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RESEARCH NOTE

Measuring the Intensity of Factors Accelerating Crop Diversification using Heckman Two Stage Model: A Micro Level Study in Thoubal District of Manipur

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ABSTRACT

The study has used household data from Thoubal district of Manipur to identify the factors which influence household decision for crop diversification and further attempts to identify the factors influencing the extent to which this diversification takes place by adopting Heckman's two stage model. The results suggest that age of the household head, family size, farm size, dependency ratio, hired labour, access to fertiliser, irrigation facility, exposure to farming information, membership of co-operative society and distance to market are the significant drivers of household level crop diversification in the study area. Further the different drivers of crop diversification have different effects on propensity to diversify and intensity of diversification at household level.

Keywords: Intensity, Factors, Crop diversification, Propensity, Diversify

JEL: Q12, Q13, Q15

I

INTRODUCTION

Agriculture is the predominant activity for most rural households in Manipur. It is not only the main source of livelihood of the overwhelming majority, but also a tradition and a way of life that moulds the socio-economic status of the people. More than half (52.19 per cent) of the total working population of the state are directly dependent on agriculture for their livelihood (Government of Meghalaya, 2016). Several programmes like technology mission, horticulture mission, pulse mission etc., have been taken up to bring changes in the agricultural scenario of the state to generate self-sufficiency in fruits, vegetables and pulses. However, the performance of agriculture in the state mainly depends on timely rainfall and weather conditions where paddy remains the main staple food crop. But of the late, a silent revolution within crop production sector is taking place in the state, i.e., crop diversification which is generally viewed as a shift from growing traditionally less remunerative crops to more remunerative crops. The motive behind this silent revolution is livelihood sustainability through raising income levels, coping mechanism for risk aversion to act as an insurance against adverse climatic conditions, business oriented motives, employment generation and finally to feed the growing population. Tuteja

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(2011), has also stated that the future of agriculture and food sector will rest on crop diversification towards high value crops, higher value addition and moreover, food security, nutritional security, sustainability and profitability are the main focus of present and future agricultural development.

Agricultural diversification in North Eastern Region of India is affected by labour, occupation, irrigation, road density, market facilities significantly (Birthal *et al.*, 2006). Landholding size, age, educational level, farming experience of farmer, off farm income, distance of farm from main road, distance of farm from main market and farm machinery are also the factors affecting crop diversification (Ashfaq *et al.*, 2008). Apart from age and level of education of the household head, the extension contact, availability of tractor hiring services, returns from crop production and road conditions significantly determine the level of crop diversification (Ibrahim *et al.*, 2009). Among the agronomic factors like landholding size, quantities of fertiliser, tillage time and tillage (using a plough) and also distance to the market determine crop diversification significantly (Kiru *et al.*, 2014). The asset ownership, soil quality, agricultural extension and level of infrastructural development are the other significant drivers of crop diversification (Rehima *et al.*, 2015). The gender of household head, education, number of livestock units, access to irrigation, membership to a farmers' group, access to markets, farming experience, farms on flat terrains, farmer to farm extension, routine extension, agro ecological zone and household income are significant contributors to increasing crop diversification (Dube and Guveya, 2016).

Although, crop diversification is a novel concept for many rural communities in the country, only limited systematic studies has been conducted to date of which most of the studies are conducted at the national level, and a few state level studies exist which calls for assessing the nature and drivers of crop diversification at the household level. In view of this, the study aims to examine the rural households' decision to participate in crop diversification and investigate the factors influencing the participation by adopting Heckman's two stage model.

II

METHODOLOGY

Sampling and Data

The study adopted multistage random technique. In the first stage, the district was selected purposively since it has the highest cropping intensity (per cent) among the districts of the state based on 2013-14 crop area data. Secondly, from the two blocks, Kakching Community Development block was selected randomly. Thirdly, clusters of four villages were selected from the selected block randomly. Finally, a sample of 120 households was selected proportionate to the population size of the respective

villages. Data were then collected using a well structured schedule through personal interview method.

Hypotheses

The drive to diversify crop of a household may be related to the characteristics of the household head such as gender of household head, age and educational level. Both male as well as female headed households can decide to diversify or not, based on their choice, preference, and access to resources. Age, measured in years is one of the factors that do affect production decisions and it may have either positive or negative influence. Elderly farmers may look at farming as just a way of life while young farmers look at farming as a business opportunity for family sustenance (FAO, 2012). On the other hand elderly farmers might have more knowledge about farming and may choose to diversify. It is believed that higher the level of education a farmer attains, the more likely a farmer is able to make constructive decisions to accept new ideas and this enhances their willingness to diversify crop expecting positive relationship (Ibrahim *et al*., 2009). Further, it is hypothesised that larger the household size, the more likely that it will be able to diversify so as to increase its food production levels (Benin *et al*., 2004). The sign of coefficient for the variable land for farming is expected to vary. It may be due to the fact that crop diversification requires intensive labour, the small land holding households may opt to diversify crops due to sufficient availability of labour while it is difficult for large holding households to get sufficient labour. In another way, large holding households can grow different crops in one particular season where land is a constraint on small land holding size. The farming experience of the farmer is expected to have positive relationship since the experienced farmers have more knowledge about farming which may influence him/her to diversify crops. Dependency ratio is expected to have negative influence since more the dependency ratio, there will be less working members in the family which will not contribute in farming. A study (Culas, 2006) reveals that a greater use of both family and hired labour is associated with more diversification, i.e., positive relationship. It is also hypothesised that easy accessibility and availability of high-yielding varieties (HYV) or improved seeds may encourage farmers to diversify crops. Growing of different types of crops throughout the year requires regular irrigation facility, so households having access to regular irrigation water sources are expected to diversify crops. One of the potential constraints to farming households in the production of their crops is not having access to inputs such as fertilisers (Xu *et al*., 2009). Access to fertiliser may enable household to diversify crops. Households having exposure to farming information may gather more knowledge thereby encouraging them to diversify crops. Similarly, farmers who participate in training regularly also may have more advanced knowledge about farming and is expected to have positive influence. However, capital-constrained households' may not choose to diversify since the

capital requirement of high-value crops is high. Hence, household's access to institutional credit may positively influence the farmers' decisions to diversify crops. Farmers' co-operative society will serve as a platform to gather and exchange several information's about cultivation practices and marketing of crops. Therefore, the households who are members of co-operative society are expected to have positive relation with crop diversification. Studies on diversification also highlight the importance of proximity to main roads and markets for development of other farm enterprises (Benin *et al.,* 2004). In some instances, farmers located farther away from markets, do diversify in order to meet their subsistence needs (Kankwamba *et al.*, 2012). Hence, it is expected that the variable will negatively or positively associate with crop diversification.

Analytical Framework

The study has considered Simpson Index of Diversification (SID) to compute crop diversity of the households. A zero value of SID indicates specialisation and its value approaches one with increase in the extent of diversification. The study also used the index values to create a dummy variable portraying whether or not a household diversified their crop activities by computing the median (0.55) of the SID values. Crop diversification is observed if the household has SID $\geq$ 0.55 represented by dummy variable 1 while 0 for not diversified households.

$$SID = 1 - \sum_{i=1}^{n} P_i \quad \text{....(1)}$$

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \quad \text{....(2)}$$

where P_i = proportionate area of the i-th crop in the gross cropped area,

Ai = area under i-th crop,

$\sum_{i=1}^{n} A_i$ = Total cropped area. i = 1,2,3.....n (no. of crops).

Generally, studies on crop diversification require not only the determinants of factors influencing households' decision to diversify crops but also the intensity of crop diversification. Such consecutive decisions assume to follow the selectivity models (Bhatta and Arethun, 2013 and Rehima *et al.,* 2015) which occur in two steps. 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 crop diversification, i.e., deciding how many crops to cultivate. The model assumes that different sets of variables can be used in the two step estimation and it is important to note that atleast

one of the explanatory variable in the first equation is not included in the second step for identification (Maddala, 1992). To analyse such sequential decisions and mitigate selectivity bias, Heckman Two Stage model is adopted for the study; given not all households diversify crops despite having the option to do so.

In Stage 1, a probit model has been applied which estimates the probability of observing a positive outcome, i.e., to diversify crops. The dependent variable in this stage is a probabilistic binary choice of being a diversified household (1) or otherwise (0).

Selection equation: Decision to diversify crops

$$D_i^* = \gamma_1 + \gamma_2 X_{1i} + e_{1i} \quad \text{....(3)}$$

where,
D_i^* = latent variable that denotes binary censoring,
γ_1 and γ_2 = parameters,
X_{1i} = vector of variables that affect diversification decision,
e_{1i} = error term,
D_i = binary variable (1 if crop diversification is observed, 0 otherwise).

$$D_i = \begin{cases} 1 & ; D_i^* > 0 \\ 0 & ; otherwise \end{cases} \quad \text{....(4)}$$

The marginal effect at the mean for the Probit model is calculated as the estimated co-efficients does not quantify the influence of the independent variables on the probability that the dependent variable takes on the value one. While in Ordinary Least Square (OLS) regression, the marginal effects are the same as the slope coefficients due to linear relationship and do not vary depending on the values of the other variables.

In Stage 2, OLS technique has been used to estimate the level of crop diversification which is conditional on observing positive values. The dependent variable in this stage is continuous (SID) and the variable gender of the head of the household is not included for identification as most of the household heads are males.

Output equation: Intensity of crop diversification

$$\ln\_ SID_i = \beta_1 + \beta_2 X_{2i} + e_{2i} \quad \text{....(5)}$$

where,

ln_SID_i = observable random variable,
β_1 and β_2 = parameters,
X_{2i} = vector of variables that explain the levels of diversification, and
e_{2i} = error term.
It is assumed that the random disturbances of the two equations are distributed as

$$\begin{bmatrix} e_{1i} \\ e_{2i} \end{bmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix} \begin{pmatrix} 1 & \rho \\ \rho & \sigma^2 \end{pmatrix}\right] \quad \text{....(6)}$$

A selectivity problem arises when $\ln\_SID_i$ is observed only when $Di = 1$ and $\rho \neq 0$. To control or correct for potential bias emerging from sample selectivity, the second stage regression includes Inverse Mills Ratio (IMR) denoted by λ, estimated from the first stage regression, as one of the explanatory variables.

The new regression equation based on conditional mean of $\ln\_SID_i$ given that it is observed is then given by:

$$E\left[\ln\_ SID_i \middle| D_i > 0\right] = \beta_1 + \beta_2 X_{2i} + \beta_\lambda \lambda_i \quad \text{....(7)}$$

$$\lambda_i = \frac{\phi(\gamma_1 + \gamma_2 X_{1i})}{\Phi(\gamma_1 + \gamma_2 X_{1i})} \quad \text{....(8)}$$

where, λ = *Inverse Mill's Ratio*; $\varphi(\cdot)$ is the standard normal probability density function and $\Phi(\cdot)$ is the cumulative density function of the standard normal random variable.

Adding a random disturbance yields (selectivity corrected model):

$$\ln\_ SID_i = \beta_1 + \beta_2 X_{2i} + \beta_\lambda \lambda_i + e_{3i} \quad \text{....(9)}$$

III

RESULTS AND DISCUSSION

Charactersitics of the Households

Table 1 presents the variables used in the Heckman Two Stage Model. Since, the state is patriarchial society, most of the (97 per cent) the sampled household heads were males unless the male counterpart has expired. On an average, the household head's age was 51 years while the average family size of the household was 5 numbers. About 87 per cent of the household heads were educated. The households had an average of 1.17 ha farmland to grow different crops. The average farming experience of the cultivators of the households was about 18.5 years. About 3 persons

in the households were non-working. On an average about 2 man-days was engaged in growing different crops other than cereal crops. Access to fertiliser, high yielding variety (HYV) or improved seed and irrigation were considered to be an important factor for crop production as well as to alleviate food shortage in the household. On an average, about 59 per cent of the households reported access to fertiliser during the *rabi* season. About 88 per cent and 76 per cent of the households reported availability of HYV or improved seed and irrigation facility, respectively, in the study area. Exposure to farming information and participation in training are also beneficial to gain information on technology, market and practical know-how that helps farmers to diversify crop. However, 80 per cent of the households' reported that they have access to farming information and about 45 per cent attended training in relation to farming. The study observed that few of the households had access to loan: only 15 per cent households availed cash credit for cropping. Membership to co-operative society is important to gain idea on different farming operations and platform for exchange of knowledge and strength that helps to diversify crop. But only about 21 per cent of the households were members of co-operative society. The average distance of nearest market from homestead was 11.11 km in the study area.

TABLE 1. DESCRIPTIVE STATISTICS OF VARIABLES USED IN HECKMAN TWO STAGE MODEL

Explanatory variables (Xi) (1)	Type (2)	Measurement (3)	Frequency/ mean (4)	Expected sign (5)
Gender_Hh	Dummy	Gender of head of the household (male =1, female = 0)	116 (96.66)	+/-
Age_Hh	Continuous	Age of household head (years)	51.12	+/-
Family_size	Continuous	Persons in household (number)	5.40	+
Education_Hh	Dummy	Education of household head (literate = 1, 0 = otherwise)	104 (86.66)	+
Farm_size	Continuous	Land operated for farming by the household (ha)	1.17	+/-
Farming_experience	Continuous	Experience in farming of the cultivator (years)	18.53	+
Dependency _ratio	Continuous	Non-working members/ Family size (Numbers)	2.80	-
Hired _labour	Continuous	Labour employed for wages in agricultural activity (man-days)	2.33	+
Fertiliser	Dummy	Access to fertiliser (Yes=1, 0 otherwise)	71 (59.16)	+
HYV_improved seed	Dummy	Availability of HYV or improved variety of seed (Yes =1, 0 otherwise)	106 (88.33)	+
Irrigation _facility	Dummy	Availability of irrigation (Yes =1, 0 otherwise)	91 (75.83)	+
Exposure_farming_ info	Dummy	Exposure to farming information (Yes =1, 0 =otherwise)	96 (80)	+
Training	Dummy	Attended training (Yes =1, 0 otherwise)	54 (45)	+
Credit	Dummy	Credit availed for cropping (Yes =1 or 0 = otherwise)	18 (15)	+
Member_co-operative	Dummy	Member of co-operative society (Yes =1 or 0 = otherwise)	25 (20.83)	+
Market_Distance	Continuous	Distance from homestead to nearest market (km)	11.11	+

Figures in parentheses are percentage to the total.

Empirical Results

The results of Heckman Two Stage Model, i.e, estimates of Probit and OLS are presented in Tables 2 and 3. While estimating the model, several mis-specification problems such as non-normality of residuals, multicollinearity, omitted variables and wrong functional form were taken into account (Gujarati and Sangeetha, 2007). The Jarque-bera normality test indicated that the residuals were normally distributed. According to Variance Inflation Factors (VIF), which all were less than 10, indicated that there was no multicollinearity among the explanatory variables. Selection bias was tested by including the Inverse Mills Ratio (IMR), which was not significant suggesting that selection bias is not a big problem in the estimation of output equation.

Decision to Diversify

The Probit estimates of household's decision to diversify crops are presented in Table 2. In line with the expectations, the co-efficient of farm size was found to be significantly negative indicating that the probability of crop diversification decreased by about 14 per cent with increase in farm size. This result is supported by Rehima *et al*. (2015). It may be due to the fact that large land holders were more secured in terms of income. Contrary to expectation, the co-efficient of dependency ratio was

TABLE 2. PROBIT ESTIMATES OF HOUSEHOLDS' DECISION TO DIVERSIFY CROPS (STAGE-1)

Variables	Co-efficient	Std.error	P- value	Marginal effect
(1)	(2)	(3)	(4)	(5)
Gender_Hh	0.15	1.20	0.90	0.059
Age_Hh	− 0.05	0.04	0.18	− 0.021
Family_size	− 0.57	0.41	0.16	− 0.226
Education_Hh	0.18	0.74	0.81	0.071
Farm_size	− 1.86	0.59	0.00***	− 0.142
Farming_experience	− 0.01	0.04	0.83	− 0.003
Dependency _ratio	0.83	0.45	0.06*	0.329
Hired _labour	1.14	0.47	0.02**	0.453
Fertiliser	1.76	0.47	0.00***	0.607
HYV_improved seed	1.16	0.90	0.20	0.386
Irrigation _facility	1.78	0.66	0.00***	0.559
Exposure_farming_info	1.85	0.76	0.01**	0.555
Training	− 0.31	0.55	0.57	0.123
Credit	1.19	0.84	0.15	0.427
Member_co-operative	0.92	0.78	0.24	0.347
Market_Distance	0.12	0.07	0.09*	0.049
Const	− 3.73	2.66	0.16	
Total observations: 120				
Censored observations: 59				
Uncensored observations: 61				

***, ** and * denote that statistically significant at 1, 5 and 10 per cent level, respectively.

positive and significant. Having more number of non-working members in the family may generate the need of more income which may influence the households to diversify crops. The coefficient of number of man-days engaged in agricultural activity had a positive and significant as expected. With more number of hired labour, the probability of crop diversification increased by about 45 per cent. Access to fertiliser affected positively and significantly the household's decision to diversify crops indicating that the probability of crop diversification increased by about 60 per cent for those households having access to fertiliser, probably because fertiliser is one of the important inputs for crop production. Irrigation facility appears as a significant determinant for crop diversification decision and the households having regular irrigation facility are more likely to diversify crop (P = 0.55). Kumar and Gupta (2015) also found a positive relationship between access to irrigation and crop diversification. The exposure to farming information affected the level of crop diversification positively and significantly. Households who have exposure to farming information are more likely to diversify crops by 55 per cent. Similar finding was observed by Dube and Guveya (2016). The distance to the nearest market from homestead is an indicator of access to market. The study indicated that the distance to market significantly and positively affected crop diversification and the households which are near to market are 4 per cent more likely to diversify crops since it provides better opportunity to the households to market their farm produce. The finding is consistent with the findings of Benin *et al.* (2004) and Kiru *et al.* (2014). The effect of other variables, viz., gender of household head, age of household head, family size, education of household head, farming experience, availability of HYV, training, access to credit and membership of co-operative society were found to be non-significant while deciding to diversify crops.

Extent of Diversification

Table 3 presents the result of the regression model with Simpson Index value as the dependent variable. Age of the household head had significantly negative relationship with crop diversification, although the variable does not influence in deciding to diversify crops in the stage 1, indicating that increase in the age of the household head was associated with the decrease in diversification level by 0.6 per cent. The farm size had also significantly negative relationship with diversification. It not only influenced the households' decision to diversify but also determines diversification level. About 8 per cent reduction in crop diversity was registered with the increase in farm size. In line with expectations, the co-efficient of family size was positively significant in this stage although it was not significant in deciding to diversify crops and the level of diversification will increase by about 0.5 per cent with the increase in family size. Dependency ratio and hired labour were no longer significant although they were significant in deciding to diversify crops. Access to fertiliser not only influence household’s decision to diversify crops but also

determines the level of diversification positively and significantly as expected. Households who had access to fertiliser increased their level of diversification by 10 per cent. Similar result was also reported by De and Chattopdhay (2010). Existence of irrigation facility not only influences in deciding to diversify crops but also determine the level of diversification positively and significantly by about 12 per cent. Exposure to farming information in this stage also positively and significantly affected level of diversification. It implies that households who had access to farming information increased their level of diversification by 15 per cent indicating that farming information may decrease the uncertainty of the households associated with crop production. Households' membership to co-operative society was not significant in the stage-1 but in stage-2, it is positively significant indicating level of crop diversification increases by about 6 per cent for those households who are members of co-operative society. Conley and Udry (2010) also found that membership to a farmers group or co-operative society positively and significantly influences crop diversification. The distance to nearest market also influenced in deciding to diversify crops and the level of diversification increased by about 0.6 per cent.

TABLE 3. OLS ESTIMATES OF HOUSEHOLDS' EXTENT OF CROP DIVERSIFICATION (STAGE-2)

Variables	Co-efficient	Std.error	P- value
(1)	(2)	(3)	(4)
Age_Hh	− 0.01	0.00	0.05**
Family_size	0.01	0.02	0.82
Education_Hh	− 0.03	0.05	0.51
Farm_size	− 0.08	0.03	0.01**
Farming_experience	0.00	0.00	0.20
Dependency _ratio	0.02	0.02	0.42
Hired _labour	0.02	0.03	0.52
Fertiliser	0.10	0.06	0.07*
HYV_improved seed	0.07	0.06	0.26
Irrigation _facility	0.13	0.07	0.08*
Exposure_farming_info	0.15	0.07	0.03**
Training	− 0.02	0.03	0.59
Credit	0.03	0.03	0.34
Member_co-operative	0.07	0.03	0.03**
Market_Distance	0.01	0.00	0.06*
Lambda (IMR)	0.07	0.06	0.21
Const	− 0.76	0.19	0.00***
Total observations: 120			
Censored observations: 59			
Uncensored observations: 61			

***, ** and * denote that statistically significant at 1, 5 and 10 per cent level, respectively.

IV

CONCLUSION

Crop diversification is considered to maximise the resource use efficiency through multi-dimensional use of limited land, time, input and intensive use of family labour to maximise the profit for the rural farm households in order to improve their

economic status. The study found that crop diversification has been adopted by about 50 per cent of the households in the study area. It also identified the factors that drive households' decision to diversify crops and the level of crop diversification stimulated by the decision to diversify. The result also indicates that the different drivers of crop diversification have different effects on propensity to diversify and intensity of diversification at household level. It can also be concluded that there are still numerous challenges like lack of irrigation facility, labour shortage, inadequate availability of inputs etc. which will prompt the households to practice crop diversification in the study area. Moreover, extension services also need to be strengthened which can play a proactive role in introducing and dessiminating new technology.

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REFERENCES

Ashfaq, M.; S. Hassan, Z.M. Naseer, A. Baig and J. Asma (2008), "Factors Affecting Farm Diversification in Rice-Wheat", *Pakistan Journal of Agricultural Sciences*, Vol.45, No.3, pp.45-47.

Benin, S.M.; Gebremedhin B. Smale, J. Pender and S. Ehui (2004), *The Determinants of Cereal Crop Diversity on Farms in the Ethiopian Highlands*, Contributed paper for the 25th International Conference of Agricultural Economists, Durban, South Africa.

Bhatta, B.P. and T. Arethun (2013), "Barriers to Rural Households' Participation in Low Skilled Off Farm Labour Markets: Theory and Empirical Results from Northern Ethiopia", *Springer Plus*, Vol.2, No.97, pp.1-7.

Birthal, P.S.; A.K. Jha, P.K. Joshi and D.K. Singh (2006), "Agricultural Diversification in North Eastern Region of India: Implications for Growth and Equity", *Indian Journal of Agricultural Economics*, Vol.61, No.3, July-September, pp. 328-340.

Conley, T.G. and C.R. Udry (2010), "Learning about a New Technology: Pineapple in Ghana", *The American Economic Review*, Vol.100, No.1, pp.35-69.

Culas, R.J. (2006), "Causes of Farm Diversification Over Time: An Australian Perspective on an Eastern Norway Model", *Australian Farm Business Management Journal*, Vol.3, No.1, pp.1-9.

De, U.K. and M. Chattopadhay (2010), "Crop Diversification by Poor Peasants and Role of Infrastructure: Evidence from West Bengal", *Journal of Development and Agricultural Economics*, Vol.2, pp.340-350.

Dube, L. and E. Guveya (2016), "Factors Influencing Smallholder Crop Diversification: A Case Study of Manicaland and Masvingo Provinces in Zimbabwe", *International Journal of Regional Development*, Vol.3, No.2, pp.1-25.

Food and Agriculture Organization of the United Nations (FAO) (2012), *The Farmer's Forum Youth Session, Facilitating Access of Rural Youth to Agricultural Activities*, Rome.

Government of Manipur (2016), *Economic Survey of Manipur, 2015-16*, Directorate of Economics and Statistics, Lamphelpat.

Gujarati, D.N. and Sangeetha (2007), *Basic Econometrics*, Tata McGraw Hill Education Private Limited, New Delhi.

Ibrahim, H.; S.A. Rahman, E.E. Envulus and S.O. Oyewole (2009), "Income and Crop Diversification Among Farming Households in a Rural Area of North Central Nigeria", *Journal of Tropical Agriculture, Food, Environment and Extension*, Vol.8, No.2, pp.84-89.

Kankwamba, H., M.A.T.J. Mapila and K. Pauw (2012), *Determinants and Spatiotemporal Dimensions of Crop Diversification on Malawi*, Report prepared for Irish Aid, Malawi, International Food Policy Research Institute, Lilongwe. Malawi.

Kiru, S.; M. Lawrence, T. Gelson and N. Davies (2014), "The Determinants and Extent of Crop Diversification Among Smallholder Farmers: A Case Study of Southern Province Zambia", *Journal of Agricultural Science*, Vol.6, No.11, pp.150-159.

Kumar, S. and S. Gupta (2015), "Crop Diversification in India: Emerging Trends Determinants and Policy Implications", *International Journal of Current Research*, Vol. 7, No. 6, pp. 17188-17195.

Maddala, G.S. (1992), Introduction to Econometrics, Maxwell Macmillan, New York.

Rehima, M.; K. Belay, A. Dawit and S. Rashid (2015), "Determinants of Crop Diversification in Ethiopia: Evidence from Oromia Region", *Ethiopia Journal of Agriculture Science*, Vol.25, No.2, pp.65-76.

Tuteja, U. (2011), *Impact of the National Horticulture Mission (NHM) Scheme in Haryana*, Research Study No. 2011/03, Agricultural Economics Research Centre University of Delhi, Delhi.

Xu, Z.; Z. Guan, T.S. Jayne, and R. Black (2009). *Factors Influencing the Profitability of Fertilizer Use on Maize in Zambia*, Agricultural Consultative Forum, Lusaka, Zambia.