Ethiop. J. Agric. Sci. 25(2) 65-76 (2015)

Determinants of Crop Diversification in Ethiopia: Evidence from Oromia Region

Rehima Mussema[1], Belay Kassa[2], Dawit Alemu[3] and Rashid Shahidur[4]
[1]Ethiopian Institute of Agricultural Research, P.O.Box 2003, Addis Ababa, Ethiopia.
[2] Haramaya University, P.O. Box 138, Dire Dawa, Ethiopia.
[3]Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia,
[4]International Food Policy Research Institute, NW, Washington, DC 20006-1002, USA.

አሕፅሮተ-ጥናት

የግብርና አማራጮችን በማብዛት መጠቀም ለኢኮኖሚ ዕድገት መሰረታዊ ነው፡፡ የግብርና አማራጭ በማብዛት መጠቀም ምርታማነትን ከማሳደግ፣ የቤተሰብ ገቢን ከመጨመር፣ የአፈርን ደህንነት (ሰብል በማፈራረቅ እእ“ ናይትሮጅንን በማቆየት) ከመጠበቅ እና በቀጣይነት ውስን መሬት ላይ ምርትን ከመጨመር አንጻር አስተዋፅዖ አለው፡፡ክልሉን ወካይ የሆነ መረጃ በመጠቀም ይህ ጽሁፍ በቆዳ ስፋት እጅግ ከፍተኛ በሆነውና በስነ-ምህዳር ከፍተኛ ልዩነት ባለው በኦሮሚያ ክልል የሚገኘ የአርሶ አደር ቤተሰብን የግብርና አማራጮችን በማበዛት መጠቀምን ገምግሟል፡፡የአርሶ አደሩ አማራጮች በሁለት ደረጃ የተፈረጁ ሂደቶች ናቸው፡- አማራጮችን በማበዛት የመጠቀም ተነሳሽነት (አማራጮች ማበዛት)እእ“ በምን ያህል አማራጮችን መጠቀም (ለማባዛት ከወሰነ የአማራጭ ማባዛት ክብደት/ብዛት) የሚሉት ናቸው፡፡ይህን ጥናት ለመስራት Hackman’s two-step method ተጠቅመናል፡፡ በጥናቱ ውጤት መሰረት በኦሮሚያ ክልል የሀብት ባለቤትነት (መሬትና የእርሻ ገቢ)፣ የአፈር ለምነት፣ ግብርና ኤክስነንሽን እናመሰረተ ልማት (መንገድ እና የገበያ መረጃ) የሰብል አማራጮች በማበዛት ለመጠቀም መወሰንና በምን ያህል አማራጮችን መጠቀም የሚያስችሉ ወይንም ሊገቱ የሚችሉ ወሳኝ ምክንያቶች ወይም ጉዳዮች መሆናቸው ታውቋሙ፡፡በመሆኑም አመልካቹ ፖሊሲ ግልጽ ነው- የህዝብ መሰረተ-ልማት በማስፋፋት እና ፖሊሲ በመከለስ አደጋ/ስጋት ለመከላከል/መቀነስ (በሀብት ይዞታ የተመለከተን) የሚያግዝ ሲሆን፣ የአፈር ለምነት በመሻሻል፣ የኤክስቴንሽን መረጃ በማጠናከር እና የገበያ ወጪን በመቀነስ የግብርና አማራጮች ማብዘትን ያበረታተል፡፡

Abstract

Diversification of agriculture is central to economic transformation. It contributes to increasing productivity, increasing household incomes, improving soil health (through crop rotation and nitrogen fixation), and sustainable intensification of agriculture. Using survey data from a regionally representative household survey, this paper examines the drivers of agricultural diversification in Oromia region – the largest and agro-ecologically most diverse region. Farm households' diversification decision is modeled as a two-step process; i.e., as the propensity to diversify (whether to diversify), and intensity of diversification (if decides to diversify, to what extent to diversify). The model was estimated using Hackman's two-step method. The results suggest that asset ownership, soil quality, agricultural extension, and level of infrastructural development are the significant drivers of crop diversification in Oromia. The policy implications are obvious – public investment and policy reform geared toward risk mitigation (reflected by the significance of asset ownership), soil health improvement, extension information, and reduction in transactions will have the greatest pay off in promoting agricultural diversification.

Introduction

Agricultural diversification plays central roles in improving food security (Pingali and Rosegrant, 1995; Acharya *et al*., 2011); generating non-farm employment (Haggblade, *et al*., 2010; Reardon, 1997; Reardon *et al*., 2007), and promoting economic transformation and structural changes (Johnston and Kilby, 1975; Block and Timmer, 1994). For Ethiopia, the topic has special implications. Almost all major policy documents including economic growth and poverty reduction strategies of Ethiopia place emphasized on broad underpinnings of agricultural diversification. For instance, the Agricultural Development Led Industrialization (ADLI) embodies all aspects of diversification and so does the Growth and Transformation Plan (GTP 2010 - 2015).

Nonetheless, despite the emphasis on the policy documents, agricultural diversification related issues are broadly defined and lacks specificity. In the literature, it is defined to be a practice of growing more than one crop or enterprise in any year to increase financial and biological stability (Johnston *et al*., 1995). However, for any agro-ecologically diverse country, such as Ethiopia, both drivers and outcomes of diversification ought to vary across space and over time. A couple of examples can better illustrate the point. First, what is optimal mix of crop in one agro-ecology, as well socio-economic and market conditions may be totally sub-optional in other settings particularly in the context of Ethiopia. The other example relates to the dynamic nature of diversification. A diversification strategy that is optimal at time *t* at a different point in time (say, t+1). Such shifts are natural in an environment where agricultural technology goes through rapid technological changes and structural shifts. Indeed, historical evidence suggests farmers tend specialize when agriculture becomes very small share of total economy (Timmer, 2014).

In Ethiopia, smallholder farmers rarely depend on only one type of enterprise for their livelihood. Farmers in general engage in a variety of enterprises and often combine crops and livestock as a way of diversification. In subsistence farming communities, agricultural diversification refers to a system of farming where in farmers cultivate varieties of crops on a given piece of land in order to reduce vulnerability, marketing risks, income stability, and food security. However, given the national aspiration of joining the middle income countries, there is a need for much broader understanding of the nature and the dynamics of agricultural diversification. This calls for assessing the drivers, analyzing the heterogeneity, and tracking the changes in the nature of diversification. To the best of our knowledge, there are limited systematic studies, and awareness among the policy makers, about these important dimensions of crop diversification and their bearings for the country's strategies.

This paper makes a small attempt in filling this knowledge gap. Using a regionally representative household survey data set from Oromia Region, which is the largest and agro-ecologically most diverse region in the country, it examines the determinants of crop diversification. The rest of the paper is organized as follows. The next section provides a description of the data and study setting, which is followed by a section that illustrate econometric method. Results are presented in section 4 and the paper concludes with a summary and implications.

Data and method of analysis

The data

The study is uses the Ethiopian Agricultural Household and Marketing Survey (EAHMS) jointly implemented by the Ethiopian Development Research Institute (EDRI) and the International Food Policy Research Institute (IFPRI) in 2008. Briefly, the survey followed a three-stage sampling procedure using agricultural value added as indicator variable. At the first stage, woredas (districts) were randomly selected followed by random selection of kebeles (villages) from the list provided by the woreda officials. In the final stage, households were randomly selected from kebeles. In Oromia, a total of 408 farm households were interviewed using 2007/08 main cropping season (Meher) as the reference period. This study has considered only households that produced at least one of the cereal crops, namely, tef, wheat, maize, sorghum or barley. This resulted in the reduction of sample to 382 households.

Method of analysis

The study used both descriptive and econometric analyses. For the purpose of analyzing the determinants of crop diversification, Heckman Two-Stage model was applied. The extent of crop diversification at a given point in time may be examined by using several indices by Hill *et al.* (2002): Herfindahl Index (HI); Simpson's Index (SI); Margalef index (MI), etc. This study used MI because it is simple (Lexerød and Eid, 2006; Yemane *et al*, 2009) and it is the most widely used index in the literature of crop diversification (eg. Benin *et al*., 2004; Fetien *et al*., 2009; Di Falco *et al*., 2010).

The rationale for the choice of analytical model is obvious: that is, given not all households diversify despite having the option to do so; using OLS would result in selectivity bias. To mitigate this bias, we used Heckman Two-Stage model, which is developed by Heckman (1979). The first stage estimates the probability of observing a positive outcome, i.e., to diversify and the second stage estimates the level of participation, which is conditional on observing positive values (Dow and Norton, 2003). This two-step method can be characterized as two step decision making process. The first step can be defined as propensity to diversify, i.e., deciding whether to diversify and the second step decision, defined as intensity of diversification, involves deciding how many crops to cultivate and 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). Hence, in this research the gender of the household head variable was excluded from second the equation.

Model specification

The general structure of the regression equations is expressed by:

$$\mathbf{D_i = a_i + b_i x + \varepsilon_i} \qquad (1)$$

Where: D_i represents the MI of richness, x is a vector of household specific characteristics; ε_i captures unobserved factors; and a_i and b_i are the parameters to be estimated. This index is adapted from Magurran (2004) ecological indices of spatial diversity in species, which is given by,

$$D_i = (S-1)/\ln A_i,\ D \geq 0 \tag{2}$$

Where: S represents the number of cereal crops grown in the household in 2007/08 cropping season; A_i denotes the total area planted to cereal crops by household in the same year. By construction, D_i is zero when a household grows only one type of crop. On this background, Heckman's (1979) two step is specified as follows:

Step-1: Probit estimation of propensity to diversify

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

$$\text{Threshold index equation: } P_i = \begin{cases} 1 \text{ if } P_i^* > 0 \\ 0 \text{ if } P_i^* = 0 \end{cases} \tag{4}$$

Where: P^*_i is a latent index variable that denotes binary censoring, X_{1i} is a vector of variables that affect diversification decision, $\mu_i$is an error term, P_i is a binary variable (1 if diversification is observed; and zero otherwise), representing the individual's participation decision (propensity to diversify). To be specific, it take 1 if a household grows multiple crops and the diversification richness index (MI index) is positive; and it is zero otherwise. Now the second stage decision, the intensity of diversification, can be represented as follows:

Step-2: Intensity of diversification (outcome equation)

$$D_i = \beta_2 X_{2i} + \upsilon_j \upsilon_i \sim N(0, \sigma^2) \tag{5}$$

$$D_i = \begin{cases} D_i^* \text{ if } P_i = 1 \\ 0 \text{ if } P_i = 0 \end{cases} \tag{6}$$

Where: $D_i{}^*$ indicates the latent value a measure of diversification, and X_{2i} is a vector of variables that explain the levels of diversification, υ_i is an error term. The observed D_i equals the value D_i^* only when the richness index MI is positive; it is zero otherwise. Notice that separate sets of factors are assumed to influence the diversification decisions. In particular, X_{1i} and X_{2i} are two different set of explanatory variables affecting two sets of decisions, represented by equation 3 and 5, respectively. These two sets of variables are tested to be uncorrelated with their respective error terms, μ_i and v_i. The β_1 and β_2 are the corresponding vectors of parameters. To control or correct for potential bias emerging from sample selectivity, the second stage regression includes inverse Mills ratio (IMR), estimated from the first stage regression, as one of the explanatory variables. The IMR is represented by,

$$\lambda = \left(\frac{\phi(X_1, \alpha)}{\Phi(X_1, \alpha)}\right) \tag{7}$$

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. If $\rho = 0$ then there is no evidence of the selection bias and the regression reverts to OLS. The new equation for the second stage regression equation is then given by:

$$E(D_i \mid X_2, P_i = 1) = \beta X_1 + \rho \lambda (\delta X_2) + \upsilon_j \qquad (8)$$

Where: E is the expectation operator, X_1 is a vector of independent variables that will affect D_i and β is the vector of the corresponding coefficients to be estimated; and to the extent that $\lambda(\delta X_2)$ is correlated with X_1 the resulting estimates will be biased unless $\rho = 0$.

Result and Discussion

Socioeconomic characteristics of farming households

Summary statistics of the variables which were used in the Heckman Two Stage analysis are presented in Table 1. The study revealed that most of (92%) the respondents are male. The average age of respondents was 44 year and on average the respondents reported that they had spent 2 years on formal education. The average family size of the sampled households was 7 while average available labor for agriculture was 4.

About 8% of the household heads had trading experience, where they were involved in the purchase and sale of agricultural and non-agricultural commodities to diversify their income. In 2007/2008 the respondents earned an average of 1,464 Birr from sale of surplus grain produced in the 2006/07 cropping season and earned an average of Birr 1,645 from non-farm income (sale of fire wood, charcoal, agricultural products and local drink, and service provision, pension etc.).

The study indicates that few of the respondents had access to loan: only 26% the respondents had cash credit access. Membership to social organizations may be beneficial to access information on technology and market, and strength financial capacity that helps to diversify crop. However, only 34% and 9% of the respondents reported that they were members of farmers' cooperative and *Equb* (traditional credit and saving association), respectively. Table 1 show that the sample households had an average of 5 livestock (TLU) and owned an average of 2 oxen. The average size of land (cultivated and non-cultivated) owned by the sample households was 1.19 hectare.

Land fragmentation is common in Ethiopia because of differences in agro-ecology, topography and variability of fertility. The sample households had an average of 5 fragmented plots of land to grow different cereal crops. Access to irrigation was reported to be important to alleviate food shortage in a household. On average, 41% of their fragmented plots were irrigable. From the fragmented plots, 36% were fertile and 16% had poor fertility. Extension service is one of the country's strategies for increasing production and productivity. The results in Table 1 show that only 27% of the sample households had access to fertilizer, improved seed and other input on credit.

Table 1. Summary of explanatory variables in Heckman Two Sage

Variables	Definition of variables	Measurement	Mean(SD)	Expected sign
GENDER	Gender	1= M, 0 =F	92	±
AGE	Age	Number of years	44.29 (13.13)	±
EDUCN	Education	Number of years	2.12(3.05)	+
FAMSIZE	Family size	Number of family	7.04(2.94)	+
LABOURSS	Labour supply	Adult equivalent	3.76(1.63)	+
TRADEEXP	Trade experience	1= yes, 0 , else	8	+
GRAININCO	Grain income	Birr	1464(1582)	+
OTHERINC	Other income	Birr	1645(2881)	_
CACRACC	Credit access	1= yes, 0 , else	26	_
COOP	Cooperative member	1= yes, 0 , else	34	±
EQUB	Equb member	1= yes, 0 , else	9	±
TLU	No. of livestock	TLU	5.47(9.89)	±
OXEN	Number of oxen	Number	1.63(1.51)	+
FARMSIZE	Land size	Hectare	1.19(1.05)	+
FRAGPLOT	Number of plots	Number	5.43(3.27)	+
IRRGN	Irrigated plot	proportion	41(25)	+
FERTILE	Fertile plot	proportion	36.02(39.70)	±
POORFERT	Poor fertile	proportion	16.26(31.47)	±
EXTENSION	Extension access	1= yes, 0 , else	27	+
MKTINF	Market info	1= yes, 0 , else	52	+
MKTDIST	Market distance	Minutes	74.00(63.72)	±
WEZEROAD	All weather road dist.	Minutes	78.45(89.30)	±
WORDADIST	distance to woreda	Minutes	153.36(106.85)	±
FARMDIST	Distance to farm	Minutes	14.05(17.25)	±

Source: Computed from 2007/08 farm households data
Figure in parenthesis standard deviation. Sample size is 382

The opportunity for households to diversify their income or to increase their market participation largely depends on market information. The findings of the study indicate that 52% of the sampled households accessed market information from TV and/or radio. A household living in a remote village tends to experience high transaction costs. The average time required to cover the distance between the households' village and the closest market and nearest all weather road was 1:14 and 1:18 hours, respectively. Households could get services such as hospital, and market and information by walking an average of 2:30 hours to the woreda town. The households needed to walk on the average for 14 minutes from home to their farm plots to perform farm activities.

Determinants of crop diversification: econometric estimates

The results of Heckman Two Stage model, i.e, estimates of Probit and OLS are presented in Table 2. The test for multicolinearity indicated that there was no multicollinearity among the explanatory variables. The Chi-square of the regression model indicates the overall goodness of fit of the model and it was statistically significant at 1% probability level. The Wald test statistics ($\chi^2(23) = 145.66$), confirmed that the coefficients of the level of diversification equation are significantly different from zero, indicating that the model fulfilled the conditions of good fit. Selection bias was tested by including the IMR, which was not significant. This suggested that selection bias was not an issue in the data.

As expected, the 2006/2007 year's income from sale of grain enhanced crop diversification of the households in 2007/08. The study found that a one Birr increase in income increased the probability of diversification by 0.56%. This implies that the previous year income may strengthen a production capacity of the households through purchasing fertilizer, oxen, and rent in land, to diversify more in the following year, 2007/08. Similarly, (Bonham *et al*., 2012) found that positive relationship between on-farm diversity of pearl millet and income from agricultural production in India.

The findings of this study reveal that land size affected crop diversification decision of the households positively and significantly. An increase in the area of cultivated land by one hectare increases the probability of diversification by 15.82%. This implies that large farm sizes may enable households to allot their land to multiple cereal crops than smaller holdings. Previous studies indicated that land size positively affected crop and variety diversification (Benin *et al.*, 2004; Ashfaq *et al.*, 2008; Fetien *et al.*, 2009, Bonham *et al*. 2012). This result is also consistent with recent findings (Rehima *et al*, 2013; Kanyua *et al*., 2013; Ji-kun *et al*., 2014; Sichoong we*et al*. 2014) that reported that an increase in the availability of cultivable land leads farmers to practice crop diversification. Conversely, as land increased by one hectare, the level of diversification of the sampled households decreased by 284.50%, implies that probably because large farm land beyond some limit demands more management skill, complimentary inputs, draft power, more technologies, etc. Hence small holder households may not able to produce multiple crops as their farm land increase above certain limit. Similarly, (Rehima *et al*, 2013) find that as farm size increases level of diversification of farm households decreased in Southern Nations Nationalities and Peoples' Regional State of Ethiopia (SNNPR) of Ethiopia.

The number of plots affected positively and significantly households' decision of crop diversification by 29.84%, probably because soil and agro-ecological differentiation among the plots has led to the production of different crops on different types of land. The findings of this study are in complete agreement with earlier studies that reported 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; Rehima *et al*, 2013).

The proportion fertile plots had a significant and negative effect on crop diversification, implying that as the proportion of fertile plots increases the probability of diversification declines. This is probably because fertile land can provide good possibilities to increase production and yield. As a result, households are inclined to produce a more profitable crop (like tef or wheat). This result is supported by Rehima *et al*. (2013) who reported that farmers who had more fertile land opted for the production of a specific crop in SNNPR.

Table 2 Heckman two stage model estimates (Probit and OLS)

Variables	Probit		OLS	
	Coef.	Marginal	Coef.	Marginal
GENDER (1=M, 0=F)	-0.0353 (0.3246)	-0.0109		
AGE	0.3885 (0.3556)	0.1210	-0.1201(0.4006)	-0.0182
EDUCN	0.0459(0.0330)	0.0143	0.0032(0.0358)	0.0008
FAMSIZE	-0.2621(0.3817)	-0.0816	0.5097(0.4113)	0.5614
LABOURSS	-0.1561(0.3900)	-0.0486	-0.3831(0.4176)	-0.3523
TRADEEXP	-0.5348(0.3477)	-0.1884	-0.2336(0.3939)	-0.1141
GRAININCO	0.0181 (0.0072)	0.0056**	0.0030(0.0056)	-0.0006
OTHERINC	-0.0016(0.0040)	-0.0005	0.0034(0.0045)	0.0037
CACRACC	0.1278(0.2054)	0.0389	-0.1998(0.2293)	-0.2245
COOP	-0.1894(0.2341)	-0.0602	-0.1283(0.2430)	-0.0903
EQUB	0.0154(0.3258)	0.0048	0.0999(0.3429)	0.0969
TLU	-0.0343(0.0748)	-0.0107	-0.1339(0.1076)	-0.1271
OXEN	0.1909(0.1490)	0.0594	0.1542(0.1874)	0.1166
FARMSIZE	0.5082 (0.2927)	0.1582*	-2.7449 (0.3133)	-2.8450***
FRAGPLOT	0.9586 (0.2054)	0.2984***	0.3590(0.2685)	0.1701
IRRGN	0.0067(0.0065)	0.0021	-0.0097(0.0101)	-0.0110
FERTILE	3.52E-06 (2.38E-05)	1.09E-06	-4.4E-05 (2.59E-05)	-4.5E-05*
POORFERT	-0.0020(0.0028)	-0.0006	-0.0027(0.0044)	-0.0023
EXTENSION	0.8381 (0.2609)	0.2222***	0.2860(0.2617)	0.1414
MKTINF	-0.0892(0.1992)	-0.0277	0.3768 (0.2107)	0.3943*
MKTDIST	0.0090(0.0294)	0.0028	0.0303(0.0308)	0.0285
WEZEROAD	-0.0016(0.0248)	-0.0005	0.0463 (0.0241)	0.0466*
WORDADIST	0.0750 (0.0268)	0.0233***	0.0504 (0.0298)	0.0356*
FARMDIST	0.0305(0.0480)	0.0095	-0.1450 (0.0568)	-0.1510**
IMR			0.4314(0.5957)	
CONS	-4.2857 (1.4819) ***		3.6235(2.0150)	
RHO	0.2993	SIGMA	1.4413	
Wald χ^2	χ^2 (23) = 145.66***			
Number of observations	382			
Censored observations	133	Uncensored observations	249	

***, ** and * indicate the level of statistical significance at 1% and 5% and 10% probability levels, respectively.
Figures in parenthesis are standard deviations.
Source: Computed from 2007/08 farm households data

Extension service affected crop diversification positively and significantly. Access to extension service increased the probability of crop diversification by 22.22%. The possible explanation is that access to extension services is associated with the spread and adoption of new technologies through the provision of technical advice, credit availability, input supplies and even to the provision of market information and building the capacity of farmers, which might be directly relevant to cereal diversification. Likewise, other studies found that extension contacts increased crop diversification in North Central Nigeria and SNNPR of Ethiopia (Ibrahim *et al.* 2009; Rehima *et al*., 2013).

As expected, market information affected the level of diversification positively and significantly. Households who had access to market information increased their level of diversification by 39.43%. This implies that market information may decrease the uncertainty of the households associated with crop diversification. The findings of this study are consistent with other studies that reported that market information affected positively the diversification of paddy to vegetables in Thailand and crop diversification in Ethiopia (Pitipunya, 1995; Wondimagegn *et al*., 2011; Rehima *et al*., 2013).

Access to all-weather is an indicator of market access. The findings of this study reveal that a one minute walking distance from the sample respondents' home to the all-weather road leads to an increase in the level of diversification by 4.63%. This implies that famers' poor access to all weather road may oblige them to diversify their production so as to be able meet their household consumption requirements. In other words, the lack of well developed infrastructure may deter farmers from enjoying the potential benefits of cultivating marketable crops. It may also show that poor road network could discourage crop diversification at the expense of high value crops as they help to maximize profit. Joshi *et al.* (2004) reported that distant farm households from the road were more diversified in livestock and crop production than the nearest households. A study in Pakistan and Malawi (Abro, 2012; Kankwamba, *et al*. 2012) also found that farmers located farther away from main roads are found to diversify in order to meet their broad subsistence and nutritional needs.

Distance from the woreda is an indicator of access to central market, information, technology and other facilities which positively affect diversification. The results of this study show that an increase of a one minute walking distances to the woreda town leads to an increase in the probability of diversification of the households by 2.33% and the level of diversification by 3.56%. The farther away households are from the woreda town, the greater the transaction costs for getting information, technology, and market which in turn might lead to increased level of crop diversification to meet their consumption needs. The results also imply that farming households located farther from the woreda town may lose benefit from commercial crop diversification due to the absence of information on technologies, extension service and market. The results of this study are in complete agreement with other studies that reported that those households who operate nearer to urban centers tend to allot more land for the production of cash crops while those who operate far from urban centers tend to allocate much of their land for the production of staple crops (Seid and Seebens, 2008). Similarly, Ibrahim *et al*. (2009) found that farming households that are farther away from the main markets face high costs of transportation to bring their produce to the market and in such case farmers prefer to grow crops for household consumption.

Walking time to the farm affected crop diversification negatively and significantly. The findings of this study indicate that an increase in walking distance to the farm by one minute is associated with a 15.10% reduction in the level of diversification. Perhaps daily journeys to the farm location to manage different crop differently with its implication on the farmers' health, time, security and labour availability can result in high diversification on the nearest farm. Similarly, Benin *et al.* (2004) found that cereal diversification was high on the very close villages.

Conclusion

The study revealed the significant drivers for crop diversification in Oromia. Previous year grain income, total farm size, number of plots operated, access to extension and distance to woreda town were found to be the key drivers in enhancing crop diversification. Moreover, intensity of diversification is affected by access to market information, access to all-weather road, and distance of farm from household’s residence. The result further indicates that the different drivers of diversification have different effect on propensity to diversify and on intensity of diversification at household level. Previous income from grain has positively affected the propensity to diversity but no effect on the intensity of diversification, which indicates that as income from grain increases farmers tend to diversify but with focus on few selected crops. Total farm size positively affected the propensity to diversity but it has negative effect of intensity of diversification. This indicates that as farm size increases, farmers tend to engage in specialized diversification. As the number farm plots increases, farmers tend to diversify crop production, which is in line with the expectation that farmers tend to produce different crops in different plots. Access to extension service facilitated crop diversification with no effect on intensity of diversification, which indicates again role of extension in promoting the involvement of farmers in selected crop types suitable to respective areas. As distance to market represented by the distance to the nearby woreda town increases, farmers tend to diversity crop production both in terms of propensity and intensity of diversification.

References

Abro AA. 2012. Determinants of Crop Diversification towards High Value Crops in Pakistan. Int.J.Buss.Mgt.Eco.Res. 3(3):536-545.

Acharya SP, H Basavaraja, LB Kunnal, SB Mahajanashetti, and ARS Bhat. 2011. Crop Diversification in Karnataka: An Economic Analysis. A*ricultural Economics Research Review,* (24):351-357.

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

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

Block S and P Timmer.1994. Agriculture and economic growth: conceptual issues and the Kenyan experience. Development Discussion Paper No. 498. Cambridge, MA, USA.

Bonham, CA, E Gotor, BR Beniwal, GB Canto, MD Ehsan and P Mathur. 2012. The Patterns of Use and Determinants of Crop Diversity by Pearl Millet (Pennisetumglaucum (L.) R. Br.) Farmers in Rajasthan. *Indian J. Plant Genet. Resource*. 25(1): 85–96 .

Di Falco, S and M Veronesi. 2010. How African Agriculture Can Adapt to Climate Change? A Counterfactual Analysis from Ethiopia. JEL classification: Q54, Q56.

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

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

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

Haggblade, Steven & Hazell, Peter & Reardon, Thomas, 2010."The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction,"*World Development*, vol. 38(10), pp. 1429-1441,

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

Hill, T.C., Walsh, K.A., Harris J.A. and Moiett, BF. 2002. Using ecological diversity measures with bacterial communities. FEMS Microbiology Ecology, 2003(43): 1-11.

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

Ji-kun H, J Jing, W Jin-xia1 and H Ling-ling. 2014. Crop Diversification in Coping with Extreme Weather Events in China. J. of Integrative Agriculture., 13(4): 677-686.

Johnston, BF and P. Kilby. 1975. *Agriculture and Structural Transformation: Economic Strategies in Late Developing Countries*. New York: Oxford University Press.

Johnston, GW, SP Vaupel, FR Kegel, and M Cadet. 1995. Crop and farm diversification provide social benefits. California Agriculture, 49(1): 10-16.

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

Kankwamba, H, M Mapila, and K Pauw. 2012. Determinants and spatiotemporal dimensions of crop diversifica-tion in Malawi. Lilongwe: IFPRI.

Kanyua, MJ, GK Ithinji, AS Muluvi, OE Gido and SK Waluse. 2013. Factors Influencing Diversification and Intensification of Horticultural Production by Smallholder Tea Farmers in Gatanga District, Kenya. Current Research J. of Soc. Sci. 5(4): 103-111.

Lexerød, NL and T Eid. 2006. An evaluation of different diameter diversity indices based on criteria related to forest management planning. Forest Ecology and Management 222 (2006) 17–28.

Maddala, GS. 1983. Limited dependent and qualitative variables in economics. Cambridge UK, Cambridge University Press. 231p.

Magurran, AE. 2004. Measuring biological diversity, Blackwell Publishing, 256p.

Nagarajan, L, M Smale, and P Glewwe. 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: 157-167.

Pingali, P. 2004. Agricultural diversification: Opportunities and constraints. Paper presented on FAO rice conference, 12-13 February 2004. Italy, Rome. 11p.

Pingali, P and M Rosegrant. 1995. Agricultural commercialization and diversification: Processes and policies. Food policy, 20(3):171-185.

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

Reardon, TJ. 1997, 'Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa', World Development, 25(5), 735–747.

Reardon, TJ, Berdegué, C.B. Barrett and K. Stamoulis. 2007. Household Income Diversification into Rural Nonfarm Activities" in S. Haggblade et al. (eds), Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World(pp. 115-140), Baltimore: Johns Hopkins University Press.

Rehima, Mussema, Belay Kassa, Dawit Alemu and S Rashid. 2013. Factors affecting farmers' crops diversification: Evidence from SNNPR, Ethiopia. *Int. J. of Agric. Sci. 3(6): 558-565.*

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

Sichoongwe, K, L Mapemba, D Ng'ong'ola, and G Tembo. 2014. The determinants and extent of crop diversificationamong smallholder farmers. A case study of Southern Province, Zambia. IFPRI working paper 05.

Timmer, CP. 2014. Food security in Asia and the Pacific: the rapidly changing role of rice. Asia and The Pacific Policy Studies, 1(1),73 – 90.

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

Yemane, T, A Zeratsion, K Afewerk and G.l Berhane. 2009. A Dynamic Sorghum (*Sorghum Bicolor* (L.) Moench diversity Management *in Situ* and Livelihood Resilience in South and Central Tigray Region, Ethiopia. (MEJS) 1 (2):67-94.

.