American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)
ISSN (Print) 2313-4410, ISSN (Online) 2313-4402

http://asrjetsjournal.org/

# Adoption of Awasi-cross Sheep Breed and its Impact on Household Income in Ethiopia

Solomon Tiruneh[a]*, Mesfin Bahita[b], Birhan Tegegn[c], Belay Deribe[d]

[a, b,c,d] *Sirinka Agricultural Research Center, Ethiopia*

**Abstract**

The study was conducted in Ethiopia to assess the impact of Awassi cross breed, which is introduced by scaling out project five years ago, on household income. Generalized propensity score technique was used to estimate the effect of producing Awasi cross sheep breed on household income. Results indicated that from nine explanatory variables included in econometric model three variables were found to significantly influence intensity of Awasi cross breed production. These include total land holding, total income from crop production and labor availability. The Dose Response functions (DRFs) for the outcome variable, income from sell of sheep, is statistically significant for all values of the treatments except from 48 onwards. The average probability of income from sheep increases from 47674.49 Eth. Birr for a farmer having one Awasi cross breed and expected to increase to 63230.54 Eth. However, the number of Awasi cross breed beyond 47 does not increase income significantly. Generally, Awassi cross breed sheep serves as important source of better income compared to local. Therefore, introducing Awasi crossbreed to similar agro ecologies will have paramount effect to improve farmers income in the crop livestock mixed farming system through scaling out.

***Key words****:* Scaling out; Dose-response function (DRF); Generalized propensity score technique; Ethiopia

## 1. Introduction

In Ethiopia, livestock is an important component of the farming system for the rural people. It generate cash income through the sale of animals and their products, serve as draught power for small holder farm operation, serve as a means of transportation, serve as a buffer against crop failures, used for direct consumption, as fertilizer, fuel and so on [1].

------------------------------------------------------------------------

* Corresponding author.
E-mail address: solomtu6@gmail.com.

Sheep and goats are among the major economically important livestock in the country. There are about 23.62 million sheep and 23.33 million goats in the country [2], playing an important role in the livelihood of resource-poor farmers. They provide their owners with a vast range of products and services such as meat, milk, skin, hair, horns, bones, manure and urine for cash, security, gifts, religious rituals, medicine, etc. Particularly, small ruminants are the major economically important livestock in the highland parts of the country in generating cash and provide social security in bad crop years [3]. Despite huge potential, the country is not able to generate expected amount of benefit from sheep production [4]. Only 125 million USD had generated from export earnings from live animal and meat export. However, it has planned to increase to 1 billion USD at the end of Growth and Transformation (GTP) in 2014/15 [5].

Sheep production is characterized by low productivity due to traditional extensive production systems with no or minimal inputs and improved technologies. They are virtually kept as scavengers, particularly in the mixed crop–livestock systems [6]. Among the reasons, the major are low potential of the breed, disease and inadequate animal feed in quality and quantity. On the other hand, the demand for live animals (especially sheep) is increasing due to the growing urban population, while farm areas are shrinking considerably because of an increase in the rural population [7].

Like in other highlands of the country, sheep are raised dominantly in the highlands of North Eastern Ethiopia. The area has a large sheep population. However, almost all of these local sheep breed belong to the low productive type. Efforts have made to improve this low productivity of the local sheep breed by crossbreeding with the exotic Awassi sheep to improve productivity and improve the income of farmers. Crossbreeding with Awasi cross breed to improve productivity of indigenous sheep is a common practice in the highlands of Central-Northern Ethiopia [8]. The capacity of Awassi sheep to transform often unused vegetation, good adaptability to the rather harsh environmental conditions [9] and ability to produce highly demanded products in the markets make them a suitable choice for income generation and in meeting the nutritional needs of the family. This multipurpose breed, indigenous to West Asia, is one of the most remarkable breeds in this context [10]. Moreover, expansion of markets and a raising demand for high quality animal products, particularly milk products and meat produced by this sheep breed offers promising opportunities for farmers to enhance their income and improve their livelihoods in the dry areas [11].

In the past 30 years, efforts were made to improve meat and wool productivity of the Ethiopian highland sheep through crossbreeding with exotic sheep breed particularly with Awasi and Corriedale breeds. With this fact, Debre Birhan produced about 5000 Awasi crossbreed and Amedguya sheep breed multiplication centres and distributed to different parts of the country [8].

As part of the effort to improve the productivity of local breed, Sirinka Agricultural Research Center (SARC) implemented pilot project of Awasi crossbreeds out scaling by using budget support from food security in 2008. One hundred with 25%, 46% and 65% blood level of Awassi crossbred rams were distributed in four *kebeles (the smallest administrative unit in the country )*of Meket and Wadla districts from North Wollo zone. Trainings and stakeholders participations were important components of the project. About 20 kg of Vetch and Oat seed each were also distributed for the participant farmers. Vaccination and treatment were given to the farmers' sheep at the beginning of the project. The project was implemented for five years with the main objective of improving productivity of sheep; thereby increase income of smallholder farmers. The crossbred rams were distributed to 147 households in the study area.

## 2. Methodology

### *2.1 Sampling Method*

Despite these efforts, much of current small ruminant research is dominated by descriptions of production systems and traits [12]. Little economic analysis has been done [13]. Therefore, to fill this gap and to further scale out the breed, it is paramount important to evaluate the impact of scaling out of Awasi cross breed on household income, which is the focus of this paper.

Multistage sampling method was used to select respondents in two districts: Meket and Wadla. First, the two *kebeles* one from each district in which scaling out project has been implemented (namely Warkaye and Talit) have been purposively selected for inclusion in the sample. Then, two *kebeles* one for each district (namely Estayish and Giorgis) from the remaining similar *kebeles* in which the scaling out project has not been implemented have been selected randomly. Then, in the second stage, a sample of 120 farm households was selected randomly, using the probability proportionate to size (PPS) sampling technique. This paper uses the term “producers” to refers to participants of the project that owned at least one Awasi cross breed sheep.

### *2.2 Data Collection*

This study was used both primary and secondary data. Primary data was collected from sampled households using structured questionnaire. Moreover, focus group and key informant discussions were held. Relevant secondary data was collected from respective offices.

### *2.3 Data analysis*

The data collected was analyzed using descriptive analysis and using non-parametric estimation: generalized propensity score matching using Stata 12 software [14].

### *2.4 Econometric model estimation*

#### *2.4.1 Impact estimation*

The choice of the appropriate model to use for impact evaluation on improved agricultural technologies depends on how the treatment was disseminated and receipt by the intended beneficiaries [4]. In our case, the overall population of farmers was not equally exposed i.e. that are the instrument was not randomly distributed. On the other hand, Awasi cross bred producers exposed to the new technology had full control over their decision to adopt or not to adopt (the receipt of the treatment is endogenous). Hence, the most plausible assumption in this case is that of selection on unobservable [15, 2]. Because farmers decide to adopt based on the anticipated benefit they would derive by adopting Awasi cross breed. However, this anticipated benefit cannot be observed, hence the need for an instrument, which will be independent of income but could affect them only through the adoption/production.

The adoption decision is modelled in a random utility framework. The difference between the utility from adoption (UhA) and non-adoption (UhNA) of Awasi cross breed may be denoted as Th*, such that a utility-maximizing farm household, will choose to adopt an Awasi cross bred, if the utility gained from adopting is greater than the utility of not adopting (Th* = UhA - UhNA > 0). However, these utilities are unobservable; they can be expressed only as a function of observable elements in the following latent variable model:

$$Th^{*}=Xh\,\gamma + Z'h\theta + \eta h,\ Th > 0 \text{ if } T^{*}h > 0, \qquad (1)$$

Where T is a continuous indicator variable, in our case number of Awasi cross breeds, $\gamma$ and $\theta$ is a vector of parameters to be estimated; Z and X is a vector of explanatory variables; and $\eta$ is the error term [16]. As discussed above, the adoption of new agricultural technologies can help improve the livelihood of farming community. Therefore, our outcome variable of interest is income from sell of sheep in year 2011.

### *2.4.2 Generalized propensity score (GPS) methodology*

To solve selection bias problem parametric and non-parametric econometric techniques have been developed including Heckman selectivity correction, instrumental variable (IV), matching methods, and error correction (EC) approaches. In this paper, we account for the endogeneity of technology adoption using the generalized propensity score (GPS) matching method developed by [15] using the gpscore, dose response STATA package.

The GPS methodology has a number of advantages compared to other econometric techniques. The GPS method allows for continuous treatment, i.e., different levels of the, proxied by number of Awasi cross breeds. In this way, we are able to determine the causal relationship between the outcome and the number of Awasi cross breeds (level of adoption intensity). Thus, it enables us to identify the entire function of the outcome over all possible values of the continuous treatment variable. A key assumption in the STATA implemented version of the GPS methods is the normality of the treatment variable conditional on the pre-treatment covariates. In our application, we assume that the log transformation of the treatment (number of Awasi cross breed) has a normal distribution, given the covariates.

The authors of [15] suggest a three-stage approach to implement the GPS method. In the second stage of the GPS method the conditional expectation of outcome (income from sold sheep) is modelled as a function of the treatment and the (estimated) generalized propensity score (equation 2). In the last stage, we estimate a dose response function that depicts the conditional expectation of outcome given the continuous treatment (number of Awasi cross breeds) and the GPS, evaluated at any level of the continuous treatment variable in the interval from 1 to 1.87 (equation 3).

$$\widehat{R_{\imath}} = 1\frac{1}{\sqrt{2\pi\hat{\sigma}^{2}}}\exp\left[-\frac{1}{2\hat{\sigma}^{2}}\{g(T_{i}) - h(\hat{\gamma}, X_{i})\}\right] \qquad (2)$$

$$E\{\widehat{Y(t)}\} = \frac{1}{N}\sum_{i=1}^{n}\hat{\beta}\{t,\hat{r}(t,x_i)\} = \frac{1}{N}\sum_{i=1}^{n}\varphi^{-1}[\psi\{t,\hat{r}(t,x_i);\hat{\alpha}\}] \quad (3)$$

## 3. Result and discussion

### *3.1 Household characteristics*

The mean age of respondents was 46.24 (SD= 12.53) with minimum and maximum age of 17 to 80 years respectively. The mean agricultural experience of the respondents was 27 years (SD=12.64). While the average family size in the study area was 5.95 with a standard deviation of 1.87. This is greater than national and regional average of 4.9 and 4.5 respectively. Other hands, the average household own labour in Man-day equivalent is 2.84 with standard deviation of 1.03 (Table 1). The mean land holding in the area was 1.86 ha with a standard deviation of 1.07 with minimum and maximum of 0.0 and 5.5 ha respectively. Land is a vital production unit for the livelihood of the rural community in the surveyed area in particular and in the country in general.

**Table 1**: Household characteristics of respondents

| Variable | Measurement | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Age | In years | 46.24167 | 12.52963 | 17 | 80 |
| Education | Years | 2.533333 | 1.302443 | 1 | 5 |
| Family size | Numbers | 5.95 | 1.869031 | 1 | 10 |
| Labour available | Man equiv. | 2.8425 | 1.026838 | .5 | 6.3 |
| Farm experience | Years | 27.2 | 12.63888 | 2 | 68 |
| Land holding | Hectare | 1.864292 | 1.07617 | 0 | 5.5 |
| Nonfarm income | Eth. Birr | 1220.925 | 2134.917 | 0 | 13656 |
| Income from crop | Eth. Birr | 390.325 | 1039.2 | 0 | 8000 |

### *3.2 Determinants of adoption intensity of Awasi cross breed*

The empirical findings of econometric analysis parameters of the variable expected to determine the intensity of Awasi cross breed production are displayed in Table 2. Nine explanatory variables were included in econometric model out of which three variables were found to significantly influence intensity of Awasi cross breed production. These include total land holding, total income from sold crop and labour availability.

The results have shown that total land holding was found positively influencing intensity of Awasi cross production at 1% significance level. This suggest that farmers having better land holding could create better opportunity to intensify Awasi cross breed through producing forage. Similarly, household labour availability was also positively and significantly influences intensification at 5% significance level. However, income from crop was negatively and significantly influences intensification at 5% significance level. The probable reason is as the income from crop decrease, farmers forced to see potential alternative cash source.

**Table 2**: Determinants of intensity of Awasi cross breed production

| Number of Awasi cross breed | Coef. | Std. Err. | z | P>z |
|---|---|---|---|---|
| Sex | 6.936 | 4.768 | 1.45 | 0.146 |
| Age | -0.147 | 0.129 | -1.14 | 0.253 |
| Education | 0.404 | 0.609 | 0.66 | 0.507 |
| Family size | 0.759 | 0.494 | 1.53 | 0.125 |
| Labour available | 0.579 | 0.924 | 2.42** | 0.041 |
| Farm experience | 0.209 | 0.133 | 1.57 | 0.115 |
| Land holding | 4.440 | 0.723 | 6.14*** | 0.000 |
| Nonfarm income | 0.000 | 0.000 | 0.45 | 0.651 |
| Income from crop | -0.002 | 0.001 | -2.12** | 0.034 |
| _cons | -14.952 | 6.712 | -2.23*** | 0.026 |

Number of obs = 120

Wald chi2 (9) = 69.51

Prob > chi2 = 0.0000

Log likelihood = -409.97211

**, *** indicated significant at 95% and 99% confidence level respectively

***3.3 Impact Awasicross breed on household income: dose response function estimates***

There is also a significant difference of market price between the local and Awasi cross breed sheep breeds at all ages. At the age of 12 months, for instance, the mean price for Awasi cross breed and local breed was 1081.4 and 686.1 Eth. Birr respectively. The adoption intensity (total share of Awasi cross sheep to total sheep population) has reached to 51.23%.

In dose response function, next step after the estimation of the GPS estimation is the conditional expectation of the outcome: gross revenue generated from sheep is regressed as a function of observed treatment and estimated General Propensity Score (GPS). Since the estimated coefficients of the regression have no direct meaning [15]. We, therefore, do not report the second stage estimates. The GPS model is estimated using maximum likelihood (ML) estimator under the log-normal assumption. The various test of goodness-of-fit indicate that the selected covariates provide good estimate of the conditional density of number of Awasi cross breed. For instance, the Wald test statistic indicates that matching variables are jointly statistically significant F (35.75, P<0.01). The assumption of normality was also statistically satisfied (P<0.01). Moreover, one-sample Kolmogorov-Smirnov test is also indicating normality assumption is satisfied at 0.05 significance level.

**Table 3**: Average price of sheep at different ages

| Average price at different age | Awassi Cross | | Local | | t-Value |
|---|---|---|---|---|---|
| | Mean | Std. Deviation | Mean | Std. Deviation | |
| 3 months | 382.4 | 119.7 | 207.3 | 56.6 | 9.6031*** |
| 6 months | 543.0 | 192.2 | 307.1 | 105.4 | 9.6810*** |
| 9 months | 716.8 | 226.9 | 425.4 | 151.2 | 8.1363*** |
| 12 months | 1030.5 | 1142.8 | 527.0 | 215.6 | 4.2457*** |
| > 12 months | 1081.4 | 409.2 | 686.1 | 278.4 | 6.7037*** |

Source: survey result; ***Significant at p<1%

After estimating the conditional expectation of outcome variables in the second step, we can obtain the average treatment effects for different values of the treatment in order to construct the dose response function (DRF). The DRF is the average conditional expectation of outcome given the intensity of Awasi cross breed and estimated GPS. We present the DRF estimates. The DRF plots are obtained with 50 Awasi cross breed production (95% confidence bands obtained using 10 bootstrap replications). The DRF estimates as shown in figure 1 for the average probability of income from sheep for various number of Awasi cross breeds.

As the survey result indicates, the Awasi crossbreed sheep have shorter time of months in giving their first birth (Age at1st lambing) with mean of 12.84 as compared to local sheep breeds (with a mean of 14.52 months). These enable the respondent to rapidly increase his sheep population and can increase his financial requirements.

The DRFs for the outcome variable: income from sheep is statistically significant for all values of the treatments except from 48 onwards. The average probability of income from sheep increases from 47674.49 Eth. Birr when a farmer having one Awasi cross breed and expected to increase to 63230.54 Eth. Birr when a farmer increase number of Awasi crossbreed to 47 (Table 4). However, the number of Awasi cross breed beyond 47 does not increase income significantly. The most probably reason is as the number of Awasi cross breed increases: the blood level of the cross declines since they share the same ram, performance of the cross declines. Then the farmer started to face lesser price.

There is a great difference between producer and non-producer in trend of their income for the last five years. About 65% and 15% of producers and non-producers perceived that their income from sheep had increased for the last 5 years. There is also difference on the amount of food the household consumed: 60% and 21.67% of the producer and non-producer of Awasi cross breed have perceived that their amount of food consumption for the last 5 years respectively. During food deficit period, 30% and 8.33% of the non-producers and producers respectively were dependents on aid or subsidy as copping mechanism to fill food gap (Table 5). Awassi cross sheep are used as important source of cash during critical condition for the beneficiary farmers and it contributes 65% of the total sale.

**Table 4**: Dose response function estimates (average treatment effects)

| Number of Awasi cross breed | Income from the sheep ( ATE) | T value | Number of Awasi cross breed | Income from sheep | T value |
|---|---|---|---|---|---|
| 1 | 47674.49 | 2.627 | 27 | 56467.04 | 3.389 |
| 2 | 48012.66 | 2.658 | 28 | 56805.21 | 3.417 |
| 3 | 48350.84 | 2.689 | 29 | 57143.39 | 3.444 |
| 4 | 48689.01 | 2.719 | 30 | 57481.56 | 3.472 |
| 5 | 49027.19 | 2.750 | 31 | 57819.74 | 3.499 |
| 6 | 49365.36 | 2.780 | 32 | 58157.91 | 3.527 |
| 7 | 49703.54 | 2.810 | 33 | 58496.09 | 3.554 |
| 8 | 50041.71 | 2.840 | 34 | 58834.26 | 3.581 |
| 9 | 50379.89 | 2.870 | 35 | 59172.44 | 3.608 |
| 10 | 50718.06 | 2.900 | 36 | 59510.61 | 3.635 |
| 11 | 51056.24 | 2.930 | 37 | 59848.79 | 3.662 |
| 12 | 51394.41 | 2.959 | 38 | 60186.96 | 3.688 |
| 13 | 51732.59 | 2.989 | 39 | 60525.14 | 3.715 |
| 14 | 52070.76 | 3.018 | 40 | 60863.31 | 3.741 |
| 15 | 52408.94 | 3.047 | 41 | 61201.49 | 3.768 |
| 16 | 52747.11 | 3.076 | 42 | 61539.66 | 3.794 |
| 17 | 53085.29 | 3.105 | 43 | 61877.84 | 3.820 |
| 18 | 53423.46 | 3.134 | 44 | 62216.01 | 3.846 |
| 19 | 53761.64 | 3.163 | 45 | 62554.19 | 3.872 |
| 20 | 54099.81 | 3.192 | 46 | 62892.36 | 3.898 |
| 21 | 54437.99 | 3.220 | 47 | 63230.54 | 3.924 |
| 22 | 54776.16 | 3.248 | 48 | 63568.71 | 0.793 |
| 23 | 55114.34 | 3.277 | 49 | 63906.89 | 0.808 |
| 24 | 55452.51 | 3.305 | 50 | 64245.06 | 0.823 |
| 25 | 55790.69 | 3.333 | | | |
| 26 | 56128.86 | 3.361 | | | |

Source: Authors own calculations from survey data.

**Table 5**: Coping mechanisms during food deficit

| Coping Mechanisms during food deficit period | Adopters (%) | Non-adopters (%) |
|---|---|---|
| Aid or subsidy | 8.33 | 30.00 |
| Local sheep as a source of cash for food purchase | 70.00 | 83.33 |
| Sell local sheep during critical condition (other than food) | 56.67 | 90.00 |
| Sell Awassi cross sheep during critical condition (other than food) | 65.00 | 00.00 |

Source: Survey result

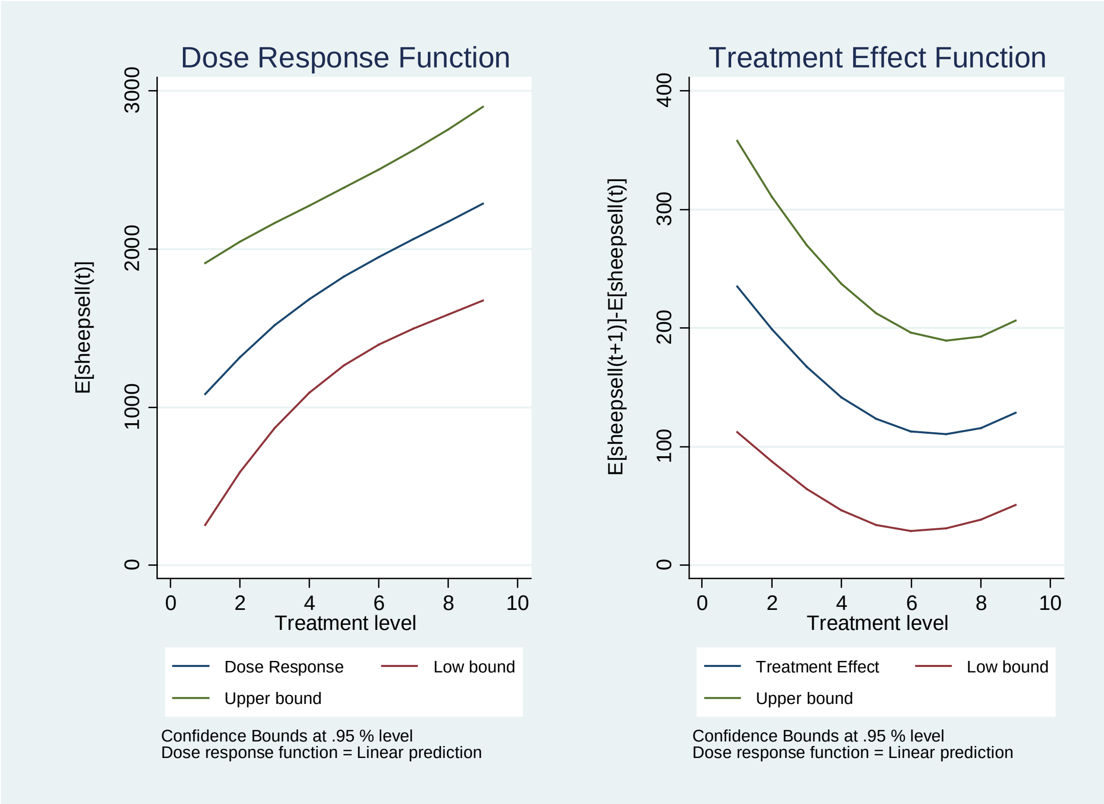


**Figure 1**: Graphs of dose response function

## 4. Conclusion and recommendation

Sheep is the dominant species in the highlands of North Wollo particularly in Wadla and Meket Districts. Efforts have been made to improve this low performance by introducing high reproductive performance exotic breeds (Awassi cross). These reproductive performance advantages of Awasi cross over the local sheep enables the farmers to improve productivity of local breed. The price difference of Awasi Cross sheep breeds over local has created better opportunity to increase their income. During food deficit period, producers are less dependents on aid or subsidy as copping mechanism to fill food gap. Generally, Awassi cross breed sheep serves as important source of income compared to local that used as coping mechanism to fill the food deficit. Therefore, introducing Awasi crossbreed to similar agro ecologies will have paramount effect to improve the income of farmers in the crop livestock farming system. Hence, government and other respective organization should give emphasis to out scale Awasi cross breed in wider scale.

## Acknowledgement

Authors greatly acknowledged Amhara Region Agricultural Research Institute (ARARI) for funding this study. Moreover, we also would like to thank all socio economics and livestock research directorate staffs who have participated in data collection.

**Reference**

[1] Ilse Köhler-Rollefson, "Farm Animal Genetic Resources: Safeguarding National Assets for Food Security and Trade, " A Summary of workshops on farm animal genetic resources held in the Southern African Development Community (SADC), Germany, 2004.

[2] A Diagne, SA Adekambi, F.P. Simtowe and G. Biaou. "The Impact Of Agricultural Technology Adoption on Poverty: The Case of Nerica Rice Varieties in Benin" A shorter version of the paper is being presented as contributed paper at the 27th Conference of the International Association of Agricultural Economists. Beijing, China, August 16-22, 2009.

[3] A. Getachew "Economic aspects of sheep production in the Ethiopian highland vertisol areas" International Livestock Centre for Africa, Addis Ababa, Ethiopia,1988.

[4] DA Spencer, G. Dorward, D.P. Abalu and D. Ogungbile "Evaluation of Adoption of Nerica and Other Improved Upland Rice Varieties Following Varietal Promotion Activities In Nigeria" A Study for the Gatsby and Rockefeller Foundations, Final Report, 2006.

[5] MoFED (Ministry of Finance and Economic Development) "Growth and transformation plan. Volume II policy matrix" Addis Ababa, Ethiopia, 2010.

[6] G. Solomon, T. Azage, G. Berhanu and H. Dirk "Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement." IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 23. ILRI (International Livestock Research Institute), Nairobi, Kenya, 2010. pp: 58.

[7] M. Siegmund-Schultz, G. Legesse, G. Abebe and A.Valle Zárate "Bottleneck analysis of sheep production systems in southern Ethiopia: Comparison of reproductive and growth parameters." Options Méditerranéennes, no. 91. Changes in sheep and goat farming systems at the beginning of the 21st century, 2009.

[8] DBARC. "Leaflet prepared by Debre Birehan Agricultural Research Center for farmers' day held at Legambo Woreda," Debrebirihan, 2006.

[9] R. Wachholz. "Socio-Economics of Bedouin Farming System in Dry Areas of Northern Syria." Kiel, Germany, 1996.

[10] H. Epstein "The Awassi Sheep with Special Reference to the Improved Dairy Type." FAO Animal Production and Health Paper, 57,Rome Italy, 1985.

[11] ICARDA "Annual Report 2002." International Centre for Agricultural Research in the Dry Areas, Aleppo, Syria. pp: 136, 2003.

[12] JE Sumberg and K .Cassaday "Sheep and goats in humid West Africa." International Livestock Centre for Africa, Addis Ababa, Ethiopia, 1986.

[13] G. Gryseels, J. McIntire and F. M. Anderson "Research with a farming systems perspective at ILCA." ILCA Bulletin 25, pp:17-22, 1986.

[14 ] Stata Corp "Stata Statistical Software: Release 12." College Station, TX: Stata Corp LP, 2011.

[15] G. Imbens and J.M. Wooldridge "Recent Developments in the Econometrics of Program Evaluation, " *Journal of Economic Literature*, 47:1, pp: 5–86, 2009.

[16] M. Kassie , M. Jaleta, B. Shiferaw., F. Mmbando., H.G. Groote "Improved Maize Technologies and Welfare Outcomes In Smallholder Systems: Evidence From Application of Parametric and Non-Parametric Approaches" Paper presented at the International Association of Agricultural Economists (IAAE), Brazil, 2012.