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## FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

# Analyzing the drivers of smallholder farmer's market participation in the Sahelian region of Niger

Seydou Zakari<sup>1\*</sup>, Bokar Moussa<sup>2</sup>, Germaine Ibro<sup>2</sup> and Tahirou Abdoulaye<sup>3</sup>

**Abstract:** Many sub-Saharan farmers rely on agricultural production for home consumption and sell crops to meet their other needs. Farmers' market intervention enhances economic expansion and helps to improve household food security. In our current study, we strive to explore the determinants of farmers' decisions and the intensity of market participation in the Sahelian region of Niger, where little has been published, thereby filling the gap in the literature. A double hurdle approach was employed to achieve this objective using a sample collected from 1784 farm households in Niger.

Our findings reveal that the total quantity of crops produced, gender, credit access, farming experience, training, drought, and assets positively impact household market participation significantly. Based on these results, as the quantity of crop sales is driven positively and significantly by the amount of crop produced, finding ways to increase crop production will increase household market participation. This can only be achieved by encouraging farmers to adopt high-yield crop varieties, such as climate-resilient ones, to boost productivity. Furthermore, considering the positive association between credit availability and smallholder market participation, any initiative in the agricultural sector that will bring efforts to supply credit and farm inputs to farmers will surely help to improve agricultural production and household market participation.

**Subjects:** Sustainable Development; Rural Development; Economics and Development; Statistics for Social Sciences

**Keywords:** Household; market participation; double hurdle; Niger

### 1. Introduction

Agriculture is by far the most significant economic sector of African countries. It employs about two-thirds of the continent's working population. The rural sector dominates Niger's economy by contributing 44% of export revenues and nearly 40% of the GDP. Agriculture and livestock, the main components of this sector, employ more than 85% of the active population. Many small-scale producers in Niger live in poverty; some only produce barely enough to feed their families. Even when they produce surpluses, in certain situations, they cannot sell their products for a significant profit because of their lack of market access. Some international organizations and NGOs often intervene through farmers' organizations to purchase local products from farmers. For example, to

strengthen the resilience of vulnerable small producers and sustainably improve food and nutrition security, the World Food Program (WFP), through its program PAA Africa—Purchase from Africans for Africa, made local food purchases from groups of small agricultural producers in Niger.

“Cereal stock market” is also an event that brings together in one place the actors and partners of the cereal value chain to facilitate the cereal trade. It helps producers find markets to sell their surpluses, learn about the characteristics of the market, be trained in marketing techniques, and meet partners to forge lasting relationships. It also allows farmers’ organizations in deficit areas to stock up on quality cereals at a reasonable price easily. The primary goal of the cereal exchange is to encourage the sale of cereal production from areas with surpluses to areas with shortages by supporting the linkage between supply and demand to meet the cereal demands of various places.

According to a number of studies, smallholders’ market participation promotes economic expansion and development (Martey, 2013; Pingali & Rosegrant, 1995; Timmer, 1997). Market accessibility allows farmers to sell their goods and purchase inputs necessary for agricultural production. Reliable market access improves productivity, income, and food security. It can help reduce poverty and hunger in households and the society in which they live if appropriate measures are taken to mitigate market risks and disparities in market power. Participation in the agri-food market generally provides a greater chance for households to expand into activities in other sectors. Rural farm households can improve their income by intervening more in the market if they can sustainably increase their productivity. Farmers’ access to productive technologies with adequate public and private goods is mandatory to generate a marketable surplus (Barrett, 2010).

Several studies were reported regarding the drivers of farm households’ market participation. Examples of a few recently published papers regarding smallholder market participation are (Abafita et al., 2016; Awotide et al., 2016; Barrett, 2010; Manda et al., 2020; Mango et al., 2018; Megerssa et al., 2020; Mmbando et al., 2015; Yaméogo et al., 2018). Despite this existing literature on smallholder farmers’ market participation, little has been done in the Sahel region. Therefore, we deemed essential to conduct this current research which tries to bridge the gap in the literature by investigating the drivers of farmers’ decisions and the intensity of crops marketed in the Sahelian region of Niger. We hypothesized that the household’s characteristics and other institutional factors influence household’s market participation. Unlike previous works (Manda et al., 2020; Mignouna et al., 2015; Schmidt et al., 2020), the subject of this investigation focuses on the smallholder’s willingness to engage in selling at least one crop, such as millet, sorghum, cowpea, etc., cultivated on their farms.

The rest of the paper is organized as follows: section 2 introduces the study area and data; analytical techniques are presented in section 3; results are discussed in section 4; and finally, section 5 provides a concluding remark.

## 2. Methodology

### 2.1. Study area and sampling procedure

Data come from a farm household survey in Niger conducted in 2019 by the International Institute of Tropical Agriculture in collaboration with the National Agricultural Research Institute of Niger.

Data was collected for the baseline survey for the purpose of implementing the CSAT-Niger project. The survey covered four regions of Niger (Tillabéri, Dosso, Maradi, and Zinder) where the project CSAT is being implemented. The project “Climate Smart Agricultural Technologies (CSAT)” aims to introduce climate-smart technologies and agricultural innovations in the Sahel, Sudan, and arid savanna regions of Niger, improving livelihoods in rural environments, food, and nutritional security. Figure 1 shows the CSAT-Niger project intervention zones.

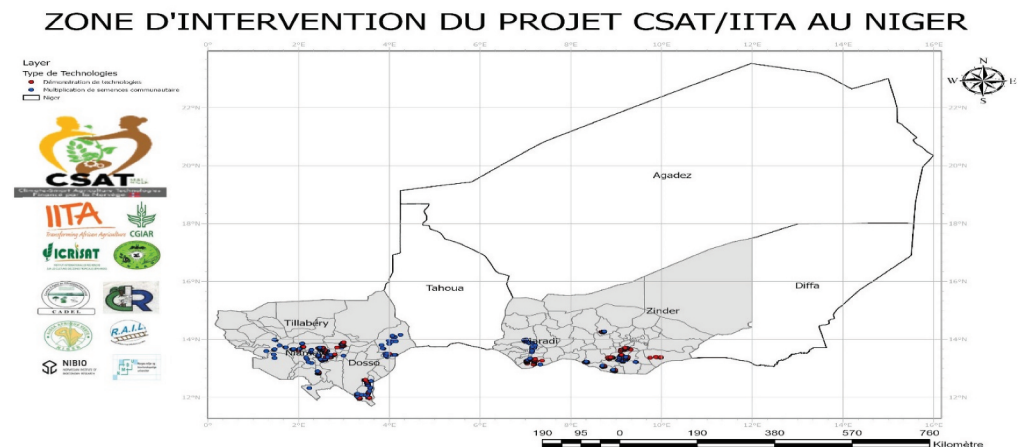
Niger is a Sahelo-Saharan, landlocked and low-income country that, according to official national statistics, had around 20 million of inhabitants in 2017. Niger has recently become the center of renewed international commitment to the Sahel region and a strategic area for controlling of many natural resources and geopolitical balances. Agriculture is the only expanding sector, while other primary sectors such as forestry, hunting and fishing are experiencing a decline of around 5.6% per year, that is why Niger is experiencing a decline in land area of about 30% per year since 1990. The main agricultural products are millet, sorghum, cowpea, cotton, groundnut, and rice, while livestock consists of cattle, sheep, goats, camels, donkeys, horses, and poultry.

During the survey, we used a multistage sampling procedure to draw an appropriate sample for the baseline survey. In the first stage, four regions (Dosso, Tillabéri, Maradi and Zinder) were purposively chosen for the project implementation based on the intensity of cereal and legumes production, agroecology, accessibility, and security. In the second stage, eight communes were purposively selected from each of the selected project regions. In the third stage, five intervention and five non-intervention villages were selected; taking into consideration accessibility, security, production of the project’s main target crops (Maize, sorghum, millet, cowpea, groundnut, and soybeans), and the villagers’ willingness to participate in the survey. A total of 320 villages (160 intervention villages et 160 non-intervention villages) were chosen. The final stage is the random selection of the households through the farmer’s listings and communal consultation forums. Households were selected from intervention and non-intervention villages. 2240 farm-households were interviewed. The sample size was distributed evenly among all the selected regions; seven households were sampled from each of the selected 320 villages (intervention and non-intervention). The sampled households were selected through the farmers’ listings and stakeholder consultation at the community level.

A well-structured questionnaire was used as the main instrument for the data collection. The comments, observations, and suggestions from the training were then incorporated into the questionnaire to produce the final version coded into the Tablets using the “Surveybe” software. Consequently, (CAPI) “Computer-Assisted Personal Interviews” were used to gather the baseline data. It is a face-to-face data collection; whereby the enumerators adopted tablets instead of papers to record the answers the farmers gave during the interview.

The questionnaire contained modules like Household’s demographic and socioeconomic characteristics, Climate change adaptation, perception, and signs, Food insecurity and hunger assessment scale, adoption of improved practices, Food, and non-food expenditure, etc. The study is designed to provide answers to the actual situation in the selected project regions at the household level before implementing the CSAT project. The study aims to understand the agricultural

**Figure 1. CSAT-Niger intervention zones in Niger.**



production activities, poverty, and food security situation, among many others. Finally, the information collected from 1784 households was valid and used for the analysis.

## 2.2. Analytical technique

The present study examines the driving factors of smallholder market participation in rural Niger. Several econometric analytical techniques have been employed in investigating smallholder market participation. Tobit models, double hurdle models, and Heckman sample selection models are some of these techniques (Dlamini & Huang, 2019; Mignouna et al., 2015) (Tabe-Ojong Jr et al., Tabe-Ojong et al., 2021); (Donkor et al., 2018; Tafesse & Korneliusson, 2020).

In the current analysis, as an alternative and more adaptable approach to the Tobit model, we adopted the Double hurdle model (Ingabire et al., 2017; Schmidt et al., 2020). This alternative two-stage model is pertinent to our research since it is predicated on the idea that distinct independent vectors drive smallholder's participating decisions. The double hurdle is a less restrictive variant of the Heckman and is best suited for samples drawn through random probabilistic sampling procedures (Adam, 2010; Dlamini & Huang, 2019). For this reason, the double hurdle was used to analyze our randomly chosen sample data.

(Cragg, 1971) introduced the Double Hurdle (DH) approach as an alternative to the Tobit model and to deal with many zeros in the data. It is a two-step decision process: first, the household decides whether to participate in the selling of crops and second the household decides on the volume of crops to be sold.

In the initial step, Probit regression was used to identify factors affecting market participation decisions. The model takes a value 1 and 0 that are assigned to represent the choice of whether a producer decides to participate or not. The choice of whether to sell was considered under the general framework of utility or profit maximization (Greene, 2007; Molua, 2012). In this theory, it is assumed that a decision-maker faces alternatives and would choose the alternative that provides the greatest utility.

The typical Probit model that evaluates the adoption decision made by the household was described in Eq. (1) as:

$$D_I = \alpha Z_I, k + \varepsilon_i$$

$$D_I = 1, \text{ if } D_I^* > 0,$$

$$D_I = 0, \text{ if } D_I^* \leq 0$$

where  $D_I$  is a dummy variable that takes the value 1 if the household participates in crop selling and 0 otherwise,  $Z_I$  is a vector of independent variables hypothesized to influence participation decision,  $k$  is the regressors,  $\alpha$  is a vector of parameters to be estimated and  $\varepsilon_i$  error term.

In the second step, the factors that affect how many crops are sold at a given time were examined using a truncated regression model with a lower left truncation of 0.

The model for the intensity of crop sold is given in Eq. (2) as follows:

$$y_i = \beta_i \chi_i + \mu \lambda_i + \varepsilon_i$$

$$y_i^* = \beta_i \chi_i + v_i$$

$$y_i = \{y_i^* \text{ if } y_i^* > 0 \text{ and } D_i = 1; 0 \text{ otherwise}\}$$

where  $y_i^*$  and  $y_i$  are latent and the observed intensity of participation, respectively,  $\chi_i$  is a vector of variables influencing intensity of crop sold and  $\theta$  is a vector of parameters to be estimated.

The error terms are assumed to be independently and normally distributed as both decisions made by the individual household independently which are as:  $\mu_i \sim N(0, 1)$  and  $v_i \sim N(0, \sigma^2)$ .

A summary of variables and their definitions used in the double-hurdle analysis are presented in Table 1. These variables were selected based on economic theory and empirical studies on market participation (Adam, 2010; Chen & Zhou, 2011; Dlamini & Huang, 2019; Mignouna et al., 2015). It is expected that these explanatory variables would affect household market participation.

In the probit regression model, the binary dependent variable that measures the probability of market participation has a value of one for farmers who sold a crop and zero for farmers who did not. The outcome variable for the truncated regression model is the quantity of crop sold, subject to the first decision to sell.

### 3. Results

#### 3.1. Methods and channels of marketing crop products

As reported in Table 2, there are two methods through which households sell crop products, namely collectively and individually. More than 96% of households adopt individual sales while only less than 4% sell collectively. The main method of marketing crop products adopted by households in many less developed countries, particularly among the rural poor is largely individual marketing (one-to-one marketing). This mode of marketing is reportedly not the best as it restricts the farmers' access to profitable markets, increasing the transaction costs and thereby reducing the farmer's profit. While collective marketing is where several farmers work together to sell their combined crops. It helps to reduce the cost of transportation. Smallholder farmers will be able to sell their goods directly to an off-taker through collective marketing, which will minimize transaction costs and do away with intermediaries. Given this, collective marketing has been the object of attention in the past few decades as a means of solving the problems associated with individual marketing. However, this method of marketing necessitated the organization of the farmers into cooperative societies.

Marketing channels of farm products refer to all the linkages or pathways through which farm products must pass through before they get to the final consumers. The descriptive results reported in Table 3 show that the larger number (48.37%) of households sell their products mostly at the local/village markets and more than 30% sell in urban markets within the region. Only very few sell directly to processors and the export market.

#### 3.2. Determinants of farmers' market participation

The differences in the means of some welfare indicators for both market participants and non-market participants are summarized statistically and presented in Table 4. The results show that both participants and non-participants have largely similar socioeconomic characteristics. However, the participants produced more crops than the non-participants. Therefore, the market participants earn more income compared to non-market participants. In addition, we found that the participants have larger farm size, bigger family size, more educated and more experience in farming than non-Market participants. Similarly, households that do participate in market receive more extension services and have larger assets.

Before analyzing the determinants of household market participation, we have performed endogeneity and multicollinearity tests. The results are reported in Appendix Tables A1, A2 and Table A3. The results in Appendix Table A1 indicate that the null hypothesis was rejected, suggesting that the variables are exogenous. This means, there is an endogeneity problem in the variables. This indicates making use of the two-stage least squares (2SLS) regression model

**Table 1. Description of variables**

Variable	Description	Mean	SD
<b>Dependent variables</b>			
Market participation decision	Dummy = It is a binary dependent variable that represents the probability of market participation of households in crop marketing. The variable takes the value of 1 for the household that participates in the market, whereas it takes the value of 0 for the household that does not participate in crop marketing	0.16	0.37
Quantity of crops sold	A continuous variable that indicates the amount of crop sold and measured in kilogram	930.38	4592.68
<b>Independent variables</b>			
<b>Household and farm characteristics</b>			
Gender	Dummy = 1 if the household head is male	0.82	0.37
Age	Age of the household head	49.19	13.83
Household size	Number of family members	10.99	6.32
Farm size	The total farm size owned by household in hectares for crop production.	5.14	5.89
Literacy	Dummy = 1 if the head of household can read and write	0.73	1.26
Income	Total household farm income	22,071.77	81, 265.99
Migration	Dummy = 1 if the head of the household migrant	0.48	0.49
Crop production	The total quantity of crop production in kilogram	1064.69	4769.59
Quantity of household assets	The total quantity of assets	0.49	1.66
Farming experience	Number of years of farming	27.00	14.63
<b>Institutional factors</b>			
Credit access	Dummy = 1 if the household has access to credit	0.33	0.47
Membership	Dummy = 1 if the household head is a member of an organization or an association	0.03	0.17
Contact with an extension agent	Dummy = 1 if the household has contact with public extension services	0.39	0.48
Training	Dummy = 1 if one (at least) household member attended training	0.15	0.35
Market access	Distance to the nearest market (in kilometers)	12.20	15.35
<b>Others</b>			
Drought	Dummy = 1 if the experienced drought in the last five years	0.29	0.45

may biased results. Thus, we can assess the factors impacting smallholder market participation using double hurdle. Similarly, the correlation matrix of continuous variables shows a high correlation between the quantity of crops produced, the amount sold and farm size on one hand and between age and farming experience on the other hand. [Appendix Table A3](#) shows a weak correlation as the acceptable value of the correlation coefficient is globally less than 0.5.

The determinants of the household’s decision and the intensity of crops sold were analyzed using double-hurdle model regression. The results are reported in [Table 5](#). The likelihood ratio test shows that the overall good fitness of the model is statistically significant at 1 % of the significance



**Table 2. Product methods of marketing**

Method of marketing	Frequency	Percent
Individually	1,748	96.63
Collectively	61	3.37
Total	<b>1,809</b>	1.00

**Table 3. Main product marketing channels**

Main marketing channels	Frequency	Percent
On-farm to consumers	77	4.26
On-farm to wholesalers	92	5.09
By the roadside	52	2.87
Local/village market	875	48.37
Urban market within the region	558	3.85
Urban market outside the region	111	6.14
Sale to agro-processors	22	1.22
Exported	22	1.22
Total	<b>1,809</b>	1.00

level. This indicates that explanatory variables jointly explained the probability of participating in crop marketing.

In the first hurdle equation (Probit, i.e., decision to participate in the model), the results indicate a positive and significant association between the variables (gender and farming experience) and the household decision to sell crops. This implies that more males participate in crop marketing but sell less quantity of crops compared to females. The reason is that most smallholder farmers rely on male-headed crop production for family food consumption and other needs. The crops are also sold to buy clothes, pay for debt incurred during the cropping season, etc. Most of the land in Niger is in the hands of men. Hence few females participate in crop production. A further argument which is households led by women have lower incomes than households headed by men, therefore, they depend more on crop sales to meet their financial needs, so they tend to sell more. In addition, because they are poorer, few of them participate in comparison to the male-headed household. This also insinuates that the experienced headed households are more likely to participate in crop marketing. However, family size, credit availability and extension services, as well as land size, are found to impact negatively and significantly farmers' marketing decisions. This demonstrates that the larger the family size, the less likely the household is to participate in crop sales. Generally, smallholder farmers rely on their own crop production to feed their members. This result is consistent with the findings of (Abu et al., 2016; Singbo et al., 2021; Siziba et al., 2011; Woldeyohanes et al., 2017). Land size is negatively and significantly associated with the probability of a household's decision to participate in crop marketing. This finding is unexpected as the larger the land size, the higher the crop production is likely to be, and the higher household market participation seems to be. It is also found that credit availability and extension services exert a positive and significant effect on the likelihood of household's market participation decisions.

Similarly, the educated -headed household impacts negatively and significantly the likelihood of the household's decision to sell crops. This indicates that the educated-headed households are more likely to not participate in crop sales. The knowledgeable farmers may have more information on prices compared to their counterparts (Nakasone, 2013). found that farmers who have price information experienced increases in sales.



**Table 4. Participants compared to non-participants based on their means differences**

Variables	All	Participants	Non-participants	Difference
Gender	0.82733	.9095	.8159	-0.0936
Age	49.194	48.924	49.232	0.308
Household size	10.996	11.43	1.93	-0.50
Farm size	5.14	5.64	5.07	-0.57
Literacy	0.73	.95	.70	-0.25
Access to credit	0.33	.32	.33	0.01
Farming experience	27.00	27.92	26.87	-1.05
Extension services	0.39	.43	.39	0.03
Household asset	0.49	.58	.48	-0.10
Attended training	0.15	0.15	0.15	0.00
Farm income	22,071.77	28192.41	21,222.41	6970.00
Access to market	12.20	12.17	12.41	0.23
TLU	1.30	1.45	1.28	-0.16
Farm equipment	0.60	.50	.61	0.11
Total crop production	582.99	612.90	392.46	-220.44

In the second hurdle equation (the intensity of crop sold), the results revealed, as expected, the quantity of crops produced impacts significantly and positively the level of crops marketed. This indicates that the more the quantity of crops produced, the more we expected an increase in the level of crops to be sold. This is consistent with the results of (Abafita et al., 2016) and (Mbitsemunda & Karangwa, 2017), stating that an increased crop production increases the likelihood of participating in crop commercialization. Similarly, training impacts positively and significantly the level of crops marketed. This indicates that trained smallholder farmers are more likely to participate in crop marketing compared to their counterparts. Trained farmers may be more knowledgeable in marketing strategies which help to improve their market participation.

Being a migrant-headed household is found to affect negatively and significantly the level of crops marketed. Several households receive remittances sent by their members abroad. The remittances are used for household needs in purchasing food, clothes, weddings, and other things. Indeed, this reduces the intensity of crops sold.

The results also show that the intensity of crop marketed is positively and significantly influenced by the number of assets owned by the households. This fits with the conclusions of (Mpombo et al., 2022) who demonstrated that possessing productive assets raises small-scale farmers' overall agricultural production, which in turn promotes agricultural marketing. In addition, credit access is found to have a positive and significant effect on the intensity of crops marketed. Acquisition of credit allows farmers to buy better agricultural inputs like fertilizer, seeds, and other production technology, which in turn increases production, and consequently, the surplus that can be sold. This is supported by (Alhassan et al., 2020) who found that credit has a favorable effect on crop production, which in turn positively impacts market participation.

Meanwhile, the distance from the main market significantly and positively affects the volume of crop sales. Since increase in the distance to market increases the transportation cost, which discourages market participation.

Drought occurrence has an unexpectedly beneficial and considerable impact on crop sale. Generally, in the Sahel, drought seriously affects crop production, thereby negatively impacting the level of crops to be marketed.

**Table 5. Estimated of double-hurdle model for the determinants of market**

Variables	First hurdle	Second hurdle
	Participation	Quantity
Total quantity produced	0.000(0.003)	0.967(0.006)***
Gender	4.786(2.006)**	-351.235(117.311)***
Age	-0.047(0.051)	-5.591(4.575)
Household size	-0.126(0.075)*	-2.407(5.573)
Total farm size	-0.331(0.135)**	3.252(10.088)
Access to credit	-4.857(1.676)***	177.566(60.75)***
literacy	-0.677(0.390)*	-19.690(21.762)
Farming experience	0.103(0.050)**	1.610(5.041)
Contact with extension services	-1.654(0.790)**	95.003(57.995)
Training	7.724(366.50)	142.860(65.825)**
Membership	-3.526(10.484)	-166.0385(405.665)
Total income	-7.60(4.86)	-0.000(0.000)
Migrant	-0.153(0.617)	-84.230(50.389) <sup>†</sup>
Occurrence of drought	-0.020(0.682)	137.3419(64.937)**
TLU	0.250(0.245)	6.922(8.744)
Asset	0.021(0.086)	18.589(9.396)**
Distance to the nearest market	0.132(0.110)	-11.219(4.914)**
_constant	1.852(2.548)	386.616(193.534)**
Sigma		5.011(0.085)***
LR chi2(17)	524.58	
Prob > chi2	0.0000	
Log-likelihood	-566.83529	
Pseudo R2	0.3163	

Notes: \*Significant at the 10% level, \*\* Significant at the 5% level, \*\*\*Significant at the 1% level. Standard Errors in parentheses

#### 4. Discussion

Smallholder market participation could be a realistic way to change subsistence farming and free millions of impoverished households from the hunger and poverty cycle (Mignouna et al., 2015).

This present study attempts to bridge the gap in the literature by investigating the drivers of farmers' decisions and the intensity of crops marketed in the Sahelian region of Niger. The findings show that most households sell their products individually through local markets and urban markets inside the area. Generally, through individual sales, farmers cannot impose prices on the market, which is possible with the collective sale. According to numerous studies, farmers can strengthen their bargaining position with producers, intermediaries, and buyers by engaging in collective marketing, which can help them achieve a competitive advantage in a global market that is becoming more commercialized and integrated. Through their groups, cooperatives, and other organizations, farmers can improve production, marketing, and livelihoods in general (Fischer & Qaim, 2012; Francesconi & Heerink, 2011). Several studies also revealed how important it is to use the appropriate market channel to reduce poverty, provide food security, and promote sustainability (Abera, 2016; Jari & Fraser, 2009; Manda et al., 2020). Inadequate market channels combined with poor price information are important factors affecting agricultural product marketing (Jaleta, 2007). The results show that different factors affect household decisions and the level of crops marketed. The total quantity of crops produced, sex, access to credit, farming experience, training, drought, and quantity of household assets are significant and positive factors influencing household market participation. Indeed,

farmers must produce more crops to decide to sell a certain portion of their crops. This implies the favorable relationship between the intensity of crops produced and household market participation. This supports (Mignouna et al., 2015) and (Mbitsemunda & Karangwa, 2017) that increasing agricultural yield increases farmers' chances of selling more products. Meanwhile, households with credit access seem to sell more crops than their counterparts. Farmers need credit to purchase farm inputs, hire labor, and even marketing of the products. This demonstrates how credit and household market participation are positively correlated. This finding aligns with those of (Abadega, 2021). According to (FAO, 2017), constraint to credit is part of the factors limiting most smallholder farmers from participating in crop sales in developing countries.

The household decision to participate in the market is favorably and considerably impacted by gender. This is supported by the findings of (Sebatta et al., 2014). Furthermore, the intensity of the crop marketed is significantly and positively impacted by training. A plausible explanation for this training allows farmers to be equipped with necessary knowledge, techniques, and skills in marketing to add value to farm products. Meanwhile, the quantity of assets or wealth household owned is tool which allows farmers to wait and enter the market when prices are high and earn more profit. Sometimes, farmers have information where they can sell products at a high price and gain more benefit, but high transportation cost causes difficulties in the product transaction.

However, drivers such as household size, distance to the nearest market, contact with extension services, and farm size influence negatively and significantly farmer market participation. The larger the household, the greater the amount of food needed to feed members. In the Sahel, household relies on agricultural production for food supply. This explains the inverse relationship between household size and market involvement. This result is consistent with the findings of (Abu et al., 2016; Singbo et al., 2021; Siziba et al., 2011; Woldeyohanes et al., 2017). Similarly, farm size shows a negative effect on household market participation decisions. This finding is unexpected; the larger the farm size, the higher the production of crops likely to be and the higher household market participation seems to be. In some cases, households may own larger farm sizes but cannot manage them well to get good productivity. This can also be due to a lack of production inputs which impact negatively farm production. The distance to the nearest market influences negatively and significantly household market participation. This negative association implies that the far is a household from the crop market, the more difficult and costly it would be the transaction cost to handle and carry crops to market. This will discourage farmers from selling crops to the market. This aligns with the findings of (Singbo et al., 2021) and (Yaméogo et al., 2018).

## 5. Conclusion

Farmer market participation is a major driver of rural welfare and development. Access to markets is essential for economic growth, where agriculture constitutes the main occupation for a large portion of the population. Indeed, rural households depend mainly on the number of crops produced and the market where some parts of production can be sold and earning cash to purchase other necessary items for household needs. In this research, a double hurdle model was employed to investigate the drivers of household market participation using a sample collected from 1784 households in the Sahelian region of Niger.

The descriptive statistics show that more than 96% of households adopt individual marketing as a mode to sell crop products. Local markets and urban markets are the two main marketing channels where farmers market their products.

The empirical results show that the factors such as the total quantity of crop produced, gender, access to credit, farming experience, training, drought, and quantity of household assets influence positively and significantly the decision and the level of crop marketed by smallholder farmers.

With regard of these findings, considering the positive and significant relationship between the quantity of crop sales and the level of crops produced, looking for ways to increase crop production

will increase household market participation. This can only be achieved by encouraging farmers to adopt high-yield crop varieties, such as climate-resilient ones to boost crop production.

Additionally, given the strong and favorable correlation between smallholder farmers' market participation and their credit accessibility, any agricultural sector initiative that aims to increase the supply of credit and farm inputs for farmers will undoubtedly help to boost crop production in the study area.

Overall, strengthening institutional factors such as access to credit, market, extension services, and group membership, and using drought-resilient crop varieties could boost agricultural production and smallholder farmers' market participation, thereby improving the Sahelian region's ability to feed its people.

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No potential conflict of interest was reported by the authors.

#### Data availability statement

Data are readily available on request from the authors.

#### Author contributions

Seydou Zakari: Conception, Data analysis, Initial draft and final write up  
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## Appendix

**Table A1. OLS regression and endogeneity test**

Instrumental	variables	(2SLS)	regression	Number of obs	=	120
		Wald chi2 (8)	=	10586.35		
		Prob > chi2	=	0.0000		
		R-squared	=	0.9931		
		Root MSE	=	381.91		
Quantity of crop sold	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Total production	1.076983	.0459053	23.46	0.000	.9870105	1.166956
Gender	499.3357	252.9316	1.97	0.048	3.598748	995.0726
Age	-8.445056	6.157506	-1.37	0.170	-20.51355	3.623435
Family size	13.79472	10.42013	1.32	0.186	-6.628356	34.2178
Farm size	-115.065	45.45814	-2.53	0.011	-204.1614	-25.96873
Access to credit	-38.97074	103.3175	-0.38	0.706	-241.4692	163.5278
literacy	-34.14878	34.87967	-0.98	0.328	-102.5117	34.21413
Farming experience	9.955452	6.653734	1.50	0.135	-3.085627	22.99653
_cons	-221.7879	300.1963	-0.74	0.460	-810.1618	366.5861
Endogeneity Test						
Ho: variables are exogenous						
Durbin (score) chi2(1) = 26.3375 (p=0.0000)						
Wu-Hausman F(1,110) = 30.9316 (p=0.0000)						

**Table A2. Correlation matrix for continuous variables**

	Quantity of crop sold	Total production	Age	Family size	Farm size	Farming experience	Total income	Asset	Distance to market
Quantity of crop sold	1.0000								
Total production	0.9991	1.0000							
Age	-0.0379	-0.0325	1.0000						
Family size	-0.1099	-0.1061	0.1879	1.0000					
Farm size	0.7146	0.7188	-0.0382	0.3226	1.0000				
Farming experience	-0.0788	-0.0762	0.7770	0.3346	0.0345	1.0000			
Total income	-0.0414	-0.0408	-0.0029	0.0188	-0.0661	0.0119	1.0000		
Asset	-0.0385	-0.0365	0.0238	0.0658	-0.0127	0.0608	-0.0251	1.0000	
Distance to market	0.0151	0.0129	-0.0400	-0.3733	0.0657	-0.0512	-0.1602	0.0605	1.0000



**Table A3. Tests for multicollinearity**

<b>Variable</b>	<b>VIF</b>	<b>1/VIF</b>
Age	7.88	0.126844
Farming experience	7.28	0.137320
Gender	3.23	0.309850
Farm size	2.73	0.365729
Total production	2.50	0.400036
Family size	2.37	0.421620
Distance to market	1.57	0.637254
literacy	1.45	0.689600
Access to credit	1.39	0.717213
Extension services	1.28	0.778380
Training	1.25	0.797970
Occurrence of drought	1.21	0.823313
Total income	1.21	0.826052
TLU	1.18	0.850028
Membership	1.18	0.850117
Asset	1.17	0.855807
Migrant	1.15	0.872813
Mean VIF	2.36	