Journal of Agricultural Science; Vol. 6, No. 11; 2014
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

The Determinants and Extent of Crop Diversification Among Smallholder Farmers: A Case Study of Southern Province Zambia

Kiru Sichoongwe[1], Lawrence Mapemba[1], Gelson Tembo[2] & Davies Ng'ong'ola[1]

[1] Department of Agricultural and Applied Economics, Lilongwe University of Agricultural and Natural Resources, Lilongwe, Malawi

[2] Department of Agricultural Economics, The University of Zambia, Lusaka, Zambia

Correspondence: Kiru Sichoongwe, Department of Agricultural and Applied Economics, Lilongwe University of Agricultural and Natural Resources, P.O. Box 219, Lilongwe, Malawi. E-mail: kirusichoongwe@yahoo.com

Received: August 4, 2014 Accepted: August 25, 2014 Online Published: October 15, 2014

doi:10.5539/jas.v6n11p150 URL: http://dx.doi.org/10.5539/jas.v6n11p150

Abstract

Agriculture is vital to Zambia's economic development and is a mainstay for the livelihoods of a large proportion of the population. Agricultural production is mainly dependent on rain-fed hoe cultivation with maize as the principal staple food crop. About 18 percent of national maize production comes from Zambia's Southern province. In order to improve food security and minimize risks associated with heavy dependence on maize, the government of Zambia has been promoting crop diversification. This study analyzed the determinants of crop diversification as well as the factors influencing the extent of crop diversification by smallholder farmers in Southern province. The study used secondary data from the Central Statistical Office of Zambia. Results from a double-hurdle model analysis indicates that landholding size, fertilizer quantity, distance to market, and the type of tillage mechanism adopted have a strong influence on whether a farmer practices crop diversification. Our findings have important implications for policies that are designed to enhance crop diversification. In particular, our results suggest the need for government to consider undertaking policies that will enhance farmers' access to and control over land, that will provide farmers with improved access to agricultural implements like ploughs, and that will bring trading markets closer to farmers.

Keywords: Africa, maize, agricultural production

1. Introduction

Agriculture is a mainstay for the livelihoods of a large proportion of the population, is an important sector of Zambia's economy, and generates approximately 10 percent of the country's foreign exchange earnings (Chiwele, 2010). Collectively, crop agriculture, livestock, fisheries, and forestry account for about 20 percent of Zambia's Gross Domestic Product (GDP) and some 35 percent of earnings from non-traditional exports (ZDA, 2011). There is a consensus throughout literature that Zambia's large potential in agriculture has not yet been fully exploited. If well managed, the sector could contribute to substantial improvements in GDP, employment and tax revenue (FAO, 2005). It is in this regard that the Zambian government seeks to position the agricultural sector as one of the driving forces for the economic growth that is required to reduce poverty in the country (Gibson, 2005).

The agricultural sector in Zambia can be disaggregated into three categories; commercial, medium, and small scale. Commercial farmers cultivate areas of 20 hectares and above and are characterized by extensive mechanization, use of modern technology and management, and the rearing of exotic breeds of livestock. They also rely extensively on hired labor. However, nearly two-thirds of agricultural land and a large share of the national herd are held by smallholder farmers. The smallholder farmers are classified as either small-scale or medium-scale. The former cultivate land areas of less than 5 hectares, while medium-scale farmers are those who cultivate areas between 5 and 20 hectares. The majority of smallholder farmers rely on rain-fed hoe cultivation and the use of unpaid family labor and focus much of their crop production on maize. Their production also is characterized by the low use of modern inputs (Chomba, 2004).

Following several drought cycles in 2004 the Government of Zambia, through the Ministry of Agriculture and Co-operatives, introduced a programme to promote crop diversification. Crop diversification is defined as the growing of two or more crops on a piece of land by a farmer. The crops considered in the diversification programme included cassava, sweet potato, groundnut, sunflower, soya bean, among others. The programme was implemented with the objective of enhancing income levels, increasing the food security and nutrition status of farm households. It was anticipated that this, in turn, would enhance the living standards of farm households, while offering various cropping alternatives to farmers, as opposed to their relying on a single crop namely maize. Among the additional advantages to the farm household of growing more than one crop is an opportunity to mitigate risks associated with crop-specific failure due to adverse weather conditions, pests, and diseases (MACO, 2004).

The study objectives were threefold; a) to compare the demographic and socio-economic characteristics of farmers who produce a diversified crop mix with those who do not, b) to identify the major determinants that influence farmer's decisions to diversify in crop production, and c) to determine the factors influencing the extent of crop diversification by smallholder farmers.

2. Methodology

2.1 Theoretical Framework

The analytical model used for this study draws upon the theory of crop diversification among smallholder farmers. The fundamental assumption is that a farmer's decision on whether to diversify or not is based upon utility maximization (Rahm and Huffman, 1984). The expression $U(W_{ji}, L_{ji})$ is a non-observable underlying utility function, which ranks the preference of the i^{th} farmer for the j^{th} diversification process (j = 1, 0; where 1 = diversification and 0 = no diversification). Thus, the utility derived from crop diversification depends on W, which is a vector of farm- and farmer-specific attributes of the diversifier and L, which is a vector of the attributes associated with crop diversification. Thus the relation between the utility derivable from the j^{th} diversification process is postulated to be a function of the vector of observed farm, farmer, and crop diversification specific characteristics and a disturbance term having a zero mean:

$$U_{ji} = \alpha_j F_i(W_i L_i) + e_{ji} \qquad (j = 1,0) \tag{1}$$

Since the utilities U_{ji} are random, the i^{th} farmer will select the alternative j = 1 if $U_{li} > U_{0i}$ or if the non-observable (latent) random variable $y^* = U_{li} - U_{0i} > 0$. The probability that Y_i equals one (i.e., that the farmer practices crop diversification) is a function of the explanatory variables.

$$\begin{aligned} P_i &= P_r(Y_i = 1) = P_r(U_{1i} > U_{0i}) \\ &= P_r[\alpha_1 F_i(W_i, L_i) + e_{1i} > \alpha_0 F_i(W_i, L_i) + e_{0i} \\ &= P_r[e_{1i} - e_{0i} > F_i(W_i, L_i)(\alpha_1 - \alpha_0)] \\ &= P_r(\mu_i > -F_i(W_i, L_i)\beta) \\ &= F_i(X_i\beta) \end{aligned} \tag{2}$$

Where X is the n x k matrix of the explanatory variables and β is a k x 1 vector of parameters to be estimated, $Pr(.)$ is the probability function, μ_i is the random error term, and $F_i(X_i \beta)$ is the cumulative distribution function for μ_i evaluated at $X_i \beta$. The probability that a farmer will diversify in crop production is a function of the vector of explanatory variables and of the unknown parameters and error term. Equation (2) cannot be estimated directly without knowing the form of F. It is the distribution of μ_i that determines the distribution of F.

The functional form of F is specified with a Cragg's Tobit alternative or a double-hurdle model that is used to assess the determinants of crop diversification as well as the factors influencing the extent of crop diversification by smallholder farmers. Since some farmers did not diversify, the dependent variable has a lot of zeros, resulting in a corner-solution outcome. In such a situation, ordinary least square regression cannot be used since its outcome generates inconsistent and biased parameter estimates (Wan, 2012). Instead, the Tobit model can be used, but is very restrictive given that it simultaneously estimates the determinants of the probability of participation in crop diversification and the extent of diversification (Keelan et al., 2006).

Thus the double-hurdle model, which is a two-stage estimation approach, is used to overcome the Tobit restriction. The double-hurdle allows for separate estimation of the probability of participation and the extent of diversification (Cragg, 1971). The first stage of the model is a probit which allows for a separate estimation of the probability of participation in crop diversification, while the second stage examines the decision by the farmer with regard to the extent of crop diversification.

$$y_{i1}^{*} = w_i^{'}\alpha + v_i \quad \textit{Participation decision} \tag{3}$$

$$y_{i2}^{*} = x_i\beta + \mu_i \quad \textit{Extent decision} \tag{4}$$

$$y_i = x_i^{'}\beta + \mu_i \quad \textit{if } y_{i1}^{*} > 0 \textit{ and } y_{i2}^{*} > 0 \tag{5}$$

$$y_i = 0 \quad \textit{otherwise} \tag{6}$$

where y^*_{i1} is a latent variable describing the farmers decision to participate in crop diversification, y^*_{i2} is a latent variable describing the extent of crop diversification, y_i is the observed dependent variable (farmer's extent to diversify), w_i is a vector of variables explaining the participation decision, x_i is a vector of variables explaining the extent decision, and v_i and μ_i are the respective error terms assumed to be independent and distributed as $v_i \sim N(0,1)$ and $\mu_i \sim N(0,\sigma^2)$.

2.2 Specification of the Empirical Model

In measuring the extent of crop diversification, the Crop Diversification Index (CDI) was used. It is obtained by subtracting the Herfindahl index (HI) from one and has a direct relationship with diversification such that its zero value indicates specialization and a movement towards one shows an increase in the extent of crop diversification (Malik et al., 2002).

The CDI index is calculated as follows:

$$P_i = \frac{A_i}{\sum_{i=1}^{n} A_i} \tag{7}$$

Where, P_i = proportion of i th crop ; A_i = area under i th crop ; $\sum_{i=1}^{n} A_i$ = Total cropped area; $i = 1,2,3,...n$ (number of crops).

$$HI = \sum_{i=1}^{n} P_i^2 \quad \textit{Herfindahl index} \tag{8}$$

$$CDI = 1 - \sum_{i=1}^{n} P_i^2 = 1 - HI \quad \textit{Crop diversification index} \tag{9}$$

After that, the Cragg's Tobit alternative model is applied in estimating the determinants of the probability of a farmer practicing crop diversification and the determinants of the extent of crop diversification. The empirical model is specified as follows:

$$Stage 1 : P(D_i = 1|X_i) = w_i^{'}\alpha + v_i \quad \textit{Participation decision} \tag{10}$$

$$Stage 2 : Y_i = x_i^{'}\beta + \mu_i \quad \textit{Extent decision} \tag{11}$$

where D_i *takes* the value of 1 if a farmer practiced crop diversification; Y_i is the crop diversification index; w_i and x_i are the vectors of explanatory variables assumed to influence participation and extent of crop diversification, respectively, and are the same for both stages; α is the vector of coefficients associated with w_i in the first stage; and β is the vector of coefficients associated with x_i in the second stage.

2.3 Data and Sample Size

This study uses secondary data from the Central Statistical Office of Zambia (CSO).The CSO keeps information for most of the government departments of the country and conducts various research projects and surveys. The data for this study is based on the Crop Forecast Survey (CFS) that CSO conducts annually. This study uses cross sectional data for this survey for the year 2010. The purpose of the Crop Forecast Survey is to obtain data for the current agricultural season. The sample size for this study was 1,555 farmers.

2.4 Study Area

Zambia's Southern province has 11 districts (Choma, Gwembe, Itezhi tezhi, Kalomo, Kazungula, Livingstone, Mazabuka, Monze, Namwala and Siavonga), with Choma as its provincial capital (see Figure 1 below which shows the map for Southern Province) The Southern plateau is the center of the province. Southern province has the largest area of farmland of any Zambian province. This study focuses on Southern province as it is an important cropping region for Zambia with maize as the dominant crop grown for commercial and subsistence purposes. About 18 percent of national maize production comes from Southern province (Ngoma, 2008). Furthermore, this province is a drought-prone area and receives less than 1000 mm of rainfall annually on average. Most of the farmers in the region depend largely on rain-fed hoe cultivation with limited usage of modern inputs for crop production. The government of Zambia has been promoting crop diversification in the

Southern province to offer farmers alternative ways of generating income and to improve food security by encouraging farmers to grow other crops in addition to maize. However, few Southern province farmers practice crop diversification (Simwambana, 2007).

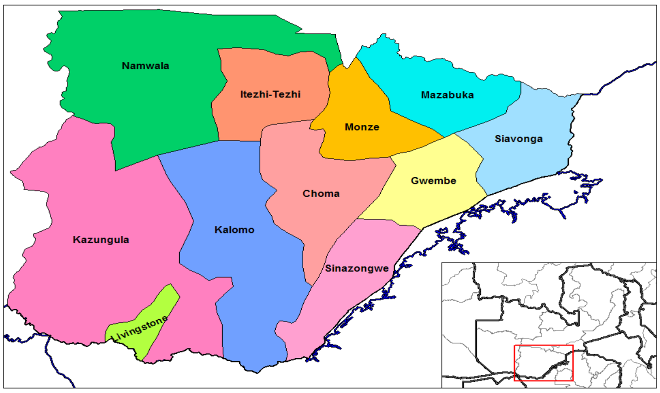

Figure 1. Zambia's Southern Province and its Districts

Data source: Central Statistical Office (2010).

2.5 Explanatory Variables for This Study

The following were expected to be the explanatory variables that determine crop diversification. The choice of these variables were based on a review of the literature on the topic and available data.

Gender of the Household Head: This is a dummy variable (a variable that takes the value 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome) that takes a value of 1 if the household head is male and 0 if female. Male as well as female headed households can choose to diversify or not based on their choice, preferences, and access to resources. Access to resources such as land is an important indicator of welfare among rural farm households and is especially critical for women with no use rights over a parcel of land. In Zambia and elsewhere in the region, women rarely own or have control over land and other assets (Shezongo, 2005). The inequality that exists in accessing and having resources between males and females determines how each household will respond to diversification. Thus the nature of the relationship of this variable is expected to vary.

Age of Household Head: is a continuous variable (a variable that takes on any value between its minimum value and its maximum value), and is one of the factors that affect production decisions on the part of the farmer. Elderly farmers look at farming as just a way of life, whereas young farmers may be more inclined to look at farming as a business opportunity in order to financially support their families. (FAO, 2012). In this study, it is expected that elderly farmers will not diversify, while younger farmers will seek to diversify. Therefore, it is expected that the variable will negatively associate with crop diversification.

Household Size: The size of the household is expected to be positively related with crop diversification. The larger the household size, the more likely that it will be able to diversify so as to increase its food production levels. Previous studies also support this hypothesis (Weiss & Briglauer, 2000; Benin et al., 2004).

Level of Education of Household Head: It is argued that educated people can understand agricultural instructions easily and are better able to apply skills imparted to them, unlike the uneducated. It is therefore expected that this variable will positively influence crop diversification. Previous findings by Ibrahim et al. (2009) indicated a positive relationship between education level and crop diversification.

Size of Landholding: This is a continuous variable (a variable that takes on any value between its minimum value and its maximum value) referring to the total area of arable farmland that a farmer owns. The amount of land a farmer has available plays a crucial role in determining how many crops a farmer can produce. Previous findings shows that crop diversification is associated with larger farms (Weiss & Briglauer, 2000; Benin et al., 2004). Therefore, it is expected that the variable will be positively associated with crop diversification.

Number of Fields or Farm Plots: This refers to the total number of fields or farm plots that a farmer has. This variable is continuous and it is expected to influence crop diversification in a positive way. According to Benin et al. (2004), the more farm plots a farmer has, the more he or she is able to diversify.

Hired Labour: In instances where farming households do not have enough domestic labour, hired labour is used as a supplement. In most cases, hired labour is sourced within the community, with wages being paid either in kind or in cash. Culas (n.d) found that a greater use of both family and hired labour is associated with increased crop diversification. As a result, this variable is expected to positively influence crop diversification.

Tillage Time: refers to the relative time period during which tillage is done, either during or before the rainy season. In Zambia, most farmers do their tillage during the rainy season due to the information they receive from the meteorological department on the availability of rainfall during that particular season. This is so because most farmers depend on rainfall for the success of their crops and would rather do their tillage during the rainy season so as to avoid the risk of crop failure (MACO, 2004). As a result, this variable is expected to positively influence crop diversification.

Plough Tillage: This refers to land tilling using a plough. The farmers who use a plough for tilling their land are more likely to diversify because ploughing involves a larger area to be brought into crop production. Studies indicate that there is a positive relationship between possession of farm implements and machinery by a farmer and diversification (Mesfin et al., 2011). As a result, it is expected that this variable will be positively associated with crop diversification.

Fertilizer Quantity: Fertilizer is an important input because without it, most crops in the Southern province do not produce well, expect for leguminous crops. As a result, fertilizer usage by farmers on their crops has continued being an essential practice to enhance their crop production. Kumar and Chattopadhyay (2010) show that the quantities of fertilizer obtained by farmers are positively associated with crop diversification. Thus, this variable is expected to positively influence crop diversification.

Distance to the Market: Distance to the market is an indicator of physical access to markets and organized trade, as well as proximity to economic resources. The nearer to the market the farmer is, the easier it becomes for him or her to diversify and to take produce to market. Studies on diversification highlight the importance of proximity to main roads and markets for development of other farm enterprises (Benin et al., 2004). However, in some instances, farmers located farther away from markets or main roads, are found to diversify in order to meet their broad subsistence and nutritional needs (Kankwamba et al., 2012). Hence, the nature of the association of this variable with crop diversification is indeterminate and could be negatively or positively associated.

3. Results and Discussions

This section presents and discusses the study findings. It starts with a discussion on the descriptive analysis to give a picture of the demographic and socio-economic characteristics of diversifier and non-diversifier farmers. Thereafter, the econometric analysis is described through the double-hurdle model which produced estimates on the determinants and the factors influencing the extent of crop diversification, thereby achieving the study objectives.

Table 1. Summary of demographic and socio-economic characteristics of farmers

	Diversifiers (%)	**Non-diversifiers (%)**	**p-value**
Male head of household	99.1	98.3	0.215
Attended school, head of household	49.1	50.2	0.690
Used plough for tillage	87.0	81.5	0.004***
Prepared land during (rather than before) rainy season	18.4	11.4	0.001***
Age of household head, yr	33.6	33.5	0.826
Household size	6.7	6.6	0.571
Distance to market, km	10.5	8.5	0.000***
Landholding size, ha	9.7	7.4	0.000***
Fields, number	4.0	3.9	0.042**
Fertilizer quantity used, kg	41.7	29.2	0.000***
Hired labourers, number	1.9	1.8	0.337
n	*1,073*	*482*	

Notes: ***, **, * significant at 1%, 5% and 10% respectively.

Source: Author's calculations based on CSO data (2010).

From Table 1, we find that the difference in the proportion of male-headed households between diversifiers and non-diversifiers was not statistically significant. Similarly, regarding education, there was no significant difference in the proportion of heads of farming households that had ever attended school between diversifiers and non-diversifiers. However, a positive association with crop diversification was found for whether a plough was used for tillage and whether tillage was done during, rather than before, the rainy season. A significantly larger proportion of diversifiers than non-diversifiers used a plough as their mode of tillage and did their tillage during the rainy season (although most farmers, both diversifiers than non-diversifiers prepared their land before the rainy season). There is a statistically significant difference between diversifiers and non-diversifiers in the mean distance to the market, size of land holding, number of fields, and fertilizer quantity used – diversifiers are located farther from the nearest market, have larger landholdings and more fields, and use more fertilizer. The study results are consistent with findings by Ibrahim et al. (2009) in which they reported a positive relationship between distance to the market and crop diversification. Also, consistent with findings by Ashfaq et al. (2008) in which they reported a positive relationship between size of land holding and crop diversification. Furthermore, Ndhlovu, 2010 reported a positive relationship between fertilizer quantity and crop diversification.

Results of the double-hurdle model (Table 2) shows that whether a farmer diversifies his or her crop production is dependent on the size of the landholding, the quantity of fertilizer used, distance from the farm to the market, and whether a plough is used for tillage. As for the extent of crop diversification, it is significantly influenced by fertilizer quantity used and distance to the market. For all significant determinants in both models, only direct positive relationships are observed. Significant negative relationships are only seen in the coefficients for some of the district dummy variables included in the model.

Table 2. Determinants and extent of crop diversification by smallholder farmers

Variable	Probability of engaging in crop diversification	Total crops grown, if engage in crop diversification
Gender (male = 1)	0.087	-0.009
Age of household head (in years)	0.034	-0.024
Household size (labor supply proxy)	-0.012	-0.000
Number of fields (ha)	-0.037	-0.003
Plough tillage (used a plough=1)	0.032***	0.036
Tillage time (during rainy season=1)	0.013	0.010
Size of land (ha)	0.011***	0.012
Distance to the main market (km)	0.027***	0.018***
Education (primary and above=1)	-0.139	-0.006
Hired labour (person-days)	-0.232	-0.038
Fertilizer quantity (kg)	0.099***	0.120**
District dummy variables (base = Sinazongwe)		
Choma (1=yes)	0.213	-0.089***
Gwembe (1=yes)	0.022	-0.031
Itezhi_tezhi (1=yes)	0.954***	0.058
Kalomo (1=yes)	0.599***	-0.002***
Kazungula (1=yes)	-0.406*	-0.142***
Livingstone (1=yes)	-0.786***	-0.153***
Mazabuka (1=yes)	-0.028	-0.038*
Monze (1=yes)	0.334*	-0.013**
Namwala (1=yes)	0.696***	0.036*
Siavonga (1=yes)	1.854	0.199
Number of observations	*1,555*	*1,073*
Wald (χ^2)		*374.0*
Prob > χ^2		*0.000*
Log Likelihood		*-182.1*

Notes: ***, **, * significant at 1%, 5% and 10% respectively.

Source: Author's calculations based on CSO data (2010).

We found no multicollinearity between any two or more explanatory variables in our study. When multicollinearity between explanatory variables is present, it is quite difficult to separate the independent effect of each parameter estimate on the dependent variable. If multicollinearity were found, we would have only limited confidence in any policy prescriptions based on these estimates. Furthermore, all the variables were tested for heteroskedasticity using the Breuch-Pagan test, and heteroskedasticity was not found. Heteroskedasticity is a phenomenon where the variance of the dependent variable is not the same for all independent observations or explanatory variables. If it is detected and is not taken care of, it leads to high standard errors and inconsistent sample estimates, which may lead to wrong hypothesis testing. In addition, a normality test was done using the kernel density plot of residuals. The kernel density plot provided a fairly smooth curve that closely matched the normal curve, indicating that the normality assumption was not violated. Also, the model specification was carried out using the Ramsey-reset test, and the results revealed that there were no omitted variables in the model.

3.1 Size of Landholding

The size of landholding increases the probability that a farmer will engage in crop diversification – there is a direct correlation between size of landholding and crop diversification. This means that an increase in the size of landholding will better enable a farmer to diversify. With the extra landholding, the farmer can decide how many crops to grow based on his or her production decisions. Increasing landholding is possible in the case of Zambia since of the 58 percent of the total land area suitable for arable farming, only 14 percent is being cultivated currently (MoFNP, 2006). Furthermore, study results are in agreement with findings by Ashfaq et al. (2008) in which they reported that the more access to additional land that a farmer has, the more he or she will be able to engage in crop diversification. Our results show that a one percent increase in the size of landholding of a farmer will increase the probability of a farmer producing more than one crop type by 1.1 percent.

3.2 Fertilizer Quantity

The results show that the quantity of fertilizer used is associated with both a higher probability of a farmer to participate in crop diversification and a greater extent in the diversification in crops grown. A one percent increase in fertilizer quantity used by a farmer will increase the probability of a farmer engaging in crop diversification by 9.9 percent. Furthermore, on average, a one percent increase in fertilizer quantity used will increase the number of crops a farmer will grow by 12 percent. The explanation for this is that increased quantities of fertilizer will provide additional incentive to farmers to diversify since most of the farmers lack fertilizer, resulting in more common crop failure and poor yields. Furthermore, fertilizer availability enables a farmer to enrich his or her land, which oftentimes is exhausted, thus making it suitable for expanding into the production of a greater variety of crops. Our results concur with findings from India (Kumar & Chattopadhyay, 2010; Singh et al., 2006) and from Malawi (Ndhlovu, 2010), in which it was found that the quantity of fertilizer a farmer uses is a significant determinant of crop diversification.

3.3 Plough Tillage

Plough tillage significantly determines the probability of a farmer to participate in crop diversification. The probability of a farmer who uses a plough engaging in crop diversification is 3.2 percent higher than for a farmer who does not use a plough. Thus a farmer who uses a plough will more likely diversify his or her crops because tillage using a plough reduces the drudgery of land preparation, reduces the requirement for manual labour, and enables the exploitation of a larger land area compared to using a hand hoe. These study results are in agreement with findings by Mesfin et al. (2011) in which they reported a positive relationship between possession of farm implements and machinery by a farmer and crop diversification.

3.4 Distance to Market

Distance to the market significantly determines both the probability of a farmer to participate in crop diversification and the extent of participation. The results entails that a one percent increase in distance to the market significantly increases the probability of a farmer's participation in crop diversification by 2.7 percent – that is, the further a farmer is from markets, the more likely he or she will diversify crop production. With regards to the extent of crop diversification, on average, a one percent increase in distance to the market will increase the number of crops a farmer will grow by 1.8 percent. The results imply that farming households located farther from the nearest market will diversify for food security due to higher transport costs in accessing market incentives to diversify for commercial purposes. A study by Ibrahim et al. (2009) shows that farming households that are farther away from the main markets face high costs of transportation to get their produce to the market and in such instances, they opt to grow crops only for subsistence purposes.

4. Conclusion and Policy Recommendations

Descriptive statistics were used to assess any differences in the demographic and socio-economic characteristics of farmers who have diversified their crop production from non-diversifiers. On average, diversifiers have larger landholdings and use more fertilizer than non-diversifiers. Additionally, a larger proportion of diversifiers used a plough as their mode of tillage than did non-diversifiers and were more likely to do their tillage during the rainy season. Results from the double-hurdle model indicates that the size of landholding, fertilizer quantity, distance to market, and tillage using a plough significantly influence farmers' probabilities to practice crop diversification. Furthermore, the extent of crop diversification is significantly influenced by the fertilizer quantity and distance to the market.

The study suggests a number of recommendations for promoting crop diversification among smallholder farmers. First; there is need for the government to consider undertaking policies that will improve farmers' access to and control over land. Since smallholder farmers are the ones who produce the bulk of the food, improved access to more land will enable farmers to grow more crops, thereby enhancing food and nutrition security status and helping in reducing poverty. In the case of Zambia, additional land allocation to some farmers is possible since the country has an enormous potential in agriculture with 58% of the total land area suitable for arable farming, yet only 14% is being cultivated currently (MoFNP, 2006). Study findings by Ashfaq et al. (2008) reveals that the more access to land a farmer has, the more he or she will be able to engage in crop diversification.

Secondly, as the majority of small-scale farmers are resource poor, have low levels of agriculture production, and are usually food insecure, the government should expand implementation of its policies especially on mechanizing agriculture production through provision of farm equipment and implements. In order to achieve this, there is a strategy in place of encouraging the involvement of the private sector in the provision of such services (MoFNP, 2006). However, the policy has not been implemented (Xu, 2009). As this study shows that farmers who till their land using a plough are able to diversify, it is important that the government implements the policy of providing smallholder farmers with agricultural implements like ploughs in order for them to diversify their crop production. One of the benefits of tilling land using a plough is that it significantly decreases the time required for farmers to accomplish farm tasks.

There is need for the government to consider promoting and supporting policies oriented towards bringing trading markets closer to the farmers given the fact that distance to the market is an indicator of market access, organized trade and proximity to economic resources. This can be done by investing in reliable and adequate market infrastructure thus fostering agricultural trade for farmers. In most cases, a lack of market infrastructure drives a wedge between the market price and the prices that farmers receive for their output, thus lowering the profits associated with crop production. Thus market infrastructure will improve farmers' access to markets, thereby increasing their earnings and improving their livelihoods. For example, a study by Kumar and Chattopadhyay (2010) reveals that policies towards the expansion of infrastructure like road network, marketing and storage facilities are important preconditions for the diversification of crops and are crucial in ensuring sustainable income and employment among farmers.

Acknowledgements

The authors would like to thank the International Food Policy Research Institute (IFPRI) -Malawi for financing this study. All errors and omissions remain the responsibility of the authors.

References

Ashfaq, M., Hassan, S., Naseer, Z. M., Baig, A., & Asma, J. (2008). Factors Affecting Farm Diversification In Rice-Wheat. *Pakistan Journal of Agricultural Sciences, 45*(3), 45-47.

Benin, S., Smale, M., Gebremedhin, B., Pender, J., & Ehui, S. (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.

Chiwele, D., Fowler, M., Humphrey, E., Hurrell, A., & Willis, J. (2010). *Evaluation of Budget Support in Zambia: Agriculture Case Study*. Oxford Policy Management, Zambia.

Chomba, G. N. (2004). *Factors affecting Smallholder Farmers Adoption of Soil and Water Conservation Practices in Zambia*. MSc dissertation, Department of Agricultural Economics, Michigan State University, USA.

Cragg, J. (1971). Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods. *Econometrica, 39*, 829-844. http://dx.doi.org/10.2307/1909582

CSO (Central Statistical Office). (2010). *Manual for Crop Forecast Survey for the 2009/2010 Agricultural Season*. Zambia.

Culas, R. J. (n.d.). Causes of Farm Diversification over time: An Australian Perspective on an Eastern Norway Model. *AFBM Journal, 3*(1).

FAO (Food and Agriculture Organization of the United Nations). (2005). *Improving Food Security in Vulnerable SADC Countries: Summary Final Report*.

FAO (Food and Agriculture Organization). (2012). *Sustainable Crop Production Intensification*. Twenty-third Session. Rome, Italy.

Gibson, D. (2005). *Conservation Farming: Answer to Drought, Expensive Fertilizer*. Lusaka, Zambia.

Ibrahim, H., Rahman, S. A., Envulus, E. E., & Oyewole, S. O. (2009). Income and crop diversification among farming households in a rural area of north central Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension,* 84-89.

Kankwamba, H., Mapila, A. T. J. M., & Pauw, K. (2012). *Determinants and spatiotemporal dimensions of crop diversification in Malawi*. Lilongwe: International Food Policy Research Institute.

Keelan, C. D., Henchion, M. M., & Newman, C. (2006). A Double Hurdle Model of Irish Households' Foodservice Expenditure Patterns. A paper prepared for presentation at the 98th EAAE Seminar, *Marketing Dynamics within the global Trading System: New perspectives*. Chania, Crete, Greece.

Kumar, U. D., & Chattopadhyay, M. (2010). Crop Diversification by Poor peasants and Role of Infrastructure: Evidence from West Bengal. *Journal of Development and Agricultural Economics, 2*(10), 340-350.

MACO (Ministry of Agriculture and Co-Operatives). (2004). *National Agricultural Policy for Zambia (2004-2015)*.

MACO (Ministry of Agriculture and Co-Operatives). (2004). *National Agricultural Policy for Zambia (2004-2015)*. Lusaka, Zambia.

Malik, D., & Singh, I. (2002). Crop Diversification-An Economic Analysis. *Indian Journal of Agricultural Research,* 61-64.

Mesfin, W., Fufa, B., & Jema, H. (2011). Pattern, Trend and Determinants of Crop Diversification: Empirical evidence from smallholders in Eastern Ethiopia. *Journal of Economics and Sustainable Development, 2*(8), 78-89.

MoFNP (Ministry of Finance and National Planning). (2006). *Fifth National Development Plan 2006-2010*. Government of the Republic of Zambia, Lusaka-Zambia.

Ndhlovu, D. (2010). *Determinants of Farm Household Cropland Allocation and Crop Diversification Decisions: The Role of Fertilizer Subsidies in Malawi*. Retrieved April 8, 2013, from http://brage.bibsys.no/umb/bitstream/URN:NBN:no-bibsys_brage_26310/3/2010-ndhlovu.pdf

Ngoma, J. (2008). *Effect of Climate Change on Maize Production in Zambia*. The Tema Institute, Norrköping, Sweden.

Rahm, M. R., & Huffman, W. E. (1984). The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables. *American Journal of Agricultural Economics, 66*, 405-413. http://dx.doi.org/10.2307/1240918

Shezongo, M. (2005). Women's property rights in Zambia. A paper presented to the Strategic Litigation Workshop held from 14-18 August 2005, Johannesburg, South Africa**.**

Simwambana, M. (2007). *A Study on Cassava Promotion in Zambia*. Prepared for The Task Force on Accelerated Cassava Utilization, ACF and ASP. Lusaka: ACF and ASP.

Singh, N. P., Kumar, R., & Singh, R. P. (2006). Diversification of Indian Agriculture: Composition, Determinants and Trade Implications. *Agricultural Economics Research Review, 19*, 23-36.

Thurlow, J., Benin, S., Diao, X., Kalinda, H., & Kalinda, T. (2008). Agricultural Growth and Investment Options for Poverty Reduction in Zambia. *IFPRI Discussion Paper 00791*. Washington, DC: International Food Policy Research Institute.

Wan, W., & Hu, W. (2012). At Home Seafood Consumption in Kentucky: A double-hurdle model approach. *Southern Agricultural Economics Association Annual Meeting*. Birmingham, AL.

Weiss, C. R., & Briglauer, W. (2000). Determinants and Dynamics of Farm Diversification. *Working paper EWP 0002*. Department of Food Economics and Consumption Studies, University of Keil, Germany.

Xu, Z., Guan, Z., Jayne, T. S., & Black, R. (2009). Factors Influencing the Profitability of Fertilizer Use on Maize in Zambia. *Policy Synthesis Food Security Research Project – Zambia*.

ZDA (Zambia Development Agency). (2011). *Agriculture, Livestock and Fisheries*. Agriculture Sector Profile, Zambia.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/3.0/).