij}}}{\sum_{j=1}^{J} e^{\beta' z_{ij}}}, j = 1, 2, ...J \tag{3}$$

In conditional logit, we estimate β while in multinomial logit, we estimate β_j.

Producers in different production systems may face different trade-offs in cattle attribute preferences due to varying production activities, and this may have different policy implications. Therefore, we obtained estimates for the two production systems identified in the area, as well as pooled estimates for both systems.

6. Results and Discussion

The multinomial and conditional logit models were estimated using STATA 8.0 (2001). The maximum likelihood parameter estimates from the conditional logit model are presented in Table 2. Since the traits had 2-3 levels each, one level was left out as base during estimation. The overall explanatory power of the model is good with a pseudo-R^2 of 0.46

The trait trypanotolerance is strongly significant (p<0.01) and has the expected positive sign in all the systems, implying that farmers in the study area prefer trypanotolerant cattle breeds. The study area is a tsetse challenge area, where cattle are at constant risk of trypanosomosis infection.

Dark coat colour has a positive sign, indicating that respondents prefer cows with dark coat colour relative to light coat coloured ones. This is despite the dark coated animals having higher chances of being bitten by the tsetse flies compared to the light coated ones. The study area is mainly inhabited by the Maasai communities, who have a high preference for dark coat coloured cattle. Dark red coat colour is considered beautiful and appealing while animals with plain black coat with white spots around the neck are slaughtered during ceremonial functions.

Table 2: Conditional Logit Maximum Likelihood Parameter Estimates of Cow Attributes

Cow attributes	All systems (pooled)	Agro-pastoral system	Pastoral system
Trypanotolerant	2.1364*** (0.1899)	2.4171*** (0.2864)	2.0489*** (0.2659)
Dark coat colour	1.8662*** (0.1620)	1.9330*** (0.2616)	1.9142*** (0.2116)
Weight at 2 year (>300Kg)	0.1780 (0.2274)	0.7257**(0.3577)	-0.2355 (0.3057)
Weight at 2 years (250-300Kg)	0.2209 (0.1816)	0.4767 (0.2949)	0.0111 (0.2411)
Needs watering once a day	0.5796*** (0.2220)	-0.4071 (0.3809)	1.2062*** (0.2889)
Needs watering twice a day	0.3183* (0.1925)	-0.1451 (0.3110)	0.6025** (0.2543)
Average milk production: 2-4 Lt/day	0.1891 (0.1614)	0.1491 (0.2556)	0.2015 (0.2148)
High reproduction potential	1.2813*** (0.1883)	1.1021*** (0.3093)	1.4936*** (0.2539)
Need to buy purchased feeds	0.0924 (0.1761)	0.2629 (0.2781)	0.0007 (0.2339)
Price at 2 years (> KSh20,000)	-0.3816 (0.2696)	0.4757 (0.4293)	-0.9552 *** (0.3622)
Price at 2 years (KSh15,000-20,000)	-0.1240 (0.2097)	0.3021 (0.3224)	-0.4109 (0.2843)
Pseudo-R^2	*46%*	*49%*	*43%*
Log likelihood	*-591.1*	*-226.3*	*-348.0*
Likelihood ratio	*912.49*	*427.1*	*518.9*
Significance level	*0.0000*	*0.0000*	*0.0000*
Degrees of freedon	*11*	*11*	*11*
Number of observations	*1800*	*756*	*1044*

***, **, * indicate that coefficients are statistically significant at the 1, 5 and 10% levels, respectively, using P-values in maximum likelihood estimation. Robust standard errors are indicated in parentheses.

High relative liveweight at 2 years has the expected positive sign for all the systems but is only significant for the agropastoral systems (p<0.05) and negative for the pastoral systems. In the pastoral systems, cattle are frequently moved from place to place in search of pasture and water. Consequently, farmers would prefer animals that are lighter and can be moved easily and faster.

The trait for cows that need watering only once a day is strongly significant (p<0.01) and has a positive sign, implying that farmers prefer cows that need to water only once a day relative to those that need to water more than two times a day. However, when differentiated by production systems, the sign is negative for the agropastoral system and positive for the pastoral systems (p<0.01). This is because water is not a constraint in the agropastoral systems, mainly found in Ngurumani sub-location of Magadi division. Ngurumani is on the escarpment to the western edge of Magadi with plenty of water and fertile arable land. However, in the pastoral systems water is a major constraint.

High reproductive potential has a positive impact on herd productivity and herd size, so a positive sign was expected. This is also highly significant (p<0.01) in all the systems. Daily milk production of 2-4 litres (representing high milk production as opposed to 1-2 litres per day) is positive but not statistically significant, suggesting that respondents' choices are not strongly influenced by changes in milk yield. This implies that milk production is not a highly ranked parameter in livestock farmers' trait preference yet most analyses of cattle systems and producer decisions focus on marketable yield attributes such as milk production for dairy animals and beef output for beef animals.

Three different price levels of cows were considered in the choice experiment. Higher prices yielded negative parameter estimates, implying that farmers are less likely to choose costly options. However, in the agro-pastoral system, the reverse is observed. Some of the farmers consider higher purchase prices to be beneficial since it shows that the animal has a higher value and consequently would fetch high market prices when sold. Another possible explanation would be due to the multifaceted functions of cattle such that market price is a low rank parameter in livestock farmers' trait preference.

7. Concluding Remarks

The integration of trypanotolerance traits of cattle into breed improvement programs in tsetse challenge areas provides a viable option to enhance cattle productivity. Research efforts should be geared towards this. Empirical results indicate that farmers in both pastoral and agro-pastoral systems value the adaptation traits, more so trypanotolerance.

Culture and tradition have an influence on the traits preferred by farmers. For instance, farmers in the study site prefer dark coat-coloured cattle, especially the dark red colour and other dark colours. The dark coated animals are used for slaughtering during ceremonial functions.

Differences in preferences across production systems are observed due to the varying production activities and available resources. Producers in pastoral systems have a high preference for hardy animals that are able to withstand severe environmental conditions. This is in contrast to the producers in agropastoral systems that prefer animals that are trypanotolerant and heavy, so as to fetch favourable market prices.

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Appendix

Choice task 1 (Alternative 1)

Tolerant to Trypanosomosis: Able to be in good condition despite infection. No need for treatment drugs	**Dark Coat Colour**	**Weight at 2 years (less than 250 Kg)**	**Watering needs: Need to be watered two times a day**
Average milk yield per day (2-4 Lts)	**Reproduction Potential: 1 calf every two years**	**Does NOT require purchased supplementary feeds**	**Purchase price: More than KSh 20,000**

Choice task 1 (Alternative 2)

Susceptible to Trypanosomosis: Poor condition after infection. Needs treatment drugs	**Light Coat Colour**	**Weight at 2 years (300 Kg)**	**Watering needs: Need to be watered two times a day**
Average milk yield per day (1-2 Lts)	**Reproduction Potential: 1 calf every year**	**Requires purchased supplementary feeds**	**Purchase price: Less than KSh 15,000**

Choice task 1 (Alternative 3)

None of the above profiles