International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 3 (6), pp. 558-565, August, 2013. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Factors affecting farmers' crops diversification: Evidence from SNNPR, Ethiopia

Rehima M[1], Belay K[2], Dawit A[3] and Rashid S.[4]

[1]Ethiopian Institute of Agricultural Research, 2003, Addis Ababa, Ethiopia.
[2] Haramaya University, 138, Dire Dawa, Ethiopia.
[3]Ethiopian Institute of Agricultural Research, 2003, Addis Ababa, Ethiopia.
[4]International Food Policy Research Institute, NW, Washington, DC 20006-1002, USA.

Accepted 1 August, 2013

Crop diversification under small-scale production system is a risk management strategy and an important step for transition from subsistence to commercial agriculture. This paper investigates the determinants of crop diversification using data on the three stage randomly selected 393 farm households in SNNPR of Ethiopia. The value of Margalef index was used as dependent variable. The Heckman two stage model was applied to estimate separately the farmers' decisions and level of diversification. The factors that affected crop diversification were gender, education and trade experience, membership in cooperatives, resource ownership, features of the land owned, access to extension services and transaction costs. Based on the findings the following recommendations were forwarded. The government should promote female participations, invest on formal and informal education of the farmers, provide incentive for extension workers and improve the extension system. Furthermore, the government and stakeholder should strengthen agricultural inputs and agricultural research particularly, generating agro-ecology based technologies and disseminates them. Non-crop activities (trade experience) and social organizations underline the need for designing integrated agriculture system (crop-non crop) and improving social organizations as powerful tools to increase diversification capacity of the farmers. Transaction costs need strengthening rural urban infrastructure to link crop diversification with markets.

Key words: Crop diversification, Ethiopia, risk management strategies, heckman-two-stage, margalef index.

INTRODUCTION

Agriculture is the predominant activity for most rural households in Ethiopia. The sector is mainly based on small holder farms and contributes about half to the total Gross Domestic Product (GDP) of Ethiopia and the livelihoods of more than 80% of the citizens (Diao et al., 2007). The small-scale farming accounts for 95% of the total area under crop and more than 90% of crop output. Ethiopia is a centre of origin and diversity for several crops. Teff, wheat, maize, sorghum and barely accounted for 86% of the cereal production and covered 80% of the total farm land under small-householder. Cereals are the staple of the Ethiopian diet and teff is the most favourable staple crop for all different income levels of rural and urban consumers. It has been seen increasing output for several years (Central Statistical Agency of Ethiopia, 2010). However, the sector is characterized by poor and backward technology, acute shortage of purchased inputs, particularly fertilizer, poor infrastructure and inefficient marketing systems (Abrar et al., 2002). The adverse effects of abnormal weather are also very common in Ethiopia. Ethiopian farm households use diverse farm systems as an insurance against uncontrollable factors such as weather, production and market fluctuations.

Crop diversification is one of the coping mechanisms of food security, production and market risks. For example, diversification was the single most important source of poverty reduction for small farmers in South and Southeast Asia (FAO and World Bank, 2001). Winters et al.

*Corresponding author E-mail: rehimamussema@gmail.com

(2006) have identified three key factors that derive farmers "demand" for crop diversity: i) managing risk, ii) adapting to heterogeneous agro-ecological production conditions and iii) meeting market demands and food security. Degye et al. (2012) confirmed that households in Central and Eastern highlands of Ethiopia would be able to improve their food security conditions by enhancing their crop diversification**.**

With heterogeneity in agro-ecological, social and economic conditions, farmers' agriculture in Ethiopia is highly diversified to meet own consumption and market needs, to withstand price fluctuation and to manage income risks. Crop diversification is considered as an important step in the transition from subsistence to commercial agriculture. A shift from food production for own consumption to a cash crop production contributes to improvement of income for small holders (Minot et al., 2006). Taking these experiences, agricultural diversification is an important strategy for overall agriculture development in Ethiopia.

Despite the significance of crop diversification against production, income and price risks of the farm households and its importance of the transition from subsistence to commercial farming it may be affected by land features and other socio economic factors. The main objective of this study is to identify the land features and socio-economic factors influencing crop diversification decision and the extent of diversification among the farm households in Southern Nation Nationalities People Region (SNNPR), Ethiopia.

Literature review

A number of studies have come up in Ethiopia and also at the international level that analyses factors affecting the decision and level of crop diversification. For example, using Logit model, Pitipunya (1995) identified the man-land ratio, education, trade experience and level of information as most important factors that influenced the cropping pattern, in Thailand.Moreover, Kimhi and Chiwele (2000), used Heckman-Two-Stage model and detected household demographics, the status of rural road construction, market access and the size of yield of maize are influenced Zambian maize diversification. Weiss and Briglauer (2000) on their part applied instrumental-variable regression model and found out that farm size, part-time farming, education, family size and the location of the district are significant determinants of farm diversification in Australia. Moreover, Joshi et al. (2004) applied the Generalised Least Square (GLS) technique and found that relative profitability, irrigation, road, markets, rural literacy, the proportion of small holders, income from crop, urbanisation, rainfall and production year affected crop diversification in South Asia. To find the determinants of agricultural diversification in Central Queensland of Australia, Windle and Rolfe (2005) employed the Nested Multinomial Logit model and observed that debt, age, education, number of children, off-farm income, farm size, start-up cost, net income, other crops grown and risk time are the most determinant factors.

By using Poission and Tobit models, Gauchan et al. (2005) discovered that growing rice varieties was significantly affected by the age and education of the household heads, adult labour, livestock, subsistence ratio, irrigation, land type, plot dispersion, modern variety sold and market access in Nepal. Other literature used household model and found that education, livestock, number of plots, road density, off-farm employment, distance to seed source, seed replacement rate, seed-to-grain price ratios, seed traders and farm location were significant determinants of the Indian household and community level millet variety diversification (Nagarajan et al., 2007). To come across the determinants of crop diversification in Pakistan, Ashfaq's et al. (2008) applied multiple regression model and discovered that farming experience, education, land size, farm distance from main road and farm machinery are the significant factors. On his part, Rahman (2008) used bivariate Probit analysis and found that Bangladesh's crop diversification was significantly affected by farm asset, irrigation access, rented in land, education, farming experience, infrastructure and non agricultural income. Moreover, Ibrahim et al. (2009) employed multiple linear regression model and identified that age and education of the household heads, extension visits, availability of tractor hiring, income from crop and road access to be the significant determinants of crop diversification in Nigeria. The multinomial logistic regression model (MLRM) result indicated that age, access to credit and regional location affected the crop diversification in Ghana (Aneani et al., 2011).

Studies that deal with the significance of crop diversification in Ethiopia and its determinant factors are few. Benin et al. (2004) used censored the least absolute deviations (CLAD) estimators and found that land size, the proportion of male, ownership of livestock and oxen, farm fragmentation, number of fragmented plots, farm distance and regional location (Tigray, Ethiopia) were the significant factors that affected cereal diversity in northern part of the country. Other researchers used Generalized Linear Model (GLM) and OLS model and observed that proximity to town, access to road, education, liquid wealth, and irrigation access are significant factors that affected crop choices in Northern Ethiopia (Seid and Seebens, 2008). Fetien et al. (2009) used Tobit model and revealed that barley variety diversity was affected by age, age square, male headed household, number of children, livestock, fragmentation index, farm size, altitude, rainfall, extension and temperature in Tigray, Ethiopia. Similarly, Wondimagegn et al. (2011) applied the same model and revealed that extension, livestock, market information, access to irrigation, number of farm plots and ownership of farm machinery significantly affected crop diversification in eastern Ethiopia. From the above literatures, it is certain that natural and socio-economic factors are among the important determinants of crop diversification and would be the focus of this study.

METHODOLOGY

Study Area

The SNNPR is located in the south of Ethiopia, sharing borders with Oromia Region in the North and East, Gambella Region in the Northwest, Kenya in the South and Sudan in the Southwest. It has a land area of 110,000 km^2 representing, 10% of the country's land mass. In the mid of 2008, the population of the region was estimated at 15.7 million, accounting for about 18% of the population of the country (Reference???). This region has an estimated population density of 142 people/km^2 ranging from 3 persons/km^2 in the Omo Zone to 900 persons/km^2 in the Wenago woreda of the Gedeo zone. (MoFED 2010, ESGPIP, http://www.esgpip.org). Average annual rainfall ranges from 400 to 2000 mm and its monthly temperature from 10˚c-30˚c (http://www.esgpip.org). Topographically the Region is diverse (the lowest area in the region is 375 meters above sea level at Lake Rudolf and the highest area is 4207 meters above sea level at mount Guge in Gamogofa Zone) (http://www.esgpip.org). It has seven big rivers.

The SNNPR is an extremely ethnically diverse region of Ethiopia, as the name suggests, it is multinational, inhibited by more than 56 ethnic groups. These ethnic groups are distinguished by different languages, cultures, and socioeconomic organizations. The Region is divided into 13 zonal administrations and its capital is Hawassa. Within the zones there are 126 woredas that are decentralized system of the government and has 8 special woredas. In this study the 10 zones of SNNPR has been taken into consideration which includes: Guraghe, Hadiya, Sidama, Wolayita, South Omo, Kefa, Gamogofa, Bench Maji, Dawuro and Selte.The SNNPR is endowed with different agro-ecological diversity with diversity of crop namely teff, wheat, maize, sorghum, barley, etc. The most characteristic product of SNNPR is enset, a food unique to Ethiopia and in modern times at least, largely confined to southern Ethiopia as a staple.

Data and Sampling Technique

The study is based on the cross sectional data collected by Ethiopian Development Research Institute (EDRI) and International Food Policy Research Institute (IFPRI) for the year 2008. The survey followed a three-stage stratified random sampling. In the first stage, from each zone based on production potentials, woredas were selected. In the second stage, from each woreda enumeration areas and rural Kebeles (RKs) were randomly selected. Finally, households were randomly selected from RK. Totally, from 10 zones, 480 farm households were interviewed using 2007/08 main cropp.ing season (Meher) as the reference period. Of these, the study used 393 households that produced at least one of the cereal crops, namely: teff, wheat, maize, sorghum or barley.

Notable data collected included farm specific characteristics including socio-economic characteristics of the selected farmers, size of land acquisition, distance of farm to homestead, crops cultivated, production, land fertility, crop varieties grown, inputs and many other data relevant to the scope of study.

Analytical Techniques

The study used both descriptive and econometric analysis. Many indices are available to represent level of diversity based on crop and variety units which were described by Hill *et al.* (2002) Herfindahl Index (HI), Simpson's Index (SI), Margalef index (MI), etc. Among these indices, the study used MI as dependent variable that widely used in the literature of crop and variety diversification.

Ideally, the OLS model is app.licable if all households participate in all types of crop, but in reality all households did not participate in all types of crop. Hence using OLS regression was assumed to create a sample selectivity bias because the model excludes the non-participants from the analysis. To mitigate this bias, the study used Heckman Two-Stage model which is developed by Heckman (1979). The first stage estimates the probability of observing a positive outcome and the second stage estimates the level of participation which is conditional on observing positive values (Dow and Norton, 2003). The model assumes that different sets of variables can be used in the two-step estimation and it is important to note that at least one of the explanatory variables in the first equation is not included in the second step for identification Maddala (1983). In this research the gender of the household head and medium fertility plot were excluded from the second equation. The general structure of the regression equations is expressed by:

$$D_i = a_i + Xb_i + \varepsilon_i \qquad (1)$$

where D_i represents the Margalef index of richness, X represents a vector of household factors, ε_i stands for unobserved factors, and a and b are the parameters to be estimated. The Margalef richness of index is adapted from Magurran's (2004) ecological indices of spatial diversity in species to represent inter-specific diversity. With a view to assess the degree of diversity in the crop sector, the index is constructed as:

$$D_i = (S-1)/\ln A_i, \quad D \geq 0 \qquad (2)$$

where S represents number of cereal crops grown in the household in 2007/08, A_i stands for the total area planted to cereal crop by household in the same year. Margalef richness index (D_i) has a lower limit of zero if the households grown only one type of crop.

App.lication of Heckman's two-step procedure used a Probit in the first stage (probability of diversification). In the second step, the level of crop choice or diversification equation

Table 1. Descriptive statistics for variables used in Heckman Two Stage Model.

Variables		Measurement	Mean	Expected sign
GENDER	Gender of household head	1= M, 0 =F	89	±
AGE	age of household head	Number of years	43.72	±
EDUCN	Education of household head	Number of years	2.0	+
FAMSIZE	Family size in the household	Number of family	6.28	+
LABOURSS	No. of family age between 15-65	Adult equivalent	3.53	+
TRADEEXP	Trade experience of the household head	1= yes, 0 , else	9	+
GRAININCO	Income from grain sale	Grain income	568	+
OTHERINC	Non farming income	Other income	1658	–
CACRACC	Cash credit access	1= yes, 0 , else	24	–
COOP	Membership of cooperative	1= yes, 0 , else	22	±
EQUB	Membership of saving	1= yes, 0 , else	15	±
TLU	Tropical livestock unit	No. of livestock	2.31	±
OXEN	Oxen	Number of oxen	0.93	+
FARMSIZE	Farm size	Hectare of land	0.80	+
FRAGPLOT	Fragmented plot	Number of plots	4.87	+
IRRGN	Irrigation aceess	Irrigation proportion	59	+
FERTILE	Fertile plot	Fertile proportion	40.16	±
POORFERT	Poor fertile plot	Poor fertile proportion	14.35	±
EXTENSION	Extension access	1= yes, 0 , else	17	+
MKTINF	Market info access	1= yes, 0 , else	42	+
MKTDIST	Market distance	Minutes	56.35	±
WEZEROAD	All weather road distance	Minutes	69.35	±
FARMDIST	Farm distance	Minutes	10.33	±
WORDADIST	Woreda/district distance	Minutes	126.87	±

Source: Computed from 2007/08 farm households data. Sample size 393

(Margalef index) was analysed. The inverse of mills ratio (IMR) was added as a regressor in this function in order to correct for potential selection bias. Based on these specifications, Heckman specified as:

(a) First, a Probit model for diversification decision or selection equation is estimated.

Probability equation:

$P_i^* = \beta_1 X_{1i} + \mu_i \quad \mu_i \sim N(0,1)$ (3)

where P_i^* is a dummy for participation in diversification whereas X_{1i} is a vector of variables that affect diversification decision, μ_i is the error term.

Threshold index equation:

$P_i = 1$ if $P_i^* > 0$ (4)

0 if $P_i^* = 0$

where $P_i = 1$ if D_i is observe and zero otherwise.

(b) Level of diversification decision:

MI equation: $D_i^* = \beta_2 X_{2i} + \upsilon_i \quad \upsilon_i \sim N(0, \sigma^2)$ (5)

D_i^* indicates the unobserved latent value, the level of diversification and X_{2i} is a vector of variables that explain the levels of diversification, υ_i is the error term.

Threshold of Margalef index equation:

$D_i = D_i^*$ if $P_i = 1$ (6)

0 if $P_i = 0$

In this specification, separate sets of factors are assumed to influence the decisions to participate in crop diversification versus the positive Margalef index of richness (D_i). Hence, X_{1i} and X_{2i} are vectors of explanatory variables that affect in equation (3) and equation (4), respectively. Both variables are also assumed to be uncorrelated with their respective error terms, μ_i and v_i assumed to have a correlation rho (ρ) and their joint distribution is normal bivariate. The β_1 and β_2 are the corresponding vectors of parameters. P_i is the observed value representing the individual's participation decision. Hence, the actual observed D_i equals the unobserved latent value D_i* only when a positive Margalef index of richness is reported; otherwise, it takes the value of 0.

In this specification, the error terms are assumed to be normally and independently distributed in equating (3) and (4), implying that there is no dependence between the diversification participation and level of diversification. Assuming that the error terms in (3) and (4) are independent with mean zero, that $\mu \sim N(0, 1)$, and that $v_i \sim N(0, \sigma^2)$, and that corr (μ, v) = ρ, the stochastic specification in (7) can be written as:

$$\begin{pmatrix}\mu_1\\ v_1\end{pmatrix} \sim N\left\{\begin{pmatrix}0\\0\end{pmatrix}\begin{pmatrix}1 & 0\\ 0 & \sigma^2\end{pmatrix}\right\} \quad (7)$$

If only the households who participate in crop diversification are included in the second step, the IMR will be computed as follows:

$$\lambda = \left(\frac{\phi(X_1,\alpha)}{\Phi(X_1,\alpha)}\right) \quad (8)$$

where λ denotes IMR, ϕ is the normal probability density function (PDF), $\Phi(.)$ is the standard normal cumulative density function (CDF), X_1 is a vector of factors known to influence a household's decision to participate. A significant coefficient of the λ indicates that the selection model must be used to avoid inconsistency. Then, the new λ is used in Equation (9) as an explanatory variable. If $\rho = 0$, then there is no evidence of the selection bias and the regression reverts to OLS. When $\rho \neq 0$, standard regression techniques app.lied to the first equation (5) correlated with X_1, yield biased results, which is corrected by including IMR in the second regression. It can be shown that the expected value of D_i^* when D is observed which is given by Equation (9). The new equation for the second stage regression (level of crop choice or diversification) equation is then given by:

$E(D_i \backslash X_1, P_i = 1) = \beta X_2 + \boldsymbol{\rho}\, \lambda(\delta X_1) + \upsilon_i$ (9)

where E is the expectation operator, D_i is the extent (continuous) of diversification (Margalef index of richness), X_2 is a vector of independent variables that will affect D_i and β is the vector of the corresponding coefficients to be estimated, ρ is the correlation between unobserved determinants of probability to diversify u and unobserved determinants of level of diversification υ, δ is a vector of unknown parameters. Equation (9) gives the expected level of diversification D_i, given vectors of observable factors X_2 and given that the household has already made the decision to diversify. This can be explained by vector of observable characteristics X_2 and the IMR evaluated at $\lambda(\delta X_1)$. To the extent that $\lambda(\delta X_1)$ is correlated with X_2, the regression equation (9) resulting estimates will be biased unless $\rho = 0$

RESULT AND DISCUSSION

Characteristics of the households

Summary statistics of the variables which used in the Heckman Two Stage analysis are presented in Table 1. The study indicated that 89% of the sample households heads were male and the average age of the households' heads was 44. On average, the household's head spend 2 years on formal education. The average family size of the households was 6. The average available labour for agriculture (labour supply) was 4. About 9% of the households' heads had agricultural trade experience. The respondents earned an average of 568 Birr from the 2006/07 grain sale. Moreover, they earned an average of Birr 1658 from non-farm income.

The result indicated that only 24% of the households had access to cash credit, 22% were members of cooperative and 15% were members of Equb (traditional credit and saving association). The households had an average of 2 livestock (TLU) and about a single ox. The average size of land owned by the households was 0.80 ha. The households had on average 5 fragmented plots of land. Regarding to land features, of the fragmented plots, 40% were fertile, 14% were poor fertile and the rest have other character. Nearly 59% of their plots were irrigated. Nearly 17% and 42% of the households had extension and market information access, respectively. The average distances from the households' village to the nearest market and to all weather road were about 1 hr each 0. The average farm distance of the households was

Table 2. Heckman Two stage model estimates.

Variables	1St stage (probit) Coef.	Marginal	2nd stage (OLS) Coef.	Marginal
GENDER (1=M, 0=F)	-0.413(0.24)	-0.164*		
AGE	0.227 (0.24)	0.089	0.291(0.37)	0.110
EDUCN	-0.016(0.03)	-0.006	0.086(0.05)	0.098*
FAMSIZE	0.135(0.25)	0.053	-0.080(0.40)	-0.188
LABOURSS	0.083(0.24)	0.032	0.216(0.36)	0.150
TRADEEXP	-0.908(0.29)	-0.302**	-0.673(0.76)	0.118
GRAININCO	-0.002(0.01)	-0.001	0.002(0.01)	0.0041
OTHERINC	0.0034(0.00)	0.001	-0.001(0.01)	-0.003
CASHCR	0.022(0.18)	0.009	0.047(0.29)	0.029
EQUB	-0.086(0.21)	-0.034	-0.256(0.37)	-0.186
COOP	-0.361(0.21)	-0.137*	-0.214(0.36)	0.082
TLU	-0.152(0.10)	-0.059	0.012(0.20)	0.133
OXEN	-0.0201(0.13)	-0.008	0.001(0.22)	0.017
FARMSIZE	0.76(0.27)	0.299***	-2.846(0.49)	-3.457***
FRAGPLOT	1.215(0.18)	0.476***	0.931(0.71)	-0.041
IRRGN	0.005(0.01)	0.002	-0.012(0.01)	-0.016
FERTILE	-4.9E-05(2.88E-05)	9.93E-07	-4.9E-05(2.88E-05)	-4.5E-05*
POORFERT	-0.001(2.6E-2)	-3. E-04	-0.005 (4.1 E-03)	-0.004
EXTENSION	0.701(0.23)	0.274***	1.414(0.47)	0.896***
MKTINF	0.028(0.17)	0.011	-0.211(0.26)	-0.234
MKTDIST	0.029(0.02)	0.011	0.061(0.034)	0.038*
WEZEROAD	-0.018(0.02)	-0.005	0.025(0.03)	0.034
FARMDIST	0.028 (0.04)	0.011	-0.049(0.07)	-0.071
WORDADIST	0.027(0.02)	0.011		
CONS	-4.492(1.07)		0.655(3.58)	
IMR			1.181(0.94)	
Wald χ2	χ2 (22)= 118.84***			
No of observations	393			
Censored observations	218			
Uncens observations	175			

***, ** and * indicate that statistically significant difference at 1% and 5% and 10% significant level, respectively, figures in parenthesis are standard deviations.
Source: Computed from 2007/08 farm households data

10 minutes. To reach the woreda town the households had to walk for about 2 hours.

Empirical results

The results of Heckman Two Stage model (estimates of Probit and OLS) were presented in Table 2. There was no significant problem of multi-collinearity among the variables. The chi-square of the model regression indicated the overall goodness of fit of the model and it was statistically significant at 1% level. The Wald test is ($\chi^2(22) = 118.84$) confirmed that the coefficients of the level of diversification equation are significantly different from zero; indicated that the model fulfilled condition of good fit. Selection bias was tested by including the IMR which was not significant. This suggested selection bias was not an issue in the data.

Table 2 indicated that, in the female-headed households, the probability of diversification increased by 16.35% in SNNPR. This implies that female-headed households more likely to be concerned about securing food for the family and income diversification than males. However, other studies indicated that female-headed households adversely affected the crop and barley variety diversification in Zambia and Tigray (Kimhi and Chiwele, 2000; Fetien *et al*., 2009). As expected, education had a positive association with the level of diversification. Increase in formal education by one year led to a 9.82% increase in the level of diversification of the households. It is most likely that education by contributing to the households' heads human capital enhances the ability to hold new production techniques more rapidly, to seek new information on technology and to meet more complex management requirements of crop diversification. The finding agree with other studies that the importance of knowledge and ability to absorb new information through formal education increased crop diversification (Gauchan *et al*., 2005; Ashfaq *et al*., 2008; Rahman, 2008; Ibrahim *et al*., 2009).

Contrary to expectation, the coefficient of trade experience was negatively related to diversification. Having trade experience of the household head reduced the probability of crop diversification by 30.17%. It was probably that the households may stick to specific crops or divert to profitable crops to satisfy market demand. Similarly, Pitipunya (1995) identified that farmers who had trade experience diversified their land to sweet corn on paddy field.

The effect of social organizations was significant and adversely affected the probability of crop diversification. The farmer being a member of a cooperative makes him/her a 13.7% less likely to diversify his/her crops. The result suggests that cooperatives might have their particular objectives (mono cropp.ing) and focus on specific crops, which may narrow the probability of diversification.

As expected, land size significantly and positively affected crop diversification decision of the households. An addition of one hectare of land brought to increase in the probability of diversification by 29.93%. This implies that large farm may enable households to allot their land to multiple cereal crops than small holders to minimize income, production and price risks. Previous studies indicated that land size positively affected crop and variety diversification (Benin *et al*., 2004; Ashfaq *et al*., 2008; Fetien *et al*., 2009). However, that the partial effect reveals that as land size increased by one hectare the level of diversification of the households decreased by 345.7%. This indicates that with an argument based on economies of scale level of diversification reduced by limiting the quantities of quasi-fixed factors (inputs, management, skills, *etc.*). This implies that probably because sizable farm land demands more management skill, inputs and draft power, households may not be able to produce multiple crops. Pope and Prescott (1980) found that when considering the production mix, large, and wealthier farms tend to exhibit a propensity to specialise.

The number of plots significantly and positively affected the households' decision and level of crop diversification. An addition of one plot led to increase the probability of diversification of households by 47.57%. This implies that farmers who operate on a large number of farm plots maintained higher levels of diversity, probably due to soil and agro-ecological differentiation among the plots may conducive for different crop which lead to allocate multiple crops across different types of land. Some evidence indicated that the number of fragmented land and fragmentation index positively affected agricultural diversification (Benin *et al*., 2004; Gauchan *et al*., 2005; Nagarajan *et al*., 2007; Fetien *et al*., 2009; Wondimagegn *et al*., 2011).

The coefficient of fertile plot had a significant and negative effect on crop diversification. As the proportion of fertile plots increased by one which lead to a small figure percentage reductions in the level of diversification. This implies that probably because fertile land is promising to increase production and yield, the households might have motivated to produce a more profitable crop (like *teff* or wheat).

Extension service positively and significantly affected crop diversification. A household who had extension access increased his/her probability by 27.39% and level of diversification by 89.85%. This implies that extension services associates with spread and adoption of new technologies, which might be directly relevant to cereal diversification. Likewise, Ibrahim *et al*. (2009) found that extension contacts increased crop diversification in North Central Nigeria. In contrast to this finding, extension contact adversely affected barley variety diversification in Tigray (Fetien *et al*., 2009).

Walking distance from residence to the nearest market significantly and positively affected diversification. A one minute walk increase to the nearest market increased the level of diversification of households by 3.80%. This explains that the households who have poor market access are more likely to rely on diversification to meet their consumption needs and to avoid transaction costs. A household far from a market was positively related to crop and variety diversification, which in turn indicated that the higher the transaction costs, the less likely him/her to integrate into the market (Joshi *et al*., 2004; Gauchan *et al*., 2005; Alpízar, 2007).

SUMMARY

The purpose of this study was to examine the determinants of the probability and the level of crop diversification SNNPR of Ethiopia. Heckman two stage model was employed to estimate the diversification decisions and the level of diversification separately. The study showed that female headed households diversified their crops more than male headed households. Level of education of households head positively affected the extent of diversification. None cereal activities (trade experience) negatively affected probability of crop diversification. Based on their aim, social organizations (cooperatives) adversely affected probability of crop diversification. Farm land size encouraged probability of diversification and adversely affected the intensity of diversification. Features of land (fragmented plot) enhanced the households to diversify while fertile plots led to specialization. Agricultural extension positively affected both the probability and intensity of crop diversification. Similarly, market distance positively affected the likelihood of diversification.

CONCLUSION AND RECOMMENDATIONS

The positive contribution of females on crop diversification needs policy attention on promotion and empowerment of females through equal access to resources, technology, credit, and other facilities. Education is an important factor in crop diversification, key policy implication is that crop diversification can be promoted by investing and/or strengthening formal and informal education for the targeted farming household. Enterprise diversification (trade experience) may generate more income and rural employment. The current integrated agriculture system policy has to be improved for sustainable crop diversification. Based on the contribution of social organizations (cooperative), strengthening and restructuring are essential to take crop diversification as their part of focus, because their potential for diversification and higher economic returns to households may high. The study concluded that larger is the size of farm the greater is the possibility of crop-diversification; and adversely affect the level of diversification. This needs agricultural inputs and modern technologies to exploit the potential of the land. Land feature (land fragmentation, fertile) considerations are more important in crop diversification, suggested that a need to strengthen the on-going effort in identifying app.ropriate technologies and soil conservation for households' diverse farming practices. With positive contribution of extension service, extension system should be strengthened through recruitment, incentive and training of adequate extension workers for successful crop diversification. With reference to transaction costs (market distance), the study prescribed rural urban infrastructure (main and feeder roads) needs due attention on its improvement.

ACKNOWLEDGEMENTS

The author acknowledges to the Ethiopian Institute of Agricultural Research (EIAR) and Rural Capacity Building Project (RCBP) for their financial support, the EDRI and IFPRI for offering the data. This work would not have been possible without the support and guidance of Prof. Belay and Dr Dawit for their valuable insight and analysis.

REFERENCES

Abrar S, Oliver M, Tony R (2002). Supp.ly response of peasant farmers in Ethiopia: A farm–level profit function analysis. Centre for research in economic development and international trade, University of Nottingham, pp.1-49.

Alpízar CA (2007). Risk coping strategies and rural household production efficiency: Quasi-experimental evidence from El Salvador. A PhD Dissertation Presented in the Graduate School of the Ohio State University. USA 209p.

Aneani F, Anchirinah, VM, Owusu-Ansah F and Asamoah M (2011). An analysis of the extent and determinants of crop diversification by cocoa (Theobroma cacao) farmers in Ghana. Afr. J. Agric. Res. 6(18):pp. 4277-4287

Ashfaq M, Hassan S, Naseer MZ, Baig IA, Asma J (2008). Factors affecting farm diversification in rice-wheat. Pak. J. Agri. Sci. 45(3):pp. 91-94.

Benin S, Smaleb M, Pender J, Berhanu GM, Ehui S (2004). The economic determinants of cereal crop diversity on farms in the Ethiopian Highlands. Agri. Econ. 31(2004):pp 197-208. Available: Online at www.elsevier.comflocate/agecon.

Central Statistical Agency of Ethiopia (CSA) (2010). Area and production of crops. Statistical bulletin No. 446.

CSA (2008). Area and production of crops. Statistical bulletin No. 417.

Degye G, Belay K, Mengistu K (2012). Does Crop Diversification Enhance Household Food Security? Evidence from Rural Ethiopia, Advances in Agriculture, Sciences and Engineering Research. 2 (11):pp 503 - 515, Available: Online at http://www.ejournal.sedinst.com

Diao X, Belay F, Haggblade S, Alemayehu ST, Kassu W, Yu B (2007). Agricultural growth linkages in Ethiopia: Estimates using Fixed and Flexible Price Models. IFPRI Discussion Paper No. 00695. pp. 1- 41.

Dow W, Norton E (2003). Choosing between and interpreting the Heckit and Two-Part Models for corner solutions. Health Services and Outcome Research Methodology. 4 :pp. 5-18.

ESGPIP (Ethiopian Sheep and Goat Productivity Improvement Program). ESGPIP's target woredas. http://www.esgpip.org.

FAO and World Bank (2001). Farming systems and poverty-improving farmer's livelihoods in a changing World, Rome and Washington D.C. pp.1- 41.

Fetien A, Bjornstad, A, Smale M (2009). Measuring on farm diversity and determinants of barley diversity in Tigray, northern Ethiopia. MEJS. 1,(2): pp. 44-66.

Gauchan D, Smale M, Maxted N, Cole M, Sthapi BR, Jarvis D, Upadhyay MP (2005). Socioeconomic and agro-ecological determinants of conserving diversity on-farm: The case of rice genetic resources in Nepal. J. Nepal Agric. Res. 6 : pp. 89-98.

Heckman JJ (1979). Sample selection bias as a specification error. J. of Econometrica. 47,(1): pp. 153-162.

Ibrahim H, Rahman SA, Envulus EE, Oyewole SO (2009). Income and crop diversification among farming households in a rural area of north central Nigeria. J. Trop. Agric. Food. Environ. Extension. 8 (2): pp. 84-89.

Joshi PK, Gulati A, Birthal S, Tewari L (2004). Agriculture diversification in South Asia: Patterns, determinants, and policy implications. Economic and Political Weekly. 39,(4): pp. 2457-2467.

Kimhi A, Chiwele D (2000). Barrier for development in Zambian small-and medium size farms: Evidence from micro data. Paper presented at the 2000 Annual Meeting of the American Agricultural Economics Association. pp.1-27.

Maddala GS (1983). Limited dependent and qualitative variables in economics. Cambridge UK, Cambridge University Press, pp. 1- 231.

Magurran AE (2004). Measuring biological diversity, Blackwell Publishing. pp. 1- 256.

Ministry of Finance and Economic Development (MoFED) (2010). Southern Nations and Nationalities Peoples' Regional (SNNPR) Government PEFA Assessment Report. pp. 55-65.

Minot N, Epprecht M, Anh TT, Trung LQ (2006). Income diversification in the northern uplands of Vietnam: IFPRI Research Report No.145. pp. 1-137.

MoFED, MoRAD (2010). Global agriculture and food security programme: FYGTP (Five-Year Growth and Transformation Plan). Addis Ababa, Ethiopia. pp.1-41.

Nagarajan L, Smale M, Glewwe P (2007). Determinants of millet diversity at the household-farm and village-community levels in the dry lands of India: The role of local seed systems. Agric. Econ. 36: pp. 157-167.

Pitipunya R (1995). Determinants of diversification on paddy field: The case of diversification to vegetables. Kassetsart J. Soc. Sci. 16: pp. 201-208.

Pope RD, Prescott R (1980). Diversification in relation to farm size and other socioeconomic characteristics. Amr. J. Agric. Econ. 2: pp. 554-549.

Rahman S (2008). Determinants of crop choices by Bangladeshi farmers: A bivariate Probit analysis. Asian J. Agric. Devt. 1,(5): pp. 29-42.

Seid N, Seebens H (2008). The impact of location on crop choice and rural livelihood: Evidences from villages in northern Ethiopia. ZEF Discussion Papers 123, Bonn. pp. 1-27.

Weiss CR, Briglauer W (2000). Determinants and dynamics of farm diversification. Department of Food Economics and Consumption Studies, University of Kiel. Working Paper EWP 0002. pp. 1-20.

Windle J, Rolfe J (2005). Diversification choices in agriculture: A choice modeling case study of sugarcane growers. Australian J. Agric. Res. Econ. 49,(1): pp. 63-74.

Winters P, Cavatassi R, Lipper L (2006). Sowing the seeds of social relations: The role of social capital in crop diversity. ESA Working Paper No. 6,(16): pp. 1-40.

Wondimagegn M, Bekabil F, Jema H (2011). Pattern, trend and determinants of crop diversification: Empirical evidence from smallholders in Eastern Ethiopia. J. Econ. Sustainable Devt. 2,(8): pp. 78-89. Available: Online at www.iiste.org.