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DETERMINANTS OF RURAL ON-FARM LIVELIHOODS DIVERSIFICATION: THE CASE OF INTSIKA YETHU LOCAL MUNICIPALITY, EASTERN CAPE, SOUTH AFRICA

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Abstract. The purpose of this paper was to identify the factors influencing households to diversify rural on-farm livelihood activities in Intsika Yethu Local Municipality. This is against a background where literature suggests low livelihoods diversification among rural households despite several claimed benefits of diversification. Cross-sectional survey data was randomly collected for this study in October 2018 from 190 rural households in Intsika Yethu Local Municipality. A structured questionnaire was used for that purpose. Ordered logistic regression analysis was used to analyze the data. The results showed that diversification of on-farm livelihood activities was influenced by the gender of household head, education level of household head, household size, and number of livestock units owned. To promote on-farm livelihoods diversification in rural areas, the paper suggests targeting gender differential, informal education and awareness, labor dynamics associated with on-farm livelihood activities and household livestock units.

Keywords: on-farm livelihood diversification, rural households, ordered logistic regression, Intsika Yethu Local Municipality

INTRODUCTION

Diversification of rural livelihoods has become a serious subject of conceptual and policy-based research because farming income has come under pressure due to population explosion (Munhenga, 2014). Livelihood diversification is defined by several scholars in different ways. It is the combination of activities and choices (Martin and Lorenzen, 2016) as a means of gaining a living (Loison, 2015); comprises the capabilities, assets, and activities required for a way of living (Dixon et al., 2004; Scoones, 2009). It is also defined as the course by which households establish progressively diverse livelihood portfolios (Niehof, 2004); adequate stocks and flows of cash to meet basic needs (Hilson, 2016), and a form of self-insurance (Barrett et al., 2001). Hilson (2016) defines livelihood diversification as a process by which household members construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standards of living. Furthermore, Brandth and Haugen (2011) refer to livelihood diversification as income strategies of rural individuals in which they increase their number of activities, regardless of the sector.

As most poor people live in rural areas of developing countries and depend on agriculture for their livelihood, the key to eradicating current suffering must lie in the creation of dynamic rural communities founded upon diversification of livelihood strategies (Dixon et al., 2004). Livelihood diversification is widely understood as a form of self-practice in which people exchange some foregone expected earnings for reduced income variability achieved by selecting a portfolio of assets and activities (Abdulai and CroleRees, 2001; Kim

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and Frongillo, 2007; Reardon et al., 2007). Due to high risks associated with the agricultural sector – such as drought and climate change – and poverty occurrences, poorer rural households with constraints of critical assets will be forced to engage in alternative incomes by participating in low-yield and sometimes risky non-farm activities (Reardon et al., 2007; Loison, 2015; Makita, 2016; Martin and Lorenzen, 2016). A study conducted in Ethiopia by Belay and Bewket (2015) notes that the complex inter-linkages of poverty, population growth and environmental degradation cause a decline in farm plot sizes leading to landlessness and expansion of farming to marginal lands. As a result, rural households are forced to engage in a number of livelihood strategies to mitigate the risk of poverty and malnutrition.

Different scholars mentioned several types of livelihood diversification activities. There are four distinct rural livelihood strategies, namely: on-farm agricultural production, unskilled on-farm or off-farm wage employment and non-farm earnings from trade, commerce and skilled employment. The fourth mixed strategy combines all the three strategies (Gebru and Beyene, 2012; Hilson, 2016; Sherren et al., 2016). The components of rural livelihood diversification are also classified by sector as farm or non-farm, by function as wage employment or self-employment or by location as on-farm or off-farm (Bowen and De Master, 2011; Loison, 2015). It is also argued that rural people establish their livelihoods via three main strategies: agricultural intensification; livelihood diversification; and migration (Barrett et al., 2001).

A comprehensive body of research revealed that rural households, especially in African countries, are resource-poor, which leads to vulnerable livelihoods (Devereux, 2001; Ellis and Freeman, 2004). Regasa (2016) pointed out that either lack of or limited access to crucial assets such as environmentally-friendly technologies or credit, and lack of arable land and finance is what forces rural households to engage in low-return strategies. Due to such a tight resource access, Murphy (1999), Barrett et al. (2001) and Stifel (2010) argued that the entry to more worthwhile farm and non-farm livelihood activities is stringent. Regasa (2016) reports that people negatively affected by such constraints in rural areas are those who rely on farming as a major livelihood activity, and yet have insufficient assets to produce a surplus from their agricultural activities.

Against this background, the paper estimated factors influencing households' decision to engage in multiple on-farm livelihood activities. The findings of this paper could serve as a point of reference for follow-up studies in South Africa, and could also be used as input for rural development strategies in Intsika Yethu Local Municipality to inspire rural households to engage in multiple on-farm livelihood activities that will eventually lead to high returns in terms of income generation. The findings of the study will therefore serve as a foundation for policymakers and developmental agencies such as the Department of Rural Development and Agrarian Reform (DRDAR).

MATERIAL AND METHODS

Study area

Intsika Yethu Local Municipality is one of six local municipalities situated within the Chris Hani District Municipality (CHDM) in the Eastern Cape Province of South Africa. According to Mgxashe et al. (2000) the municipality was established pursuant to the 1998 Municipal Structures Act, and consists of two main towns, namely Cofimvaba and Tsomo. Intsika Yethu Local Municipality covers the greater part of the province, which until 1994 was known as the Transkei. It has a total area of about 3,041 km^2 (Mgxashe et al., 2000). The average minimum temperature ranges from 24°C in September to 29°C between December and February, and winter is said to be cold. The lowest temperatures are recorded

Fig. 1. Map of South Africa
Source: Google Maps.

in June and July when the mercury levels drop to about 12°C on average (Gidi, 2013). Further, the area is said to experience winds of low to moderate speeds and variable direction, and wind affects the cultivation of crops like tobacco, cotton and citrus (Gidi, 2013). The study by Manona (2005) notes that the rainfall in Intsika Yethu Local Municipality is relatively high from November to April (401–500 mm) and low from May to October (151–200 mm). This implies that summer is the suitable season for crop production, especially maize.

Data and empirical model used

The study used a cross-sectional field survey whereby data was gathered from 190 households using the availability sampling method with respect to 4 randomly selected villages of Intsika Yethu Local Municipality. Ordinal/ordered logistic regression was used to analyze the factors influencing households' decisions to engage in multiple on-farm livelihood activities. The calculations were based on the Simpson Index of Diversification (SID).

Simpson Index of Diversification (SID)

In literature, the extent of households' livelihood diversification is mostly measured with diversification indices. The vector of income share in association with different income sources is most commonly used as a measure of income diversity (Khatun and Roy, 2012; Babatunde and Qaim (2010). The definition of diversification relates to the number of sources of income and the balance among them. The Simpson index of diversity is widely used to measure diversity, including by Khatun and Roy (2012), Shaha (2010) and Hill (1973). Joshi et al. (2004) also adopted the Simpson index to compare crop diversification in several South Asian countries. Datta and Sing (2011), Babatunde and Qaim (2010) and Sujithkumar (2007) used the diversity index to quantify the income and livelihood diversification. Following the above-cited studies, this paper also employed the Simpson index of diversity because of its simplicity in terms of computing, wider applicability and robustness. The formula for the Simpson index of diversity is given in Equation 1 (Yobe, 2016; Khatun and Roy, 2012).

$$SID = 1 - \Sigma_{i=1}^{n} Pi^2 \quad (1)$$

where:

SID = Simpson index of diversity
n = total number of income activities
Pi = income proportion of the i^{th} income source

The value of SID ranges from zero (0) to one (1). However, in cases where there is only one source of income, i.e. Pi = 1, then SID = 0. Therefore, households with the most diversified income sources have the largest SID; on the other hand, households with the less diversified income sources are associated with a smallest SID. For the least diversified households (i.e. those depending on a single income source), SID takes on its minimum value of 0. The upper limit for SID is 1, and depends on the number of income sources available and their relative shares in total household income. The higher the number of income sources and the more evenly distributed the income shares, the higher the value of SID.

Below is how the SID model was expressed in this paper:

$$SID = 1 - \sum_{i=1}^{9} \left(\left(\frac{cti}{thi}\right)^2 + \left(\frac{spi}{thi}\right)^2 + \left(\frac{gti}{thi}\right)^2 + \left(\frac{pgi}{thi}\right)^2 + \left(\frac{cki}{thi}\right)^2 + \left(\frac{pci}{thi}\right)^2 + \left(\frac{cci}{thi}\right)^2 + \left(\frac{vci}{thi}\right)^2 + \left(\frac{lci}{thi}\right)^2 \right)^2 \quad (2)$$

Where; *cti* = cattle income, *spi* = sheep income, *gti* = goat income, *pgi* = pig income, *cki* = chicken income, *pci* = potato crops income, *cci* = cereal crops income, *vci* = vegetable crops income, and *lci* = legume crops income.

Based on SID values, the level of livelihood diversification is defined as following:

1) No diversification (SID < 0.01)
2) Low level of diversification (SID = 0.01–0.25)
3) Medium level of diversification (SID = 0.26–0.50)
4) High level of diversification (SID = 0.51–0.75)
5) Very high level of diversification (SID ≥ 0.76)

A number of socioeconomic factors, institutional factors and household characteristics that encourage a typical household from Intsika Yethu Local Municipality, Eastern Cape Province of South Africa to diversify its on-farm livelihood activities can be determined with the use of regression analysis, as detailed in the following section.

Ordered Logistic Regression (OLR)

Ordered logistic regression, also called ordinal logit regression, is similar to binary logistic regression. However, the latter allows for a dependent variable with only two categories (Holst and Martens, 2016). Ordered logistic regression models are based on the principles of

binary logistic regression. However, an ordered logistic regression model allows for a dependent variable with multiple categories that have a meaningful order.

Tsue (2015) defines the ordered logit model as a regression model for ordinal dependent variables. The model can be thought of as an extension of the logistic regression model that applies to dichotomous dependent variables, allowing for more than two (ordered) response categories. It is also noted that the model is applicable only to data that meets the proportional odds assumption that the relationship between any two pairs of outcome groups is statistically the same (Tsue, 2015). Historically, the ordered logistic regression model was referred to as the constrained cumulative logit model, as proposed by Walker and Duncan (1967). Later, it was called the proportional odds model by (McCullagh, 1980; Ananth and Kleinbaum, 1997).

A study by Dong (2007) used the ordered logistic regression model to study self-efficacy in colorectal cancer screening. Adepoju and Adegbite (2009) also used the ordinal logistic model in studying the relationship between staff categories (as outcome variable) with gender, indigenous status, educational qualification, previous experience and age treated as explanatory variables.

Adeyemo and Kayode (2015) used the ordered logistic regression model to identify factors influencing sustainability of a community in the study entitled "Factors influencing sustainability of community-driven development approach of World Bank in south western Nigeria." Alemu (2015) also applied the ordered logistic regression model in the study entitled "Determinants of wheat yield variation of smallholders in south eastern Ethiopia." The study attempted to identify factors that affect the probability of wheat yield to be relatively low, medium or high among farm households in south eastern Ethiopia.

Jepson and Vandewalle (2016) also used the ordered logistic regression model in the study entitled "Household water insecurity in the global north: a study of rural and peri-urban settlements on the Texas–Mexico border." With the use of the model in question, the study attempted to identify household characteristics that are more likely to result in water insecurity in Texas–Mexico border. A recent study entitled "Determinants of Animal Protection Policy (APP)" by Holst and Martens (2016) also employed the ordered logistic regression model to determine the influence of economic development, democracy, and civil society on policy variations between 48 countries.

Another recent study by Adanacioglu (2017) used the ordered logistic regression model in a project entitled "Factors affecting farmers' decisions to participate in direct marketing: a case study of cherry growers in the Kemalpasa District of Izmir, Turkey." In the study, the model in question was used to analyze the effects of agricultural businesses and demographic features on the tendency of growers to choose direct marketing channels in cherry selling. Suharyanto and Indrasti (2017) also applied the ordered logistic regression model in a study entitled "Assessment of food security determinants among rice farming households in Bali province." In the study, socioeconomic factors that affected household food security levels were estimated using ordered logistic regression. More recently, Nengovhela et al. (2018) also used the ordered logistic regression to estimate the determinants of indigenous fruits consumption frequency among rural households in South Africa. The dependent variable was the ordered categorical indigenous fruits consumption frequency (Y = 1: high consumption level – daily consumers; Y = 2: neutral consumption level – weekly consumers; Y = 3: low consumption level – monthly consumers).

Guided by previous literature, this paper applied the ordered logistic regression model to determine the factors influencing rural households' diversification of on-farm livelihood activities based on the following ordered categories of household on-farm livelihood diversification: [1 = No diversification (SID < 0.01), 2 = Low level of diversification (SID = 0.01 – 0.25), 3 = Medium level of diversification (SID = 0.26 – 0.50), 4 = High level of diversification (SID = 0.51 – 0.75) and 5 = Extremely high level of diversification (SID ≥ 0.76)].

Following an approach by Tsue (2015), a typical logistic regression model was used as illustrated in Equation 3:

$$y^* = \mathrm{x}'\beta + \varepsilon \tag{3}$$

where: y^* is the exact but unobserved dependent variable (SID), x is the vector of independent variables and β is the vector of regression coefficients which are to be estimated. While y^* cannot be observed, the categories of response can be observed instead:

$$y = \begin{cases} 1 \text{ if } y^* \le \mu_1 \\ 2 \text{ if } \mu_1 < y^* \le \mu_2 \\ 3 \text{ if } \mu_2 < y^* \le \mu_3 \\ : \\ N \text{ if } \mu_N < y^* \end{cases}$$

Then the ordered logit technique will use the observations on y, which are a form of censored data on y*, to fit the parameter vector β. However, since the dependent variable (y) is categorized, the following model is specified:

$$p(Y \le i) = p_1 \ldots + p_i \quad (4)$$

$$\text{odds}(Y \le i) = \frac{p(Y \le i)}{1 - p(y \le i)} = \frac{p_1 + \cdots + p_i}{p_{i+1} + \cdots + p_{k+1}} \quad (5)$$

$$\text{logit}(Y \le i) = \ln\left(\frac{p(Y \le i)}{1 - p(y \le i)}\right), i = 1,..., k \quad (6)$$

The cumulative logistic model for ordinal response data is given by:

$$\text{logit} = (Y \le i) = \alpha_i + \beta_1 X_1 + \ldots + \beta_m X_{im}, i = 1,\ldots \quad (7)$$

The model follows then that the cumulative odds are given by:

$$\text{odds}\ (Y \le i) = \exp(\alpha_{\downarrow} i)\ \exp(\beta_1 X_1 + \ldots + \beta_{\downarrow m} X_{\downarrow m},\ i = 1, \ldots \quad (8)$$

By fitting the variables into the model, the model was represented as illustrated in Equation 9.

$$\begin{aligned} \text{SID} = {} & \beta_1\text{Age} + \beta_2\text{Gender} + \beta_3\text{Marital status} + \\ & \beta_4\text{Education level} + \beta_5\text{Household size} + \\ & \beta_6\text{Land size} + \beta_7\text{Access to credit} + \\ & \beta_8\text{Membership CBOs} + \beta_9\text{Market distance} + \\ & \beta_{10}\text{Employment status} + \varepsilon \end{aligned} \quad (9)$$

RESULTS AND DISCUSSION

This section presents the findings of the study. Firstly, descriptive statistics of all the sampled households are presented; this is followed by a summary of on-farm livelihood activities that rural households pursue, the estimated livelihood diversification index and factors that influence rural households to diversify their on-farm livelihood strategies.

Descriptive statistics of all households sampled

Table 1 below presents the basic sample statistics from the study area. A total of 190 respondents were considered for this study with a mean household head age

Table 1. Basic sample statistics summary

Variables	N	Min	Max	Mean	Std. dev.	Skewness
Age	190	1	6	3.42	1.466	–0.118
Gender	190	0	1	0.45	0.499	0.213
Education level	190	0	3	1.11	1.066	0.440
Marital status	190	0	3	0.96	1.041	0.842
Employment status	190	0	2	0.53	0.656	0.867
Household size	190	1	11	3.06	2.461	1.787
Land ownership	190	0	1	0.86	0.345	–2.130
Credit access	190	0	1	0.26	0.439	1.116
Membership to CBOs	190	0	0	0.00	0.000	–
Extension service	190	0	0	0.00	0.000	–
Distance to market	190	0	3	1.19	1.279	0.284

Key: age (0 = less than 20; 1 = 20–29; 2 = 30–39; 3 = 40–49; 4 = 50–59; 5 = 60–69; 6 = more than 70), gender (0 = female; 1 = male), education level (0 = no education; 1 = primary education; 2 = secondary education; 3 = tertiary education), marital status (0 = single; 1 = married; 2 = divorced; 3 = widowed), employment status (0 = unemployed; 1 = employed; 2 = retired), access to land (0 = no; 1 = yes), access to credit (0 = no; 1 = yes), membership to cbos (0 = no; 1 = yes), access to extension service (0 = no; 1 = yes), distance to market (0 = below 10 km; 1 = 10 to 15 km; 2 = 15 to 20 km; 3 = over 15 km).

between 40 and 49 years. The mean education level was 1, which implies that, on average, respondents were educated up to primary level. Basic statistics also suggest that the sample included more females than males. Sample results further reveal an average household size of 3 family members with a minimum of 1 and a maximum of 11. The mean marital status and employment status was 0.96 and 0.53, respectively, implying that, on average, the majority of respondents were married and unemployed. Sample statistics also suggest that most respondents had access to land. However, the basic sample statistics reveal that the majority of respondents did not have access to credit.

In terms of extension service and membership to community-based organizations, basic sample results indicate that there are no respondents who have access to any of these services. Lastly, with reference to distance to market, the basic sample statistics indicate that, on average, the majority travel between 10 to 15 kilometers to market. The distribution was mostly positively skewed, with the exception of household-head age and land ownership variables, as shown in Table 1. Most of the characteristics had a skewness value below 1, with the exception of household size and access to credit. This implies that the distribution did not differ significantly from a normal symmetric distribution.

On-farm livelihood activities in the study area

This section presents common on-farm livelihood activities pursued by rural households covered by this study. Figure 2 presents the reported common types of on-farm livelihood activities in the study area.

The results indicate that cattle production is the most common livelihood activity in the study area (30.9%), followed by goat keeping (25.8%). Sheep and chicken keeping both stand at 10.3%, and lastly, production of legume crops and piggery are the least popular livelihood strategies in the study area (1.0% and 2.1%, respectively). These findings suggest that rural on-farm livelihood activities in the study area are dominated by livestock production (79.38%) with minor cropping activities (20.62%). Several previous studies acknowledge that most poor African farmers depend on livestock (Nin et al., 2007; Seo and Mendelsohn, 2008; IFAD, 2009; FAO, 2009; IUCN, 2010) which is normally kept as insurance when crops fail (Fafchamps et al., 1998). Multiple direct and indirect benefits of livestock, as suggested

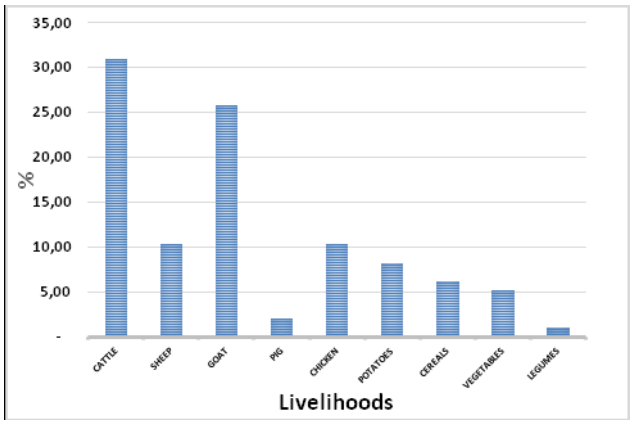

Fig. 2. Distribution of common on-farm livelihood activities in the study area

by Pica-Ciamarra et al. (2011), also further explain the dominance of livestock in rural on-farm livelihoods activities. These findings further reveal that small livestock plays a more important role in main livestock livelihood activities (48.45%) than large livestock (30.93%).

With reference to crops, the results suggest that horticultural crops dominate the crop livelihood activities (14.43%) compared to cereals (6.19%). The respondents noted that due to climate change, most rural farmers were focusing on irrigated horticultural crops rather than on field cereal crops.

Degree of on-farm livelihood diversification

This section presents the extent of household on-farm livelihood diversification in the study area. Table 2 illustrates the distribution of households into different levels

Table 2. Distribution of households into different levels of diversification

SID range	Number of households	Percentage (%)	Level of livelihood diversification
< 0.01	166	87.4	no
0.01–0.25	4	2.1	low
0.26–0.50	14	7.3	medium
0.51–0.75	6	3.2	high
0.76 >	0	0	very high

SID mean = 0.05, SID minimum = 0.00, SID maximum = 0.65.

of on-farm livelihoods diversification with frequencies and percentages.

The results indicate a minimum diversification index of 0 (SID = 0.00), a maximum of 0.65 (SID = 0.65) and a mean of 0.05 (SID = 0.05). On average, the results suggest that the household on-farm livelihood diversification index (SID = 0.05) is low, with 87.4% of the respondents reporting no diversification at all, and only 3.2% having a high livelihood diversification index. The respondents reported that they were more into non-farm livelihood activities than on-farm activities due to several challenges facing the latter, ranging from climate change to poor institutional support (missing rural markets, poor extension and lack of credit to support on-farm livelihoods activities). These results are consistent with findings by Megbowon and Mushunje (2018) and Yobe (2016) who also established that rural households in the Eastern Cape and KwaZulu-Natal provinces of South Africa are highly vulnerable to various kinds of climate, mainly because of a low level of diversification of farm activities.

Determinants of on-farm livelihood diversification

This section presents the econometric results for the factors that influence households to engage into multiple rural on-farm livelihood activities. The previous section noted a low on-farm livelihood diversification index (0.05) among rural households; this section estimates factors that influence on-farm livelihood diversification at household level as summarized in Table 3. The parallel lines test (which assesses whether the assumption

Table 3. Determinants of rural on-farm livelihood diversification

Predictor variables	Estimate	Std. error	Sig.
(1) Age of household head	0.380	0.345	0.271
(2) Gender of household head	–1.985	0.895	0.027**
(3) Education level	1.551	0.528	0.003***
(4) Marital status	0.205	0.442	0.643
(5) Employment status	–1.177	0.803	0.143
(6) Household size	0.833	0.179	0.000***
(7) Land ownership	–0.998	0.851	0.241
(8) Credit access	–0.269	0.958	0.779
(9) Distance to market	0.339	0.316	0.284
(10) Number of livestock owned	0.025	0.011	0.021**

Model fitting information				Goodness of fit			Pseudo R-squared	
Model	–2 Log Likelihood	Chi-squared	Sig.		Chi-squared	Sig		
Intercept only	190.204			Pearson	158.488	1.000	Nagelkerke	0.769
Final	63.570	126.63	0.000	Deviance	63.570	1.000		

Test of parallel lines

Model	–2 Log likelihood	Chi-squared	Sig.
Null hypothesis	67.865		0.998
General	57.215	6.355	

***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

that the parameters are the same for all categories is reasonable) was cogent with a large *p-value* of 0.998 which is greater than the 5% significance level. This implies that the proportional odds assumption appears to have held for the general model. As for the coefficient of determination, pseudo R-squared was computed to summarize the proportion of variance in the dependent variable associated with the predictor variables. In the model, a Nagelkerke R^2 of 76.9% was obtained, implying that most of the variation was explained by the model. Concerning the goodness of fit, the large significant value (Pearson's chi-squared statistic = Sig. 1.000; chi-squared statistic based on the deviance = Sig. 1.000) implies that the data and the model predictions are similar, and the models' estimates fit the data at an accepted level.

The model used to analyze this objective was discussed in detail above under the data analysis section. Diversification was measured on ordinal terms; very high diversification (> 0.76 = 5), high diversification (0.51–0.76 = 4), medium diversification (0.26–0.50 = 3), low diversification (0.01–0.25 = 2), and no diversification (< 0.01 = 1). These diversification levels were used as dependent variables in the Ordered Logit Regression Model. The interpretation shall be that a higher net value (5) indicates a high diversification while a low net value (1) indicates a low (no) diversification. The interpretation is as follows: a positive estimate value [ordered log-odds (logit) regression coefficient] indicates that an increase in that variable increases diversification (thus encourages diversification), while a negative estimate value [ordered log-odds (logit) regression coefficient] indicates that an increase in that variable decreases (discourages) diversification.

Gender: model results confirm a negative association between household head gender and on-farm livelihood diversification. The results reveal that for every unit positive change in household head gender (moving from female to male-headed households), there is a 1.985 decrease in the log odds of on-farm livelihood diversification, holding all other independent variables constant (thus, it discourages diversification). These findings, therefore, suggest that female-headed households are more likely to engage in multiple on-farm livelihood diversifications than their male-headed counterparts. Several comparable previous studies argue that female-headed households are more likely to diversify their livelihoods than male-headed households mainly because of culture, where female-headed household are expected to take care of children left by their fathers (Agyeman et al., 2014; Manjur et al., 2014; Mukotami, 2014). Other studies, however, note that male-headed households are more likely to diversify their on-farm livelihoods than female-headed households arguing that male-headed households have the energy to take extra activities during off days, and take up some other activities that add to their total income to improve household welfare (Mutenje, 2010). The observed variation may be explained by cultural differences from the study areas, including the decline in gender barriers.

Level of education: the model confirms a positive association between the level of education and on-farm livelihood diversification. The results indicate that for every unit increase in household head education, there is a 1.551 increase in the log odds of on-farm livelihood diversification, holding all other independent variables constant (thus, it encourages diversification). These findings therefore suggest that as household head education increases, so does on-farm livelihood diversification. These findings are consistent with those by Echebiri et al., Nwaogu (2017); Agyeman et al. (2014); Asmah (2011), Saha and Bahal (2016) and Babatunde and Qaim (2010) who noted that higher education attainments improve the households' understanding of farming practices and related issues. Contrary to the above statement, it is popularly believed that educated household heads are less likely to diversify their on-farm livelihood activities mainly because a high level of education places an individual at higher levels of specialization, more often characterized by a single livelihood option (formal employment).

Household size: the model results confirm a positive association between household size and on-farm livelihood diversification. The results show that for every unit increase in household size, there is a 0.833 increase in the log odds of on-farm livelihood diversification by households, holding all other independent variables constant. These findings suggest that as household size increases, so does on-farm livelihood diversification. This may be possible because large household sizes mean more hands (family labor) to handle more on-farm livelihoods that are typically labor-intensive, as well as more mouths to feed that triggers more production activities. These findings support previous comparable studies which highlight that an increase in household size leads to an increase in livelihood diversification

because of availability of extra labor force (Maniriho and Nilsson, 2018; Manjur et al., 2014).

Number of livestock owned: the model results confirm a positive association between the number of livestock owed and on-farm livelihood diversification. The results disclose that for every unit increase in the number of livestock owned, there is a 0.025 increase in the log odds of on-farm livelihood diversification by households, holding all other independent variables constant. These results suggest that as the number of livestock owned increases, so does on-farm livelihood diversification. Livestock is a critical component of on-farm livelihood diversification through draught power (cattle), manure (most livestock) and income source to finance crop production inputs (small livestock). Thus, an increase in livestock numbers will trigger on-farm diversification in a typical rural setting where livestock finance inputs for crop-related livelihood activities.

CONCLUSION AND RECOMMENDATIONS

The study concludes that rural households from the study area engage in different on-farm livelihood activities which are a combination of poultry (chicken), livestock production (cattle, goats, sheep, pig) and crop production (potatoes, vegetables, cereals and legumes). The study also concludes that rural households diversify their on-farm livelihood activities to a small degree. The level of education of the household head, household size and number of livestock owned were the major factors capable of positively influencing households to diversify their on-farm livelihood activities, while gender of the household head was negatively related to diversification of on-farm livelihood activities.

To promote an on-farm livelihood diversification public policy, research and investments may target:

(a) Education: the study revealed that, as household head education increases, so does on-farm livelihood diversification. With that background, the study recommends that government and research institutes in collaboration with other relevant stakeholders come up with rural workshops, rural faming associations and extension programs that will train rural households about producing a variety of crops and livestock products. The informal school system and vocational or skill training in rural farming households' communities in South Africa should be initiated and intensified to enhance rural households' ability to understand modern practices and government policies, so as to take advantage of them and enhance on-farm livelihood diversification. In general, on-farm income diversification should be encouraged among South African farming households to enable them raise their total household income to address household demands and investment purposes.

(b) Labor dynamics associated with on-farm livelihood activities: the shortages of labor and the subsequent abandoning of farming in rural communities are regarded as one of the key reasons for the reduced involvement in diverse on-farm livelihood activities. The study therefore recommends the creation and promotion of rural labor market platforms to enhance labor availability in rural areas (these could be in the form of social media applications popular with the youth and village skills inventory database publicised at village meetings). Awareness campaigns should be targeted at households with a high number of members to take advantage of family labor. Further research is required towards rural appropriate technology compatible with rural on-farm livelihoods activities to address rural labor shortages.

(c) Household livestock units: the results discovered that as the number of livestock owned increases, on-farm livelihood diversification increases through financing cropping inputs and draft power. The study therefore recommends promotion and intensification of livestock production programs among rural households to enhance household livelihood diversification. The projects or programs such as Masibuyele Esibayeni Programme, KyD (Kaonafatso ya Dikgomo) and Nguni cattle project are examples of livestock programs that can be extended further to the disadvantaged rural communities to allow them to increase their livestock numbers. Targeting small livestock (goats, sheep and poultry) that can be easily traded is also critical for large livestock (cattle) which is kept for multiple uses (including social status) and not easy to sell.

(d) Gender dynamics: the study established that gender imbalance exists in terms of participating in diverse on-farm livelihood activities whereby female-headed households diversified more than male-headed households. Thus, the paper recommends targeted awareness campaigns towards promoting on-farm livelihood diversification among male-headed households to trigger their participation.

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