Factors Influencing Smallholder Crop Diversification in Zambia and the Implications for Policy

by

Rhoda Mofya-Mukuka and Munguzwe Hichaambwa

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Indaba Agricultural Policy Research Institute (IAPRI)

Lusaka, Zambia
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The Indaba Agricultural Policy Research Institute is a non-profit company limited by guarantee and collaboratively works with public and private stakeholders. IAPRI exists to carry out agricultural policy research and outreach, serving the agricultural sector in Zambia, so as to contribute to sustainable pro-poor agricultural development.

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Any views expressed or remaining errors are solely the responsibility of the authors.

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EXECUTIVE SUMMARY

Background

Zambian policy recognizes that crop diversification is one of the key essentials for achieving food and nutrition security and ultimately agricultural transformation among smallholder farm households. Although crop diversification targets are prominent in almost all development objectives it appears difficult for the country to attain its desired level of diversification as most of the land remains typically mono-cropped with maize dominating agricultural production. The dominance of maize in Zambia’s agriculture systems appears to be a direct result of the country’s policy focus on promoting maize production since independence by consistently spending more than two thirds of the country’s public allocation to the agricultural sector on maize input and marketing subsidies.

The study investigates demographic, socioeconomic, institutional services and market access factors affecting smallholder crop diversification including the effect of Government’s Farmer Inputs Support Programme (FISP) and Government maize purchases through Food Reserve Agency (FRA). The main objective is to investigate the factors determining smallholder crop diversification and the implications on diversification related policies. The specific objectives are to:

i. Study the relationship between crop diversification and each of the demographic, socioeconomic factors for smallholder farm households;

ii. Examine how the demographic, socioeconomic factors influence the decision to diversify crop production among smallholder farm households; and

iii. Assess how FISP and FRA affect crop diversification at household level.

Data and Methods

The study uses the Simpson Index of Diversification (SID) as a measure of crop diversification and econometric methods for fractional response variables as developed by Papke and Wooldridge (1996). Two waves of nationally representative panel data on rural farm households in Zambia that were collected by the Indaba Agricultural Policy Research Institute (IAPRI), in collaboration with the Central Statistical Office (CSO), and the Ministry of Agriculture and Livestock (MAL) are used. The first wave is the 2012 Rural Agricultural Livelihoods Survey (RALS), which has 8,090 observations at household level and representing the 2010/11 agricultural season. The second wave of the RALS covers 7,934 households covering the 2013/14 agricultural season conducted in 2015.

Key Findings

1) Access to crop diversification related extension advice such as minimum tillage, crop rotations and mixed cropping has a positive significant effect on crop diversification. Access to such advice increases the probability for smallholder farm households to diversify their cropping by 1.7 percentage points all other factors kept constant. This has a direct bearing on the type of extension messages that MoA should promote in order to enhance smallholder crop diversification.

2) Both the value of productive assets at the beginning of the season and landholding size has significant positive effects on smallholder crop diversification. A one percent increase in the productive assets is associated with an increase in the SID of 0.6% all other factors
kept constant. This suggests that poor smallholder farm households need some form of support with working capital in order to increase their crop diversification.

3) Hours to the nearest urban center (with at least 100,000 inhabitants) has a significant positive overall effect on SID. This suggests that proximity to markets is an important factor in smallholder farm households’ decisions to diversify.

4) Weather conditions as reflected by long-term average rainfall conditions also affect crop diversification. Increasing the long-range average rainfall by 100 mm is associated with an increase in crop diversification of four percentage points all other factors held constant.

5) Finally, both government key policy instruments (FRA and FISP) are significantly and negatively associated with smallholder crop diversification. An increase in FRA community maize purchases of 10,000 MT is associated with a decrease in diversification of 3 percentage points all other factors held constant; a similar increase in fertilizer receipts under the traditional FISP as opposed to using the electronic voucher is associated with a decrease in diversification of 0.1 percentage points all other factors held constant. This suggests that FRA maize purchases have to reduce in order to promote smallholder crop diversification and that distribution of FISP inputs through the electronic voucher is a clear way forward for Zambian smallholder agriculture.

Conclusions and Policy Implications

First and foremost, the study has demonstrated that the key government policy instruments of FRA and FISP negatively affect crop diversification in addition to their many other effects in the smallholder agricultural value chains such as distorting input and output markets. This should be viewed together with the fact that the government continued spending on these programs deny resources for other key drivers of agricultural growth and tend to benefit mostly the small proportion of better off smallholder farmers. The findings of this study amplify previous IAPRI work including stakeholder consultations which have recommended a much reduced role of the government in maize purchases, perhaps only for purposing of maintaining strategic reserves and purchases from remote areas that cannot be reached by the private sector.

However, the government piloting of FISP input distribution through the electronic voucher need to be commended as this is expected to increase agricultural diversification, crowd-in private sector participation in input distribution and overall efficiency of input distribution. IAPRI is in the process of empirically assessing the impacts of the distribution of FISP inputs through the electronic voucher.

Second, the study shows that the role of extension in promoting productivity enhancing technologies including crop diversification is very important. Therefore there is need for the government and other concerned stakeholders to ensure that sufficient resources, both human and financial, are put in place to revitalize the extension system of the country. Not only should as many agricultural camps as possible be manned but also equip extension workers with transport and appropriate advice to disseminate to their smallholder farming clients. Key among the messages should be productivity enhancing technologies including climate smart agriculture and agricultural diversification.

Thirdly, the study has shown that crop diversification is positively influenced by asset endowments of smallholder farm households. This means that vulnerable but viable smallholder farm households need support with working capital to fulfil their crop diversification needs. A well-targeted FISP input distribution using the electronic voucher
would go a long way in contributing to this cause. Furthermore, the study and other IAPRI work has shown that increasing smallholder access to land would significantly increase crop diversification and commercialize which would significantly contribute to broad-based rural poverty reduction. Therefore, efforts targeted at increasing smallholder commercialization should include deliberate efforts to increase smallholder land access.

Fourthly, access to markets tends to positively influence crop diversification. This implies that deliberate efforts and resources need to be devoted to developing input, output, and food markets in remote areas of the country, especially where IAPRI work has over the years consistently demonstrated that a significant proportion of smallholder farm households are net buyers of even the staple food, maize.

Lastly, is that rainfall increases crop diversification. Rainfall is a natural phenomenon over which man has little control and therefore this finding suggests that investments in irrigation and water harvesting need to be promoted in drier southern parts of the country in addition to deliberate extension messages to enhance crop diversification.

All in all, the agricultural sector offers potential to contribute significantly to national GDP through producing a diversified range of products for the local and international markets. However, current and past agricultural development policies have inclined towards promoting maize production. If the government’s spending on agriculture is to yield meaningful results especially with regards to poverty reduction, Government needs to create an enabling environment in which alternative value chains to maize can flourish. It would include investments to:

i. Improve extension advice and services for these alternative production areas;
ii. Research and development to produce improved seeds and disease control systems;
iii. Help both the producers and the private sector to manage risk associated with prices, input supply systems, output markets and other environment factors; and
iv. Invest in the road, water, and electricity infrastructure to make these markets work.
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<th>Definition</th>
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<tbody>
<tr>
<td>APE</td>
<td>Average Partial Effect</td>
</tr>
<tr>
<td>AU</td>
<td>African Union in a reference?</td>
</tr>
<tr>
<td>CAADP</td>
<td>Comprehensive African Agriculture Programme</td>
</tr>
<tr>
<td>CDF</td>
<td>Cumulative Distribution Function</td>
</tr>
<tr>
<td>CFS</td>
<td>Crop Forecast Survey in ref?</td>
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<tr>
<td>CRE</td>
<td>Correlated Random Effects</td>
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<tr>
<td>CSO</td>
<td>Central Statistical Office</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<tr>
<td>FISP</td>
<td>Farmer Input Support Programme</td>
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<tr>
<td>FRA</td>
<td>Food Reserve Agency</td>
</tr>
<tr>
<td>FSRP</td>
<td>Food Security Research Project</td>
</tr>
<tr>
<td>FTAE</td>
<td>Full time adult equivalents</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>Ha</td>
<td>Hectare</td>
</tr>
<tr>
<td>HDDS</td>
<td>Household Dietary Diversity Score</td>
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<tr>
<td>IAPRI</td>
<td>Indaba Agricultural Policy Research Institute</td>
</tr>
<tr>
<td>MAL</td>
<td>Ministry of Agriculture and Livestock</td>
</tr>
<tr>
<td>MoA</td>
<td>Ministry of Agriculture</td>
</tr>
<tr>
<td>mm</td>
<td>millimeters</td>
</tr>
<tr>
<td>MT</td>
<td>Metric Tons</td>
</tr>
<tr>
<td>NDP</td>
<td>National Development Programme</td>
</tr>
<tr>
<td>QMLE</td>
<td>Quasi Maximum Likelihood Estimation</td>
</tr>
<tr>
<td>RALS</td>
<td>Rural Agricultural Livelihood Survey</td>
</tr>
<tr>
<td>SE</td>
<td>Robust Standard Error</td>
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<tr>
<td>SEAs</td>
<td>Standard Enumeration Areas</td>
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<tr>
<td>SID</td>
<td>Simpson Index of Diversification</td>
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</table>
1. INTRODUCTION

Household crop diversification is often viewed as key for achieving food and nutrition security as well as for mitigating the risk of crop failure and market uncertainties. According to Imbs and Wacziarg (2003) crop diversification is a strategy to stabilize, diversify, and enhance household farm income. It is mostly considered a risk management strategy of cultivating more than one crop. Not only has it the added advantage of mitigating price risk, but also reduces the risk of crop yield fluctuations.

Furthermore, there is strong evidence that diversification in agriculture has tremendous benefits on uplifting resource-poor smallholder farmers (Singh, Squire, and Strauss 1986). If well implemented, diversification can be used as a tool to improve household incomes, reduce malnutrition, alleviate poverty, and conserve water and soil (Joshi et al. 2004). According to Mofya-Mukuka and Hichaambwa (2015), a lack of agricultural diversification and, specifically, a focus on maize production limits the potential to use agriculture as a poverty reduction tool. As a low value cereal, maize production is more likely to benefit larger-scale farmers. Because the majority of Zambian farmers cultivate less than two hectares of land, maize production is unlikely to serve as a means out of poverty. Additionally, low crop diversification tends to limit the number of economic multiplier effects of agriculture, by limiting the scope and scale of agro-processing, intermediation/trading, and input supply.

Crop diversification can also improve food and nutritional diversity as it provides a broader choice in the production of a variety of crops in a given area and lessens the risk of crop failure. It also can offer comparatively higher net returns from crops, higher net returns per unit of labor, optimization of resource use, and higher land utilization. Therefore, a farmer’s decision to diversify is considered a major economic decision that has a strong bearing on the farmer’s income level and food security (Pope and Prescott 1980).

Zambian policy recognizes that crop diversification is essential for achieving food and nutrition security and, ultimately, agricultural transformation. Crop diversification targets are prominent in almost all development objectives. In the Comprehensive African Agriculture Development Plan (CAADP) for Zambia, a key objective is to increase sustainable crop production, productivity, and value addition for a diversified range of competitive crops apart from maize (MAL 2013). The recent Malabo declaration of the CAADP aims to increase resilience of the livelihoods and production systems to climate change and variability and other shocks (African Union 2016). Similarly the objectives of the five-year National Development Plans (Fifth NDP, Sixth NDP, and Revised-Sixth NDP) have placed emphasis on crop diversification.

However, it appears difficult for the country to attain its desired level of diversification as most of the land remains typically mono-cropped with maize dominating agricultural production. Despite year-to-year maize bumper harvests, Zambia’s exports from the agricultural sector have remained low with the sector contributing less than 10% to the national gross domestic product (GDP) (CSO 2014) despite employing more than 70% of the working-age population. Of the 13 million Zambians, 60% live in the rural areas and directly depend on agriculture for their incomes and food provisions. According to the CSO (2016),

1 Fifth National Development Plan (2006-2010) Sixth National Development Plan (2011-2015), Revised Sixth National Development Plan (2013-2016) of the Ministry of Finance and National Planning. The FNDP goal states that “To increase and diversify agriculture production and productivity so as to raise the share of its contribution to 20 percent of GDP.”
about 76% of the rural population is estimated to be poor, while national hunger rates are estimated to be 43%.

Currently 98% of the 1.5 million smallholder households cultivate maize, which occupies 54% of the 1.4 million hectares of land under crop production. The dominance of maize in Zambia’s agriculture systems appears to be a direct result of the country’s policy focus on promoting maize production since independence (Mofya-Mukuka and Hichaambwa 2015). The country spends over 60% of the annual public expenditure on agriculture on maize input and output subsidies (Hichaambwa, Chamberlin, and Kabwe 2015; Kuteya et al. 2016) through the Farmer Input Support Programme (FISP) which until recently have been focusing on maize and the Food Reserve Agency (FRA) respectively.

The study investigates two research hypotheses. The first is that the decision to diversify crop production among smallholder households in Zambia is influenced by a combination of demographic, socioeconomic, institutional services, and market access factors. Second, Government’s FISP and Government maize purchases through FRA negatively affect crop diversification among smallholder farm households. The main objective is to investigate the factors determining smallholder crop diversification and the implications on diversification related policies. The specific objectives of the study are the following:

i. Study the relationship between crop diversification and each of the demographic, socioeconomic factors for smallholder farm households;

ii. Examine how the demographic, socioeconomic factors influence the decision to diversify crop production among smallholder farm households; and

iii. Assess how FISP and FRA affect crop diversification at household level.

The rest of the paper is organized as follows: chapter two reviews smallholder agricultural diversification in Zambia while chapter three outlines the conceptual framework and estimation procedure for the study. Chapter four gives the data and methods. The results of the study are discussed in chapter five starting with analysis of bivariate relationships followed by econometric analysis including some simulations for policy. Chapter six concludes and gives insights into policy implications giving highlights on some pathways for crop diversification in Zambia.

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2 Distribution of FISP inputs through the electronic voucher piloted in the 2015/16 season in theory encourages farmers to acquire a diversity of inputs, not only maize seed and fertiliser
2. SMALLHOLDER AGRICULTURAL DIVERSIFICATION IN ZAMBIA

The average number of crops cultivated by smallholder farm households in Zambia is quite limited. About 80% of the smallholder farm households cultivate not more than three crops of which 18% cultivate only one crop, 32% two crops and 29% three crops as shown in Figure 1. Given that 89% of the households grow maize, it is highly likely that maize is the crop grown by those households who produce only one crop.

The level of crop diversification among smallholder farm households in Zambia has remained low, in fact, decreasing from their levels in 2004 according to estimates using nationally representative rural farm household data as shown in Figure 2. In 2015, Zambia’s level of crop diversification as measured by the Simpson Index of Diversification (SID) was estimated at 0.37, a slight decrease from 2012 estimate of 0.38. This falls slightly short of the 0.40 optimal SID required to reduce malnutrition in Zambia as reported by Mofya-Mukuka and Kuhlgatz (2015).

Figure 1. Percent Smallholder Farm Households Cultivating Number of Crops (1-9)

Source: CSO/MAL/IAPRI 2015.

Figure 2. Trends in SID among Smallholder Farmers in Zambia (2004-2015)

Dietary diversity is one of the measures used to indicate nutritional status of households. Given that most rural households depend on their own farm production for food consumption, low dietary diversity can be presumed to be a direct consequence of limited household crop diversification. We use Household Dietary Diversity Score (HDDS), which is a sum of the number of food groups consumed in the household or by an individual household member over a 24-hour recall period (FAO 2013) to assess the level of dietary diversity among smallholder farm households in Zambia. The food groups included were proposed by FANTA (Swindale and Bilinsky 2006). Analysis of the Rural Agricultural Livelihoods Survey (RALS) of 2015 data shows that 32% of the smallholder households in Zambia have a HDDS of between 0-4 while a further 58% have a HDDS of 5-8. Only 9% have HHDS exceeding 9 (Figure 3).

**Figure 3. Household Dietary Diversity Score**

<table>
<thead>
<tr>
<th>HDDS</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 4</td>
<td>32.5</td>
</tr>
<tr>
<td>5 to 8</td>
<td>58.1</td>
</tr>
<tr>
<td>9 to 12</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Source: CSO/MAL/IAPRI 2015.
3. CONCEPTUAL FRAMEWORK AND ESTIMATION PROCEDURE

3.1. Conceptual Framework

The household is the smallest unit in agricultural management where decisions on farm production are made and actions taken. Singh, Squire, and Strauss (1986) developed the agricultural household model to explain the fundamentals of smallholder households’ decision-making. This household model has been underpinning most such research work in the last three decades. According to Singh, Squire, and Strauss (1986) the need for decision-making is based on two theories: the consumer and the producer theory. In the case of agricultural smallholder households who entirely depend on their production for food needs as well as for income generation, their behavior can be understood by both the consumer and the producer theories.

Where a household makes decisions to maximize their utility and at the same time maximize their profits, Singh, Squire, and Strauss (1986) demonstrates that optimal household production can be determined independent of leisure and consumption choices. Given the maximum income level derived from profit-maximizing production, family labor allocation and commodity consumption decisions can be made. Assuming that the household is making a decision to diversify (A=1) or not (A=0), the utility function can be expressed as

\[ U = U(H_{ij}D_{ij}) \]

where \( H_{ij} \) represents the household characters while \( D_{ij} \) represents diversification-specific attributes. The utility function is non-observable and ranks the \( i^{th} \) household and the \( j^{th} \) diversification process as \( i \) or \( j = 1 \) or \( 0 \) where 1 is complete diversification and 0 is no diversification. In this case the utility maximization becomes a function of the observable households and diversification specific characteristics and the appropriate analytical framework is a recursive model with profit- and utility-maximizing components (Singh, Squire, and Strauss 1986).

Given that utilities are random, the household will select the alternative \( j = 1 \) if \( U_{it} > U_{o_t} \) or if the non-observable (latent) random variable \( y^* = U_{it} - U_{o_t} > 0 \). The probability that \( Y_t = 1 \) (i.e., that the farmer practices crop diversification) is a function of several explanatory variables.

It follows that a critical decision that a household makes is how to allocate the limited production resources such as land, labor, and capital. Economic theory of crop diversification suggests that farmers are more likely to diversify if they face a threat in crop production such as reductions in expected returns due to market and environmental factors, among others. According to Jill and Erin (2005) and Imbs and Wacziarg (2003), factors influence the households’ decision to diversify, which include:

1. environmental factors where substitution of one crop or mixed cropping/intercropping may be a useful tool to risk associated with bad weather, especially in drought-prone areas. Over the years, production of maize in the southern half of Zambia has become difficult and unprofitable as the region continues to record below average annual rainfall figures (Sichoongo 2014);
2. price related factors, which include input and output prices influenced by national, regional, or international trade policies, or other market factors that drive prices either way. When farmers diversify their production, they are able to turn to alternative commodities when prices of other commodities drop to unprofitable levels;
3. market factors associated with availability of input and output markets either at national, regional, or international levels. Farmers who are totally dependent on
export markets run a risk of changes in those markets, which could be due to policy, or political changes in those countries;

4. technological factors, which include production, storage, agro-processing, and distribution. Production technologies such as seeds and fertilizers become attractive for production if they result in higher yields; and

5. food and nutrition needs and preferences, which include food consumption patterns and preferences.

Diversifying from the monoculture of traditional staples can have important nutritional benefits for farmers. Evidence shows that when consumers’ income increase, there are noticeable changes in the patterns of food consumption where people shift from diets mainly composed of staples to animal products (meat, eggs, and dairy), fish, and fruits and vegetables (Delgado 2003). In the last decade, Zambia has recorded economic growth of around 7%, a growing middle class, and a gradual change in food consumption patterns.

SID, a widely used measure of the level of diversification in the context of crop production, is used as the dependent variable. SID is presented as:

\[
SID = 1 - \sum_{i=1}^{k} P_i^2
\]

\(P_i^2\) represents the proportionate share of the ith crop in the gross cropped area. The SID ranges from 0 to 1 such that 0 is a complete lack of diversification or complete specialization and 1 indicates complete diversification. Therefore if \(\sum_{i=1}^{k} P_i^2 = 1\) there will be complete specialization. A similar measure of diversification is the Herfindahl Index, which is an inverse of the SID. The Herfindahl Index has also been widely applied to crop diversification. We choose to use the SID to show that as the index increases the level of diversification also increases, unlike the Herfindahl Index that will show an inverse relationship. In addition, some researchers have used the count of crop types grown by households to show the levels of diversification. The SID has an advantage over this measure because it not only takes into account the count of crop types cultivated but also the share of land allocated to each crop type.

3.2. Estimation Procedure

Since the dependent variable, the SID, is a fraction varying from 0 to 1, we use econometric methods for fractional response variables as developed by Papke and Wooldridge (1996) who proposed direct models for the conditional mean of the fractional response that keep the predicted values in the 0 to 1 interval. They applied the method of quasi-maximum likelihood estimation (QMLE) to obtain robust estimators of the conditional mean parameters with satisfactory efficiency properties. Correlated random effects (CRE) were utilized in the analysis of the panel data in order to control for unobserved heterogeneity by including time averages of all the explanatory variables in the model. Using CRE we preferred the fractional probit over the logit as recommended by Papke and Wooldridge (2008).
4. DATA AND METHODS

This study uses two waves of nationally representative panel data on rural farm households in Zambia that were collected by the Indaba Agricultural Policy Research Institute (IAPRI), in collaboration with the Central Statistical Office (CSO), and the Ministry of Agriculture and Livestock (MAL). The first wave is the 2012 Rural Agricultural Livelihoods Survey (RALS), which has 8,090 observations at household level and representing the 2010/11 agricultural season. The second wave of the RALS covers 7,934 households covering the 2013/14 agricultural season conducted in 2015.

In total, 442 Standard Enumeration Areas (SEAs) were enumerated targeting 20 randomly selected households per SEA. Due to attrition between the two panel survey waves, attrition bias is a potential concern and we used the approach recommended by Wooldridge (2010) to test for attrition bias but fail to reject the null hypothesis of no attrition bias in all models (p>0.10) using ordinary least squares regression without CRE. Therefore, attrition bias was not an issue in the study.

The variables used in this analysis were classified into household demographic characteristics, farm assets, market accessibility, technological endowments, local rainfall conditions, and the local indicators of key governmental activity within the agricultural sector.

a) **Demographic Characteristics**: These included the sex, age, and educational level of household head and number of household full time adult equivalents (FTAE). The first three give an indication of the human capital endowment of the household through the head. Female-headed households in the rural parts of Zambia tend to face greater social barriers to income and asset accumulation than their male-headed counterparts (Farnworth, Akamandisa, and Hichaambwa 2011). While older household heads may be more experienced and achieve better farming outcomes, younger and more educated ones may be amenable to change away from the maize monoculture that has characterized Zambian agriculture since independence, adopt new farming ideas, and diversify away from maize. Some agricultural enterprises can be labor intensive and it is expected that households with more adult equivalents would be in a better position to meet this requirement.

b) **Farm Assets**: Wealth and differential access to capital are often-cited factors for farmers achieving differential farming outcomes (Carter 2000). We use farm size and the total value of productive assets (farm implements and livestock) owned in the year prior to the survey year to measure this factor.

c) **Technological Endowments**: This is captured through households having been exposed to crop diversification related extension messages. This gives the households the additional motivation to diversify.

d) **Market Access**: Access to agricultural input and output markets is very important in smallholder production and marketing and can largely influence decisions on what to produce. We measure market access as the number of hours to the nearest urban center (with at least 100,000 inhabitants) and distance to the nearest feeder road in kilometers.

e) **Weather Conditions**: Weather conditions, especially rainfall amounts, play a very important role in level of crop production and productivity in Zambia such that whether the country records a bumper harvest of its staple food crop maize depends

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3 SEAs are the lowest geographical sampling units used by CSO and were the primary sampling units. An SEA typically contains 100-200 households.
on this factor (Burke, Jayne, and Chapoto 2010). We used long range (25 years) average district seasonal rainfall obtained from the TAMSAT African Rainfall Climatology and Time-Series dataset (Maidment et al. 2014).

f) **Main Policy Environment:** The main government policy instruments in the agricultural sector are focused on maize input subsidies and maize market (price and quantities) subsidies. These public investments are likely to alter the incentives into crop diversification. The effects of these polices are measured as:

a) The previous season SEA total fertilizer received by farmers from traditional FISP in MT’000 as captured from the RALS of 2015, and

b) Lagged SEA maize purchases in MT’000 by FRA (from the 2010/11 season) from the RALS data.

We estimate using the household SID as the dependent variable first testing fixed effects and then a QMLE model to test for robustness of the results. The descriptive statistics of the sample household are presented in Table A1 in the Appendix.
5. RESULTS AND DISCUSSION

5.1. Analysis of Bivariate Relationships

In this section, we present an analysis of the relationship between the household SID on one hand and each of the explanatory variables on the other with the aim of comparing with the effects isolated from the econometric analysis controlling for other variables. We use the normalized cumulative distribution function (CDF) for categorical variables and the scatter plot with a best fitting graph for continuous ones to achieve this.

Starting with demographic characteristics Figures 4 and 5 show that:

1) The sex of the household head does not seem to affect the SID (Figure 4);
2) The age of the household head seems to have a weak decreasing effect on the SID (Figure 4);
3) The SID increases with increasing educational level of the household head up to about 9 or 10 years and then reduces drastically with increasing education thereafter (Figure 5); and
4) The SID seems to initially increase before levelling off with increasing household FTAE (Figure 5).

Figure 4. Distribution of SID by Sex and Age of Head

![Figure 4](image1.png)

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.

Figure 5. Distribution of SID by Education of Head and FTAE

![Figure 5](image2.png)

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.
Access to crop diversification related extension messages seems to positively affect the SID at the household level. Figure 6 clearly shows cumulative probability of households having access to this type of extension information above the higher levels of the SID.

Figure 7 shows that lagged productive assets have an increasing effect on crop diversification. In the case of landholding size, there is a general increase in diversification as it increases up to about 3 hectare (ha) after which it levels off (second graph of Figure 7).

Figure 6. CDF of SID by Access to Diversification Extension Advice

![Figure 6. CDF of SID by Access to Diversification Extension Advice](image)

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.

Figure 7. Distribution of Household SID by Lagged Productive Assets

![Figure 7. Distribution of Household SID by Lagged Productive Assets](image)

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.
Hours to the nearest urban center with at least 100,000 inhabitants are positively related to diversification at both household and SEA levels up to about eight hours after which diversification starts decreasing with increasing distance to the nearest urban center (Figure 8). The second graph of Figure 8 shows a general decline in household crop diversification with increasing distance to the nearest feeder road.

Crop diversification increases with increasing district rainfall long-range average rainfall as shown in Figure 9.

Figure 8. Distribution of SID by Market Accessibility

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.

Figure 9. Distribution of SID by Long Range Average District Seasonal Rainfall

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.
In the case of effect of key government policy instruments, Figure 10 shows a general decline in diversification with increasing lagged SEA FRA maize purchases and FISP district fertilizer receipts respectively. The level of decrease seems to be sharper for FRA maize purchases than for FISP fertilizer distribution.

5.2. Econometric Analysis

We start the econometric analysis by comparing results of fixed effects and QMLE with CRE models to gauge the robustness of the results. Two variables of interest, hours to the nearest urban center and district long range average seasonal rainfall, are excluded because their values are the same for both panel waves and drop out of the fixed effects model after time-demeaning. Nevertheless, Table 1 (columns 1 to 4) shows that apart from the sex of the household head and distance to the nearest feeder road—which show significant effects in the fixed effects and not the QMLE model—all variables showing significant effects do so in a similar manner in two models.

Both models show a significant positive effect of education of the household head and confirm the negative significant quadratic effect discerned from the bivariate analysis. Furthermore, both models show significant positive effect of receiving crop diversification related extension advice, value of productive assets and landholding size. The effects of FRA purchases and FISP fertilizer distribution are negative and significant in both models while their interaction effect is positive and significant in both models.

In columns 5 and 6 of Table 1, we present the average partial effects (APE) and robust standard errors (SE) estimated with the QMLE model. The model includes the quadratic function of the educational level of the household head and the hours to the nearest urban center as well as the interaction between FRA purchases and FISP fertilizer receipts. We, however, only present the overall effects of these variables in the table.

As seen in the bivariate analysis, the model results show no significant effect of the gender and age of the household head as well as full time adult equivalents on smallholder crop diversification. The educational level of the household head has a significant positive and significant negative quadratic effect as seen in Table 1. However, its overall effect is not significant (Table 1).
Table 1. Fixed Effects and QMLE with CRE Model Results

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<tbody>
<tr>
<td>Demographic characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Female headed household = 1</td>
<td>-0.0366*</td>
<td>0.020</td>
<td>-0.0840</td>
<td>0.067</td>
<td>-0.0307</td>
<td>0.025</td>
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<tr>
<td>Age of household head</td>
<td>-0.0013</td>
<td>0.001</td>
<td>-0.0032</td>
<td>0.003</td>
<td>-0.0012</td>
<td>0.001</td>
</tr>
<tr>
<td>Level of education head in years</td>
<td>0.0116***</td>
<td>0.004</td>
<td>0.0429***</td>
<td>0.007</td>
<td>0.0024</td>
<td>0.002</td>
</tr>
<tr>
<td>Educational years of head squared</td>
<td>-0.0008**</td>
<td>0.000</td>
<td>-0.0031***</td>
<td>0.000</td>
<td></td>
<td></td>
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<tr>
<td>Full time adult equivalents</td>
<td>0.0024</td>
<td>0.002</td>
<td>0.0066</td>
<td>0.006</td>
<td>0.0027</td>
<td>0.002</td>
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<tr>
<td>Technological endowments</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Received extension advice = 1</td>
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<td>0.006</td>
<td>0.0447**</td>
<td>0.020</td>
<td>0.0170**</td>
<td>0.007</td>
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<td>Farm assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Log productive assets</td>
<td>0.0067**</td>
<td>0.003</td>
<td>0.0163*</td>
<td>0.009</td>
<td>0.0062*</td>
<td>0.003</td>
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<tr>
<td>Landholding size (ha)</td>
<td>0.0025***</td>
<td>0.001</td>
<td>0.0064***</td>
<td>0.002</td>
<td>0.0024***</td>
<td>0.001</td>
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<tr>
<td>Market access</td>
<td></td>
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</tr>
<tr>
<td>Distance to the nearest feeder road</td>
<td>-0.0009**</td>
<td>0.000</td>
<td>-0.0024</td>
<td>0.002</td>
<td>-0.0009</td>
<td>0.001</td>
</tr>
<tr>
<td>Hours to nearest urban center</td>
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<td></td>
<td></td>
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<tr>
<td>Weather conditions</td>
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<tr>
<td>Long range average seasonal rainfall</td>
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<td></td>
<td></td>
<td></td>
<td>0.00004***</td>
<td>0.000</td>
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<tr>
<td>Key government policy instruments</td>
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<td></td>
<td></td>
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<tr>
<td>Lagged FRA maize purchases in MT'000</td>
<td>-0.0038***</td>
<td>0.001</td>
<td>-0.0098**</td>
<td>0.004</td>
<td>-0.0025*</td>
<td>0.001</td>
</tr>
<tr>
<td>Lagged FISP fertilizer in MT'000</td>
<td>-0.0001***</td>
<td>0.000</td>
<td>-0.0003***</td>
<td>0.000</td>
<td>-0.0001***</td>
<td>0.000</td>
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<tr>
<td>FRA by FISP interaction</td>
<td>0.0000***</td>
<td>0.000</td>
<td>0.0000**</td>
<td>0.000</td>
<td></td>
<td></td>
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<tr>
<td>Constant</td>
<td>0.3867***</td>
<td>0.052</td>
<td>-0.2926***</td>
<td>0.046</td>
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<tr>
<td>Observations</td>
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<td>14,208</td>
<td>14,208</td>
<td>14,208</td>
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<tr>
<td>R-squared</td>
<td>0.019</td>
<td></td>
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<td></td>
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<tr>
<td>Number of hhid</td>
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<td></td>
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</tbody>
</table>

* , ** and *** denote significance at 10%, 5% and 1% levels of probability respectively.

Access to crop diversification related extension advice such as minimum tillage, crop rotations, and mixed cropping has a positive significant effect on crop diversification. Access to such advice increases the probability for smallholder farm households to diversify their cropping by 1.7 percentage points all other factors kept constant. This has a direct bearing on the type of extension messages that the Ministry of Agriculture (MoA) should promote in order to enhance smallholder crop diversification. Similar results are found from a study by Sichoongo et al. (2014), which show that the type of tillage mechanism adopted have a strong influence on whether a farmer practices crop diversification.

With regard to farm assets, both the value of productive assets at the beginning of the season and landholding size have significant positive effects on smallholder crop diversification. A one
percent increase in the productive assets is associated with an increase in the SID of 0.6% all other factors kept constant. This suggests that poor smallholder farm households need some form of support with working capital in order to increase their crop diversification.

A one-hectare increase in smallholder farm size is associated with an increase in SID of 0.2 percentage points all other factors kept constant. The results are consistent with the findings of Turner (2014) who finds that in Mozambique, wealthier households with larger farms are more likely to diversify. Sichoongo et al. (2014) also find that size of farmholding to positively and significantly affect crop diversification. This suggests that increasing smallholder access to land should be part of measures aimed at increasing smallholder crop diversification, more especially that according to Hichaambwa and Jayne (2014) this will also increase smallholder commercialization and broad-based rural poverty reduction. Figure 11 shows the simulated impact of increasing smallholder farm size on household crop diversification. Using the dotted reference lines, we find that increasing farm size by 1 ha corresponds to an increase in household SID of 0.1 (dividing the change in Y by the change in X). Therefore, efforts that seek to increase smallholder access to land would go a long way in increasing crop diversification. This would have the added benefit of increasing smallholder agricultural sales sufficient to reduce the poverty rates, according to Hichaambwa and Jayne (2014), from 86% to 53% for smallholders with less than 1 ha farms.

On accessibility to markets, Table 1 (columns 5 and 6) shows that the distance to the nearest feeder road has no significant overall effect on crop diversification, but hours to the nearest urban center (with at least 100,000 inhabitants) has a significant positive overall effect on SID. This suggests that proximity to markets is an important factor in smallholder farm households’ decisions to diversify whether there is a feeder road nearby or not. Figure 12 shows that increasing the number of hours to the nearest urban center to about 16 hours corresponds to an increase in crop diversification.

Figure 11. Simulated Impact of Increasing Smallholder Farm Size on Household SID

![Figure 11. Simulated Impact of Increasing Smallholder Farm Size on Household SID](image)
Figure 12. Distribution of Market Accessibility and Predicted Mean Household SID

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.

Thereafter, no increase results with increasing distance until after 27 hours when crop diversification starts decreasing. This suggests that remote rural areas very far from urban centers face challenges in crop diversification due to input and output market constraints. These markets in remote areas need to be improved to enhance crop diversification.

Weather conditions as reflected by long-term average rainfall conditions also affect crop diversification. Table 1 (columns 5 and 6) shows a significant positive effect: increasing the long-range average rainfall by 100 mm is associated with an increase in crop diversification of four percentage points all other factors held constant.

Finally, both government key policy instruments (FRA and FISP) are significantly and negatively associated with smallholder crop diversification. An increase in FRA SEA maize purchases of 10,000 MT is associated with a decrease in diversification of three percentage points all other factors held constant; a similar increase in SEA fertilizer receipts under the traditional FISP as opposed to using the electronic voucher is associated with a decrease in diversification of 0.1 percentage points all other factors held constant. This suggests that FRA maize purchases have to reduce in order to promote smallholder crop diversification and that distribution of FISP inputs through the electronic voucher is a clear way forward for Zambian smallholder agriculture. Figure 13 shows that the negative effects on smallholder diversification of FRA maize start after community purchases average about 4,000 MT.
Figure 13. Distribution of FRA District Maize Purchases and Predicted Household SID

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.
6. CONCLUSIONS AND POLICY IMPLICATIONS

This study has examined factors influencing crop diversification at household level. The study is founded on a theoretical understanding that a farming household makes a decision to allocate its limited resources on the production of a diverse range of crops to achieve its investment objectives. The study has shown that crop diversification is a multi-dimensional issue that requires consideration of a number of factors that have implications for policy.

First and foremost, the study has demonstrated that the two key government policy instruments of FRA and FISP negatively affect crop diversification in addition to their many other effects in the smallholder agricultural value chains such as distorting input and output markets. This should be viewed together with the fact that the government's continued spending on these programs denies resources for key drivers of agricultural growth and tends to benefit mostly the small proportion of better off smallholder farmers. The findings of this study amplify previous IAPRI work including stakeholder consultations that have recommended reduced role of government in maize purchases, perhaps only for purposes of maintaining strategic reserves, and purchases from remote areas that cannot be reached by the private sector.

However, the government piloting of FISP input distribution through the electronic voucher needs to be commended, as this is expected to increase agricultural diversification, crowd-in private sector participation in input distribution, and overall efficiency of input distribution. IAPRI is in the process of empirically assessing the impacts of the distribution of FISP inputs through the electronic voucher.

Second, the study shows the importance of the role of extension in promoting productivity-enhancing technologies, including crop diversification. Therefore, there is need for Government and other concerned stakeholders to ensure that sufficient resources, both human and financial, are put in place to revitalize the extension system of the country. Not only should as many agricultural camps as possible be manned, but extension workers should have transport and they must also receive appropriate training to expertly advise and have educational material they can give their smallholder farming clients. Key among the messages should be productivity enhancing technologies including climate smart agriculture and agricultural diversification.

Thirdly, the study has shown that crop diversification is positively influenced by asset endowments of smallholder farm households. This means that vulnerable but viable smallholder farm households need support with working capital to fulfil their crop diversification needs. A well-targeted FISP input distribution using the electronic voucher would go a long way in contributing to this cause. Furthermore, this study and other IAPRI work have shown that increasing smallholder access to land would significantly increase crop diversification and commercialization, which would significantly contribute to broad-based rural poverty reduction. Therefore, efforts targeted at increasing smallholder commercialization ought to include deliberate efforts to increase smallholder land access.

Fourthly, access to markets tends to positively influence crop diversification. This implies that deliberate efforts and resources need to be devoted to developing input, output, and food markets in remote areas of the country, especially where IAPRI work has over the years consistently demonstrated that a significant proportion of smallholder farm households are net buyers of even the staple food, maize.

Finally, but importantly, is that rainfall increases crop diversification. Rainfall is a natural phenomenon over which man has little control. Therefore, this finding suggests that investments in irrigation need to be promoted in drier southern parts of the country in addition to deliberate extension messages to enhance crop diversification.
All in all, the agriculture sector offers potential to contribute significantly to national GDP through producing a diversified range of products for the local and international markets. However, current and past agricultural development policies have leaned towards promoting maize production. If the government’s spending on agriculture is to yield meaningful results, especially with regards to poverty reduction, Government needs to create an enabling environment in which alternative value chains to maize can flourish. It would include investments to:

1) Improve extension advice and services for these alternative production areas;
2) Research and development to produce improved seeds and disease control systems;
3) Help both the producers and the private sector to manage risk associated with prices, input supply systems, output markets and other environment factors; and
4) Invest in the road, water, and electricity infrastructure to make these markets work.

The agricultural growth being recorded is only being experienced by a minority of relatively better off smallholder farmers who are benefiting from the government support to the maize subsector. This means that this growth has not been broad based and cannot lead to significant rural poverty reduction outcomes. This calls for policy paradigm shift to investment areas that have higher potential pay offs as far as broad based smallholder income growth and poverty reduction is concerned.

Furthermore, there are other land-use investment areas among smallholder farmers with high export and poverty reduction potential such as horticulture. Recent evidence has shown that participating in horticultural markets would increase household income by 167% among smallholder households cultivating one hectare or less compared to 28 % for the same type of farmers growing maize, all other factors held constant. In particular gross margins of cabbage, tomato, and onion were found to be much higher than that of maize: 219 times for cabbage, 179 times for tomato, and 138 times for onions (Hichaambwa, Chamberlin, and Kabwe 2015).
## APPENDIX

### Table A1. Descriptive Statistics of Variables Used In the Study

<table>
<thead>
<tr>
<th>Variable</th>
<th>2010/11 season</th>
<th></th>
<th>2013/14 season</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Median</td>
<td>N</td>
</tr>
<tr>
<td>Simpson Index of Diversification</td>
<td>7,143</td>
<td>0.43</td>
<td>0.49</td>
<td>7,089</td>
</tr>
<tr>
<td>Proportion of female headed households</td>
<td>7,254</td>
<td>0.19</td>
<td>0.00</td>
<td>7,254</td>
</tr>
<tr>
<td>Average age of household head</td>
<td>7,251</td>
<td>46.20</td>
<td>44.00</td>
<td>7,254</td>
</tr>
<tr>
<td>Educational level of household head (years)</td>
<td>7,254</td>
<td>6.07</td>
<td>7.00</td>
<td>7,254</td>
</tr>
<tr>
<td>Household full time adult equivalents</td>
<td>7,254</td>
<td>2.85</td>
<td>2.27</td>
<td>7,254</td>
</tr>
<tr>
<td>Proportion receiving diversification extension</td>
<td>7,254</td>
<td>0.56</td>
<td>1.00</td>
<td>7,254</td>
</tr>
<tr>
<td>Value of productive assets at beginning of season</td>
<td>7,254</td>
<td>23.38</td>
<td>3.06</td>
<td>7,254</td>
</tr>
<tr>
<td>Land holding size (ha)</td>
<td>7,254</td>
<td>3.70</td>
<td>2.40</td>
<td>7,254</td>
</tr>
<tr>
<td>Hours to the nearest urban</td>
<td>7,254</td>
<td>11.10</td>
<td>11.02</td>
<td>7,254</td>
</tr>
<tr>
<td>Distance to the nearest feeder road</td>
<td>7,234</td>
<td>2.11</td>
<td>0.00</td>
<td>7,253</td>
</tr>
<tr>
<td>Long range district average seasonal rainfall</td>
<td>7,254</td>
<td>979.01</td>
<td>929.40</td>
<td>7,254</td>
</tr>
<tr>
<td>Lagged total SEA FRA maize purchases</td>
<td>7,254</td>
<td>2.72</td>
<td>1.76</td>
<td>7,254</td>
</tr>
<tr>
<td>Previous season SEA FISP fertilizer receipts</td>
<td>7,254</td>
<td>97.24</td>
<td>50.98</td>
<td>7,254</td>
</tr>
</tbody>
</table>

Source: CSO/MAL/IAPRI 2012, 2015 and authors’ computations.
REFERENCES


