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Determinants of livelihood diversification in an integrated agricultural and non-agricultural livelihood system in Ghana

Jude Dokbila Kolog [a,*], Freda Elikplim Asem [a], Akwasi Mensah-Bonsu [a], Roger Ayimbillah Atinga [b]

[a] Department of Agricultural Economics and Agribusiness, P. O. Box LG 68, University of Ghana, Legon, Accra, Ghana
[b] Department of Health Services Management, P. O. Box LG 78, University of Ghana, Legon, Accra, Ghana

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ABSTRACT

The diversification of livelihoods by households has been widely acknowledged as a way to overcome food insecurity and poverty challenges in developing countries. Diversification of livelihoods helps spread the risk among multiple livelihood earning activities to provide households with a range of their food needs all year round. By examining the integrated livelihood systems of 405 rural farm households in the Upper East Region of Ghana, empirical evidence is provided in this study using the Sustainable Livelihoods Framework to advance arguments in the literature for the creation of sustainable strategies that improve diversified livelihood systems. The mean diversification indices estimated were 0.45 for agricultural diversification systems, 0.32 for non-agricultural diversification systems and 0.59 for integrated agricultural and non-agricultural diversification systems. With the use of the Cragg two-step regression model, we demonstrate that the decision to diversify and the extent of diversification of rural livelihoods are distinct decisions and are influenced by distinct sets of factors. Similarly, for the three categories of livelihood diversification studied, the effect of these factors also differed. The results emphasize the significance of access to good road network, credit and market information in encouraging rural farm households to diversify their livelihoods. In the short term, improving access to credit and market information through community-based initiatives can provide immediate support to rural households. Communities should also organize local markets and cooperatives to strengthen their economic resilience. While government and stakeholders should focus on long-term infrastructure projects, these community actions can complement such efforts and contribute to achieving global and regional goals targeting food insecurity and poverty eradication.

Introduction

The diversification of livelihoods has been acknowledged as one of the strategies to eradicate the problems of food insecurity and poverty, especially in rural settings. Livelihood diversification refers to the process by which individuals, households or communities seek to reduce their dependence on a single source of livelihood due to economic uncertainties, environmental changes or other factors that may threaten the stability of their primary livelihood by engaging in multiple means of subsistence [1,2]. Livelihoods in rural communities have been greatly affected by issues of food insecurity and poverty for ages. Farm households are more exposed to

* Corresponding author.
E-mail address: jdkolog@st.ug.edu.gh (J.D. Kolog).

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poverty relative to those in other sectors of the economy, of which about 42.7 % of farm or self-employed agricultural households in Ghana fall below the poverty line [3]. Globally, climate change has also been found to be a hindrance, with the agricultural sector being the most affected, especially in Sub-Saharan Africa [4-6]. For this reason, households in rural areas of developing countries whose livelihoods are mainly agriculture dependent adopt different livelihood strategies to diversify their livelihood sources to spread the risk associated with livelihood activity [1,7]. Livelihood diversification has long been pursued for its known benefits globally, especially in the case of rural settings [2,8,9].

Globally, rural livelihoods have been known to be agriculture dependent and confront the stark reality of climate change-induced challenges [2,6]. Increasingly erratic rainfall patterns, prolonged droughts and unpredictable weather events pushe households towards the brink of vulnerability [6,9]. The high uncertainty in the main livelihood activity of rural farm households plunges them further into poverty and most farm households might not be able to meet their essential needs, leading households to go in search for alternative means of livelihood to cope. For this reason, many households rely on a blend of non-agricultural and agricultural livelihoods to earn a living. In developing countries, rural farm households in their pursuit of food security, consume and sell off their surplus produce [10,11]. Rural households also rely on non-agricultural earnings to sustain their livelihoods [12]. Climate extremes coupled with other factors render some geographic locations even more vulnerable in their quest to earn a livelihood. For instance, the Upper East Region of Ghana records rainfall within 800 mm and 1100 mm on the average per annum, which is the lowest in the country, with only one rainy season and the highest temperature of 43 °C. [13] indicated that agriculture is associated with many risks, so the livelihood of farm households is adversely affected by erratic rainfall. It is therefore, no mere coincidence that the Upper East Region is considered the most food insecure and one of the poorest regions in Ghana [14-16].

The significance of livelihood diversification in the fight against food insecurity and poverty has been documented [2,8,17]. However, studies on livelihood diversification are few and have mainly focused on income or non-farm diversification [18-20]. Limited attention is paid to the main push factors that lead rural farm households to diversify their livelihoods. To the best of our knowledge, no study has been conducted focusing on diversification of livelihoods in an integrated agricultural and non-agricultural livelihood system. Previous studies have treated the decision to diversify and the extent of diversification as a single decision which leads to confounding recommendations [21]. Only [21] studied the two diversification decisions separately, thus, the discrete decision to diversify and the continuous decision to increase the extent of diversity, but in the context of an integrated crop-livestock system. This paper, therefore, adds to the diversification literature by examining, discretely and continuously, the factors that influence diversification in agricultural, non-agricultural as well as integrated agricultural and non-agricultural livelihood systems as a coping strategy to poverty and food insecurity in Ghana. This is one of the few papers to disaggregate the diversification decision-making process and apply the Cragg two-step approach to study both the discrete and continuous diversification decisions, which in the past has been mostly analysed as a joint decision process deprived of performing the required tests.

The concept and determinants of livelihood diversification

The diversification of livelihoods is a process where rural households create a more diverse portfolio of assets and enterprises to survive and enhance their living standard [22]. Livelihood diversification is also defined as "the process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and to improve their standards of living" [1]. Livelihood diversification is defined in this study following [23] as "attempts by individuals and households to find new ways to raise incomes and reduce environmental risk, which differ sharply by the degree of freedom of choice (to diversify or not), and the reversibility of the outcome".

Studies have categorised livelihoods distinctively. [24] classified income sources into three categories; farm, on-farm and off-farm. [25,26], however, contended that though not suitable, many studies have used these terms interchangeably and therefore argued for some form of standardisation of the terms thereby suggesting the use of standard national accounting sectoral classifications to address this misunderstanding. They proposed the classification of livelihood sources by sector (agricultural versus non-agricultural), function (wage employment versus self-employment) and location (on-farm versus off-farm) [27]. For the purpose of this study, livelihood sources are classified by sector, thus, agricultural and non-agricultural livelihoods. In Ghana, a typical rural farm household will keep some livestock or cultivate some crops, or a combination of these, in addition to other non-agricultural activities to earn a living. The main aim of engaging in these non-agricultural activities is to complement the agricultural livelihood sources. For this paper, an integrated agricultural-non-agricultural system will refer to the combination of any one or more agricultural and non-agricultural livelihood activities.

In the livelihood diversification literature, individual, household, community and institutional factors among others have been identified to influence a household's decision to diversify their livelihood sources. In a study [28], using a multinomial logit model to estimate the predictors of diversification into different livelihood sources found age of household head, educational level of household head, household size, dependency ratio, land size, access to irrigation, access to agricultural inputs, access to extension services as well as access to credit being significant factors influencing livelihood diversification in the Eastern Tigray Region of Ethiopia. In analyzing the determining factors of diversification of livelihoods, thus, share of livestock income in pastoral societies of Southern Ethiopia [29], found livestock ownership, distance to market and household size positively influence livelihood diversification. In another study [17], reported that household size, farm size, sex, age and dependency ratio influenced livelihood diversification significantly in Nigeria. Using a multinomial logit model with evidence from Western Ethiopia [30], found that household size, livestock holding and access to cooperative had a significantly positive effect on livelihood diversification whereas household head's age, extension contact, accessibility to credit and fertilizer usage had a significant negative effect on diversification into different livelihood sources. Another study by [31], where nonfarm diversification was used as a proxy for livelihood diversification, age, dependency ratio, distance to market,

educational level, family size, access to cooperative and access to irrigation were drivers of livelihood diversification. One theme is obvious from the above, these determinants of livelihood diversification differ from one place to another in terms of the direction and extent of their effect on diversification. This study, therefore, examines the factors that influence rural households' choice and extent of diversification of livelihoods in the study area.

Measuring diversification

Many techniques have been used as indicators of diversification. The most commonly used techniques include; the Simpson index, the Herfindahl index and the Ogive index of diversification [32-34]. Both the Herfindahl Index and the Ogive Index are revenue-based measurements of diversification, unlike the Simpson index which measures diversification horizontally with regard to the proportion of area allocated to different activities [21]. Hence, the Herfindahl Index and the Ogive Index are appropriate for measuring diversity in agricultural, non-agricultural and integrated agricultural and non-agricultural livelihood enterprises. We adopt the Herfindahl Index to estimate diversity in an integrated agricultural and non-agricultural livelihood system. This index is chosen due to its suitability to the study's objectives, ease of use and straightforward interpretation. Additionally, it allows for easy comparison with the findings of other studies like [21,35], unlike the more complex Ogive index.

Materials and methods

Study setting

This study was conducted in four districts in the Upper East Region of Ghana. The selected districts included the Talensi, Nabdam, Kassena-Nankana West and Kassena-Nankana East districts, respectively. The Upper East Region is located in the North-Eastern corner of Ghana with its capital at Bolgatanga and covers an overall land area of 8848 km, which is approximately 3 % of Ghana's total land area [36]. The region lies between latitude 10° 15′ and 10° 10′ N, longitude 0° and 1° 4′W. The map of the study area with sampled communities are shown in Fig. 1.

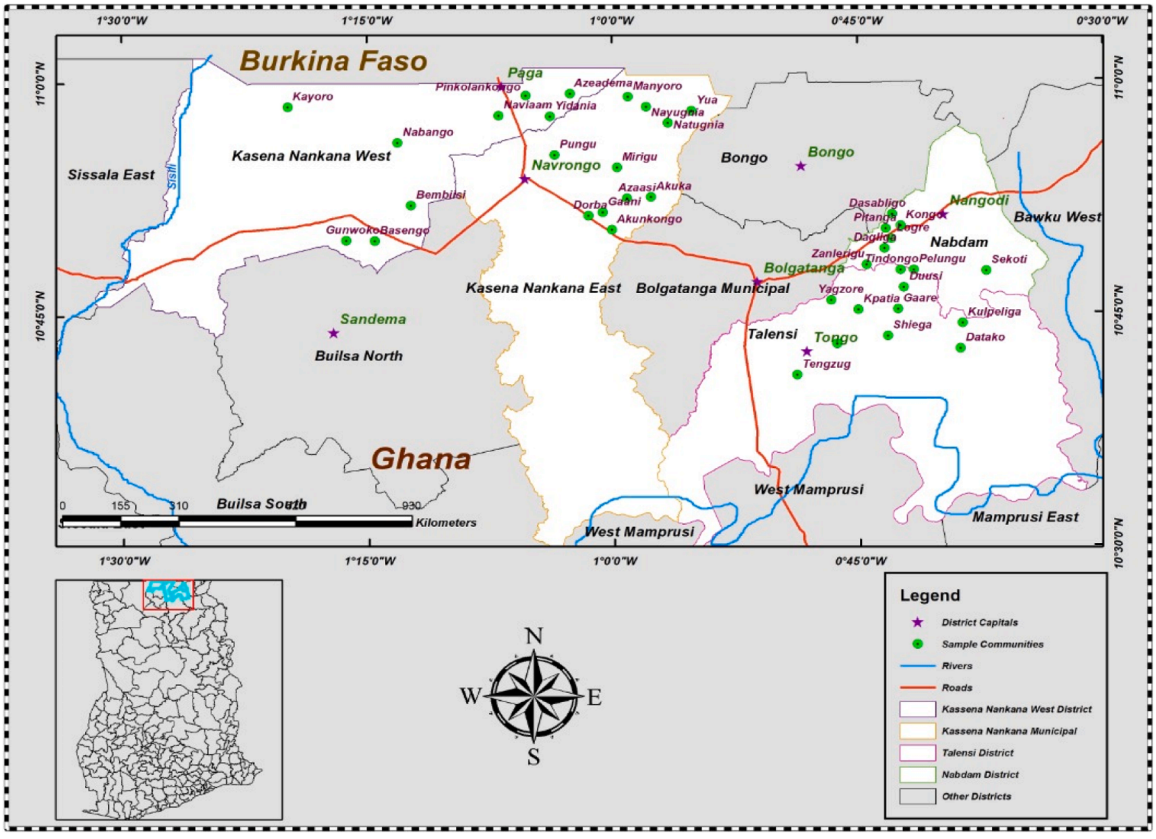

Fig. 1. Map of the study area.
Source: Remote Sensing and Geographic Information System Laboratory, University of Ghana (2019).

Data and sampling technique

A multi-stage sampling technique was employed in this study consisting of four stages. These stages used purposive, systematic and simple random sampling methods at appropriate stages. The foremost phase involved selecting the Upper East Region. The region was selected purposely for this study because of its well-documented vulnerability regarding food insecurity and livelihood earning activities in Ghana [14]. Livelihood diversification has always been pursued as a food insecurity mitigating strategy and earlier studies have pointed to the region being the most affected region with respect to food insecurity in Ghana [14,37]. From a rural farm household population of 127,082 [36] in the region, a sample size of 399 was calculated with the formula;

$n = \frac{N}{1+N(\varepsilon)^2}$, as proposed by [38], where n = the sample size,

N = the population size (127,082) and

ε = the sampling error (5 % = 0.05).

To cater for non-responses, the sample size of 399 was increased by 5 % to 419 farm households.

The second stage involved selecting the four districts purposely. These four districts were selected for the study because an earlier study by [37] found that these four districts which were all in the Upper East region were part of the seven most food insecure districts in the whole of northern Ghana. The third stage involved a systematic sampling of ten communities from each district using a list of rural farming communities provided by the respective district assemblies. For this stage, the second community from every group of five communities in the list was selected based on a sample fraction of one in every five communities. This was after the second community was first randomly selected based on the sample fraction. Finally, for the fourth stage, a total of 419 farm households were sampled using a random sampling technique with probability proportionate to the number of households in each of the ten communities sampled from each district. This was done by first listing all households in each of the sampled communities. Then, using probability proportionate to the number of households in each community, households were randomly selected from these lists. Enumerators visited the selected households and conducted interviews with those who agreed to participate. Of the 419 farm households sampled, 405(97 %) successfully completed the questionnaire with our four trained field research assistants. By distribution of sample, 120 farm households were sampled in Talensi, 60 in Nabdam, 100 in Kassena-Nankana West and 125 in Kassena Nankana Municipal. The sample sizes for each community were determined based on the population proportion of households in each district, ensuring that the sample is representative of the population in the respective communities. This proportional sampling method ensured that each district's sample size reflects its share of the total population, thereby, providing a reliable representation of the region's diverse households. Cross-sectional data were collected from mainly household heads of sampled farm households using a structured questionnaire following pretesting among 10 respondents a week earlier. The purpose of the pretest exercise was to ensure the instrument was valid and could be used for the purpose. Feedback from this exercise was incorporated into the final instrument used for the study. The questionnaire which required an average of 30 min to complete was mainly structured in two parts. The first part captured household level demographic data, community level and institutional factors that were hypothesized to influence livelihood diversification. The second part captured all household livelihood earning activities. Field observations confirmed that participants typically took around 30 min to complete a single questionnaire as expected.

Theoretical framework

Rural farm households' decision to diversify their livelihood activities is centered on the concept of diversification, which the basic assumption, according to [39], is rooted in the utility maximization theory. The latent utility of the ith household for the jth diversification choice is thus, represented by U_{ji}, where $j = 1$ or $j = 0$ should the household be diversified or otherwise. It is assumed that the utility derived by a household from diversifying their activities is dependent on a vector of specific farm and household characteristics, $G_{i,}$ and a vector of characteristics linked with diversification, K_i, for the ith household. The utility is assumed to be a function of the vector of observed farm-specific, household-specific, institutional, diversification-related factors and a random error term with zero mean although the utility is a latent unobserved variable in a linear relationship. This is specified as follows;

$$U_{ji} = X_i\alpha_j + e_{ji}, j = 0, 1; \text{and } i = 1, 2, 3, \ldots..405 \quad (1)$$

Where X_i is a vector of values of variables hypothesised to influence the ith household's utility derived.

Since utilities (U_{ji}) are assumed random, the ith household will only select the alternative $j = 1$ if $U_{1i} > U_{0i}$ or if the latent unobservable random variable, $d_i = U_{1i} - U_{0i}$, is positive. Thus, a household will only diversify its livelihood activities within each livelihood strategy if the expected utility of diversifying is more than the expected utility of not diversifying.

Specification of empirical model

Indicators of diversification are computed first using the Herfindahl index (HI) following [21,40]. Secondly, the determinants of livelihood diversification were estimated with the use of Cragg's two-step model as proposed by [41]. For the preliminary step, the probit model was employed in analyzing the discrete decision of farm households to diversify or not to diversify. Secondly, analysis of the intensity of diversification by the subsample that was considered to diversify from the first stage was done using a truncated regression model. The use of the truncated regression model to analyse the second step allowed for the analysis of only the subsample that diversified their livelihood activities. Thus, the subsample that did not diversify their livelihoods were left out in the analysis of the factors influencing the extent of diversification since they did not diversify. The HI is specified as;

$$HI = \sum_{k=1}^{n} S_k^2 \tag{2}$$

Where S_k^2 denotes the square of the revenue share of the *k*th agricultural or non-agricultural activity in the total revenue for a household's agricultural, non-agricultural or integrated agricultural and non-agricultural livelihood ventures, respectively, $k = 1, 2,\ldots,$ n (number of ventures involved in all household's livelihood operations)

The HI is used to calculate the level of diversity in agricultural activities (ADI), non-agricultural activities (NADI) and integrated agricultural and non-agricultural activities (ANDI). The range of the HI is between one and zero. HI of one denotes specializing completely, thus, only one activity undertaken, while an index closer to zero indicates near-complete diversification. The HI for agricultural (HI_A), non-agricultural (HI_N) and integrated agricultural and non-agricultural (HI_{AN}) activities are computed. ADI, NDI and ANDI are then obtained by transforming the respective HI as follows;

$$\mathrm{ADI} = 1 - \mathrm{HI_A}; \mathrm{NADI} = 1 - \mathrm{HI_N} \mathrm{and} \mathrm{ANDI} = 1 - \mathrm{HI_{AN}} \tag{3}$$

Households in this study consist of households who diversify their livelihoods by engaging in diverse agricultural, non-agricultural activities or both activities and those who did not diversify, thus, engaged in at most one livelihood activity in that sector of livelihood source. Households are considered to be diversified when they obtained an ADI, NADI and ANDI of 0.5 or more, respectively and those with ADI, NADI and ANDI of <0.5 are considered not diversified. Let $\boldsymbol{d_i}$ be the discrete decision by households, such that the decision to diversify is $\boldsymbol{d_i} = 1$, otherwise, $\boldsymbol{d_i} = 0$. For this study, the separability and selectivity bias tests in choices are conducted. In the case where separability is established, a further test is carried out to know if both decisions are not dependent on one another. This study assumed that the same variable set influences the discrete decision by farm households to diversify and the continuous decision to increase the extent of diversification of their livelihood activities but these variables affect the two decisions differently. Additionally, should initial analyses with Heckman's model reveal insignificant Mill's ratios, this, [42] draws two direct inferences: firstly, it implies insignificant sample selection bias; and also, indicates that distinct variables can determine the discrete and continuous livelihood diversification decisions. Thus, the two models can be separately estimated and consequently, using the Cragg two-step model is appropriate in estimating the discrete and continuous determinants of livelihood diversification in an integrated agricultural and non-agricultural livelihood system.

The discrete decision by households to diversify their livelihood strategy or not was estimated by the probit model specified as;

$$\begin{aligned} \mathrm{P_i} &= \mathrm{P(d_i = 1) = P(U_{1i} > U_{0i})} \\ &= \mathrm{P(X_{i\alpha 1} + e_{1i} > X_{i\alpha 0} + e_{0i}) = P(\mu_i < X_i\beta)} \\ &= \mathrm{X_i\beta + \mu_i \ Choice\ of\ participation} \end{aligned} \tag{4}$$

Where X_i represents variables that explains the probability (P_i) of the discrete decision to diversify or not to diversify. μ_i is an error term characterised as: independent, homoscedastic, normally distributed.

Given that a household is considered to have diversified from the first step, the household's continuous decision of the degree of diversification is estimated by the truncated regression model specified as follows;

$$\mathrm{P_{i2} = X_i\alpha + \varepsilon \ Intensification\ Decision} \tag{5}$$

$$\mathrm{D_i / d_i^* > X_i\alpha + \varepsilon_i > L} \tag{6}$$

Where P_{i2}, D_i, d_i, X_i, ε_i and L represents the latent endogenous term denoting household's intensification decision to increase the extent of diversification, random variable that defines diversification, unobservable latent variable, vector of values of explanatory variables hypothesized to affect the diversification and intensity of livelihood diversification, error term and unobservable threshold value ($d_i = 0$ or $d_i = 1$), respectively.

Using Cragg's two-step model was substantiated by conducting a joint decision test following [21,43]. This was done by estimating separately the probit, truncated and Tobit models of livelihood diversification and using their log-likelihood values to calculate the likelihood ratio test statistic, as follows:

$$\lambda = -2(\mathrm{LL_{Probit}} + \mathrm{LL_{Truncated}} - -\mathrm{LL_{Tobit}}) \tag{7}$$

Where LL_{Probit}, $LL_{Truncated}$ and LL_{Tobit} represent the log-likelihood functions of the probit, truncated and Tobit regression models, respectively, per the three livelihood diversification strategies under consideration in this study. λ is the likelihood ratio test statistic and must be more than the χ^2 critical value (with 13 degrees of freedom for this study) to validate the use of Cragg's two-step model. Preliminary analyses of the data with the Heckman selection model revealed insignificant Mill's ratios. Following interpretation by [21], this has two implications for this study: first, it indicates that selection bias is not significant in the sample; secondly, it suggests that different factors can influence the discrete decision to diversify and the continuous diversification decisions regarding the extent of diversification [42]. For instance, a rural farm household may decide to diversify their agricultural livelihoods without considering how much additional crops or livestock they intend to grow. Additional activities may be continuously added as the production season unfolds. Consequently, the two models can be estimated separately, thus, the use of the Cragg two-step model was appropriate for estimating the determinants of livelihood diversification in an integrated agricultural and non- agricultural livelihood system.

Model diagnostics and justification of model appropriateness

To validate the choice of model, the likelihood ratio test was carried out by running the probit, truncated and Tobit regression models for the data set. The results revealed that the likelihood ratio test statistic (λ) was greater than the χ^2 critical value (with 13 degrees of freedom). This validated the use of the Cragg's two-step model in this study. For model robustness, the model was run with robust standard errors reported as shown in Table 3.

Results and discussion

Summary statistics of variables

The summary statistics of variables for the sampled rural farm households for the study are presented in Table 1. The average age of the heads of the sampled households was about 50 years. About 85 % of the sampled households were male headed with about 45 % of them being educated and about 87 % of the household heads were married. The average percentage of dependents was about 65 %. Only about 14 % perceived that there were jobs available in their area. The average farm size of sampled households was about 1.5 hectares and traveled an average distance of 2.37 km to the nearest market. From the sampled households, 54 %, 60 %, 24 %, 44 % and 24 % had access to good roads, market information, credit, extension and formal cooperative, respectively.

Distribution of diversification indices

Households' diversification in agricultural livelihood earning activities was on the high, as the average diversification index estimated from the sampled households was 0.73 with a standard deviation of 0.13, as shown in Table 2. As shown in Fig. 2, agricultural diversification indices were generally distributed symmetrically. Majority of households diversified their agricultural livelihood earning activities, thus obtained an Agricultural Diversification Index (ADI) of at least 0.5. Only 0.49 % of households engaged in a single agricultural livelihood earning activity, thus obtaining an ADI of zero (0).

A similar distribution was obtained for the integrated agricultural and non-agricultural diversification indices, as shown in Fig. 4. The average integrated Agricultural and Non-agricultural Diversification Index (ANDI) was 0.69 and a standard deviation of 0.20, as shown in Table 2. About 85 % of the households engaged in integrated agricultural and non-agricultural livelihood activities diversifying their activities, thus obtaining an index of at least 0.5. It is justifiable to say that the majority within this sub-sample, diversified their integrated agricultural and non-agricultural livelihood activities.

The narrative is somehow different with regard to diversity in non-agricultural livelihood activities. With an average diversification index of 0.18 and a standard deviation of 0.23 as shown in Table 2, it is clear, as shown in Fig. 3 that most households did not diversify their non-agricultural livelihood activities. Only about 18 % of the households diversified their involvement in non-agricultural livelihoods. A total of 111 (52.11 %) households that were involved in non-agricultural livelihoods, engaged in just a single non-agricultural livelihood earning activity, thus obtaining a NADI of zero (0). The respondents attributed this to a lack of non-agricultural livelihood earning opportunities in rural settings.

Estimates of diversification indices given as shown in Table 2 for agricultural, non-agricultural and integrated agricultural-non-agricultural livelihood ventures, indicate a significant level of livelihood diversification among rural farm households in Ghana. These rural farm households are faced with two distinct decisions during the production period. Their decision to diversify or not may be a preliminary to their decision concerning the number of activities under each livelihood strategy to undertake. This paper assesses these two decisions separately following works by [21].

Table 1
Summary statistics for explanatory variables.

Variable	Mean	SD
Age of household head (years)	50.49	14.17
Gender of household head (male = 1; female = 0)	0.84	0.37
Marital status of household head (married = 1; unmarried = 0)	0.87	0.34
Education (yes = 1; no = 0)	0.45	0.50
Perceived availability of jobs (yes = 1; no = 0)	0.14	0.34
Household size	6.68	2.80
Dependency ratio (percentage)	65.69	19.91
Farm size (ha)	1.54	0.95
Access to good roads (yes = 1; no = 0)	0.54	0.50
Distance to market (km)	2.37	2.14
Access to market information (yes = 1; no = 0)	0.60	0.49
Access to credit (yes = 1; no = 0)	0.24	0.43
Access to extension (yes = 1; no = 0)	0.44	0.50
Access to formal cooperative (yes = 1; no = 0)	0.24	0.48

Source: Field survey (2019).

Table 2
Summary statistics of agricultural, non-agricultural and integrated agricultural & non-agricultural diversification indices.

Diversification Indices	Mean	SD
Agricultural diversification index (ADI)	0.728	0.129
Non-Agricultural diversification index (NADI)	0.181	0.225
Integrated Agricultural and Non-Agricultural diversification index (ANDI)	0.692	0.201

Source: Field survey (2019).

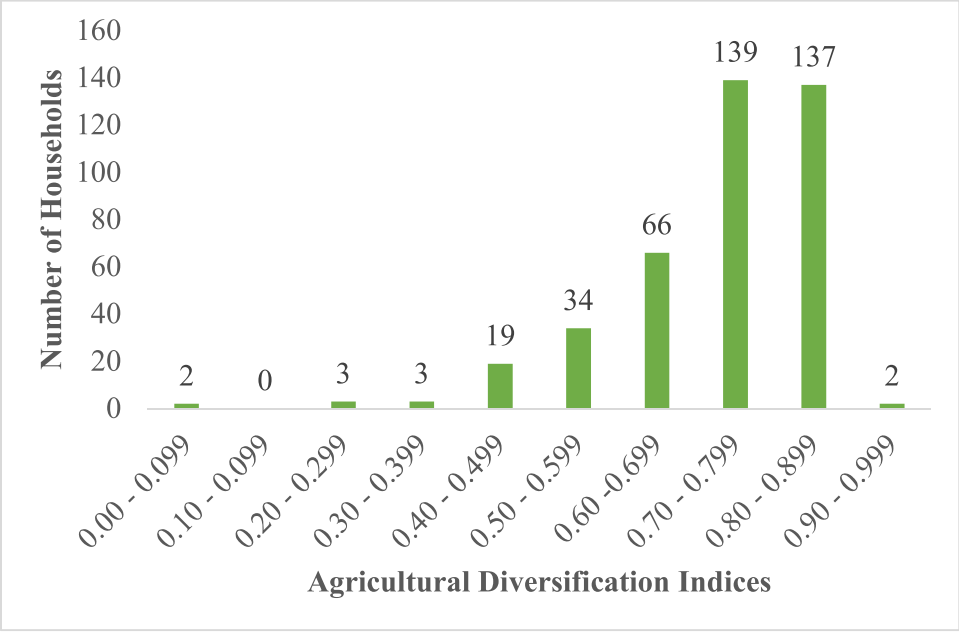

Fig. 2. Distribution of agricultural diversification index (ADI).
Source: Field Survey (2019).

Determinants of diversification

This section presents and discusses the results estimated for the determinants of livelihood diversification in agricultural, non-agricultural and integrated agricultural-non-agricultural livelihoods.

Determinants of agricultural diversification

For the decision regarding the diversification and extent of diversification of agricultural livelihood earning activities, education had a positive effect on both decisions. This was as expected in this study as educated people are more likely to be well schooled and trained in the agricultural sector [44]. This makes educated people have the needed exposure and access to productive resources to engage in diverse agricultural activities to maximise the full benefit of diversification. This finding is consistent with the literature, which suggests that educated individuals are more likely to engage in diverse agricultural activities due to their enhanced access to information and resources [45]. Perceived job availability and access to market information had a positive effect on the discrete decision but had a negative effect on the continuous decision to increase the extent of diversification. This mixed effect aligns with the work of [46], who noted that while access to market information encourages initial diversification, it may reduce the need to further diversify as farmers become more confident in their primary activities. Farm size had a positive effect on the discrete decision to diversify. This is because land is an important input in agricultural livelihood ventures, hence households with bigger farm size are in a better position to use the land for diverse agricultural ventures to minimise risk [47]. Good roads as well had a positive effect on the continuous decision to increase the extent of diversification of agricultural livelihood activities. This is probably because good road network allows for easy and faster transportation of farm inputs and that of farm produce to the markets. Access to good roads makes households more likely to decide to increase their level of diversification of their agricultural livelihood activities. This supports the findings of [48], which highlighted that improved infrastructure facilitates market access, thereby encouraging farmers to diversify. Access to credit negatively influenced the continuous decision to increase the extent of diversification, likely because credit is often earmarked for specific activities, limiting flexibility [49].

Access to credit negatively influenced the continuous decision to increase the extent of diversification. This can be associated with the very fact that most credit facilities secured are usually for activity specific purposes. This means that when households are given

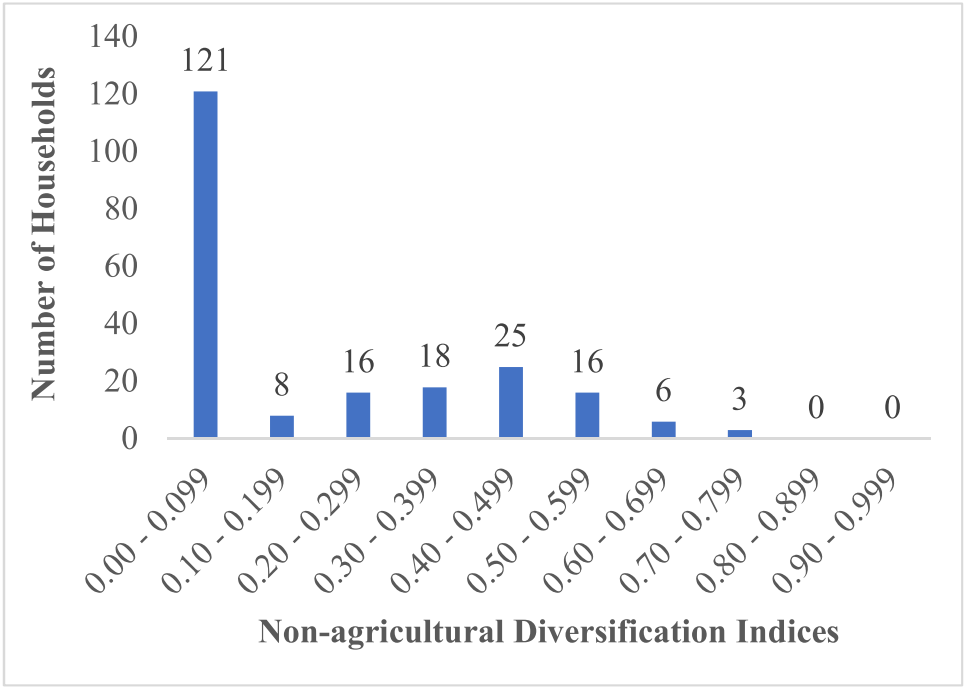

Fig. 3. Distribution of Non-agricultural diversification index (NADI).
Source: Field Survey (2019).

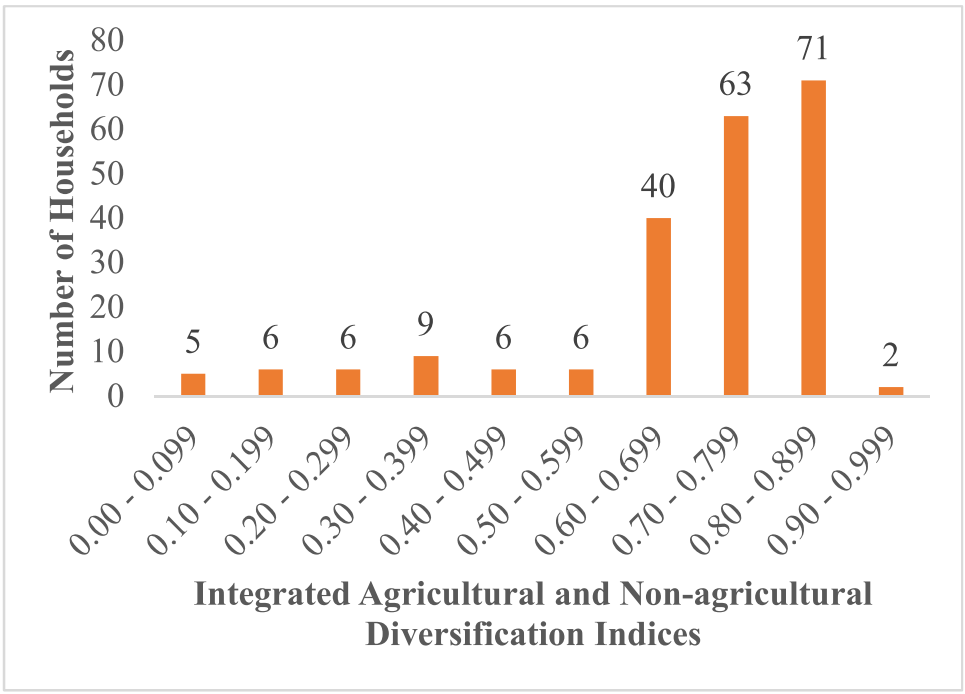

Fig. 4. Distribution of integrated agricultural and non-agricultural diversification index (ANDI).
Source: Field Survey (2019).

credit, they have planned usage for it which does not allow them to add additional ventures. This makes households who secure credit less likely to increase the extent of diversification of their agricultural livelihood activities. Access to extension services also had a positive effect on the continuous decision to increase the extent of diversification. This is also probably because households acquire

useful knowledge on a variety of agricultural ventures which allows them to increase the extent of diversification along the production season. Rural farm households are educated by extension officers on the importance of diversification in reducing the production risk associated with the agricultural sector. This finding is supported by [50], who found that extension services provide critical knowledge that enables farmers to diversify. The positive effect of gender of household head on the discrete decision to diversify indicates that male household heads are more likely to diversify than their female counterparts. This can probably be due to the very fact that male household heads have more access to productive resources relative to females [51]. With this access to resources, they can go into diverse agricultural activities to minimise risk.

Determinants of non-agricultural diversification

Considering non-agricultural livelihood diversification, the negative effect of distance to market on both the discrete and continuous decision to diversify signifies the relative importance of closeness to market in conducting non-agricultural livelihood activities. This is because most non-agricultural activities involve the exchange of goods and services, which the market plays a significant role. The farther a household is from the market, the less probable they are to diversify their non-agricultural livelihood earning activities. This is consistent with the literature that emphasizes the importance of market proximity for non-agricultural activities [52]. In the same light, access to good roads positively impacts both the discrete and continuous decision to diversify and increase the extent of diversification, respectively. This is basically because good network makes the transportation of goods and services easier and faster.

From Table 3, age had a positive effect on the discrete decision to diversify but a negative effect on the continuous decision to diversify households' non-agricultural livelihoods. Older household heads due to their experience may become risk averse and, hence are more likely to diversify their livelihood earning activities at the beginning of the production year. On the continuous decision,

Table 3
Determinants of diversification in agricultural, non-agricultural and integrated agricultural and non-agricultural livelihood diversification strategies.

Variables	AD		NAD		AND	
	Discrete Decision	Continuous Decision	Discrete Decision	Continuous Decision	Discrete Decision	Continuous Decision
Age	0.007	0.000	0.018*	−0.002**	−0.004	−0.001*
	(0.008)	(0.000)	(0.009)	(0.001)	(0.010)	(0.001)
Gender	0.515*	−0.022	0.413	−0.071***	−0.368	0.005
	(0.290)	(0.016)	(0.349)	(0.027)	(0.429)	(0.020)
Marital Status	−0.445	0.031*	0.093	0.000	−0.657	0.012
	(0.357)	(0.017)	(0.395)	(0.000)	(0.453)	(0.019)
Education	0.453*	0.034***	−0.047	0.077***	0.058	−0.001
	(0.250)	(0.011)	(0.283)	(0.022)	(0.270)	(0.017)
Job availability (perception)	0.787**	−0.048***	0.558	0.017	−0.707**	−0.037
	(0.394)	(0.016)	(0.386)	(0.019)	(0.312)	(0.026)
Household size	−0.091**	0.000	0.025	0.032***	0.020	−0.004
	(0.041)	(0.002)	(0.004)	(0.006)	(0.059)	(0.003)
Dependency ratio	0.009*	0.000	−0.017***	0.000	0.017***	0.001
	(0.005)	(0.000)	(0.006)	(0.000)	(0.006)	(0.000)
Farm size	0.441***	−0.004	0.027	−0.036***	−0.044	0.006
	(0.143)	(0.007)	(0.125)	(0.011)	(0.130)	(0.009)
Access to Good road	0.066	0.031**	1.136**	0.114***	1.519***	0.028
	(0.281)	(0.013)	(0.498)	(0.019)	(0.302)	(0.022)
Distance to market	0.002	−0.001	−0.200**	−0.029***	−0.091	−0.002
	(0.047)	(0.002)	(0.088)	(0.010)	(0.062)	(0.004)
Access to market information	0.838***	−0.036***	0.629	−0.231***	−0.896***	−0.034
	(0.291)	(0.013)	(0.455)	(0.040)	(0.338)	(0.021)
Access to credit	−0.358	−0.024*	0.117	−0.013	0.052	−0.005
	(0.284)	(0.014)	(0.290)	(0.021)	(0.363)	(0.019)
Access to extension	0.280	0.032***	0.413	0.083***	0.942***	0.027*
	(0.249)	(0.011)	(0.319)	(0.029)	(0.270)	(0.015)
Access to formal corporative	−0.106	0.012	0.981***	0.019	0.273	0.027*
	(0.248)	(0.012)	(0.264)	(0.015)	(0.350)	(0.015)
Constant	−0.083	0.714***	−3.672***	0.625***	0.464	0.774***
	(0.710)	(0.033)	(0.790)	(0.105)	(0.804)	(0.053)
Sigma		0.090***		0.030***		0.084***
		(0.004)		(0.005)		(0.005)
Number of obs	405	378	213	25	213	182
Pseudo R^2	0.174		0.282		0.250	
Wald/LR χ^2 (14)	38.60***	57.12***	52.52***	47.53***	54.34***	22.46*
Prob > chi2	0.000	0.000	0.000	0.002	0.000	0.070
Log-likelihood	−81.934	390.447	−55.345	58.671	−66.261	197.971

***, ** and * denotes statistically significant variables at 1 %, 5 % and 10 % levels, respectively.
Figures reported in parenthesis are Robust Standard Errors.
Source: Field Survey (2019).

which is made along the season to increase the extent of diversification, older household heads are less likely to increase the extent of diversification along the production period. This is because older heads with their lived experience do not want to try new ventures as compared to their younger counterparts who will be more adventurous to try new portfolios during the production period [53]. Education has a positive effect on the continuous decision to increase diversification. This is probably because educated people have more exposure than uneducated people. This makes educated people more likely to be exposed and well trained to go into additional livelihood earning activities during the production year [45]. Household size as well has a positive effect on households' continuous decision to increase the extent of diversification of their livelihood activities. This effect is probably because, with more numbers in a household, there is the tendency, especially if they are adults, that they diversify in their livelihood activities to support their families. Especially during the dry season, household members go into diverse ventures to increase the revenue stream of the family and it is only natural that households with more members be in the position to increase the extent of diversification of their activities as compared to households with fewer household members.

Dependency ratio had a negative effect on households' discrete decision to diversify in their non-agricultural livelihoods. This means that households with high dependency ratio are less likely to diversify their non-agricultural livelihood earning activities. This is probably because most non-agricultural livelihoods are highly capital intensive, hence households with higher dependency ratios are not able to raise such capital given the burden on them to take care of many dependants. Farm size had a negative effect on the continuous decision to increase the extent of diversification of non-agricultural livelihoods. This implies households with larger land sizes were less likely to increase the extent of diversification in their non-agricultural activities. This is probably due to the fact that non-agricultural livelihood activities require little or no land to be carried out. Hence, households with more would rather look to utilise the land by going into agricultural production which will need the available land, this forces households not to increase the extent of diversification of their non-agricultural activities. Access to extension services has a positive effect on the continuous decision to increase the extent of diversification. This is probably because extension officers sometimes educate households to engage in multiple livelihood activities, hence households contact with extension officers increases their likelihood to increase the extent of diversification of their non-agricultural livelihood earning activities. in the same light, households who belong to formal cooperatives are exposed to some opportunities in the non-agricultural sector to exploit. These cooperatives share useful information with members on how to set up non-agricultural livelihood ventures. This explains the positive relationship between access to formal cooperative and households' discrete decision to diversify their non-agricultural livelihood activities.

Determinants of integrated agricultural and non-agricultural diversification

Access to extension services was the sole factor with a significantly positive effect on the probability and extent of diversification in integrated agricultural and non-agricultural livelihood systems in this study. The effect of access to extension services on diversification is probably because of the additional pieces of information that extension officers share with households on their visit. This additional information aids households to engage in diverse range of activities from agricultural to non-agricultural [54]. Age of household head had a negative effect on the continuous decision to increase the extent of diversification. This is probably because older household heads are not as adventurous as their younger counterparts to try new ventures along the season to increase the extent of diversification of their livelihood activities [44]. this makes them less likely to increase the extent of diversification of their integrated livelihood earning activities.

Access to market information had a negative effect on the discrete decision to diversify. This is probably because households do not see the need to diversify with the guarantee of having access to all needed information regarding the market [46]. This information can be on demand and supply as well as prices of essential household commodities. Households are fully aware of when they can make purchases and when not to. This leads households to not consider diversifying their livelihood activities with full Access to market information. High dependency ratios force households to go in search of more activities to fetch additional livelihood sources to complement already existing sources of livelihood. This makes households to diversify their line of activities to look after their dependents [1]. Access to good roads positively affected the discrete decision to diversify. This is basically because good roads make the transportation of goods and services less costly. Access to formal cooperatives positively affected the continuous decision to increase the extent of diversification. This may be because households belonging to formal cooperatives are exposed to some opportunities in both the agricultural and non-agricultural sector to exploit. These cooperatives share useful information with members on how to best combine setups of both agricultural and non-agricultural livelihood ventures.

Conclusions and policy implications

In this paper, we have investigated the predictors of diversification within agricultural, non-agricultural as well as an integrated agricultural and non-agricultural livelihood systems among Ghanaian rural farm households to provide empirical evidence. The study examines this household livelihood diversification decision-making process by applying the Cragg two-step. The outcomes revealed that both discrete and continuous agricultural diversification decisions were influenced by factors such as education, availability of jobs and access to market information. For non-agricultural diversification, the determining factors included the age of household head, access to good road network and distance to market. For integrated agricultural and non-agricultural diversification, the significant factor that significantly predicted both the discrete and continuous decisions was access to extension. Other determinants examined predicted one or both decisions, such as sex of household head, marital status, household dependency ratio, household size, farm size, access to credit and access to formal cooperative.

The outcomes of this paper restate the significance of access to information, which is mainly provided to farmers through institutions such as research, extension and other agricultural projects in encouraging diversification among smallholder farmers. In fact,

agricultural extension services have been crucial in promoting and distributing information to farmers on production and marketing. Extension and information services pertaining to diversification must be provided to rural farm households in order to strengthen this effort. This may come in the form of organizing training on the most effective and sustainable blends of diversified livelihood systems that yield optimum outcomes for farm households and, most importantly, reduce all risk possible related with their livelihood earning activities. This could be complemented by training that improves the capacities of these institutions in terms of personnel, logistics and operating resources. As shown by the empirical evidence of this study, farm households' access to good roads and extension services are significant factors and, hence, these access should to be enabled among rural farming communities in developing countries for them to optimize the benefits that comes with diversified livelihoods. While long-term infrastructure projects like road construction are important, short-term measures such as improving access to credit and market information through community-based initiatives can provide immediate support to rural households. Communities should also organize local markets and cooperatives to strengthen their economic resilience.

The study's findings demonstrate that the discrete decision to diversify and the decision about the degree of diversification are independent choices, and as a result, they are influenced by distinct sets of factors. Estimating the likelihood of diversification on its own does not give enough insight into the factors influencing the entire decision making process. Furthermore, assuming that the two decisions are taken concurrently could be deceptive. Therefore, it is crucial that future research, especially on agricultural diversification, take into account integrating adequate tests of separability in the two decisions to identify which estimating approach is suitable for the data. By doing this, the pitfall of not adequately capturing the relevant sets of factors that affect the two decisions would be avoided. As a result, empirically backed recommendations that are appropriate for the two decisions can be made. The factors that determine diversification of agricultural, non-agricultural and agricultural-non-agricultural livelihood systems are another significant finding of this study. To address challenges of food insecurity and poverty, this paper gives specific recommendations for all relevant stakeholders on how to improve these three production systems. The empirical outcomes of the paper highlight the significance of diversification within agricultural, non-agricultural as well as integration of agricultural and non-agricultural livelihood systems among rural farm households in Ghana. Researchers, extension agencies, development partners, and policy makers need to carefully consider the factors outlined in this study to build sustainable measures for improving the livelihoods of rural farm households.

Limitations of the study

While our study contributes valuable insights into the predictors of diversification within Ghanaian rural households, it is important to acknowledge several limitations. Firstly, the utilization of the Cragg two-step model, while providing a framework for analyzing diversification decisions, is not without its shortcomings. Endogeneity issues, selection bias, and reliance on certain assumptions may impact the robustness of our findings. Despite efforts to mitigate these concerns through robustness checks and sensitivity analyses, residual biases may still exist. Additionally, the study's scope is limited to a specific geographical context and may not fully capture the diversity of livelihood strategies across different regions or contexts within Ghana. Furthermore, the reliance on survey data introduces the potential for measurement error and recall bias, which may influence the accuracy of our results. Future research endeavors should aim to address these limitations by exploring alternative methodologies and expanding the geographical scope to enhance the generalizability of findings.

CRediT authorship contribution statement

Jude Dokbila Kolog: Conceptualization, Investigation, Methodology, Formal analysis, Writing – original draft. **Freda Elikplim Asem:** Supervision, Conceptualization, Methodology, Writing – review & editing. **Akwasi Mensah-Bonsu:** Supervision, Methodology, Writing – review & editing. **Roger Ayimbillah Atinga:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial or otherwise interests that could have appeared to influence the work reported in this paper.

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