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Determinants of Smallholder Farmers' Adaptation Methods to Agro-biodiversity Loss: The Case of Assosa Zone, Benishangul Gumuz Regional State, Ethiopia

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Abstract
Agro-biodiversity loss is a serious problem in affecting to agricultural productivity. The dependence of agricultural production on natural environment has adversely affects the availability of agro-biodiversity and household food security. The objective of this study was to determine smallholder farmers' adaptation methods to the agro-biodiversity loss in the selected sample Woredas of Assosa zone, Benishangul Gumuz regional state, Ethiopia. Two stage sampling procedure was used to collect data from 397 sample households through cross-sectional survey in the production year of 2016 and was analyzed using both descriptive statistics and econometric methods. In the study area dangerous weeds (local language Akenchira), traditional burning of trees and grass, over grazing of land, use of poor and traditional agricultural practices are the major causes for agro-biodiversity loss. The probit estimation analysis revealed that family size, farm income, pilot size, soil quality, agricultural extension service, settler farmers and access to awareness on weather condition are the main significant determinant factors on farmers' choice to undertake adaptation method to agro-biodiversity loss in the study area. Moreover, Multivariate probit model revealed that age of the household head, education level of the household head, soil qualities, tropical livestock units, off farm income, distance to the farm and distance to the market are statically significant factors on affecting to the choice of the adaptation strategies to agro-biodiversity loss in the study area. Therefore, policies should designed and aimed at improving farm-level adaptation need to emphasize on the crucial role of providing information on better production agricultural technologies and enhancing farmers' awareness on loss of agro-biodiversity and enable farmers to respond agro-biodiversity loss.
Keywords: Agro-biodiversity loss, adaptation, probit, multivariate, Assosa Zone

1. Introduction

Agro-biodiversity is part of biodiversity which encompass agriculture to nutrition, livelihoods and the maintenance of habitats. Its scope covers agricultural crops, productive livestock, raw materials and medical plants. Agro-biodiversity loss is a serious problem, which is affected to social, ecological and economic aspects (Wolff F., 2003). The causes of agro-biodiversity loss are manifold and interrelated. The economic developments, especially production of cash crops are affected by the environmental factors in the overall countries of the world (FAO, 2003).

Ethiopia agriculture is based on subsistent farming systems, and currently the food demand has been increasing continuously. This is due to the fact that there is an increment in the numbers of population density form time to time and consequently leads to over exploit the cultivated farm agricultural land. As a result directly or indirectly affects the ecosystem and agro-biodiversity conservation loss. Even though, Ethiopian societies have not great attention to biodiversity conservation (FDRE, 2005). The capital asset depletion, drought, environmental and ecological imbalance, changes in soil properties in the drainage basins are adversely affecting to farming output and the ecosystem in general (Wabusya et al., 2015). Similarly, soil erosion, nutrient depletion and soil structural change are the main forms of land degradation observed in Ethiopia (Lakew et al., 2000). This degradation resulted mainly through the conversion of natural vegetation to agricultural lands, unbalanced crop and livestock production, rapid population growth and settlement are also the main causes for this rapid deterioration of forest covered areas in Ethiopia (Winberg, 2010). Thus, agricultural adaptation practices and technologies adoption has been outlined by the previous researchers such as Gbetibouo G.A., (2009) and Deressa et al., (2010). However, the choice of any adaptation practice to agro-biodiversity loss is differs with cultural diversity and local knowledge that support communities' to agriculture (Thrupp L.A, 2000). Congruent this fact, to address one specific local study is appropriate to make accurate findings and to forward policy implication. In the study area burning of plants and forests, cutting of bamboo trees and crop diseases were existed and this effect leads to agro-biodiversity loss in the area .Therefore, to reduce the loss of agro-biodiversity and enhance food security, adaptation mechanisms are urgently required. Therefore understanding all of these facts, urgent design strategy and procedures practiced to safeguard remaining forests and recover degraded ones effort to strength smallholder farmers' adaptation to agro-biodiversity loss is appropriate. Given the losses in agro biodiversity in the area, adaptation has become necessary. Therefore, this study was investigated on smallholder farmers' adaptation method to agro biodiversity loss by undertaking Assosa, Menge, Shorkole and Bambasi Woredas of Assosa Zone as a case study.

The general objective of this study is to investigate the determinants of smallholder farmers' adaptation motheds to agro-biodiversity loss in the selected woredas of Assosa zone, Benishangul Gumuz regional state, Ethiopia.

The specific objectives are:-

- To examine the factors that influence smallholder farmers' adaptation methods to agro-biodiversity loss in the study areas.
- To identify smallholder farmers' adaptation methods to agro-biodiversity loss in the study areas.
- To find out the challenges and constraints of farmers in undertaking adaptation mechanisms to agro-biodiversity loss in the study area.

2. Methodology of the Study

Source of Data Collection

Both primary and secondary data were collected from different sources so as to meet the specific objectives of the study. The primary data were obtained by the use of semi-structured questionnaires containing closed and open-ended questions from the smallholder farmers in the production period of 2016. Secondary data were collected from various published and unpublished sources including official government reports and previous research papers.

Sampling technique and Sample Size

This study was used two stage sampling process to collect accurate data from the sample respondents. In the first stage, purposive sampling method was used to select sample Woredas and kebelles according to the severity of agro-biodiversity loss in the study area. Accordingly, four sample Woredas were selected (Namely; Assosa, Bambasi, Menge and Shorkel Woredas) from the total seven woredas of Assosa Zone and two kebelles were selected in each Selected Woredas according to highly affect areas by agro-biodiversity loss. The sample kebelles were Amba 3 and Baro of Assosa woreda, Amba 48 and Amba 46 of Bambasi woreda, Kudeyu and Kashafi of Menge woreda and Tumot Qobe and Tenzye of Shorkole woreda. In the second stage, simple random sampling method was employed to select sample smallholder farmers from each selected kebelles. Besides, the study was used 397 respondents as sample size.

Methods of Data Analysis

The data was analyzed using both descriptive and econometric procedures of data analysis method. Descriptive statistics like mean, variance, standard deviations, frequency distributions, ratios, and percentage, graphical and tabular analysis were used to examine and understand the socio-economic situations of the sample respondents. The study was also employed the probit and multivariate probit models as an econometrics model to determine the factors that influence smallholder farmers' adaptation method to agro-biodiversity loss and to identifying the farmers' adaptation strategies in response to agro-biodiversity loss respectively.

To describe the probit model, let Y represents vector of agro-biodiversity loss adaptation alternatives (strategies) where as the X represents the factors that influence choice of the adaptation method. Assuming the adaptation option farmers' choices are depend on socioeconomic characteristics of the farmers, institutional factors and climatic factors (Gbetibouo G.A., 2009; Deressa et al., 2010). Therefore, the researcher was used as an explanatory variables based on the literature review and researchers knowledge in the study area.

The probability density function (pdf) of the error term is the standard $\mu \approx N(0, 1)$ normal distribution and the model is called the probit model (Wooldridge, 2002).

The cumulative standard normal distribution function, evaluated at;

$$Y = \beta_0 + \beta_1 X_i \text{--}(1)$$

$$P(Y = 1|X) = \Phi(\beta_0 + \beta_1 X_i) \text{--------------------------------}(2)$$

Φ is the cumulative normal distribution function.

To estimate probit mode we use log likelihood functions;

$$\ln L = \sum w_i \ln \Phi(x_i b) + \sum w_i \ln(1 - \Phi(x_i b) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

Where w_i is denoted optional weights

The marginal effect is appropriate to interpret coefficients probit regressions;

$$ME_j = (\partial p(y_i=1))/(\partial x_{ji}) = \partial F(\beta_0+\beta_1 x_{1i}+\beta_2 x_{2i}+\beta_k x_{ki})/(\partial x_{ji}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4')$$

Where, F is the cumulative distribution function of a standard normal random variable.

The theoretical framework was drawing on adopting a version of model based on the random utility model. The utility farmer i receive from alternative strategy $j \in J$ can be represented by random utility model (Kennedy, 1992): discrete choice random utility model is used to explain how an individual chooses a specific alternative when a number of alternatives are available.

For the i_{th} consumer faced with J choices, suppose that the utility of choice j is;

$$U_{ij} = \beta x_{ij} + \varepsilon_{ij}.$$

If the consumer makes choice j in particular, then we assume that U_{ij} is the maximum among the J utilities. Hence, the statistical model is driven by the probability that choice j is made, which is $Prob(U_{ij} > U_{ik})$ for all other $k \neq j$.

These are all distinct from the multivariate probit model we examined. In that setting, there were several decisions, each between two alternatives. Here there is a single decision among two or more alternatives. We have to examine two broad types of choice sets, ordered and unordered. Unordered-choice models can be motivated by a random utility model.

Besides, the multivariate probit model estimates for those non mutual exclusive choices. Let Y_{ij} denote the binary response of i_{th} farmer on the j_{th} adaptation and then let $Y_i=(Y_{i1},\ldots,Y_{ij})$ denote the aggregation of responses on all J adaptation strategies.

According to the multivariate probit model (Chib and Greenberg, 1998), the probability that $Y_i=y_i$, in condition on parameters β, Σ, and a set up of covariates x_{ij}, is given by

$$P(Yi = yi \mid \beta, \Sigma) = \int_{AiJ} \ldots \int_{Ai1} \phi_J(t_1,\ldots,t_J \mid 0, \Sigma) dt_1 \ldots dt_J \ldots \quad (1)$$

Whereas $\phi_J(t \mid 0,\Sigma)$ is the density of J-variate normal distribution with vector mean of 0 and correlation Matrix $\Sigma = \{\delta_{jk}\}$, and A_{ij} is the interval

$$A_{ij} = \begin{cases} (-\infty, x'_{ij}\beta_j) & if\ y_{ij} = 1 \\ (x'_{ij}\beta_j, \infty) & if\ y_{ij} = 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..2$$

$\beta_j \epsilon R^{k_j}$ is an unknown parameter vector an $\beta_j = \left(\in \beta_1^{k_j} \ldots\ldots\ldots\ldots.., \beta'_J\right) \in R^k, k = \Sigma k_j$ we denote the p=J(J-1)/2 free parameters of $\Sigma =$ by $\delta_{12}, \delta_{13} \ldots.\delta_{J-1,J}$

3. Results and Discussions

Under this section the responses of the farm households of in the study area was analyzed by using descriptive statistical method. Based on the responses of respondents about awareness of agro-biodiversity loss, climate change information, natural vegetation and soil classification responded on this study.

Table 1: Cause of Agro-biodiversity Loss

Causes of Agro bio Diversity Loss	Number	Percent (%)
Burning of Plants and grass	265	66.7%
Traditional agricultural practices	25	6.3%
Deforestation/ degradation	57	14.4%
Overgrazing	44	11.1%
Over cultivation	6	1.5%

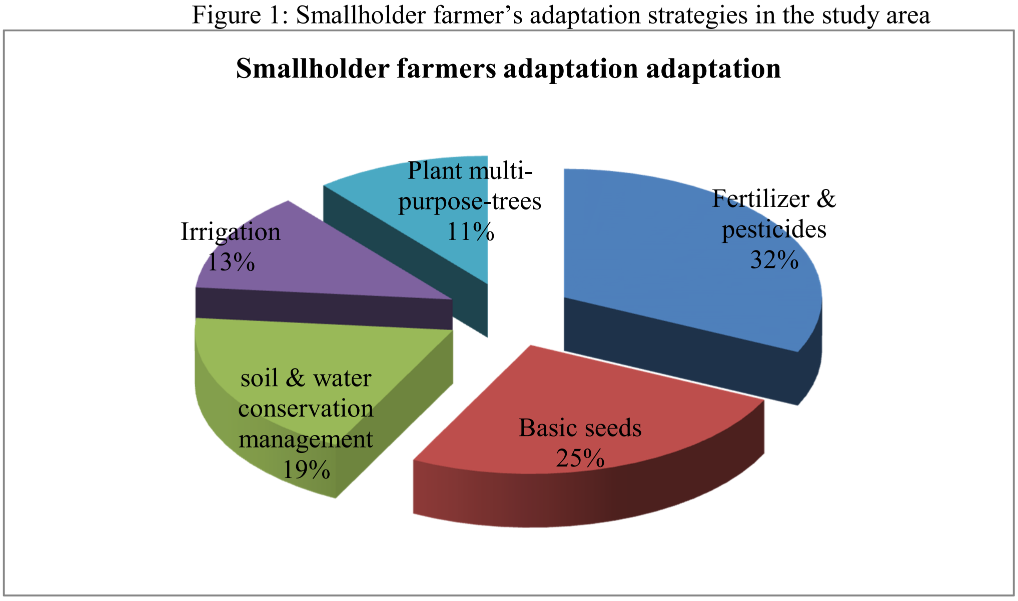
Source: own survey results, 2016

The above table shows that, 66.7% of the respondents perceived that burning of plants and grass practices were the most causes of agro-bio diversity loss, and followed by 14.4% of the farmers who considered that deforestation are the major ones.

Introduced Adaptation Strategies of Agro-Biodiversity Loss in the Woredas

Farmers were asked which introduced adaptation strategies they have been using among the lists of different adaptation strategies so far and response of the respondents were represented in below figure.

Figure 1: Smallholder farmer's adaptation strategies in the study area



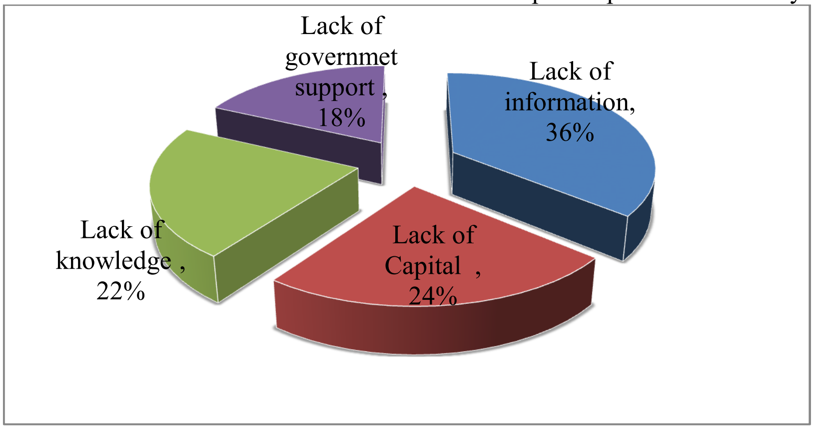
Source: Own survey result, 2016

From the above table, the results shows that 11% of the respondents were used planting permanent multi-purpose trees strategy, 25% were used basic seeds strategy, 32% used fertilizers & pesticides strategy, 19% used water and soil conservation management and the remaining 13% are modern irrigation strategy to agro-biodiversity loss.

Challenges of Smallholder Farmers for Not Taking Responses to Agro-Biodiversity Loss

There are some factors which are constrained to the farmers who are not responded to the case agro-biodiversity loss in the study area. Thus, the respondent raised different reasons. Those are presented as follows;

Figure 2: Barriers to smallholder famers for not to take adoption options in the study area



Source: Own survey 2016

Estimated Results of the Probit Model

The results of probit model shows that how factors that influence farmers' choice of adaptation strategies to agro-biodiversity loss in the study area. The table 2 below indicated that the estimation results of the probit Regression model. The likelihood ratio statistics as indicated by Ch^2 statistics (LR chi-square (4) = 70.62 are highly significant P < 0.0000), suggesting the model has a strong explanatory power in to affecting the dependant variable.

Table 2: Parameter Estimates of the Probit Regression on Agro-biodiversity Loss

	Probit regression			Marginal effect		
Adaptation to Agro-biodiversity loss	Coef	Stad. Err.	P-value	dy/dx	Std. Err.	P-value
HH sex	0.128	0.261	0.624	0.033	0.070	0.641
HH age	0.004	0.007	0.566	0.001	0.002	0.567
HH education	0.010	0.061	0.864	0.003	0.015	0.864
Family size	0.069	0.0384	0.074*	0.017	0.009	0.076*
Farm income	0.00002	0.00001	0.061*	5.14e-06	.00000	0.058*
Off income	0.0005	0.0005	0.302	0.0001	.0001	0.298
Pilot size	0.369	0.088	0.000***	0.090	0.018	0.000***
Soil quality	0.277	0.162	0.087*	0.067	0.039	0.088*
Distance to farm	0.004	0.003	0.169	0.001	0.0008	0.169
Distance to market	0.0006	0.001	0.661	0.0002	0.0003	0.661
Agricultural Extension	0.520	0.161	0.001***	0.125	0.039	0.001***
Ownership of radio	0.175	0.159	0.271	0.042	0.039	0.274
Tropical livestock unit(tlu)	-0.030	0.020	0.123	-0.007	0.005	0.119
Access to credit	-0.010	0.189	0.959	-0.002	0.046	0.959
Settler,(if 0 native)	0.881	0.367	0.016**	0.190	0.106	0.073*
Access to awareness	0.363	0.193	0.060*	0.098	0.057	0.086*
Constant	-0.434	0.483	0.369			

Dependent variable: adaptation to agro-biodiversity loss(if yes=1, otherwise=0)
Number of observations= 397 LR chi2 (4)=70.62*
Prob > chi2 = 0.0000 Pseudo R2=0.1671, Log likelihood=-175.95505
*Significant at 10%; ** significant at 5%; ***significant at 1%.

Source: Own survey result, 2016

The Probit model estimation revealed that family size, farm income, pilot size, soil quality, access to agricultural extension, settler farmers and access to awareness on weather condition are positively and statistically significance factors in affecting to undertake adaptation option to agro-biodiversity loss in the study areas.

Besides, Multivariate Probit Model was also employed to determine the factors that affect for the choice of not mutually exclusive choices in undertaking to the response of agro biodiversity loss in the study areas. The estimation result shows age of the household head and soil qualities, education level of the household head and tropical livestock units, off farm and distance to the market are the significantly affected to the choice of the adaptation strategies to agro-biodiversity loss in the study areas. The variables of age of the household head and soil qualities are positively and statically significant in affecting to farmers' the probability to use soil and water conservation adaptation method to agro-biodiversity loss. Besides, education level of the household head and tropical livestock unit are also positive and statically significance determinant factors for fertilizer and pesticides adaptation choice. Moreover, the exogenous variables such as off farm and distance to the market are statically significant and negatively affected to the choice of irrigation adaptation option. The adaptation strategy of planting tree is also positively and statically determined by age of the household head and soil quality while distance to the market is negatively and statically affected it. Besides, education level of the household head and soil quality are positively and statically significant determinant factors to the adaptation mechanism of basic seed while distance to farm and distance negatively and statically significance determinant factors to basic seeds adaptation choice of the smallholder farmers to agro-biodiversity loss in the study area.

Table 3: Multivariate Probit Estimation Adaptation Option to Agro-biodiversity Loss

	Soil & Water Conservation			Fertilizer& Pesticides			Irrigation			Permanent Tree Planting			Basic Seeds		
Variables	Coef	Std. Err.	P-value	Coef	Std. Err.	P-value	Coef	Std. Err.	P-value	Coef	Std.Err.	P-Value	Coef	Std. Err.	p-value
HH Sex	-0.271	0.296	0.361	0.415	0.268	0.122	-0.010	0.259	0.970	-0.318	0.274	0.245	0.046	0.270	0.865
HH Age	0.014	0.008	0.080*	0.003	0.008	0.738	-0.005	0.007	0.506	0.017	0.008	0.029*	-0.003	0.007	0.674
HH Education	-0.048	0.056	0.398	0.020	0.060	0.095*	0.067	0.054	0.215	0.011	0.058	0.846	0.116	0.056	0.039**
Family size	-0.060	0.044	0.173	0.010	0.041	0.808	0.0002	0.039	0.996	-0.053	0.042	0.207	0.008	0.039	0.831
Farm income	0.0001	0.0002	0.362	-6.52e	0.0001	0.552	-7.43e	0.0001	0.946	0.0002	0.0001	0.115	-3.07e	0.0001	0.779
Off farm income	0.0005	0.0005	0.300	0.0002	0.0004	0.527	-0.001	0.0004	0.083*	0.0006	0.0005	0.218	0.0004	0.0004	0.343
Pilot size	0.068	0.049	0.166	-0.006	0.033	0.850	-0.041	0.034	0.233	0.018	0.033	0.577	0.036	0.033	0.277
Soil quality	0.457	0.169	0.007*	-0.047	0.160	0.770	-0.225	0.154	0.145	0.279	0.158	0.076*	0.007	0.003	0.030**
Dist To farm	0.002	0.003	0.645	0.001	0.003	0.765	-0.001	0.003	0.742	0.005	0.003	0.155	-0.259	0.154	0.092*
Dist. to mkt	0.002	0.002	0.316	-0.002	0.001	0.166	-0.003	0.001	0.053*	-0.003	0.001	0.061*	-0.003	0.001	0.051*
Access Credit	-0.150	0.192	0.435	0.209	0.188	0.267	-0.097	0.177	0.583	0.026	0.185	0.887	0.025	0.181	0.891
Agri.extension	-0.142	0.177	0.420	-0.222	0.170	0.191	0.005	0.161	0.977	0.022	0.166	0.893	-0.110	0.162	0.496
TLU	-0.003	0.025	0.909	0.048	0.022	0.030**	-0.010	0.021	0.630	-0.009	0.021	0.677	-0.003	0.020	0.899
Constant	0.087	0.483	0.857	-0.068	0.432	0.876	0.732	0.427	0.087	0.051	0.443	0.909	0.273	0.432	0.528

Multivariate probit (SML, # draws = 20) Number of obs = 308 Wald chi2(65) = 81.18
Log likelihood = -816.23215 Prob > chi2 = 0.0848
*Significant at 10%; ** significant at 5%; ***significant at 1%.

Source: Own survey result 2016

4. Conclusions and Policy Implications

Biodiversity loss is abroad meaning to express, but in this paper it is mainly focused on agricultural related householders. Based on the respondents' response the major problems that associated with in the woredas were like dangerous weeds (local language Akenchira) and traditional burning of trees and cutting of bamboo tree for market as a means of income were commonly operated. On the other hand, land degradation/soil erosion was also another main hazard to soil fertility and agricultural production. The soil erosion, deforestation/ cut off trees, over grazing and use of poor /traditional agricultural practices are the major causes to agro-biodiversity loss. As per of the study, lack of information, lack of capital and lack of knowledge are the major challenges for the farmers not to undertake any adaptation strategies to agro-biodiversity loss in the study area. The result from the probit estimation analysis revealed that family size, farm income, pilot size, soil quality, agricultural extension service, settler farmer and access to awareness on weather condition are the main determinant factors in affecting farmers' choice of adaptation method to agro-biodiversity loss in the study areas. Moreover, Multivariate probit model revealed that age of the household head, education level of the household head, soil qualities, tropical livestock units, off farm income, distance to the farm and distance to the market are also significantly affected to the choice of the adaptation strategies to agro-biodiversity loss in the study areas.

Depending on the findings of this study, policy implications are vital to improve the agro-biodiversity and agricultural outputs. In Benishangul Gumuz region state especially in the study area there are enormous farmer whose livelihood strategies are depended on mixed farming system. Therefore, governmental experts and responsible body should motivate, give awareness creation, and follow up to farmer in order to overcome the problems of agro-biodiversity loss. Besides, the policy program which is intended at reducing the climate related problems should also focus on accessing improved inputs such as improved seeds, improved livestock breeds and fertilizer to farmers with reasonable price. Policies should also designed and aimed at improving farm-level adaptation need to emphasize on the crucial role of providing information on better production agricultural technologies and enhancing farmers' awareness on loss of agro-biodiversity to enable farmers mitigate agro biodiversity loss.

Reference

Chib, S. & Greenberg, E. (1998). Analysis of Multivariate probit model. Biometrika, Vol.85, No. 2, pp.347-361

Deressa, T.T. Ringler C. & Hassan, R.M. (2010). Factors Affecting the Choices of Coping Strategies for Climate Extremes: The Case of Farmers in the Nile Basin of Ethiopia. IFPRI

Eyayu, M., Heluf, G., Tekalign, M. & Mohammed, A. (2009). "Effects of land use changes on selected soil properties in the Tara Gedam Catchment and Adjacent Agro-Ecosystems". Ethiopian Journal of Natural Resources, 11(1): 35-62

FAO. (2003). Agrobiodiversity: the case for conserving domestic and related animals

Federal Democratic Republic of Ethiopia, (2005). Institute Of Biodiversity Conservation National Biodiversity Strategy and Action Plan, Addis Ababa Ethiopia.

Gbetibouo, G.A. (2009). Understanding Farmers' Perception and Adaptation to Climate Change and Variability: The Case of the Limpopo Basin, South Africa". IFPRI Discussion Paper 00849

Genene, T. & Wagayehu, B. (2010). "Farmers' perceptions of land degradation and determinants of food security at Bilate Watershed," Southern Ethiopia. EJAST 1(1): 49-62, 2010.

Lakew, D., Menale, K., Benin, S. & Pender, J. (2000). "Land degradation and strategies for sustainable development in the Ethiopian highlands," Amhara Region, Amhara National Regional State Bureau of Agriculture. International Livestock Research Institute, Socio-economic and Policy Research Working Paper

Kennedy, P. (1992). A Guide to Econometrics. Cambridge: MIT Press.

Thrupp, L.A. (2000). Linking Agricultural Biodiversity and Food Security: the Valuable Role of Agrobiodiversity for Sustainable Agriculture. International Affairs, 76:2, 265-281.

Wabusya, M., Humphrey, N., Martha, K., Humphrey, A., Mugatsia, T. (2015). Effects of Land use Practices on Soil Organic Carbon, Nitrogen and Phosphorus in River Nzoia Drainage Basin, Kenya. Agriculture, Forestry and Fisheries. Vol. 4, No. 4, pp. 153-158

Winberg, E. (2010). "Participatory forest management in Ethiopia." Practices and experiences food and agriculture organization sub regional office for Eastern Africa, Addis Ababa

Wolff, F. (2003). Industrial Transformation and Agriculture: Agrobiodiversity Loss as Sustainability Problem. Governance for Industrial Transformation. Proceedings of the Berlin Conference on the Human Dimensions of Global Environmental Change. Environmental Policy Research Centre: Berlin. pp. 338 - 355.

Wooldridge, J. (2002). Econometric Analysis of Cross Section Data and Panel Data. MIT Press.