Is Agricultural Extension a Determinant of Farm Diversification - Evidence from Kenya

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Abstract:

Farm diversification is a common coping strategy among smallholder farmers, especially in the developing countries. As a result, understanding the determinants of farm diversity is paramount. Access to extension has been found to be an important determinant of farm diversity through the technology adoption pathway. Despite farmers’ access to several extension services, no evidence exists on the effect of different extension services on farm diversity. This study evaluates the effect of extension services on farm diversity in Kenya. It uses a truncated Poisson model on a sample of 743 households who were selected using a multi stage sampling technique. The findings show that there are significant differences between the least and the most diversified farms. Furthermore, access to government, private and NGO extension services, alongside farmer demographic characteristics, increases farm diversity. This study therefore recommends for hiring, training and facilitating extension officers. In addition, the different extension services should be used as compliments and targeted to where their impact is highest.

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Abstract

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Key words: Diversification, Poisson, Extension, Multi stage, Determinants, Truncated.
1. Introduction

Smallholder agriculture dominates food production in developing countries. In Sub-Saharan Africa, it accounts for 80 percent of all the farms (AGRA, 2014). In East Africa, it accounts for 75 percent of all the agricultural output (Salami et al., 2010). According to Sichoongwe et al. (2014), smallholder agriculture is characterised by small parcels of cultivated land (less than 5 hectares) and low use of improved inputs, such as fertilizer, leading to low productivity. Due to the above characteristics, smallholder agriculture is vulnerable to production risks such as erratic weather and marketing risks such as fluctuating prices (Kahan, 2008).

To cope with the vulnerabilities, farmers have espoused farm diversification as a viable strategy. According to Kankwamba et al. (2012), farm diversification refers to the allocation of productive resources to a wider range of farm activities and can be categorized as horizontal or vertical. Horizontal farm diversification occurs when farmers add a new enterprise to existing ones, for example adding a new livestock enterprise to existing crop enterprises. Vertical farm diversification occurs when farmers add value to existing farm produce through processing, branding and merchandising.

Farm diversification is beneficial to farmers in several ways. Makate et al. (2016) demonstrate that farm diversification (especially crop diversification) enhances crop productivity, food and nutrition security in Zimbabwe. Studies by Demeke et al. (2017); Sibhatu et al. (2015) and Jones et al. (2014) have shown a positive linkage between farm diversity and dietary diversity. According to Barbieri et al. (2009), farm diversity increases income security through the sale of farm produce from the additional enterprises. Besides, farm diversity minimizes production and marketing risks by introducing tolerant crop and livestock enterprises and targeting multiple agricultural markets (Barbieri et al., 2009).
The importance of farm diversification has elicited interest among researchers, especially on its determinants. Several socio-economic and institutional factors have been found to significantly influence farm diversification including age, income, formal education, access to markets and access to extension services. Since the effect of extension services on farm diversification is the interest for this study, studies reviewed in the following paragraph analyse the linkage between extension and farm diversity.

According to Mussema et al. (2015), the significant association between access to extension services and farm diversification can be explained by the adoption of new agricultural technologies (vertical diversification). McCord et al. (2015) found that access to extension services increased crop diversification in Kenya by 0.27 units. In Ethiopia, Mussema et al. (2015) found that exposure to extension services increased the probability of farm diversification by 22 percent. According to Kankwamba et al. (2012), access to extension services increased the likelihood of farm diversification by 2 percent in Malawi. On the contrary, Abay et al. (2009) found a negative association between extension and farm diversity among barley farmers in Ethiopia as farmers specialized to cash crops.

According to Muyanga and Jayne (2008), extension can be categorized into government or private extension. Government extension services are provided by County governments (for the case of Kenya because agriculture is a devolved function). A main strength of government extension services is that they are affordable because the cost of accessing information is borne by the government. Farmers only incur opportunity cost of their time. Furthermore, government extension targets and reaches many beneficiaries and often promotes numerous enterprises concurrently (Muyanga and Jayne, 2008). However, government extension is limited by the bureaucratic processes involved in government procurement and inadequate financing.
Private extension services are either provided by commercial companies for profit or by non-commercial organizations for development, such as non-governmental organizations (NGOs) (Muyanga and Jayne, 2008). Although private extension is efficient and enjoys sufficient financial support (compared to government extension), it only covers limited geographic areas and reaches few farmers, especially those managing high value enterprises like dairy because they can afford the services. According to Muyanga and Jayne (2008), the short period of most extension programs by private providers (especially NGOs) as another drawback that limits their results achievement, considering that behaviour takes time to change.

Even though a wide range of literature points to the significant association between extension services and farm diversification, none of the previous studies control for the type of extension services accessed by farmers. Although several types of agricultural extension services exist including government, private and NGOs extension services, studies such as (McCord et al., 2015; Mussema et al., 2015; Kankwamba et al., 2012) use a single dummy variable to control for extension services, regardless of the type. As a result, the effect of different types of extension services on farm diversity is not well known. Consequently, there is need for empirical studies to address this gap.

This study attempts to bridge the existing information gap by evaluating the effect of agricultural extension on farm diversity in Kisii and Nyamira Counties, Kenya controlling for government, private and NGOs extension services. In addition, this study includes livestock diversity as an outcome variable following an observation that most of previous studies have only analysed the determinants of crop diversity as a proxy to farm diversity. This study seeks answers on whether the type of extension service significantly influences farm diversification among smallholder farmers.
The specific objectives of this study are: to characterise smallholder farmers based on their level of farm diversification and to evaluate the effect of agricultural extension on farm diversification. The rest of this paper is organized as follows: section two presents the analytical framework. The results are discussed in section three. Section four concludes and provides policy implications of the study.

2. Analytical framework

2.1 Theoretical framework

Farm decisions to diversify can be assumed to maximize utility and thus, can be modelled based on utility theories. According to Batz et al. (1999) and Debertin (2002), the two theories that have been widely used in analysing utility maximization decisions are random utility theory and expected utility theory. According to Polak and Liu, (2006), the random utility theory applies when the outcomes of a particular decision are known, such as for the case of revealed preferences whereas the expected utility theory is applied when decisions are made under uncertain circumstances and therefore, the outcome of the decisions are not known such as for the case of stated preferences.

In this study, farmers’ decision to diversify or otherwise are revealed because the number crop species they grow and livestock breeds they kept is known. This implies that the benefits of diversification are known, at least to the farmers. As a result, this study is founded on the random utility theory. Assuming that the utility of existing farm enterprises yields utility equivalent to \( U_a \) while the introduction of an additional enterprise or enterprises yields utility equivalent to \( U_b \), the \( i^{th} \) farmer will diversify \( (D) \) if the resulting utility is higher than the utility of not diversifying.
Following Greene (2012), the decision to diversify or otherwise can be specified as:

\[ D_i = \begin{cases} 
U_b > U_a, & \text{the farmer diversifies,} \\
U_b \leq U_a, & \text{the farmer does not diversify} 
\end{cases} \]  

(1)

Farm diversification is a two stage process that are successive. In the first stage, a farmer decides whether to diversify or otherwise. This stage can be modelled as the probability that the \(i^{th}\) farmer will diversify. Following Rahm and Huffman (1984), the probability that the \(i^{th}\) farmer will diversify can be specified as follows:

\[
P_r(D_i|I) = \left[ \alpha_b(X_i) + \varepsilon_{bi} > \alpha_a(X_i) + \varepsilon_{ai} \right] \\

P_r(D_i|I) = \left[ \varepsilon_{bi} > X_i(\alpha_a - \alpha_b) \right] \\

P_r(D_i|I) = \left[ \mu_i > X_i\beta \right] = F(X_i\beta) 
\]

(2)

Where, \(P_r(D_i|I)\) is the probability function, \(\mu_i = \varepsilon_{bi} - \varepsilon_{ai}\) is a random disturbance term with mean zero, \(\beta = \alpha_a - \alpha_b\) is a vector of parameters to be estimated, and \(F(X_i\beta)\) is the cumulative distribution function for \(\mu_i\) evaluated at \(X_i\beta\). Therefore, the probability of the \(i^{th}\) farmer diversifying is the probability that the utility of diversification is greater than the utility of failing to diversify.

The second stage in the diversification process involves a decision on the intensity of diversification (which refers to the number of enterprises a farmer manages). Although the utility of the \(i^{th}\) farmer from the \(j^{th}\) diversification decision is unobservable, it is influenced by observable socio-economic and institutional characteristics associated with the farmer.
Following Sichoongwe et al. (2014), the relationship between the intensity of farm diversification and farmer specific characteristics can be specified as follows:

\[U_{ij} = \alpha_j (X_i) + \varepsilon_{ij}\] .................................................................(3)

Where, \(U_{ij}\) is the unobservable random utility of the \(i^{th}\) farmer from the \(j^{th}\) diversification decision, \(X_i\) are the observable demographic characteristics associated with the \(i^{th}\) farmer, \(\alpha_j\) is a vector of parameters to be estimated and \(\varepsilon_{ij}\) is the error term.

2.2 Empirical model

Based on equation 2, the outcome variable is count data (integers) and takes a value greater than 1 if the \(i^{th}\) farmer decides to diversify and the value of 1 if a farmer manages a single enterprise (fails to diversify). In addition, the resulting data is non-negative and therefore it is truncated from below. According to Maddala (1983), non-negative data is negatively skewed implying that estimates of linear models are inefficient. The most appropriate techniques for analysing count data are Poisson model, negative binomial model, zero inflated Poisson model and zero inflated negative binomial regression model (Okello et al., 2011).

According to Yusuf et al. (2017), the zero inflated Poisson model and the zero inflated negative binomial model are applicable for a set of data that exhibits over-dispersion (or under-dispersion) due to the presence of zeros on the outcome variable. According to Lambert (1992), in zero inflated Poisson regression, the response (\(Y = Y_1, Y_2 \ldots Y_n\)) is independent and with probability \(p\), the only possible observation is 0, whereas with probability \((1 - p)\), a Poisson \((\lambda)\) random variable is observed in \(Y\).
The zero-inflated negative binomial regression model assumes that, there are two distinct data generation processes (Yusuf et al., 2017). Moreover, Yusuf et al. (2017) argue that for the $i^{th}$ observation with probability $\pi_i$, the only possible response of the first process is zero counts, and with probability of $1-\pi_i$, the response observed in the second process is governed by a negative binomial with mean $\lambda_i$.

The Poisson and the negative binomial regression models apply when the outcome variable is non-negative (Greene, 2008; Winkelmann and Zimmermann, 1995). According to Winkelmann and Zimmermann (1995), the merits of the Poisson regression model include that it captures the non-negative and discrete nature of count data sets, allows inference to be drawn based on probabilities of event occurrence. As well, the equi-dispersion assumption of the model accounts for heteroscedasticity and skewed nature of count data. Nonetheless, the Poisson model is constraint by the assumption that events occur randomly over time making the resulting estimates inefficient if this assumption is violated (Winkelmann and Zimmermann, 1995).

In cases where the outcome variable does not have zeros but exhibits over-dispersion (or under-dispersion), the Poisson estimator is inefficient (Rodríguez, 2013). According to Greene (2008), the negative binomial model is employed as a functional form that relaxes the equi-dispersion (or the under-dispersion assumption) restriction of the Poisson model. The outcome variable in this study did not have zeros and therefore the zero inflated Poisson and the zero inflated negative binomial were not appropriate. Moreover, tests for over-dispersion (and under-dispersion) showed that the assumptions were not violated (the mean to variance ratio was one and the Pearson statistic was insignificant) and therefore, the Poisson regression model was deemed appropriate.
Following Greene (2012), the Poisson model is specified such that each $y_i$ (farm diversity for this study) is drawn from a Poisson population with parameter $\lambda_i$, which is related to a set of regressors $X_i$ as shown below:

$$P_r(y_i|x_i) = \frac{e^{\beta (x') \beta}}{y_i!}, \ y_i=0, 1, 2,..., n \ ..........................................................(4)$$

Where, $P_r(y_i|x_i)$ is the probability that a farmer diversifies, $y_i=0, 1, 2... n$ are the number of farm enterprises per household and $x_i$ is a vector of predictor variables. Wooldridge (2002) shows that the expected number of enterprises is given by:

$$E(y_i|x_i) = var(y_i|x_i) = \lambda_i = exp(\alpha + X_i \beta) \ \text{for} \ i=0,1,2...,n \ ..........................................................(5)$$

Where, $E(y_i|x_i) = \lambda_i$ is the log-linear mean condition and $var(y_i|x_i) = \lambda_i$ is the equi-dispersion assumption. The log-linear function accounts for the non-negative restriction imposed by the Poisson model on the dependent variable (Winkelmann and Zimmermann, 1995). To measure farm diversity, a farmer was supposed to be managing at least a single enterprise and therefore not possible to capture zero diversity resulting to an outcome variable that was truncated from below. Consequently, equation 5 was estimated using the truncated Poisson regression model.

2.3 Measurement of variables

The dependent variable in this study was farm diversity (the number of agricultural enterprises a farmer managed). This study defines an agricultural enterprise as the crop species grown or livestock breed kept by the $i^{th}$ farmer. For example, maize and beans were considered as two enterprises whereas cattle and goats were considered as two enterprises. Farm diversity was captured using three proxies namely: crop diversity (number of crop species per household) and livestock diversity (number of livestock breeds per household). A total farm diversity
proxy (hereafter, farm diversity) was also used and computed as the sum of crop and livestock enterprises per household. According to Tung (2017) and Sibhatu et al. (2015), there are two main methods of measuring farm diversity namely: i) farm diversity as indices, and ii) farm diversity as count for existing crop and livestock enterprises per household.

The use of indices is limited to measuring crop diversity and requires that data on land share for each crop grown is available. The data available on land share for crops grown was not disaggregated by species for intercrops (which is the most common farming system) in Kisii and Nyamira Counties. As a result, it was not possible to compute an index using land shares. This study therefore adopted the second method of measuring farm diversity (count of crop and livestock enterprises per household).

The independent variable of interest in this study was the types of extension service accessed by farmers. Following Muyanga and Jayne (2008) and Schwartz (1994), the three types of extension services included in the econometric analyses were government extension, private extension and NGO extension services. To capture the access to any of the extension services, farmers were asked whether they accessed a particular service. The responses were coded 1 if a farmer accessed and 0 if otherwise. To test for consistency in the relationship between the dependent variable and access to extension, selected farmers’ demographic characteristics were also included as regressors in the empirical model as summarized in Table 1.
Table 1: Definition of the variables included in the Poisson model

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Variable description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop diversity</td>
<td>Total count of crop enterprises per household</td>
</tr>
<tr>
<td>Livestock diversity</td>
<td>Total count of livestock enterprises per household</td>
</tr>
<tr>
<td>Farm diversity</td>
<td>Crop diversity plus livestock diversity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Variable description</th>
<th>Hypothesized effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to extension</td>
<td>Dummy, 1=accessed; 0=otherwise</td>
<td>+</td>
</tr>
<tr>
<td>Farm size</td>
<td>Land available for cultivation, acres</td>
<td>±</td>
</tr>
<tr>
<td>Access to credit</td>
<td>Dummy, 1=accessed; 0=otherwise</td>
<td>-</td>
</tr>
<tr>
<td>Household size</td>
<td>Number of members in a household</td>
<td>+</td>
</tr>
<tr>
<td>Wealth</td>
<td>Wealth status of the household, index</td>
<td>+</td>
</tr>
<tr>
<td>Age</td>
<td>Age of the household head, years</td>
<td>-</td>
</tr>
<tr>
<td>Education</td>
<td>Education of the household head, years</td>
<td>-</td>
</tr>
<tr>
<td>Distance to market</td>
<td>Distance from the homestead (km)</td>
<td>-</td>
</tr>
</tbody>
</table>

Computation of the wealth index

Principal Component Analysis (PCA) was used to compute farmers’ wealth index. It was applied on data of selected households’ asset values. Before applying the PCA method, its suitability was assessed using the Kaiser-Meyer-Olkin Measure Sampling Adequacy (KMO-MSA) statistic. According to Gyau et al. (2016), a KMO-MSA value equal to or greater than 0.5 is acceptable for the use of PCA technique.

The wealth index was computed in two stages. In the first stage, the asset values were normalized (scaled to values between 0 – 1) by applying equation 5. Asset values may vary significantly, for example some farmers may have a tractor which is worth much more compared to farmers with simple implements such as hand hoes. The normalization process makes these scaled values comparable.
Following Langyintuo (2008), equation 5 was used to normalize the asset values.

\[
  i = \frac{x_l - x_{min}}{x_{max} - x_{min}} \tag{5}
\]

Where, \( i \) is the normalized asset value, \( x_l \) is the actual asset value and \( x_{min} \) and \( x_{max} \) are the minimum and maximum values of \( x \), respectively.

In the second stage, a weight for each asset was calculated and used as the criterion to select assets that significantly contributed to the wealth of farmers in Kisii and Nyamira Counties. Assets with weights equal to or greater than 0.5 were considered to significantly contribute to household wealth status (Gyau et al., 2016).

Following Langyintuo (2008), the wealth index was then computed as:

\[
  W_j = \sum_{i=1}^{k} b_i \frac{(a_{ij} - x_i)}{s_i} \tag{6}
\]

Where, \( W_j \) is the standardized wealth index for each household; \( b_i \) represents the weights assigned to the \( k^{th} \) asset; \( a_{ij} \) is the value of each household on each of the \( k \) asset; \( x_i \) is the mean of each of the \( k^{th} \) asset and \( s_i \) is the standard deviation.

2.4 Sampling and data collection procedure

This study uses cross sectional data from 743 households collected in Kisii and Nyamira Counties, Kenya. Stratified by groups, the households were selected using a two stage sampling procedure. In the first stage, 94 registered farmers’ groups (71 from Kisii and 23 from Nyamira) were listed to form the groups’ sampling frame. Considering the proportion of groups in each County, simple random sampling was used to select 48 groups (32 from Kisii and 16 from Nyamira Counties).
In the second stage, a complete list of farmers in each of the selected groups was used as the sampling frame. Similarly, simple random sampling was used to select 20 farmers per group. In cases where a group had 20 or less than 20 members, a group census was conducted. The survey was conducted between October – December 2016 and the responses were captured using a semi-structured questionnaire.

3. Results and discussion

Descriptive results

The characteristics of smallholder farmers in Kisii and Nyamira Counties are presented in Table 2, disaggregated by their level of farm diversification. The 25 percent least diversified (25%LD) farms were compared with the 25 percent most diversified (25%MD) farms. Consistent with Sibhatu et al. (2015), farm diversity was high (on average, 14 enterprises) and ranged from 9 enterprises for the least diversified farms to 19 enterprises for the most diversified farms (Table 2). The most diversified farms were characterised by older farmers (52.4 years) compared to the least diversified farms (49.33), probably because older farmers are endowed with more resources enabling them to invest in additional enterprises.

On average, farmers were middle aged (50.01 years) and their age ranged from 8.95 years for farmers managing the least diversified farms to 9.67 years for farmers managing the most diversified farms (Table 2). Similarly, significant differences (at the 1 percent level) were observed on farm size. On average, farmers in Kisii and Nyamira Counties owned small parcels of farms (0.9 acres). Farm sizes ranged from 0.75 acres for the least diversified farms to 1.02 acres for the most diversified farms (Table 2).
Table 2: Farmers’ characteristics in Kisii and Nyamira Counties Kenya, by level of farm diversification

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Full sample</th>
<th>(25%) LD</th>
<th>(25%) MD</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm diversity (number)(^a)</td>
<td>13.91 (0.14)</td>
<td>9.19 (0.14)</td>
<td>18.73 (0.13)</td>
<td>-9.54***</td>
</tr>
<tr>
<td>Age (years)(^a)</td>
<td>50.01 (0.44)</td>
<td>49.33 (0.97)</td>
<td>52.40 (0.77)</td>
<td>-3.07**</td>
</tr>
<tr>
<td>Education (years)(^a)</td>
<td>9.39 (0.11)</td>
<td>8.95 (0.20)</td>
<td>9.67 (0.23)</td>
<td>-0.72***</td>
</tr>
<tr>
<td>Farm size (acres)(^a)</td>
<td>0.90 (0.02)</td>
<td>0.75 (0.03)</td>
<td>1.02 (0.03)</td>
<td>-0.27***</td>
</tr>
<tr>
<td>Household size (number)(^a)</td>
<td>5.33 (0.06)</td>
<td>5.18 (0.11)</td>
<td>5.47 (0.12)</td>
<td>-0.29*</td>
</tr>
<tr>
<td>Distance to nearest market (km)(^a)</td>
<td>1.97 (0.10)</td>
<td>2.09 (0.17)</td>
<td>1.73 (0.12)</td>
<td>0.36</td>
</tr>
<tr>
<td>Wealth status (index)(^a)</td>
<td>0.02 (0.04)</td>
<td>-0.11 (0.05)</td>
<td>0.11 (0.08)</td>
<td>-0.22</td>
</tr>
<tr>
<td>Accessed credit (percent)(^b)</td>
<td>35.08</td>
<td>23.12</td>
<td>46.24</td>
<td>-23.12***</td>
</tr>
<tr>
<td>Accessed government extension (percent)(^b)</td>
<td>30.28</td>
<td>24.73</td>
<td>41.4</td>
<td>-16.67***</td>
</tr>
<tr>
<td>Accessed NGO extension (percent)(^b)</td>
<td>54.97</td>
<td>49.46</td>
<td>59.68</td>
<td>-10.22**</td>
</tr>
<tr>
<td>Accessed private extension (percent)(^b)</td>
<td>10.62</td>
<td>9.68</td>
<td>17.2</td>
<td>-7.52**</td>
</tr>
<tr>
<td>Observations</td>
<td>743</td>
<td>186</td>
<td>186</td>
<td></td>
</tr>
</tbody>
</table>

Notes: LD, least diversified; MD, most diversified; Standard errors in parentheses; mean differences significant at ***1%, **5%, *10% based on one-way ANOVA (\(^a\)) and Chi square (\(^b\)).

Source: Survey data, 2016

Overall, a significantly higher proportion of farmers managing the most diversified farms accessed agricultural extension compared to their counterparts managing the least diversified farms. Extension services by non-governmental organizations were the most common, accessed by 50 percent and 60 percent of farmers managing the least diversified and most diversified farms, respectively (Table 2). Government extension services were accessed by 30 percent of the farmers and significant differences (at the 1 percent level) were observed between the least diversified farms and the most diversified farms. Private extension services were the least accessed (only by 10.62 percent) and ranged from 9.68 percent for the least diversified farms to 17.2 percent for the most diversified farms (Table 2). This is probably because private extension is expensive compared to the government and NGO extension services.
A minority (35.08 percent) of farmers accessed credit (Table 2). Among the least diversified farms, 23.12 percent of farmers accessed credit whereas 46.24 percent of farmers managing the most diversified farms accessed credit and the difference was significant at the 5 percent level). This finding could possibly be explained by the fact that farmers managing the most diversified are more likely to be wealthier and therefore, can use part of their wealth such as land as collateral making them credit worth.

**Econometric results**

The Wald’s statistic was used to test for the models’ fit and was significant at the one percent level (Table 3). The Pearson statistic was used to test for over-dispersion (an assumption that renders the Poisson estimator inefficient if violated) was insignificant indicating that the assumption was not violated. The independent variables were tested for multicollinearity using the pairwise correlation and the variance inflation factor (VIF) tests. The correlation coefficients for the pairwise test were all less than 0.5 while the coefficients of the VIF test were all less than 10 confirming that the independent variables did not exhibit multicollinearity.

Results of the truncated Poisson regression model are presented in Table 3. As hypothesized, all the three types of extension services positively and significantly influence farm diversity. Government extension services positively influenced farm diversity and was significant at the 1 percent level (Table 3). Access to government extension increases the number of farm enterprises by 9 percent. Farmers who access government extension services are more likely to be aware of existing new technologies (enterprises). Moreover, access to government extension services improves farmers’ knowledge of managing the new enterprises. Thus, access to government extensions services increases the likelihood of adopting new technologies probably explaining the positive and significant association.
Although the effect of government extension services is consistent across the three measures of diversity (farm, crop and livestock diversity), the effect is larger on livestock diversity implying that an additional livestock enterprise leads to a higher marginal benefit compared to an additional crop enterprise. This is plausible considering that farmers in Kisii and Nyamira Counties keep an average of 2 livestock species compared to the 12 crop species they grow. Similar findings were reported by McCord et al. (2015) who found that access to extension services increased farm diversity. However, the study by McCord et al. (2015) did not control for the type of extension accessed by farmers.

**Table 3: The effect of extension type on farm diversity: Poisson regression results**

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Farm diversity</th>
<th>Crop diversity</th>
<th>Livestock diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Coefficient</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Government extension (dummy)</td>
<td>0.09*** (0.02)</td>
<td>0.08*** (0.02)</td>
<td>0.12*** (0.04)</td>
</tr>
<tr>
<td>Private extension (dummy)</td>
<td>0.08** (0.03)</td>
<td>0.09** (0.04)</td>
<td>0.01 (0.05)</td>
</tr>
<tr>
<td>NGO extension (dummy)</td>
<td>0.03 (0.02)</td>
<td>0.03 (0.02)</td>
<td>0.08** (0.04)</td>
</tr>
<tr>
<td>Constant</td>
<td>2.58*** (0.02)</td>
<td>2.41*** (0.02)</td>
<td>0.53*** (0.03)</td>
</tr>
<tr>
<td>Log pseudo likelihood</td>
<td>-2028.37</td>
<td>-1981.70</td>
<td>-974.85</td>
</tr>
<tr>
<td>Wald Chi²(3)</td>
<td>28.03***</td>
<td>22.47***</td>
<td>14.68***</td>
</tr>
<tr>
<td>Pearson goodness-of-fit</td>
<td>p value = 0.65</td>
<td>p value = 0.3</td>
<td>p value = 1.00</td>
</tr>
<tr>
<td>Pearson ratio test for over dispersion</td>
<td>0.98</td>
<td>1.02</td>
<td>0.26</td>
</tr>
<tr>
<td>Observations</td>
<td>743</td>
<td>743</td>
<td>743</td>
</tr>
</tbody>
</table>

Dependent variables: farm diversity, crop diversity and livestock diversity. Robust standard errors in parentheses: Denotes estimate is significant at ***1%, **5% and *10% levels, respectively.

*Source: Survey data, 2016*

Private extension increased farm diversity by 8 percent and was significant at the 5 percent level (Table 3). Similar to government extension, private extension increases farm diversity through awareness creation and adoption of new enterprises. The results also show that private extension had a positive and significant effect on crop diversity at the 5 percent level (Table 3). Although private extension is relatively expensive, a significant number of farmers in Kisii and Nyamira Counties grow high value crops such as tea and coffee implying that they can afford private extension services. However, the effect of private extension on livestock
diversity was insignificant, though the sign was positive. Most farmers in Kisii and Nyamira Counties keep small livestock such as poultry and goats which are associated with resource poor farmers. This could feasibly explain the insignificant association.

Access to extension services provided by NGOs positively increased livestock diversity by 4 percent and was significant at the 5 percent level (Table 3). According to Muyanga and Jayne (2008), most NGOs focus on subsistence enterprises such as poultry because they are associated with smallholder farmers who are resource poor. In Kisii and Nyamira Counties, small livestock such as poultry and goats are common among resource poor farmers probably explaining the positive association between access to NGOs extension services and livestock diversity. Contrary to expectation, the effect of NGO extension services on farm and crop diversity was insignificant, despite the sign being positive as hypothesized. Muyanga and Jayne (2008) argue that NGO extension services are based on short term programs limiting their impact. Moreover, NGOs promote a limited number of enterprises, often a single technology perhaps explaining the insignificant association.

In order to evaluate the independence of the association between access to extension and farm diversity, the regression model was re-estimated controlling for socioeconomic and institutional factors. The results are presented in Table 4. The results show that the effect of the three types of extension services on farm, crop and livestock diversity is consistent (the direction and significant levels do not change substantially from the findings in Table 3. However, the magnitude of the effect decreases once socioeconomic and institutional factors are controlled for (Table 4). For example, the unconditional results in Table 3 show that, government extension increases farm diversity by 9 percent. Results on the effect of extension on farm diversity, conditional on demographic characteristics (Table 4) show that government
extension increases farm diversity by 5.2 percent (3.8 percent decline). This shows that other factors (than access to extension) also influence farm diversity and should be controlled for to avoid over estimating the effect of agricultural extension.

Table 4: The effect of extension type on farm diversity controlling for socio-economic factors:
Poisson regression results

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Farm diversity</th>
<th>Crop diversity</th>
<th>Livestock diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government extension (dummy)</td>
<td>0.052***</td>
<td>0.047**</td>
<td>0.086**</td>
</tr>
<tr>
<td>Access to private extension (dummy)</td>
<td>0.058**</td>
<td>0.069**</td>
<td>-0.003</td>
</tr>
<tr>
<td>Access NGO extension (dummy)</td>
<td>0.012(0.019)</td>
<td>0.008(0.021)</td>
<td>0.064*</td>
</tr>
<tr>
<td>Age of household head (years)</td>
<td>0.023***</td>
<td>0.026***</td>
<td>0.005</td>
</tr>
<tr>
<td>Age squared</td>
<td>-0.000***</td>
<td>-0.000***</td>
<td>-0.000</td>
</tr>
<tr>
<td>Education of household head (years)</td>
<td>0.005(0.003)</td>
<td>0.005(0.004)</td>
<td>0.002</td>
</tr>
<tr>
<td>Farm size (acres)</td>
<td>0.137***</td>
<td>0.141***</td>
<td>0.168***</td>
</tr>
<tr>
<td>Accessed credit (dummy)</td>
<td>0.084***</td>
<td>0.094***</td>
<td>0.059</td>
</tr>
<tr>
<td>Household size (number)</td>
<td>0.003(0.006)</td>
<td>0.000(0.007)</td>
<td>0.033***</td>
</tr>
<tr>
<td>Wealth status (index)</td>
<td>0.013*(0.008)</td>
<td>0.010(0.009)</td>
<td>0.046***</td>
</tr>
<tr>
<td>Distance to village market (km)</td>
<td>0.005(0.004)</td>
<td>0.005(0.004)</td>
<td>0.009</td>
</tr>
<tr>
<td>Constant</td>
<td>1.766(0.158)</td>
<td>1.515***</td>
<td>0.035(0.312)</td>
</tr>
<tr>
<td>Deviance goodness of fit test</td>
<td>p-value=0.93</td>
<td>p-value=0.60</td>
<td>p-value=1.00</td>
</tr>
<tr>
<td>Pearson test for over dispersion</td>
<td>p-value=0.99</td>
<td>p-value=0.87</td>
<td>p-value=1.00</td>
</tr>
<tr>
<td>Wald test of model significance Chi2</td>
<td>126.10***</td>
<td>109.1</td>
<td>55.66***</td>
</tr>
<tr>
<td>Log pseudo likelihood</td>
<td>-1987.56</td>
<td>-1942.84</td>
<td>-967.9</td>
</tr>
<tr>
<td>Number of observations</td>
<td>743</td>
<td>743</td>
<td>743</td>
</tr>
</tbody>
</table>

Notes: Dependent variables are farm diversity, crop diversity and livestock. Robust standard errors in parentheses. ***, ** and * denotes significance at the 1%, 5% and 10% levels, respectively. Coefficient estimates are interpreted as % change.

Source: Survey data 2016.

Age influenced farm diversity and crop diversity positively and was significant at the one percent level (Table 4). A year’s increase in age of the household head increases farm diversity and crop diversity by 2.3 percent and 2.6 percent, respectively. However, the diversities increase at a decreasing rate as farmers’ age increase beyond a given point as shown by the
negative and significant effect of age squared (Table 4). A plausible explanation of this finding could be that older farmers are risk averse and therefore may use farm diversification as a strategy to minimize risks. Similar findings were reported by Abay et al. (2009). However, McNamara and Weiss (2005) found a negative association between age and farm diversity and argued that older farmers are likely to be wealthier and therefore risk loving.

Farm size had a positive and significant effect on farm, crop and livestock diversity at the one percent level (Table 4). An acres increase in farm size increases farm, crop and livestock diversity by 13.7 percent, 14.1 percent and 16.8 percent, respectively. According to McNamara and Weiss (2005), returns to land declines as farms expand up to a point beyond which, there is no incentive to expand existing activities. This generates a motivation for larger farms to diversify to new enterprises in order to obtain higher returns to land. Similar results were reported by Mussema et al. (2015) who found a positive association between farm size and the probability to diversify.

Access to credit was positively and significantly associated with farm and crop diversity at the one percent level (Table 4). Access to credit increases farm diversity and crop diversity by 8.4 percent and 9.4 percent, respectively. Additional enterprises require funds for purchasing inputs such as seed and labour. This finding therefore suggests that farmers who have access to credit can afford the extra cost associated with additional enterprises. Moreover, credit worth farmers are more likely to be wealthier implying that they are risk loving implying that they are more likely to adopt new technologies leading to higher farm diversification. This finding is consistent with Akaakohol and Aye (2014) who found that access to credit increases the likelihood of farm diversification.
Household size significantly influenced livestock diversity. A member’s increase in the household size increases livestock diversity by 3.3 percent (Table 4). Family labour predominate smallholder farming because it is affordable and flexible. Therefore, larger households can diversify to new livestock enterprises because of labour availability that is required in managing the additional enterprise, for instance feeding the animals. Contrary to expectation, the association between household size and crop diversity was insignificant. However, this observation is conceivable considering the current high level of crop diversity (of 12 crop enterprises) implying that returns to labour from an additional crop enterprise may not profitable.

The wealth status of a household had a positive effect on livestock diversity and was significant at the one percent level (Table 4). Being wealthier by a single unit increases livestock diversity by 4.6 percent signifying that wealthy farmers can afford to invest in new livestock enterprises. This is true especially in cases where farmers diversify to high value livestock (such as dairy cattle which is a common enterprise in Kisii and Nyamira Counties) that are costly to manage in terms of feed and veterinary services. This finding is in agreement with McCord et al. (2015) who argues that wealthier farmers can afford the extra cost of investing in additional enterprises leading to diversification. Moreover, wealthier farmers are risk loving and therefore are more likely to adopt new technologies leading to further diversification.
4. Conclusions and policy implications

This study evaluates the effect of extension services on farm diversification in Kisii and Nyamira Counties, Kenya. Cross sectional data from 743 households were analysed using the Poisson regression model. Descriptive results show that, the least diversified farms were significantly different from the most diversified farms. Econometric results show that access to extension services positively and significantly influence farm diversity. In conclusion, extension types are an important determinant of farm diversity.

To enhance the role of farm diversity as a coping mechanism among smallholder farmers, provision of extension services should be supported by policy. Given that government and private extension increases farm diversity by 5.2 and 5.8 percent, respectively, County governments should strengthen the provision of agricultural extension services through hiring competent extension officers and facilitating their operations. Since government, private and NGO extension services positively and significantly influences farm diversity suggests that extension policies should recognize the three types of extension services as complements, but not competitors. However, efforts should be put in focussing each of the extension services where it has most impact, NGOs extension should focus on livestock enterprises.

Despite the fact that NGO extension services were accessed by a majority (55 percent) of the farmers, it doesn’t influence farm and crop diversity. This finding has an important implication in that, programs by NGOs should be made longer term to allow time for behavioural change among target beneficiaries, a process that is not instant. Moreover, NGOs should promote multiple technologies concurrently and especially livestock to increase their impact.
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