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## Article

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# Market participation of smallholder groundnut farmers in Northern Ghana: Generalised double-hurdle model approach

Dominic Tasila Konja<sup>1\*</sup> and Franklin N. Mabe<sup>1</sup>

**Abstract:** Market participation is both a cause and a consequence of economic development. Markets offer households the opportunity to specialize according to comparative advantage and thereby enjoy welfare gains from trade. The current literature on product marketing in Ghana is inadequate for designing and implementing effective policies to overcome problems in the marketing system, especially leguminous crops. Based on this, the study analyses the determinants of groundnut farmers' decision to participate and the level of market participation in Northern Ghana using cross-sectional data from 250 smallholder farmers. We employed the generalized double hurdle model to analyse the objectives of this study. On average, the study found that 62% of groundnut output harvested by farm households in Northern Ghana was sold on the market. The most significant



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### ABOUT THE AUTHORS

Dominic Tasila Konja is currently a PhD candidate in the field of Agricultural Economics at the University of Kiel, Germany. He obtained both his MPhil. Agricultural Economics and BSc. Agribusiness from the University for Development Studies, Ghana. His main research interest includes adoption, agricultural productivity, agribusiness and value-chain analysis, climate change economics, and welfare economics. Franklin N. Mabe is a Senior Lecturer in the Department of Agricultural and Resource Economics, University for Development Studies. He is an Agricultural and Resource Economist with extensive experience in teaching, research and development work. Most of his research is in the area of agricultural productivity analysis, impact evaluation of projects, econometric modelling, climate change economics, agricultural policy analysis.

### PUBLIC INTEREST STATEMENT

Groundnut is one of the important legumes grown in Ghana and SSA at large. About 90% of groundnut production is done by smallholder farmers in the Northern part of Ghana. Irrespective of this huge groundnut production in the region, the incidence of poverty is still high relative to other regions. One of the promising ways to remove farmers from chronic poverty is by building their capacity to participate in the output market. Meanwhile, the groundnut market participation in Ghana is low and this could be influenced by policy and household-specific factors. Our study seeks to identify the determinants of groundnut market participation in Northern Ghana. The most significant determinants of market participation decision and intensity of participation in the groundnut market are extension service, distance to output market, farmer-based organization, off-farm income, output price, use of improved groundnut variety, and access to transport. We recommend that policies aiming at promoting smallholder commercialization should focus on providing rural infrastructure, market-oriented extension services, and forming farmer groups for collective marketing.

determinants of market participation decision and intensity of participation in the groundnut market include extension service, distance to output market, farmer-based organization, off-farm income, output price, use of improved groundnut variety, and access to transport. We recommend that strategies and policies aiming at promoting smallholder commercialization should focus on providing rural infrastructure, market-oriented extension services, and forming farmer groups for collective marketing.

**Subjects:** Economics and Development; Sustainable Development;;; Industrial Economics; Sociology of Science & Technology

**Keywords:** Market participation; probit model; generalised linear model; smallholder farmers; Northern Ghana

## 1. Introduction

The need to integrate smallholder agriculture into the market economy is urgently required to increase agricultural contribution to poverty reduction and economic growth of developing countries in the world. The importance of agricultural commercialization is deeply rooted in the sustainable development goals (SDGs), specifically goal one which calls for an end to all forms of poverty. Despite increased research and development efforts, addressing multiple productivity and market failures, smallholder farmers in developing countries are still confronted with myriad challenges regarding agricultural commercialization due to a lack of access to information on supply, demand, price, and alternative opportunities (Abokyi et al., 2020; Demeke & Balié, 2016; Moctar et al., 2015; Morton & Martey, 2021). These uncertainties make farmers vulnerable to various risks such as loss of income and assets that make shifting to commercialized agriculture difficult (Anderson, 2003; Rogers, 1995). Nevertheless, there is an increasing belief that if smallholder farmers break out of the subsistence production trap and become more entrepreneurial and market-driven, it will contribute more to rural livelihoods (Mabuza et al., 2016; Tipraqsa & Schreinemachers, 2009).

Agricultural commercialization refers to the process of increasing the proportion of agricultural production that is sold by farmers (Pradhan et al., 2010). In the context of this study, it is the transition of farmers from subsistence farming to a market engagement mode where inputs are increasingly purchased, and outputs are sold to traders. The agricultural sector in sub-Saharan Africa is characterised by subsistence-oriented with low production of marketable surpluses. Low market participation by smallholder farmers in developing countries has hampered agriculture-driven economic growth and exacerbated poverty, since farmers have not been able to benefit from the associated welfare gains and income growth. This calls for the implementation of collective strategies by the government, and value chain actors to cause a paradigm shift towards profit-oriented production. Principally, for agriculture to make a meaningful contribution to economic growth, smallholder farmers have to commercialize their farming activities to produce marketable surpluses (Pingali et al., 2015; Barrett et al., 2012).

Groundnut (*Arachis hypogaea* L) is one of the important legumes grown in Ghana and SSA at large. Groundnuts are a great blend of healthy fats, protein, and fiber that curbs appetite, lowers heart disease, and regulates blood glucose levels. It offers natural soil maintenance benefits through nitrogen-fixing, which improves yields of cereals through crop rotation and reduces fertilizer use to enable smallholder farmers to reduce the cost of production (CSA, 2008). In Ghana, about 90% of groundnut production is done by smallholder farmers in the Northern part of the country (MoFA, 2019). Irrespective of this huge groundnut production in the region, the incidence of poverty is still high relative to other regions in Ghana (GSS, 2020). The question why poverty is extremely high in the study area irrespective of its large production of groundnut in the country remains unanswered. One of the promising ways that can

enable smallholder farmers to come out from chronic poverty, malnutrition, and food insecurity is by building their capacity to participate in the output market. Generally, the decision of smallholder farmers to participate in the output market is influenced by several factors which could vary across geographical areas and crop types. According to Oluwatayo (2019), a lack of access to a reliable and lucrative formal market forced most smallholder farmers not to sell their crops, therefore restricting their crop production to household consumption rather than marketing. When they sell their crops to middlemen, they do so at lower prices and make little-to-no profit. The low involvement of smallholders in the crop market results in them realizing low incomes, exposing them to food insecurity and a vicious cycle of poverty (Oluwatayo, 2019). It is therefore necessary to examine the key factors that affect farmers decision to participate in agricultural output market. Availability of current information and good marketing facility empower farmers to plan their production more in line with the market demand, to schedule their harvest at the most profitable time, to decide to which market to sell their produce, and to negotiate on a more even footing with traders (Lunndy et al., 2004).

There is mixed and inconclusive empirical evidence on the determinants of commercialization by researchers over the years (Andaregie et al., 2021; Olanrewaju et al., 2016; Mango et al., 2018; Oduntan and Alade 2020; Morton and Martey 2021). These varying findings can be attributed to the varying geographical areas, crop type, as well as the estimation methods used, hence, giving a firm reason for further assessment. This paper seeks to contribute to literature by examining the factors that affect the decision and extent of groundnut commercialization. Plethora of research on agricultural commercialization have dwelt on cereals with less attention given to leguminous crops such as groundnut. Specifically, knowledge on the drivers of market participation will enable the researchers to make policy recommendations that would help farmers to reorient their production systems to overcome the constraints of participating in output markets in Ghana and the world at large. This research also contributes to methodological gap in analyzing determinants of commercialization. Previous studies (e.g. Abu et al., 2014; Martey et al., 2012; Olanrewaju et al., 2016) have extensively used ordinary least squares (OLS), Tobit, and Cragg's double hurdle models in analyzing determinants of agricultural commercialization. Meanwhile, these analytical methods have been criticized by Jones (1989, 1992) and Yen (2005) that their use predicts the value of commercialization outside the range of zero and one, which is incorrect. Our study employs the Cragg double hurdle approach, but instead of using the Tobit model in the second hurdle, the generalized linear regression model (GLM) is employed, owing to the fractional nature of the commercialization index (i.e. values lie between zero and one) in the settings of sub-Saharan Africa.

The remaining of this paper is structured as follows: section 2 presents the literature review on determinants of commercialization, while section 3 details the material and methods. Section 4 outlines the empirical results and discussions, and followed by conclusions and recommendations in section 5.

## 2. Literature review

Over the years, researchers and developmental agencies have tried to tackle barriers to agricultural commercialization. Studies carried out in different parts of the world have revealed some determinants of commercialization (Andaregie et al., 2021; Olanrewaju et al. (2016); Mango et al. (2018); Oduntan and Alade (2020); Morton and Martey (2021). For example, Anderagie et al. (2021) found that educational status, non-farm income from non-farm employment, number of extension contacts, gender, improved seed use, chemical fertilizer, and farmers' perception of land degradation affects the market participation decision of smallholder farmers in Ethiopia. However, the amount of output supplied to the market was influenced by age, experience, livestock holding, non-farm income, extension contacts, gender, market access, and membership in a marketing association.

Also, Morton and Martey (2021) analyzed the effect of market information on maize commercialization in the savannah and northern region of Ghana using the double hurdle regression model. They found that institutional factors, demographic factors, and locational dynamics affect farmers' access to agricultural market information. Morton and Martey indicate that access to market information and extension services increases the propensity of farmers to participate in the out market. They also revealed that the availability of marketable surplus triggers smallholder farmers to strongly decide to commercialize. Notably, the farming experience of farmers also significantly affects the extent to which farmers sell out maize output on the market. Hagos et al. (2020) reported that the most important determinants of mango market participation are resource ownership (land allocated for mango and land fragmentation), asset ownership (number of productive mango trees and availability of mango seedlings), access to farmers' clubs, support from knowledgeable individuals in the village, and income from different agricultural products. Lu et al. (2010) reported that farmers' modern market participation will be further enhanced by faithful buyer-seller relationships with buyers and complying with buyers' quality requirements; on the other hand, having formal contracts is directly related to farmers' trusting interactions with buyers.

Olanrewaju et al. (2016) assessed crop commercialization among smallholder farming households in Southwest Nigeria using the Tobit model. The result from the study indicates that the commercialization index for maize, cassava, and yam was 81%, 88%, and 77%, respectively. Generally, this study observed that credit access, extension service, fertilizer used, education, association membership, total output, and access to market information are determinants of agricultural commercialization in Nigeria. They further explicated that credit access improves the commercialization of households through the purchase of agricultural inputs like improved seed and chemical fertilizer to produce market surpluses for commercialized-oriented production. Abu et al. (2014) investigated the market participation of smallholder maize farmers using cross-sectional data from the Upper East region of Ghana. The researchers found that the decision and extent of maize commercialization are influenced by specific farmer characteristics, private assets, public assets, and transaction cost variables. The study further revealed that about 48% of households in maize production participate in the maize output market in the study area.

Oduntan and Alade (2020) have also looked at the determinants of market participation by plantain farmers in Nigeria. The researchers used a truncated regression modeling technique and found that factors affecting the percentage of plantain sold by smallholder farmers include the age of the farmer, quantity of plantain harvested, farm size, plantain output price, farm distance, and farming experience. The study concluded that although, there is a higher (64.6%) proportion of plantain sold by farmers but was not sufficient and calls for the attention of all the concerned stakeholders to implement measures to improve the productivity of plantain in production in the study area. Megerssa et al. (2020) reported that the age of the household head, household family size, educational level of the household head, labour market, market information, and distance from the marketplace were statistically significant factors influencing market participation among smallholder vegetable producers.

A study conducted by Asumining-Brempong et al. (2013) on the determinants of commercialization of smallholder tomato and pineapple farms in Ghana reported that the factors affecting the extent of market participation among tomato farmers were land productivity and labour productivity. Similarly, the main determinants of commercialization among pineapple smallholder farmers are land productivity and savings. Beyene et al. (2020) reported that the allocated amount of land, labour, seed, chemical fertilizer, and oxen have a positive and significant influence, whereas market distance and crop diversification have a negative influence on the production of haricot beans. From the above empirical studies, one can agree that factors that influence market participation vary across geographical areas and crop types, which triggers further analysis. Also, apart from the study of Abu et al. (2015), most studies carried out on commercialization in the crop sub-sector of agriculture have focussed on maize, rice, cassava, and soybean in Ghana. Abu's



study on groundnut commercialization only covered the Upper East region out of the three main regions in Northern Ghana, which has the potential issue of generalization. Again, previous studies have employed different methodological approaches to analyze the driving factors of market participation in the agriculture sector. Most studies (Abu et al., 2014; Martey et al., 2012; Olanrewaju et al., 2016) have used ordinary least square (OLS), Tobit, and Cragg's double hurdle approaches, however, these models have been criticized by some scholars (Baum, 2008; Maddala, 1991; Papke & Wooldridge, 1996). Maddala (1991) and Baum (2008) opined that such approaches are not appropriate because the observed data are not censored, and values outside the unit interval (0, 1) are not possible in the case of proportional data. Moreover, Papke and Woodridge (1996) argue that the use of a simple average response model when the dependent variable is fractional is inappropriate because it can result in the prediction of the expected dependent variable outside the range of 0 and 1 and therefore the GLM regression model, which is an example of fractional regression, is recommended for such analysis. Since the dependent variable is fractional and bounded from 0 to 1, the use of GLM helps to correct the inconsistency and biases that might be contained in the parameter estimates when OLS regression is used (Ferrari & Cribari-Neto, 2004).

### 3. Materials and methods

#### 3.1. Study area

The study was conducted in Northern Ghana. Northern Ghana includes the Upper East, Northern, and Upper West regions in this case. The three regions share boundaries with the Republic of Togo to the east, Ivory Coast to the west, and Burkina Faso to the north. Geographically, the three regions are between longitude 8°46'01.88" N and 10°58'34" S and latitude 2°45'45.40" W and 0°32'59.95" E and cover a total land area of 97,666 km<sup>2</sup> with an estimated population of 3,317,478 in 2010 (Ghana Statistical Service GSS, 2012). The annual temperature in the region is between 15°C at night during the harmattan and 40°C during the day during the hot season. The annual rainfall varies between 750 mm and 1050 mm. The main vegetation is grassland, interspersed with guinea savannah woodland, characterized by drought-resistant trees such as acacia, mango, baobab, shea-nut, *Dawa Dawa*, and *neem*. The northern regions are the driest in Ghana, owing to their proximity to the Sahara Desert and the Sahel region. The climate is hot and dry, with one rainy season. Agriculture, hunting, and forestry are the main economic activities. The main crops cultivated in Northern Ghana include groundnut, maize, rice, soybeans, yam, cassava, millet, sorghum, etc. The rearing of livestock such as goats, sheep, cattle, guinea fowls, chicken, etc. is also common in Northern Ghana. Northern Ghana is described as the basket of staple food crops. Over 90% of groundnut is produced in Northern Ghana (MoFA, 2019) and this is why the area is chosen as the study area. The annual rainfall varies between 750 mm and 1050 mm. About 73% of households in Northern Ghana are smallholder farmers who cultivate approximately five acres (Ghana Statistical Service [GSS], 2019). Ghana Statistical Service (GSS, 2020) found that the incidence of poverty in the three northern regions of Ghana remains as high as 52.8%, 60.7%, and 53.1% in the Upper East, Northern, and Upper West regions, respectively.

#### 3.2. Data collection, sampling procedure, and sample size

The study collected cross-sectional and primary data from groundnut farm households. A five-stage sampling technique was employed. In the first stage, the northern region and upper east regions were randomly selected from Northern Ghana. In the second stage, districts within the selected regions were clustered into two (i.e. districts with average groundnut production figure less than 6000Mt and figures greater or equal to 6000Mt) using information from the Ministry for Food and Agriculture of Ghana. In the third stage, whilst four districts (i.e. Tolon, Savelugu, Yendi, and East Gonja) were randomly selected from the northern region, two districts (i.e. Sadema and Bongo) were also randomly selected from the upper east region. These six districts were selected from the cluster of districts with average groundnut production figures greater or equal to 6000Mt using a proportional probability sampling technique. In the fourth stage, random sampling was employed to select 12 communities from the sampled districts. In the last stage, between 15 and

25 households producing groundnut were randomly selected from the sampled communities due to the unequal number of groundnut farmers in each community. The study used a sample size of 250 households for its analysis.

### 3.3. Data analysis

#### 3.3.1. Theoretical framework: households' market participation

Literature on agricultural commercialization traces its theoretical ancestry to the trade theory postulated by Ricardo in 1817. The trade theory is based on comparative advantage in production, where farmers specialize or direct their resources into productions that maximize their productivity, consumption, and welfare than an alternative in the market (Siziba et al., 2011). Farmers either participate in the market as sellers, subsistence, or both depending on the benefit they gain from the either alternative. Meanwhile, these decisions are influenced by households' socioeconomic characteristics, public social capital variables, and transaction cost variables. Though the Ricardian trade theory underpins commercialization, however, its intrinsic macro nature makes it inapplicable in empirical agricultural-related studies, which are often micro in nature. The Ricardian trade theory is unable to establish causal relationships between micro variables in agricultural settings which have triggered the novelty of a new theoretical model (Barrett, 2008; Boughton et al., 2007). The correct theory underpinning commercialization is the Barrette (2008) non-separate model which opines that farmers are stimulated to sell (a proportion of) their produce to maximize their utility derived from the market. Households' decision-making of production and consumption is non-separable in subsistence farming whilst it is separable in market-oriented farming (Gebre-Ab, 2006). The proportion of sales that define commercialization is expressed as a function of the marketed surplus a household generates, transaction costs, household-specific characteristics, and institutional factors. Mathematically, the proportion of sale (commercialization), PS, is expressed as;

$$PS = f(SM, TF, HC, IF) \quad (1)$$

Where SM is marketed surplus, TF is transaction variables, HC is households' specific characteristics, and IF is institutional factors.

#### 3.3.2. Empirical framework: the generalised double-hurdle regression model

To identify the factors that affect the decision of farmers to participate and the level of market participation, the generalized double-hurdle model was employed. The first expression of the generalized double-hurdle model is a probit regression model (PRM). The PRM was used to identify the factors that influence the decision of farmers to participate in the market. PRM has a dichotomous dependent variable which is modelled against various explanatory variables, and this specified as:

$$\Pr(Y_i/X_i) = \alpha X_i + \mu_i \quad (2)$$

Where:  $Y_i$  represents a dummy outcome variable, which takes the value of 1 if a groundnut-producing household participates in the output market and 0 if otherwise, conditioned on a set of explanatory variables denoted by  $X_i$ .  $\alpha$  denotes the vector of the parameter to be estimated, and  $\mu_i$  represents the error term which is normally distributed with zero mean and constant variance.

The level of market participation of smallholder groundnut farmers was estimated with the help of the households' market participation index (HMPI) method. The HMPI method as postulated by Govereh et al. (1999) and Strasberg et al. (1999) is used but modified to estimate an index that measures the level of market participation of smallholder groundnut farmers. The household market participation index (HMPI) measures the ratio of the gross value of groundnut sales by



household  $i$  in year  $j$  to the gross value of all groundnuts produced by the same household  $i$  in the same year  $j$ .

$$HMPI_{ij} = \frac{\text{Gross value of groundnut sale}_{ij}}{\text{Gross value of all groundnut production}_{ij}} \quad (3)$$

where  $HMPI_{ij}$  represent the  $i^{\text{th}}$  farm household's market participation or commercialization index in the  $j^{\text{th}}$  year; the numerator is the total value of groundnut sold by the  $i^{\text{th}}$  household in the  $j^{\text{th}}$  year ( $j = 2018$  farming season) and the denominator is the total value of the output of groundnut produced by the  $i^{\text{th}}$  household in the  $j^{\text{th}}$  year.  $HMPI_{ij}$  is used as a proxy for market participation and serves as the dependent variable ( $HMPI_{ij}$ ) in Equation (8). The index measures the extent to which household groundnut production is oriented toward the market. Following the approach of Endalew et al. (2020), this study uses the below rule of thumb to categorize farm households under various market orientations.

**Decision rule:**

- (1)  $0 \leq HMPI \leq 0.25$ , it implies that the households are subsistence-oriented farmers whose key interest is only for households' food production without cash income generation.
- (2)  $0.25 < HMPI \leq 0.50$ , it implies that the households are classified as transition farmers whose key interest is in both household's food production and cash income generation.
- (3)  $0.50 < HMPI \leq 1.00$ , it implies that the households are classified as commercial farmers whose key objective is cash income from production.

The study expects that the more a household participated in the market, the more they become profit-oriented and are therefore able to participate in the input market to increase output. An increase in yield/output through the adoption of improved inputs in production will enable farmers to further commercialize to meet their basic needs for improved welfare.

The second hurdle of the generalized double-hurdle model is the generalized linear regression model (GLM), which is an example of a fractional regression (FRM). The values of  $HMPI_{ij}$  range from 0 to 1 which are fractional in nature. Fractional dependent variables can be estimated using the GLM regression framework (using the Stata glm command). In Stata (see Baum, 2008) demonstrates the implementation of the FRM using GLM, and we adopted this method for the analysis. This approach corrects the inconsistency and biases that might be contained in parameter estimates if OLS regression is used (Ferrari & Cribari-Neto, 2004). To regress the dependent variable ( $HMPI_{ij}$ ) against various explanatory variables, the GLM as proposed by Papke and Woodridge (1996) is employed. This is specified as:

$$E(HMPI_{ij}/X) = X\beta + e_i \quad (4)$$

Where  $HMPI_{ij}$  represent households' market participation index,  $X$  is a matrix of explanatory variables,  $\beta$  is a matrix of parameters to be estimated, and  $e_i$  also represents the error term.

Papke and Woodridge (1996) noted that the use of a simple average response model when the dependent variable is fractional is inappropriate because it can result in the prediction of the values of the dependent variable outside the range of 0 and 1. The use of ordinary least squares (OLS) in such a situation biases the estimates unlike GLM (Ferrari & Cribari-Neto, 2004). In statistics, a generalized linear model (GLM) is a flexible generalization of ordinary linear regression that allows for the response variable to have an error distribution other than the normal distribution. The GLM generalizes linear regression by allowing the linear model to be related to the response variable via a link function and by allowing the magnitude of the variance of each measurement to be a function of its predicted value (Nelder & Robert, 1972). This study employed

Cragg's double hurdle model but instead of using the Tobit model in the second hurdle, GLM was applied. Following Ansah and Tetteh (2016), GLM is made up of a linear predictor which links the fractional dependent variable  $HMPI_{ij}$  to the explanatory variables as shown below:

$$E(HMPI_{ij}/X) = g(X\beta) \quad (5)$$

$E(HMPI_{ij}/X)$  represents the expected households' market participation index of the  $i^{th}$  household given  $X$  as a matrix of explanatory variables.  $g$  is a nonlinear distribution function that transforms the predicted value of the dependent variable to lie between 0 and 1. A distribution suggested by Papke and Wooldridge (1996) and Koundouri et al. (2006) is a Bernoulli distribution and the parameters in the model (4) are estimated using quasi-likelihood estimators such as GLM. The procedure requires the specification of both a link function and a distribution function. The parameters in the model are obtained by maximizing the Bernoulli quasi-log-likelihood function for the FRM that takes the form of:

$$1nL(\beta) = \sum_{i=1}^N w_i HMPI_{ij} 1n\{g(X_i' \beta)\} + w_i (1 - HMPI_{ij}) 1n\{1 - g(X_i' \beta)\} \quad (6)$$

where  $HMPI_{ij}$  is the dependent variable,  $N$  denotes sample size (spanning from 1 to 250),  $X_i$  are the independent variables for  $i^{th}$  farmer, and  $w_i$  is an optional weight. This study assumes that the link function  $g(.)$  follows a logit distribution with the function shown in model (6):

$$g(X_i' \beta) = \frac{e^{X_i' \beta}}{1 + e^{X_i' \beta}} \quad (7)$$

#### Empirical specification of the generalized linear model (GLM)

$$HMPI_i = \left[ \begin{array}{l} \beta_0 + \beta_1 Sex_i + \beta_2 Age_i + \beta_3 Hhs_i + \beta_4 Ext_i + \beta_5 Edu_i + \beta_6 FBO_i \\ + \beta_7 Exp_i + \beta_8 Mst_i + \beta_9 AxInfo_i + \beta_{10} Of Fam_i + \beta_{11} AxMob_i \\ + \beta_{12} AxTras_i + \beta_{13} DMkt_i + \beta_{14} Inten_i + \beta_{15} FomSal_i + \beta_{16} Fms_i \\ + \beta_{17} Output_i + \beta_{18} Adt_i + V_i \end{array} \right] \quad (8)$$

Table 1 depicts the description, measurement, and expected signs of the explanatory variables in the probit regression model (PRM) and generalised linear model (GLM).

## 4. Empirical results and discussions

### 4.1. Demographic and farm-specific characteristics of farm households

In Table 2, there was a statistically significant difference in some socioeconomic characteristics between market participants and nonparticipants. These variables include household size, farming experience, output unit price, distance to market, number of FBO meetings, number of extension contacts, farm size, off-farm income, use intensity of improved groundnut variety, and total output. From the table, whilst farmers who participated in the market recorded an average household size of eight persons, nonparticipants recorded an average of seven persons. There is a statistically significant difference between the two. Both the average household size of participants and nonparticipants is higher than the national average value of 4.0 (Ghana Statistical Service GSS, 2014). Also, the average farming experience (14 years) of participants was statistically lower than their counterparts (18 years). According to Konja et al. (2019), high farming experience enables farmers to adequately specialize in production to increase efficiency and profit in the market. Again, whilst participants recorded an average of three number of farmer-based organization (FBO) meetings, the non-participants had only 1 per year. Being a member of FBO affords farmers the opportunity of sharing information on modern production techniques, purchase inputs in bulk as well as fix good prices for their produce (Olwande & Mathenge, 2012). The study also revealed that, whilst

**Table 1. Description, unit of measurement, and expected signs of the explanatory variables in the models**

Variables	Description	Measurement	Expected sign	
			PRM	GLM
Sex	Sex of respondent	1 if male; 0 = female	±	+
Age	Age of respondent	Years	+	+
Hhs	Household size	Number	±	+
Mst	Marital status	1 if married; 0 = unmarried	±	±
Ext	Extension contacts	Number	+	+
Edu	Years of education	Number	+	+
FBO	Farmer-based organization meetings	Number of meetings in a year	+	+
Exp	Farming experience	Number of years in groundnut farming	+	+
AxInfo	Access to market information	1 if yes; 0 = No	+	+
AxMob	Access to mobile phone	1 if yes; 0 = No	+	+
OffFam	Off farm income	Cedis	+	+
Fms	Farm size	Acres	+	+
AxTras	Access to transport	1 if yes; 0 = No	+	+
Output	Quantity of groundnut harvested	Kilogram (kg)	+	
FomSal	Form of groundnut sale	1 if unshelled; 0 = otherwise	±	±
OutPx	Output unit price	Bowls (2.5 Kg)	+	
DMkt	Distance to output market	Kilometers (km)	-	-
Adpt	Adoption of improved groundnut variety	1 if yes; 0 = No	+	+
Inten	Intensity use of improved groundnut variety	Ratio of acres of land planted with CGS to the total size of groundnut farm in acres	+	+

participants had an average of two extension contacts, the non-participants had only 1. Extension workers usually provide information on market availability as well as information on new and improved varieties that enhance farmers' knowledge and provide a range and choice of market opportunities (Sebatta et al., 2014).

Notes: \*\*\*, \*\*, and \* denotes significant levels at 1%, 5% and 10%, respectively.

Again, whilst participants cultivated 1.7 acres of farmland, the non-participants cultivated 2.1 acres. This suggests that acres of land cultivated by participants are statistically lower than that of non-participants. It was found that participants statistically recorded a larger off-farm income (GH¢1985.1) compared to their counterparts (GH¢ 993.9). An off-farm income is an alternative income source for agricultural production. High off-farm income increases farmers' purchasing power to access improved technologies to improve productivity in production to participate in the market

**Table 2. Disaggregated descriptive statistics by market participants and non-participants**

Variable	Mean		
	Participants	Non-participants	Difference
Age	42.042	40.832	1.210
Household size	8.368	7.116	1.252**
Years of education	2.439	2.768	-0.329
Farming experience	14.474	17.613	-3.139**
Number of FBO meetings	3.453	0.832	2.621***
Number of extension contacts	2.042	0.658	1.384***
Farm size	1.711	2.103	-0.392*
Off-farm income	1985.063	993.899	991.164***
Use intensity of improved groundnut variety	0.763	0.023	0.740***
Distance to output market	8.224	5.270	2.954***
Output unit price	9.863	8.535	1.328***
Total output (kg/acre)	337.580	251.900	85.68***

Source: Field survey (2018).

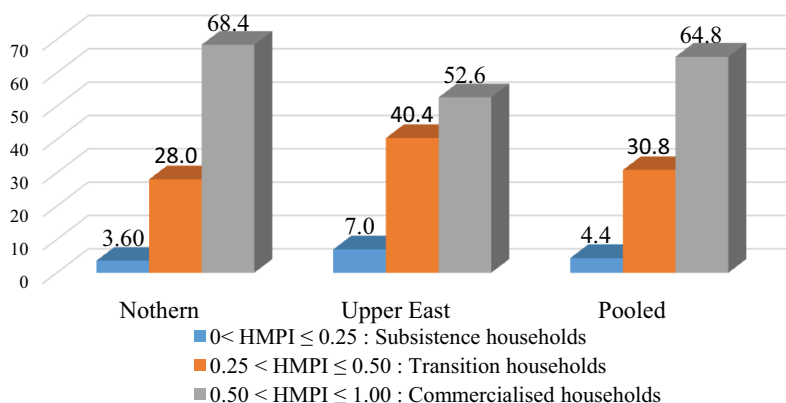
(Abu et al., 2014; Martey et al., 2012). The study indicates that participants statistically recorded a higher output unit price (GH¢ 10.0/2.5 kg) compared to their counterparts (GH¢ 9.0/2.5 kg). High output unit price is an incentive for farmers to increase production to maximize profits in the market (Mmbando et al., 2015). It was also revealed that participants recorded a higher use intensity of improved groundnut variety (0.76 units) relative to their counterparts (0.02 units). Agricultural intensification via the use of improved and quality planting materials increases yield/output to encourage market participation of farmers. It was noted that groundnut farmers who travel long distances (averagely 8.2 km) rather tend to participate in the output market more than their counterparts (averagely 5.3 km). Lastly, participants obtained higher output (337.6 kg/acre) than their counterparts (251.9 kg/acre).

#### 4.2. Distribution of households' market participation index

Figure 1 shows the distribution of the groundnut commercialization index among farmers in the Upper East region (UER) and Northern region (NR) under commercial, transitional, and subsistence-oriented production systems. Out of the 250 groundnut farm households interviewed across the regions, about 65% of them were commercial farmers, 31% were transitional farmers, and 4% were subsistence farmers. This estimate indicates that the average output of groundnut sold

**Figure 1. Percentage distribution of households' market participation index (HMPI).**

Source: Field survey (2018).



within the production season was about 62%. Although this average value is relatively high yet there is more room for improvement since 38% of groundnut output is unsold on the market. A statistical student's t-test was conducted to examine the commercialisation mean difference between farm households in NR and UER. The analysis indicates that the average output of groundnut sold by farm households within the production season in NR and UER was about 36% and 11%, respectively, a finding implying that groundnut market participation is higher among households in NR than UER. In reference to the below market orientation classification, groundnut production in the NR and UER is classified as transition-oriented and subsistence-oriented systems, respectively.

A further analysis shows that the extent of household market participation under the various market-participation orientations differs across the sampled regions. We now begin to discuss the percentage of groundnut sold in NR and UER under each category of market participation orientation. From Figure 1, the percentage of groundnut sold by commercialized households in the NR was relatively higher than commercialised households in UER. Whilst about 68% of groundnut output in NR was sold by commercial farmers, the study recorded 53% for commercial farmers in the UER. As observed by MoFA (2019), the average yield of groundnut per hectare in the NR is relatively higher than in UER and, hence, the difference in the quantity of groundnut sold among the two regions could be attributed to yield gaps. According to Barrett (2008) households with higher value of crop produced sell higher proportion of their produce. In line with Oduntan and Alade (2020), the proportion of plantain sold on the market is influenced by the total quantity of output. Turning to the percentage of groundnut sold by transition households within NR and UER, we found that farm households in UER sold relatively higher groundnut output than those in NR. Whilst about 40% of groundnut output in UER was sold by transition-oriented farmers, 28% was recorded for transition-oriented farmers in the NR, a result suggesting that households in UER are more transitional in commercialization than in NR. Thus, they are in the process of moving their production from subsistence farming to commercialize-oriented production. Lastly, the study found that the proportion of groundnut output sold by households under the subsistence-oriented production system was relatively higher in the UER than in NR. Whilst farm households in the UER sold about 7% of their harvested groundnut output, only 3% was sold in the NR. The study by Tipraqsa and Schreinemachers (2009) pointed out that commercialized farmers have a better living standard than subsistence farmers.

#### **4.3. Determinants of households' decision to participate in the groundnut market**

Table 3 shows the estimates of factors that influence the decision of farm households to participate in groundnut output market. From Table 3, the regression output indicates a Pseudo R-square of 0.797 which is statistically significant at 1%. This implies that about 80% of the variation in the result is jointly explained by the explanatory variables. The result shows that the factors that significantly influence farmers' decision to participate in the market include marital status, years of education, number of farmer-based organizations, off-farm income, number of extension contacts, farm size, output unit price, access to transport, distance to output market, the form of groundnut sale, intensity use of improved groundnut varieties, and a total output of groundnut harvested.

Notes: \*\*\*, \*\*, and \* denotes significant levels at 1%, 5% and 10%, respectively.

Marital status was statistically significant at 10% and negatively affects the decision of farmers to participate in groundnut output market. Married farmers are more likely to have large household size which increase household consumption of farm produce that reduce their decision to participate in the output market. This result agrees with the finding of Martey et al. (2012) and Abu et al. (2014) that married farmers are more likely to reduce their decision to participate in output market in Ghana. In contrast, Abu (2015) found that married household heads have economic and social responsibilities to meet which increases their decision to participate in output markets. The years of education of farmers were significant at 10% and positively affect farmers' decision to sell groundnut in the market. A plausible explanation of this result is that education influences a

**Table 3. Determinants of households' decision to participate in groundnut market: A probit regression model (PRM)**

Variables	Coefficient	Standard error	P-value
Age	−0.0174	0.0219	0.4250
Sex	1.2523	0.5524	0.0230
Marital status	−0.9093*	0.5010	0.0700
Household size	0.0128	0.0683	0.8520
Years of education	0.1032**	0.0541	0.0560
Number of FBO meetings	0.7082***	0.1874	0.0000
Off-farm income	0.0155**	0.0078	0.0460
Access to mobile phone	−0.6497	0.6318	0.3040
Number of extensions contact	0.2724**	0.1400	0.0520
Farming experience	−0.0175	0.0249	0.4840
Farm size	−1.0579***	0.2887	0.0000
Output unit price	0.4479***	0.1569	0.0040
Access to transport	1.0402**	0.4692	0.0270
Distance to output market	0.0765**	0.0402	0.0570
Access to market information	0.2526	0.4571	0.5800
Form of groundnut sale	2.1766***	0.5149	0.0000
Intensity use of an improved variety	−0.5486***	0.1490	0.0000
Total output	0.1657***	0.0457	0.0000
Constant	−0.6634	2.1245	0.7550
<b>Number of observations = 250</b> <b>Pseudo R2 = 0.797</b> <b>Log likelihood = −34.092</b> <b>LR chi2(18)</b> <b>Prob &gt; Chi = 0.000</b>			

Source: Field survey (2018).

households' understanding of market dynamics and therefore improves market participation decisions. This result is in line with the empirical evidence by Megerssa et al. (2020) and Martey et al. (2012) that education increases the decision of participation in agricultural output market in Africa. However, Mirie and Zemedu (2018) found a negative but insignificant effect of education on farmers' decision to participate in teff output market in Ethiopia.

Extension service was statistically significant at 10% and positively affects the participation decision of farmers in groundnut output market, a result similar to the finding of Mango et al. (2018), Andaregie et al. (2021), and Hagos et al. (2016). Thus, extension agents are a source of information on the usage of inputs, production and marketing, and frequent extension visits increase the chance of farmers participating in the market. Interestingly, the number of FBO meetings was significant at 1% and exhibits a positive association with farmers' decision to participate in the output market. This finding implies that farmers are likely to participate in the groundnut output market when they increase their FBO meetings. Abu et al. (2014) and Olwande and Mathenge (2012) found that farmers who belong to farmer-based organizations participate in the market more than their counterparts, due to their ability to enjoy economies of scale in accessing bigger output markets. However, belonging to a farmer-based organisation shows insignificantly negative effect on farmer participation decision in haricat bean market (Andaregie et al., 2021). This result by Andaregie et al. (2021) implies that farmer-based organisation does not explain farmers' decision to participate in output market.



The variable representing off-income was statistically significant at 5% and positively influenced the decision of farmers to participate in groundnut output market, and a finding implying that smallholder farmers who receive non-farm income from non-farm employment are more likely to participate in groundnut output market than those who do not engage in off-farm activities. The plausible explanation to this effect is that non-farm income helps smallholder farmers to purchase agricultural inputs that would enable them to produce more and decide to sell more portion of their produce. This effect agrees with the finding of Ola and Menapace (2020) and Andaregie et al. (2021) that off-farm activities are an alternative source of agricultural financing to increase input use and productivity to commercialize. Farm size was significant at 1% and inversely related to farmers' market participation decisions, a finding indicating that farmers with larger farm sizes are less likely to participate in the groundnut output market. This finding is consistent with the empirical evidence of Amao and Egbetokun (2018) that farm size reduces the probability of farmers to participate in vegetable market. However, the effect of farm size on market participation was positive in the study of Abu et al. (2014) and Mango et al. (2018).

Output unit price was significant at 1% and positively affects farmers' decision to participate in the groundnut output market, a finding suggesting that higher price provides a greater opportunity for the farmers to participate in the groundnut market. This result validates the empirical evidence by Oduntan and Alade (2020) and Mmbando et al. (2015) that high price of agricultural commodity increases commercialization. However, a study by Hagos et al. (2020) found an opposing association between price of mango and the decision of farmers to participate in mango market. Again, this study found that access to transport was significant at 5% and positively affects farmers' decision to participate in the market. This result connotes that farmers with transport access are likely to participate in the market more than their counterparts. This result is in line with the finding of Mango et al. (2017) who found that access to bicycle played a very important role in transporting commodities from the rural homes to nearby markets for sale. Distance to the output market was significant at 5% and positively influences farmers' market participation decisions, a result suggesting that an increase in the distance between output market and farm communities increases groundnut market participation. This result is not in line with the expected effect of this study. This result is not in line with the finding of Geremewe (2019) who found that distance to the nearest market declines the probability of participation in the wheat market. However, studies such as Megerssa et al. (2020) and Mmbando et al. (2015) also found similar finding which agrees with the result of this study.

Again, the form of groundnut sale was significant at 1% and positively affects the decision of market participation. This implies that farmers who sold their groundnut in the unshelled form are likely to participate in the output market more than those who sold in the shelled form. This result agrees with the finding of Abu (2015) that decision of market participation is increases for farmers who sell unshelled groundnut. The variable representing use intensity of improved groundnut variety was significant at 1% and negatively affects farmers' decision to participate in the groundnut output market in the study area. This result is contrary to the expected effect of use intensity of improved groundnut variety on farmers' decision to commercialize, and this could be attributed to likely crop failure as a result of climate change. Lastly, the study found that the total output of groundnut harvested was statistically significant at 1% and positively affects farmers' decision to participate in the market. This result is similar with Barrett (2008) who found surplus production serves as an incentive for a household to participate in market. In fact, households with higher value of crop produced sell higher proportion of their produce. The variable representing use intensity of improved groundnut variety is statistically significant at 1% and negatively influences the decision of market participation, a result which does not meet the expectation of this study but this effect could be attributed to crop failure as a result of climate change in the production. This result is not in line with the finding of Mango et al. (2017) who revealed that farmers who practice conservation agriculture increase propensity to participate in the output market. Andaregie et al. (2021) also found similar result that farmers who adopted improve haricot bean seed were more likely to decide to participate in the output market that otherwise in Northwest Ethiopia. Kebede

(2020) also reported that low input usage and limited availability of seed and market problems were the causes of the low productivity of grain legumes in Ethiopia.

#### 4.4. Determinants of level of HMPI in groundnut production

Table 4 shows the factors that affect the extent of market participation or commercialization by farm households in the study area. From the table, the value of the AIC (1.060544) shows a general goodness of fit for the model. The study shows that factors such as farmers' age, off-farm income, number of extension contacts, farming experience, distance to output market, the form of groundnut sale, intensity use of improved groundnut varieties, and adoption of improved groundnut variety significantly affect the degree of groundnut market participation. Age of the household head was significant at 5% and negatively affected the extent of commercialization. An increase in the age of household head by 1 year reduces the level of commercialization by about 0.3% on the average, holding all other explanatory variables constant. The negative relationship between age and level of market participation may be due to the inability of older farmers to access market information to increase the level of market participation. This result agrees with the finding of Andaregie et al. (2021), Megerssa et al. (2020) and Mango et al. (2018) but contradicts the finding of Hailua et al. (2015) who found that age of farmers positively influences the extent of market participation in Ethiopia.

Notes: \*\*\*, \*\*, and \* denotes significant levels at 1%, 5% and 10%, respectively.

The result also shows that off-farm income was significant at 10% and positively affects the level of farmers' groundnut sales in the market. The extent of market participation increases by

**Table 4. Determinants of level of HMPI: A generalized linear model**

Variables	Coefficient	Standard error	Marginal effect
Age	-0.0130**	0.0053	-0.003
Sex	-0.0571	0.1394	-0.0133
Marital status	-0.0110	0.1430	-0.0026
Household size	-0.0153	0.0163	-0.0036
Years of education	-0.0059	0.0135	-0.0014
Number of FBO meetings	-0.0216	0.0417	-0.0051
Off-farm income	0.0023*	0.0013	0.00054
Access to mobile phone	0.1175	0.1407	0.02759
Number of extensions contact	-0.1011***	0.0397	-0.0236
Farming experience	0.0111*	0.0061	0.00258
Farm size	-0.0416	0.0293	-0.0097
Access to transport	0.1093	0.1236	0.0256
Distance to output market	0.0454***	0.0112	0.0106
Access to market information	0.0786	0.1381	0.0184
Form of groundnut sale	0.3335***	0.1325	0.0779
Adoption of an improved variety	0.4931***	0.1850	0.1132
Intensity use of an improved variety	0.0503**	0.0222	0.0117
Constant	-0.3417	0.4968	
<b>BIC = -1237.037</b>		<b>AIC = 1.060544</b>	<b>Log pseudolikelihood = -114. 5680</b>

Source: Field survey (2018).

0.05% for an increase in farmers' off-farm income. This is true because smallholder farmers who generate income from off-farm activities reinvest it into groundnut production to increase productivity and extent of commercialization. This result conforms with the finding of Martey et al. (2012) and Hailua et al. (2015) but is inconsistent with the finding of Abu et al. (2014) who found that off-farm income reduces farmers' level of output sold.

The number of extension contact was statistically significant at 1% and exhibited a negative association with the quantity of groundnut sold. The result connotes that the extent of groundnut sold reduces by 2.4% as farmers increase their number of extension contacts in production. Access to extension is expected to provide farmers with better farm management skills to increase marketable surpluses of farm households in production; however, this result did not meet the expectation of this study. This finding is in line with the result of Martey et al. (2012) but it is inconsistent with the result of Ahmed et al. (2016) who found a positive association between extension access and the quantity of potatoes sold. Also, farming experience was significant at 10% and positively affects the volume of groundnut sold. The marginal effect shows that an increase of farming experience of farmers increases quantity of groundnut sold by 0.3%, and a finding implying that farmers with longer years of experience in groundnut production sell high quantity of groundnut than low-experienced farmers. An experienced farmer is exposed to market networks that accrue over time to enhance the search for trading partners and improve bargaining power to sell large quantity of groundnut. This finding is in line with the result of Egbetokun (2016), Oduntan and Alade (2020), and Martey et al. (2012) but contradicts the result of Andaregie et al. (2021) which exerts that farming experience of farmers reduces the quantity of haricot bean sold in northwest Ethiopia.

The variable representing distance to the output market was significant at 1% and positively affects the quantity of groundnut sold, a finding similar to the result of Dube and Guveya (2016). Empirically, the extent of market participation increases by 1.1% as the distance from farmers' residence to the output market increases. This result does not confirm the finding of Hailua et al. (2015) and Endalew et al. (2020) which opines that output market distance and extent of commercialization are negatively related. The study also found that the form of groundnut sold was significant at 1% and positively affects the quantity of groundnut sold. Empirically, the quantity of groundnut sold increases by about 7.8% more for households who sell groundnut in the unshelled form than those who sell in shelled groundnut. A reason supporting this finding is that, shelling of groundnut is a labour intensive, time-consuming, and tedious activity. Therefore, households turn to sell without shelling so that they could have the time to engage in other activities. This result is consistent with the finding of Abu (2015) that indicates that groundnut farmers who sell their groundnut in unshelled form commercialize more than those who sell in shelled form. Again, the study found that the use of improved groundnut varieties in production was 1% significant and positively affects the volume of groundnut sold by farm household. The coefficient of use of improved varieties implies that farmers who use improved groundnut varieties sell about 11.3% of their output more than non-users. This result is consistent with the finding of Degafa et al. (2022) and Awotide et al. (2016) who found that farmers who adopt improved seed varieties in production enhance productivity to increase the quantity of crop sale.

## 5. Conclusions and recommendations

As mentioned, about 90% of groundnut is produced in Northern Ghana; meanwhile, the chunk of households in this part of the country is characterized as poor. Groundnut output expansion is largely accounted for by an increase in farm size rather than farm productivity. Low farm yield affects the decision and the proportion of groundnut sold on the market. Therefore, the need for policymakers and stakeholders such as ICRISAT, Alliance for Green Revolution in Africa (AGRA), Crop Research Institute (CRI) of the Council for Scientific and Industrial Research (CSIR), and Ministry for Food and Agriculture to implement effective programs to reverse the current situation to promote agricultural commercialization in the country cannot be underscored. Low agricultural commercialization could be affected by transaction costs, household-specific characteristics, and institutional factors. Motivated by this, our study seeks to identify the factors affecting farmers' decision to market participation and the extent of market participation in groundnut production in Northern Ghana. The study seeks to encourage groundnut

farm households to reorient production from subsistence to commercial production. Due to this, the respondents were categorized into three levels of market participation, namely, commercial farmers, transitional farmers, and subsistence farmers. The analysis of the data from a sample size of 250 groundnut farm households shows that 65% of them were commercial farmers, 31% were transitional farmers, and 4% were subsistence farmers. On average, the study found that 62% of groundnut output harvested by farm households in Northern Ghana was sold on the market. Though this figure is high, there is more room for improvement since about 38% of groundnut output is still unsold on the market in the study area. Therefore, groundnut production in Northern Ghana is classified as commercial-oriented, where the key objective is cash income from production.

The regional distribution of households under commercial-oriented production was relatively higher in NR than their counterparts in the UER. Meanwhile, households in UER under transitional-oriented production sold a larger proportion of their groundnut output than households in the NR. Nevertheless, we found that the households in the NR sold a larger proportion of their groundnut output compared with farm households in the UER. The most significant determinants of market participation decision and intensity of participation in the groundnut market in terms of both the levels of significance and magnitude of the effect are extension service, distance to output market, farmer-based organization, off-farm income, output price, use of improved groundnut variety, and access to transport. These variables have proven to be policy variables that, when considered in governance, could potentially improve market participation and the welfare of farmers in the agriculture sector.

We, therefore, suggest the below policy recommendations to the government and other stakeholders based on the magnitudes of significant explanatory variables in the model. Firstly, we encourage that the government of Ghana in collaboration with the Modernising Agriculture in Ghana project (MAG) to provide farmers with groundnut shellers on subsidy for a paradigm shift from manual shelling method to a more advanced method to increase sales of shelled groundnuts in the study area. Secondly, the Planting for Food and Jobs (PFJ) program should create easy access to price subsidized improved groundnut seeds to farmers to increase productivity for higher market participation. The Planting for Food and Jobs (PFJ) has only selected soybeans as the only leguminous crop in its program; meanwhile, the majority of households in Northern Ghana produce groundnut than soybeans.

Thirdly, we encourage the Ministry of Food and Agriculture (MoFA) to form farmer-based organization among smallholder farmers in the rural areas to facilitate collective groundnut marketing. The formation of farmer-based organization will improve social network among farmers that encourage information sharing on existing profitable markets to increase farm household's level of market participation. Fourthly, given the evidence that access to transport and the distance of output market to rural farmers affect groundnut market participation, we propose that government investment in road infrastructures and set-up of output markets closer to rural communities could facilitate easy access to transport means for groundnut produce transport to nearby markets for sale. With this action, higher transportation costs incurred by farmers to distant markets and postharvest losses resulting from untimely market access will drastically reduce for high market participation. Lastly, since off-farm income increases groundnut market participation, we recommend that the government should establish location-specific off-farm economic activities to help farmers generate supplementary incomes to finance production and market transaction cost to increase groundnut market participation in the study area.

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#### Availability of data and material

The authors want to declare that they can submit the data at any time based on the publisher's request.

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