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Full Length Research Paper

Can Livelihood Capitals Promote Diversification of Resource-Poor Smallholder Farmers Into Agribusiness? Evidence from Nyando and Vihiga Counties, Western Kenya

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Abstract

The push towards the transformation of rural smallholders' subsistence production into market-oriented agribusiness has been in the public policy debates of many low- and middle-income countries, including Kenya. While various studies have highlighted the lack of livelihood capitals as a reason for most smallholders not to diversify into agribusiness, how these livelihood capitals influence smallholders' decisions and choices have, however, only been partially researched. Using systematic random sampling, 392 households in Western Kenya were interviewed through a researcher administered questionnaire. Multinomial logistic regression method was used to analyse the data. The findings reveal that livelihood capitals acted in parallel and jointly to determine the decisions of smallholders to participate in agribusiness. Results shows that education level, gender, landholding size, distance to markets, farm input access, and agriculture extension services positively and significantly influenced the decision choices of households to participate in agribusiness. Households with higher livelihood capitals accumulation resulted in a higher probability of participating in agribusiness while those with limited livelihood capitals resulted in a lower probability to participate in agribusiness. We argue that designing appropriate pro-poor targeted policy interventions to improve poor household's livelihood capitals could address the problem of non-participation of rural smallholders' in agribusiness markets.

Keywords: Livelihood capital, smallholder farmers, market participation, agribusiness markets, food security.

INTRODUCTION

Presently, there is increased opportunity at the local and global level for agribusiness due to increased demands for food and the globalization of agri-food markets (Abdullah et al., 2017). Although the greatest benefits have been felt by the better-off households including medium and large-scale farmers, the poor rural smallholders, who constitute the majority of food producers globally, are largely excluded from participation in the emerging agribusiness markets (Donovan & Poole, 2014; Van den Broeck & Maertens, 2017). In sub-Saharan Africa, rural smallholders account for the largest proportion of food sources (Abraham & Pingali, 2020) and dominate the production segment of a rural and locally oriented agri-food supply (Collier & Dercon, 2014). In contrast, the national and regional input and output markets have mostly been dominated by commercial 'medium and large'

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agribusiness supply chains.

Empirical studies have attributed smallholders' exclusion in agribusiness to a multiplicity of barriers that limit their participation in modern agribusiness and food supply chains (Hazell & Rahman, 2014). Amongst the barriers is their high poverty levels that manifest in their lack of or insufficient access to productive capital assets (Armendáriz, Armenia, & Atzori, 2016; Donovan & Poole, 2014; Manlosa, Hanspach, Schultner, Dorresteijn, & Fischer, 2019) that significantly jeopardize their ability to pull themselves out of the vicious cycle of poverty. Many studies report that the majority of poor smallholders in Low- and Middle-Income Countries (LMICs) lack resources, appropriate skills, and motivation to enable them to move out of food insecurity and poverty traps (Boratyńska & Huseynov, 2017; Burchi & De Muro, 2016; Conceição, Levine, Lipton, & Warren-Rodríguez, 2016).

In addressing these challenges, governments and policymakers in many LMICs, such as Kenya, are actively promoting sustainable agriculture and agriculture sector transformation geared toward farm modernization, rural-urban market integration, and inclusive local food value chains. Strategies such as bottom-up initiatives, market development, state parastatals, producer organizations, cooperative movements, contractual arrangements, value chain financing, and multi-actor supply chain governance are used to boost smallholder agribusiness development (Abdullah et al., 2017; Aman, Bekele, & Lemma, 2014; Koopmans, Rogge, Mettepenningen, Knickel, & Šūmane, 2018; Muriithi & Matz, 2015). Implementation of these strategies is premised on the belief that they will ultimately promote a paradigm shift in existing smallholder production practices from subsistence towards highly market-oriented agribusiness practices. The push for smallholder commercialization is also considered as a possible driver of rural economic growth and pro-poor poverty reduction strategies (Klasen & Reimers, 2017a). This is expected to stimulate rural entrepreneurship for small agribusinesses, raise their agriculture productivity, improve the quality of production, and create surplus thus increasing their chances of participating in agri-food markets (Gebru, Ichoku, & Phil-Eze, 2018; Manlosa et al., 2019). However, much of the efforts to address the problem of smallholder non-participation have been biased towards the provision of technical-based solutions to improve agriculture productivity and less on improving the livelihood capital base of the resource-poor smallholders.

In Kenya, the majority of subsistence-oriented smallholders, who account for the bulk of agriculture food production, are inherently poor. Most own an average 0.2–3 acres and are to be found in the marginalized rural areas, where 70% of rural households are dependent on subsistence agriculture as their main livelihood pillar (UNDESA, 2017). However, in the last 2 decades, there have been sustained efforts by both government and private entities to address the high poverty levels and the high non-participation of rural smallholders in agribusiness through the commercializing of agriculture (Muriithi & Matz, 2015). Despite such efforts, the majority of rural smallholders remain inherently poor, aloof, and mainly excluded from participation in contemporary agribusiness markets. The high poverty levels mean that poor smallholders are lowly endowed with critical productive-capital assets and resources that are crucial in entrepreneurial efforts (Donovan & Poole, 2014) like starting new on-farm and off-farm ventures or in upgrading their peasant livelihoods to more income-generating agribusiness ventures. Thus, they are constrained to effectively exploiting the opportunities of contemporary agribusiness markets.

Whereas literature shows productive-livelihood capitals influence smallholders' choices in different ways, it is rarely understood what combination of these livelihood capitals could result in a higher probability of smallholders to diversify their subsistence production into more probable income-generating agribusiness given different contexts. Though there is evidence from the literature that suggests better-off smallholders with sufficient assets are more likely to achieve successful integration in agribusiness (Loison, 2015), not much research has been conducted to investigate at the micro-level, how livelihood capitals affect the participation of poor households in agribusiness activities. Yet, a critical investigation of this is important because empirical findings have shown that higher productive-capital assets endowment has been associated with increased diversification in farm and non-farm livelihood activities and as a source of higher dietary diversity (Manlosa et al., 2019; Pritchard, Rammohan, & Vicol, 2019; UNDESA, 2017). For this study, we apply the livelihood assets approach to understand the extent to which differentiated asset configurations impact smallholder households' decisions to participate in agribusiness activities. Using Kisumu and Vihiga counties of Western Kenya as a case study area, this research aims to explore how household's capital endowments influence smallholders' decisions to participate (or not) in agribusiness activities. The study contributes to the knowledge gap towards a better understanding of the causative relationships between livelihood capital assets and their influence on smallholders to participate in agribusiness. It contributes to a more nuanced identification of systemic interventions that are required for successful pro-poor smallholder agribusinesses development in LMICs.

Literature review

Academic discourse on the link between rural poverty, access to productive livelihood assets, and market participation suggest that poor smallholders have too few

livelihood capital assets to effectively participate in agribusiness and agri-food markets (Donovan & Poole, 2014; Ha, Bosch, & Nguyen, 2015a). For a large number of rural smallholders who derive their main livelihoods from small-scale subsistence agriculture, they directly or indirectly depend on accumulated productive capital assets to diversify in income-oriented agribusiness.

Several studies have used the sustainable livelihood approach as a theoretical and analytical framework to bring a deeper understanding of the ways individuals and households, in different contexts, use their livelihood capital assets to diversify their livelihoods into the farm and non-farm activities (Manlosa et al., 2019).The sustainable livelihood assets-based approach conceives six classes of resources held at the individual, household, or collective levels to include a combination of physical, human, financial, natural, social, and cultural capital assets (Rakodi, 2002; Scoones, 1998). Recent literature suggests that low livelihood assets have been identified as a considerable constraint (Donovan & Poole, 2014; Van den Broeck & Maertens, 2017) to livelihood diversification and for exploiting the opportunities of expanding agri-food markets.

Livelihood capitals are defined as the "asset base" upon which individuals and households build their livelihoods (Donovan & Poole, 2014; Morse & McNamara, 2013). The *physical capitals* include basic infrastructure households need to support livelihoods including transportation, roads, buildings, water supply and sanitation, energy, technology, access to information (e.g. radio or mobile phones), and access to agricultural implements (Abdullah et al., 2017; Olwande, Smale, Mathenge, Place, & Mithöfer, 2015). It has been found that higher asset holdings are essential for marketable surplus production at a smallholder level hence could positively influence smallholder decision to invest in local agribusiness (Noromiarilanto, Brinkmann, Faramalala, & Buerkert, 2016; Osmani & Hossain, 2015). At the macro level, rural-urban connectivity, market opportunities, off-farm employment, and technology adoption (Tittonell, 2014) have contributed to shaping food production decisions and strategies of smallholder agriculture.

The Department for International Development (DFID) considers *human capital* as the generic assets or "sufficient conditions" that serve as building blocks for the achievement of livelihood outcomes. Human capitals include age, gender, education level, years of experience, skills, training, family size, dependency ratio, labor power, and ability to adopt new technology (Fredriksson, Bailey, Davidova, Gorton, & Traikova, 2017; Olwande et al., 2015). Household's human capital endowment and utilization can generate multiple benefits towards achieving sustained small-scale agribusiness success (Ha, Bosch, & Nguyen, 2015b; Osmani & Hossain, 2015). Some studies (Ha, Bosch, Nguyen, & Trinh, 2017) assert that human capital is amongst the effective strategies that enhance knowledge production and agronomic skills that smallholders could capitalize on to diversify into agribusiness.

Social capital represents the ability of individuals or households to secure benefits through membership and relationships. They are accrued from shared norms and values embedded in social networks that enable individuals or households who belong to them to access and exchange different resources (Wagah & Mwehe, 2019). Empirical findings show that higher social capital could positively facilitate increased agricultural productivity outcomes. For example, Wagah & Mwehe (ibid) found that social capital positively contributed to improving the food security of poor peri-urban households in Kisumu city, Kenya, and recommended the improvement of smallholders' informal social networks. Additionally, social capital has contributed to the dissemination of locally adoptive farmer-led innovations that complement externally promoted agriculture technologies for improving agriculture and food security (Knickel et al., 2018; Tambo & Wünscher, 2017).

Natural capital consists of land, water, biodiversity, air quality, and wild resources. Some studies (Gebru et al., 2018) report that the associated costs of mitigating the negative impact of natural capital (e.g. climate change) could far outstrip the benefits accrued from agribusiness thereby making agribusiness less attractive for poor smallholders.

Financial capital includes fiscal resources individuals or households use in constructing their livelihoods including savings, access to credit, inflows like pensions, and remittances (Morse & McNamara, 2013). Additionally, livestock assets, crop sales, wages on-off farm employment is also considered as financial capital. Several studies have found that access to financial capital by households, including affordable credit, and agricultural extension services to have a positive relationship with market participation (Abdullah et al., 2019; Wagah & Mwehe, 2019).

In addition to livelihood capitals, exogenous variables like *institutional factors* exert a lot of influence on the development of farming systems. These factors include market regulations, trade policies, property rights, and land tenure, and proximity to input and output markets (Coppola et al., 2018; Khapayi & Celliers, 2016; Osmani & Hossain, 2015) influence farmers' choices to participate in agribusiness, even though they are not confined by spatial boundaries. The institutional factors influence how individuals and households use their livelihood assets in shaping their different livelihood strategies and outcomes.

However, the challenge for many rural smallholder households in many LMICs is that they are peculiarly and tragically the most asset poor and food-insecure demographic group (Collier & Dercon, 2014; Conceição et al., 2016). Thus, the critical question is how differentiated livelihood capitals endowments could create different outcomes necessary for sustenance and well-being

in terms of incomes, food security and participation in income-generating agribusiness activities.

METHODS

Study area

This study was conducted in two study sites (Figure 1) located in Kisumu and Vihiga counties in the Western part of Kenya. Nyando's study site is located in Kisumu County along the shores of Lake Victoria while the Central Maragoli site is located in Vihiga County along the equator in the upper Lake Victoria basin. Both areas receive fairly well-distributed rainfall throughout the year. The motivation for selecting these study sites is that they experience a very high prevalence of food insecurity, high population pressure, and are located in the peri-urban hinterlands of Kisumu city. Additionally, these two areas are predominated by a high level of small-scale agricultural activities and have a spatially heterogeneous landscape.

We used a multistage sampling method to select study sites and sample households. After choosing Kisumu and Vihiga county, we used a stratified sampling technique to select Nyando and Central Maragoli wards as our study sites. 392 sample households were selected using a systematic random sampling technique from the two areas for the survey. Research assistants were used to administering the closed and open-ended questionnaire to these households. Permission to interview was sought from every participant before the commencement of the interviews and only adult members of households above 18 years of age were interviewed.

Variables used

Before fieldwork, we conducted an exploratory study through field reconnaissance visits to identify main farming types and various livelihoods capitals assets available in the study area. We categorized household production orientation into three main types; Horticutlure, semi-commercial and subsistence (either mixed 'with livestock'or pure 'crop only'). These categorization were derived from the tabulation of the types of food production practices that were observed in the study area during fieldwork data collection. The categorization was deduced from analyzing each household's farming activities; food crops grown, cash crops grown, fruit and vegetable crops grown and livestock kept (cows, goats, chickens). By combining different choices made by households, four farming production orientations were deduced;

- Horticulture-oriented households: mostly grew high-value crops (fruits and vegetables) specifically for selling to the markets, but also grew staple food for own consumption.
- Commercially-oriented households: mostly grew commercial crops (tea, coffee, and sugarcane) and sold their products through marketing cooperatives, but also grew staple crops for consumption.
- Subsistence-oriented households (mixed): mostly kept livestock in addition to growing various crops.
- Subsistence households (crops only): grew crops only for own consumption and hardly ever sold any to the markets.

Table 1 describes the variables selected for this stidy.

Data Analysis

Data analysis was done by use of Statistical Package for the Social Sciences (SPSS) software The multinomial logistic regression model was applied to identify statistically significant factors that influence smallholder households to participate in agribusiness market activities. Before conducting multinomial regression, the explanatory variables were examined through various SPSS analytical techniques for basic assumptions of multinomial logistic regression including missing values, outliers, normality of distribution, and multicollinearity (Tabachnick & Fidell, 2007). Household annual income, with missing values on more than 20% of the cases, was deleted. The normality test identified five continuous cases to be univariate outliers with extremely high z scores over 3.29 ($p<.001$, two-tailed). To improve the normality of their distribution, livestock assets, household assets, farm tools assets, on-farm income, and land size variables were logarithmically transformed. However, household assets and farm tools assets still returned a high skewness and kurtosis after transformation and were subsequently omitted. Using Mahalanobis distance function, four cases were found to be multivariate outliers with X^2 (7) = 24.322, ($p< .001$) and were deleted.

Nine continuous explanatory variables were screened for multicollinearity using the Variation Inflation Factor (VIF) and tolerance coefficient where off-farm income, off-farm employment, and livestock assets were greater than 10 indicating high multicollinearity. After model iteration, off-farm income was left out of the analysis. After satisfying all the assumptions of multinomial regression analysis, SPSS version 20 was used to analyze the data. Out of the 20 hypothesized variables (Table 1) presumed to influence smallholder's agriculture production choices, only 9 were found to be statistically significant at 0.05, 0.01, and 0.1 alpha levels and are further discussed in the results section.

RESULTS

Demographic characteristics of respondents

A total of 392 sample household heads were interviewed comprising 21% youths (18-35 years), 55% adults (36-60 years), and 24% aged (61 years and above). The sample

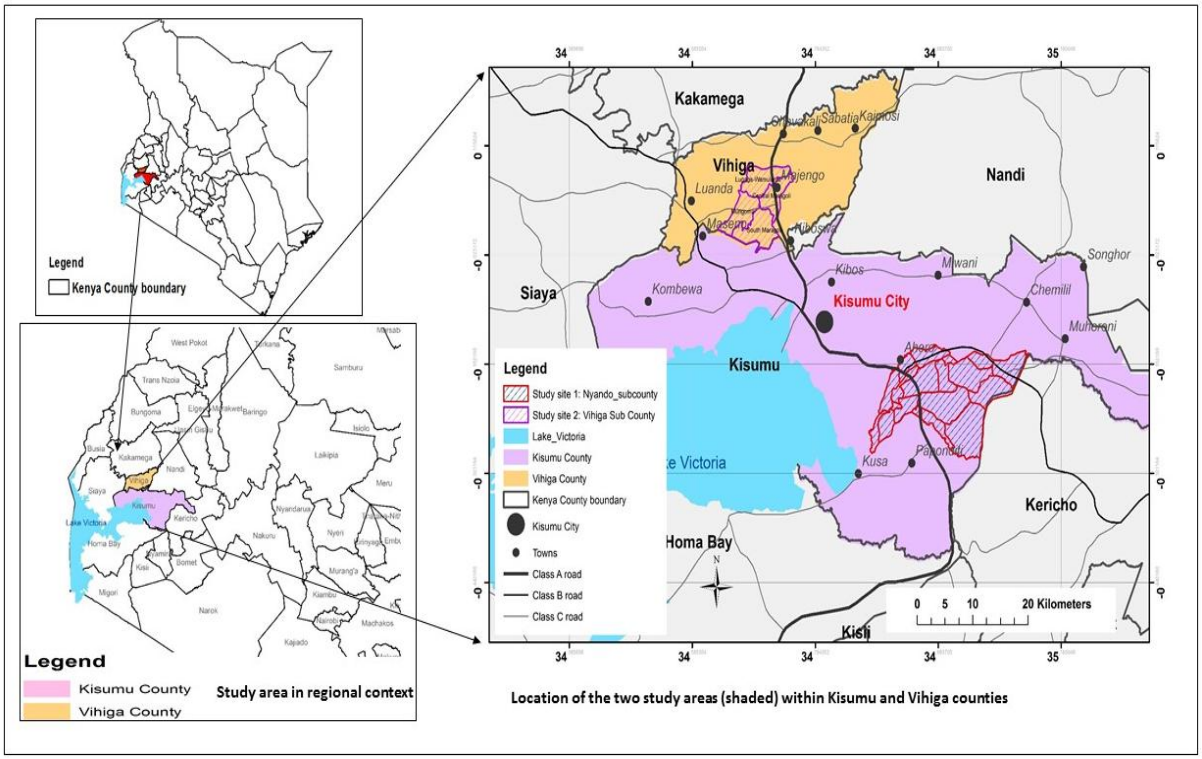

Figure 1. Geographical location of thetwo study sites in Western Kenya.

size was comprised of an almost equal number of males (49.7%) and females (50.3%). The average household size was found to be 7 persons per household, with households having 5 persons and above comprising 85% of the total sample. This is above the national average household size of 3.9 persons, as per the Kenya National Bureau of Statistics 2019 census report (Government of Kenya (GoK), 2019). It is presumed that to meet the food demands for such large family sizes, they would ideally require larger parcels of land, or agriculture intensification on smaller ones, or even diversification of food production choices. However, the landholding sizes in the study area was found to be very low, with 62% of a sampled household having an average of 2 acres and below.

Farming production orientation

The main farming types (Table 2) practiced by the majority of sampled households as observed in both study areas included subsistence oriented 'both mixed and crops only' (90.9%). Other farming orientations practiced by minority of sampled households includes commercial oriented (5.1%) and horticulture oriented (4.8%) duction orientation practiced by sampled households. The crops grown by the majority of households were maize, vegetables, and beans (Figure 2). We found little level of agriculture intensification and crop diversification in the sampled households.

Based on the subjective perception of households' food insecurity, results show there is a higher prevalence of food insecurity in Vihiga and Nyando areas. 49% of households in Nyando and 36% in Vihiga indicated they experienced food insecurity incidences in the last year preceding this survey. Among the surveyed households, livelihood diversification was found to be minimal, with the majority 79% engaged in farming, 12% in the formal employment, and 9% in informal employment.

Livelihood capitals influence on households

The result of the Multinomial logistic regression model (Table 3) revealed a mixed influence of various variables on household decision choices. Nine of the hypothesized predictor variables were found to be statistically significant. They positively and negatively influenced smallholders' decisions to participate in agribusiness farming production at different significant levels.

In interpreting Table 3, the pure subsistence farming option is made as to the reference category in which the regression model calculations are based. It was the widely practiced farming option by the majority of households in the study areas. The table is interpreted by taking the statistically significant (*p* column) independent variables and reading its corresponding Log odds ratio (OR column). An assumption is made that if all factors are kept constant (i.e. c*eteris paribus)*, the probability of a household in the reference category to shift to other agribusiness farming choices (mixed, commercial, or horticulture) would need *x* number of times (*x*= value of OR column) of the predicted estimate value of the odds ratio of each variable, at a statistically significant level (p column). The positive or negative sign that precedes the

Table 1. Description of Variables used in the Multinomial regression model.

Variable	Variable explanation	Expected sign		
Dependent variables				
Production orientation choices	0. Semi-commercial	n/a	n/a	n/a
	1. Horticulture	n/a	n/a	n/a
	2. Subsistence	n/a	n/a	n/a
Independent variables				
			Descriptive statistics	
(a.) Human capital			**Mean**	**Std Dev**
GENDER	Binary, 1 if the head is male and 0 if female	+/-	1.50	.50
AGE	Continuous, HH head age in years	+	49.86	14.89
OCCU	Categorical, HH head occupation	+	3.55	1.29
EDULVL	Categorical, HH head education level	+	2.41	.81
SCHLYRS	Continuous, household head years of schooling		9.18	4.22
(c.) Financial capital				
FINCOME (in Kshs)	Continuous, Natural Log, On farm income	+/-	8,356	28,310
LVTKASSET (in Kshs)	Continuous, Natural Log, value of livestock assets	+/-	63,404	64,98
CHKASSET (in Kshs)	Continuous, value of chicken assets		10.80	14.64
AGRIC CREDIT	Binary, 1 if the head has access to agric. Credit and 0 otherwise	+	1.83	0.38
(d.) Natural and Physical capital				
LANDSIZE (in Ha)	Continuous, Natural Log, land size	+	.396	.240
SFERTILITY	Categorical, soil fertility level	+/-	2.39	.54
FINPUT	Categorical, Farm input availability		1.61	1.07
CLIM	Ordinal, Climate change variability (drought and famine)		1.99	1.04
RAINAVAIL	Ordinal, Rainfall availability		2.40	.763
(e.) Social capital				
SNTWK	Binary, 1 if head belong to a social network and 0 otherwise	+	1.43	.50
SAVINGS	Binary, 1 if head saves money, 0 otherwise	+	1.43	.50
LABOR	Binary, 1 if HH has enough family labor and 0 otherwise	+	1.48	.50
(f.) Economic capital				
TRAINING	Binary, 1 if the head has the training, 0 otherwise	+	1.73	.45
SKILLS	Binary, 1 if the head has relevant agribusiness skills, 0 otherwise	+	1.78	.41
(g.) Transaction costs				
DISMKT	Ordinal, effect of proximity to market on household, little, to very high effect	+	4.74	1.51

value in the coefficient (coef. column) is reported concurrently with the odds ratio and denotes either an increase or decrease of predicted probability value (odds ratio). For example, the highly significant (p= .000) LVTKASST variable has an odds ratio of 0.098, and a negative sign of the coefficient. This means that if all other factors are kept constant, the likelihood of a household practicing pure subsistence category to shift to the other farming choices would decrease by a factor of 0.098 as livestock unit increases by one unit.

Predictive accuracy of the regression model using 10-fold cross-validation

We used the 10-fold cross-validation method to estimate the

Table 2. Farming production orientation practiced by sampled households.

Farming production choices	Frequency	Marginal Percent
Horticulture oriented	16	4.8
Commercial oriented	17	5.1
Subsistence (mixed)	146	44.5
Subsistence (crops only)	149	46.4

Table 3. Result of the multinomial logistic regression model (pure subsistence farming option is the reference category).

Dependent variable: Household farming choices adopted by sample households in Vihiga and Nyando area												
Independent variables	**Mixed Subsistence choice**				**Commercial farming choice**				**Horticulture farming choice**			
	Coef.	**SE**	**OR**	**p**	**Coef.**	**SE**	**OR**	**p**	**Coef.**	**SE**	**OR**	**p**
Intercept	8.043	1.767		.000	4.529	2.350		*.054*	6.810	2.532		*.007*
LVTKASST	-2.327	.296	*.098*	*.000*	-1.700	.352	.183	*.000*	-1.986	.383	.137	*.000*
DISMKT	.000	.000	1.000	.971	.000	.001	1.000	.400	-.002	.001	.998	*.066*
INPUT	-.297	.212	.743	.161	-.658	.261	.518	.012	-.284	.336	.753	.397
GENDER	.383	.375	1.466	.308	.082	.464	1.086	.859	1.517	.613	4.558	.013
EDU	1.975	1.197	7.208	.099	2.497	1.277	12.152.	.050	1.114	1.417	3.045	.432
SVNG	-1.099	.446	.333	*.014*	-.162	.522	.850	.756	-.429	.652	.651	.511
AGRIEXT	-1.025	.507	.359	*.043*	.196	.581	1.216	.736	-.175	.776	.840	.822
CLIM	1.624	.567	5.071	.004	2.009	.683	7.453	.003	-.579	1.045	.307	.580
LSZE	-.290	.814	.748	.722	-1.233	1.053	.291	.241	1.280	.764	3.597	.094
The reference category:	Pure subsistence											
Maximum likelihood estimates												
Dependent variable:	Farming system orientation											
Number of observations	392											
− 2 Log likelihood fitting	Intercept only: 885.406, Final: 576.459											
Chi-square test	308.947											
Degrees of freedom	111											
P-value	The significant level at less than 1, 5, and 10% probability levels											

predictive performance of our logistic regression model. We randomly partitioned our sample size into 10 folds, with a training data set to train the model and a testing data set to validate it, and performed 10 rounds of cross-validation using different partitions. The results (Figures 3. 1 to 3.3) shows our regression model's predictive performance for commercial, horticulture, and mixed subsistence farming choices. The figures demonstrate that our logistic regression model is very robust and able to estimate the predictive accuracy of the determinants of the adoption of the three farming choices, irrespective of the resampled data sets used for the estimation.

Reliability and predictive accuracy of the regression model using the Hit Ratio analysis

Subsequently, we assessed the reliability and predictive accuracy of the model using the *hit ratio analysis* by cross-tabulating the actual observed data against predicted probability data from the regression model (Table 4).

The overall performance of our logistic regression model shows it correctly reproduced 65% of pure subsistence observations, 75% of mixed subsistence 24% of commercial, and 6% of horticulture farming observations.

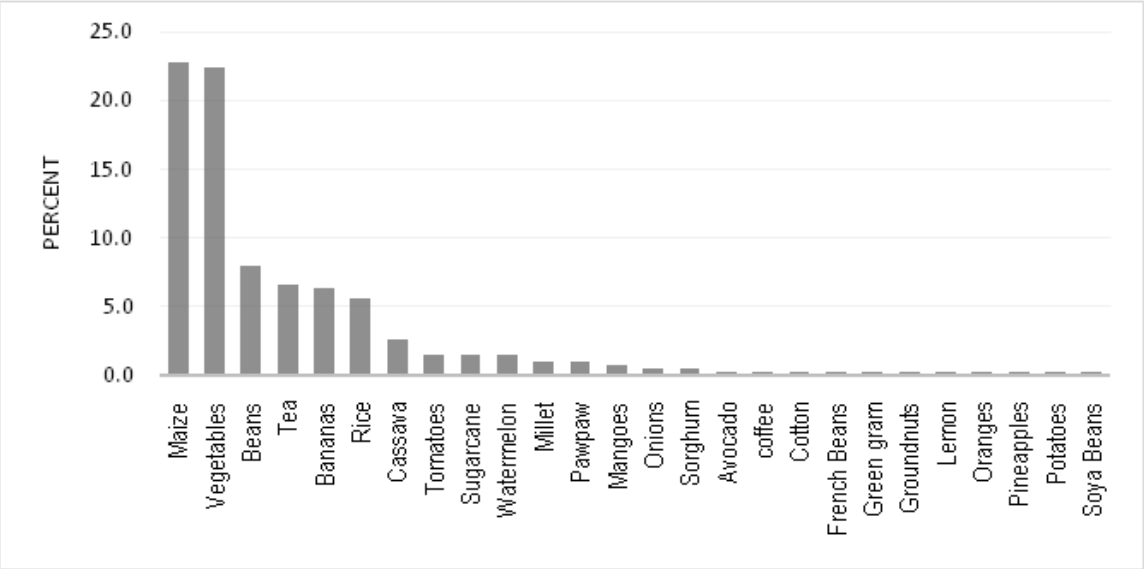

Figure 2. types of crops grown by households in the study areas.

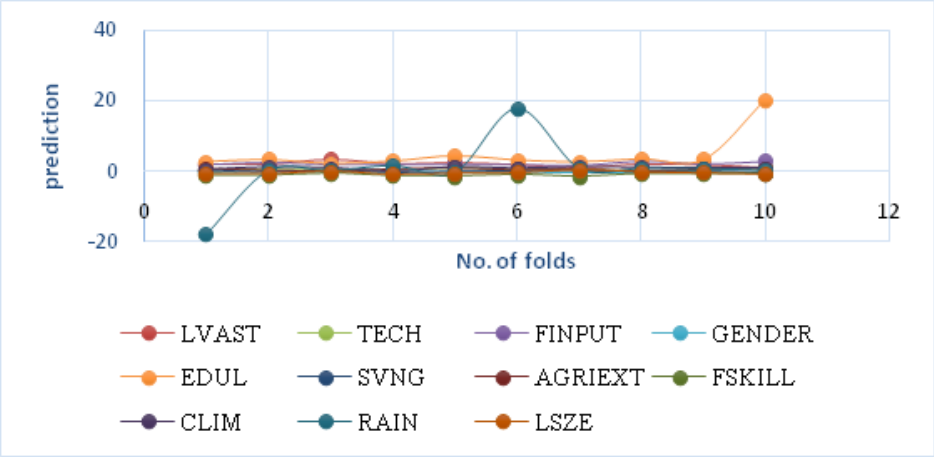

Figure 3.1. Result of 10-fold cross-validation for commercial farming choice.

The results show that our regression model correctly predicted and classified 109 (75%) of the total 146 actual observations of mixed subsistence category, under-prediction occurred in 36 (25%) cases wrongly categorizing into pure subsistence and 1 (0.7%) into the commercial category. Additionally, the model was able to correctly predict more than half 97 (65%) of the total 149 actual observations of pure subsistence farming category, and only underpredicted 50 (34%) which were categorized as mixed subsistence and 2 (1.3%) as a commercial category.

However, the model underpredicted horticulture by only 1 (6%) observation and instead wrongly placed horticulture predictions into 8(50%) mixed subsistence category and 7(44%) into pure subsistence. Likewise, it also underpredicted 4 (24%) of the 17 observations of commercial farming. Instead, it wrongly classified commercial farming observation into 10 (50%) pure subsistence categories and 3(18%) into mixed subsistence. The reason for the model underestimation for the horticulture and commercial categories can be explained by the small marginal percent (refer to Table 2) of the actual observations of commercial and horticulture farming choices in the study areas.

DISCUSSION

Overall, livelihood capitals acted in parallel and jointly to influence the decision choices of smallholders to participate in agribusiness. As expected, households with higher livelihood capital accumulation resulted in a higher probability of participating in agribusiness while those with limited livelihood capital ownership resulted in a lower probability to participate in agribusiness.

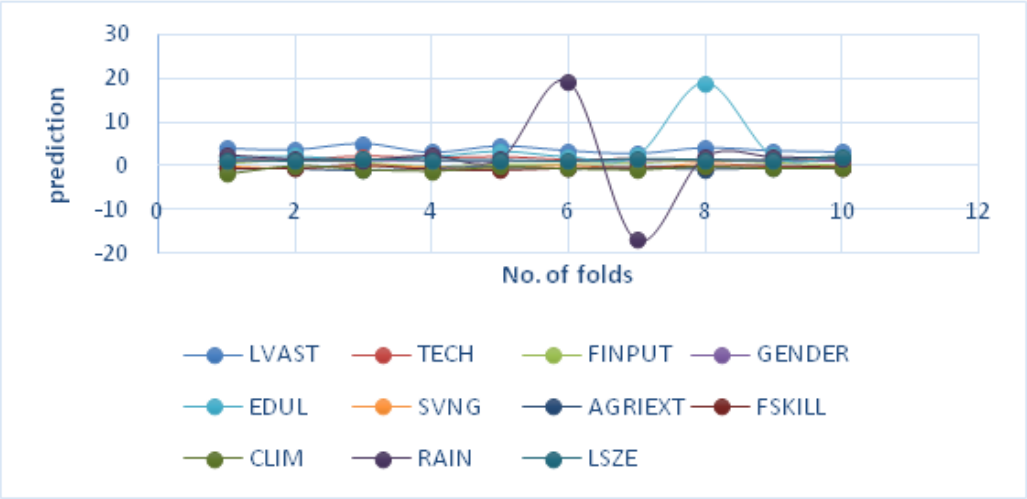

Figure 3.2: Result of 10-fold cross-validation for horticulture farming choice.

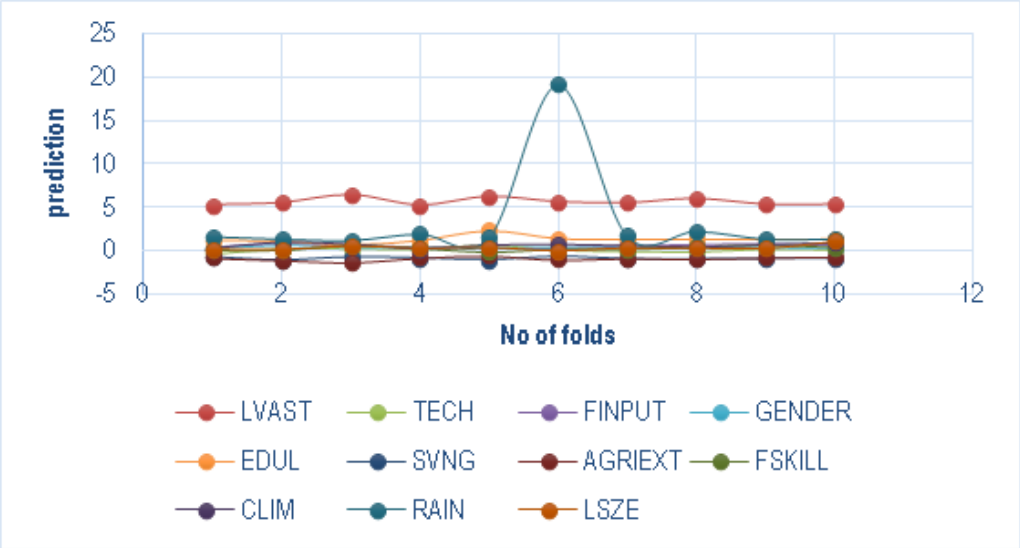

Figure 3.3. Result of 10-fold cross-validation for mixed subsistence choice.

A detailed analysis of the results is provided below.

GENDER of the household head had a positive and significant influence on smallholders' decision to participate in horticulture farming options at a 5% probability level. The odds ratio indicates that the probability of male household head participating in horticulture farming are 4.6 times more likely as would female household head if all factors are kept constant. Results of cross-tabulation of gender and farming type (Table 5) shows a higher percentage of male and engaged in horticulture (72.7%) and commercial (62.5%) farming. More females (53.5%) than males (46.5%) were confined in the subsistence production category.

Lack of participation by women in agribusiness activities could be explained by several factors observed from the study area; our findings show that more males than females had a higher literacy level, owned more assets, and had higher technical skills of agribusiness (horticulture farming is presumed to require a higher level of agribusiness skills and investment). Supportive evidence from empirical studies (Asfaw, Simane, Hassen, & Bantider, 2017) suggests that women are significantly more likely to engage in low-productivity and low-return agricultural activities in rural areas. For example, Abimbola (2013) argues that male-headed households are more likely to participate in agribusiness activities that fetch higher returns since they possess high technical knowledge of doing business. Policy and development interventions aimed at promoting gender mainstreaming in agribusiness development should be prioritized if women are to have more opportunity in participating in

Table 4. Results of the Hit ratio analysis on the predictive accuracy of the logistic regression model.

Farming categories		Predicted probabilities category				Actual Observations
		Horticulture	Commercial	Mixed Sub	Pure sub	
Horticulture	Count	**1 (6%)**	0 (0%)	8 (50%)	7 (44%)	16
Commercial	Count	0 (0%)	**4 (24%)**	3 (18%)	10 (59%)	17
Mixed subsistence	Count	0 (0%)	1 (0.7%)	**109 (75%)**	36 (25%)	146
Pure subsistence	Count	0 (0%)	2 (1.3%)	50 (34%)	**97 (65%)**	149

Table 5. Crosstabulation of farming system practiced by household's vs Gender of the household head

			Gender		Total
			Male	Female	
Farming types practiced by household	Pure & mixed subsistence	Count	148	170	318
		Per cent	(46.5%)	(53.5%)	(100%)
	Commercial	Count	20	12	32)
		Per cent	(62.5%)	(37.5%)	(100%)
	Horticulture	Count	24	9	33
		Per cent	(72.7%)	(27.3%)	(100%)

agribusiness. These should especially target the issue of women's land rights and tenure security, which has been attributed to affect investment confidence of women-headed households who would want to venture into higher income-generating agribusiness opportunities.

Education level (EDULVL) of the household head positively and significantly influenced smallholders' decision in diversifying into a commercial and mixed farming option, the results were significant at 99% and 95% confidence level, respectively. Interpretation of the odds-ratio shows that *ceteris paribus*, the odds of the likelihood of households in the reference category to participate in commercial and mixed farming option would be 12.1 and 7.2 times if the household head possessed a higher level of education. Generally, in the entire dataset of Nyando, the education levels of sampled participants were low, with more than half (66%) of interviewed household responding to having only completed primary level education. The survey findings also revealed that half (50%) of all sampled household heads with higher education qualification (college level and above) were in the formal (salaried) employment. Only 30% of the household heads with college education practiced farming, and none with university education had his main occupation in farming. This supports the argument that highly educated persons tend to diversify their livelihood options in off-farm and non-farm activities. The result of this finding contradicts with the findings obtained by several other studies (Abimbola, 2013; Eshetu, 2016; Gebru et al., 2018; Reimers & Klasen, 2013) who reported that a higher level of educational attainment had a positive impact on household choices in diversifying their livelihood strategies.

There is a widely shared perception that household heads with a higher level of education possess more agribusiness technical skills and hence more likely to participate in agribusiness. However, contrary to this perception, the general education did not seem to bequeath household heads with technical agribusiness skills in the two study areas. The results ofcrosstabulation between agribusiness skills possession and education level (Figure 4) revealed that agribusiness technical skills declined as level of education increased. Possible reasons could be that at higher education levels, people tend to get specialized skills other than farming and venture into formal employment which is presumed to fetch higher income returns than farming. There is need for tailor-made training interventions in agribusiness skills necessary to empower smallholders to exploit the increasing opportunities of agribusiness markets.

In figure 6, the sharp spikes of skills agribusiness possessions at 8 years of schooling indicate (primary level education), at 12 years indicate (secondary level), at 15 years indicate (college level) and at 20 years indicate (university level education). The small spikes at 0 years indicate that there were quite a number of households who never went to school but possessed some level agribusiness skills.

Agriculture extension services (AGRIEXT) was found to significantly ($p<0.05$) and negatively influence smallholder's decision in choosing mixed farming. In interpreting the odds ratio, keeping all other covariates constant, households in the reference category with limited or no access to extension services were 0.35 times less likely to diversify their farming to agribusiness. There was a low level of provision of agriculture extensions

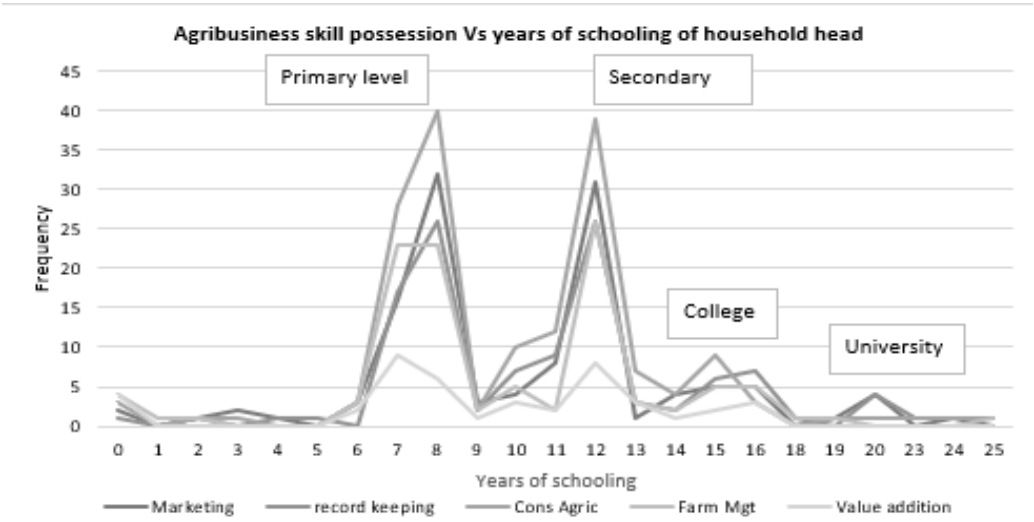

Figure 4. Household head education level vs agribusiness skills possession.

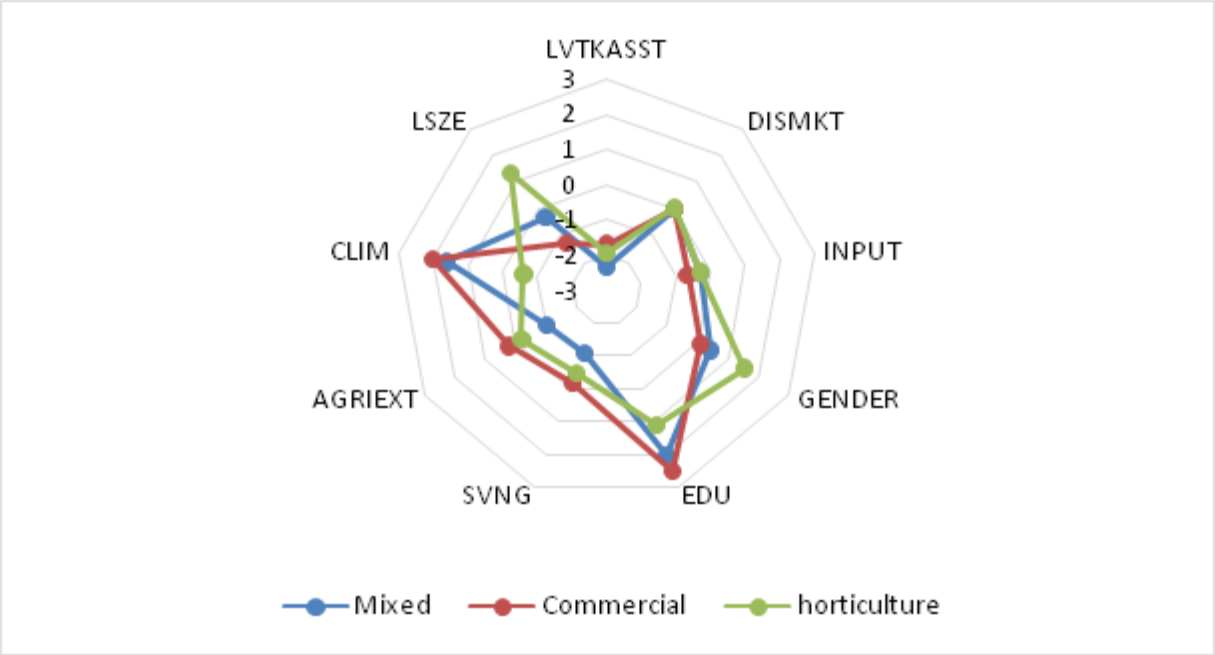

Figure 5. The extent of influence of predictor variables of smallholder farming choices.

services in the two study areas despite the high demands for agronomic skills by households. For example, a high percentage (83.8%) of households practicing mixed farming did not have access to agriculture extension services. Likewise, 80.6% of households practicing horticulture and 60.7% of those practicing commercial farming activities said they lacked access to extension services in the last year. Overall, only a marginal percent (14.3%) of respondents indicated to have either received or attended agriculture training organized by county government and other agencies in the last year. This may explain why the majority of households had low agribusiness technical skills and knowledge. This in turn affected their agricultural productivity and market participation; both of which were found to be very low among households in the study area. Agriculture extension services are a decisive component in supporting small scale agribusiness adoption especially in impacting agronomic skills and agronomic information provision. For example, in the study of Birhanu, Girma

and Puskur (2017), the provision of agricultural extension services significantly impacted the intensity of input use, agricultural productivity, technology adoption, and market participation of smallholders in Ethiopia. There is a need for the government and other stakeholder's collaboration in imparting agronomic skills and dissemination of relevant agribusiness information to poor smallholder farmers including crop husbandry, use, and application of herbicide, pesticides, and fertilizers usage. Other studies consistent with our findings include that of (Khan, Jamshed, Fatima, & Dhamija, 2019). In increasing poor smallholders participation in agribusiness, there is need for the government to design effective agriculture extension services that target household skills deficiencies. For example, in the study of Birhanu et al., (2017), the authors found that provision of agricultural services significantly impacted the intensity of input use, agricultural productivity, technology adoption and market participation of smallholders in Ethiopia.

Livestock assets (LVTASST) had a negative and significant ($p<.01$) influence on smallholder choices in diversifying in agribusiness farming choices. *Ceteris paribus*, odds ratio in favor of the likelihood of smallholders to choose commercial and horticulture farming choices decreased by a factor of 0.18 and 0.13, respectively, per unit ownership of livestock. Households with livestock assets were more likely to rely on supplementary income from livestock products (e.g. additional income of selling their products) than they would on income from farming activities. Our study findings also revealed unequal livelihood assets ownership within the households, with women owning more of low-value assets (chickens and birds) while men had higher ownership of high-value assets (cows and goats). The results of these findings concur with those of several other studies (M. Birhanu et al., 2017; Gebru et al., 2018; Maniriho & Nilsson, 2018).

Landholding size (LANDSIZE) positively and significantly ($p<.01$) influenced the likelihood for smallholders in the reference category to participate in horticulture farming but also had a negative influence on mixed and commercial farming. Interpreting the odds ratio, a unit increment in landholding size could increase the probability of smallholder farmers' practicing pure subsistence to shift to horticulture farming by 3.5 times, if all other factors were held constant. However, small land sizes diminished the odds of households to diversify into other farming types. In interpreting the odds ratio, c*eteris paribus*, there is a low chance of 0.74 and 0.29 odds of a household owning small land size to diversify in mixed and commercial farming, respectively. The majority of smallholders owned very small uneconomical land sizes, a factor that jeopardized their choices of diversifying in agribusiness. Households with small land sizes barely produced enough food to support their household food demands. About 58% of sampled households reported their farms produced barely enough food to sustain them till the next harvest. High population growth is resulting in high land fragmentation and small land sizes, which is a big threat to food security for smallholder households in the two study areas. For example, Vihigacounty had one of the highest population density in Kenya of 2019 census (1,117 persons per km2) against the nation's average of 92 persons per km^2 (Government of Kenya (GoK), 2019). As a consequence, the region grapples with high food insecurity incidences (Vihiga County development Plan 2018-2022). Promoting pro-poor agriculture development strategies and policies among smallholder farmers is seen as an alternate strategy for increasing aggregate-level food availability for smallholder households. Such strategies have been viewed as very promising pathways to accelerate poverty reduction in rural areas of developing countries (Klasen & Reimers, 2017a; Tobin, Glenna, & Devaux, 2016). The result of this finding is consistent with the findings of other studies (L. Birhanu & Haji, 2014; Gebru et al., 2018; Khan et al., 2019).

Distant to markets (DISMKT) was found to exert a negative influence on smallholders from participating in horticulture farming at 0.01 level of significance. The negative sign of the coefficient indicates that the probability of a household to participate in horticulture farming will diminish with an increase in distance from the input source. In interpreting the odd ratio, if all factors are kept constant, there is 0.99 likelihood for a household in the reference category to engage in horticulture if it is located farther away from the market center. Nyando and Vihiga are highly productive areas for horticulture production, yet the deplorable state of dirt roads makes market accessibility difficult. Poor infrastructure has been observed to increase transaction costs and distances have been observed to confine rural smallholders to the production of low-value and non-perishable commodities, thereby diminishing the prospects of adoption of agribusiness. As distances from the main road increased, so does the transport costs, which in turn affected the profits margins. This ultimately diminishes the allure of market-oriented farming among rural smallholders. Small-scale agribusiness ventures are most susceptible to food price and transport cost shocks, especially horticulture farming, which places a high demand for efficient infrastructure connectivity (Sellitto, Vial, & Viegas, 2018). Since agricultural policies are rarely geared towards the improvement of road infrastructure, a multi sectoral collaboration with sectors such as spatial planning and transport and infrastructure are needed to address infrastructural needs and deficits in rural and peri-urban areas. This study finding concurs with that of (Teshome & Edriss, 2013).

***Weather* variability** (CLIM), especially drought and famine were identified to be positive and highly significant, (at 99% confidence level) decisive factors influencing households wishing to participate in commercial and mixed subsistencefarming. In interpreting the odds ratio, the

Is 7.4 and 5.1 odds of a smallholder subsistence-oriented household to diversify into commercial and mixed farming, respectively, if it is vulnerable to climate change. In the study area, about 67.8% of households responded to experience the negative effects of climate change which had high influences on their farming activities. Yet, government responses to addressing the vulnerability of smallholder households from climate change were found to be minimal, and rather reactive than proactive. For example, in the Nyando area that experiences a high risk of flooding, the government response was by dredging the river. However, the ripple effect of this was felt by many farmers who reported that their soil fertility has significantly lowered since the fertile silt brought by floodwater was cut off. This, they reported, reduced their farm productivity. As a consequence, production costs increased as they spent more on buying fertilizers and pesticides compared to before the dredging was done. Climate variability in Kenya and sub-Saharan Africa continue to aggravate smallholder's productivity, causing severe food shortages (Abdul-Razak & Kruse, 2017; Chandra, McNamara, Dargusch, Caspe, & Dalabajan, 2017; Tian & Lemos, 2017). Overarching strategies, both mitigative and adoptive are required to effectively strengthen the resilience and coping strategies of resource-poor smallholders to climate change effect (Abdul-Razak & Kruse, 2017). These would include promoting farmer-led technological innovations which have been reported to significantly reduce the severity of hunger and food shortages (Knickel et al., 2018; Tambo & Wünscher, 2017), harnessing local knowledge to improve the agronomic skills (Gutiérrez García, Gutiérrez-Montes, Hernández Núñez, Suárez Salazar, & Casanoves, 2020), promoting agricultural intensification and inclusive monitoring systems. Besides, Chriest & Niles (Chriest & Niles, 2018) empirical research found that rural households with high levels of social capital enabled them to build a higher resilience and adaptation to climate change and food insecurity. This study finding concurs with that of other studies (Khan et al., 2019; Nguyen, Nguyen, Lippe, & Grote, 2017).

Household savings (SVNG) was found to significantly ($p<.05$) and negatively influence farmers decision in choosing mixed subsistence. Ceteris paribus, the odds ratio in favor of the probability of households to choose mixed farming decreased by a factor of 0.33 times as savings of the household decreased by one unit. This means that poor households with little or no savings have a lower probability of engaging in mixed subsistence farming. It has been found that if households do not have access to credit, farm inputs, and other productive capital resources, they are likely to be more vulnerable to food insecurity than those who have access (Wagah & Mwehe, 2019). The results of this study are consistent with the findings of (Chriest & Niles, 2018). There is a need for policymakers to design and implement pro-poor policy and development interventions including improving access to banking services, lowering collaterals, and interest rates for the poor and marginalized households. Besides, a saving culture among poor households should be promoted.

Farm inputs (INPUT) including fertilizers, hybrid seeds, and other farm implements were found to significantly and negatively influence commercial farming adoption at a 90% confidence level. In interpreting the odd ratio, if all other factors are kept constant, the likelihood of pure subsistence households to participate in commercial farming would decrease by 0.51 times if they have no farm inputs. The result of this finding is consistent with the findings of (Khan et al., 2019).

Level of influence of predictor variables on smallholder choices

We also wanted to find out the level of influence each predictor variable has on smallholders' choices in diversifying in agribusiness. We used the coefficient of the statistically significant variables to report the degree of influence. According to Tabachnick and Fidell (2007), variables which tend to change the odds of the outcomes have the most influence. Thus, the coefficient was sorted from very low (negative) to very high (positive) in classifying the extent of influence of the variables on the three farming choices. The results (Figure 5) indicate that household choice of the commercial farming option was positively influenced by EDULVL, CLIM, and INPUT, while LVSTCK had a negative and low influence. Household choice in horticulture option was highly influenced by GENDER, LANDSIZE, DISMK, and AGRIEXT while LVSTCK exerted very low influence. Likewise, EDULVL, AGRIEXT, and CLIM exerted a positive influence on mixed farming choice.

From the analysis findings, we report that higher human, economic, and financial capital endowments could result in higher participation in agribusiness. In effect, strategies aimed at promoting and integrating smallholder farmers in agribusiness would require a targeted improvement of households' livelihood capital base. As Wagah and Mwehe (2019) notes, households with greater access to a variety of resources arising from linkages, partnerships, and capital asset endowments are expected to be more effective in achieving improved livelihoods and food security than those with low resource access

Policy implication

Results from investigations on the the role of livelihood capitals in stimulating smallholder participation in contemporary agribusiness is of great importance since this would lead to poverty reduction, food and nutrition security and diversification of rural economies in sub-Saharan Africa. This study has shown that amongst the barriers of smallholder participation in agribusiness is their high poverty levels, that manifest in lack of or insufficient

access to productive livelihood capitals, which significantly jeopardize their ability to pull themselves out of the vicious cycle of poverty and food insecurity. However, the challenge for many rural smallholders in Sub-Sahara Africa is that they are peculiarly and tragically the most asset poor and food-insecure demographic group. Nonetheless, as Donovan & Poole (2014) note, the stronger a household's asset base, the greater is its ability to expand and intensify livelihood activities, with those highly endowed having a higher probability to be food secure and to participate in agribusiness than others. It is imperative for policymakers to recognize the critical role livelihood capitals play when designing pro-poor agriculture diversification strategies aimed at improving food security, of poverty-stricken rural households in LMICs (Manlosa et al., 2019; Pritchard et al., 2019; Vicol, Pritchard, & Htay, 2018). Livelihood capital improvement would not only complement poor households' efforts in meeting food and nutrition security but also rejuvenate their livelihood diversification efforts. As Abraham &Pingali, (2020) emphasises, "increased market participation also marks the transition from subsistence-based agriculture to commercialized agriculture" (pg. 192), targeting of livelihood capitals would also stimulate poor smallholders interest in participation in agribusiness activities.

CONCLUSION

The catalytic role livelihood capitals have on smallholder decision making and choices to diversify in agribusiness activities cannot be downplayed. As the results from logistic regression model has shown, higher livelihood capital ownership resulted in a higher probability of households to diversify in agribusiness activities while lower livelihood capitals ownership resulted in lower probability. All livelihood capitals acted in parallel and jointly to influence the decisions of smallholders. Smallholders' decision to participate in agribusiness was positively and significantly determined by livelihood capitals such as education level, gender, landholding size, savings, access to agriculture extension services, livestock ownership, input access, and proximity to markets. Exogenous variables like climate variability also had a higher influence. The study highlights the need for policymakers to formulate and prioritize the implementation of inclusive pro-poor agricultural policies and interventions that mainly target the improvement of smallholders' livelihood capitals and their proper utilization. Such strategies have been taunted as the most promising pathways to accelerate poverty reduction in rural areas of developing countries (Klasen & Reimers, 2017b, 2017a; Tobin et al., 2016) and could enable smallholders to shift from subsistence-oriented production to market-oriented agribusiness.

Limitation of the study

The limitation of this study emanates from the complex nature of factor interactions that influence smallholder farming decisions daily. The possibility of unintended interactions emanating from confounding stressors and complex 'wicked' problems cannot be ruled out. These problems include climate change, poverty, demographic shifts, and social-spatial inequality, which are overrunning poor smallholder farmers coping capacity and resilience. Further studies that can interrogate exhaustively, all the possible combinations of productive livelihood assets, taking into consideration the effect of confounding stressors and other exogenous factors are needed. Besides, further research could combine the influence of spatial-explicit (geographic) factors and their effect on smallholder decision choices. This would shed more light on location-specific spatial determinants of smallholder agribusiness adoption and practices.

Declarations

Abbreviations: LMICs (Low- and Middle-Income Countries)

Ethics approval and consent to participate:

Ethical approval to conduct this study was granted by Maseno University Ethical Review Committee, with reference number (MSU /DRPI/ MUERC/00633/18). Permission to interview was sought from every participant before the commencement of the interviews.

Consent for publication:

Not applicable.

Availability of data and materials:

The data supporting the results presented in this study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

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