

*Full Length Research Paper*

# Econometric estimation of herd stocking decisions in South Ethiopia

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**This paper aims to share knowledge and the theoretical basis for understanding herd dynamics in pastoral communities of Hadiya, Southern Ethiopia, with the intention that it may improve effectiveness of development interventions. The study is based on data collected from two districts considering 160 pastoral households. Focus group and key informant discussions were also made to generate data to supplement the personal interviews. A Probit model was utilized for analyzing factors that determine cattle stocking. The Hadiya pastoralists stock cattle not mainly as a security against risks but it is also the cultural obligation to attain the cultural titles to some clans. Social interaction expressed as marriage bond and social capital as well as herding experience determines willingness and intensity of herd stoking, besides natural factors. However, financial factors have little effect on cattle dynamics. The results imply that, if any kind of development interventions is planned to improve the livelihood of the community and or the environment, strategies related to optimal stocking rates (considering cultural dimension of stocking) should be developed.**

**Key words:** Ethiopia, herd stocking, Hadiya, pastoralism.

## INTRODUCTION

Livestock make an important contribution to most economies, especially in developing countries. Addressing poverty (income and non-income) is an imperative development agenda of the developing countries. Owen et al. (2005) estimated that 76% of people in developing countries are poor rural dwellers and 2/3 of these people are livestock keepers. Ethiopia, among the least developed countries in the world, aspires to become a middle income country in 2025. The government formulated several ambitious national growth strategies in order to realize this vision, the latest being the Growth and Transformation Plan (GTP: 2011-2015). Considering that agriculture accounts for some 40% of

GDP, 80% of employment and 90% of all exports, it is inevitable that a rapid commercialization of this sector is a key priority.

Ethiopia is an agrarian, landlocked country characterized by high population growth, huge dependence on erratic rainfall, low agricultural productivity and structural bottlenecks (Ministry of finance and Economic Development (MoFED, 2006). However, it also has the largest number of livestock in Africa with a total of about 47 million head of cattle, 26 million head of sheep 24 million goats, 49 million chicken, 6 million equines (donkey, horses and mules) and 2 million camels Central Statistical Authority (CSA, 2007). The richness of

the country is both in terms of large number and diversity of livestock population. Like the human population the cattle distribution in the highlands is three times greater than the lowland area. Although the lowland has fewer animals than the highlands, the lowlands, which are mainly pastoral, play an important role in the livelihood of the highlanders. The highland is considered as livestock deficit, the lowlands being a major source of supply, for instance 20% of the highland draught animals come from the lowlands (Kejela and Bezahih, 2006).

According to the International Department for Environment and Development (IIED, 2009), pastoralism is still a way of life and an essential livelihood for a substantial part of East Africa's population, up to 20 million people. With all its critics and ailing livelihood pastoralism has sustained itself because of its basic features: flexibility, low costs, freedom of movement, light regulatory environment and operation in regions that are unsuitable for agriculture. Pastoral areas remain the least developed part of Ethiopia despite the fact that the sector supports over 40% of the country's livestock, 61% of the total area of the country of which 46% is arable land, and 12% of the population (CSA, 2007). Livestock define the lives of pastoralists, being means of fulfilling and satisfying nutritional, social and cultural needs of the family.

The purpose livestock serves varies across economies, ecologies and cultures. Livestock farmers keep cattle for multiple purposes including milk, meat, blood, hides, horns and income (Sharon et al., 2003). Socio-cultural functions of cattle include their use as dowry and to settle disputes (as fines) in communal areas (Chimonyo et al., 1999). They are reserved for special ceremonial gatherings such as marriage feasts, weddings, funerals and circumcision. They are also used to strengthen relationships with in-laws and to maintain family contacts by entrusting them to other family members (Bayer et al., 2004; Dovie et al., 2006). Sacrificial offering of cattle also play an important role in installation and exorcism of spirits.

Review of literatures on pastoral studies indicates many of the previous studies have been undertaken mainly to inform institutional analyses of pastoralism and of common property resource management. Other studies have been undertaken mainly by anthropologists, focusing on social and cultural changes and challenges facing pastoralists (Michael, 2006). Little is known about the relationship between cultural and economic variables of the system. Pastoralism has immense potential value for reducing poverty, managing the environment, and promoting sustainable development. Pastoralism as a system is a complex production system; furthermore the available information on the subject is not substantial. Therefore this paper adds to the understanding of the social and economic features of pastoralism. Besides, it brings to light the nature and feature of herd stocking in Hadiya Pastoral production system because the nature

of herd dynamics affects commercial off-take and therefore response for the increasing demand for meat.

## METHODOLOGY

### Data and data sources

Both desktop and primary research methods were employed for this study. Information was collected from a variety of sources such as Government publications, nongovernment organization publications and journals. Primary data were collected using both formal and informal methods. The primary data sources include individual pastoral households, traders, and key informants. Individual interviews using a pre-tested questionnaire generated household level data.

Data were collected by means of structured and pretested questionnaire between September and December 2009. For the overall understanding of the study area's production and marketing system, Participatory Rural Appraisal (PRA) tools were used (experts and knowledgeable elders of pastoralists, consumers and traders) using the checklist prepared for the purpose. Field observations and Rapid Market Appraisal were also been made to observe the overall features of the selected Peasant Association (PAs) markets and to pre-test the questionnaire (to make sure that important issues had not been left out).

### Sample size and method of sampling

The survey districts were selected based on secondary information from Central Statistical Authority, Socioeconomic profile bulletin of the zone and expert knowledge. Six major pastoral PAs from Soro district and three PAs from Gombora district (one third pastoral PAs from each district) were then identified based on season of the pastoralists available in the PAs; besides, accessibility, clan distribution, neighboring ethnic groups and area of production were also considered. From total of these nine PAs, proportional to the pastoral population, totally 160 pastoral household heads were selected, 108 from Soro and other 52 from Gombora districts. The respondents were informed of the purpose of the research, and assured that their responses would be treated confidentially.

### Method of data analysis

#### *Descriptive statistics analysis*

To describe some of the variables of interest and their interrelationship descriptive and inferential statistics were applied in the documentation of the basic characteristics of the sampled households. These include use of ratios, percentages, means, and standard deviations and related tests of student's t and chi square.

With the hypothesis that herders stock mainly to hold cultural titles, the producers are categorized according to their production behavior as title holders (those with 1000 cattle attain *Kuma*, and with 100 cattle attaining *Abagaz/Gerad* titles) and non-title holders.

#### *Econometric method of data analysis*

The modeling methodology used to analyze the factors decisive in attaining the cultural title (by cattle stocking) is probit regression that allows the prediction of discrete variables by a mix of continuous and discrete predictors (McCullagh and Nelder, 1983). The probit model constrains the estimated probabilities to be either 0 or 1, relaxes the constraints that the effect of independent variables is

constant across different predicted values of the dependent variable. The probit model assumes that while only the values of 0 and 1 are observed for the variable  $Y$ , there is a latent, unobserved continuous variable  $Y^*$  that determines the value of  $Y$ . It is assumed that  $\epsilon_i$  is normally distributed across observations, and the mean and variance of  $\epsilon$  are normalized to 0 and 1. The  $Y^*$  can be specified as follows:

$$Y^*_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \epsilon_i \tag{1}$$

and that:

$$Y_i = 1 \text{ if } Y^*_i > 0$$

$$Y_i = 0 \text{ otherwise}$$

As with logit model, it is assumed that  $y_i^*$  is a function of observed and unobserved variables

$$y_i^* = \beta_0 + x_{1i} \beta_1 + x_{2i} \beta_2 \dots + x_{ki} \beta_k + \epsilon_i \tag{2}$$

$$y_i^* = x_i \beta + \epsilon_i \tag{3}$$

Where  $y_i^*$ = latent and measure of level/ of herd stocked by  $i^{th}$  household,  $X_i$  = a vector of explanatory variables describing the personal, social, economic and environmental factors,  $\beta_i$  = a vector of parameters to be estimated, and  $\epsilon_i$  = a random error term (assumed to follow a standard normal distribution).

The model is determined by the assumed distribution of  $\epsilon$ . The observed and coded discrete herd stocking variable,  $y_i^*$ , is determined from the model as follows:

$$\Pr (y_i=1)$$

$$= \Pr (\epsilon_i \geq -(\beta_0 + x_{1i} \beta_1 + x_{2i} \beta_2 \dots + x_{ki} \beta_k))$$

$$= 1 - \Pr (\epsilon_i \leq -(\beta_0 + x_{1i} \beta_1 + x_{2i} \beta_2 \dots + x_{ki} \beta_k))$$

$$= 1 - \Phi(-x_i \beta)$$

Where,  $\Phi$  represents the cumulative normal distribution function.

The interpretation of this model's primary parameter set,  $\beta$ , is as follows: positive signs indicate likely factor for title holding/herd stocking as the value of the associated variables increase, while negative signs suggest the converse.

The model considers pastoral households as utility maximizers who compare and rank level of utility that they get by securing the traditional title against its reservation utility attained without the title. In general, the effect of a change in one of the explanatory variables (say the  $j$ -th variable) on the choice probability is given by the derivative.

## RESULTS AND DISCUSSION

### Demographic characteristics of pastoral households

All respondents were male. Title holders, who attained the traditional title by accumulating at least 100 cattle, and non-title holders on average have 2.23 and 1.17 wives respectively. This indicates that a woman cannot be household head, even if widowed; they then need to marry someone from the family, at least as polygamy because resource governance in the community is totally a male responsibility. It is also possibly one means to protect clan's wealth by not letting a widow marry someone out of the clan and take herds. However, the case is totally different for girl's first marriage, where marriage into larger clans establishes a marital tie which

serves as a security against all sorts of risks. There is significant difference ( $P < 0.01$ ) in the age of the household heads between the title holders and non-title holder. Household heads who have secured the traditional title (*Kuma, Gerad/Abagaz*) are significantly older (average 45.68 years) than that of the non-title holders (32.7 years). This implies a strong relationship between age, wives and title holding; probably, labour contribution of wives (and hence their children) as well as pre marriage herd of the wife boosts herd size. The dependency ratio, proportion of dependents to 100 working age population of the sample respondents was 160%. This ratio is possibly attributed to polygamous nature of the pastoralists. Statistically there is a significant mean difference in terms of dependency ratio between the two positions 32% for the title holders and 43% for non-title holders. In regard to their religion, 93% of the title holders follow the traditional *Wa'a* religion while 71% of the non-title holders are protestant Christians (Table 1). The average year of schooling 1.54 years for both groups is not significantly different. The result would imply the entire reliance of the producers on traditional knowledge.

### Cattle production and marketing system

For a considerable part of East Africa's population, pastoralism remains a way of life and an essential livelihood with cattle production being a major part of the system. There are a wide range of reasons for which households keep cattle in different communities. Cattle production in the community is a family business where every capable member participates based on the division of labor in the community. Normally stronger family members take care of stronger cattle. In Hadiya pastoral system herders give name to cattle based on either behavior or color. The cattle are trained to respond to particular names and this is important in managing large number of cattle. The Hadiya Pastoralists are also experienced in breeding. Every traditional breeder seeks parameters that the community wants to have in his herd: First, milk ability; second, walking ability: the ability to walk long distances over rugged terrain and third coat color (it enables cattle to stand desert flies and heat besides the aesthetic value of the skin).

In this pastoral system, nomads, transhumant and the agro pastoralists are known to co-exist<sup>1</sup>. The survey revealed that livestock production system in the area is characterized by cattle-dominated livestock production and rainy season transhumance. Pastoralism in this community is characterized by entire dependence on naturally growing pasture via mobility. In addition to pasture and conflict avoidance, traditional beliefs and faith determine where and with whom to migrate. The

<sup>1</sup> Though it was only the nomads considered in this study.

**Table 1.** Demographic characteristics of the pastoral households by traditional title.

Variable	Title holder	Mean(Std. deviation)	t- value
Age	H	45.68(8.7)	9.19***
	NH	32.67(9.2)	
Education level (years of formal schooling)	H	1.54(1.3)	0.009
	NH	1.54(1.4)	
Dependency ratio	H	0.32(0.1)	-6.28***
	NH	0.433(0.1)	
Number of wives	H	2.23 (0.9)	8.36***
	NH	1.17(0.7)	
TLU <sup>2</sup> (Tropical Livestock Unit)	H	101.3(14.6)	18.23***
	NH	57.2 (15.9)	

\*\*\*, statistically significant at 1%, level of significance, N=160, title holder (H)=78, non-title holder (NH)=82. <sup>2</sup>One tropical livestock unit is roughly equal to 250 kg of live animal weight.

peak months when the herders migrate are June (24.7%), December (36.6%), and March (38.7%). Reasons for migration vary with season. For instance in June 61% migrated due to disease, 24% wild life attack and the remainders because of bad feeling (traditional belief). In December 50.6% ranked traditional belief (worship and inauguration of the *Tibima/Kumima* ceremony), 32% pasture depletion and 17.4% due to conflict (mainly between clan conflict). The title holding ceremony takes place in river areas where the clan congregates. In March 66.5% move due to feed and water, 17.3% due to traditional faiths and ceremonies, the remaining 6.2% caused by conflicts (both between clans and Human- wild life conflicts). Participants of the focus group discussion confirmed that mortality because of different factors is predictable (both with respect to occurrence and magnitude of loss) which determines herd dynamics/stocking-destocking/ decision. There are different factors which determine their precision of prediction. The survey result implied that 57% of the respondents anticipated 10 to 15% of loss, 34% less than 10% and the others anticipated more than 15%.

According to focus group and key informants' discussion this estimation is mainly based on past experience on cyclic prevalence of drought and disease.

Conflicts are among the common phenomena characterizing the pastoral system. In some cases it becomes more destructive even than the drought and disease since these factors have limited affect on human life. Among all sorts of conflicts, the respondents ranked the Human-policy conflict as the worst, mainly because it is non avoidable. For instance, the construction of the huge *Gilgel Gibe III* hydro electric power dam evicted them from their grazing land and left them vulnerable to risks. Besides its migration the pastoral system is also

characterized by herd species composition; on average the surveyed pastoralists possessed 78 Tropical Livestock Unit (TLU) and standard deviation of 14 where all pastoralists rear cattle and donkey, with a varying intensity of small ruminants. According to the focus group and key informants' discussions the herd composition is a function of 'risk mitigating' nature of the pastoralists', topography and tradition (cow is the symbol of the spirit of *wa'a* (traditional God). Hadiya pastoralists do not rear camel, 44.6% think it is Islamic, 43% suspect it does not adapt the rugged topography in the *Gibe-Omo* basin, and the remainders do not even know the animal. This is possibly because the community entire on own knowledge and the 'within' the system information for livelihood decisions.

### Determinants of pastoralist's herd stocking decision

In order to analyze factors determining securing cultural title (stocking herd), seven variables were used in Probit regression model. With the knowledge that his/her decision making is invariably surrounded by uncertainties and, risks; different classes of variables are considered based on socio-economic, demographic and cognitive factors. The analysis was made using STATA version 12 statistical software. Before conducting the analysis multicollinearity among the explanatory variables was checked so that the parameter estimates will not be seriously affected by the existence of multicollinearity among variables. The variables were also tested for hetroskedastisity and the test rejected for all variables the null that there is a significant difference among the variables in the same group variances (Table 2). The likelihood ratio chi-square of 194.32 with a p-value of

**Table 2.** Determinants of Pastoralist's herd stocking.

Variable	Estimated coefficient (B)	Odds ratio	Wald	Standard error	p-value
Number of wives (NWV)	0.959	1.632	9.26	0.315	0.006*
Herding experience (HE)	0.114	1.919	1.032	0.083	0.310
Education level (EDUCLVL)	0.255	0.775	0.246	0.513	0.620
Net social transfer (NST)	1.167	0.846	0.758	0.991	0.384
Access to market (ACMKT (1))	0.407	1.503	0.100	1.289	0.752
Modality of payment (MOP)	0.238	0.788	7.866	0.085	0.005**
Mortality (MORT)	-0.66	-0.96	6.96	0.25	0.02*
Constant	24.154	308897	9.038	8.034	0.003

Number of observation = 160,  $\chi^2(10)=194.320$ , Prob >  $\chi^2=0.0001$ , Pseudo  $R^2=0.1831$ , \*\*\*, \*\*, \* statistically significant at 1%, 5% and 10% level of significance respectively,

0.0001 tells us that the model as a whole is statistically significant, that is, it fits significantly better than a model with no predictors. The significant variables and possible reasons are discussed thus.

### Herding experience (HE)

This variable is used as a proxy to age, traditional knowledge and or social capital of the household head. Pastoralists in southern Ethiopia do not have access to any research, extension or modern veterinary facilities.

Therefore grazing area selection, breed and herd composition selection, replacement decision and medication are indigenous to the herder's experience and naturally increase with age. In this model, the variable is found to be significantly and positively related to stocking cattle (to attain cultural title). The coefficient of HE suggests that an increase in the herding experience of the household head is likely to increase the probability of title holding, keeping all other variables constant. Increases in age of the household head accompanied by increase in responsibility (social/family) helps the household head to accumulate experience. Besides, at older ages either through birth or extended family the household would have enough labor, which is the major and irreplaceable input of cattle production in such system of production. The increase in the herding experience of the household head by a year increases the likelihood of becoming title holder by 11% as compared to the other alternative.

### Modality of payment (MOP)

This is whether the payment is made on cash or credit basis. The positive relationship shows that, other variables held constant the likelihood in favor of being non-title holder increases if the payment is made on credit than on cash basis. Therefore if the payment is made on credit the seller wouldn't have the chance to make immediate replacement. By implication the ones with the purpose of stocking their herd have lesser interest to sell on credit. Since their sale's purpose is mainly either to

replace older staff or to expand herd size the non-title holders prefer to widen their liquidity by selling on cash. They are reluctant to sell unless they can replace the herd. Beside the "on credit sale" is at least one third greater than the "on cash sales", this gives additional income for the sellers. In this drylands the sellers do not have other options to invest their money, but to purchase additional cattle. This implies that the pastoralists do not have other means to invest their money but to expand their herd size. The evidence from the model shows that a shift from 'on credit' to 'on cash sale' increases the probability of the household to be a title holder by 23%.

### Number of wives (NWV)

The number of wives the household head had has positive and significant relation with title holding option. In regard to the casual link of wives and title holding, additional wife provides two things, first, additional cattle as a marriage gift and second, security in case of any risk, that is, restocking gifts from her clan. This positive relationship entails that, keeping all other variables constant the odd in favor of holding the traditional title increases. The possible explanation for this is that those who have more wives have access to cattle first as (beginning capital) marriage gift that is, in this community when a daughter leaves her parents because of marriage she will be given her share to begin her new life, and second because of marital ties relatives help her restock cattle during shocks. Moreover, polygamy in this community is a source of social security during conflicts and natural hazards. This is mainly due to the fact that Hadiya pastoral communities more often than not do not fight with the clan they get married. As the number of *wives* increase by one the probability of securing the traditional title increases by 9.9% rather than being non-title holder.

Besides, marriage in this pastoral community is the most effective diplomatic means to secure peaceful relation with the neighboring tribes/clans. Because, raiding has already been identified as restocking strategy

in case of disease/drought, according to the PRA result, however raiding may not always serve as presupposed and in most case it inflict more damage than the natural disaster. A positive coefficient says the log-odds of title holding are increasing as a function of number of wife (the more wives got, the more likely the household is to secure the cultural title (stock cattle).

### **Mortality (MORT)**

Mortality in this model is used to represent effects of natural calamities on herd stocking (Getachew and McPeak, 2004). This variable is a proxy for herd loss due to drought, disease and wild life attack. So that it can help estimate the intensity of loss, the variable is used in the model as ratio of total loss due to the above mentioned causes to total herd owned. As it is shown in the table a percentage increase in mortality rate decreases the likelihood of holding the cultural title by 66% as compared to the non-title holding option. A previous study by Ayana (2011) showed that rainfall variability greatly influenced herd dynamics under communal and ranch managements in terms of herd die-offs and lower birth rates, which also considerably affected milk production for household consumption. The result implies that management of herd size is therefore a compromise between harvesting production in average years and the risk of losses in a drought.

### **Access to market (ACMKT)**

It is a dummy variable taking a value of 1 if the pastoralist has access to market and 0 otherwise. The access to market variable considers the distance to the market, language, cultural and other barriers to the market. It has been hypothesized not to have clear effect on herd stocking but markets may help pastoralists to stock back. Because, producers that have access to market are likely to supply more and buy larger than the ones not having access to the market. Goetz (1992) noted that better market significantly raises the probability of market participation (both as a buyer and seller) for households. However, evidence from Table 2 establishes that markets do not have a significant effect on title holding decision. This finding is in line with the works of Sharon et al. (2003) and Getachew and McPeak (2004) that social purposes of cattle by far outweigh the monetary ones.

### **Net social transfer (NST)**

The net transfer is a continuous variable measured in TLU. It is the difference between herd given/loan in and given/loan out divided by total TLU, in the study period. As shown in Table 2, the variable has positive and significant relation with the title holding position. It means

that 1% increase in NST will raise the likelihood of herd stocking (title holding) by more than 16% as compared to non-title holding option. Probably the cattle given out in this way may serve multiple purposes like security against risks in case of disaster, save labor and strengthen social bond which might be source of assistance in case of crises. Hence, the number of cattle given out in this way is believed to have a positive effect on the rate of herd stocking decision. The net transfer increases (other things being fixed) the chance of holding the traditional title, this is primarily because, the household has the right to return back his cattle whenever needed. It points to social transfers being the main sources of herd stocking (social security) after crises because of natural and human factors.

## **CONCLUSION AND RECOMMENDATIONS**

This study has significant implications for pastoral development and environmental initiatives. Its findings will enable development practitioners to better understand the needs and wants of the pastoral community, and offer a useful reference point for future studies. One major viewpoint revealed by this study is that the Hadiya pastoralists stock large number of cattle not only as a security against risks but also for social reasons. This might imply that some development initiatives, for instance, settlement, may not suit the pastoralists' purposes of cattle production. The research also identified that net social transfer, herding experience, market access, and number of wives positively affect herd stocking. It has also been observed that monetary factors have little effect on herd dynamics.

The results indicate that the system relies entirely on traditional knowledge for all decisions made, possibly expansion of formal education and extension services might be way out for some of the problems the system faced. Therefore, for any development intervention to be effective in improving the livelihood of the community and or the environment, strategies related to optimal stocking rates (considering cultural dimension of stocking) should be developed.

Finally, what need to be focused on is any development effort in this area need to match the belief and attitude of the community, at least for efficiency and sustainability. Future research should also look into how the pastoral community's attitudes towards herd stocking changes as a result of climate change, and what factors govern the relationship. Researchers may also investigate the impact of cultural values on multifaceted developmental endeavors in pastoral areas.

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