Aus dem Institut für Ernährungswirtschaft und Verbrauchslehre

der Christian-Albrechts-Universität zu Kiel

Economic Valuation of the Preferred Traits of Indigenous Cattle in Ethiopia

Dissertation

zur Erlangung des Doktorgrades

der Agrar- und Ernährungswissenschaftliche Fakultät

der Christian-Albrechts-Universität zu Kiel

Vorgelegt von

M.Sc. Girma Tesfahun Kassie

aus Äthiopien

Kiel, Dezember 2007

Dekan:	**Prof. Dr. Joachim Krieter**
Erster Berichtersstatter:	**Prof. Dr. Awudu Abdulai**
Zweiter Berichtersstatter:	**Prof. Dr. Clemens Wollny**
Tag der munlichen prufung:	**14, February 2008.**

Acknowledgement

This thesis is part of the final chapter of my academic life as a student which started at the early age of my childhood. I owe a lot of people an enormous gratitude. Mentioning all the people who helped me achieve my objective is virtually impossible. Nonetheless, I can not pass without specifically appreciating some of them. Before all, I would like to thank my parents for sending me to school and following up my progress as meticulously as they could. My academic life would have been hardly successful had it not been for the unremitting interest and support of my father the late Ato Tesfahun Kassie and my mother W/o Kebebush Mamo.

My three years effort as a PhD student was successful only because of the high standard technical support I received from my supervisors Prof. Dr. Awudu Abdulai and Prof. Dr. Clemens Wollny. Dr. Adam Drucker and Dr. Workneh Ayalew have also contributed so much for the quality of this research. I am very grateful to all of these scholars and feel privileged to have worked with them. All the teachers I learned from since the very day I started my student life are always in my heart. I would like to take this opportunity to pass on my heartfelt appreciation and gratitude particularly to my inspirational teachers and mentors Dr. Habtemariam Kassa, Dr. Zenete Franca, Dr. P. Anandajayesekeram, Dr. Wolfgang Bayer, and Dr. Ann-Waters Bayer.

This research would have been enormously difficult without the enthusiastic encouragement and support of my ILRI colleagues Dr. Yilma Jobre, Dr. Markos Tibbo, Dr. Tadelle Dessie, Dr. Gete Zeleke, Yetnayet Mamo, Rahel Mesganaw, Ekin Keskin, Dr. Aynalem Haile, Befikadu Alemayahu, Michael Temesgen, Eshetu Zerihun, Wagaye W/mariam and all others in the ILRI-Addis compound who have been very kind to me. I have also benefited from the unreserved efforts of researchers at Bako research center, all data collectors of all the surveys, and the generosity and openness of the hospitable community of Dano district. I very much hope that the results and recommendations of this research would be beneficial to the community in particular and Ethiopian livestock keepers in general as a token of gratitude for all the assistance I received.

Life as a foreign student could have been more difficult with out the support of all my colleagues in Goettingen, Kassel and Kiel who helped me cope up. My particular thanks to Mrs. Brigitta Lunderstadt of IPAG – and Mrs. Grete Ter Muellen of Goettingen, and my friends Inken and Liane (who translated the summary of this thesis to German), Inga, Havier,

Rhoda, Andrea, Christiane, Christian, Akhter and all the student assistants here in Kiel for their ubiquitous support.

The moral and material support I enjoyed for so long from my brothers and sisters both in Ethiopia and in the United States is so much that I would always feel indebted. Particularly, Sileshe Mulugeta and Fasika G. Fetene deserve my heartfelt gratitude for their special contributions for my academic life. My friends from Alemaya University, Sirinka, ARARI, OARI, IFPRI, and EIAR deserve a special mention for their continuous support.

My gratitudes also go to all who stood by my family in my absence for about three years. My mother-in-law, W/o Nigist Shiferaw, and my father-in-law, Ato Abraham Belay, deserve a special mention. Above all, I would like to thank my loving and strong wife W/o Redaet Abraham for her invaluable support in raising our son Birhanu at his very demanding age and for her strength to run the family alone. May God Bless You All, Amen! Praise be to the Holy God.

Table of Contents

Chapter 1

Summary

Valuation of the characteristics of indigenous livestock populations serves a number of purposes. These include clear understanding and appreciation of the multi-functionality of the animals, identification of the most preferred traits for conservation and breeding purposes, understanding of the marketing system, and transformation of the livestock production system. The rural communities in developing countries keep livestock for a number of direct (e.g., consumables, traction, prestige, security) and indirect (e.g., complementarities with crop production and natural resources) uses and objectives. Virtually no attention was given for this intricacy in the objectives of traditional livestock keeping while enormous resources were allocated to introduce livestock breeds with very specialized traits developed for high production systems to developing countries.

If countries like Ethiopia are to benefit from the livestock wealth they are endowed with, a well-informed livestock and conservation strategy has to be formulated based on comprehensive inventory of the genetic resources and proper valuation of their traits or characteristics which explain the reasons why they are kept for. Only two documented efforts by Zander (2006) and Ouma *et al*. (2007) were made to elicit preferences and estimate relative values of traits in the pastoral areas of southern Ethiopia. Yet, no attempt has been made to do same in the most dominant crop-livestock mixed production systems of the country.

This research aims at filling this gap by focusing on the cattle population in Central Ethiopia. The research has characterized the livestock production system, discussed the theoretical and empirical importance of economic valuation of traits, valued traits of cows and bulls using both stated and revealed preference approaches and suggested a community based management (CBM) framework for conservation and sustainable use of animal genetic resources (AnGR). The logical flow of the components of this research thesis is indicated with the sketch below (Figure 1.1). The boxes with italic fonts represent independent chapters of the thesis. The sketch is followed by summary of each part of the thesis.

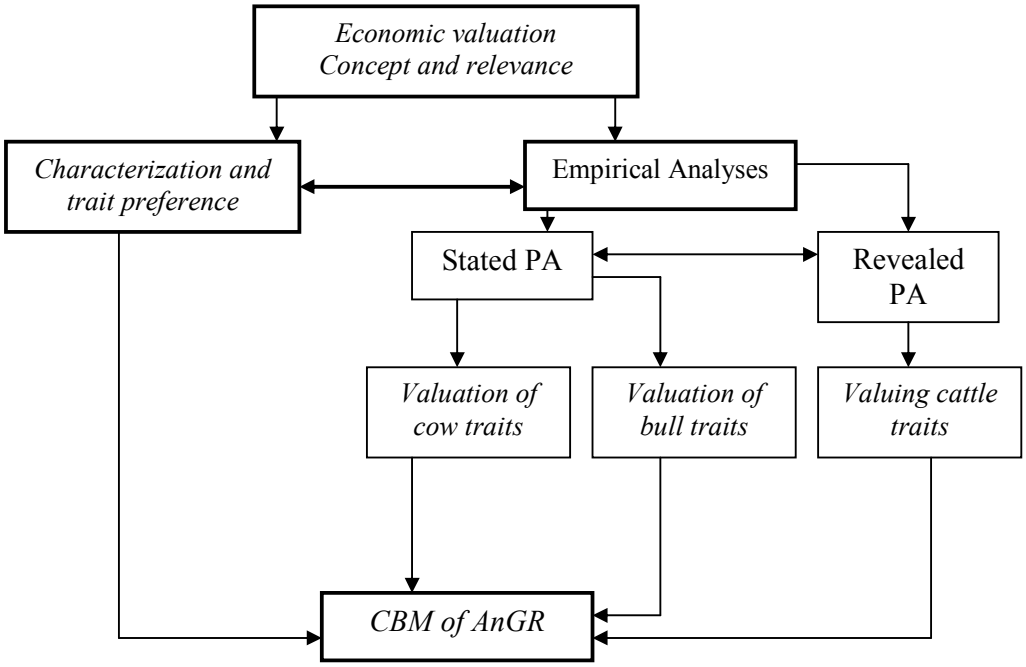


Figure 1.1: The logical flow of parts of the thesis (PA = preference analysis)

Economic Valuation of Phenotypic Traits: An Impetus for Market Orientation of Livestock Production Systems?

This paper presents the role economic valuation of preferred traits can play in the transformation of the subsistence oriented livestock production system in Ethiopia. It argues that the demand for functions of cattle is embedded in the preferences for phenotypic characteristics and the most demanded would have higher economic value. The livestock production system would then focus on the production and marketing of the preferred characteristics of the animals in order to transform itself and secure sustainable market share. The conclusion drawn is that economic valuation can contribute significantly in transforming the livestock production systems through efficient allocation of resources for development, utilization and conservation of the valuable animal genetic resources.

Cattle Trait Preferences in the Semi-subsistence Agricultural Production Systems of Central Ethiopia

This study describes the different components of the livestock production system and the cattle trait preferences of farmers in their production and marketing setups. The livestock production system in Dano, Central Ethiopia, can be described as highly subsistence and resource constrained. Through their multiple functions, cattle are playing a very important and

increasing role in the rural livelihoods which depend on this traditional and complex agricultural production system. The cattle keeping decisions of farmers depend on the different functions they expect and the different traits of the animals related to the functions. Elicited preferences for traits of cattle manifest the functions animals are kept for and the objectives of cattle production. The preferences for cattle traits show that age, plowing strength, origin of the cattle, and calf vigor are the most important traits of bulls, whereas age, origin, milk yield, calf vigor and fertility are for cows. Such empirical evidence on cattle trait preferences is useful to make better informed decisions in developing interventions to improve the contribution of cattle to livelihoods of their keepers.

Valuing Traits of Indigenous Cows in Central Ethiopia

This research aimed at identifying and estimating the relative weight assigned to the preferred traits of indigenous cow population in the most dominant crop-livestock mixed production system in Ethiopia. The study used data generated through choice experiment conducted with 195 cattle buyers in five rural markets. The results show that fertility, disease resistance and calf vigor traits are equally or more important than milk. The place the cows are brought from is also an important attribute for buyers. Results from the simulation on the influence of changes in attribute levels showed that fertility and disease resistance affect preferences more than other traits. The smallholder community in this part of Ethiopia depends on semi subsistence agriculture and so livestock development interventions should focus on a multitude of reproductive and adaptive traits which stabilize the herd structure than focusing on traits which are only important to commercial purposes. Specifically, the husbandry and breeding strategies should focus on shortening the calving interval, improving the disease resistance and work on factors that improve the strength of the calves.

Preferences for Bull Traits in Semi-subsistence Agricultural Production Systems of Central Ethiopia

Random parameters logit was employed to estimate the relative importance of preferred traits of indigenous bulls and to analyze taste heterogeneity. Kernel density estimators were also used to examine the distribution of the willingness to pay for the individual traits. Data on the stated preferences of 198 cattle buyers were generated using choice experiments in five rural markets from May – June, 2006. The results indicate that cattle buyers assign high values for good traction potential, big body size, 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. Careful consideration of preferences for attributes should be made before introducing or reinforcing crossbreeding efforts meant to enhance only a few of the attributes or purposes animals are kept for. In addition to producing breeds that are preferred by cattle buyers, incorporating these preferred attributes in breeding programs would contribute in reducing the erosion of the genetic diversity of the indigenous animal genetic resources.

A Hedonic Price Model for Cattle in the Rural Markets of Central Ethiopia

This study identified the factors influencing cattle price and determined their relative weight in five rural markets of Central Ethiopia. Data on 411 cattle transactions were generated through quarterly surveys, from February to November 2006, focusing on the phenotypic traits of the animals traded, places where the animals were brought from, price, and the characteristics of the buyers. The phenotypic characteristics included coat color, age, body size, and class (sex and function) of the animal bought. A hedonic price function was formulated and estimated with heteroscedasticity consistent covariance matrices, feasible generalized least squares, and structural heteroscedasticity models. All the estimations show that season, market location, class of cattle, body size and age are very important determinants of cattle price in the rural markets of central Ethiopia. The result shows the significance of the preferences of traits at the grassroots level for decisions related to buying and/or selling cattle. These preferences are crucially important in shaping up the diversity of animals kept at farm level. Therefore, interventions related to cattle genetic resources should duly consider the preferences explained through the prices paid.

A Framework for Community Based Management of Indigenous Cattle Genetic Resources in Dano District, Central Ethiopia

This paper outlines the essential components and activities needed to be considered to empower the cattle keeping community for effective collective action in the conservation and sustainable use of the indigenous cattle population. There is currently a growing tendency of favoring the conservation of animal genetic resources (AnGR) by maintaining genetic diversity of local breeds within their production systems. Communities manage their livestock using a wide range of indigenous knowledge that emanates from varying socio-economic, cultural and bio-physical environmental conditions. The growing interest in working with communities with due appreciation and use of indigenous knowledge has given rise to the concept of Community Based Management (CBM) of resources. CBM of AnGR is a system

of AnGR and ecosystem management in which the AnGR keepers are responsible for the decisions on identification, priority setting and the implementation of activities in conservation and sustainable use of the AnGR (Rege, 2003; Kohler-Rollefson, 2004). The community and the AnGR it owns are the central components of CBM of AnGR; while its main purpose is empowering, motivating, informing and building the capacity of the community for a sustainable management of the AnGR. The initial step in implementing a community based organizations like the CBM of AnGR has to be the full awareness, empowerment, and ownership of the whole process by the community. Assumptions of a favorable political environment, complementarity among the different stakeholders, continuous capacity building, and access to comprehensive market information were made in developing this framework.

References

Kohler-Rollefson, I., 2004**.** Farm Animal Genetic Resources. Safeguarding National Assets for Food Security and Trade. A Summary of workshops on farm animal genetic resources held in the South African Development Community (SADC). GTZ, BMZ, FAO, CTA, SADC. Eschborn.

Ouma, E., A. Abdulai and A. Drucker. 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.

Rege, J.E.O, 2003. Defining Livestock Breeds in the Context of Community-Based Management of Farm Animal Genetic Resources. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 –11 May 2001. Pp. 27 -35.

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

Chapter 2

Background

2.1. Ethiopia – Geographic Profile

Ethiopia is located in East Africa between 3° and 15° N latitude and between 33° and 48° E longitude. The country shares borders with Eritrea in the North, Djibouti and Somalia in the East, Kenya and Somalia in the South and The Sudan in the West (Figure 2.1). Ethiopia is 1.1 million sq. km wide with an estimated human population of 77.13 million in the year 2006 (CSA, 2006). Ethiopia's landscape tremendously varies in altitude ranging from 110 meters below sea level in the Danakil depression of the East African Great Rift Valley to about 4,620 meters above sea level in the Ras Dashen mountain chains of North Western Ethiopia. Climatic variation is quite prominent in Ethiopia such that the country is divided into 18 major and 49 sub agro-ecologies based on altitude, rainfall, soil type, length of plant growing period, vegetation cover, and dominant crop and livestock species (MoA, 2000).

Ethiopia is one of the oldest independent countries in Africa with a recorded history of about 3,000 years. The modern day Ethiopia has experienced three types (including the current) of political governance over the last 80 years. The feudalistic era lasted from 1930-1974 until it was forcefully replaced by a Stalinist junta which remained in power until 1991. In 1991, the military *Derg* was itself ousted by the ethno-centric rebel fighters who are in power ever since. The contemporary image of famine stricken and poverty ridden Ethiopia is essentially a cumulative result of the inefficiencies, biases, and confusions of the political systems in place since the early 20th century. Apparently, the natural and manmade calamities have also been tremendously important in the history of Ethiopia's fragile economy. The ensuing famines and deep rooted poverty have made Ethiopia one of the poorest nations on Earth.

Figure 2.1: Regional Map of Ethiopia

2.2. An Overview of Ethiopian Economy

Ethiopia is among the poorest states on the globe in any standard. Poverty is pervasive and widespread over the length and breadth of the country. Based on the Human Development Index (HDI) of the United Nations Development Program (UNDP), Ethiopia has been ranked among the eight poorest countries of the world since 1998 (Table 2.1). Despite the fact that Ethiopia was a net exporter of food crops until 1947 and a food self sufficient country until 1958 (Kassa, 1994, as cited in Kassa, 2003), it has become one of the major receivers of both cereal and non-cereal food aid. A European Union (EU) document indicates that Ethiopia has received between 600,000 and 800,000 MT of food aid yearly over the last fifteen years (EU, 2002). FAO statistics show that Ethiopia continued to receive nearly 0.9 million metric tones of cereal food crop aid annually in the period 2001-2003 (FAOSTAT, 2007).

Some 35-40 percent of the Ethiopian population spends less than required to consume 2,200 calories of food per day (World Bank, 2007). Data on agricultural production, the most important sector in the economy, show that the country is unable to produce enough grains to feed its population even in years of good rainfall (Kassa, 2003). The domestic production is estimated to supply only about 70% of the total food requirement, and each year 4 to 6 million people need food assistance despite the existence of potentially productive resources for food

self sufficiency and even surplus production (EEA, 2006). In addition to its geographic and demographic size, one would have also expected that Ethiopia's wealth of human labor, land, and highly diverse biodiversity to be properly harnessed to change the livelihoods of the people. Nonetheless, feudalistic, Stalinist, and ethno-centric ideologies of the country's successive governments' seem to have favored continuous exercising of political power than economic prosperity of the people. As emphasized by the World Bank (2007), Ethiopia's long history of autocratic rule, followed by a brief period of a particularly militaristic form of Stalinism, combined with inter-group conflict was inimical to long-term growth.

Like all other developing economies, agriculture, manufacturing, other industries and private and public services are crucial components of Ethiopian Economy. Agriculture is the dominant sector contributing the largest share to GDP, employment, foreign earnings, and sustaining lives. Its contribution to the GDP of the country shows a declining trend that it contributed 76%, 56.1%, 49.3%, 52.3% and 45% in the early 1960s, in 1970, 1980, 2000, and 2003/04, respectively (Knipes, 2004; EEA, 2005). Agriculture accounted for 82.2% of the foreign earnings in 2003/04, lower as compared to 90% in 1999, and still employs about 85% of the working population (EU, 2002; EEA, 2005; World Bank, 2007). This big dependence on agriculture makes the country extremely vulnerable to external shocks like a shortage of rainfall or declining commodity prices (coffee) on the international markets. According to EEA (2005), the Ethiopian industrial sector has been stagnant over the years both in terms of its share in GDP and growth performance. Its share has not changed much from the 10 percent mark as a ratio of GDP over the last four decades and its growth rate only moved within the 3 to 7 percent range during the same period. The services sector exhibited some appreciable changes over the last decade. The distributive services sector has registered a slight increase in terms of its share in GDP during the same period. As a result, Ethiopian Economy will remain to be characterized as agrarian for significant number of years to come. Table 2.1 shows the low and stagnant life expectancy at birth and adult literacy trends, the low and marginally increasing overall school enrolment ratio, the extraordinarily low GDP per capita (in US$ purchasing power parity – US$ PPP), and the abysmally constant HDI rank of the country based on the UNDP's human development reports of years 2000 to 2007.

Table 2.1: Major Indicators of the Human Development Index for Ethiopia

Year	Life expectancy	Adult literacy	Enrolment ratio	GDP/Capita (US$ PPP)	HDI rank	Source
1998	43.4	36.3	26	574	171/174	UNDP 2000
1999	44.1	37.4	27	628	158/162	UNDP 2001
2000	43.9	39.1	27	668	168/173	UNDP 2002
2001	45.7	40.3	34	810	169/175	UNDP 2003
2002	45.5	41.5	34	780	170/177	UNDP 2004
2003	47.6	41.5	36	711	170/177	UNDP 2005
2004	47.8	-	36	756	170/177	UNDP 2006
2005	51.8	35.9	42.1	1055	169/177	UNDP 2007

2.3. Ethiopian Agriculture Sector brief

Ethiopian agriculture is characterized as traditional, rainfed, low-input, low-productivity, predominantly subsistence, and yet as the most important sector in the national economy. Despite such paramount importance, due to many natural and man-made factors, the performance of the Ethiopian Agriculture is very low by all measures (EEA, 2005). Reports show that Ethiopia is yet to find the right path of economic prosperity. For instance, the World Bank indicates that there is no evidence of an overall economic take-off since the early 1990s and that it is possible to construct gloomy scenarios for peasant agriculture since agricultural output per capita evidences long-run decline (World Bank, 2007).

Official reports of domestic authorities (CSA, 2006) are, on the other hand, indicating continuous economic growth over the last four years (2002/03-2006/07). Economic assessments, however, attribute the short-span boost to the favorable rainfall and cite the drought in 2002/03 and the negative 12.6%% growth rate in the same fiscal year to refute the claims of overall economic growth (EEA, 2005). The general trend is, however, that the per capita income in agriculture over the last four decades (1953-1995) declined by over 45% compared to its level in the early 1950s and this simply reflects the structure of the agrarian economy of the country (EEA, 2005).

The structural problem with Ethiopian agriculture is its extreme dependence on rainfall. The rainfall pattern is so important that it is becoming the single most important factor explaining the performance of Ethiopian economy from year to year (Devereux, 2000). The challenge lies in the high variability and unpredictability of the rainfall pattern. This variability is an important constraint of agricultural production and productivity at household

level as much as it is a predicament for the national economy (Tesfahun et al., 2006). According to UNDP, a single drought event in a 12-year period will lower GDP by 7%–10% and increase poverty by 12%–14% (UNDP, 2006).

Ethiopia has a potential of 2.3 – 3.7 million hectares for irrigated agriculture. Computations made based on the figures of CSA (2006) and the ceiling (3.7 million hectare) irrigation potential show that only 4% of the potential is cultivated by smallholder farmers in the production year of 2005/06. Given the fact that commercial and state farms are quite limited, the underutilization of the irrigation potential will remain to be a daunting reality.

2.4. The Livestock Production Sub-Sector

Ethiopia possesses the largest livestock population in Africa with an estimated number of 40.3 million cattle, 20.7 million sheep, 16.25 million goats, 6.2 million equines, and 32 million poultry in 2005/06 excluding the Afar and Somale pastoral areas (CSA 2006). A conventional livestock population survey done in 2004 in the pastoral regions of Afar and Somale, reported 2.12 million cattle (5.6% of the country's cattle population in 2004), 2.6 million sheep (15.7% of the total), 4.14 million goats (30% of the total), 1.02 million equines (18.4% of the total), and 100% of the camel population (CSA 2004). This wealth of large livestock population, genetic diversity, and production system is attributed to the country's geographical location being close to the historical entry point of many livestock populations from Asia along the Nile Basin, topography of the country, and its climatic conditions (EEA, 2005, 2006).

Four major livestock production systems are known to exist in Ethiopia (IBC, 2004; EEA, 2005). These are mixed crop-livestock production, pastoral, agro-pastoral, and the urban and peri-urban systems. The mixed crop-livestock system is found in the high and mid altitude areas. Most of livestock population is kept in this system because of the more favourable climate and relatively moderate disease and pest problems. The pastoral systems include both nomadic and transhumant types found in the vast arid and semi-arid areas of Afar, Somale, Borana (Oromia), and Southern regions. In these systems, livelihoods entirely depend on livestock. The agro-pastoral systems are prevalent in areas where the rainfall is sufficient enough to produce some crops and short enough to force livestock keepers move their animals seasonally for search of feed and water. The urban and peri-urban production system is a newly emerging small component of the livestock sector of Ethiopian agriculture.

Generally, the livestock resource of Ethiopia sustains and supports the livelihoods of an estimated 80% of the rural people (FAO, 2004). The livestock sector constitutes 30-40 percent of the agricultural gross domestic product (AGDP) and 17-20 percent of the overall

GDP (Knips, 2004). Despite this high contribution to the economy, the government reportedly allocated only 5% of its recurrent expenditure on agriculture and less than 0.3% on livestock. This clearly indicates that financial flows to the livestock sector do not reflect its contribution to the economy nor the potential wider impact of investment in the sector (FAO, 2004). Due to lack of focus and investment, the livestock sector is a low input, poorly performing component of a rather more inefficient agricultural system.

The reasons responsible to the very low performance of the livestock production sector include inadequate feed and nutrition, widespread diseases and poor health, poor breeding practice, inadequate livestock development policies with respect to extension, marketing, and credit, and poor infrastructure (EEA, 2005). It is also argued that the current land tenure policy and the common property nature of grazing land motivate households to keep livestock beyond the carrying capacity of the land, damaging pasture land and contributing to declining livestock productivity (FAO, 2004). Entangled in such policy, institutional, technical, marketing and socio-cultural constraints, livestock production makes marginal contribution towards the improvement of the welfare of the farmers and pastoralists.

The Ethiopian policies and strategies of livestock development, in general, and cattle production, in particular, are characteristically uninformed, non-participatory and short-sighted. According to Kassa (2003), lack of well-balanced policies and appropriate accompanying measures are partly due to inadequate understanding of the structure of the target farming systems and factors governing farmers' behavior. The policies and strategies focused on substituting the indigenous 'low' productivity breeds of animals (mainly cattle, small ruminants and poultry) with pure or crossed exotic breeds. This yet seems to be the interest of technicians in the field (e.g., EEA, 2006, pp.121 -177). Indiscriminate artificial insemination (AI), provision of cross and pure exotic breeds, and bull service have been the essential components of the livestock development interventions over the last four decades with the aim of increasing production of milk and to a lesser extent beef, egg, and chicken and small ruminant meat. The profound consequences of genetic erosion, in terms of losing the important adaptive and productive traits of the indigenous livestock breeds, have never been accounted for.

The misguided interventions of the government appear to be continuing posing the greatest risk of diluting the indigenous genetic resources without any clear idea as to what and how much is being lost. Although well designed and properly managed interventions could contribute to the improvement of livelihoods, this is not happening in the livestock sector development of Ethiopia. This research bases on the fact that there is little known about the

animal attribute preferences of livestock keepers and the mechanisms by which livestock keepers use and conserve the genetic resources at their disposal. Information in this regard bridges a big gap of knowledge and the focus on cattle is justified by the fact that cattle are the most important components of the livestock sector and the most exposed to the breed improvement programs over the last forty years.

2.5. Cattle production in Ethiopia

Cattle play a crucial role in the livelihoods of Ethiopians. They are by far the most important animals rendering different functions for the resource poor communities in the rural areas. The functions of cattle include traction power, consumables (milk, beef, etc.), fuel and soil fertilization (dung), cash generation (selling milk, hides and/or live animals etc.), social prestige, and risk buffering. This importance has probably initiated the series of interventions to develop cattle production and productivity in the country.

The interventions focused on increasing milk yield through introduction of exotic dairy breeds either by crossbreeding or using AI. Beef production enhancement has also been an agenda that programs targeting fattening under smallholder production systems have been implemented for over four decades now. While all the effort made focused on milk and beef, the non-commercial, but important, attributes of cattle have not been considered at all. In some cases, some favorable attributes of indigenous cattle breeds (such as plowing strength) were sought after exotic breeds rarely developed for such traits (Zerbini and Gebrewold, 1999; Larsen, 2002).

On the other hand, traits of cattle define the long-term genetic and environmental changes the animals evolved through in the given production system. The rich diversity in the adaptive and productive traits of the indigenous cattle is crucially important for the sustainable development of cattle production. Since the demand in the future is largely unknown, agro-biodiversity also provides the reservoir of genes to respond to changes in production circumstances, market needs or disease challenges. Genetic diversity is highly relevant in Ethiopia where specific adaptive attributes of indigenous animal genetic resources are vital, and where the production systems depend not on external inputs, but rather on the capacity of genetic resources to thrive under unfavorable environment, like the extremes of climate, disease challenge, and poor plane of nutrition (EEA, 2005). It is this valuable resource the country is losing without knowing it.

The important factors behind the unnoticed erosion of animal genetic resources in Ethiopia include misguided and uncontrolled crossbreeding, drought, inbreeding among the

indigenous populations, haphazard restocking schemes, changes in producer preferences, and inappropriate interventions. Drought plays an important role in eroding the genetic resource in the pastoral and agro-pastoral livestock production systems. Cattle relinquish in enormous numbers under the frequent drought in these arid and semi-arid agro-ecologies. The 1973/74 drought in Afar area (then called Hawsa), reduced the cattle population by 72%, while the 1984/85 drought in Borana reduced the cattle population by 60% (RRC, 1985; Sandford and Yohannes, 2000). The 1995/97 drought in Somali region was reported to take toll of 78% of the cattle population (Sandford and Yohannes, 2000). Devereux (2000) reported 70% drought induced decline in cattle population in Somale and Borana regions in one year period between May 1999 and May 2000. The consequences of drought are paramount and can result in vanishing of a breed as such. A recent study on six cattle breeds of northern Ethiopia showed that the cattle population in the pastoral and agro-pastoral areas is decreasing and most of the breeds have high probability of extinction (Zarabruk et al., 2007).

The importance of drought as a cause for genetic erosion is relatively very low in the mid and highland areas of the country where series of livestock development programs have been undertaken. The challenge in these areas is the poor planning and implementation of the main components of the interventions - AI and crossbreeding. Taking introduction of pure or cross exotic breeds as a case in point, a recent survey (EEA, 2006) showed that about 17% of the farmers in Tigray possess pure exotic cattle breeds. This figure was reported to be 10% in Oromia, 10.1% in Amhara, 6% in Dire Dawa, and 3.3% in Southern regions. Regarding crossbreeds, 27% of farmers in Tigray, 20% in Oromia, 14% in Amhara, 8% in Southern Nations, 4.17% in Dire Dawa, and 4% in Harari regions, reported that they or their neighbours have received crossbred dairy cows over the last ten years. Nearly 60% of the sample farmers are unaware of the types (eg., Boran **X** Jersey, Arsi **X** Holstein Friesian, etc.) and 78.2% do not know the blood level (e.g., half-cross, $3/4^{th}$ cross, etc.), whereas majority of the respondents are unaware of the sources (e.g., research centres, extension institutes, etc.) of the 'improved' cows they received. This lack of knowledge implies, at least, the poor participation of the target communities, the possible mismanagement of the introduced genetic materials, the likelihood of generating unexpected off-springs, and dilution of the indigenous genetic base without knowledge of the extent.

Essentially, the weakness of the whole approach emanates from the lack of information about the preferences and subjective values attached to attributes of cattle by the cattle keepers in the mid and highland crop-livestock mixed production systems. The obvious and considerable threat on the genetic diversity wealth of the country therefore entails appropriate

elicitation of preferences and valuation of the preferred traits, so that informed policy and strategies can be formulated and enacted. This research illustrates the trait preferences as well as the stated and revealed relative values of traits of cattle in the semi-subsistence crop-livestock mixed production systems of Dano district in Central Ethiopia.

2.6. Objectives of the Study

The general objective of this research is to elicit farmers' preferences of indigenous cattle attributes and to estimate the relative economic weights of the preferred traits for the formulation of a community based management of animal genetic resources in Dano district, central Ethiopia. Specifically this research addresses the following objectives.

1. Describing the livestock production and marketing system and eliciting the cattle trait preferences under farmers' circumstances,
2. Estimating the relative economic values of and the willingness to pay for the attributes of cows and bulls based on stated preferences,
3. Identifying the factors that determine the revealed preferences of cattle buyers and quantifying the relative importance of the factors, and
4. Proposing a framework for the community based management of indigenous cattle genetic resources in the study area.

2.7. Structure of the Thesis

The thesis has two essential parts. The first part is about setting the scene of the whole research and summarizing results of the different components of the thesis research. Chapters 1, 2, 9 and 10 (German version of chapter 1) can be categorized in this part. The second part encompasses the six technical papers of the thesis. The essential theoretical underpinnings of the whole study are elaborated in chapter 3. Chapter 4 presents a general overview of the livestock production system and farmers' trait preferences elicited both in their villages and in their market places. Chapters 5 and 6 present empirical stated choice analysis of traits for cows and bulls, respectively, based on data generated using choice experiments. Chapter 7 presents a hedonic cattle price analysis to complement the stated preference analyses reported in chapters 5 and 6. Chapter 8 presents a framework for CBM of AnGR based on the empirical observations within the study area and documented experiences from other areas.

2.8. References

CSA (Central Statistical Authority), 2004. The 2004 National Statistics. Available at http://www.csa.gov.et/text_files/2004_national_statistics.htm (Last accessed in November 2007).

CSA (Central Statistical Authority), 2006. The 2006 National Statistics. Available at http://www.csa.gov.et/text_files/2006_national_statistics.htm (Last accessed in November 2007).

Devereux, S., 2000. Food Insecurity in Ethiopia. A Discussion Paper for DFID, IDS Sussex.

EEA (Ethiopian Economic Association), 2005. Report on The Ethiopian Economy, Volume IV 2004/05. Ethiopian Economic Association, Addis Ababa, Ethiopia.

EEA (Ethiopian Economic Association), 2006. Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on Participatory Demonstration and training Extension System (PADETS). Ethiopian Economic Association/ Ethiopian Economic Policy Research Institute, Addis Ababa, Ethiopia.

EU (European Union), 2002. Country Strategy Paper and Indicative Programme for the period 2002 – 2007. Available at - http://unpan1.un.org/intradoc/groups/public/documents/cafrad/unpan002976.pdf (Last accessed in November 2007).

FAO, 2004. Livestock Sector Brief, Ethiopia. FAO, Rome, Italy.

FAOSTAT, 2007. Food Security Statistics. FAO, Statistics Division. Available at - http://www.fao.org/faostat/foodsecurity/index_en.htm (Last accessed in November 2007).

IBC (Institute of Biodiversity Conservation), 2004. State of Ethiopia's Animal Genetic Resources - Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC. May 2004. Addis Ababa, Ethiopia.

Kassa, H., 2003. Livestock and Livelihood Security in the Harar Highlands of Ethiopia: Implications for Research and Development. Swedish University of Agricultural Sciences, Uppsala. PhD Thesis.

Knips, V., 2004. Review of the Livestock Sector in the Horn of Africa (IGAD Countries). FAO. Rome, Italy.

Larsen, C.E.S., 2002. Adoption of Crossbred Cows Used for Dairy-Draught Technology in Ethiopia. KVL, Copenhagen, Denmark. PhD Thesis.

MoA (Ministry of Agriculture), 2000. Agro-Ecological Zones of Ethiopia. Natural Resources Management and Regulatory Department, Ministry of Agriculture. Addis Ababa, Ethiopia.

RRC (Relief and Rehabilitation Commission), 1985. The Challenges of Drought: Ethiopia's Decade of Struggle in Relief and Rehabilitation. Addis Ababa, Ethiopia.

Sandford, S., and H. Yohannes, 2000. Emergency Response Interventions in Pastoral Areas of Ethiopia: Report of the Pastoral Appraisal Team. DFID, London.

Tesfahun, G., B. Emana, and N. Abdoulaye, 2006. Managing Moisture Stress Risk to Cope with Food Insecurity: The Case of Kalu District in North Eastern Ethiopia. *Ethiopian Journal of Agricultural Economics*, 6 (1): 17 -34.

UNDP, 2000. Human Development Report 2000. New York, USA.

_____, 2001. Human Development Report 2001. New York, USA.

_____, 2002. Human Development Report 2002. New York, USA.

_____, 2003. Human Development Report 2003. New York, USA.

_____, 2004. Human Development Report 2004. New York, USA.

_____, 2005. Human Development Report 2005. New York, USA.

_____, 2006. Human Development Report 2006. New York, USA.

_____, 2007. Human Development Report 2007. New York, USA.

World Bank, 2007. Ethiopia: Accelerating Equitable Growth Country Economic Memorandum, Part I: Overview. Available at - http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/04/25/000020953_20070425090039/Rendered/PDF/386620ET.pdf (Last accessed in November, 2007).

Zarabruk, M., O. Vangen, and M. Haile., 2007. The Status of Cattle Genetic Resources in North Ethiopia: On-farm Characterisation of Six Major Cattle Breeds. *Animal Genetic Resources Information*, No. 40: 15-32.

Zerbini, E., and A. Gebrewold. Effect of Work Applied at Different Stages of Lactation on Milk Production, Reproduction and Live-weight Change of F1 Crossbred Dairy Cows Used for Draught. *Animal Science,* 69:(3): 473 – 480.

Chapter 3

Economic Valuation of Phenotypic Traits: An Impetus for Market Orientation of Livestock Production Systems?

Girma T. Kassie, Clemens B. A. Wollny, Awudu Abdulai, Adam G. Drucker, and Workneh Ayalew

Presented on the 14th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, 5 -7 September 2006.

Abstract

This paper aims at presenting the importance of economic valuation for the market orientation of livestock production systems in Ethiopia. Reorientation of livestock production systems towards consumer preferences and demands through timely and comprehensive transformation is currently the main agenda among the stakeholders of livestock development. Market orientation of livestock production system requires proper valuation of both traded and non-traded products and services generated from the system. Intermediate results based on a sample of 275 households in Dano district of Central Ethiopia revealed that farm households have consistent preferences for the different phenotypic traits of the animals they keep in the farms and buy from the market. Economic valuation of these preferred traits of the indigenous cattle population is one of the inputs to increase the dynamism and efficiency of the livestock production system given the need for market orientation. The valuation would also help in fine tuning livestock improvement interventions to enhance the intensification and commercialization of the traditional livestock keeping systems predominant in agrarian Ethiopia.

3.1. Introduction

Livestock resources contribute on average 35% and up to 80% of agricultural GDP in some Sub-Saharan African (SSA) countries (ILRI, 2003). The livestock wealth of communities in Africa is not merely a source of food, or a means of income, or a marginal enterprise. Rather, it is much more important asset buffering livelihood shocks due to failures in inert resources and enterprises, absorbing production risks that happen in more risky farm enterprises, building assets for vulnerable communities, and saving lives under desperate social scenarios. This way, it significantly contributes towards achieving food security at household level.

Ethiopia is said to have larger livestock resource than any country in Africa. An estimated 42 million cattle, 15 million sheep, 14 million goats, and 7 million pack animals, among others, exist in private holdings (CSA, 2004). The national animal genetic resource (AnGR) status report by the Institute of Biodiversity Conservation (IBC) shows that there are 25 cattle, 13 sheep, 15 goat, 4 camel, 4 donkey, 2 horse, 2 mule and 5 chicken indigenous breeds identified so far in Ethiopia. There are also 3 dairy cattle, 7 sheep, 7 chicken and 2 goat exotic breeds used for food and agriculture (IBC, 2004).

Although Ethiopia has presumably the largest livestock population in Africa, performance in the production of major food commodities of livestock origin has been quite low (Befekadu

and Berhanu, 2000). Even at its current undeveloped state, the sector contributes 30-33% of the national agricultural Gross Domestic Product (GDP) and 15-16% of the national foreign currency earnings (Ayele Solomon et al., 2003; Sileshi Ashine, 2003).

The livestock production system of the country at large is predominantly subsistence oriented whereby the livestock products and services are primarily produced for household/on farm consumption. The system is also a low input production process with most of the required inputs supplied by the family. The feeding system is virtually entirely dependent on natural pasture and free grazing. Very few areas in the country practice cut and carry fodder feeding regime or rotating paddock system. Such a system can hardly meet the growing demand for livestock products and services due to the ever increasing human population.

Reorientation of livestock production systems towards consumer preferences and demands through timely and comprehensive transformation is currently the main agenda among the stakeholders of livestock improvement. Market orientation of livestock production system requires proper valuation of both traded and non-traded products and services generated from the system. This is why eliciting farmers' preferences of the phenotypic characteristics of livestock and estimating the economic values of these characteristics become crucially important. Proper identification and valuation of the different characteristics would make resource allocation decisions among the different livestock improvement interventions for commercialization of the system quite fast and easy. This paper aims at showing how eliciting and valuation of the preferred phenotypic traits would facilitate transformation of livestock production. The next section briefly describes what economic valuation of the phenotypic traits means. Section three provides an explanation of the market orientation concept as related to livestock production. Section four shows how economic valuation and commercialization of livestock production are related. Section five presents an example from a case study in Dano district of Central Ethiopia. The final section presents concluding remarks.

3.2. What is Economic Valuation of Phenotypic Traits?

The fitness of local breeds of livestock for the diverse needs and objectives of subsistence and semi-subsistence livelihoods emanates from the various traits they have as a result of immense genotypic and environmental processes. Sustainable development of the livestock sector and concomitantly the improvement in such livelihoods, therefore, depends very much on properly identifying, understanding, valuing, prioritizing, and maintaining the important traits of the livestock.

Any strong argument in favor of conservation of animal genetic resources in general and domestic farm animal genetic resources in particular, needs to be substantiated with strong economic logic clearly implying why a society has to conserve given the unfavorable market trend. Roosen et al. (2005) argue that the value of livestock breeds is not captured completely in the market because of the (quasi) public good character of genetic resources. For this reason, methods for valuing livestock biodiversity have to go beyond the market place. With specific reference to developing countries, the difference between the market value of a particular livestock genetic resource and its total economic value to humans is particularly large (Roosen et al., 2005).

Some research activities have been carried out in the area of economic valuation of traits of animal genetic resources preferred by producers, who are the primary beneficiaries of improvements in AnGR (Drucker, 2004a, 2004b; Wollny, 2003). Earlier undertakings are in developed countries of North America and Europe. Ladd and Gibson (1978) conducted a research to estimate the worth of a trait of an animal using the production function approach in the United States. Kulak et al. (2003) also used production function approach to estimate values of sheep traits, taking only two of them, to compare values calculated with and without consideration of risk due to price changes. Sy et al. (1997) did a research in Canada aimed at economic valuation of the traits of cattle preferred by three groups of producers using consumer demand approach.

Scarpa et al. (2003a) quantified the economic values of the traits of a creole – local – pig in Yacutan Mexico. Similarly, Scarpa et al. (2003b) have estimated the values for the traits of indigenous cattle in Kenya while comparing methods which depend on stated and revealed preferences of consumers. Both studies used the consumer demand approach instead of the production function approach. Tano et al. (2003) estimated the economic values of traits of indigenous breeds of cattle focusing on trypanotolerance.

As a new area of economic investigation, there are still some differences among researchers in methods of trait data collection, preference elicitation, and data analysis. Revealed preference approach of data generation was used by few researchers (e.g., Richard and Jeffrey, 1996; Jabbar and Diedhiou, 2003) while others used stated preference approaches (e.g., Sy et al., 1997; Scarpa et al., 2003a, 2003b; Tano et al., 2003).

Contingent valuation and conjoint analysis are the two main stated preference methods used to elicit preferences of respondents for cattle traits (e.g. Sy et al., 1997; Tano et al, 2003) But, very recently researches advocating choice modeling (e.g., Scarpa et al., 2003a) are coming up. The other convergence of research in this thematic area is the data analysis part.

Discrete choice models are being employed universally in economic valuation studies as they convincingly relate the stated value of the good to the perceived utility of the characteristics of the good. In the case of revealed preference studies the empirical estimation is solely hedonic price function (Roosen et al., 2005).

3.3. Market Orientation

Market orientation is a wide concept which can be defined in different ways depending on the biophysical and socioeconomic patterns of the production system. Different writers have used different terminologies to denote the structural transformation of the production system – in this case the livestock production system – towards the consumer preferences and profit maximization. For example, Pingali and Rosegrant (1995) and Quiroz and Valdés (1995) used the concept of agricultural commercialization, Delgado (1995) and Barghouti et al. (2004) used agricultural diversification whereas Timmer (1988) and Nindi (1993) employed the concept of transformation in agricultural production context. The essential elements in all of the theories are consumer preferences, profit maximization and dynamism. This paper employs the definition given by Pingali (1997) that market orientation is the production of goods and services with the required quantity and quality level as determined by the demand in the market. Market orientation also implies dynamic, developed, demand driven, high quality, profit maximizing, high input, and diversified production system.

3.4. Economic Valuation and Market Orientation

Economic valuation of phenotypic traits starts from elicitation of the preferences of consumers of the livestock raised or bought from the market. This preference underlies the willingness to pay for the traits. The economic value to be attached for each of the traits therefore estimates the price the consumer/farmers would be willing to pay for the specific trait of the animal. Market orientation, as indicated above, is principally about reorienting the production system to generate products and services demanded by the consumers. The demand of the consumers is embedded in the preference of phenotypic characteristics and the most demanded would have higher economic values. Therefore, the livestock production system would focus on the preferred characteristics of the animals in order to secure sustainable market share and commercialize the whole system.

In addition to the change in the collegial relationships which the professional community used to work with (Zohrabian et al., 2003), the ratification of the Convention on Biological Diversity (CBD, 1992) has brought about the issue of attaching economic values of

species/breed/trait preferences both for crops and animals for sustainable management of genetic resources. Attaching economic values for preferred breeds or traits of animals in a breed is not straightforward. For easily marketable goods and services, markets usually provide important information about intrinsic values (Roosen et al., 2005) through the fact that market prices reflect the relative scarcity of traded goods and preferences for these goods. However, for (quasi) public goods markets are not available to provide such information. While farm animals can be considered as private goods, animal genetic resources embedded in these animals can be considered as quasi-public goods (Scarpa et al., 2003b). Markets generally fail to capture all classes of economic value, especially when a resource has public good properties (non-rival, non-excludable, or non-transparent), as do genetic resources (Drucker, 2004a).

The development of the economic values, therefore, makes resource allocation and marketing decisions more rational and welfare maximizing. There would also be a shift in enterprise choice as conventional wisdom or belief might also be changed as found out by Ayalew et al. (2003) that conventional productivity evaluation criteria were inadequate and biased towards crossbred animals with readily marketable products and services while the total welfare gain from indigenous breeds was not less at all. This would increase the efficiency with which resources are used and outputs are mixed so that producers would maximize their profits. This integrity of the production and marketing decisions would result in comprehensive transformation of the production system with due consideration of the intrinsic values of the different components of the system. This is essentially an input from the whole process of economic valuation for sustained market orientation of the (Semi-) subsistence livestock production system.

3.5. An Example from Central Ethiopia

A comprehensive study is being conducted in Dano district of West Shewa zone in central Ethiopia with the general objective of estimating the economic values of the preferred phenotypic traits of the indigenous cattle population in the district. The research focuses on the elicitation of the preferences of phenotypic traits, estimating the economic value of each of the traits, and comparing these stated preferences with the revealed ones as observed in the actual transactions in cattle markets. The research was justified for the basic reason that prices of animals are determined mainly based on phenotypic and qualitative traits than quantitative traits such as live weight or carcass weight as commonly practiced in developed markets.

Intermediate results based on a sample of 275 households revealed that households have consistent preferences for the different phenotypic traits of the animals they buy from the market. The preferences are strongly influenced by the purpose of buying and/or selling and by the occupation of the buyer (butcher, farmer, or live animal trader). The report by Kassie (2005) shows that livestock keepers in Dano district and livestock buyers in the markets, wherein cattle from the district are traded, look for specific traits to determine the price of the cattle they want to buy or sell. At the farm-level, important traits of male cattle include origin, age, plowing strength, body size, and calf vigor.

In the markets, farmer-buyers focus more on plowing strength, age, origin, calf vigor, and body size, in order, to set the price of the male cattle they want to buy. For female cattle, farmers give priority to fertility (in terms of the number of calves and calving interval), age, calf vigor, origin, milk yield, and body size, in order, when asked in their villages. In the markets, farmer buyers look at origin, milk yield, age, fertility, calf vigor, and body size. These trait preferences are the main elements in determining the willingness to pay of the livestock keepers in Dano district and the relevant markets.

This explicit elicitation of the trait preferences of livestock keepers and traders shall help in refining cattle type selection for both production and reproductive purposes. Elicited preferences are apparently the revealed demands expressed through the attributes (phenotypic characteristics) of the good (in this case, cattle). This is a real world example of the Lancasterian utility theory which states that goods are not the direct objects of utility; rather it is the characteristics of the goods from which utility is derived (Lancaster, 1966).

Estimating the economic values for these preferred traits would also add value to the decision making process in selecting cattle types with specific and useful characteristics. If research and development efforts make use of the result, then livestock production will be reoriented towards satisfying the needs and wants of the consumers and concomitantly towards maximizing profit. The research results are expected to develop a local level capacity and a middle and upper level awareness in this regard to transform the low production and subsistence production to highly productive and market oriented one.

3.6. Conclusions

Market orientation of the livestock production system is not an alternative any more, rather an obligatory option that has to be designed and started sooner than later. This orientation requires a number of activities and changes both with in and out of the production system. External factors are crucially important and yet reorientation starts from structural

transformation of the system itself in order to make it responsive to the market demands and efficient in allocating resources and choosing enterprises. Economic valuation of the preferred traits of the indigenous cattle population is one of the inputs to increase the dynamism and efficiency of the livestock production system. Consumer preferences would be identified, knowledge about the preferred characteristics of the animals would be generated, and estimation of the marginal economic gains from improvement of a trait will be possible as a result of economic valuation. This should be an indispensable component of the overall research and development effort in the livestock production arena.

Currently comprehensive research activities are being carried out by International Livestock Research Institute (ILRI) and collaborating institutions in Africa – specifically in Benin, Ethiopia and Kenya – so as to make use of economic valuation (and generated values) for improving the livelihoods of poor livestock keepers in the continent. We strongly believe that concerted effort from all concerned stakeholders can bring about the well needed reorientation of livestock production and, particularly, economic valuation would strongly reinforce the argument for rational resource allocation in the development, utilization and conservation of the valuable animal genetic resources that countries like Ethiopia are endowed with.

Acknowledgement

We would like to thank ILRI-BMZ project for funding this research. The valuable comments of Habtemariam Kassa, Tadele Dessie, Ashenafi Mengistu and Ekin Keskin on the earlier version of the paper are highly appreciated. We also thank the research staff of Bako agricultural research centre and above all the farmers in Dano district.

3.7. References

Ayalew, Workneh, J. M. King, E. Bruns, and B. Rischkowsky, 2003. Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program. *Ecological Economics* 45(3): 473 - 485.

Ayele Solomon, Assegid Workalemahu, Jabbar M. A., Ahmed M. M. and Belachew Hurissa, 2003. Livestock Marketing in Ethiopia: A Review of Structure, Performance and Development Initiatives. Socioeconomics and Policy Research Working Paper 52. ILRI (International Livestock Research Institute), Nairobi, Kenya. 35 pp.

Barghouti S., S. Kane, K. Sorby, and M. Ali, 2004. Agricultural Diversification for the Poor: Guidelines for practitioners. Agriculture and Rural Development Discussion Paper 1. The World Bank, Washington D.C.

Befekadu Degefe and Berhanu Nega, 2000. Annual Report on the Ethiopian Economy: Volume I, 1999/2000. The Ethiopian Economic Association, Addis Ababa, Ethiopia. 429 pp.

CSA (Central Statistics Authority), 2004. The 2001/02 Ethiopian Agricultural Sample Enumeration (ESAE), Executive Summary. May, 2004, Addis Ababa, Ethiopia.

Delgado, C.L., 1995. Agricultural Diversification and Export Promotion in Sub-Saharan Africa. *Food Policy,* 20, 225-243.

Drucker, A.G., 2004a. The Economics of Farm Animal Genetic Resource Conservation and Sustainable Use: Why is it Important and What have we Learned? Background Study Paper Number 21. Commission on genetic resources for food and agriculture. FAO, Rome, Italy.

Drucker, A. G., 2004b. Economics of AnGR Conservation and Sustainable Use: Theory, Practice and Implications. *In*: ESAP (Ethiopian Society of Animal Production) 2004. Farm Animal Biodiversity in Ethiopia: Status and Prospects. Asfaw Yimegnuhal and Tamrat Degefa (eds.). Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 28 –30, 2003. ESAP, Addis Ababa.

IBC (Institute of Biodiversity Conservation), 2004. The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC. May 2004. Addis Ababa, Ethiopia.

ILRI (International Livestock Research Institute), 2003. Improving the Livelihoods of Poor Livestock-keepers in Africa through Community-Based Management of Indigenous Farm Animal Genetic Resources. Project Proposal Submitted to German Federal Ministry for Economic Cooperation and Development (BMZ). ILRI. Addis Ababa, Ethiopia.

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

Kassie, Girma T., 2005. Economic Valuation of the Preferred Traits of Indigenous Horro Cattle in Ethiopia: trait preferences and cattle marketing. Report of a qualitative survey. (Unpublished research report).

Kulak, K., J. Wilton, G. Fox and J. Dekkers, 2003. Comparisons of Economic Values with and without Risk for livestock trait improvement. *Livestock Production Science*, 79: 183 – 191.

Ladd, G.W. and C. Gibson, 1978. Microeconomics of Technical Change: What's a Better Animal Worth? *American Journal of Agricultural Economics*, 60: 236-240.

Lancaster, K., 1966. A New Approach to Consumer Theory. *Journal of Political Economy*, 74: 132-57.

Nindi, B., 1993. Agricultural Transformation in Sub-Saharan Africa: The Search for Viable Options. *Nordic Journal of African Studies*, 2(2): 142–158.

Pingali, P.L., and M.W. Rosegrant, 1995. Agricultural Commercialization and Diversification: Processes and Policies. *Food Policy* 20 (3): 171–85.

Pingali, P.L., 1997. From Subsistence to Commercial Production Systems: The Transformation of Asian Agriculture. *American Journal of Agricultural Economics* 79 (May): 628–34.

Quiroz, J.A. and A. Valdes, 1995, Agricultural Diversification and Policy Reform,. *Food Policy* 20, 245-255.

Richards, T.J. and S.R. Jeffrey, 1996. Establishing Indices of Genetic Merit Using Hedonic Pricing: An Application to Dairy Bulls in Alberta. *Canadian Journal of Agricultural Economics*, 44: 251-264.

Roosen, J., A. Fadlaoui and M. Bertaglia, 2005. Economic Evaluation for Conservation of Farm Animal Genetic Resources. *J. Anim. Breed. Genet.*, 122 (2005), 217 – 228.

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

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

Sileshi Ashinie, 2003. Managing Water for Livestock and Fisheries Development. In: Integrated Water and Land Management Research and Capacity Building Priorities for Ethiopia. Proceedings of a MoWR/EARO/IWMI/ILRI, International workshop, ILRI, Addis Abeba, Ethiopia, 2-4 Dec. 2002.

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

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

Timmer, C.P., 1988. The Agricultural Transformation. In *Handbook of Development Economics,* edited by H.B. Chenery and T.N. Shrinivasan. Amsterdam: North Holland.

Wollny, C. B. A., 2003. The Need to Conserve Farm Animal Genetic Resources in Africa: Should Policy Makers be Concerned? *Ecological Economics*, 45: 341-351.

Zohrabian, A., G. Traxler, S. Caudil, and M. Smale, 2003. Valuing Pre-Commercial Genetic Resources: A Maximum Entropy Approach. *American Journal of Agricultural Economics*, 85: 429 – 436.

Chapter 4

Cattle Trait Preferences in the Semi-subsistence Livestock Production Systems of Central Ethiopia

Girma T. Kassie, Awudu Abdulai, Clemens B. A. Wollny, Adam Drucker, and Workneh Ayalew

Revised and extended version of

1. Paper published in Proceedings of ESAP (Ethiopian Society of Animal Production), under the title "Institutional arrangements and challenges in market-oriented livestock agriculture in Ethiopia". Proc. 14th annual conference of ESAP, 5-7 Sept. 2006, Addis Ababa, Ethiopia. Part I: Plenary Session. Pp.53-63.
2. Poster presented at the Deutscher Tropentag 2006 - Prosperity and Poverty in a Globalised World: Challenges for Agricultural Research. 11 - 13, October 2006, Bonn, Germany.

Abstract

Production and marketing decisions in the semi-subsistence cattle keeping systems of Ethiopia are principally influenced by farmers' preferences of cattle phenotypic traits. Eliciting the preferences and quantifying the economic worth of these characteristics would reinforce efforts in the production, marketing, and sustainable use and hence conservation of animal genetic resources (AnGR). This study focused on characterizing the livestock production and marketing systems and on understanding which cattle traits farmers and farmer-buyers prefer. The research was conducted in and around Dano district of Central Ethiopia both in the rural villages and in the cattle markets. Farmers, as cattle keepers, identified age, origin, and plowing strength for bulls, and age, fertility, origin of the animal, and calf vigor for cows, as the most important traits. As cattle buyers, farmers selected age, plowing strength, origin of the animal, and calf vigor for bulls and age, origin, milk yield and calf vigor for cows as the crucial traits in their buying decisions. The various functions of respective animals underlie these distinct trait preferences. Such consistency in trait preferences imply that decisions for genetic improvement and conservation of indigenous cattle in these production systems should be based on comprehensive understanding of the relative importance of these traits.

Keywords: Cattle buyers, Cattle keepers, Trait preferences, Dano, Ethiopia.

4.1. Introduction

While market oriented cattle production systems base market decisions on measured performance and appearance of animals, visual appraisal of the form, size, appearance and in some cases relative performance of animals are used as basis to make animal type choices and marketing decisions in less market oriented farming systems. To the extent that phenotypic characteristics are determined by the genotype of animals, animal choices based on phenotype also influence the resultant genotype of animals chosen for breeding, rearing or direct utilization (sales, slaughter). Therefore eliciting trait preferences also serves to evaluate the choices of implied genotypes. Assessment of the (relative) economic worth of preferred traits can therefore be effectively used to evaluate the relative economic value of associated genotypes. These relationships provide a useful framework to objectively evaluate the relative economic merit and utility of animal genetic resources (AnGR) in subsistence and low input/low output livestock production systems.

Design for the sustainable utilization of indigenous AnGR, particularly in developing markets such as Ethiopia, should base on a thorough understanding of owners' reasons for keeping their livestock. However, little documented empirical evidence is available in Ethiopia on the comparative use values of indigenous cattle genetic resources (ESAP, 2004). On the other hand, the genetic resource base of the country is believed to be declining. Different reasons, including uncontrolled crossbreeding with exotic breeds, droughts and consequences of drought associated improvised restocking schemes, interbreeding among the indigenous populations, and political instability and associated civil unrest, were indicated to be responsible for the decline (ESAP, 2004).

Poorly managed artificial insemination (AI) using semen of exotic cattle breeds has also been implemented over the last four decades with the aim of 'improving' the indigenous cattle breeds. While AI has, in most cases, been and is still being executed on indigenous breeds that have not been evaluated and/or not characterized, necessary efforts to conserve the gene pool of the indigenous breeds are non-existent. Preferred largely for its virtue of simplicity, indiscriminate crossbreeding through AI is resulting in unforeseen levels of dilution of the indigenous gene pool (ESAP, 2004; IBC, 2004). Also important is the fact that Ethiopia is yet to implement a livestock breeding policy. Therefore, the level of threat to animal genetic diversity in Ethiopia cannot be easily projected. Virtually no studies have been conducted to look into the trait preferences in the production and marketing of indigenous AnGR in the country. Without due recognition of local knowledge on preferences and management of AnGR, it is practically difficult to develop and implement participatory conservation and utilization strategies at national and local levels (Wollny, 2003).

The contemporary school of thought advocates the presentation of solid argument to justify investment on indigenous genetic resources while they are hardly rewarding in the specialized formal markets (Mendelsohn, 2003). As a contribution, efforts are being made to include the economic worth of the different productive and non-productive traits in selection for breeding (Kosgey *et al*., 2004). The development of economic weights for the preferred traits (both productive and non-productive) of animals starts from identifying the preferences of livestock keepers and consumers. This paper briefly describes the basic features of the livestock production system and elicits the cattle trait preferences of farmers in Central Ethiopia. The study specifically aims at understanding what farmers and farmer-buyers' preferences are regarding the characteristics of the cattle they want to buy, keep or sell.

4.2. Materials and Methods

4.2.1. The study area

Dano is located some 250 km west of Addis Ababa in Oromia regional administration in central Ethiopia. It has an area of about 659 square km and human population of 83 thousand in 2005. Traditional classification of the agro-ecologies indicates that 5% of the district is highland (>2200 m.a.s.l.), 80% midland (1500 - 2200 m.a.s.l.), and 15% lowland (<1500 m.a.s.l.). The district receives on average 900-1400 mm annual rainfall and has 15-30^{o}C average daily temperature. There are about 75 thousand cattle, 4.5 thousand goats, 2.9 thousand sheep and 3.5 thousand equines (Archives of the district office of agriculture and rural development). Livestock are crucially important for the farming community in the district.

4.2.2. Sampling and Data Management

Dano district was purposefully selected as a study site in 2004 for an International Livestock Research Institute (ILRI) project on improving the livelihoods of poor livestock keepers in Africa through a community based management of indigenous animal genetic resources. The district was selected for its remoteness and indigenous cattle population. Such criteria were used essentially to elicit the absolute preferences of livestock keepers for attributes of the indigenous cattle they raise. A total of 75 informal and 199 formal interviews were conducted in the study area. Three rounds of field visits were made and data were collected using different participatory and conventional approaches and techniques. Transect walk, simple observation, key informant discussions, semi-structured interviews, and pair-wise comparisons were employed in the informal survey. The sample households for the formal survey were randomly selected from 10 of the 23 Peasant Associations (PAs) within Dano district. Twenty household heads were interviewed using a structured questionnaire in each of the 10 PAs and one observation was found to be erroneous and dropped. A set of descriptive statistical techniques are employed to analyze the quantitative variables.

Distributions of the total livestock unit (TLU) owned by a household and the per capita farm land holding were analyzed using Lorenz curve and Gini-coefficient. The Lorenz curve shows the cumulative distribution of a probability function of a non-negative and non-aggregated variable over a population. Following Gastwirth (1971), let **X** denote TLU owned by a sample household and F(x) be its cumulative distribution function. F(x) represents the proportion of the population owning TLU less than or equal to x. The Lorenz curve for the

random variable TLU (**X**) with cumulative distribution function F(x) and finite mean $\mu = \int xdF(x)$ is defined as,

$$L(P) = \mu^{-1} \int_0^p F^{-1}(t)dt, \quad 0 \le p \le 1 \tag{1}$$

where L(P) is the fraction of total TLU that the holders of the lowest P^{th} fraction of livestock units possess. $F^{-1}(t)$ is the inverse of F(x).

The Gini-coefficient (G) is another measure of inequality calculated based on the Lorenz curve. It is equal to the ratio of the area between the equidistribution line and the Lorenz curve to the area below the equidistribution line. If the Lorenz curve function is given as L(x), then G can be computed as

$$G = 1 - 2\int_0^1 L(x)dx \tag{2}$$

The Gini-coefficient ranges between zero and one, where zero implies perfect equality and one implying perfect inequality.

Spearman's non-parametric rank correlation coefficient was also used to analyze the comparability of the preference rankings of traits by the different respondents. Spearman's correlation coefficient is computed as:

$$r = 1 - \frac{6\sum d^2}{n(n^2 - 1)} \tag{3}$$

where d denotes the difference between ranks of corresponding pairs of the two farmers, and n represents the number of observations.

4.3. Results and Discussion

4.3.1. The Sample population

The sample for the formal survey had only five female household heads that were single, widowed or divorced. Almost all of the respondents (95.5%)[1] are farmers while the rest are farmer-traders. The literacy level shows about 50% of the sample households have attended

[1] In this chapter, percentage figures are frequencies of responses in the formal survey unless indicated otherwise.

elementary and secondary schools, whereas 36% were illiterate. The rest of the sample do read and write. Average family size was computed to be 7.3 persons per household with standard deviation of 2.74 persons and range of 2 to 19 persons. The ranges for the number of male and female family members are 1 to 8 and 1 to 11, respectively, with marginally higher average number of females in the family. The age pattern of the sample is typical of a developing country whereby 56.4% of the sample population is aged below 15 years, 23.5% aged between 16 to 30 years, 16.8% between 31 and 55 years and the remaining 3.3% aged above 55 years. This pattern shows, among others, the high fertility rate of the population with significant proportion of the infant generation depending on the active section of the community.

4.3.2. Livestock resource and importance

Livestock are highly valued assets in this rural part of Ethiopia. Given the fact that farmland shortage is a crucial constraint (72%), and that only 21% of the respondents are generating sufficient income for living, the role livestock play in sustaining the livelihoods in this district cannot be overemphasized. Different benefits were mentioned to be generated from livestock including consumables (93%), cash generation by selling livestock and their products (74%), consumption smoothing in the household (39%), convertibility to liquid asset (44.7%), serving as collateral (2%) and others (42.2%). About 77% of the respondents mentioned 2 to 6 of these benefits. On a separate discussion, livestock ownership was indicated to imply social prestige (85%).

Moreover, nearly 79.4% of the sample respondents reported that they rely on selling their livestock to generate cash income while 20.1% of the sample mentioned selling livestock products as well. The perceived trend of the income generated from livestock is quite encouraging as 69.3% of the respondents believed it is increasing. On the other hand, only 55.3% of the households perceive that livestock production and productivity has improved over the years. The most important challenge for higher productivity of livestock was indicated to be feed shortage (93%). Only 49.7% of the households have grazing land and only 28% of these owners responded to have sufficient grazing land. The community has in fact been using communal lands for grazing until very recently when the government distributed most of the communal lands for cropping purposes.

Solutions suggested by farmers for the feed shortage include storing feed, appropriate use of crop residue, use of natural vegetation around, buying feed and others, in order of importance. Currently, 93% of the respondents store feed while nearly 37% buy feed for their

animals. Only farmers who recently settled from the eastern part of the country in one of the PAs are using their crop-residues for feeding their cattle while the native community admits to have not been using the residues for feed. Feed shortage is a seasonal constraint which becomes severe in the period that stretches between June and September when crop fields are fully covered and hence free grazing restricted.

Despite the challenges such as feed shortage, 78% of the sample respondents believe that they have favorable natural environment for cattle production. This belief partially explains why 66.3% of the respondents plan to increase the size of their cattle herds even under the prevailing constraints. The current livestock ownership in terms of tropical livestock unit (TLU[2]) is on average 6.73 TLU per household (SD = 5.93), or the equivalent of about 7 cows. The ownership ranges from 0.2 to 49.55 units. Both the standard deviation and the range show high variation indicating potential inequality in livestock ownership. Gini-coefficient was computed and Lorenz curve was drawn (Figure 4.1) to look into how unequally the livestock are distributed across the households. The Lorenz curve shows that the bottom 25% of the households own less than 10% of the TLU owned by the sample population, whereas the top 25% of the sample households own more than 50% of the livestock wealth of the sample population. The Gini-coefficient is about 0.4 indicating a considerable inequality.

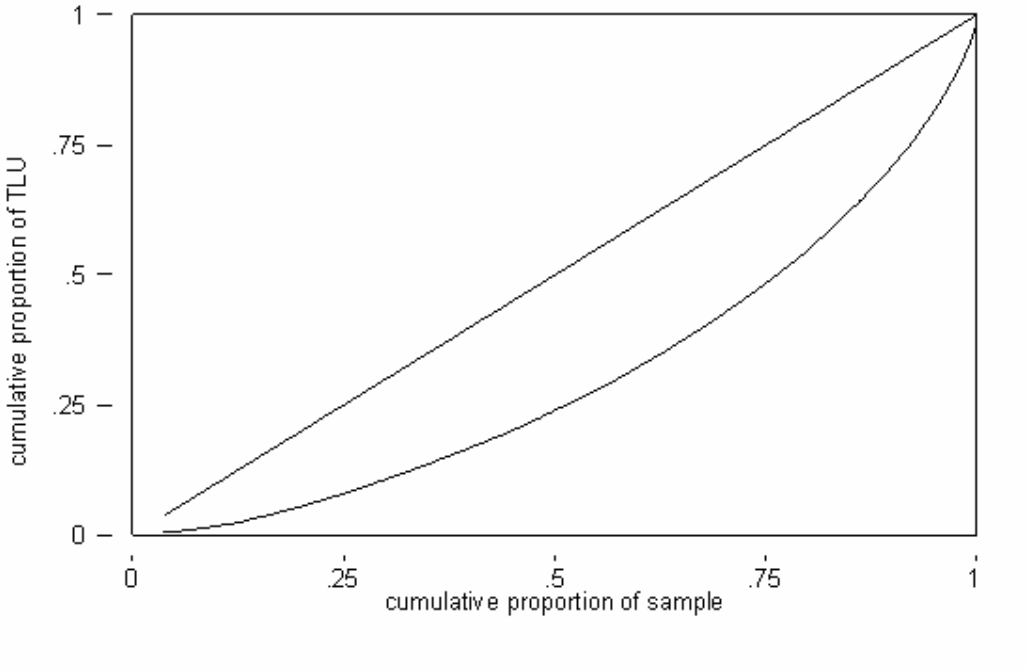


Figure 4.1: Lorenz curve for TLU owned per household

[2] The conversion factor used is Cattle = 0.7 TLU, Sheep/goat = 0.1, Horse = 0.8, Mule = 0.7, Donkey = 0.5, and Chicken = 0.01 (following Jahnke, 1982).

Dissection of the intra-household cattle ownership shows an interesting pattern in that only in 14.1% of the cases the cattle are owned by the whole family whereas in 46.2%, 25.2%, 2.5%, and 2% of the cases the cattle were reported to belong to the husband and wife, husband, wife, and to others, respectively. Decisions related production and marketing of cattle were reported to be made by the whole family (4%), only by husband and wife (52.3%), and only by the husband (41.7%). This ownership and decision making pattern within the household has a very important implication on who should be involved and how in the interventions that need to be made for the sustainable use and conservation of the animal genetic resources.

4.3.3. Cattle Population and Keepers' Interests

Scientists have been arguing that the concept breed has hardly any meaning in traditional livestock production systems (e.g., Rege, 2003). The survey results verify this in that farmers in Dano do not have any nomenclature related to the technical concept of breed[3]. Majority of the sample respondents (69%) think that the cattle population in their area is homogenous and one type, whereas 29% of the farmers think it is of different types. Among the latter group of farmers, the basic criterion to classify cattle was the place where the animals came from. Effort was made to see which location was preferred. Most of the farmers (73.4%) prefer cattle from within or around the district. This has a lot to do with acquiring an animal of known pedigree, and the major perceived function of the animal (what it is bought for). The general tendency within the community is to have preference for livestock/cattle from the vicinity when decision is to be made of acquiring animals of unknown origin. Asked about their willingness to receive improved (in the general sense of the term, means indigenous X exotic crossbred) cattle, nearly 73% of the farmers responded positively implying the readiness to try crossbred cattle. This interest has to be seen in accordance with the preferred traits valued most by the community than in terms of breed as such.

Sample farmers emphasized the importance of providing better and more feed (94.5%) to improve cattle production and productivity. Farmers have also mentioned as potential solutions better housing (41.2%), improved veterinary services (36.7%) and cross breeding (2.5%). Farmers also consider the technical information they acquire from different sources as

[3] Technically, breed is either a homogenous, sub-specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species, or it is a homogenous group for which geographical and/or cultural separation from phenotypically similar groups has led to acceptance of its separate identity (Turton, 1974).

very important. District Office of Agriculture and Rural Development (DOARD) was mentioned by 56% of the respondents while radio, conferences and other farmers were mentioned as sources by 2%, 2%, and 8% of the respondents, respectively. Most of the farmers (69.3%) mentioned that the support they are getting from DOARD is not sufficient. The topics of the required professional support are mainly related to livestock production and management including housing, fertility management, fattening, feed management, animal health, and market related issues.

4.3.4. Livestock Marketing

Markets and marketing are crucially important components of the rural livelihoods in Ethiopia. There are four primary markets in Dano district namely Sayo, Dano Roge, Menz, and Awadi Gulufa (or Harbi Gulufa). Farmers also visit quite often Ijaji market in the neighboring Cheliya district. Less frequently visited markets include Silk Amba, Shanan, Guder, and other markets in neighboring Keffa and East Wellega zones. Figure 4.2 shows the results of market place preferences elicited from sample farmers to buy and to sell their cattle. As expected, most of the farmers prefer markets within the district both for buying and for selling. Ijaji is the second important market for this community. The poor marketing infrastructure and lack of timely, precise and appropriate market information makes the transaction considerably high that most farmers prefer to do their transactions within or close to their district.

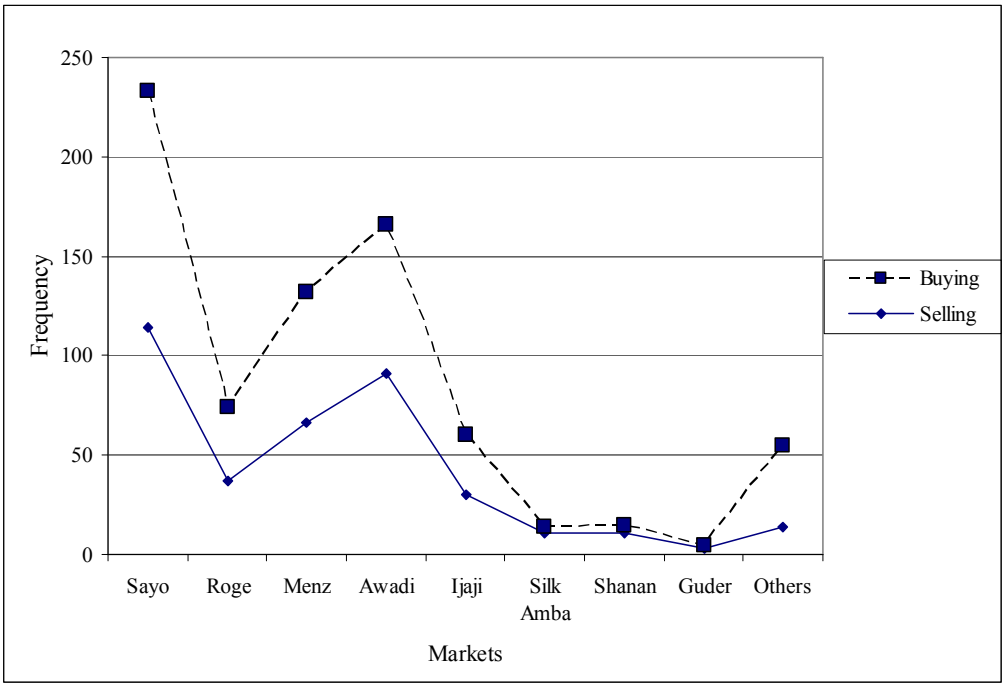


Figure 4.2: Market place preferences of farmers in Dano to sell and to buy cattle

Farmers conduct few visits in some of the markets, consult farmers who recently went to markets or talk to traders or brokers who are close to them to generate information to get some idea about the price of animals to buy or to sell. The inadequacy of the information generated this way and the high transaction costs usually tend to undermine the bargaining power of the farming community. Despite the fact that most of the farmers transact at the primary markets within the district, 27% and 25.1% of the sample farmers reported pressures when buying and when selling, respectively. In both cases, traders and brokers were mentioned to be the main (>80%) sources of pressure on farmers. This is because brokers and traders are relatively well informed and bear much less transaction costs as compared to the poor farmers.

4.3.5. Agricultural Resource Access and Ownership

The most important resource in rural Ethiopia, in general, and in crop-livestock mixed production systems, in particular, is land. A household can hardly make a living in the rural areas unless it has access to a plot of agricultural land. Land is not a tradable resource in Ethiopia, as it is owned by the state. Farmers have only usufruct right on the plot of land they own. They can not trade it or formally pass their legal ownership right to any other person in any form. This situation creates a sense of insecurity when it comes to land tenure. More immediate and probably more important is, however, the absolute size of the farmland farmers depend on for their livelihoods. The average land holding per household was found to be 2.54 hectare (SD =1.78 hectare) and ranges from none to 15 hectare. The per capita land holding was on average 0.36 hectare (SD = 0.25) and ranges between zero and two hectare. Farmland ownership is not only insecure but also very small. Gini-coefficient was computed and Lorenz curve was drawn for per capita land holding (Figure 4.3). The curve portrays that the bottom 25% of the sample population owns about 10% of the farmland while the top 25% section owns nearly half of the farmland owned by the sample population. The Gini-coefficient was computed to be 0.33. This implies a moderate inequality even if the absolute landholding per capita is quite small.

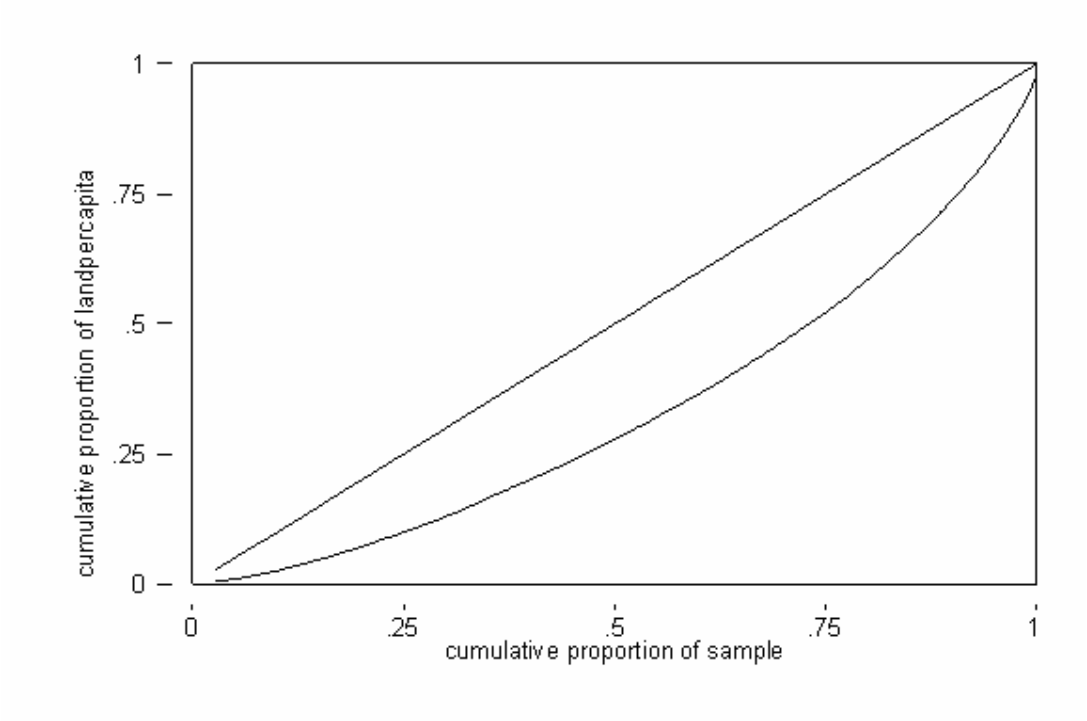


Figure 4.3: Lorenz curve for land owned per capita

Farmland shortage was indicated to be the most important constraint in these rural areas and the respondents conferred that the principal reason for the shortage is the population pressure (82%). Leasing in and leasing out farmland is one of the strategies farmers employ to deal with this constraint. About 48% of the farmers reported leasing in land whereas about 16% reported leasing out. Households which tend to lease out are mainly those with human labor and traction power shortage and those who lease in are those who have the labor power they need and sometimes with no land of their own.

Labor in rural areas of developing countries was traditionally considered to have opportunity cost of close to zero. The seasonality of labor availability is recognized only recently. In this survey, only 42.7% of the farmers reported that they have sufficient labor throughout the year. The causes for labor shortage were indicated to include seasonal activity congestion (70%), schooling of children (30.6%), and lack of children (17.1%). These facts, coupled with the fact the family is the source of the agricultural labor power, entail careful look into the implications of these perceived causes onto the challenges to literacy and family planning related interventions in the area.

The seasonal congestion of agricultural activities is indeed a very important determinant of the labor shortage calendar as depicted in Figure 4.4. The peak labor demand periods are the ones when land preparation (April – June), sowing, weeding and cultivation (June –

August), and harvesting and threshing (November – December) are done in the cropping season.

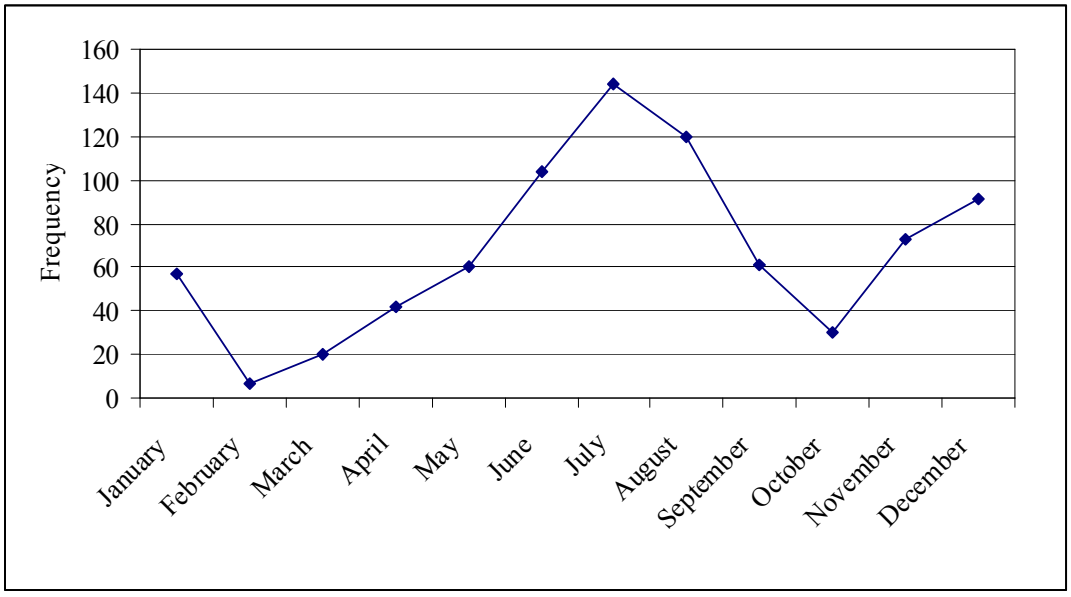


Figure 4.4: Labor shortage calendar in Dano district

3.3.6. Cattle Trait Preferences

Farmers' preferences for cattle attributes were elicited using a pair wise comparison technique both in the villages and in the markets. The traits were identified by farmers as attributes considered in cattle transactions. Seven traits were considered for bulls and eight traits were considered for cows. The traits considered for bulls were color, age, origin, body size, horn type, plowing strength, and calf vigor. For cows, color, age, origin, body size, horn type, fertility, milk yield, and calf vigor were the traits of interest. Tables 4.1 and 4.2 show the frequency with which the attribute (column head) received the rank indicated in the first column for cows and bulls, respectively. For example, in Table 4.1, fertility - in terms of short calving interval – was ranked 'first' six times by farmers in their villages (FA) and origin of the cow was ranked 'first' five times by buyers when interviewed in the markets (MA). Horn type was ranked 'last' eleven times by respondents both in the villages and in the markets.

Generally, fertility, age and calf vigor were ranked highest when farmers were asked in their villages about cow traits. Origin, age, milk yield and fertility were highest ranked traits of cows by buyers in the market. For farmers, age, origin and plowing strength were highest ranked attributes of bulls, whereas for buyers in markets the highest ranking traits were

plowing strength, age, origin and calf vigor (Tables 4.1 and 4.2). Body size was found to be a second rate trait for both farmers and buyers. Color and horn shape were uniformly ranked least by both groups for both cows and bulls.

Table 4.1: Count of rankings for cow traits in the villages (FA) and in the markets (MA)

Trait	Color		Age		Origin		Body Size		Horn type		Fertility		Milk yield		Calf vigor	
Rank	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA
1			4	2	2	5		1			6	2	1	3	3	1
2			3	5	3	1		2			1	1	1	1	1	3
3			2		2	1	2	1			2	3	1	1	2	2
4				2	1	1	2	4			1	3	7	1	5	
5			1	2	3		3	1			1	1		4		2
6		3	1			2	4	1				1	1	1		3
7	11	8				1		1								
8									11	11						

Table 4.2: Count of rankings for bull traits in the villages (FA) and in the markets (MA)

Trait	Color		Age		Origin		Body size		Horn type		Draft power		Calf vigor	
Rank	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA	FA	MA
1			5	4	6	2	1				3	5	1	2
2			3	2	1	3	1				3	1		3
3	2	1	1	4	1	2	2	5			4	4	3	2
4	1	1	2	1	1	1	3	2	1		1	1	2	
5	4	2			1	2	2	4					3	2
6	4	7				1	2		2				2	2
7					1				8	11				

The correlation matrices computed for the ranks given to each attribute by individual respondents show an expected pattern. The rankings of both cow and bull attributes made by most of the respondents are positively and significantly correlated both in the villages (Tables 4.3 and 4.5) and in the markets (Tables 4.4 and 4.6). The Spearman's non-parametric rank correlation coefficients generally show that co-variations of the rankings are strong and mainly occur along the upward slant. This implies that trait preferences are consistent and vary in the same direction.

Table 4.3: Correlation of farmers' rankings of cow traits in the villages

	Farm1	Farm2	Farm3	Farm4	Farm5	Farm6	Farm7	Farm8	Farm9	Farm10
Farm2	.629									
Farm3	.875*	.403								
Farm4	.878*	.331	.952*							
Farm5	.457	.808†	.346	.325						
Farm6	.531	.739†	.457	.446	.963*					
Farm7	.679	.926*	.383	.410	.707†	.616				
Farm8	.753†	.702	.531	.663	.689	.744†	.799†			
Farm9	.756†	.847*	.439	.524	.735†	.699	.952*	.916*		
Farm10	.659	.847*	.366	.452	.843*	.807†	.916*	.916*	.976*	
Farm11	.975*	.710†	.821†	.801†	.583	.621	.735†	.735†	.801†	.726†

†Correlation is significant at the 0.05 level, *Correlation is significant at the 0.01 level (2-tailed).

Table 4.4: Correlation of farmers' rankings of cow traits in the markets

	Farm1	Farm2	Farm3	Farm4	Farm5	Farm6	Farm7	Farm8	Farm9	Farm10
Farm2	.952*									
Farm3	.561	.575								
Farm4	.071	.073	.537							
Farm5	.190	.220	.512	.952*						
Farm6	.830†	.825†	.575	.244	.317					
Farm7	.91*	.765†	.605	.205	.265	.778†				
Farm8	.690	.659	.366	.381	.405	.903*	.663			
Farm9	.548	.561	.220	.524	.571	.488	.434	.714†		
Farm10	.929*	.952*	.512	.071	.262	.683	.771†	.500	.524	
Farm11	.317	.400	.775†	.830†	.878*	.525	.346	.439	.366	.366

†, * same as in Table 4.3.

Table 4.5: Correlation of farmers' rankings of bull traits in the villages

	Farm1	Farm2	Farm3	Farm4	Farm5	Farm6	Farm7	Farm8	Farm9	Farm10
Farm2	.556									
Farm3	.750	.546								
Farm4	.764†	.364	.600							
Farm5	.075	.038	.019	.556						
Farm6	.566	.377	.434	.630	-.077					
Farm7	.835†	.339	.615	.955*	.299	.748				
Farm8	.472	-.139	.315	.618	.604	-.151	.523			
Farm9	.655	.873†	.837†	.571	.111	.556	.541	.000		
Farm10	.417	.639	.278	.709	.755†	.340	.532	.306	.600	
Farm11	.849†	.585	.811†	.927*	.385	.692	.898*	.434	.815†	.679

†, * same as in Table 4.3.

Table 4.6: Correlation of farmers' rankings of bull traits in the markets

	Farm1	Farm2	Farm3	Farm4	Farm5	Farm6	Farm7	Farm8	Farm9	Farm10
Farm2	.500									
Farm3	.482	.519								
Farm4	.667	.667	.692							
Farm5	.927*	.519	.692	.692						
Farm6	.357	.929*	.371	.378	.371					
Farm7	.429	.750	.593	.252	.519	.857†				
Farm8	.655	.746	.887*	.881*	.811†	.527	.564			
Farm9	.306	.955*	.411	.600	.337	.919*	.649	.633		
Farm10	.909*	.636	.245	.615	.736	.546	.436	.509	.505	
Farm11	.929*	.607	.741	.757†	.964*	.429	.571	.855†	.396	.764†

†, * same as in Table 4.3.

Interesting is also the way farmers measure the different traits and set the levels of traits in order to decide on keeping or buying an animal. Mutual trust is the only verifying means of the information exchanged between sellers and buyers, which is the main source of information on most of the traits and characteristics considered. An effort was made to identify the means of measurement of the traits and the common levels of the traits according to the farmers themselves and the detail is given below in Table 4.7.

Table 4.7: Means of measurement of the preferred traits and their common levels

Traits	Means of measurement	Commonly used levels of trait expression
Age	Teeth and horn examination and discussion with the seller.	Bull: 4 years old and 1 year plowing experience Cow: 1-2 parturition
Origin	Discussion with the seller and sometimes examination of the fur coat of the cattle.	Dano, Wellega, Neighbor districts, Keffa.
Body size	Observation.	Small, medium, big
Calf vigor	Discussion with the seller and examination of the frame of the cattle.	Good, medium, bad
Draft power	Discussion with the seller and observation of the obedience of the bull.	Very good, good, bad
Fertility	Discussion with the seller and examination of the body frame.	Good (1 calf/year), bad (1 calf in or more than 2 years)
Milk yield	Discussion with the seller and observation of the naval flap and the teats.	1-3 liter/day (when lactating)

4.3.7. Implications of the preferences

The dual purpose of bull keeping is clearly seen here as farmers highly rank traits related to draft power and calf vigor. Bulls render the services of plowing and serving cows up until they are considered unfit for plowing, by which time they are turned for fattening and (re)selling. Farmers consider coat color and horn type as least important. Coat color is an interesting trait that white and black colors are excluded from the possibilities and farmers seem to be determined not to buy animals with these coat colors. This perhaps explains why not many white and black colored cattle were seen in the market. This implies that such colors are being deliberately excluded from breeding and trading. Such selective handling practices on these and other traits may need to be closely examined for their real and potential influence on current breed phenotypic characteristics. Horn type was also particularly reported by farmers as something related more to communal beliefs than to anything biological or economic.

4.4. Conclusion

Livestock through their multiple functions play a crucial role in the livelihoods of the growing human population in Dano district. The majority of the farming community believes that the contribution of the livestock sector for their livelihoods has increased over years. Most of the respondents also believe that the natural environment they own is favorable. Diagnosis of the

livestock production sector shows, however, a formidable set of constraints including feed shortage, resource limitation, lack of technical support, and limited market outlets with a bearing on the productivity and welfare effects of the sector.

A look into the resource ownership and livestock related decision making illustrates that the household heads (both husband and wife) are the main owners of livestock and make virtually all the decisions related to production and marketing. This will have an important implication in addressing interventions related to livestock as owners and decision makers might not be involved in conducting the actual tasks

Majority of the respondents consider the cattle population in their respective areas as homogenous and prefer cattle from within or nearby the district. This preference is also reflected in the markets where cattle from nearby areas are preferred to others. The detailed elicitation of the cattle trait preferences show that age, plowing strength, origin of the cattle, and calf vigor are the most important for bulls, whereas age, origin, milk yield, calf vigor and fertility are for cows. This result indicates that cattle keeping farmers have clear and consistent preferences for the attributes of the bulls and cows they keep or buy, and that the evaluation of such traits starts at early age of the animal, as in the case of calf vigor. Such empirical evidence on livestock trait preferences is useful to make better informed decisions in developing interventions to improve the contribution of cattle to livelihoods of their keepers. These interventions could be in the form of short-term management improvements or longer-term activities for genetic improvement. Therefore, the identification and evaluation of such trait preferences should be based on comprehensive understanding of the relative importance attached to each phenotypic trait.

Acknowledgement

The authors would like to thank the ILRI-MBZ project for funding this research. We are also very grateful for the comments and suggestions given by Tadelle Dessie, Solomon Gizaw, and Aynalem Haile. Above all, our heartfelt gratitude goes to the farmers of Dano district for their valuable time and shared knowledge.

4.5. References

ESAP (Ethiopian Society of Animal Production), 2004. Farm Animal Biodiversity in Ethiopia: Status and Prospects. Asfaw Yimegnuhal and Tamrat Degefa (eds.). Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 28 –30, 2003. ESAP, Addis

Ababa. Gastwirth, J. L., 1971. A General Definition of the Lorenz Curve. *Econometrica* 39 (6): 1037 – 1039.

IBC (Institute of Biodiversity Conservation), 2004. The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC. May 2004. Addis Ababa, Ethiopia.

Jahnke, H. E., 1982. Livestock Production Systems and Livestock Development in Tropical Africa. Kieler Wissenschaftsverlag Vaul, Kiel, Germany. 253 pp.

Kosgey, I.S., A.M. Johan, V. Arendonk, and R.L. Baker, 2004. Economic Values for Traits in Breeding Objectives for Sheep in the Tropics: Impact of Tangible and Intangible Benefits. *Livestock production Science* 88, 143-160.

Mendelsohn, R., 2003. The challenge of conserving indigenous domesticated animals. *Ecological Economics* 45: 501 – 510.

Rege, J.E.O., 2003. Defining Livestock Breeds in the Context of Community-Based Management of Farm Animal Genetic Resources. In: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 –11 May 2001. Pp. 27 -35.

Turton, J.D., 1974. The Collection, Storage and Dissemination of Information on Breeds of Livestock. Proceedings of the 1st World Congress on Genetics Applied to Livestock Production, II, 61-74.

Wollny, C. B. A., 2003. The Need to Conserve Farm Animal Genetic Resources in Africa: Should Policy Makers be Concerned? *Ecological Economics*, 45: 341-351.

Chapter 5

Valuing Traits of Indigenous Cows in Central Ethiopia

Girma T. Kassie, Awudu Abdulai, Clemens Wollny

Paper submitted to Journal of Agricultural Economics.

Abstract

This research aimed at identifying and estimating the relative weight assigned to the preferred traits of indigenous cow population in the most dominant crop-livestock mixed production system in Central Ethiopia. Choice experiment approach was employed to elicit the preferences and random parameters logit model was used to estimate the relative importance of the preferred attributes of indigenous cows. The results show that fertility, disease resistance and calf vigor traits are at least as important as milk. The location the cows are brought from is also an important attribute for buyers. Results from the simulation on the influence of changes in attribute levels showed that fertility and disease resistance affect preferences more than other traits. The findings suggest that the smallholder community in this part of Ethiopia depends on semi subsistence agriculture and so livestock development interventions should focus on a multitude of reproductive and adaptive traits that stabilize the herd structure rather than focusing on traits that are only important for commercial purposes.

Keywords: Choice experiment, cow traits, economic valuation, preference heterogeneity.

5.1. Introduction

The livelihood of rural communities in Africa is heavily dependent on livestock resources. Livestock contribute on average 35% and up to 80% of agricultural GDP in some Sub-Saharan African (SSA) countries (Benin *et al.*, 2003). Ethiopia reportedly owns the largest livestock wealth in Africa. The livestock sector contributes 30 - 40% of the country's national Agricultural Gross Domestic Product (AGDP) and 13 - 16% of the national foreign currency earnings (Benin *et al.*, 2003; EEA, 2006). However, the performance of the livestock sector has been reported to be very low (Befekadu and Berhanu, 2000). The low performance of the sector is attributed to policy, institutional, technical, marketing and socio-cultural constraints (EEA, 2006).

Strategic interventions to enhance the productivity of the livestock sector over the last four decades have focused on increasing milk production through provision of 'improved' in-calf crossbreeds, artificial insemination (AI), and exotic bull services (Desta, 2002). Thorough assessments made about the interventions revealed that in urban and peri-urban areas, the efforts have considerable success considering milk production. In the rural areas, however, these interventions not only fell short of their objectives but also resulted in unexpected effects such as unintended and unknown genotype calves (e.g., ESAP, 2004). There is still no any concrete and binding national breeding policy with regard to choice of exotic breed types

to be crossed with indigenous animals and the optimal exotic blood level of the crosses (Desta, 2002).

The growing demand for milk and milk products has often been used to justify the focus of breeding policy on dairy development. However, in a country where agriculture is predominantly semi-subsistence mixed crop-livestock production, cattle production and marketing decisions are principally influenced by keepers' preferences for a multitude of adaptive and productive traits of the animals. This is so essentially for two basic reasons. First, the livestock products and services are primarily produced for household/ on farm consumption, and secondly, livestock keepers are aware that fitness of their animals for the diverse needs and objectives emanates from the various traits that are the result of immense genotypic and environmental processes the animals passed through.

Sustainable management of animal genetic resource diversity entails proper identification, valuation, and maintenance of the different traits of the genetic resource to make it available for future use without compromising current consumption. The main challenge in this regard is that the economic implications of the erosion of the genetic diversity and consequently that of its conservation are not well understood. This is so essentially because the diversity of AnGR has a quasi-public[1] nature (Scarpa *et al.*, 2003a) and this makes the revealed preferences for genetic resources in ordinary markets less appropriate to value the diversity. Stated preference based analysis methods have instead become more common in the valuation of non-traded attributes of genetic resources.

The significance of stated choice based valuation of attributes has generated a considerable amount of interest and research in this area in recent times. After the pioneering work by Sy *et al.* (1997) in Canada, many authors have analysed economic values of cattle traits for some African countries. Tano *et al.* (2003) analysed 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 the traits of a creole – local – pig in Yacutan Mexico. Scarpa *et al.* (2003b), employing the same approach, estimated the values for the traits of indigenous cattle in Northern Kenya. Ouma *et al.* (2007) employed choice experiments and mixed logit and latent class models to analyze the relative values of traits and heterogeneities in trait preferences in the pastoral areas of Northern Kenya and

[1] The quasi-publicness emanates from the fact that although cattle are privately owned, the genetic diversity embedded in them can be accessed with no or low cost by others, especially in a system where mating of cattle is uncontrolled. Similarly, the payment made while buying an animal is not for the invaluable genetic diversity due to the animal and yet the buyer can benefit from this diversity.

Southern Ethiopia. Zander and Holm-Muller (2007) and Zander and Drucker (2008) 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.* (2007) 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 cattle traits and preference heterogeneities in Northern Kenya using choice experiments and latent class modelling.

The present study contributes to the literature by employing choice experiments and random parameters logit model to identify and estimate the relative weight assigned to the preferred traits of indigenous cow population in the most dominant crop-livestock mixed production system in Ethiopia. The mixed farming system covers almost all the highlands of Ethiopia and consists of 73% of the cattle population. The pastoral system covers the semi-arid and arid lowlands of Ethiopia consisting of 27% of the cattle, 66% of the goat, 26% of the sheep and 100% of the camel population. Commercial farms are quite marginal and concentrated in the pre-urban and urban area (EEA 2006). The study not only addresses the most important livelihood system in Ethiopia, but also contributes to the growing literature in stated choice-based valuation of AnGR diversity as it peculiarly deals with remote and traditional society in a developing country. Globally, this research adheres to the strategic priority areas of the Interlaken Declaration (FAO, 2007) that are related to supporting production systems and associated knowledge systems of importance to the maintenance and sustainable use of animal genetic resources.

The remaining part of the paper is organized as follows; next, a description of the study area, choice experiment, and the analytical framework of the research is presented. This is followed by a brief characterization of the sample population, and a presentation and discussion of the empirical results. The final section contains conclusions and implications of the results.

5.2. Materials and Methods

5.2.1. The study area

This paper reports results of a research done as part of a continental project of the International Livestock Research Institute (ILRI) which aims to improve the livelihoods of poor livestock keepers in Africa through a community based management of indigenous animal genetic resources. Dano district was selected as a pilot site for its remoteness and indigenous cattle population. Such criteria were used essentially to elicit the absolute

preferences of livestock keepers for attributes of the indigenous cattle they raise. The district is located some 250 km west of Addis Ababa in Oromia Region in Central Ethiopia. It has an area of about 659 square km and human population of 83 thousand. Traditional classification of the agro-ecologies indicates that 5% of the district is highland (>2200 m.a.s.l.), 80% midland (1500 - 2200 m.a.s.l.), and 15% lowland (<1500 m.a.s.l.). The district receives on average 900-1400 mm annual rainfall and has 15-30^{o}C average daily temperature. Livestock are crucially important component of the fully semi-subsistence livelihood system characterizing the district.

The study covered five markets. Four of the markets, namely, Sayo, Menz, Dano-Roge and Awadi-Gulfa, are situated within Dano district. Sayo, the administrative and economic capital of the district, has two different cattle market places that set on Wednesdays and Saturdays. Menz is a small market located at about 12 km north of Sayo and sets on Tuesdays. Dano-roge is located at the northern tip of the district some 28 km far from Sayo. Roge sets on Thursdays and, unlike in other markets, cows and calves are the cattle frequently exchanged. Awadi-Gulfa market is located 24 km northeast of Sayo and sets on Wednesdays. The fifth market, which is called Ijaji, is located in neighboring Cheliya district and sets on Saturdays. Ijaji market is the only fenced market of about 30m by 80m area and, comparatively, traders are more frequent in this market than in others. None of the markets has any shade for both human beings and animals or any trough for water and feed. Only Ijaji and Sayo are accessible by car throughout the year, while the others can be accessed only on foot in the rainy season. Animals are trekked to and from the markets throughout the year. All cattle markets are dominated with male buyers and sellers.

5.2.2. Choice Experiment

Choice experiment (CE) is a popular stated preference method which is used to elicit preferences for attributes of attribute differentiated goods based on statistically efficient designs of attributes and attribute levels. CE has theoretical underpinnings on random utility theory (McFadden, 1974) and characteristics theory of value (Lancaster, 1966; Rosen, 1974). CE is a significant improvement over the well known contingent valuation method (Bateman *et al*., 2003; Hensher *et al*., 2005) in that it goes beyond willingness to pay/accept for a non-specific change to determining the relative weight of attributes of a good on its total economic value. CE also differs from conjoint rating and conjoint ranking in that it enables estimation of demand theory consistent marginal values of the attributes of a differentiated good which is practically less appealing in the rating and ranking approaches (Bateman *et al.*, 2003; Hensher

et al., 2005). For detailed elaboration, interested readers are referred to Louvier *et al.* (2000), Bateman *et al.* (2003), and Hensher *et al.* (2005).

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 resource (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 of the abovementioned studies (Scarpa *et al.,* 2003a,b; Ouma *et al.,* 2007; Roessler *et al*., 2007; and Ruto *et al*., 2008) employed it to elicit preferences.

The most important issues in designing a CE survey are attribute and attribute level determination, generation of statistically efficient and practically manageable experiment 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 Dano district make a living and undertake cattle transactions. Respondents were asked to mention the attributes they consider to value the animals they keep or buy. Table 5.1 presents the traits of cows and their levels as described by respondents including the ways of assessment.

Table 5.1: Preferred Traits of cows with ways of assessment and common levels

Trait	Ways of assessment	Level
Age	Teeth and horn examination and discussion with the seller.	2 – 4 years
Body size	Observation.	Small, Medium, and big
Fertility	Discussion with the seller and examination of the body frame.	Good and Bad
Origin	Discussion with the seller and sometimes examination of the fur coat of the cattle.	Wellega, Keffa, Dano, and nearby districts in West Shoa zone.
Calf vigor	Discussion with the seller and examination of the frame of the cattle.	low, medium, and high
Milk yield	Discussion with the seller and observation of the naval flap and the teats.	1 – 3 lt/day

After further discussions with farmers, and based on additional information generated by pair wise ranking during subsequent surveys, traits for the CE were determined to be seven including disease resistance and price after age was fixed to be 3 years. The age was fixed at three years because it was the average of the figures indicated by respondents and literature indicates that the average age of a cow at its first parturition is about 3.2 years in this part of the country (Workneh and Rowlands**,** 2004). 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 – average as perceived by respondents. Table 5.2 presents the traits and trait levels used in the choice experiment.

Table 5.2: Cow traits and levels included in the choice experiment

Variable	Levels	Reference level
Origin	Dano	Dano
	Nearby districts	
	Wellega	
	Keffa	
Body size	Small	Small
	Medium	
	Big	
Fertility	A calf/ 2 years	A calf/2 years
	A calf/ year	
Milk yield	1 liter/day	1 liter/day
	2 liter/day	
	3 liter/day	
Calf vigor	Poor	Poor
	Good	
Illness	>2 times per year	>2 times per year
	<2 times per year	
Price	Small price = 500.00 Birr[2]	500.00 Birr
	Medium price = 700.00 Birr	
	High Price= 900.00 Birr	

The traits and trait levels were statistically combined in an efficient way to generate profiles based on the attributes and attribute levels. Experimental designs commonly used in resource valuation studies are fractional factorial designs that focus on orthogonality (Rose

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

and Bleimer, 2004). In orthogonal designs, ensuring statistical independence among the attributes is the primary objective. However, maintaining this orthogonality throughout the experiment to the data analysis stage is known to be highly unlikely (Bleimer and Rose, 2005). Hence, the more comprehensive approach suggested by Kuhfeld (1997, 2005) to generate statistically efficient design with SAS algorithm was employed in this study. 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 criteria most often used in developing experimental designs for such studies are A-efficiency and D-efficiency. Although the absolute values of the efficiency measures are not that useful, they give an insight of the data generating process. The SAS algorithm results show that the CE design has D-efficiency of 99.6% and A-efficiency of 99.2%. This high efficiency implies that the variance matrix has quite small value with positive implications on the reliability of the estimates to be generated. The design generated 36 profiles classified into 18 choice sets (two profiles in each set) blocked into three so that each respondent could be presented with six 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 survey was enumerated by three experienced researchers from the department of livestock improvement at Bako Agricultural research Center (BARC) and an agricultural economist for a consistent and clear explanation of all the attributes and attribute levels considered.

As expected, undertaking the CE survey was very much demanding for some peculiar reasons. Most of the markets set for very few hours in the afternoon and the marketers have to travel to and from the markets for hours, sometimes half a day. Administering more than six choice sets would have been very difficult. The remoteness and poor accessibility of some of the markets had also taken its own toll of time. The CE survey was conducted in May-June 2006 in the five markets described above. The survey was done in the markets simply because the markets add up an objectivity dimension to a rather hypothetical choice analysis and respondents would be in the proper context to understand the questions much more easily than otherwise.

A total sample of 195 cattle buyers (39 from each market) were selected and presented with six choice sets in random order. The total number of choice sets responded to were 1170 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. The sampling procedure employed can not be considered as purely random, even though no criterion was used to discriminate buyers. 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. Except very few who declined for reasons of time shortage, all approached marketers were willing to participate in the CE survey. 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 Dano district.

5.2.3. Analytical Framework

Values of (quasi-) public goods are not typically exclusively derived from private use of resources and, therefore, the revealed preferences in the markets can hardly be used to generate the marginal effects of attributes of an animal, which can be considered as an attribute differentiated good (Drucker *et al*., 2001; Anderson, 2003; Roosen *et al*., 2005). In our case, market prices are aggregated payments for animals without any indication as regards the different attributes of the animal. The main advantage of CE over the revealed choice ones, like most stated choice-based methods, is the possibility of varying multiple attributes of the good in order to see the effect of a change in each attribute on the total economic value.

This study employed CE to elicit the preferences of cattle buyers. These choices were made in six choice situations and were about selecting the best option among three alternatives (including opting out) in each choice set. A choice of an alternative over the others implies that perceived utility of the chosen alternatives is higher than the rest. For an individual '*n*', presented with a choice situation '*t*', choice of an alternative '*j*' can be modeled as

$$Y_{njt} = \begin{cases} 1 \; if \quad U_{njt} \geq U_{nlt} \\ 0 \; otherwise \end{cases} \quad \text{, for all } j = 1,2,.,l,.. \text{ m}, j \neq l \text{ ; } n = 1... N, \text{ and } t=1,.., T. \qquad (1)$$

where Y_{njt} is the choice variable which takes the value '1' if an alternative '*j*' is chosen and '0' if not in the choice set '*t*', and U_{njt} is individual *n*'s perceived utility of alternative '*j*' in the '*t*' choice set.

Based on utility formulation approaches of Lancaster (1966) and McFadden (1974), it can be shown that the chosen profiles are not preferred simply because they denote a cow, rather

they are preferred because of the attributes characterizing the cow profiles. The attributes included in characterizing the profiles were very carefully identified and their levels determined and yet not all of the attributes were included. In addition, not all the issues cattle buyers consider in choosing a given profile could be considered in analyzing the level of perceived utilities. As explained by McFadden (1980), the unobserved variations in preferences and in the attributes of alternatives and errors of perception and optimization by the respondents are the sources of randomness in the perceived utility.

Maximization of utility, therefore, needs to include both the deterministic and random components of the perceived utility. The random utility theory (McFadden, 1974) enables the formulation of utility (U) as additive function of these deterministic and random components. This can be formulated as

$$U_{njt} = X'_{njt}\,\beta_n + \varepsilon_{njt} \qquad (2)$$

where, X_{njt} is a vector of explanatory variables including attributes of alternatives and interactions of attributes and socioeconomic characteristics, 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. Interaction variables of attributes and socioeconomic characteristics are introduced to account for sources of taste heterogeneity among the respondents. Significance of the coefficient of an interaction term indicates that there is heterogeneity of preferences around the mean of the attribute because of the respective socioeconomic variable (Hensher *et al*., 2005).

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

$$\mathrm{CP}_{njt}(\beta_n) = \frac{\exp X'_{njt}\,\beta_n}{\sum_{l=1}^{m} \exp X'_{nlt}\beta_n} \qquad (3)$$

This specification, however, assumes homogeneous taste for traits across all respondents and the taste parameters of each individual (β_n) are known and completely explained by their means only**.**

Attribute taste heterogeneity is, however, shown to be a common phenomenon among cattle producers and consumers (e.g., Sy *et al*., 1997; Scarpa *et al.,* 2003a; Ouma *et al.,* 2007). A random parameters logit model which accounts for heterogeneity of attribute tastes is therefore employed in this study. In random parameters logit (RPL), the β_n's are specified to be random and to follow, most commonly, normal distribution[3] given as

$$\beta_n \sim \mathrm{N}[\beta, \Sigma_\beta] \tag{4}$$

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

$$P_{njt} = \Pr[y_{nt} = j] = \int \frac{\exp(\mathrm{x'_{njt}}\,\beta_\mathrm{n})}{\sum_{l=1}^{\mathrm{m}} \exp(\mathrm{x'_{nlt}}\,\beta_\mathrm{n})} \phi(\beta_n \mid \beta, \Sigma_\beta) d\beta_n \tag{5}$$

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

$$\ln L_N = \sum_{n=1}^{N} \sum_{j=1}^{m} y_{njt} \ln P_{njt} \tag{6}$$

with respect to β and variance Σ_β. This maximization can not be solved; because, the integral (equation 5) 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) According to Cameron and Trivedi (2005), using a direct simulator the integral (equation 5) is replaced by the average of R evaluations of the integrand

[3] Other possible distributions the random taste parameter can take include lognormal, uniform and triangular (Train, 2003; Hensher et al., 2005a). We have tried different distributional assumptions for the random parameters before deciding to use the multivariate normal distribution.

at random draws of β_n from the N[$\boldsymbol{\beta}$, Σ_β] distribution. The maximum simulated likelihood estimator then maximizes

$$\ln \hat{L}_N(\beta, \Sigma_\beta) = \sum_{n=1}^{N} \sum_{j=1}^{m} y_{njt} \ln \left[\frac{1}{R} \sum_{r=1}^{R} \frac{e^{x'_{njt} \beta_n^{(r)}}}{\sum_{l=1}^{m} e^{x'_{njt} \beta_n^{(r)}}} \right] \quad (7)$$

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 $\phi(\beta_n \mid \beta, \Sigma_\beta)$. This study employed a range of numbers of draws (100 – 1000) and the results were found to be consistent. The results of the estimations with 1000 Shuffled Halton draws are, therefore, reported. The attributes and socio-economic variables used in the model estimated are shown in Tables 5.2 and 5.3.

5.3. The sample population

All respondents were males as cattle selling is exclusively men's job in the district. Nearly 90% of the sample respondents are farmers or farmer traders as expected in such primary rural markets of a semi-subsistence livelihood system. Full time traders accounted for 7.7% of the sample whereas the remaining 3.1% of the sample composed of civil servants and small restaurant and bar owners. The mean age of respondents is 36.3 years, while the age range is between 18 and 68 years. About 22% of the sample buyers are illiterate, 9.2% do read and write, 2.6% have attended some religious schools, and about 52% of them have attended elementary school. The remaining 14% have attained secondary and higher education. The socioeconomic variables can not be entered to the regression as they are constant over all the choice sets presented to a respondent. They are entered as interactions to avoid multicollinearity induced rejection by the estimation procedure. The socioeconomic characteristics considered in the econometric estimations are described in Table 5.3.

Table 5.3: Socioeconomic variables included in the RPL model

Variable	Code	Descriptives
Trader	1 if trader	7.7%
	-1 if farmer	
	0 otherwise	
Farmer trader	1 if farmer trader	42.6%
	-1 if farmer	
	0 otherwise	
Other occupations	1 if has other occupation	3.1%
	-1 if farmer	
	0 otherwise	
Farmer	(-1) Reference level	46.7%
Education	1 if illiterate	22.1%
	2 if reads and writes	9.2%
	3 if attended religious schools	2.6%
	4 if attended elementary	51.8%
	5 if attended secondary	13.8%
	6 if attended above secondary	0.5%
Age	In years.	Mean 36.3

5.5. Results and Discussion

More often, the econometric analysis of discrete choice data starts with conditional logit model estimations. Accordingly we initially estimated a conditional logit model and run a test to check whether the basic assumption of the conditional logit that the independence of irrelevant alternatives (IIA) holds. The Hausman test rejected ($P << 0.001$) the IIA assumption implying that the odds ratio of any two alternatives is dependent on the inclusion or exclusion of the other alternative in the choice set (Hausman and McFadden, 1984; Greene, 2003). The rejection of IIA assumption, which follows the assumption of independent and homoscedastic random component of the utility function, implies that the CL model is not appropriate. Hence, a random parameters logit (RPL) model was estimated.

5.5.1. Parameters of Trait Preferences

Choosing a profile in the choice sets, as opposed to opting out, was found to be highly preferred as indicated by the significant constant term (Table 5.4). 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 statistically significant (P<< 0.001) at 29 degrees of freedom (Table 5.4).

The magnitude of the parameter estimates show that fertility – or short calving interval – is much more important than all other attributes considered by cattle buyers. Disease resistance was also found to be more important than calf vigor, milk yield and the area the cow was brought from. 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 producing sufficient food for the annual demand of the family. Secondly, households aim at supplying part of their produces to generate cash to pay for other costs of life including food, as food shortage is not uncommon. The main contribution of livestock in achieving these objectives is through traction power generated from bulls and through selling of live animals. Shorter calving interval implies more animals to sell and higher possibility of getting male calves to replace the aging bulls. Disease resistance is so important not only because it assures the herd stays productive but also saves the scarce cash resources 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 importance of these traits is comparable to the corresponding findings of the studies which analyzed preferences for cow traits (Tano *et al*., 2003; Ouma *et al.,* 2007; Zander and Drucker, 2008) with apparent differences in the relative weights of the attributes.

Milk yield is also a highly significant attribute of cows. However, the relative weight assigned to milk potential of cows is lower than those for other traits. In Dano 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 the storing facilities, or can not sell it. This result differs from 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 all the livestock development efforts have focused on dairy cows, the relative weight of milk trait shows the considerable disparity between the government's livestock development agenda and rural livelihood objectives.

The area the cows are brought from is another important attribute cattle buyers consider. The concept of breed does not have any recognition within the cattle keeping population in the area or among cattle buyers in the markets. 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 the closely neighboring districts are preferred to that of the district. Although it does not seem that there is so much difference among the cattle populations within and around the district, farmers must have some reasons in the details of the characteristics of the cows. 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.

Identification of traits (including price) and trait levels was completed four months before the CE survey. In the following four months, the inflation that has been rampant in Ethiopia since May 2005 made the prices of the CE quite low. The respondents apparently considered the price levels small for most of the profiles presented. The three price levels were entered as categorical variables like all other traits with low price (500.00 Birr) fixed as reference level[4]. 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[5]. Categorical treatment of price gave good results in isolating sources of taste heterogeneity. A significant drawback of the statistical insignificant price variable is the fact that implicit prices of the traits could not be quantified. The relative importance of the traits, nonetheless, can be observed from the coefficients of the choice model.

5.5.2. Preference Heterogeneity

Choice analysis is all about explaining heterogeneity in preferences (Hensher *et al*., 2005) and this research gives due emphasis to analysis of taste heterogeneity based on the means and standard deviations of the random parameters and the mean coefficients of the interaction terms. Different distributional assumptions were tried for random parameters, following Hensher *et al* (2005) and Train (2003), and finally all random taste parameters were assumed to be normal based on the likelihood ratio test and intuition.

[4] See Mtimut and Albisu, 2006; for similar experience.
[5] Although only three fixed price levels were used throughout the survey, we have also tried to estimate the RPL with price as a continuous variable, but price was found to be statistically insignificant under all appropriate distributional assumptions.

Taste 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, 60% of the respondents prefer the fertility to be good (a calf per year), while 40% of the respondents prefer lower fertility (a calf/ 2 years). Similarly, 72% 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. The taste heterogeneity around the mean of the taste parameter for big body size was essentially due to differences in education level. The positive sign of the coefficient shows that as education level of the cattle buyer increases, his/her sensitivity to the changes in the big body size of the cow decreases. It is not clear as to how this happens but it can be said that the educated group of cattle buyers are the young people who are starting to build up their herds with less interest in the big body size as it always implies old age – a less favorable attribute.

Preferences are also heterogeneous around the mean taste parameters of disease resistance particularly due to the less sensitivity of one group of respondents which includes owners of small restaurants and civil servants. This is obvious for the fact that these are buyers who will immediately slaughter the animals for consumption and would be expected to care less about the disease resistance of the cows they buy. This group of buyers is less sensitive about the high price level as well. They are arguably the richest group of respondents and are still expected to be less worried about the 'high' price level, which was in fact not that high at the time of the survey, due to inflation.

Cattle buyers who are farmer traders by occupation were found to be very sensitive to the fertility, disease resistance and the high price of cows. These results are quite intuitive that these group of people need to get cows with high fertility, healthy and cheaper price in order to buy cows either for reselling or keeping. Full time traders were found to be very sensitive about milk and high prices. Traders aim at reselling the cows they buy and they take their animals as far as to Addis Ababa to sell. Therefore, milk will be more demanded in areas where it is marketable and accessible to traders. The high sensitivity of traders to the high price level is expected and self explanatory. Heterogeneity of preferences around the mean taste parameter of fertility was also found to emanate from differences in family size. As the family size increases, the sensitivity to the fertility of the cow increases, implying that big

families want to have cows with shorter calving intervals. This is due to the obvious interest of having bigger herds that can serve as buffers at times of crisis, to which big families are more vulnerable.

Table 5.4: Simulated Likelihood estimates of the random parameters logit model

Variable	Structural Parameters		SD of the parameter distributions	
	Coefficient	St. Error	Coefficient	St. Error
Random parameters				
Medium body size	-0.420	0.303	0.207	1.623
Big body size	0.281	0.468	0.066	3.344
Fertility	1.802***	0.607	1.062*	0.595
Milk yield	1.003***	0.334	0.596	0.371
Calf vigor	1.049***	0.294	0.107	1.883
Disease resistance	1.593***	0.508	1.450***	0.535
Medium price	-0.200	0.288	0.977	0.990
High price	-0.130	0.319	0.794	0.771
Non-random parameters				
Nearby districts	0.552*	0.303		
Wellega zone	-0.469	0.323		
Keffa Zone	-0.270	0.294		
Constant	-2.980***	0.653		
Heterogeneity in mean parameters				
Big body*education	0.166*	0.099		
Fertility* farmer trader	-0.290*	0.160		
Fertility*family size	-0.093**	0.043		
Milk*trader	-0.505**	0.237		
Disease res.*farmer trader	-0.809**	0.350		
Disease res.*other occupant.	1.002*	0.580		
High price*trader	-1.003*	0.557		
High pr.*farmer trader	-0.312	0.302		
High Pr.*other occupant.	1.249*	0.659		
N = 1170	LL = - 630.47		Pseudo R^2 = 0.51	
χ^2 (df=29)= 1309.80	LL* = -1285.4		Adj. R^2 = 0.50	

****, **, and * significant at alpha is equal to 0.01, 0.05, and 0.1. N is number of observations, LL is value of log-likelihood function, LL* is value of the restricted (no coefficient) log likelihood function and χ^2 is chi-squared.*

5.5.3. Simulation of changes in attribute levels

Policy implications of changes in attribute levels can be drawn from simulations with different attribute level scenarios assigned to each alternative. Based on the basic heterogeneity model discussed above, a number of scenarios were drawn by fixing attributes at different levels in each profile to find out the extent to which the choice of the profiles would be influenced. The simulation results show what influence a fixed change in an attribute level would have on choice of one of the profiles while the other attributes and levels are still varying in all the profiles across all choice sets. Careful look into the changes in proportions of profile choice informs which attributes should be given emphasis in improving the production and productivity of cows without much mathematical procedure.

The base level of the simulation is the proportion with which each profile (including the opting out) was chosen by the respondents based on the 1170 choice sets. Each choice set has two alternatives numbered profile 1 and profile 2 and an opting out option. At the end of the survey, profile 1 was chosen in 43.19% of the cases, profile 2 was chosen in 55.41% of the cases, and in the remaining 1.4% of the cases respondents opted out (Table 5.5). The first scenario was about fixing the fertility attribute to be good (1 calf/ year) in profile 1 across all the choice sets. The result shows that, *ceteris paribus*, this could have increased the proportion with which profile 1 of all choice sets was chosen by 20.23%. This is well above the results of the scenarios which fixed milk to be maximum (3 lt/day), calf vigor to be good or disease resistance to be good in profile 1 over all the choice sets. Another simulation with fertility fixed to be good in profile 2 of all the choice sets, resulted in 18.68% increase in the proportion with which this profile would have been chosen, everything else constant. This increase is again very high as compared to similar assumptions about the milk, calf vigor and disease resistance attributes.

Comparison of the results in general shows that changes in the levels of the different attributes have different influences on the proportional choice of the cow profiles. The changes in fertility levels are the most influential followed by changes in disease resistance. Changes in milk yield were found to be influencing choices only more than changes in calf vigor. Also consistent is the reduction in the proportion of opting out under all scenarios which fixed the attributes at their most preferred level. This shows that respondents are interested to buy than not if they get the type of animal they are interested in.

Table 5.5: Simulated changes in choice proportion of the profiles in the choice set

Scenario	Simulated Changes in Choice Proportion		
	Profile 1 (Base = 43.19%)	Profile 2 (Base = 55.41%)	Opt out (Base = 1.4%)
Fertility = good (profile 1)	20.23	-19.52	-0.70
Fertility = good (profile 2)	-18.26	18.68	-0.42
Milk = 3 lt/day (profile 1)	8.79	-8.51	-0.28
Milk = 3 lt/day (profile 2)	-9.17	9.78	-0.62
Calf = good (profile 1)	6.43	-6.28	-0.16
Calf = good (profile 2)	-8.25	8.85	-0.59
Disease =good (profile 1)	16.72	-16.12	-0.60
Disease =good (profile 2)	-9.46	9.85	-0.39

5.6. Conclusions

This research employed choice experiments and random parameters logit to elicit and analyze cow trait preferences of buyers in the semi-subsistence livelihood systems of rural central Ethiopia. The results 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 (Workneh 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 nearby locations. 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.

Respondents were found to display heterogeneous preferences for the attributes included in the study. Differences in occupation are very important sources of preference heterogeneity in that respondents who are engaged in farming and trading at the same time are very sensitive to attributes like fertility, disease resistance and high price levels as compared to farmers. Similarly, traders were also found to be more sensitive to the milk yield potential of cows and the high price levels. People who are not engaged in farming or cattle trading were relatively insensitive

about disease resistance and high price levels as they are buyers who slaughter the animals soon after buying and can afford higher prices as compared to farmers. The heterogeneity of preferences across occupations have important implications in extending livestock development interventions. For instance, the sensitivity of farmer-traders to fertility, disease resistance, and price suggests the need to focus on these aspects of cattle production if commercialization of the system is sought after.

The government of Ethiopia needs to revise the structure of the livestock improvement programs still running and needs to make note of the important details that influence the production, marketing and utilization of livestock products. 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. Specifically, the breeding strategies should focus on shortening the calving interval, improving the disease resistance and work on factors that improve the vigor of the calves. It can also be observed that improving these traits of cows owned by small holder farmers in the area will facilitate adoption of the new innovations or improvements instead of bringing over cattle from unknown sources and obviously with low adaptability.

Acknowledgement

The authors would like to thank all the respondents for their enthusiasm and collaboration. We are also grateful for ILRI-BMZ project for funding this research and researchers Temesgen, Chala and Birhanu for their role in data collection. This paper has benefited from the discussions we had with Getachew Gebru and Wolfgang Bayer.

5.7. Reference

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

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

Befekadu Degefe and Berhanu Nega *Annual Report on the Ethiopian Economy: Volume I, 1999/2000* (The Ethiopian Economic Association, Addis Ababa, Ethiopia, 2000).

Benin S., Ehui S. and Pender J. *Policies for Livestock Development in the Ethiopian Highlands* (Socio-Economics and Policy Research Working Paper 41; International Livestock Research Institute, Nairobi, Kenya, 2002).

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

Bleimer, M. C. J. and Rose, J. 'Efficient Designs for Alternative Specific Choice-Experiments', The University of Sydney, Institute of Transport and Logistics Studies Working Paper ITLS-WP-05-04, 2005.

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

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

Desta K. B. *Analysis of Dairy Cattle Breeding Practices in Selected Areas of Ethiopia* (PhD Dissertation; Humboldt University of Berlin, 2002).

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

EEA (Ethiopian Economic Association). *Evaluation of the Ethiopian Agricultural Extension with Particular Emphasis on the Participatory Demonstration and Training Extension System (PADETS)* (Ethiopian Economic Association: Ethiopian Economic Policy Research Institute, Addis Ababa, Ethiopia, 2006).

ESAP (Ethiopian Society of Animal Production). *Farm Animal Biodiversity in Ethiopia: Status and Prospects* (Asfaw Yimegnuhal and Tamrat Degefa (eds.). Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 28 –30, 2003. ESAP, Addis Ababa, 2004)

Ferrini, S. and Scarpa, R. 'Designs with a-priori information for nonmarket valuation with choice-experiments: A Monte Carlo study', *Journal of Environmental Economics and Management*, Vol. 53 (2007) pp. 342-363.

Greene, W. *Econometric Analysis* 5th edn (Prentice Hall, New Jersey, USA, 2003).

Hausman, J. and McFadden, D. 'Specification Tests for the Multinomial Logit Model', *Econometrica* Vol. 52, (1984) pp.1219 - 1240.

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

Huber, J. and Zwerina, K. 'The Importance of utility Balance and Efficient Choice Designs', *Journal of Marketing Research*, 33 (August), (1996) pp. 307-317.

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

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

Lancaster, K. 'A New Approach to Consumer Theory', *Journal of Political Economy*, Vol. 74 (1966) pp. 132-57.

Louvier, J. J., Hensher, D. A. and Swait, J. *Stated Choice Methods: Analysis and Application* (Cambridge, Cambridge University Press, 2000).

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

McFadden, D. 'Econometric Models for Probabilistic Choice among Products', *The Journal of Business.* Vol. 53 (3) Part 2, (1980), pp. S13 –S29.

Mtimet, N. and Albisu, L. M. 'Spanish Wine Consumer Behavior: A Choice Experiment Approach', *Agribusiness*, Vol. 22 (3), (2006) pp. 343–362.

Ouma, E., Abdulai, A. and Drucker, A. 'Measuring Heterogeneous Preferences for Cattle Traits amongst Cattle Keeping Households in East Africa', *American Journal of Agricultural Economics* 89(4), (2007) pp. 1005-1019.

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

Roessler, R., Drucker, A. G., Scarpa, R., Markemann, A., *et al*. , 'Using choice experiments to assess smallholder farmers' preferences for pig breeding traits in different production systems in North-West Vietnam', *Ecological Economics* (2007), doi:10.1016/j.ecolecon.2007.08.023

Rolfe, J., Bennet, J., and Louviere, J. 'Choice modelling and its potential application to tropical rainforest preservation', *Ecological Economics*, Vol. 35 (2), (2000) pp. 289-302. Roosen, J., Fadlaoui, A. and Bertaglia, M. 'Economic Evaluation for Conservation of farm animal genetic resources', *Journal of Animal Breeding and Genetics*, Vol. 122 (2005) pp. 217-228.

Rose, J. M. and Bleimer, M. 'The Design of Stated Choice Experiments: The State of Practice and Future Challenges', University of Sydney and Monash University, Institute of Transport Studies Working Paper ITS-WP-04-09, 2004.

Rosen, S. 'Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition', *Journal of Political Economy* 82 (1), (1974) pp. 34-35.

Ruto, E., Garrod, G. and Scarpa, R. 'Valuing animal genetic resources: a choice modelling application to indigenous cattle in Kenya', University of Waikato, Hamilton, New Zealand, Department of Economics Working Paper in Economics 5/07, 2007.

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

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

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

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

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

Windle, J. and Rolfe, J. 'Diversification choices in agriculture: a Choice Modelling case study of sugarcane growers', *The Australian Journal of Agricultural and Resource Economics* 49(1), (2005) pp. 63-74.

Workneh Ayalew and Rowlands J. (eds). *Design, Execution and Analysis of the Livestock Breed Survey in Oromiya Regional State, Ethiopia* (Oromia Agricultural Development Bureau, Addis Ababa Ethiopia and ILRI, Nairobi, Kenya, 2004).

Zander, K. and Holm-Mueller, K. 'Valuing farm animal genetic resources by using a choice ranking method', in J. Meyerhoff, N. Lienhoop, and P. Elsasser, (eds.) *Stated Preference Methods for Environmental Valuation: Applications from Austria and Germany* (Metropolis, Marburg, Germany, 2007).

Chapter 6

Preferences for Bull Traits in Semi-Subsistence Agricultural Production Systems of Ethiopia

Girma T. Kassie, Awudu Abdulai, Clemens Wollny

Paper submitted to Agricultural Systems.

Abstract

Economic valuation of preferences for cattle traits can play a major role in reducing the continuous erosion of genetic diversity partly caused by breeding policies that focus on few commercial traits. This study examines the bull trait preferences of cattle buyers and estimates the relative willingness to pay for the preferred attributes. Data employed in the study were collected in five markets in central Ethiopia using choice experiments methods. Standard and Heterogeneity in Mean (H-M) Random Parameters Logit (RPL) models were used to analyze buyers' preferences for traits, while kernel density estimators were employed to examine the distribution of the willingness to pay for the individual traits. The results imply the necessity of careful consideration of preferences for attributes before introducing or reinforcing crossbreeding efforts meant to theoretically enhance a couple of attributes or purposes animals are kept for. In addition to producing breeds that are preferred by cattle buyers, incorporating preferred and highly valued attributes in breeding programs would also contribute in reducing the erosion of the genetic diversity of the indigenous animal genetic resources.

Keywords: Choice experiment, Heterogeneous preferences, Random parameters logit, Willingness to pay.

6.1. Introduction

Erosion of the genetic diversity of indigenous livestock resources is a global challenge of higher intensity in the developing world. Efforts to increase directly consumable outputs of the livestock sector are narrowing the diversity of the genetic base through substitution of existing and well adapted livestock populations. Such substitutions set a large group of livestock populations or breeds mainly in developing countries aside from food producing livestock systems making them vulnerable to extinction (Oldenbroek 2007). Nonetheless, the fitness of the local breeds of livestock for the diverse needs and objectives of subsistence and semi-subsistence livelihoods stems from the various traits they possess because of the enormous natural selection and environmental processes they evolved through. Therefore, the risk to loose unique genes through the widespread and global use of few breeds is an important argument to conserve local breeds.

Although the rural population depends very much on these resources, conservation of indigenous livestock resources has seldom been a priority in Ethiopia. With particular emphasis

on cattle, introduction of exotic genotypes has been made merely for improving the marketable milk and meat outputs although the results were not encouraging (e.g., Demeke et al. 2004). The rural community keeps cattle for a number of purposes some of which are more important than milk and meat. These include draft power for crop production and transportation, cash generation, asset accumulation, collateral and security functions.

Improving and sustaining the general performance of such a multipurpose production system requires interventions that are multifaceted and that build upon the endogenous knowledge and efforts of managing the available animal genetic resource. This is indispensable as, in addition to the poorly oriented livestock improvement interventions, new mating structures, disease epidemics, civil strife and warfare, changes in prices and market structures can influence the level of genetic diversity of a given livestock population (Wollny 2003). Characterization of indigenous farm animal populations provides essential information for the development of effective livestock development interventions. However, animal breeding studies have tended to focus only on a few market driven traits often utilizing profit functions as objective functions in calculation of economic values to be included in the breeding objective (e.g. Kahi and Nitter 2004). While this may seem prudent for developed countries where the aim of livestock production is mainly profit-oriented, it may not be appropriate if targeted for small-scale and low-input systems of developing countries where production is not necessarily profit-oriented.

In such small scale and low-input production systems, cattle perform multiple livelihood functions ranging from income to non-income and social functions that are not always marketable. Thus, it is important to employ non-market valuation approaches that allow the estimation of economic values of the characteristics of livestock, which explain the functions they render, without market values. In essence, the non-market valuation approaches assume utility to be random and the economic agent as a utility maximizing individual. The economic agent in such production systems denotes the livestock keepers whose preferences determine the importance of the traits of the cattle – both as buyers and as sellers – and whose decisions shape the genetic diversity of the indigenous breeds they keep or exchange (Scarpa et al. 2003; Drucker 2004).

Few studies have recently employed the random utility framework to examine producers' preferences of cattle traits and the associated taste heterogeneities, as well as willingness to pay (WTP). Random utility theory (RUT) explains that the overall utility composes of explainable

and unexplainable components and this explanation provides a sound basis for many forms of preference elicitation procedures, typically those associated with the design of discrete choice experiments (Louviere 2004). Tano et al. (2003) used ordered probit to investigate phenotypic trait preferences of livestock keepers in Burkina Faso elicited through conjoint rating. Their findings suggest that disease resistance, fitness for traction and reproductive performance are traits that are highly preferred compared to milk and meat by cattle keepers across the different production systems in Burkina Faso. However, conjoint rating methods do not generate welfare consistent estimates and ordered probit has limitations in accounting for preference heterogeneity.

Scarpa et al. (2003) employed a mixed logit model to study cattle trait preferences in seven markets in Kenya and reported that estimated slaughter weight, body condition, sex, and breed of the animal are very important characteristics cattle keepers consider when purchasing animals. Scarpa et al. (2003) considered very few traits as the main aim was validation of the preference elicitation procedure. So far, there are a only two studies which estimated relative economic values of traits of cattle in Ethiopia. Ouma et al. (2007) employed choice experiments and mixed logit and latent class models to analyze the relative values of traits and heterogeneities in trait preferences in the pastoral areas of Northern Kenya and Southern Ethiopia. Zander and Holm-Mueller (2007) employed conjoint ranking and mixed and multinomial logit models to study the relative values of traits and preference heterogeneities of pastoralists in Northern Kenya and Southern Ethiopia. Pastoral and agro-pastoral production systems inhabit much less human and livestock population than the dominant crop-livestock production systems in Ethiopia. Our study employs random parameters logit (RPL) models to analyze taste heterogeneity and Kernel density estimators to examine the distribution of the WTP for the individual traits. The data used in the study are from choice experiments in a semi-subsistence mixed crop livestock production system in central Ethiopia. The next section discusses the choice experiment used and presents the analytical framework and data collection. This is followed by a presentation and discussion of the empirical results. The paper ends with conclusions and implications of the results obtained.

6.2. Using Choice Experiment to Value Cattle Traits

Choice Experiment (CE) is a systematic approach of eliciting preferences of individuals based on hypothetical combination of different levels of various attributes of a given good or service to sketch preferences for the attributes and the weights attached to them by the decision makers (Louviere et al. 2000; Alpizar et al. 2003; Hensher et al. 2005). The framework arises from the consumer theory developed by Lancaster (1966), which posits that preferences for goods are a function of the traits possessed by the good, rather than the good per se. An implication of this theory is that total utility derived from a good can be decomposed into separate utilities for its individual traits. A good can therefore be described by the characteristics that generate utility or disutility to individuals. Choice experiments can also be used to attach monetary values for attributes if prices or costs are included in the attributes being considered. The elicitation of preferences is made through asking the individual to choose an alternative they prefer most among all alternatives including an opt-out option.

Two common discrete choice models used in the empirical analysis of the choice experiment data are conditional logit and random parameters logit models. Both models are based on the random utility theory developed by Marschak (1960) and McFadden (1974). In this framework, utility *'**U**'* is assumed to be latent, with only the choice *'**Y**'* of alternative '***i***' by individual *'**n**'* observed. Given a choice set '***t***' with ***'J'*** alternatives, the utility function can generally be written as

$$U_{nit} = X'_{nit}\,\beta_n + \varepsilon_{nit}, \qquad (1)$$

where $\boldsymbol{U_{nit}}$ is the perceived utility of alterative ***'i'*** in choice set ***'t'*** by individual ***'n'***, $\boldsymbol{X_{nit}}$ is vector of observed variables, $\boldsymbol{\beta_n}$ is conformable vector of unknown taste parameters, and $\boldsymbol{\varepsilon_{nit}}$ is the unobserved component of perceived utility that is assumed to be identically and independently distributed (iid) extreme value type I.

The choice variable '***Y***' takes the value '1' if an alternative '***i'*** is chosen and '0' if not and, hence, the basic choice model of choosing an alternative '***i'*** over alternative *'**j**'* in a given choice set '***t***' by an individual ***'n'*** can be written as:

$$Y_{nit} = \begin{cases} 1\ if \quad U_{nit} \geq U_{njt} \\ 0\ otherwise \end{cases}$$, for all ***i*** = 1... *J*, ***n*** = 1... *N,* and t = 1, 2, .., T. (2)

The probability (Pr) of choosing alternative '***i',*** [Pr ($\mathbf{Y}_{nit}$ = 1)], over alternative '***j'*** in choice set '*t*' is then given as

$$\Pr(Y_{nit} = 1) = \Pr(V_{nit} + \varepsilon_{nit} \geq V_{njt} + \varepsilon_{njt}) \quad (3)$$

where $V_{nit} = X'_{nit}\beta_n$.

For a given value of $\boldsymbol{\beta}_n$ and an assumption of $\boldsymbol{\varepsilon_{nit}}$ to be iid, extreme value type I across all respondents, the probability that cattle buyer ***'n'*** would choose profile ***'i'*** in a choice set '***t***' of ***'J'*** alternatives is conditional logit (McFadden 1974) given by

$$\mathrm{L}_{\mathrm{nit}}(\beta_n) = \frac{\exp X'_{nit}\beta_n}{\sum_j \exp X'_{njt}\beta_n}, \quad (4)$$

The iid assumption in the conditional logit model corresponds to Luce's Independence of Irrelevant Alternatives (IIA) property, which states that "the relative odds of one alternative being chosen over a second should be independent of the presence or absence of an unchosen third alternative" (McFadden, 1974). The implication of this assumption is that the relative probability of two choices is independent of the attribute levels in the third. An additional limitation of the model emanates from the fact that the representation of heterogeneity of preferences over attributes is restricted to those individual attributes that are measured and may be included in the specification. Unobservable heterogeneity cannot be captured within this framework.

The underlying iid assumption is also restrictive in that it does not allow for the error components of different alternatives to be correlated (Hensher and Greene 2003). A reformulation of the $\boldsymbol{\beta}_n$**'**s in equation (4) as random parameters, to allow for variation of preferences across respondents, transforms the conditional logit model into a random parameters logit (RPL) model. The coefficient vector $\boldsymbol{\beta}_n$**,** which is unobserved for each '***n',*** will be assumed to vary in the population with density $f(\beta_n \mid \overline{\beta}, \Omega_\beta)$, where $\overline{\beta}$ is the mean and Ω_β, is the

covariance of the vector of parameter estimate $\boldsymbol{\beta}_n$ if it is assumed to follow a multivariate normal distribution**.** However, the density function of the parameter estimate, $\boldsymbol{f}(.)$, can take different forms including lognormal, uniform, and triangular (Brownstone and Train, 1998). In this study, multivariate normal distribution was assumed for all taste parameters, except that of places where the animals came from as they were fixed to be non-random. Given this distribution of the density function, the RPL model can be used to estimate the unconditional probabilities of choice of an alternative as integral of the conditional probability over all values of the taste parameters weighted by the density function. That is,

$$P_{nit} = \int L_{nit}(\beta_n) f(\beta_n \mid \overline{\beta}, \Omega_\beta) \partial \beta_n, \tag{5}$$

where $L_{nit}(\beta_n)$ is as in equation 4.

This multidimensional integral has no closed form and cannot be estimated with standard maximum likelihood estimation procedure. Simulated maximum likelihood estimation is used to estimate the unconditional choice probabilities (Train 2003). For a given value of the parameters of $\boldsymbol{f}(.)$, a value of $\boldsymbol{\beta_n}$ is drawn from its distribution. This draw is, then, used to estimate equation (4). This process is repeated for R number of draws and the average of $\boldsymbol{L_{nit}}$ over all R draws will give the simulated choice probability consistently[1] estimating unconditional choice probabilities as given below.

$$\hat{P} = \tfrac{1}{R} \sum_r^R L_{nit}(\beta_n^{\,r}) \tag{6}$$

where, $\hat{\boldsymbol{P}}$ is the simulated choice probability and $\boldsymbol{\beta_n^r}$ is the value of $\boldsymbol{\beta}_n$ at the r^{th} draw.

In determining the number of draws for the simulation, Hensher et al (2005) suggest trying a range of draws starting from as low as 25 and going up to 2000 once well-behaving models are fit. The few applications of CE in livestock resource economics used 100 Halton draws (e.g., Scarpa et al. 2003). We used 1000 Halton draws to show the statistical stability of the results.

[1] Train (2003) and Hensher and Greene (2003) explain that $\hat{\boldsymbol{P}}$ is a consistent estimator of **P** for any **R**.

6.3. Taste heterogeneity

For an examination of the sources of taste heterogeneities, interactions of attributes and socioeconomic variables are incorporated in the utility model. The specification of the utility model will then be

$$U_{nit} = X'_{nit}\beta_n + S_{nit}\varphi_n + \varepsilon_{nit}$$
$$\beta_n \sim N[\overline{\beta}, \Sigma_\beta] \quad (7)$$

where $\boldsymbol{\varphi}$ is vector of heterogeneity in mean parameters and $\boldsymbol{S}$ is vector of interactions of attribute and socioeconomic variables. Significance of the elements in $\boldsymbol{\varphi}$ shows that there is heterogeneity in preferences around the mean of the attribute because of the socioeconomic variable. The terminologies standard random parameters logit (S-RPL) and heterogeneity in mean random parameters logit (H-M-RPL) are used in this paper to denote the RPL estimations without and with interaction terms, respectively.

6.4. Experimental Design and Data Collection Method

The choice experiment for the study was conducted in Dano district of Oromia region in Ethiopia. The district is located 250 km west of the capital Addis Ababa. Livestock, particularly cattle, are indispensable assets of the community. Semi-subsistence crop-livestock mixed farming system is the mainstay of livelihood for the district's population. The experiment was carried out in all four markets within Dano district (namely, Dano Sayo, Dano Roge, Harbi Gulfa, and Menz) and at Ijaji market – the biggest market close to the district and weekly visited by Dano people. The sample size for the experiment was 200 randomly selected buyers in the markets with 40 respondents from each market. The effective sample size was 198, as one incomplete observation was dropped (i.e., dropping responses of two respondents).

An unlabeled choice experiment was used with six choice sets presented to each respondent. Each choice set composed of two profiles and an opting out option of no purchase. Each of the profiles was described by a combination of varying levels of six attributes including price. Before developing the survey instruments, a series of surveys were conducted to understand how the livestock production and marketing systems operate. This helped in identifying the

characteristics of cattle in which respondents are interested both as producers and marketers. Framers identified age, origin, and traction potential as the three most important characteristics, while color and horn shape were the least preferred traits. Body size and calf vigor were also mentioned by farmers to be middling traits of bulls. Age, traction potential, origin of the animal, and calf vigor were identified to be the most important characteristics of bulls in the markets by cattle-buyers. Color and horn shape were the least significant traits, while body size was found to be of average importance in the markets as well. In developing the experimental design, color and horn shape were dropped and age was fixed at 4 years, as this is the age at which a bull would have ploughed for a year. The summary of attributes and levels used in the CE is given in Table 6.1.

Experimental designs commonly used in resource valuation studies are fractional factorial designs that focus on orthogonality (Rose and Bleimer 2004; Kuhfeld 2005; Ferrini and Scarpa 2005). In orthogonal designs, ensuring statistical independence among the attributes is the primary objective. However, maintaining this orthogonality throughout the experiment to the data analysis stage is known to be highly unlikely (Bleimer and Rose 2005). Hence, the more comprehensive approach suggested by Kuhfeld (1997) to generate statistically efficient design with SAS algorithm was employed in the present study. 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 criteria most often used in developing experimental designs for such studies are A-efficiency and D-efficiency. Both efficiency measures depend on the number of choices sets, number of attributes, and on the traces of the inverse of the information matrix, $(X'X)^{-1}$, where X is the design matrix (Kuhfeld 2005). An efficient design will have small variance matrix and the eigenvalues of the inverse of the information matrix $(X'X)^{-1}$ will measure the size. If scaled to range from 0 to 100, designs with values close to 100 are considered relatively efficient.

D-efficiency is in use more than A-efficiency and other measures mainly because of its relative simplicity for a computer program to optimize and the invariance of the ratio of D-efficiencies over different coding types which is not the case for A-efficiency. Although the absolute values of the efficiency measures are not that useful, they give an insight of the data generating process.

The results of the SAS algorithm show that the bulls CE design has D-efficiency of 99.7% (A-efficiency was reported to be 99.4%). This high efficiency implies that the variance matrix has quite small value with positive implications on the reliability of the estimates to be generated. The design generated 24 profiles classified into 12 choice sets (two profiles in each set) blocked into two so that each respondent could be presented with six choice sets. This procedure ensures that the attributes of the design are statistically independent (Ferrini and Scarpa 2005). Accordingly, a simple correlation analysis between pairs the attributes generated very few non-zero values all of which were statistically insignificant. The no-purchase option of opting out was included in each choice set to avoid a forced choice and to be able to convert individual preferences into a measure of individual demand (Hensher et al. 2005).

Table 6.1: Attributes and levels included in the choice experiment

Variable	Levels	Reference level
Origin	Dano	Dano
	Nearby districts	
	Wellega	
	Keffa	
Body size	Small	Small
	Medium	
	Big	
Plowing strength	Poor	Poor
	Good	
Calf vigor	Poor	Poor
	Good	
Illness frequency	>2 times per year	>2 times per year
	<2 times per year	
Price	Price0 = 800.00 Birr[2]	800.00 Birr
	Price1 = 1000.00 Birr	
	Price2= 1200.00 Birr	

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

Nearly half (47%) of the respondents are farmers, while 41.4% are farmer-traders (farmers with trading activities in their slack periods), 8.1% full time traders and 3.0% are others including bar owners. The average age of the respondents is 36 years with minimum of 18 and maximum of 68 years. The experiences (in years) of livestock keeping of the respondents, is on average 15 years with a minimum of no experience and maximum of 55 years experience in cattle keeping. The average family size was found to be 6.73 persons per household with the range of 1 to 20 persons. Close to a quarter (23.7%) of the respondents are illiterates, 9.1% of them do read and write, 51% have attended elementary school, 12.6% have attended secondary school, and 1% have attended beyond secondary school. All the socioeconomic variables discussed above were examined as sources of preference heterogeneity (Hensher et al. 2005). The socioeconomic variables included in the final model to test taste heterogeneity are described in Table (6.2).

Table 6.2: Socioeconomic variables included in the final heterogeneity in mean RPL model

Variable	Code	Descriptives
Trader	1 if trader	8.1%
	-1 if farmer	
	0 otherwise	
Farmer trader	1 if farmer trader	41.4%
	-1 if farmer	
	0 otherwise	
Other occupations	1 if has other occupation	3.0%
	-1 if farmer	
	0 otherwise	
Farmer	(-1) Reference level	47.0%
Education	1 if illiterate	23.7%
	2 if reads and writes	9.1%
	3 if attended religious schools	2.5%
	4 if attended elementary	51.0%
	5 if attended secondary	12.6%
	6 if attended above secondary	1.0%
Age	In years.	Mean 36, Range 18 – 68

6.5. Empirical Results

The conditional logit (CL) model was estimated and included for comparison with the random parameter logit models. The Hausman test rejected the null hypothesis of Independence of Irrelevant Alternatives (IIA) property, implying that the odds ratio of the choice probabilities of two alternatives in the choice set is dependent on the third one in the choice set and, therefore, the results of the CL are less useful. Discussion is therefore restricted to the RPL models.

Estimates of the standard random parameters logit (S-RPL) and the heterogeneous in mean random parameters logit (H-M-RPL) models are presented in Tables 6.3 and 6.5, respectively. The S-RPL estimations have, for instance, improved the model significantly at $p<0.01$ with chi-squared distribution at seven degrees of freedom. The model results show that the intercept is significantly different from zero, suggesting that the respondents tend to choose than not to, given the profiles in the choice set. The origin of the bull is included not only because it was what buyers ask about it while purchasing, but also as a proxy for the scientist's concept of breed, which is essentially based on geographical concentration, at least in the Ethiopian context.

The RPL models consistently produced 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 Dano 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 preferences of farmers in Dano, as cattle from Keffa region are considered trypanosomosis infected and less adaptable within the Dano district. This again implies that most of the buyers 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 information and the uncertainties under which farmers make decisions, it is obvious that cattle buyers in this semi-subsistence farming system would prefer cattle from their districts.

Body size is also a very important characteristic of cattle in the production system. Negative sign of the medium body size level was unexpected and this might potentially be due to the lack of distinct level description in the survey or the levels were too close to differentiate from respondents' perspective. Big body size was found to be positive and statistically significant, thus positively influencing choice of a bull. The relative magnitudes of the taste parameters are

as expected and show that big body size has more weight on preference than medium body size. 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. Plowing strength has the largest taste coefficient with the expected positive sign and high statistical significance, indicating that good plowing strength is a trait that respondents consider most when purchasing bulls.

The rural community has multiple objectives in buying and keeping cattle in such a production system. The bulls are purchased 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, which is proxied here with the calf vigor. The attribute's coefficient is highly significant in the estimations. The more vigorous the offspring of a bull is, the higher the probability that it will be chosen and the higher the utility derived. Low frequency of contracting diseases 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 S-RPL model has generated a non-significant mean for the coefficient of the medium (birr 1000.00) level of bull price and a significant mean for the coefficient of the high (birr 1200.00) level of bull price. These results appear realistic, given that the price levels used during the choice experiment were already low (in four months time - due to the lingering 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.

Table 6.3: Simulated Likelihood parameter estimates of the S-RPL model

	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
Plowing	1.994*	0.218	1.357*	0.255
Calf vigor	0.752*	0.084	0.006	0.300
Illness freq.	0.821*	0.124	0.003	0.307
Price 1 (1000.00 birr)	0.237	0.183	0.003	0.245
Price 2 (1200.00 birr)	-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 base = -1305.15		χ^2= 1024.4	
LL = -792.9	Ps. R^2 = 0.392		df=18	

*, †, and ‡ significant at alpha is equal to 0.01, 0.05, and 0.1. N is number of observations, LL is value of log-likelihood function, and χ^2 is chi-squared.

6.6. Willingness to Pay Values

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,

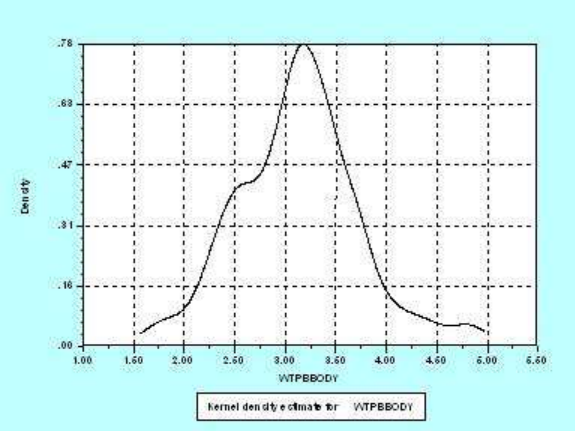
and 2.39 times more than a comparable change in offspring vigor, disease resistance and big body size, respectively (Table 6.4).

Table 6.4: Willingness to pay for bull traits computed at the highest price level

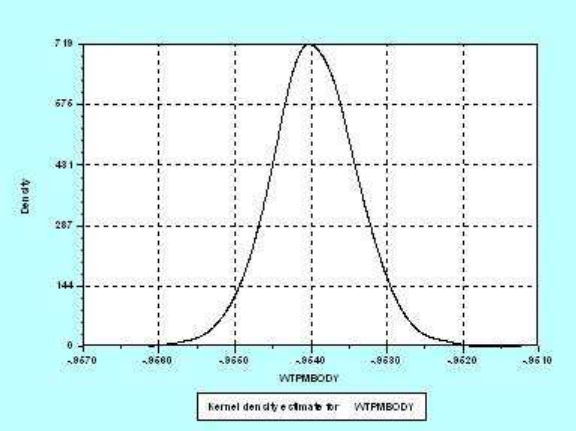
Trait	**$WTP_{\gamma} = E(-\beta_{\gamma}/\beta_{p})$***	**$SD = E(-\delta_{\gamma}/\beta_{p})$**	**Min.**	**Max.**
Medium Body	-0.954	0.018	-0.956	-0.951
Big body	3.134	2.382	1.698	4.842
Plowing strength	7.476	4.550	-1.624	11.286
Calf vigor	2.819	0.021	2.811	2.824
Illness freq.	3.078	0.013	3.070	3.084

* E = expected value; SD = standard deviation.

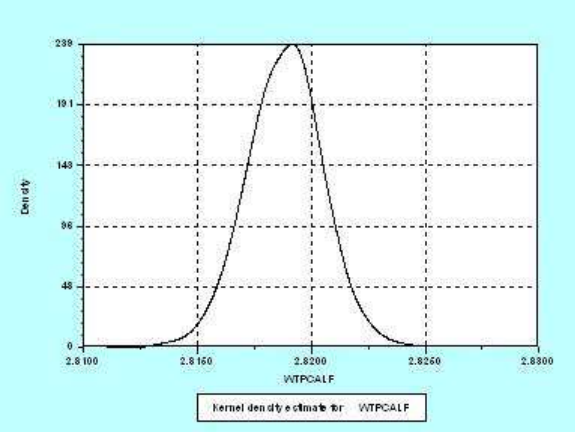
Kernel density estimators were plotted to examine the distribution of the WTP for the individual traits. These distributions are presented in figure 6.1a-e. The distributions of WTP values for traits of bulls show that, with the notable exception of the change from small to medium body size, cattle buyers generally have positive willingness to pay for improvement in each of the traits. The distributions are generally normally distributed with slightly negative skewness (-0.808) for the WTP values distribution for traction suitability and slightly positive skewness (0.342) for big body size.



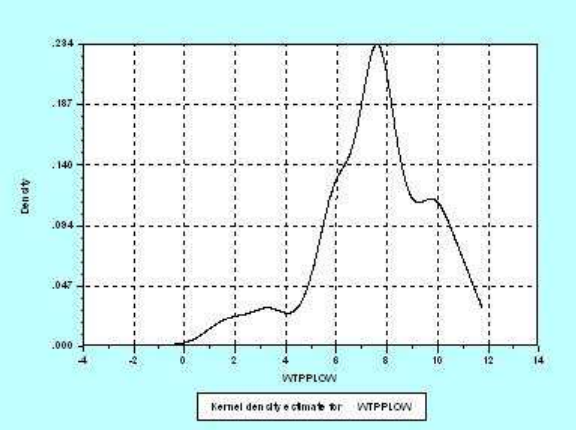
a. Big body size



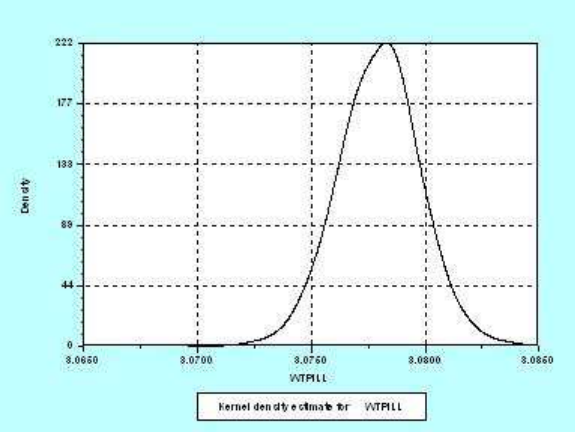
d. Medium body size



b. Calf vigor



e. Plowing strength



c. Illness frequency

Figure 6.1a-e: Kernel distribution of the willingness to pay for important bull traits

The WTP distributions for big body size and traction potential indicate heterogeneity in preferences of the taste parameters for these traits. The differences in taste for the change from small to big body size are essentially due to the fact that meat is not the primary objective of the majority of the buyers, although there are some who buy bulls for immediate consumption. The preferences for the traction potential attribute are also heterogeneous as there are still some marketers who are not so much interested in the traction potential, although most of the respondents are expected to be otherwise. Notably, the WTP distributions of all, but medium body size level, traits and trait levels lie in the positive quadrant as expected.

The results of the H-M-RPL model show that the dispersions of the big body size level and the traction potential attribute are statistically significant. This is an indication of preference heterogeneity within the sample around mean parameter estimates of these features of bulls. Implications can be drawn that not only these two attributes are important but also show variation in terms of the weights the cattle buyers attach to these two preferred traits. The H-M-RPL model was estimated with variables included as interactions of socioeconomic variables and attributes of the profiles to find out the sources of preference heterogeneity (Table 6.5).

Table 6.5: Simulated Likelihood estimates of the parameters of the H-M-RPL model

	Structural Parameters		SD of the parameter distributions	
Variables	Coefficient	St. Error	Coefficient	St. Error
Random parameters				
Medium Size	-0.766†	0.309	0.008	17.209
Big Size	0.471	0.288	1.039*	0.368
Plowing	1.570*	0.471	1.127*	0.297
Calf vigor	0.723*	0.118	0.006	10.873
Illness freq.	0.872*	0.159	0.035	6.719
Price 1 (1000.00 birr)	0.239	0.200	0.008	11.321
Price 2 (1200.00 birr)	-0.191	0.169	0.020	6.653
Non-random parameters				
Constant	-2.613*	0.244		
Nearby districts	-0.482‡	0.252		
Wellega zone	0.230	0.158		
Keffa zone	-0.685*	0.246		
Heterogeneity in mean parameters				
Medium body*age	0.015†	0.008		
Big body*trader	0.489*	0.168		
Big body*education	0.161†	0.069		
Plow*trader	-1.018*	0.187		
Plow*education	0.222*	0.076		
Plow*age	-0.016‡	0.008		
Calf*trader	-0.302*	0.109		
Illness*farmer trader	-0.296*	0.097		
High price* other occup	0.345†	0.167		
N= 1188	LL = -748.2		Pseudo – R^2 = 0.427	
χ^2= 1113.9, df=27	LL base = -1305.15			

*, †, and ‡ significant at alpha is equal to 0.01, 0.05, and 0.1. N is number of observations, LL is value of log-likelihood function, and χ^2 is chi-squared.

The H-M-RPL estimation shows that the unobserved heterogeneity in tastes around the mean parameter estimate of medium body size level is partially caused by variations in age. Similarly, being a trader and differences in education level are sources for the taste heterogeneity about the big body size level. The unobserved heterogeneity around the mean of the estimated parameter of the traction potential attribute is explained by factors such as status as a trader, differences in age and differences in education levels. The heterogeneity in tastes for calf vigor, illness and the high price level are all due to differences in occupation.

As age increases, the interest in medium body sized bull decreases implying that as age increases the marginal utility from this level of body size tends to be zero. Quite interesting is the observation that traders are insensitive to big body size, as is the case for buyers who are relatively educated. Purchasing cattle for consumption purposes is a luxury for the majority of the rural community, a fact that is reflected in the low interests in body weight. This is further supported by the observed high sensitivity of traders to traction potential of the bull they purchase form the market. The markets covered in this study are all primary markets (except Ijaji to some extent) and the traders could only think of farmers as their ultimate buyers/consumers.

The interest in traction potential increases as age increases, implying that the marginal utility of having good bulls for traction is higher for older people. This is probably due to the increasing scarcity of farmland, which results in the younger generation seeking other employment alternatives than farming. In particular, the more educated people become less dependent on land as a source of livelihood, a fact that explains the low sensitivity for traction potential by the educated buyers. Traders also appear to be very sensitive to and highly value the vigor of the offspring of the bull they are purchasing. This is also interesting as reproduction is the second reason why bulls are kept in such a farming system. Farmers engaged in trading were also found to be very sensitive and attaching high value to disease resistance, possibly for two reasons. First, they cannot afford to keep sick animals and, second, they will be able to sell the animal whenever they want to if it is healthy. Finally, cattle buyers with other occupations, such as civil servants or inn owners, were found to be less sensitive to the highest price level used in the study simply showing this group could afford it.

6.7. Conclusions

This study applied choice experiment to examine the bull trait preferences of cattle buyers and to estimate the relative willingness to pay for the preferred attributes in five markets in Dano district of central Ethiopia. The paper focused on a crop-livestock mixed semi subsistence production system where livestock rearing is practiced for several purposes. This system is the most dominant production system in Ethiopia's agriculture and as such is quite representative of the country's production systems.

The results indicate that cattle buyers of central Ethiopia assign high values for good traction potential, big body size, 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 big body size and 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.

The findings do have some implications for policy. In particular, the national livestock breeding strategy needs to aim at building the indigenous practices of selecting, improving and conserving animal genetic resources. It is also clear from the empirical results that attributes such as good traction potential, offspring viability, and disease resistance have to be given as much attention as the two focus traits – milk and meat. Thus, careful consideration of preferences for attributes should be made before introducing or reinforcing crossbreeding efforts meant to theoretically enhance a couple of attributes or purposes animals are kept for. In addition to producing breeds that are preferred by cattle buyers, incorporating these attributes in breeding programs would also contribute to a reduction in the erosion of the genetic diversity of the indigenous animal genetic resources. It is, however, significant to mention that additional

research in the different production systems would provide additional insights into cattle buyers' preferences and help in the design and implementation of livestock improvement initiatives.

Acknowledgement

The authors would like to thank ILRI-BMZ for funding this research. Our deepest gratitude goes for all the sample respondents who generously shared their time with us and for researchers Temesgen Ayana, Chala Merera and Birhanu for their role in data collection. We appreciate the comments made by Habtemariam Kassa, Wolfgang Bayer, and Ann Waters-Bayer on earlier version of this paper.

6.8. References

Alpizar, F., Carlsson, F., Martinsson, P., 2003. Using Choice Experiments for Non-Market Valuation. Economic Issues 8: 83 - 110.

Bleimer, M.C.J., Rose, J., 2005. Efficient Designs for Alternative Specific Choice-Experiments. Working Paper ITLS-WP-05-04, Institute of Transport and Logistics Studies., The University of Sydney.

Demeke, S., Neser, F. W. C., Schoeman, S. J., 2004. Estimates of Genetic Parameters for Boran, Friesian, and Crosses of Friesian and Jersey with the Boran Cattle in The Tropical Highlands of Ethiopia: Milk Production Traits and Cow Weight. J. Anim. Breed. Genet. 121: 163–75

Drucker, A., 2004. The Economics of Farm Animal Genetic Resource Conservation and Sustainable Use: Why is it Important and What have we Learned? Background Study. Paper Number 21. Commission on Genetic Resources for Food and Agriculture. FAO, Rome, Italy.

Ferrini, S., Scarpa, R., 2005. Experimental Designs for Environmental Valuation with Choice – Experiments: A Monte Carlo Investigation. Working Papers in Economics 8/05, Department of Economics, University of Waikato, New Zealand.

Hensher, D., Greene, G., 2003. The Mixed Logit Model: The State of Practice. Transportation 30 (2), May 133-76.

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, 33 (August), 307-317.

Kahi, A., Nitter, G., 2004. Developing Breeding Schemes for Pasture-Based Dairy Production Systems in Kenya, Derivation of Economic Values Using Profit Functions. Livestock Production Science 88:161-177.

Kuhfeld, F. W., 1997. Efficient Experimental Designs Using Computerized Searches. Sawtooth Software. Research Paper Series. SAS Institute, Inc.

Kuhfeld, F. W., 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. J., 1966. A New Approach to Consumer Theory. Journal of Political Economy 74: 132-57.

Louviere, J., Hensher, D., Swait, J., 2000. Stated Choice Methods and Analysis. Cambridge: Cambridge University Press.

Louviere, J., 2004. Random Utility Theory-Based Stated Preference Elicitation Methods: Application in Health Economics with Special Reference to Combining Sources of Preference Data. Centre for the Study of Choice (CenSoC), Working Paper No. 04-001, University of Technology, Sydney.

Marschak, J., 1960. Binary Choice Constraints on Random Utility Indicators. In Stanford Symposium on Mathematical Methods in the Social Sciences. Arrow, Kenneth (ed.) Stanford University Press.

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

Oldenbroek, K. (ed.) 2007. Utilization and Conservation of Farm Animal Genetic Resources. Academic publishers, Wageningen, The Netherlands.

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 89(4), 1005-1019.

Rose, J., Bleimer, B., 2004. The Design of Stated Choice Experiments: The State of Practice and Future Challenges. Working Paper ITS-WP-04-09, Institute of transport Studies, University of Sydney and Monash University.

Scarpa, R., Kristjanson, P., Ruto, E., Radeny, M., Drucker, A., Rege, J.E.O., 2003. Valuing Indigenous Farm Animal Genetic Resources in Kenya: A Comparison of Stated and Revealed Preference Estimates. Ecological Economics 45: 409-26.

Tano, K., Faminow, M., Kamuanga, M., Swallow, B., 2003. Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa. Ecological Economics 45: 393 –408.

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

Wollny, B. A. C., 2003. The Need to Conserve Farm Animal Genetic Resources in Africa: Should Policy Makers be Concerned? Ecological Economics 45, 341-351.

Zander, K., Holm-Mueller, K., 2007. Valuing farm animal genetic resources by using a choice ranking method. In J. Meyerhoff, N. Lienhoop, and P. Elsasser, (eds.) Stated Preference Methods for Environmental Valuation: Applications from Austria and Germany. Metropolis, Marburg, Germany.

Chapter 7

A Hedonic Price Model for Cattle in the Rural Markets of Central Ethiopia

Girma T. Kassie, Awudu Abdulai, Clemens Wollny

Paper submitted to Applied Economies.

Abstract

This study employs a hedonic price model to examine the factors that influence cattle prices in rural markets of central Ethiopia. The empirical results show that season, market location, class of cattle, body size and age are very important determinants of cattle price. The relative weight of the phenotypic characteristics of the animals is among the highest of all the factors considered. The importance of these characteristics shows the crucial role of preferences for animal traits in the purchasing and selling decisions of farmers and farmer-traders in these rural markets. These preferences at the farmers and farmer-traders levels are the ones that matter most in shaping up the diversity of animals kept at farm level. The diversity of cattle genetic resources is quite essential for generating or identifying best suited breeds of cattle, given the livelihood objectives of the target community.

Keywords: Dano, hedonic analysis, heteroscedasticity, phenotypic characteristics

7.1. Introduction

Cattle are indispensable components of rural livelihoods in Ethiopia. In arid and semi-arid parts of the country, the pastoral communities depend entirely on their livestock for their livelihoods (Little et al., 2001; Barrett et al., 2003; Ouma et al., 2007). In the more dominant crop-livestock mixed livelihood system, cattle serve in providing traction power, in generating cash, in buffering shocks, as sources of consumables and as sources of prestige, being the main indicator of wealth.

Despite their significance to the livelihood of rural households, not much research has been carried out to identify the determinants of prices of cattle or livestock in general. The very few exceptions are Andargachew and Brokken (1993), Fafchamps and Gavian (1997), Jabbar (1998), Barrett et al. (2003) and Jabbar and Diedhiou (2003). Using a weekly sheep price data collected over a year in central Ethiopia, Andargachew and Brokken (1993) reported that animal characteristics; i.e., weight, age, sex, body condition, coat color, and reason of buying are important factors influencing prices of the animals. Fafchamps and Gavian (1997), who employ monthly price data of over 20 years in Niger to examine the determinants of prices, reported that season of selling, rainfall pattern, district location and seasonal holidays influence prices of

livestock. Jabbar (1998) analyzed a monthly sheep and goat price data over 14 months in Nigeria and concluded that breed type and seasonal holidays significantly influence prices.

Based on a detailed transaction level data on cattle prices collected weekly for four years, Barrett et al. (2003) employ the concepts of structural heteroscedasticity and GARCH-M models to examine the determinants of prices and price variability in Northern Kenya. They conclude that season, rainfall pattern, holidays, market locations, restrictions such as quarantines and animal characteristics – body size and castration – are the main determinants of cattle prices in Kenya. Using data from Nigeria, Jabbar and Diedhiou (2003) observed that body size and body condition are more important determinants of cattle prices than breed type, type of buyer, and trading time.

The importance of cattle in the rural livelihoods and the global threat of the erosion of animal genetic resources justify a thorough analysis of the preferred characteristics of the animals to guide conservation and improvement programs. The present study makes a contribution in this direction by using various econometric techniques to examine the various factors that influence cattle prices and to determine their relative weights in the pricing of cattle. Although heteroscedasticity is expected in hedonic price analysis, not so much attention is given to it in relevant scientific reports (e.g., Jabbar and Diedhiou, 2003; Huang and Lin, 2007). We employ regression with heteroscedasticity consistent errors, FGLS, as well as SHM approaches to analyze transaction level data in five rural Ethiopian markets. To the extent that we use these methods on the same data set, we are able to compare the models to show the specification that yields appropriate results with our data set. The results should contribute to the knowledge gap that persists in price discovery in rural livestock markets of Sub-Saharan Africa

The next section of the paper describes the rural markets and the data source. This is followed by an outline of the analytical framework employed. The section that comes next discusses the results of the econometric analyses. A conclusion of the research findings is presented in the final section.

7.2. Study Location and Data Generation

7.2.1. Dano District, the Rural Markets and Price Discovery

The study was conducted in the Dano district, which is located 250 km west of the Ethiopian capital Addis Ababa. The district is about 66,000 hectares wide, with a human population of

83,000. Livestock, particularly cattle, are important assets of the community. In 2005, it was estimated that there are 75,000 cattle, 3,500 equines and 7,500 small ruminants in the district. Semi-subsistence crop-livestock mixed farming system is the mainstay of livelihoods for the district's human population. The most important annual objective of the average household is producing sufficient food for the family.

The study covered five markets. Four of the markets, namely, Sayo, Menz, Dano-Roge and Awadi-Gulfa[1], are situated within Dano district. Sayo, the administrative and economic capital of the district, has two different cattle market places that set on Wednesdays and Saturdays. Menz is a small market located at about 12 km north of Sayo and sets on Tuesdays. Dano-roge is located at the northern tip of the district some 28 km far from Sayo. Roge sets on Thursdays and, unlike in other markets, cows and calves are the cattle frequently exchanged. Awadi-Gulfa market is located 24 km northeast of Sayo and sets 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 and it sets on Saturdays. 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. None of the markets has any shade for both human beings and animals or any trough for water and feed. Only Ijaji and Sayo are accessible by car throughout the year, while the others can be accessed only on foot in the rainy season. Animals are trekked to and from the markets throughout the year. All cattle markets are dominated with male buyers and sellers with virtually no women around. All the markets set for half a day mostly in the afternoons.

Farmers and farmer-traders are the main marketers, both as sellers and as buyers in these rural livestock markets of central Ethiopia. Brokers and full time traders are increasingly available as the size and proximity of the markets to highways increases. Price discovery in such markets is a long and intricate process normally done through a one to one bargaining between the seller and the buyer with brokers helping in facilitation. The bargaining is essential mainly because farmers, both as sellers and as buyers, have no sufficient market information and they want to make sure that what they receive or pay is not less or more than what the animal is worth.

[1] It is also known as Harbi Gulfa.

A farmer who wants to sell an animal has to go through a number of market visits and discussions with neighbors who have sold livestock recently, friends who have been in the markets, and if available, traders and brokers who live nearby to come up with a starting price[2] for the animal. One important feature of farmers as sellers in rural markets is that they barely have a clear idea as to how much direct and indirect cost they have incurred on their products. The starting prices for the animals are, therefore, set based on the prevailing market prices, with all the characteristics of the animal and the circumstances of selling considered. Likewise, buyers go through virtually the same process to have some idea about the price they will pay for an animal.

The discussions and visits made to fix the price of an animal are influenced by the different characteristics of the animal. The relative importance attached to each of the traits and the bargaining power of the seller tends to influence the price the buyer pays in the end. The prices sellers receive naturally determine the income available to the rural households in that particular period, with clear implications on the sustenance of their livelihoods.

7.2.2. Sampling and Data Generation

Data were generated through surveys in the district and in the five rural markets described above. The first survey aimed at quantifying the important variables related to livestock production and marketing with a deliberate focus on cattle. The sample size for this survey was 200 randomly selected households from 10 randomly selected peasant associations of Dano district. The second survey was a quarterly cattle transaction survey in the five rural markets with a sample of 20 cattle buyers in each season from each market. Given that some of the buyers purchased two animals at a time, the final sample size was 411. This paper employs the second survey with the previous one used only in describing the production and marketing systems.

The quarterly transaction survey focused on the phenotypic traits of the animals traded, places where 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. Age was estimated by the buyers by observing the teeth of the animal.

[2] The difference between the starting (bargaining) price and the final selling price ranges between 50 - 350.00 Ethiopian Birr (1 US dollar ≈ 8.70 Birr in 2006).

Data collection for each season was carried out over two weeks (two market days) simultaneously in all of the markets. The first season was end of February to beginning of March. This is immediately after the crop harvesting period 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. This is evident from Figure 7.1. Data collection for the second season was carried out after three months in late May to early June. This is a period when prices of cattle decline, as buyers, predominantly farmers, usually lack funds to purchase cattle. Moreover, since it is the beginning of the rainy season, farmers tend to focus on their cropping activities.

The third round of data collection was conducted in 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 restricted free grazing in the rainy season. As expected, this is the most favored period by buyers and the least preferred by sellers (see Figure 7.1). The last round of data was collected in late November. This is the beginning of the harvesting period for early maturing crop varieties and the declining prices for 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. The feed scarcity declines, whereas farmers become more interested in selling their animals.

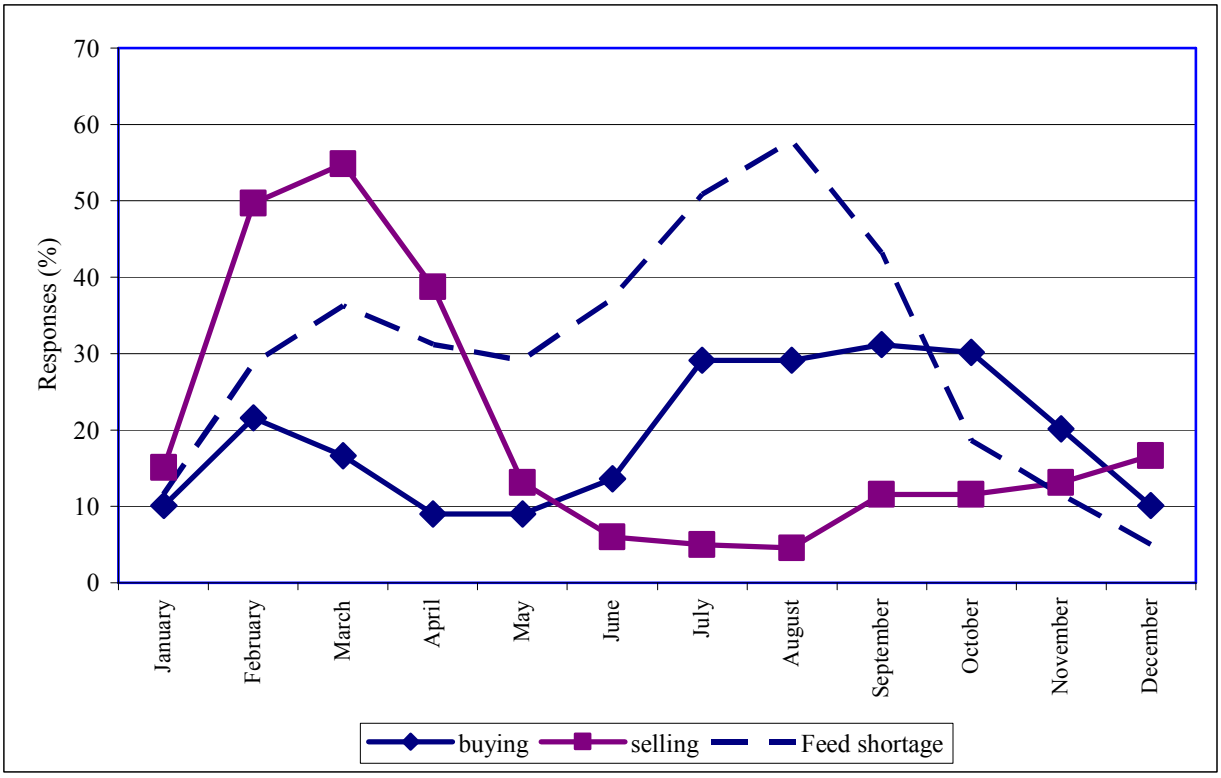


Figure 7.1: Feed availability calendar and cattle selling and buying season preferences of Dano farmers.

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 plowed for more than 2 seasons and sometimes castrated are called '*sangota*'. Younger male cattle with plowing experience of less than 2 seasons and uncastrated are called '*jibbota'*. A Female cattle 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'*. In this paper we use ox, bull, cow, heifer, and calf to mean '*sangota'*, '*jibbota'*, *'sa'a'*, '*gorba'*, and '*jabbota',* respectively. It is worth noting that these classifications somehow overlap 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 employs the buyers' classification.

7.3. Analytical Framework

Theoretically, the prices cattle sellers receive are reflections of the utility anticipated 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 research focuses on the main phenotypic attributes that buyers inspect when buying an animal. The external features farmers look at and attach value to are age, color, body size, sex, and the place where the animals were brought from. As discussed above, experiences with some of these characteristics have shown that they significantly influence market prices of livestock.

The different levels of the similar attributes that differentiate cattle are known to both buyers and sellers. 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.

Following Rosen (1974) and Palmquist (2006), let x_{0j} be the total amount of the j^{th} product characteristic provided to the consumer by consumption of all products, x_{ij} be the quantity of the j^{th} characteristic provided by one unit of product i, and q_i be quantity of the i^{th} product consumed. Then, the total consumption of each characteristic can be given as

$$x_{0j} = f_i(q_1,...,q_n; x_{1j},...,x_{nj}) \quad (1)$$

and the consumer's utility function is expressed as

$$U = (q_1,..q_n; x_{11}, x_{12},.., x_{1m}, x_{21}, x_{22},., x_{nm}) \quad (2)$$

where ***n*** is the number of products and ***m*** the number of characteristics.

The consumer is assumed to maximize this utility function subject to a budget constraint that can be specified as

$$\boldsymbol{Y} = \sum_{i} \boldsymbol{p_i q_i} \tag{3}$$

where $\boldsymbol{Y}$ is fixed money income, and p_i is fixed price paid for the i^{th} product. The consumer's utility maximizing level quantity of each product can then be estimated by maximizing the Lagrangian:

$$\boldsymbol{L} = \boldsymbol{U}(\boldsymbol{x}_{01},..,\boldsymbol{x}_{0n}) - \boldsymbol{\lambda}(\sum_{i} \boldsymbol{p_i q_i} - \boldsymbol{Y}) \tag{4}$$

where $\boldsymbol{\lambda}$ is the Lagrangian multiplier.

Assuming an interior solution, the first-order condition of the Lagrangian for q_i is given as

$$\frac{\partial \boldsymbol{L}}{\partial \boldsymbol{q_i}} = 0 = \sum \left(\frac{\partial \boldsymbol{U}}{\partial \boldsymbol{x}_{0j}} \right) \left(\frac{\partial \boldsymbol{x}_{0j}}{\partial \boldsymbol{q_i}} \right) - \boldsymbol{\lambda p_i} \tag{5}$$

It can easily be shown that $\boldsymbol{\lambda}$ is equal to the marginal utility of income $\boldsymbol{(\partial U/\partial Y)}$. Substituting $\boldsymbol{\partial U/\partial Y}$ for $\boldsymbol{\lambda}$ and solving for $\boldsymbol{p}_i$, equation (5) can be rewritten in order to express the demand for attributes as a function of the marginal utility of the attribute and the marginal utility of income.

$$p_i = \sum \left(\frac{\partial x_{0j}}{\partial q_i} \right) \left[\frac{\left(\frac{\partial U}{\partial x_{0j}} \right)}{\left(\frac{\partial U}{\partial Y} \right)} \right] \tag{6}$$

As income is defined to be equal to expenditure (equation 4), the term in the square bracket is the marginal rate of substitution between expenditure and the j^{th} product characteristics.

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). This is essentially due to poor

communications and transport infrastructure, limited rule of law, and restricted access to commercial finance, all of which make markets function much less effectively. Several empirical studies have shown that prices are also related to the attributes 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, in this case 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. 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 starts with 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[3] given by

$$\ln(\boldsymbol{price}) = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \tag{7}$$

where $\boldsymbol{X}$ is the vector of independent variables including the constant term, characteristics of cattle and the socioeconomic variables considered, $\boldsymbol{\beta}$ is a vector of parameters to be estimated and $\boldsymbol{\varepsilon}$ is an independent 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[4].

White's formula (White, 1980) has generally been used in the empirical literature to obtain heteroscedasticity consistent (HC) standard errors. However, White's estimator (HC_0) is believed to be less useful in small samples because the squared OLS residuals tend to underestimate the squares of the true disturbances. Simulation based results indicate that the white estimator is a bit too optimistic and the matrix a bit too small resulting in larger asymptotic t-ratios (Greene, 2003). To obtain more reliable standard errors, MacKinnon and White (1985) and Davidson and MacKinnon (1993) suggest three (HC_1, HC_2 and HC_3) alternative ways of corrections. The alternative covariance matrix estimators of the error term, including the OLS and that of White (1980), are specified as:

[3] Taking the natural log of price as dependent variable makes the estimated coefficients approximations of the percentage price change associated with a unit change in the independent variable.

[4] According to Long and Ervin (2000) and Verbeek (2004), the immediate procedure in this case is to assume the heteroscedasticity to be of an unknown form and to modify the error terms accordingly. The regression analyses employed here therefore aim at addressing this heteroscedasticity.

$$\boldsymbol{OLS} = \frac{\sum \boldsymbol{e}_i^2}{\boldsymbol{n}-\boldsymbol{k}}\left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1} \tag{8}$$

$$\boldsymbol{HC}_0 = \left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1}\boldsymbol{X}'\boldsymbol{diag}\left[\boldsymbol{e}_i^2\right]\boldsymbol{X}\left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1} \tag{9}$$

$$\boldsymbol{HC}_1 = \frac{\boldsymbol{n}}{\boldsymbol{n}-\boldsymbol{k}}\left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1}\boldsymbol{X}'\boldsymbol{diag}\left[\boldsymbol{e}_i^2\right]\boldsymbol{X}\left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1} \tag{10}$$

$$\boldsymbol{HC}_2 = \left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1}\boldsymbol{X}'\boldsymbol{diag}\left[\frac{\boldsymbol{e}_i^2}{1-\boldsymbol{h}_{ii}}\right]\boldsymbol{X}\left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1} \tag{11}$$

$$\boldsymbol{HC}_3 = \left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1}\boldsymbol{X}'\boldsymbol{diag}\left[\frac{\boldsymbol{e}_i^2}{\left(1-\boldsymbol{h}_{ii}\right)^2}\right]\boldsymbol{X}\left(\boldsymbol{X}'\boldsymbol{X}\right)^{-1} \tag{12}$$

where $\boldsymbol{n}$ is number of observation, $\boldsymbol{k}$ number of parameters estimated, and $\boldsymbol{h}_{ii}$ is $\boldsymbol{x}_i^{'}(\boldsymbol{X}'\boldsymbol{X})^{-1}\boldsymbol{x}_i$. The empirical observations made by MacKinnon and White (1985) and by Chesher and Austin (1991) show that HC_0 performs worse than HC_2 and HC_3. Davidson and MacKinnon (1993) also advise against HC_0 in favor of HC_2 or HC_3, particularly when the diagonals of the hat matrix ($\boldsymbol{h}_{ii}$) are available. We have estimated regressions with all (OLS, HC_0 to HC_3) types of standard errors as a first option.

The second option to deal with heteroscedasticity employed in this study is the feasible generalized least squares. The general specification of the covariance matrix of the error term can be given as $\mathbf{V\{\varepsilon\}} = \boldsymbol{\sigma^2\psi}$, where $\boldsymbol{\psi}$ is a positive definite matrix that might depend on $\boldsymbol{X}$ and which can have known or unknown form. It is apparent that HC standard errors can be obtained either by using OLS estimator and adjusting the standard errors to make them robust (the first option discussed above) or by deriving an alternative estimator that is efficient (Verbeek, 2004). The latter approach begins with the identification of a transformation matrix P such that $\boldsymbol{\psi^{-1}} = \boldsymbol{P'P}$. This implies that $\boldsymbol{P\psi P'} = \boldsymbol{I}$. By transforming the regression model with P, we can generate the following equation

$$\boldsymbol{P}[\ln(\boldsymbol{price})] = \boldsymbol{PX\beta} + \boldsymbol{P\varepsilon} = \ln(\boldsymbol{price})^* = \boldsymbol{X}^*\boldsymbol{\beta} + \boldsymbol{\varepsilon}^* \tag{13}$$

The estimator for the slope parameters will hence be given as

$$\hat{\boldsymbol{\beta}}^{*} = (\boldsymbol{X}^{*}{}'\boldsymbol{X}^{*})^{-1}\boldsymbol{X}^{*}{}'\boldsymbol{y}^{*} = (\boldsymbol{X}'\boldsymbol{\psi}\boldsymbol{X})^{-1}\boldsymbol{X}'\boldsymbol{\psi}^{-1}\boldsymbol{y} \quad (14)$$

and this is the basic form of the generalized least square (GLS) estimator. This is estimable only if the form of the heteroscedasticity is detected and so $\boldsymbol{\psi}$ is known. However, if $\boldsymbol{\psi}$ is unknown, the feasible or estimated generalized least squares (FGLS or EGLS) can be employed, first to estimate $\boldsymbol{\psi}$ and then to estimate the parameters. Hence, FGLS model was estimated as an alternative way of dealing with the heteroscedasticity observed in the error terms.

The third set of analysis carried out 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 estimates 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

$$\ln(price) = X\beta + \sigma\gamma + \varepsilon \quad (15)$$

where $\boldsymbol{\sigma}$ is the conditional standard deviation of the natural log of price and $\boldsymbol{\gamma}$ is its coefficient. The second model is the regression of $\boldsymbol{\sigma}$ on selected exogenous variables (Z) in X.

$$\boldsymbol{\sigma} = \boldsymbol{Z}\boldsymbol{\lambda} + \boldsymbol{\upsilon} \quad (16)$$

where $\boldsymbol{\lambda}$ is the vector of parameter estimates and $\boldsymbol{\upsilon}$ is an iid error term.

The estimation is conducted such that the predicted values of equation (16) will be substituted into equation (15) in each step until the parameters converge[5]. This simultaneous estimation strategy is suitable for an analysis of price risk and the risk premiums relevant to cattle marketing (Barrett et al., 2003). The rigorous econometric analysis employed in the present study has two advantages. First, it helps in modeling and explaining the highly intricate pricing

[5] We used STATA 9.2 SE's default convergence level of three stages iterative least square estimation.

of cattle in these rural markets. Second, it allows us to check the consistency of the results of the modeled data that has heteroscedastic standard error.

7.4. Results and Discussion

7.4.1 General

The results from the OLS regression and those from the estimations with adjustments following MacKinnon and White – M&W - (1985) and Davidson and MacKinnon – D&M - (1993) are presented in Table 7.1. The estimates of the OLS regression show no omitted variables, but imply heteroscedastic errors. The adjustments made on the standard errors following M&W (1985) and D&M (1993) resulted in standard errors often greater than that of the OLS. As expected, the White standard errors were found to be very low. The White errors resulted in highly inflated t-ratios and hence are not discussed here. The statistical significance of the estimated parameters is uniform for the adjusted M&W and D&M standard errors.

Based on the Akaike and Bayesian information criteria, the FGLS appeared to be a significant improvement over the ordinary linear regressions (Table 7.2). The simultaneous equations estimation was also found to be an improvement over the single equation models (Table 7.2). The signs and magnitudes of the parameter estimates show a slight difference across the models. Season dummies have virtually the same significance pattern in all the models. Market locations have similar signs and significance of coefficient estimates in all specifications except that Roge market dummy was not statistically significant in the modified SHM. Cattle class dummies also show a similar pattern of significance across the models, while attributes of cattle reveal a similar pattern of significance across the different models, with the notable exception of medium body size in the modified SHM. Among the places where animals are brought from, Wellega was found to be statistically significant ($\alpha = 0.1$) in the OLS and SHM estimations while the rest are not significant even at the 10% level in all estimations.

Education dummies are the ones which show considerable differences in terms of magnitude across the different models. Higher education (secondary and above secondary) levels are statistically significant in OLS and HC_1 to HC_3 models. Reading and writing was found to be significant in the HC_1 to HC_3 estimations only. Elementary and above secondary levels are significant in the FGLS estimations whereas only secondary school level was significant in the modified SHM.

7.4.2 Determinants of Prices

All the econometric estimations consistently show that season, market location, class of cattle, body size and age are very important determinants of cattle prices in the rural markets of central Ethiopia. Cattle prices in seasons one and two were found to be similar across all estimations. However, the prices in season three were consistently significantly lower than those in season one. This is the period when farmers would not have harvested their crops and their liquid assets are also quite low. Season three is therefore the least preferred period to sell cattle by farmers (see Figure 7.1). Price in season four was found to be significantly higher than that of season 1 in all specifications. This is expected because it is the period when farmers can postpone their cattle selling decisions if the prices are not acceptable, since they can easily rely on the recently harvested crop yield.

Most of the coefficients of the market dummies were also found to be significantly different from zero, implying price differentials for cattle relative to Dano, the base market. The frequency of each class of animal is also decisive in this particular estimation. It is only at Roge market that the frequency of the bigger animals – oxen and cows – is less than that of Sayo. This clearly undermines the prices in 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.

Table 7.1: OLS and Heteroscedasticity Consistent Standard Error Estimations

ln(price)	Coefficient	OLS SE	HC_1SE	HC_2SE	HC_3SE
Constant	6.2694*	0.0798	0.0958	0.0983	0.1046
Season 2	0.0161	0.0167	0.0178	0.0179	0.0186
Season 3	-0.0374†	0.0172	0.0162	0.0163	0.0170
Season 4	0.0975*	0.0166	0.0166	0.0167	0.0173
Menz	0.1240*	0.0226	0.0195	0.0196	0.0203
Awadi	0.0926*	0.0196	0.0208	0.0209	0.0218
Ijaji	0.0097	0.0254	0.0253	0.0256	0.0268
Roge	-0.0845*	0.0228	0.0265	0.0266	0.0277
Ox	0.2825*	0.0294	0.0293	0.0295	0.0308
Cow	-0.0214	0.0318	0.0317	0.0319	0.0332
Heifer	-0.1153*	0.0268	0.0278	0.0281	0.0294
Bull	0.0675†	0.0237	0.0297	0.0299	0.0312
Medium Body	0.0345†	0.0139	0.0146	0.0147	0.0153
Big body	0.1786*	0.0185	0.0185	0.0185	0.0193
Color-red	0.0281	0.0212	0.0232	0.0241	0.0259
Color-black	-0.0875†	0.0289	0.0300	0.0309	0.0331
Color-white	0.0339	0.0485	0.0546	0.0579	0.0635
Age	0.1639*	0.0228	0.0256	0.0260	0.0273
Age square	-0.0098*	0.0014	0.0015	0.0015	0.0016
Neighbor distr.	-0.0410	0.0316	0.0386	0.0418	0.0469
Wellega	0.1190	0.0675	0.0883	0.0973	0.1110
Keffa	-0.0683	0.0585	0.0807	0.0870	0.0971
Read and write	-0.0421‡	0.0315	0.0260	0.0263	0.0276
Elementary	-0.0271	0.0211	0.0216	0.0220	0.0232
Secondary	0.0659†	0.0287	0.0261	0.0265	0.0279
Above second.	0.0981‡	0.0537	0.0482	0.0499	0.0534
Religious study	-0.0827	0.0508	0.0641	0.0662	0.0708

*, †, and ‡ significant at $\alpha = 0.01$, $\alpha = 0.05$, and $\alpha = 0.05$, respectively, using HC_3 standard errors.

Farmers' classification of cattle into sex and functional categories was found to be important determinant of prices. Based on the results of the FGLS, for example, oxen have a price premium of about 30% 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 in the linear models (Table 7.1) and in the modified SHM (Table 7.2). It has, nonetheless, the expected sign in the FGLS (Table 7.2) model. Though the cow dummy coefficient is not statistically significant, the results generally show that the relative value attached to female cattle is lower, since milk is not tradable in the district.

Body size was found to be very important determinant of cattle prices, with big size having a price premium of about 18% over small size. As evident from the results of the FGLS estimation, even medium sized cattle received prices that were about 5% higher than small cattle. This is a clear indication of the interests of cattle keepers/buyers of the area and conforms to previous studies on the topic (Jabbar and Diedhiou, 2003; Barrett et al., 2003; Scarpa et al., 2003). 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 with the maximum effect occurring at 8.96 years (using FGLS results). At older ages, the prices decrease as age increases. The maximum effect is well above the average age (6.23 years) of animals captured in the transaction survey, suggesting that the prices of cattle decline, as they get out of age for the basic household level activities such as plowing.

The coat color of cattle is also an attribute buyers normally consider when purchasing an animal. Virtually all econometric estimations consistently reveal that red and white colors have no significantly different influences on prices, 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 dummy is not only statistically significant but also exhibits the highest value among the colors included in the model. Specifically, black coated cattle will attract a downward premium of about 9% as compared to mixed color coated cattle. The survey results showed that this is essentially due to the fact that black coated animals are considered very susceptible to trypanosomosis that is prevalent in the area.

Table 7.2: FGLS and Modified SHM estimations

	FGLS		Modified SHM [ln(price)]		Modified SHM [St.dev. ln(price)]	
ln(price)	Coef.	St. Err.	Coef.	St. Err.	Coef.	St. Err.
Constant	6.420*	0.081	6.2650*	0.0790	0.540*	0.038
Season 2	0.018	0.014	0.0170	0.0160	0.004	0.018
Season 3	-0.045*	0.014	-0.0320‡	0.0190	0.018	0.019
Season 4	0.118*	0.015	0.1010*	0.0170	0.033‡	0.018
Menz	0.119*	0.018	0.1180*	0.0240	0.017	0.023
Awadi	0.091*	0.019	0.0880*	0.0200	-0.025	0.021
Ijaji	0.011	0.022	0.0080	0.0250	-0.015	0.027
Roge	-0.090*	0.023	-0.0630	0.0400	0.095*	0.023
Ox	0.306*	0.025	0.2520*	0.0530	-0.110*	0.018
Cow	0.025	0.028	-0.0770	0.0930	-0.255*	0.023
Heifer	-0.145*	0.023	-0.0980*	0.0370	0.061*	0.026
Bull	0.076*	0.025	0.0590†	0.0270	-0.103*	0.025
Medium Body	0.047*	0.013	0.0280	0.0200		
Big body	0.174*	0.017	0.1740*	0.0190		
Color-red	0.036	0.024	0.0360	0.0260		
Color-black	-0.092*	0.034	-0.0910*	0.0290		
Color-white	0.024	0.060	0.0210	0.0530		
Age	0.115*	0.022	0.1810*	0.0290		
Age square	-0.006*	0.001	-0.0110*	0.0015		
Neighbor distr	-0.049	0.039	-0.0360	0.0310	-0.075*	0.034
Wellega	0.099	0.106	0.1130‡	0.0660	0.110	0.073
Keffa	-0.019	0.051	-0.0670	0.0560	0.080	0.064
Read and write	-0.027	0.024	-0.0370	0.0320	0.025	0.035
Elementary	-0.033‡	0.020	-0.0200	0.0240	0.002	0.023
Secondary	0.025	0.028	0.0670†	0.0280	-0.009	0.031
Above second.	0.088†	0.038	0.0740	0.0660	-0.054	0.058
Religious study	-0.030	0.069	-0.0780	0.0500	0.028	0.055
St.dev. ln(price)			-0.155	0.267		

*, †, and ‡ significant at $\alpha = 0.01$, $\alpha = 0.05$, and $\alpha = 0.05$, respectively

Among the origin of cattle dummies included, only Wellega appears to be marginally significant in the modified SHM. These results show that cattle from Wellega have a price premium of up to 13% over those within Dano district. This is expected as the field surveys revealed that cattle from Wellega are considered to be big in size, disease free and highly marketable. Although statistically insignificant, the Keffa dummy has the expected negative sign as cattle from this zone are considered to be susceptible to diseases. Literacy variables included as proxies for bargaining power did not reveal any statistical significance of the variable for cattle price.

The coefficient of the conditional standard deviation of the natural log of price in the natural log price equation of the modified SHM is negative as expected but 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 defined by marketers as well as season, market, and origin of the cattle.

7.5. Conclusion

This study employed a hedonic model to examine the determinants of cattle prices in the primary rural markets of central Ethiopia. Transaction level data of cattle farmers and farmer-traders were used in the analyses. Data collected in rural markets to identify cattle price determinants resulted in estimates with standard errors that are mostly heteroscedastic. We employ heteroscedasticity consistent error regression, feasible generalized least squares and SHM estimations to account for heteroscedastic errors. Based on Akaike, Bayesian and log-likelihood criteria of model selection, we found that the feasible generalized least square and modified SHM formulations are best suited in examining price functions in such rural markets.

The empirical estimations consistently 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 kept at farm level. This diversity of the cattle genetic resources is essential for generating or identifying best suited breeds of cattle 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.

This study also contributes to the knowledge on how to deal with the rarely available transaction level data in rural markets of developing countries. The markets in such countries are perceived to be highly inefficient as a result of high transaction costs, information asymmetry, difficulties in contract enforcement and volatile prices (Fafchamps and Gavian, 1997; Abdulai, 2000; Barrett et al., 2003). Markets in rural Ethiopia generally lack physical infrastructure, and mostly have no watering facilities and shades both for human beings and animals, resulting in shorter market durations and potentially lower prices for cattle sellers.

Markets, especially those far from towns, seem to be quite alien to farmers who are buyers and sellers. In such cases, the influence and margin of brokers increase at the expense of mainly the sellers. Interventions aimed at increasing the bargaining power of cattle sellers could help them realize higher prices to raise their incomes. In particular, improving the physical infrastructure in these rural markets will enhance the marketability of cattle traded in the markets. Provision of information to cattle keepers to help them make appropriate decisions as to when and where to sell their animals would also be an advantage for them in realizing higher prices for their animals.

Acknowledgement

The authors would like to thank ILRI-BMZ project for funding this research. We are also very grateful for all respondents and all those involved in collecting the two sets of data used in this paper. The authors are solely responsible for the content of the manuscript.

7.6. References

Abdulai, A., 2000. Spatial Price Transmission and Asymmetry in the Ghanaian Maize Market. Journal of Development Economics 63, 327 – 349.

Andargachew, K., Brokken, R.F., 1993. Intra-Annual Sheep Price Patterns and Factors Underlying Price Variations in the Central Highlands of Ethiopia. Agricultural Economics 8, 125 – 138.

Anglin, P. M., Gencay, R., 1996. Semiparametric Estimation of a Hedonic Price Function. Journal of Applied Econometrics 11, 633-648.

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

Barret, C. B., Chabari, F., Bailey, D., Little, P., Coppock, D., 2003. Livestock Pricing in the Northern Kenyan Rangelands. Journal of African Economies 12 (2), 127 – 155.

Chesher, A., Austin, G., 1991. The Finite Sample Distributions of Heteroscedasticity Robust Wald Statistics. Journal of Econometrics 47, 153 – 173.

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 70 (4), 668 – 675.

Davidson, R., MacKinnon, J. G., 1993. Estimation and Inference in Econometrics. Oxford University Press, Cambridge.

Fafchamps , M., Gavian, S., 1997. The Determinants of Livestock Prices in Niger. Journal of African Economies 6 (2), 255-295.

Greene, W., 2003. Econometric Analysis, 5th Edition. Prentice Hall, New Jersey, USA.

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.

Huang, C. L., Lin, B. –H., 2007. A Hedonic Analysis of Fresh Tomato Prices among Regional Markets. Review of Agricultural Economics 29 (4), 783 - 800.

Jabbar, M. A., 1998. Buyer Preferences for Sheep and Goats in Southern Nigeria: A Hedonic Price Analysis. Agricultural Economics 18 (1), 21 -30.

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

Lancaster, K., 1966. A New Approach to Consumer Theory. Journal of Political Economy 74, 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 32 (3), 401 – 433.

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

MacKinnon, J. G., White, H., 1985. Some Heteroscedasticity Consistent Covariance Matrix Estimators with Improved Finite Sample Properties. Journal of Econometrics 29, 305 - 325

Oczkowski, E., 1994. A Hedonic Price Function for Australian Premium Table Wine. Australian Journal of Agricultural Economics 38, 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 89(4), 1005-1019.

Palmquist, R. B., 2006. Property Value Models. In: Maler, K.-G., Vincent, J., (Ed.) Handbook of Environmental Economics, Edition 1, Volume 2. Elsevier, pp. 763 – 819.

Parmeter, C.F., Henderson, D.J., Kumbhakar, S. C., 2007. Nonparametric Estimation of a Hedonic Price Function. Journal of Applied Econometrics 22, 695 – 699.

Rosen, S., 1974. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. Journal of Political Economy 82 (1), 34 -35.

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

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

Chapter 8

A Framework for Community Based Management of Indigenous Cattle Genetic Resources in Dano District, Central Ethiopia

Girma T. Kassie, Workneh Ayalew, Awudu Abdulai, Clemens Wollny, and Wolfgang Bayer

Paper submitted to Ethiopian Journal of Animal Production.

Abstract

This paper presents a framework for Community Based Management (CBM) of indigenous cattle in Dano district of Central Ethiopia. Results of multi-disciplinary research conducted over three years served as a foundation for this framework. It outlines the essential activities and components needed to be considered to empower the cattle keeping community for effective collective action in the conservation and sustainable use of indigenous cattle. Community based initiatives stand a better chance of success with positive effect on the sustainable use of the genetic resources under stressful environments. CBM of animal genetic resources (AnGR) is responsive to the dynamism within the community, AnGR and the eco-system. The most important institutions with strong bearing on the community's management of AnGR are the informal institutions (herding groups, social gatherings, etc.), the formal institutions in the locality (cooperatives, financial or religious institutions, etc.), the market, the administrative (political) entities, the research and extension institutions, and the interactions among the crop, natural resource and livestock sub-systems. Assumptions of favorable political environment, complementarity among the different stakeholders, continuous capacity building, and access to comprehensive market information were made in developing this framework.

Keywords: Community based management, Animal genetic resources, Sustainable utilization, Dano.

8.1. Introduction

An essential element for the continued contribution of livestock to supporting rural livelihoods in developing countries is the maintenance of genetic diversity in the livestock population. Genetic diversity in domestic animals encompasses the spectrum of measurable genetic differences among species and across all breeds within each species as well as within each breed[1] differences which are of interest for food and agricultural production (Köhler Rollefson, 2004). Variation in

[1] Breed is either a homogenous, sub-specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species, or it is a homogenous group for which geographical and/or cultural separation from phenotypically similar groups has led to acceptance of its separate identity (Turton, 1974).

the types of animal used enables the production of different combinations of products, product attributes and services that suit local community needs for consumption, savings and disposal.

The poor livestock keepers that live in usually low potential and unfavorable agricultural areas depend directly upon genetic, species and ecosystem diversity for their livelihoods (Anderson, 2003). Despite the paramount importance of diversity of animal genetic resources (AnGR) to the livelihoods of rural communities in developing countries, and the uncertainty about the actual magnitude of the loss, Tisdell (2003) argues that the continued loss of this diversity is undoubtedly of considerable significance even based on conservative estimates. According to FAO (2007), one breed becomes extinct every month and so its genetic wealth is irretrievably lost. Livestock genetic resources underlie the productivity and resilience of local agricultural systems. Thus, genetic erosion within livestock and their wild ancestors is of particular concern because of its implications for the sustainability of locally adapted agricultural practices and the consequent impact on food supply and security (Rege and Gibson, 2003).

Ethiopia, with an area of 1.12 million km^2, is said to have the largest volume and diversity of livestock resources than any other country in Africa. An estimated number of 40.3 million cattle, 20.7 million sheep, 16.25 million goats, 6.2 million equines, and 32 million poultry were reported to exist in private holdings in 2005/06 excluding the Afar and Somale pastoral areas (CSA 2006). A conventional livestock population survey done in 2004 in the pastoral regions of Afar and Somali, reported 2.12 million cattle, 2.6 million sheep, 4.14 million goats, and 1.02 million equine populations (CSA 2004). The overall camel population was estimated to be 2.3 million in 2004 (CSA, 2004). The national AnGR status report by the Institute of Biodiversity Conservation (IBC) shows that there are at least 25 cattle, 13 sheep, 15 goat, four camel, four donkey, two horse, two mule and five chicken indigenous breeds in Ethiopia. There are also three dairy cattle, 7 sheep, 7 chicken and two goat exotic breeds used for food and agriculture (IBC, 2004). This wealth of genetic resources is reported to be shrinking due to genetic erosion (ESAP, 2004).

Major causes threatening diversity of genetic resources in Ethiopia include poorly designed and managed introduction of exotic genetic materials, droughts and consequences of drought associated indiscriminate restocking schemes, political instability and associated civil unrest, and weak development interventions (ESAP, 2004). The effects of the misguided and uncontrolled introduction of exotic genes and that of interbreeding among indigenous breeds might require

application of molecular genetics for purposes of precision. In extreme scenarios, however, it could have a drastic effect leading to extinction of a breed within few generations. The application of artificial insemination in indigenous cattle using semen from exotic cattle breeds is, for instance, resulting in unforeseen substitution of indigenous genes by exotic genes (ESAP, 2004; IBC, 2004).

More important is the fact that Ethiopia is yet to develop and enact a binding livestock breeding policy. The limitations in skilled manpower and facilities are also paramount bottlenecks for the aspired development in the livestock sector. However, the relative importance and level of threat to maintenance of animal genetic diversity in Ethiopia is not precisely known. Encouraging, but far from sufficient, effort has been made to comprehensively document the AnGR diversity in the country. In addition to their inconclusiveness, previous research and development efforts generally ignored the importance of adapted indigenous farm AnGR due to a general belief that they are not adequately productive and incapable of contributing to increased agricultural production (IBC, 2004). The past and present neglect of local knowledge regarding AnGR and traditional breeding practices causes major difficulties to develop and implement appropriate participatory strategies at national and local level (Wollny, 2003).

8.2. Conserving AnGR Diversity

The irreversibility of extinction of AnGR and continuity of the undesirable reduction of the genetic diversity necessitate holistic and participatory approaches to conservation. FAO defines conservation of AnGR as all human activities, including strategies, (management) plans, policies and actions undertaken to ensure that the diversity of AnGR is maintained to contribute to food and agricultural production and productivity now and in the future (FAO, 2000). There are strong scientific arguments for conservation of AnGR. Apart from their known use values, AnGR are carriers of numerous genes that can serve current as well as future emerging needs. There are several strategic options discussed as regards how to maintain AnGR. In the short term a pragmatic option is the conservation of AnGR by maintaining genetic diversity of local breeds within their production systems (Gandini and Oldenbroek, 1999; Rege, 2003).

It is also argued that AnGR conservation aimed at sustaining livelihoods needs to take an approach that recognizes the array of contributions livestock make to livelihoods and the genetic characteristics related to these (Anderson, 2003). There are two broad approaches through which

AnGR can be conserved: *ex-situ* and *in-situ* (Rege and Gibson, 2003). *Ex-situ* approaches to conservation include cryopreservation of semen, oocytes and embryos, and keeping of live animals in designated localities, e.g. government farms or ranches. In marked contrast to the situation in plants, cryopreservation is technically feasible for very few livestock species at present. *In-situ* conservation, also called 'on-farm conservation', can be defined as the continuous maintenance of breeding populations by farmers in the agro-ecosystems where those populations have evolved (Rege, 2003). Thus, *in-situ* conservation encompasses entire ecosystems, including immediately useful species of crops, forages, agroforestry species, and other plant and animal species that form part of the system.

Traditional practices of livestock keeping communities probably involve multiple breeding goals (i.e. multipurpose uses), aesthetic values and behavioral aspects. Likewise, village communities may have different needs, perceptions and preferences by which they make decisions for buying, selling or mating of animals. The bottom line here is that communities manage their livestock using a wide range of indigenous knowledge that emanate from varying socio-economic, cultural and bio-physical environmental conditions (ESAP, 2004).

Hammond and Leitch (1996) assert that although no compelling quantitative data is available, about 50% of the total genetic variation in AnGR is between species and the remaining 50% is variation among breeds within species. Yet, the focus on conservation of AnGR is on maintaining intra-specific variation (within species). The genetic variation between breeds is likely to be much more relevant when a global perspective is taken, and when more extreme traits such as adaptation to harsh environments and disease resistance are considered (Rege and Gibson, 2003). Moreover, Wollny (2003) argues that intra-specific genetic diversity in AnGR is a function of natural selection and random or systematic human interventions, hence with more direct links to current human livelihoods of poor livestock keepers.

8.3. Definition and Importance of CBM of AnGR

The essence of CBM of AnGR emanates from the meanings of the terms community, community-based, and management. The term community usually refers to a group of people living under similar circumstances with common primary objectives and interests in life. A community-based organization is an entity formed or recognized by a community based on communal interests and objectives and to implement agreed decisions on behalf of the

community (Köhler-Rollefson, 2004). Management of AnGR is defined by Rege (2003) as the combined set of actions by which a sample, or the whole, of an animal population is subjected to a process of genetic and/or environmental manipulation with the aim of sustaining, utilizing, restoring, enhancing and characterizing the quality and/or quantity of the AnGR and their products. Thus, CBM of AnGR can be defined as a system of AnGR and ecosystem management in which the AnGR keepers are responsible for the decisions on identification, priority setting and the implementation of activities in conservation and sustainable use of the AnGR (Rege, 2003; Köhler-Rollefson, 2004).

Community based initiatives are receiving growing attention as sources of creative and productive activities of individuals or groups in societies (Rege, 2003). Such initiatives stand a better chance of success with positive effect on the sustainable use of the genetic resources under stressful environments. The dominant contemporary arguments about maintaining domestic animal diversity advocate for support and provision of incentives to local communities so as to continue managing their AnGR in their respective ecological contexts, but with the opportunity to develop by responding to or taking advantage of changing marketing and macroeconomic situations (Köhler-Rollefson, 2003). According to Rege (2003), this is so because local communities have a vested interest in all the natural resources (including AnGR) on which their livelihoods depend, and have the most to lose in the event of loss of these resources. The communities are also best placed to conserve them and have a better understanding than any other group of what it takes to manage their traditional resources sustainably.

CBM of AnGR responds to the dynamism within the community, AnGR and the eco-system whilst keeping the current and future objectives and interests of the custodian human society. The dynamism in the framework is explained through its sensitivity for the changes in preferences of traits and or the natural or man-made changes that may occur in the AnGR populations, e.g. effects of flooding, disease epidemics, drought or market demand. Changes in trait preferences imply that transformation in the agricultural sector might alter the priorities implied in the current preference analyses (see Chapters 5-7). Mechanization of farms, for instance, would make suitability for plowing a less preferred trait. Establishing a CBM of AnGR is, therefore, a continuous process with its components changing in type and importance in response to decisions of the communities.

8.4. Relevance and Logical Link of CBM of AnGR to Livelihoods

Most of the livestock wealth in developing countries is owned by smallholder farmers, who are likely to maintain this essential role under prevailing socio-economic and cultural circumstances until substantial economic developments lead to drastic changes in the size and structure of household incomes. Thus, until more viable alternatives to smallholder subsistence livestock keeping come into play so as to transform rural livelihoods, the most reasonable option for sustainable use of AnGR is working with and for these rural communities who maintain them. Smallholder farmers have unique features, particularly as compared to pastoralists, in that they do not rely exclusively on livestock and therefore have to organize the management of AnGR in their possession in different ways (Bayer *et al*., 2003).

Attempts to substitute elements of the smallholder farming system with research generated technologies are associated with risks to smallholders. For instance, the livestock resources have evolved for centuries under the custody of smallholders in response to recurrent challenges of harsh environments where the majority of poor smallholders live in. The massive efforts to replace the indigenous livestock resources with 'improved' types developed for specific traits under ideal conditions were not only ineffective (Rege, 2003) but also resulted in erosion of valuable genetic diversity (FAO, 2000)[2].

The scientific community has very recently realized the flaw in the conventional approach and agreed to start with what the communities can offer and to work with them. This is justifiable as indigenous livestock breeds play an important, even crucial, role for sustainable rural livelihoods and the utilization of marginal ecological areas (Köhler-Rollefson, 2003). In addition, rural communities and their livestock breeding strategies depend not only on natural and socio-economic conditions, but also on the abilities and interests of the livestock keeping families (Bayer *et al.*, 2003). This growing interest in working with communities with due appreciation and use of indigenous knowledge has given rise to the concept of Community Based Management (CBM) of resources. Earlier applications are in the field of forestry and other environmental resources. Application on management of AnGR started very recently. The documented experiences in Africa are the CBM project to manage poultry diversity in Malawi (Gondwe *et al*., 2003), the one designed to improve and conserve the indigenous Djallonke sheep

[2] In fact, in transforming or reorienting production systems, crossbreeding and AI can be implemented in a controlled manner to create the access for animals with functions and products the markets demand.

breed in Ivory Coast (Yapi-Gnaore *et al*., 2003), and the initial efforts on CBM of local goat genetic resources in Benin (Dossa, 2007). This specific framework is to be the first of its kind in Ethiopia.

8.5. Components of CBM of Indigenous Cattle in Dano District

Empowering, motivating, informing and building the capacity of the community for a sustainable management of the AnGR is the main purpose of a CBM of AnGR. For instance, in Dano district of central Ethiopia, smallholders own the entire cattle population. Thus, community refers in this case to these smallholders. The focus of the CBM framework discussed hereafter is on cattle, basically for two reasons. First, the study focused on cattle as these are by far the most important species of farm animals in the district. Second, this is the first initiative to implement a CBM framework in the country and so would be sensible to start with one priority species.

CBM of AnGR starts with careful analysis of the prevailing production system. The livestock production system in Dano district can be described as semi-subsistence, resource-constrained, cattle dominated and risk prone. The most important institutions with strong bearing on the community's management of AnGR are the informal institutions (herding groups, social gatherings, etc.), the formal institutions in the locality (cooperatives, financial or religious institutions, etc.), the market, the administrative (political) entities, the research and extension institutions, and the interactions among the crop, natural resource and livestock sub-systems. The sketch below shows the confluence of these forces (Figure 8.1).

Social institutions, both formal and informal, play a significant role in determining the effectiveness of a CBM of AnGR. These institutions can influence farmers' access to, and management of, household and community–level resources affecting their action regarding the farm animal genetic diversity. The way herding groups, religious institutions, and social norms and values operate determines the size and characteristics of livestock a household is willing to keep. For instance, in areas where black or white coated cattle are considered culturally or religiously bad, a selective culling would eventually minimize the numbers of cattle with undesirable coat colors in the herd[3]. The same can be said about hump and horn size and shape. This deliberate exclusion of animals based on a single attribute might eventually influence other

[3] Farmers in Dano believe that black coated cattle are susceptible to trypanosomosis and white coated cattle are considered inappropriate for fattening.

characteristics. A two pronged intervention is required in this regard; i.e., first, identifying and analyzing the important traditional norms regarding management of AnGR; second, enhancing the useful traditions to make them quickly rewarding and sensitizing the community against harmful traditions. The emphasis should, however, be on harnessing the social institutions for the sustainable management of the genetic resources by the people.

Formal institutions such as cooperatives and rural credit institutions will also have a paramount role in conserving and sustainably using the communally managed AnGR. Voluntarily established cooperatives increase the bargaining power of smallholders and the access to inputs and intermediary outputs. Therefore, smallholders would be able to reduce unfair payments and can opt to postpone selling decisions thereby saving genetic resources from desperate and less rewarding marketing. Valuations of the unique traits, labeling products accordingly, and, if possible, certification of genetic property rights would obviously increase the market margins of smallholders at the same time improving marketability and hence utilization of the genetic resources.

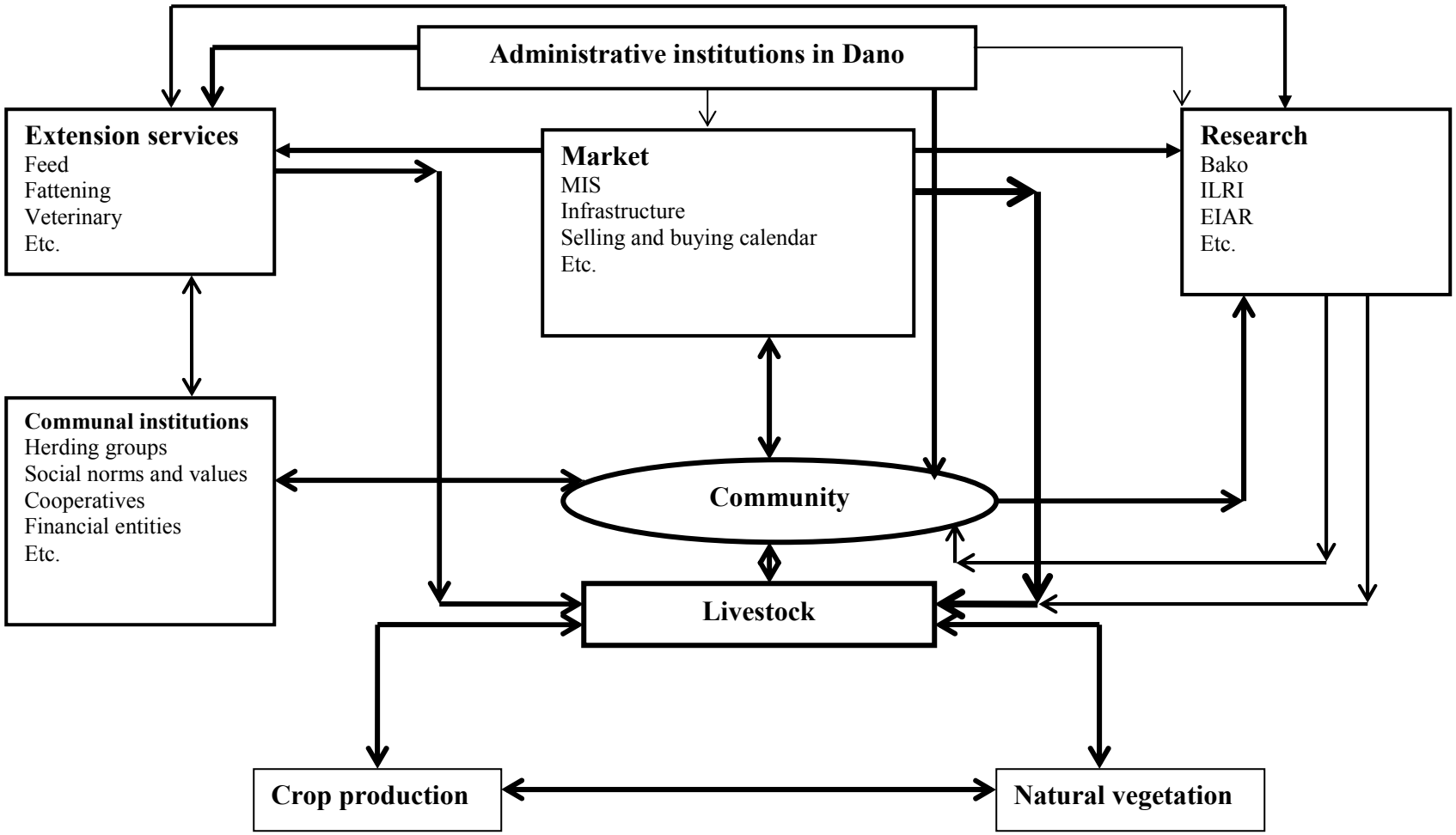


Figure 8.1: Schematic representation of the important actors and their interactions in the CBM of AnGR in Dano district

Source: Authors' formulation

Another crucial component influencing the community - AnGR nexus is the marketing system. The market forces do challenge conservation by smallholders of the genetic resources with no easily tradable uses and no immediate benefits. As a result, identifying sound reasons why society should preserve genetic resources that specialized formal markets have abandoned for some reasons is still an important challenge in conservation of AnGR (Mendelsohn, 2003). Efforts are needed in valuing the different attributes and functions of the AnGR owned by the smallholders as well as in availing timely, adequate, and precise (*tap*) market information for the community.

Proper identification, characterization and valuation of the non-tradable traits of the genetic resources might facilitate the recognition and legal protection of livestock keepers' entitlements for the important characteristics of their genetic resources thereby securing a continuous market. Otherwise, the conservation of AnGR option values through livestock husbandry by the poor is a hitherto unrecognized and unrewarded service to society (Anderson and Centonze, 2006). Hence, all improvements that can be introduced into the production system based on the relative economic values of the traits of the indigenous AnGR might increase the marketability of the indirect and/or long term values of the AnGR. Inter-temporal and spatial patterns of supply and demand need to be analyzed and made available to the community to enable them to decide with full information. Equally important is the development of the market infrastructure to avoid undermined prices as well as forced selling as the transaction costs are often unbearable in such remote rural areas.

Research and extension institutions are expected to describe and analyze the dynamism and the interactions within the livestock production system. Only after thorough understanding of the system should interventions be made with a clear objective of empowering the community to sustainably generate greater benefits from their AnGR. Bayer *et al.* (2003) strongly advise that the current breeding strategies and breeding objectives of the smallholders should be clear before support is given to any specific type of breeding operation or suggestions are made for improvement. Interventions that have a bearing on CBM of AnGR cannot be confined to issues of breeding and have to fit into the wider livelihood systems of smallholders.

Research and extension procedures need re-designing so as to allow communities take greater roles in initiating the research process. The focus of research and extension has to be on the gaps and interests of the community. Concerted effort is needed among the research institutions (in this particular case, the International Livestock Research Institute (ILRI), Bako Agricultural Research Center (BARC), and the Ethiopian Institute of Agricultural

Research (EIAR) and between the research institutions and the District Office of Agriculture and Rural Development (DOARD) which handles all extension related activities in the district. A list of sample activities identified based on the discussions made with the community and that can be incorporated in the implementation of the CBM of AnGR are indicated in Table 8.1.

The administrative entities are also very powerful part of the system enormously influencing the community and the AnGR through the official policies and strategies they implement. The most important influences are related to rights to own and use the basic means of production such as land and credit. Farmers in Ethiopia have only usufruct right on the land and hardly have access to affordable rural credit scheme. Changes that empower the smallholders for a better utilization of the basic resources would significantly contribute to the success of the communal management of the animal genetic resources.

On the other hand, although Ethiopia is yet to enact a livestock breeding policy, the overall tendency for the last four decades in the area of genetic improvement has been limited to loose AI services and crossbreeding of some indigenous breeds with supposedly improved exotic breeds to increase milk production with little (if any) consideration to other production and service functions of cattle. Sustainable management of the AnGR requires policy formulation to be based on the objectives of the livestock keepers and their manifestations through trait preferences for bulls and for cows. Suggesting such a major re-orientation of the policy setting procedure in developing countries like Ethiopia is easier said than done in practice. Nonetheless, it would be much less costly to carefully design the policies that help avert the continued loss of genetic diversity in indigenous cattle.

In general, the important components of the livestock production system and their interactions have both direct and indirect influences and they need to be manipulated to enable the community own, manage and benefit from the AnGR in a sustainable manner. As the genetic resources are crucially important to the livelihoods of the community in all aspects of the socioeconomic setup, CBM of AnGR appears to be a promising alternative as compared to the traditional approaches which focused less on the immediate and long term objectives of the communities they were supposed to benefit. In fact, capacity building and awareness creation on all aspects of the CBM of AnGR framework are essential for the community in order to boost confidence and transparency. Similarly, modalities for communication and protocols of accountability among the stakeholders need to be clearly stated and made known to all.

Table 8.1: Sample activities in the CBM of AnGR in Central Ethiopia

Interventions	Leading Stakeholders
1. Empowering	Community
• Sharing the results of technical analysis of livelihood systems	Research and extension organizations
• Developing existing communal bylaws	
• Capacity building in resource management	
• Develop a manageable monitoring and evaluation system	
• Research and extension assistance on, for instance,	
Improved forage species	
Efficient use of crop residues and natural vegetation	
Disease monitoring and veterinary service	
Sustainable use of AnGR	
2. Tailored training for the community	Community
• Feed management	Research and extension organizations
• Disease management	
• Controlling and recording animal movement	Brokers and traders
• Safe management of newly introduced genetic resource	
• Livestock marketing	
Market intelligence	
Market demand and supply assessment	
Identifying markets and time for marketing	
3. Communicating timely, adequate, and precise (*tap*) information	Community
• Access to *tap* market information	Brokers and traders
Developing the traditional information management system	Research and extension institutes
Looping in brokers and traveling traders	
• Access to *tap* research and extension information about	
Feeds and nutrition	
Disease management	
Maintaining preferred traits	
Livestock marketing	
Policies and strategies and their implication	

8.6. Genetic Improvement and Management Interventions

Empirical analysis of preferences done in the markets within and around Dano district indicates that fertility, disease resistance, and calf vigor are equally or more important than

milk (see Chapter 5). Similarly it was found out that buyers assign high values for good traction potential, big body size, disease resistance, calf vigor and for places of origin when choosing bulls in the market (see Chapter 6). These results need to be used to articulate the improvements to be made on the AnGR owned and/or used by the community.

The operational unit for the appropriate interventions needs to be the herding group for the following two basic reasons. First, almost everyone in the group knows which animal belongs to whom and how many animals a household owns. Second, members know when new animals are brought in to the group and when animals are taken away for any reason. Accordingly, leading farmers within the herding group in collaboration with leaders in the cooperatives should be helped to select, develop, and share breed stock of cattle based on the preferred traits identified. Cattle herd formation and composition management needs high emphasis to ensure that the preferred traits of the cattle keepers are maintained with mechanisms in place to reduce the likelihood of inbreeding. The replacement rate and the dynamism in the preferences of the different adaptive and productive traits will have to be carefully investigated to understand the pattern in the genetic resources and the requirements for new trait introductions that might develop over time.

The research and extension institutes need to render assistance to the community in issues related to record keeping, developing and using breeding indices – with due consideration of preferred traits, performance evaluation, distribution and marketing management and controlling the use and conservation of AnGR. The record keeping shall be designed in a comprehensive and systematic way so that the not-so-literate community can easily manage it. Establishing a pilot breeding centre managed by leading farmers in particular and the community in general appears to be the best way to start up.

8.7. Implementing the CBM Framework in Dano District

Community based organizations principally aim at harnessing resources to achieve the short and long run objectives of the community they stand for. Therefore, the initial step in implementing a community based organizations like the CBM of AnGR has to be the full awareness, empowerment, and ownership of the whole process by the community. The communities, therefore, need to be assisted to develop breeding structures of their target AnGR so that breeding is fully controlled and parents of the next generation of animals can be selected from within the breeding population.

Concomitantly, communities will be encouraged to set minimum standards of management of their animals to improve efficiency of production and eventually increase level of production. In this way a village-as-a-herd scheme of breeding structures are organized within the village on voluntary basis. The community would then be able to prioritize and refine the potential interventions to increase the productivity and marketability of the indigenous cattle population it owns. A participatory *ex-ante* evaluation of the identified interventions needs to follow to foresee the potential costs and benefits associated. Implementation plans will have to be developed for the interventions to be made at the end. A community managed participatory monitoring process needs to be established as well. Finally, evaluations will be made and plans will be designed to replicate the positive lessons to similar production systems. This will be a cyclical process in each community as long as the community keeps on benefiting from the collective action.

Usually the best way to enhance ownership and responsibility in such community based initiatives is to build up on the informal institutions and organizations governing the access, ownership and use of the resources in the community. Hence, clear understanding and promulgation of these informal entities of the community need to be given priority in the implementation of this framework. Moreover, building the communities in data and information management will need to be started at the outset of the implementation. This capacity is very important to make inter-generational transfer of knowledge and the resources associated with it.

A formidable challenge in continuously and effectively running a CBM of AnGR will be the access and use of local level financial resources. As indicated above in the sample list of activities, the way to start will be to invest on the traditional financial institutions which are usually meant to supporting mourning or wedding families. Small scale revolving financial schemes can be developed based on the traditional practices which are quite common in Ethiopia. The second option is to build the capacity of the cooperatives to manage small scale financial services for the community based on terms agreed by the community. Both options indicated above need intensive capacity building interventions from resourceful institutions particularly in the field of financial management. The last and the most costly option is accessing financial resources from the formal rural financial institutes.

Finally, this framework is developed with the following assumptions.

i. Stakeholders with the financial resources would support and pursue the implementation of the CBM of AnGR framework developed based on over three years of multi-disciplinary participatory research.

ii. The simmering political instability in the region would not interfere with effective implementation of the framework.
iii. The research and extension institutions would keep up the collaborative and complementing activities in support of the collective action in CBM of AnGR.
iv. The community and other stakeholders will have the required capacity to observe clearly the dynamism within the livestock production system and to deal with the emerging market trends.
v. Continuous and comprehensive market information will be available for the community and for the research and extension institutes to gauge the responsiveness of the marketers.

Acknowledgement

The authors would like to the ILRI-BMZ project for funding this research. We are also very grateful for Dr Aynalem Haile's comments on an earlier version of this paper. Above all we appreciate the cooperation and shared wisdom of the sample households in the study area.

8.8. References

Anderson, S., 2003. Animal Genetic Resources and Sustainable Development. Ecological Economics, 45: 331 – 339.

Anderson, S., and R. Centonze, 2006. Property Rights and the Management of Animal Genetic Resources. CGIAR System wide program on Collective Action and Property Rights. CAPRi Working Paper # 48. IFPRI, Washington DC, USA.

Bayer, W., von Lossau A.., and Feldmann A., 2003. Smallholders and Community-Based Management of Animal Genetic Resources. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 – 11 May 2001. Pp. 13-26.

CSA (Central Statistical Authority), 2004. The 2004 National Statistics. Available at http://www.csa.gov.et/text_files/2004_national_statistics.htm (Last accessed in November 2007).

CSA (Central Statistical Authority), 2006. The 2006 National Statistics. Available at http://www.csa.gov.et/text_files/2006_national_statistics.htm (Last accessed in November 2007).

Dossa, L. H., 2007. Small Ruminants in the Smallholder Production System in Southern Benin: Prospects for Conservation through Community-Based Management. Institute of Animal Breeding and Genetics, Georg-August University Goettingen, Goettingen, Germany. PhD Thesis.

ESAP (Ethiopian Society of Animal Production), 2004. Farm Animal Biodiversity in Ethiopia: Status and Prospects. Asfaw Yimegnuhal and Tamrat Degefa (eds.). Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 28 –30, 2003. ESAP, Addis Ababa.

FAO (Food and Agriculture Organization of the United Nations), 2000. World Watch List for Domestic Animal Diversity, 3rd Ed., FAO, Rome, Italy.

FAO (Food and Agriculture Organization of the United Nations), 2007. The State of the World's Animal Genetic Resources for Food. Rischkowsky, B. and D. Pilling (eds.) FAO, Rome, Italy.

Gandini, G.C., and J. K. Oldenbroek, 1999. Choosing the Conservation Strategy. *In*: Oldenbroek, J.K. (eds.) Genebanks and the Conservation of Farm Animal Genetic Resources. DLO, Lelystad, Pp. 11 - 31.

Gondwe, T., C.B.A. Wollny, A.C.L. Safalaoh, F.C. Chilera, and M. G.C. Chagunda, 2003. Community-Based Promotion of Rural Poultry Diversity, Management, Utilization and Research in Malawi. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 –11 May 2001. Pp. 69-76.

Hammond, K. and H. Leitch, 1996. The FAO Global Program for the Management of Farm Animal Genetic Resources. *In*: Miller R., V. Pursel, and H. Norman (eds.), Beltsville Symposia in Agricultural Research. XX. Biotechnology's Role in the Genetic Improvement of Farm Animals. American Society of Animal Science, IL: 24-42.

IBC (Institute of Biodiversity Conservation), 2004. State of Ethiopia's Animal Genetic Resources - Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC. May 2004. Addis Ababa, Ethiopia.

Köhler Rollefson, I., 2003. Community-Based Management of Animal Genetic Resources – with Special Reference to Pastoralists. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 –11 May 2001. Pp. 13-26.

Köhler-Rollefson, I., 2004**.** Farm Animal Genetic Resources. Safeguarding National Assets for Food Security and Trade. A Summary of Workshops on Farm Animal Genetic Resources

Held in the South African Development Community (SADC). GTZ, BMZ, FAO, CTA., SADC. Eschborn, Germany

Mendelsohn, R., 2003. The Challenge of Conserving Indigenous Domesticated Animals. Ecological Economics, 45: 501 – 510.

Rege, J.E.O., 2003. Defining Livestock Breeds in the Context of Community-Based Management of Farm Animal Genetic Resources. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 – 11 May 2001. Pp. 27 -35.

Rege, J.E.O., and J. P. Gibson, 2003. Animal Genetic Resources and Economic Development: Issues in Relation to Economic Valuation. Ecological Economics: 45, 319 – 330.

Tisdell, C., 2003. Socioeconomic Causes of Loss of Animal Genetic Diversity: Analysis and Assessment. Ecological Economics, 45: 365 – 376.

Turton, J.D., 1974. The Collection, Storage and Dissemination of Information on Breeds of Livestock. Proceedings of the 1st World Congress on Genetics Applied to Livestock Production, II, 61-74.

Wollny, C. B. A., 2003. The Need to Conserve Farm Animal Genetic Resources in Africa: Should Policy Makers be Concerned? Ecological Economics, 45: 341-351.

Yapi-Gnaore, C. V., B. Dagnogo, and B. A. Oya, 2003. Community-Based Livestock Improvement and Conservation: Experiences from Open-Nucleus Breeding Programs in West Africa. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 –11 May 2001. Pp. 89-95.

Chapter 9

General Conclusion

Economic valuation of preferred cattle traits serves much more than estimating implicit prices or willingness to pay. It reveals the fact that the relative economic values consumers attach to traits they consider important inherently determine the types and composition of animals kept under their custody. The preferences elicited and the relative values of traits can, therefore, serve as basis for biological research and policy interventions for the sustainable use of the animal genetic resources. This is the rationale behind this research which aimed at elicitation of cattle trait preferences and estimation of the relative economic values of the preferred traits within the context of a semi-subsistence livelihood system in Central Ethiopia.

The research has both theoretical and empirical components. Chapter two gives general background on Ethiopian economy. The agricultural and livestock production sectors are characterized in detail. Chapter three discusses the theoretical underpinnings that link up valuation of preferred traits with transformation of the livestock production and marketing systems. The fourth chapter presents the basic features of the livestock production and marketing components of the rural livelihood system. This part also shows the general preferences of farmers for cattle traits in their production and marketing contexts. The fifth chapter illustrates estimations of the relative economic weights of cow traits estimated based on the stated preferences of cattle buyers in five rural markets in and around Dano district of Central Ethiopia. The sixth chapter similarly analyses the relative values of traits of bulls and the heterogeneities in preferences of cattle buyers. The seventh chapter identifies and determines the importance of phenotypic and socioeconomic characteristics in influencing the observed prices of cattle based on transaction level data. Chapter eight presents a framework for the community based management (CBM) of animal genetic resources (AnGR). Brief conclusions for each of the technical chapters in the thesis are given below.

Economic valuation of Phenotypic Traits: An Impetus for Market Orientation of Livestock Production Systems?

Transforming the livestock production system into a more productive and rewarding type requires continuous assessment and valuation of preferred traits of the animals. As markets in developing economies hardly capture the total economic value of a given animal genetic resource, valuation methods need to go beyond market places and revealed preferences

(Scarpa *et al*., 2003; Drucker, 2004; Roosen *et al*., 2005). Economic valuation of preferred traits helps in estimating the implicit prices or the willingness to pay for the important traits of livestock, in our case cattle, and these estimates can be used in research and development interventions meant to enhance the dynamism and efficiency of the production system. Specifically, economic values for preferred traits facilitate decision making process in selecting cattle types with specific and useful characteristics. Economic valuation, in general, strongly reinforces the argument for rational resource allocation in the development, utilization and conservation of the valuable animal genetic resources owned by countries like Ethiopia.

Cattle Trait Preferences in the Semi-subsistence Agricultural Production Systems of Central Ethiopia

Comprehensive understanding of the basic components of the cattle production and marketing system is a vital starting point to design interventions designed to enhance efficiency with in the system. It is specifically advised that the current breeding strategies and breeding objectives need to be clearly known before any support is given to any specific type of breeding operation or suggestions are made for improvement (Bayer *et al.*, 2003). This part of the thesis characterizes the production and marketing systems and elicits farmers' preferences for cattle traits both as producers and as buyers. The livestock production system is principally subsistence oriented, multi-purpose, resource constrained and risk prone. Similarly, the marketing system operates with very poor infrastructure and information asymmetry. The trait preferences elicited in the production areas and in markets show the consistent choices of farmers and buyers. For farmers, age, origin and draft power were the most important attributes of bulls, whereas for buyers it was plowing strength, age, origin and calf vigor. Short calving interval, age and calf vigor were ranked highest when buyers were asked in the markets about cow traits. Origin, age, milk yield and fertility were the most important traits of cows for buyers in the market. These observed preferences are useful to make better informed decisions in designing interventions to improve the contribution of cattle to the livelihoods of their keepers.

Valuing Traits of Indigenous Cows in Central Ethiopia

The focus of Ethiopian livestock development initiatives over the last four decades has essentially been increasing milk yield per animal (Desta, 2002). Like all other animals, and

particularly as cattle, cows are raised for different functions where milk is one but not the only product. The different functions of cattle and the purposes they are kept for are manifested through the different characteristics of the animals that are preferred by the cattle keepers. The cattle keepers in rural Ethiopia are again the main consumers of the functions and services of the cattle population they own. This intricacy of producer-and-consumer and multiple-function-cattle production necessitated estimation of the relative weights of the different attributes presumed to influence the perceived utility level from a given cow. The econometric estimations and simulation analysis show that the farming community consistently attaches more importance to fertility (short calving interval), disease resistance and calf vigor than to milk. The results also show that farmers prefer animals from their surroundings. These smallholder farmers depend on semi subsistence agriculture and so livestock development interventions should focus on reproductive and adaptive traits that stabilize the herd structure than focusing on traits which are only important to commercial purposes.

Preferences for Bull Traits in Semi-Subsistence Agricultural Production Systems of Central Ethiopia

Of all classes of cattle, the genetic diversity within bulls appears to be highly compromised for the sake of generating high yielding dairy and beef breeds in the developed world. The well founded and funded projects over the last four decades to replace the 'poorly productive' breeds with few and homogenous 'highly productive' breeds in Ethiopia through AI and crossbreeding pose a great deal of risk. With the valid argument that indigenous cattle and specifically bulls have multiple functions, this research quantified the relative economic values of the preferred attributes of indigenous bulls. Results of the random parameters logit (McFadden and Train, 2000; Train, 2003) estimated based on data generated with choice experiments show that good traction potential, big body size, disease resistance, and places where animals are brought from are very important for cattle buyers in the rural markets of central Ethiopia. Although there is heterogeneity in these preferences due to differences in occupation, education and age, majority of the cattle buyers are willing to pay more for traits that imply the functions vital for the livelihoods of the rural community. The macro-level implication of these stated preferences is that national livestock breeding policy and strategies need to aim at building the indigenous practices of selecting, improving, conserving and sharing of animal genetic resources.

A Hedonic Price Model for Cattle in the Rural Markets of Central Ethiopia

Merging stated preference and hedonic analyses is a recommendation often made to generate reliable estimates for the relative values of characteristics of attribute (or quality) differentiated goods (Scarpa *et al*., 2003; Hensher *et al*., 2005). This paper complemented the stated preference analyses reported in chapters five and six. Hedonic price regression models were estimated under different formulations to deal with the strong heteroscedasticity observed in the error terms of the linear regression model initially estimated. All the formulations identified season, market location, class of cattle, body size, and age as very important factors influencing the level of price paid for cattle. The importance of these traits is manifested through the preferences of buyers in the markets while deciding to pay for an animal, as a bundle of attributes, which presumably maximizes their perceived utility. These preferences are the ones which matter most in shaping up the diversity of animals kept at farm level. The cattle breeding strategies and activities should, therefore, consider the preferences of cattle keepers who are the main buyers and sellers and the rural markets of rural Ethiopia. For formulating transaction level price functions in rural markets, we suggest using feasible generalized least square and structural heteroscedasticity models. Not only statistically, but also the two models appear to be defining the cause and effect relationship between price and the determinant factors in line with the theoretical and contextual expectations.

A Framework for Community Based Management of Indigenous Cattle Genetic Resources in Dano District, Central Ethiopia

The essential purpose of the economic valuations of cattle attributes reported in this thesis is developing a framework for community based management (CBM) of animal genetic resources (AnGR) in the study area. The essential components and activities needed to be considered to empower the cattle keeping community for an effective collective action in the conservation and sustainable use of the indigenous cattle population are identified and discussed. Effective and long-lasting CBM of AnGR requires that the important components of the livestock production system and their interactions be manipulated to enable the community own, manage and benefit from the AnGR. As cattle are crucially important to the livelihoods of the community in all aspects of the socioeconomic setup, CBM of cattle genetic resources appears to be a promising alternative as compared to the traditional

approaches which focused less on the immediate and long term objectives of the communities they were supposed to benefit.

References

Bayer, W., Annette V. L., and Feldmann A. 2003. Smallholders and Community-Based Management of Animal Genetic Resources. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 – 11 May 2001. Pp. 13-26.

Desta K. B. 2002. Analysis of Dairy Cattle Breeding Practices in Selected Areas of Ethiopia. Humboldt University of Berlin, Germany. PhD Dissertation.

Drucker, Adam G. 2004. The Economics of Farm Animal Genetic Resource Conservation and Sustainable Use: Why is it Important and what have we Learned? Background Study. Paper Number 21. Commission on Genetic Resources for Food and Agriculture. FAO, Rome, Italy.

Hensher, D., J. Rose, and W.A. Greene. 2005. *Applied Choice Analysis: A Primer*. Cambridge University Press.

McFadden D., and K. Train. 2000. Mixed MNL Models for Discrete Response. *Journal of Applied Econometrics*, Vol. 15, pp. 591 – 608.

Roosen, J., A. Fadlaoui and M. Bertaglia, 2005. Economic Valuation for Conservation of Farm Animal Genetic Resources. *J. Anim. Breed. Genet*., 122, 217 – 228.

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

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

Chapter 10

Zusammenfassung

Die Bewertung von Charakteristika von einheimischen Tierpopulationen dient vielzähligen Zwecken. Dazu zählt das grundlegende Verständnis und die Wertschätzung der Multifunktionalität von Nutztieren, sowie die Identifizierung der präferierten Merkmale und Eigenschaften für die Zucht und den Erhalt genetischer Ressourcen, sowie das umfassende Verständnis des Marketingsystems und die Transformation der Tierproduktion. Für die Haltung von Nutztieren in ländlichen Gemeinschaften der Entwicklungsländer gibt es eine Vielzahl direkter (Konsum, Zugkraft, Prestige, Sicherheit) und indirekter (komplementär zur Pflanzenproduktion and natürlichen Ressourcen) Nutzungsziele. Tatsächlich aber wurden diese intrinsischen Motive der traditionellen Viehhaltung bisher wenig berücksichtigt, obwohl enorme Ressourcen dafür aufgewendet wurden, Nutztiere mit sehr spezialisierten Eigenschaften, die für eine Hochleistungsproduktion entwickelt wurden, in Entwicklungsländern einzuführen.

Damit Länder wie Äthiopien Nutzen aus dem reichen Viehbestand ziehen können, mit dem sie ausgestattet sind, muss eine fundierte Strategie für die Viehhaltung und den Erhalt der genetischen Ressourcen formuliert werden. Solche Strategien müssen auf einer durchdachten Inventarisierung von genetischen Ressourcen und einer adäquaten Bewertung von Eigenschaften und Charakteristika beruhen, welche die Verwendungsbereiche und Gründe der Haltung von Nutzvieh mit einbeziehen. Nur zwei Studien (Zander 2006; Ouma et al. 2007) sind dokumentiert, die diese Präferenzen für Rindercharakteristika eruieren und den relativen Wert dieser Eigenschaften in den pastoralen Gebieten Äthiopiens schätzen. Bisher wurden keine Schätzungen von Präferenzen für Charakteristika von Rindern und den relativen Wert dieser Eigenschaften für das im Land am meisten verbreitete, gemischte Produktionssystem (Ackerbau und Viehwirtschaft) durchgeführt .

Die vorliegende Forschungsarbeit hat zum Ziel, diese Lücke zu schließen und konzentriert sich auf die Rinderhaltung in Zentral-Äthiopien. Es wird das Produktionssystem der Tierhaltung charakterisiert und die theoretische und empirische Bedeutung der ökonomischen Bewertung von Merkmalen am Beispiel der Rinder diskutiert. Des Weiteren werden Charakteristika von Bullen and Rindern unter Verwendung der ‚stated preference'-Methode and der ‚revealed preference'-Methode geschätzt, und ein auf ländlichen

Gemeinschaften basierendes Managementsystem (‚Community based Management' = CBM) zum Erhalt und nachhaltigen Gebrauch der genetischen Ressourcen von Nutztieren (Animal Genetic Resources = AnGR). vorgeschlagen

Die Strukturierung dieser Arbeit folgt der unten abgebildeten Darstellung (Abbildung 1). Die kursiv dargestellten Felder stehen dabei für unabhängige Kapitel. Der Abbildung 1 folgen kurze Zusammenfassungen jedes Kapitels.

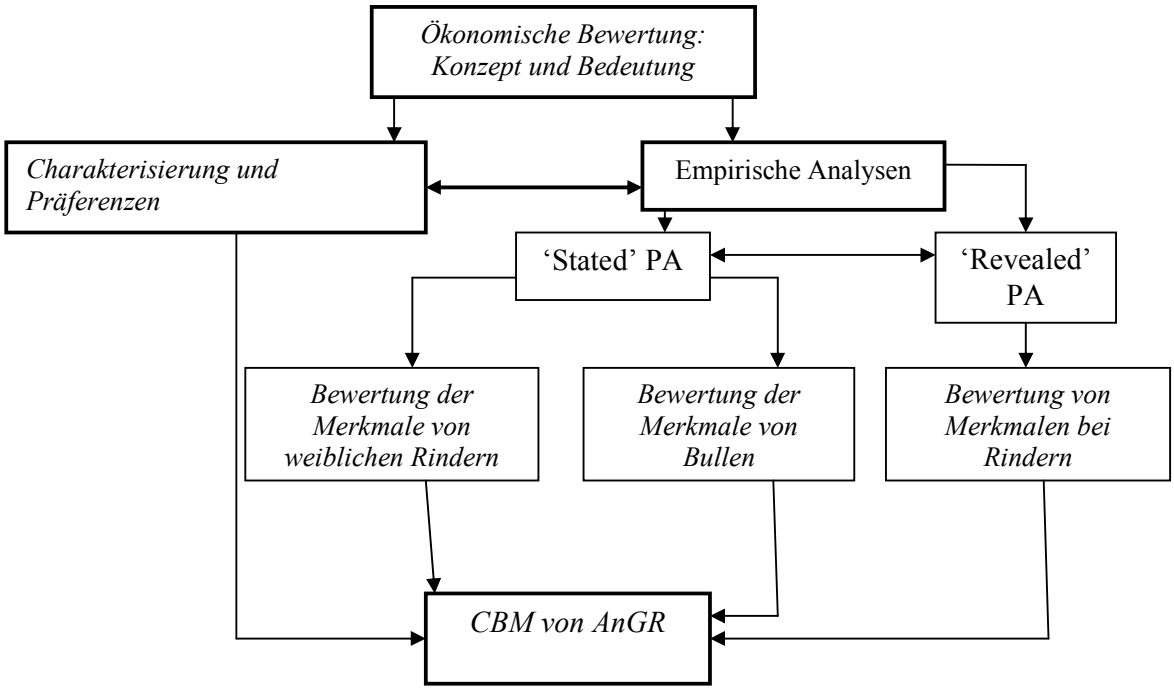


Abbildung 10.1 – Aufbau der Arbeit (PA = Präferenzen Analyse)

Ökonomische Bewertung von Merkmalen: Ein Impuls für die Marktorientierung von Tierproduktionssystemen?

Diese Studie zeigt die mögliche Rolle von ökonomischer Bewertung präferierter Eigenschaften bei der Transformation von Subsistenzhaltung in Äthiopien. Es wird dargestellt, wie die gewünschten Verwendungszwecke von Rindern in die Präferenzen für phänotypische Charakteristika eingebettet sind, wobei die am stärksten nachgefragten Eigenschaften einen höheren ökonomischen Wert erzielen. Zur Transformation des Sektors weg von Subsistenzorientiertung und zur nachhaltigen Sicherung von Marktanteile, könnte sich der Viehwirtschaftssektor dann auf die Produktion und das Marketing der präferierten Eigenschaften konzentrieren. Es kann argumentiert werden, dass die ökonomische Bewertung

bedeutsam dazu betragen kann, den Viehwirtschaftssektor durch eine effiziente Allokation von Ressourcen zu transformieren - für Entwicklung sowie die Nutzung und den Erhalt von wertvollen genetischen Ressourcen.

Präferenzen für Merkmale von Rindern in der semi-subsistenziellen Landwirtschaft Zentraläthiopiens

Diese Studie beschreibt die verschiedenen Komponenten der Viehhaltung sowie die von den Bauern präferierten Merkmale und Eigenschaften in ihrer durch Produktion und Marketing gekennzeichneten Rahmenbedingungen. Das Viehhaltungssystem in Dano, Zentral-Äthiopien kann als vorwiegend subsistenzorientiert und Ressourcen limitierend beschrieben werden. Rinderhaltung spielt aufgrund der vielfältigen Funktionen eine sehr wichtige und wachsende Rolle in der Erwirtschaftung des ländlichen Lebensunterhalts, der von diesem traditionellen und komplexen landwirtschaftlichen Produktionssystem abhängt. Die Entscheidung über die Rinderhaltung durch den Bauern hängt dabei von den verschiedenen Funktionen ab, die die Rinder erfüllen sollen und den unterschiedlichen Eigenschaften der Tiere die für diese Nutzungsarten relevant sind. Die offenbarten Präferenzen für bestimmte Merkmale unterstreichen die Funktionen und Ziele, für die die Tiere gehalten werden. Die Analyse der Präferenzen zeigen dass Alter, Stärke beim Pflügen, Herkunft, und Kraft und Gesundheit eines Kalbes die wichtigsten Merkmale bei Bullen sind, während Alter, Herkunft, Milchertrag, Kälbergesundheit sowie Fruchtbarkeit bei weiblichen Rindern am wichtigsten sind. Solche empirischen Ergebnisse sind grundlegend um besser fundierte Entscheidungen in Entwicklungsinterventionen zu treffen um den Beitrag der Rinderhaltung für die Lebensgrundlage ihrer Halter zu verbessern.

Bewertung von Merkmalen einheimischer weiblicher Rinder in Zentraläthiopien

Ziel dieser Studie ist die Identifizierung und Schätzung des relativen Gewichtes der bevorzugten Merkmale und Eigenschaften der einheimischen Population von weiblichen Rindern im dominierenden, gemischten System von Ackerbau und Viehzucht in Äthiopien. Die in der Studie verwendeten Daten wurden mit Hilfe eines ‚choice-experiments' erhoben. Im Rahmen dieses Experimentes wurden 195 Viehkäufer auf fünf ländlichen Märkten befragt. Die Ergebnisse zeigen, dass Merkmale wie Fertilität, Krankheitsresistenz als auch Gesundheit der Kälber gleich oder wichtiger sind als Milchleistung. Außerdem ist die Region

aus der die Kühe stammen von Bedeutung für den Käufer. Das Ergebnis der Simulation des Einflusses einer Veränderung der im Rahmen des ‚choice-experiments' verwendeten Attribute zeigt, dass die Fertilität und die Widerstandfähigkeit gegen Krankheiten die wichtigsten Merkmale sind. Die Kleinbauern in dieser Region Äthiopiens hängen in erster Linie von der Subsistenzwirtschaft ab. Daher sollten alle Maßnahmen, die die Viehzucht stärken sollen, aus einem Maßnahmenpaket bestehen, das diese Merkmale in Zucht und Haltung berücksichtigt. Die alleinige Fixierung auf ausschließlich ein kommerzielles Merkmal ist unter den gegebenen Bedingungen abzulehnen. Die Züchtung sollte primär auf eine Verkürzung der Zwischenkalbezeit,, die Verbesserung der Widerstandfähigkeit gegen Krankheiten und die Stärkung der Robustheit Kälber abzielen.

Präferenzen für Merkmale von Bullen in der semi-subsistenziellen Landwirtschaft Zentraläthiopiens

‚Random parameters logit' Modelle wurden verwendet um die relative Bedeutung von präferierten Merkmalen von einheimischen Bullen zu schätzen und um die Heterogenität der Präferenzen zu analysieren. Kerndichte-Schätzungen wurden durchgeführt um die Verteilung der Zahlungsbereitschaft für bestimmte Eigenschaften zu untersuchen. Die Daten der von 198 Rinderkäufern angegebenen Präferenzen (‚stated preferences') wurden mittels ‚choice experiment' auf fünf ländlichen Märkten gewonnen (Mai 2006-Juni2006). Die Ergebnisse zeigen, dass Rinderkäufer bei der Auswahl von Bullen auf dem Markt hohe Werte für ein hohes Potential für Zugkraft vergeben, außerdem für großen Körperbau, Resistenz gegen Krankheiten, Vitalität von Kälbern und für bestimmte Herkunftsorte. Die Präferenzen, die Rinderkäufer unterscheiden sich signifikant nach Erwerbstätigkeit, Bildung und Alter. Eine sorgfältige Betrachtung von Präferenzen sollte vor Einführung neuer Kreuzungen und züchterischer Selektionsmassnahmen, die nur auf wenige dieser Eigenschaften und Verwendungszwecke der Tiere angelegt sind, durchgeführt werden. Zusätzlich zur Zucht von Rassen, die von den Rinderkäufern bevorzugt werden, würde die Berücksichtigung der präferierten Merkmale in Zuchtprogrammen dazu beitragen, die Erosion der genetischen Vielfalt des einheimischen Genpools zu reduzieren.

Hedonisches Preismodell für Rinder auf ländlichen Märkten in Zentraläthiopien

Die Studie identifiziert die Einflussfaktoren auf den Rinderpreis und stellt deren relative Gewichtung auf fünf verschiedenen ländlichen Märkten in Zentraläthiopien dar. Die Daten von 411 Rinderverkäufen wurden mittels vierteljährlicher Befragung erhoben (Februar 2006 – November 2006). Dabei wurden die phänotypischen Merkmalen der gehandelten Tiere, die Orte, aus denen die Tiere stammten, der Preis wie auch die Charakteristika der jeweiligen Käufer erfragt. Die phänotypischen Merkmale der gekauften Tiere beinhalten jeweils die Fellfarbe, das Alter, die Größe sowie die Einstufung in eine Klasse. Letztere umfasst verschiedene Merkmale wie das Geschlecht und alle Faktoren, die einen Einfluss auf die funktionelle Beschaffenheit (beispielsweise die Milchleistung) des Tieres haben. Eine hedonische Preisfunktion wurde mit Hilfe heteroskedastischer Co-Varianz-Matrixen formuliert und geschätzt. Die Least-Square- Schätzung war genauso zulässig wie die Verwendung heteroskedastischer Modelle. Sämtliche Schätzungen zeigen, dass die Jahreszeit, der Ort des stattfindenden Marktes, die Rinderklasse, die Körpergröße sowie das Alter sehr wichtige Determinanten für den Rinderpreis auf ländlichen Märkten in Zentraläthiopien sind. Das Ergebnis unterstreicht die Bedeutung der Merkmalspräferenzen auf der untersten Stufe des Rinderhandels. Diese Präferenzen sind ausschlaggebend dafür, dass sich eine Vielfalt von Nutztieren entwickeln kann. Aus diesem Grunde müssen die Züchtungsmaßnahmen diesen Präferenzen Rechnung tragen.

Rahmenbedingungen für ein auf ländlichen Gemeinschaften basierendes Managementsystem genetischer Ressourcen endemischer Rinderrassen im Dano-Distrikt in Zentraläthiopien

Dieser Abschnitt behandelt die wichtigsten zu beachtenden Maßnahmen und notwendigen Aktivitäten, die berücksichtigt werden müssen, wenn die Gemeinschaft der Rinderzüchter dabei unterstützt werden soll, einheimische Rinderrassen nachhaltig zu erhalten. Die vielseitigen genetischen Ressourcen können konserviert werden indem die einheimischen Rassen innerhalb der Produktionssysteme erhalten bleiben. Gemeinden oder ländliche Gemeinschaften organisieren ihre Viehhaltung indem sie auf ihr indigenes Wissen zurückgreifen, das auf den sozioökonomischen, kulturellen als auch den biologischen und physikalischen Bedingungen der Umwelt basiert. Das wachsende Interesse, auf Ebene der Kommunen oder Gemeinschaften zu arbeiten, führte zusammen mit der Wertschätzung und

der Einbeziehung indigenen Wissens zum Konzept des ‚community –based managements' (CBM) von Ressourcen. CBM der genetischen Ressourcen der Tiere ist ein System des Managements tierischer Ressourcen und des Ökosystems, in dem die Besitzer der genetischen Ressourcen für Fragen bzw. Entscheidungen der Identifizierung, das Aufstellen der Prioritäten sowie die Implementierung von Maßnahmen zur Erhaltung der genetischen Ressourcen verantwortlich sind (Rege, 2003; Kohler-Rollefson, 2004). Die Gemeinden oder Gemeinschaften und die von ihr verwalteten genetischen Ressourcen der Tiere sind die zentralen Bestandteile des CBM. Grundbedingung für die Einführung einer Organisation auf kommunaler Ebene, wie es bei der CBM der genetischen Tierressourcen der Fall ist, ist die umfassende Kenntnis der betreffenden Sachverhalte durch die jeweiligen Gemeinden sowie die Übertragung der Verantwortung und Eigentumsrechte auf sie. Thesen für ein förderliches politisches Umfeld, die Komplementarität der verschiedenen betroffenen Akteure, beständiges Ausbauen der Kapazitäten sowie den Zugang zu Marktinformationen wurden bei der Entwicklung dieser Rahmenbedingungen aufgestellt.

Literaturverzeichnis

Kohler-Rollefson, I. 2004**.** Farm Animal Genetic Resources. Safeguarding National Assets for Food Security and Trade. A Summary of workshops on farm animal genetic resources held in the South African Development Community (SADC). GTZ, BMZ, FAO, CTA, SADC. Eschborn.

Ouma, E., A. Abdulai and A. Drucker. 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.

Rege, J.E.O, 2003. Defining Livestock Breeds in the Context of Community-Based Management of Farm Animal Genetic Resources. *In*: Community-Based Management of Animal Genetic Resources. Proceedings of the workshop held in Mbane, Swaziland, 7 – 11 May 2001. Pp. 27 -35.

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

Appendices

Appendix 1

Checklist for the reconnaissance survey (September 22 – October 7, 2005)

Livestock Production, productivity and consumption

- What species of livestock do you keep?
- Why do you keep livestock?
- What are the constraints in livestock production?
- Who is doing what in livestock production management?
- What animal products do you consume at home?
- How often per month/year do you consume these products? (One product at a time)
- Do you think the livestock production and the crop production activities are related? How?
- Is there any problem on the crop production activity due to your cattle? Or vice versa?
- Do you think the livestock production and the natural vegetation you have in this area are related? How?
- Is there any problem on the natural vegetation due to your livestock production? Or vice versa?
- Where do you keep your animals at night?
- How and who looks after the cattle in the field?
- What is the pattern of division of labor (among household members) in livestock production? (An activity at a time)

Trait Preferences

- What type of cattle would you like to keep? Why?
- Which types of your cattle you like most? Why?
- How do you want to keep your livestock in general? Your cattle in particular?

- Do you want to keep these breeds of cattle or do you want the types provided by district office of agriculture? Why?
- Do you see any importance of controlling the mating of your cattle?
- What type of improvements do you want to have on your cattle?
- Do you think the community has the capacity to bring about these improvements? Why or why not?
- What assistance does the community need to be able to reach for these improvements?
- How do you differentiate between the different types of cattle? Or are they all the same?
- Have you heard of a cattle breed called Horo?
- Do you have it here?
- Do you have other types of cattle? What do you call them?
- Can you compare Horo and others?
- Which one do you like most? Why?
- What qualities of Horo cattle are you interested in?
- Do you think these merits of cattle are available in the breeds of cattle you keep?
- What would you do if you want a specific/special type of calf?
- What are the things you want changed in relation to cattle re-production/breeding?

Livestock marketing

- Do you buy cattle from the market?
- Which markets do you prefer to buy cattle? Why?
- How do you determine the buying price of the cattle you want to buy?
- Are you satisfied with the prices of the cattle you have been buying?
- Do you sell cattle in the market?
- Which markets do you prefer to sell cattle? Why?
- Are you satisfied with the prices of the cattle you have been selling?
- How do you set the price of your animals?
- What are the problems associated with cattle marketing?
- Do you buy animal products for in house consumption? Which markets?
- Do you think the price of these products is appropriate? Why?
- Which cattle type fetches good prices?
- How do you take your cattle to the market?
- From whom do you buy your animals?
- Whom for do you sell your animals?

General trends

- What is the trend of the population size of livestock/cattle?
- What is the trend of the price of livestock/cattle?
- What is the trend in the incidence of disease?
- What is the trend in the availability of feed?
- Do you think the current flock composition will stay for long? Why?
- What other issues do you want to raise in relation to livestock production?

Appendix 2

Checklist used for the final qualitative survey

A. Checklist for Livestock Keepers

1. Pair wise comparison of preferred phenotypic trait
    a. For bulls

	Color	Age	Origin	Body size	Horn type	Plowing strength	Calf vigor
Color	X						
Age		X					
Origin			X				
Body Size				X			
Horn type					X		
Draft						X	
Calf vigor							X

b. For cows

	Color	Age	Origin	Body size	Horn type	Fertility	Milk yield	Calf vigor
Color	X							
Age		X						
Origin			X					
Size				X				
Horn					X			
Fertility						X		
Milk							X	
Calf vigor								X

2. Measurement and determination of the levels of the traits
    a. For bulls

Traits	Measurement unit	Common levels	Remark

b. For Cows

Traits	Measurement unit	Common levels	Remark

3. Price ranges of average cattle types

	Minimum *when	Maximum *when	Average *when	Markets
Fattened ox				
Normal ox				
Fattened bull				
Normal bull				
Pregnant Cow				
Normal cow				
Fattened heifer				
Normal heifer				
Male calf				
Female calf				

4. Preferred origins of cattle to buy and reasons.

Origin	Reasons	Remark

5. Buying and selling seasons for the farming community in Dano.

Buying seasons	Selling seasons

B. Market Survey

1. Pair wise comparison of preferred phenotypic characteristics
    a. For bulls

	Color	Age	Origin	Body size	Horn type	Plowing strength	Calf vigor
Color	X						
Age		X					
Origin			X				
Body Size				X			
Horn type					X		
Draft						X	
Calf vigor							X

    b. For cows

	Color	Age	Origin	Body size	Horn type	Fertility	Milk yield	Calf vigor
Color	X							
Age		X						
Origin			X					
Size				X				
Horn					X			
Fertility						X		
Milk							X	
Calf vigor								X

2. Measurement or determination of the levels of the traits of cattle
    c. For bulls

Traits	Measurement unit	Common levels	Remark

    d. For Cows

Traits	Measurement unit	Common levels	Remark

3. Price ranges of average cattle types

	Minimum *when	Maximum *when	Average *when	Markets
Fattened ox				
Normal ox				
Fattened bull				
Normal bull				
Pregnant Cow				
Normal cow				
Fattened heifer				
Normal heifer				
Male calf				
Female calf				

4. Preferred origins of cattle to buy and reasons.

Origin	Reasons	Remark

5. Buying and selling seasons for the farming community in Dano.

Buying seasons	Selling seasons

Appendix 3

Questionnaire Prepared for the Study on Cattle Production and Marketing in Dano District (Formal Survey, February – March, 2006).

Instruction:

1. **Start with greetings in local language.**

2. **Read the following for the respondent**

   This is a questionnaire prepared to generate data for the study on cattle production and marketing conducted by Oromia Agricultural Research Institute and International Livestock Research institute. Data to be generated with this questionnaire will not be transferred to a third person and will be used only for the purpose of the study. Thanks for your willingness to discuss with us.

Note: The questions can have more than one answer.

Introduction

Introduce yourself very simply and clearly.

Code: _____.

1. Date _____ (DD/MM/YYYY)
2. Interviewer's name _____
3. Kebele (PA) _____ Village (Got) _____
4. Main job of the respondent
   a. Farmer
   b. Merchant
   c. Farmer merchant
   d. Religious leader (worker)
   e. Government employee
   f. Other_____

5. Gender of respondent
    a. Male
    b. Female
6. Marital status of the respondent
    a. Married
    b. Single
7. Age of respondent _____ (years)
8. Education level of respondent
    a. Illiterate
    b. Reading and writing
    c. Elementary school
    d. Secondary school
    e. Above secondary school
    f. Spiritual education
9. Respondent's religion
    a. Orthodox Christian
    b. Islam
    c. Protestant
    d. Other
10. Family size and composition
    a. Total family size: male _____ female_____

Sex	Age in years					
	< 2	2 -10	11- 15	16-30	31-55	>55
Male						
female						
Labor contribution	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No

11. How long is your farming experience? _____ (years).
12. Who makes the important decisions of agricultural production (like crop to produce, livestock to raise etc.) in the household?
    a. Husband
    b. Wife
    c. Husband and wife
    d. The family
    e. Other _____

13. Who makes the important decisions (like buying, selling, medicating, etc.) about livestock?
    a. Husband
    b. Wife
    c. Husband and wife
    d. The family
    e. Other _____
14. What are the sources of income for living?
    a. Crop production
    b. Livestock production
    c. Wage labor
    d. Crop and livestock production
    e. All
    f. Other _____
15. Who is the owner of cattle in the household?
    a. Husband
    b. Wife
    c. Husband and wife
    d. The family
    e. Other _____
16. Which of the income generating activities you focus on and give priority to?
    a. Crop production
    b. Livestock production
    c. Wage labor
    d. Crop and livestock production
    e. All
    f. Other_____
17. Do you have sufficient family labor power for crop and livestock production?
    a. Yes
    b. No
18. How many of your family members do not engage in agriculture? _____
19. In which months do you face labor shortage?

    _____
20. What are the main reasons of labor shortage?
    a. School opening
    b. Migration
    c. Work load
    d. Lack of children
    e. Disease epidemic
    f. Alternative work availability
    g. Other _____
21. Which of your activities do you give priority when there is labor shortage in the rainy season?

a. Crop production
b. Livestock production
c. Both for crop and livestock
d. For off-farm activities
e. Others _____

22. Which type of livestock do you give priority under labor scarcity?
    a. Oxen/bulls
    b. Cows
    c. Sheep
    d. Goat
    e. Cattle
    f. Calves
    g. Pack animals
    h. Chicken
    i. Bees

23. Do you hire labor under labor scarcity?
    a. Yes
    b. No
    c. Other _____

24. Do you work for others with payment when you are available?
    a. Yes
    b. No
    c. Other _____

25. What are your sources of cash?
    a. Crop selling
    b. Livestock selling
    c. Sell livestock products
    d. We work for wage
    e. We work for salary
    f. We borrow from credit institutions
    g. Borrow from relatives and friends
    h. Remittances
    i. Other _____

26. Do you have sufficient cash income for living?
    a. Yes
    b. No
    c. It depends on the season
    d. Other _____

27. What should be done to increase your cash income?
    a. Availing rural credit
    b. Strengthening the markets

c. Assistance to increase production
d. Increase government aid
e. Assistance form office of agriculture
f. Availing employment opportunities
g. Other _____

28. is the cash income from crop production increasing or decreasing?
    a. Increasing
    b. Decreasing
    c. It varies
    d. I don't know
    e. Other _____

29. is the cash income from livestock increasing or decreasing/
    a. Increasing
    b. Decreasing
    c. It varies
    d. I don't know
    e. Other _____

30. If your total annual income is assumed to be 100.00 birr, how much of it comes from livestock? _____

31. If your total annual income from livestock is assumed to be 100.00 birr, how much of it comes from cattle? _____

32. How big is your farm land? _____

33. How many farm plots do you have?_____

34. Is your farm size sufficient to sustain your family?
    a. It is sufficient
    b. It is insufficient
    c. It depends on the season
    d. Other _____

35. Do you have a private grazing land?
    a. Yes
    b. No
        1. If yes, how big is it? _____

36. Do you lease in land?
    a. Yes
    b. No

37. Do you lease out land?
    a. Yes

b. No

38. What do you think are the reasons for farmland scarcity?

a. Population pressure
b. Scarcity of land
c. Land degradation
d. Impossibility to trade land
e. Due to arrival of settlers
f. I don't know
g. Other_____

39. What are the problems related to land, other than the scarcity?

a. Erosion
b. Weed infestation
c. Ruggedness
d. Moisture stress
e. No problem
f. Other _____

40. What are the main crops you are producing?

a. Sorghum
b. Maize
c. Tef
d. Faba bean
e. Field pea
f. Lentil
g. Wheat
h. Barley
i. Linseed

41. Which is the most important crop for you? _____

42. Why?

a. For consumption
b. For selling
c. For livestock feed
d. For fuel wood
e. For construction
f. For medication
g. Other _____

43. What Livestock do you raise

Type	How many?
Cows	
Calves	
Heifer	
Bull	
Oxen	
Donkey	
Horse	
Mule	

Sheep	
Goat	
Chicken	
Bee hives	

44. What benefits do you get from your livestock?
    a. Milk, meat, egg, honey, hide/skin, manure
    b. Sell in the market
    c. Home consumption
    d. Generate cash during difficult times
    e. Serve as collateral
    f. Make me self dependent
    g. Make me respected
    h. Other _____
45. Which of the animals do you focus on and give emphasis to?

    _____
46. Why?
    a. _____
    b. _____
    c. _____
    d. _____
    e. _____
47. Do you think your surrounding/environment is suitable for livestock raising?
    a. Yes
    b. No
    c. I don't know
48. Cattle of which origin do you want to keep?
    a. Dano
    b. Neighboring districts
    c. Wollega
    d. Keffa
    e. Kola area
    f. Dega areas
    g. All places
    h. Other _____

49. If possible, what type of cattle do you want to keep?

a. Cattle of my area
b. Cattle from Wollega
c. Cattle from Keffa
d. Cattle from Kola areas
e. Cattle from Dega areas
f. Cross breeds
g. Cows only
h. Oxen/bulls only
i. Others _____

50. Which cattle type is more productive in your area: the crossbreeds supplied by office of agriculture or your local breeds?

a. Our local breeds
b. The crossbreeds
c. I don't know
d. Other _____

51. Do you want crossbred cattle to come to your area?

a. Yes
b. No
c. It depends
d. Other _____

52. If you have the capacity, what do you want to do for your cattle?

a. Buy feed
b. Construct barn
c. Take to veterinary clinics
d. Add some more cattle
e. Reduce the number for quality
f. Cross them with exotic breeds

53. For what activities in cattle production do you spend money?

a. Medication
b. Feed
c. Attending
d. Barn construction
e. Cleaning
f. Salt

54. Is the breed of all your cattle in this area similar or different?

a. Different
b. Similar
c. I don't know
d. Other _____

55. Do you practice cattle fattening?

a. Yes
b. No

1. If yes, when did you start? --------- (year)
    1. Where do you get the animals for fattening?
        a. Buy from market
        b. Buy from neighbors

c. From own herd
d. From relatives
e. From office of agriculture
f. From other organizations
g. Other _____

2. If no, why?
    1. It is not profitable
    2. No cash/credit to start with
    3. Lack of feed
    4. Disease prevalence
    5. No market
    6. Labor shortage
    7. I don't know how to do it
    8. I don't like it
    9. Other _____

56. What is your future plan about fattening?

a. I will do fattening
b. I won't do fattening
c. I don't know
d. Other _____

57. What is your source of technical support about livestock production?

a. Office of Agriculture
b. From fellow farmers
c. Radio
d. Newspapers and television
e. Conferences of the administration
f. Other _____

58. Is the technical support sufficient?

a. Yes
b. No

59. On what issues do you want to get technical support?

a. livestock health
b. livestock feeds
c. livestock product utilization
d. Livestock marketing
e. Other _____

60. Do you want to expand your livestock production or to maintain as it is now?

a. Reduce
b. Expand
c. Maintain as it is
d. It depends
e. Other _____

61. What is the opinion of the family on the future size of the livestock production?

a. To expand
b. To reduce
c. To maintain as it is
d. It depends
e. Other _____

62. Is the trend of livestock production and productivity increasing or decreasing?

a. Increasing
b. Decreasing
c. No change
d. Other _____

63. Do you sufficient grazing land for your cattle?

a. Yes
b. No

64. Is there feed shortage for cattle in general?

a. Yes
b. No
c. It depends on the season

65. When is feed shortage critical?

_____ (write months)

66. What do you do to cope up with the feed shortage in this (these) month (s)?

a. Rely on stored feed
b. Rely on farm residues
c. Rely on the natural vegetation
d. Send my animals to other areas
e. Rely on the market
f. Other _____

67. Do you store feed for your animals?

a. Yes
b. No
    1. If yes, what type?
        1. Teff straw

2. Maize stalk
3. Sorghum stalk
4. Other _____ (specify)

68. Is there a problem of cattle disease?
    a. Yes
    b. No
    c. It depends on the season
69. How much do you pay on average per year for medication of your cattle? _____
70. How much do you pay on average in a single trip to medicate your cattle? _____
71. How much do you pay per month for salt for cattle? _____
72. Do you buy cattle feed from the market?
    a. Yes
    b. No
        1. If yes, how much do you spend per year? _____
73. Considering the costs and benefits, how do you see the profitability of cattle keeping?
    a. Profitable
    b. Not profitable
    c. Break even
    d. I don't know
    e. Other _____
74. Do you have a barn for your cattle?
    a. Yes
    b. No
75. In which markets do you sell your cattle?
    a. Seyo Dano
    b. Kemsi roge
    c. Menz
    d. Harbi Gulfa
    e. Ijaji
    f. Silk Amba
    g. Shenen
    h. Guder
    i. Other _____
76. From which markets do you buy cattle?
    a. Seyo Dano
    b. Kemsi roge
    c. Menz
    d. Harbi Gulfa

e. Ijaji
f. Silk Amba
g. Shenen
h. Guder
i. Other _____

77. As a buyer, how do you see the current price of cattle?
    a. High
    b. Low
    c. Medium
    d. Other _____

78. As a seller, how do you see the current price of cattle?
    a. High
    b. Low
    c. Medium
    d. Other _____

79. Which are your favorite months to buy cattle? _____

80. Which are your favorite months to sell cattle? _____

81. How many months do you milk your cows in a good year? _____

82. How many months do you milk your cows in a bad year? _____

83. How many days in a month do you eat meat in a good year? _____

84. How many days in a month do you eat meat in a bad year? _____

85. Do you rent in farm oxen?
    a. Yes
    b. No
        1. If yes, how much do you pay per day? _____

86. Do you rent out farm oxen?
    a. Yes
    b. No
        1. If yes, how much do you charge per day? _____

87. Is there the culture of selling (dried) cow dung for fuel and/or manure?
    a. Yes
    b. No
        1. If **yes**, how do you measure it for fuel and manure?
            1. For fuel_____
            2. For manure _____
        2. If **yes**, what is the price of a unit of
            1. Cow dung for fuel_____

2. Cow dung for manure_____

88. Do you face any pressure in the market when you go to buy cattle in the market?

a. Yes
b. No
c. Sometimes
d. Other _____

1. If **yes**, who exerts the pressure upon you?
    1. The merchants
    2. Other farmer merchants
    3. The brokers
    4. Other buyers
    5. Other marketers
    6. Other _____

89. Do you face any pressure in the market when you go to sell cattle in the market?

a. Yes
b. No
c. Sometimes
d. Other _____

1. If **yes**, who exerts the pressure upon you?
    1. The merchants
    2. Other farmer merchants
    3. The brokers
    4. Other buyers
    5. Other marketers
    6. Other _____

90. Is there a time when you went to sell and could not sell your cattle in the market?

a. Yes
b. No

1. If **yes**, why couldn't you sell your cattle?
    1. Low price offer
    2. Expected higher price
    3. Changed my idea
    4. the market was disturbed
    5. Wanted to take to another market
    6. Other _____

91. Is there a time when you went to buy and could not buy cattle in the market?

a. Yes

b. No

1. If **yes**, why couldn't you sell your cattle?

1. High price
2. Couldn't get the cattle I wanted
3. changed my idea
4. the market was disturbed
5. Wanted to go to other markets
6. Other _____

92. Which market is the most suitable to sell cattle?

a. Seyo Dano
b. Kemsi roge
c. Menz
d. Harbi Gulfa
e. Ijaji
f. Silk Amba
g. Shenen
h. Guder
i. Other _____

93. Which market is the most suitable to buy cattle?

a. Seyo Dano
b. Kemsi roge
c. Menz
d. Harbi Gulfa
e. Ijaji
f. Silk Amba
g. Shenen
h. Guder
i. Other _____

94. Where do you want to sell your cattle, in the market or at home?

a. At home
b. In the market
c. I am indifferent
d. Other _____

95. Where do you want to buy your cattle, from the market or from the seller's home?

a. From seller's home
b. From the market
c. I am indifferent
d. Other _____

96. Which earns higher price for cattle: selling at home or selling in the market?

a. Selling in the market
b. Selling at home
c. It depends
d. Other _____

97. Do you think there is a difference in social respect between people who have livestock and those who don't?
    a. Yes
    b. No
    c. I don't know
    d. Other _____

98. Is the general trend of the size of benefits you acquire from cattle increasing or decreasing?
    a. Decreasing
    b. Increasing
    c. No change
    d. I don't know
    e. Other _____

99. Is the general status of living of the farming community improving or deteriorating?
    a. Improving
    b. Deteriorating
    c. No change
    d. I don't know
    e. Other _____

100. What are the basic challenges of the farming community?
    a. Farm land shortage
    b. Moisture stress
    c. Shortage of cash
    d. Human disease
    e. Lack of potable water
    f. Lack of education
    g. Lack of roads
    h. Lack of markets
    i. Lack of farm inputs
    j. Crop and livestock diseases
    k. Theft
    l. Other _____

101. Do you thing cattle are useful to improve the living standard of the farming community?
    a. Yes
    b. No
    c. I don't know
    d. Other _____

Present a heartfelt gratitude and depart with greetings!

Appendix 4

Appendix 4.1: Questionnaire for the Choice experiment Survey (May – June, 2006)

Instruction:

1. **Start with greetings in local language.**

2. **Read the following for the respondent**
   This is a questionnaire prepared to generate data for the study on cattle production and marketing conducted by Oromia Agricultural Research Institute and International Livestock Research institute. Data generated with this questionnaire will not be transferred to a third person and will be used only for the purpose of the study. Thanks for your willingness to discuss with us.

Note: The questions can have more than one answer.

Introduction

Introduce yourself very simply and clearly.

General Information

1. Date ---------- (DD/MM/YYYY)
2. Interviewer's name ----------
3. Market name ----------
4. Main occupation of the respondent
   a. Farmer
   b. Trader

c. Farmer trader
d. Religious leader (worker)
e. Government employee
f. Other_____

5. Gender of respondent
    a. Male
    b. Female
6. Marital status of the respondent
    a. Married
    b. Single
7. Age of respondent _____ (years)
8. Education level of respondent
    a. Illiterate
    b. Reading and writing
    c. Elementary school
    d. Secondary school
    e. Above secondary school
    f. Spiritual education
9. Respondent's religion
    a. Orthodox Christian
    b. Islam
    c. Protestant
    d. Other
10. Family size and composition
    a. Total family size_____
    b. Male_____
    c. Female _____
11. How many family members do participate in income generation for the family?

    _____

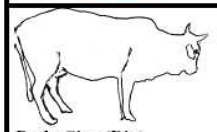
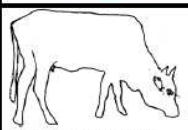
12. Please fill the responses of the choice experiment in the following table for both cows and bulls.

Cow Profile Choice				Bull Profile Choice			
Number of respondent group_____				Number of respondent group_____			
Card No.	Selected Profile			Card No.	Selected Profile		
	1	2	Opt-out		1	2	Opt-out

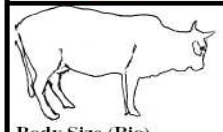
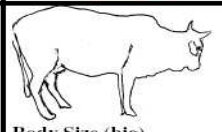
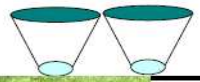
Depart with genuine gratitude.

Appendix 4.2: Choice sets (designs) used in the CE survey to elicit cow trait preferences

Respondent group – 1
Design – 1

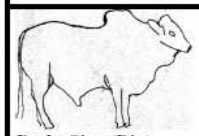
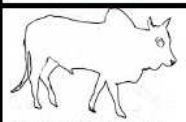
Cow 1 (Profile 1)	Cow 2 (Profile 2)	No purchase
Origin Nearby Dano	Origin Keffa	Opt-out option
 Body Size (Big)	 Body Size (small)	
Fertility (1 calf/2 years) Year 1 | Year 2 | Year 3 | Year 4 + | | + |	Fertility (1 calf/2 years) Year 1 | Year 2 | Year 3 | Year 4 + | | + |	
Milk 2 lt/day 	Milk 1 lt/day 	
 Calf strength (poor)	 Calf strength (poor)	
 Illness >2 / year	 Illness 1-2/year	
 Price - 500.00 birr	 Price - 500.00 birr	

Respondent group – 1
Design – 2

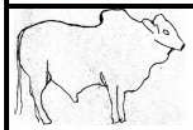
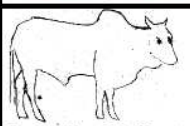
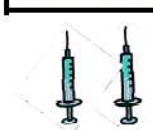
Cow 1 (Profile 1)	Cow 2 (Profile 2)	No purchase
Origin Wellega	Origin Nearby Districts	Opt-out option
 Body Size (Big)	 Body Size (big)	
Fertility (1 calf/2 years) Year 1 | Year 2 | Year 3 | Year 4 + | | + |	Fertility (1 calf/ year) Year 1 | Year 2 | Year 3 | Year 4 + | + | + | +	
Milk 3 lt/day 	Milk 2 lt/day 	
 Calf strength (good)	 Calf strength (good)	
 Illness 1-2/year	 Illness >2/year	
 Price - 500.00 birr	 Price - 700.00 birr	

Appendix 4.3: Choice sets (designs) used in the CE survey to elicit bull trait preferences

Respondent group – 1
Design – 1

Bull 1 (Profile 1)	Bull 2 (Profile 2)	No purchase
Origin Nearby Districts	Origin Wellega	Opt-out option
 Body Size (Big)	 Body Size (small)	
Ploughing – Good 	Ploughing - Good 	
 Calf strength (poor)	 Calf strength (good)	
 Illness >2 / year	 Illness >2/year	
 Price - 1200.00 birr	 Price - 800.00 birr	

Respondent group – 2
Design – 1

Bull 1 (Profile 1)	Bull 2 (Profile 2)	No purchase
Origin Wellega	Origin Dano	Opt-out option
 Body Size (Big)	 Body Size (Medium)	
Ploughing - Suitable 	Ploughing - Unsuitable 	
 Calf strength (good)	 Calf strength (good)	
 Illness 1-2 / year	 Illness >2/year	
 Price - 800.00 birr	 Price - 800.00 birr	

Appendix 5

Questionnaire Prepared for Transaction Level Data (February – November, 2006)

Instruction:

1. **Start with greetings in local language and introduce yourself.**

2. **Read the following for the respondent**

   This is a questionnaire prepared to generate data for the study on cattle production and marketing conducted by Oromia Agricultural Research Institute and International Livestock Research institute. Data generated with this questionnaire will not be transferred to a third person and will be used only for the purpose of the study. Thanks for your willingness to discuss with us.

Code: _____ Date: _____DD/MM/YYYY

I – Information about the respondent (buyer)

1. Place where he\she came from _____
2. Age (in years) _____
3. Gender _____
4. Educational status
   a. Illiterate
   b. Reading and writing
   c. Elementary
   d. Secondary
   e. Above secondary
   f. Religious studies
5. Religion
   a. Orthodox Christian
   b. Muslim
   c. Protestant
   d. Other _____ (specify).

6. Marital status
    a. Married _____
    b. Single/Divorced/Widowed _____
7. Family size and composition
    a. Total family size _____
    b. Males _____
    c. Females _____
8. Type of cattle purchases
    a. Ox
    b. Cow
    c. Calf
    d. Heifer
    e. Bull
9. Purpose of purchase

	Ox	Cow	Calf	Heifer	Bull
A					
B					
C					
D					

10. Purchase price
    a. Ox
    b. Cow
    c. Calf
    d. Heifer
    e. Bull

II – Data regarding the cattle purchased.

Cattle type	Origin of cattle	Body size	Coat color	Age (year)	Reason for selling
		a. Small b. Medium c. Big			a. make profit b. animal is ill c. Cash for wedding d. Cash for mourning e. To repay loan f. Feed shortage g. Cash for schooling h. Cash for medication i. Other
		a. Small b. Medium c. Big			a. make profit b. animal is ill c. Cash for wedding d. Cash for mourning e. To repay loan f. Feed shortage g. Cash for schooling h. Cash for medication i. Other