

Determinants of Cultivar Choice and Market Participation Among Smallholder Pearl-Millet Farmers in Jigawa State, Nigeria

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Abstract

This empirical study was carried out to determine cultivar choice and market participation among smallholder Pearl-Millet farmers in Jigawa State, Nigeria. Primary data were used for the study and this was obtained using a multistage sampling technique. Structured questionnaires were used to capture responses from pearl millet farmers in the study area. A sample of 296 was selected for the study. The data were analyzed using descriptive statistics, multinomial Logit Regression, market participation index and double hurdle model. The findings revealed that the respondents were literate with mean age of 39 years and mostly married; 52.36% of the farmers had household sizes between 1 and 8 persons. Majority (81.42%) of the farmers had between 2-17 years' experience in pearl millet farming. The result of the MNL shows age, marital status, household size, farming experience; education and extension visit were found to influence cultivar choices of pearl millet at different significant probabilities. There is low level (27%) of farmer's market participation in the study area. Market information, non-farm income and cultivar choice were the factors found to influence decision to participate in pearl millet marketing. Meanwhile, market information and contact with extension agent were found to influence extent of farmer participation in pearl millet marketing in the study area. The study concludes low level of market participation among smallholder's pearl millet farmers in the study area, therefore recommends improving their access to markets information through organized extension services will enhance their market participation.

Keywords: Pearl Millet, Cultivar Adoption, Market Participation, Extension Services, Jigawa State.

Introduction

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, Strijker, Asiedu, & Daams, 2020; Morton & Martey, 2021). These uncertainties make farmers vulnerable to various risks such as loss of income and assets there by making a shift to commercialized agriculture difficult. 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. Pearl millet plays significant role in food security of the drier regions of WCA. It has three generic names corresponding to three different types in the Hausa Language in Nigeria: *Gero* (early maturing), *Maiwa* (late maturing and photosensitive), *Dauro* (transplantable and photosensitive). Pearl millet is a descendent of the Wild West African grass and was domesticated over 4,000 years ago in the West African Sahel, spreading later to East Africa and India (Sharma *et al.*, 2021). Pearl millet is being cultivated over 30 million ha worldwide, with over 60% ha of the crop grown in Africa and over 10% ha in Asia (Raheem, Dayoub, Birech & Nakiymba, 2021). Around 90 million people in the Sahelian region of Africa and north western India consume pearl millet grain as a staple food (Srivastava, Bollam, Pujarula, Pusuluri, Singh & Potupureddi, 2020). In Nigeria and particularly in the Northern region, pearl millet is a traditional crop, both in terms of production and consumption and it is a very important staple crop for over 40% of the populace.

Problem Statement

Agricultural output markets in Nigeria and other developing countries are mainly characterized by small numbers of traders, poor road networks, long market distance, a small quantity produced, high marketing costs, imperfect market information between buyers and sellers, weak bargaining power, and amongst other factors (Olutumise, 2020), these factors discourage farmers to produce more for market purpose. Despite increase in yield and high market price of pearl millet, the high production has not been translated into high yield vis-a-vis farmer market participation. There is a steady decline in the farmer's participation in pearl millet market in the Northern Nigeria. Also, the absence of a market will not make farmers benefit from the increased production of pearl millet. The pearl millet market is characterized by smallholders and unorganized enterprises which faced challenges such as low quality, less value addition and irregularity in supply. The output market is also constrained by seasonal conditions which lead to the variation in the supply of pearl millet in the market. 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 smallholder farmers in marketing their crops results in them realizing low incomes, exposing them to food insecurity and a vicious cycle of poverty (Oluwatayo, 2019).

Literature Review

There is mixed and inconclusive empirical evidence on the determinants of market participation by researchers over the years (Andaregie, Astatkie, Teshome, & Yildiz 2021; Olanrewaju *et al.*, 2016; Mango *et al.*, 2018; Odunt 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. Studies also showed that market participation by smallholder farmers in developing countries is very low (Barrett, 2007). This scenario has slowed down agriculture driven economic growth and exacerbated poverty levels. As such farmers cannot benefit from the welfare gains and income growth associated with market participation. No research exists on the intricacies of pearl millet farmers' decision-making processes, their preferences and the challenges they encounter in participating effectively in the market in the study area and in the North-west zone of Nigeria at large. Thus, this study aims to conduct a comprehensive analysis of market participation and preferences among pearl millet farmers, exploring the socio-economic and market factors that shape their choices. By addressing this gap in knowledge, the research seeks to provide valuable insights that can inform policies, interventions, and support mechanisms aimed at empowering pearl millet farmers, fostering sustainable agricultural practices, and enhancing the overall resilience of the pearl millet farming sector.

Objectives of the Study

It is against this research gap that this study seeks to answer the following specific objectives;

- i. Describe socio-economic characteristics of the respondents
- ii. Identify factors influencing the Choice of Pearl Millet Cultivar.
- iii. Estimate the level of farmer's market participation.
- iv. Determine factors influencing Farmer's decision and extent of Market Participation.

Methodology

Description of the Study Area

Jigawa state was carved out from the old Kano state in 1991. It is situated in the Northern part of the country, geographically between latitudes 10°57'N to 13°03'N, longitudes 8°08'E to 10°37'E of the equator and has a land area of about 22,210km² (2.2 million hectares). It is bordered to the North by Katsina State, Yobe State and Niger Republic, to the East and South by Bauchi state and to the West by Kano state (JARDA, 2015). Most parts of the State lie within the Sudan vegetation zone, though traces of Guinea Savannah exist on some part of the southern boundaries. The State has an average annual rainfall of about 700mm, which is higher in the southern part. (JARDA, 2015). Mean daily temperature is estimated at 27°C with minimum and maximum put at 19°C and 35°C respectively. The maximum temperature has two peaks occurring in April and October, while lowest temperatures are

recorded during December and January. Relative humidity can be as high as 80% in the month of August and as low as 15% in December. Jigawa State has a projected population of 7,499,100 people (NPC, 2022). Eighty per cent (80%) of the population is found in the rural areas and is made up of mostly Hausa, Fulani and Manga (a kanuri dialect). Jigawa State is considered to be agrarian, as more than 90% of the working adults are engaged in agriculture as a means of livelihood (JARDA, 2015). Cash crops include date palm, sesame, cowpea, groundnut, bambara nuts, pepper and bitter lemon (JARDA, 2015) Popular rain fed crops are rice, sorghum, millet and beans. Some of the major markets in Jigawa State include Gujungu market, Kazaure market, Shuwarin market, Garki market, Hadejia market etc.

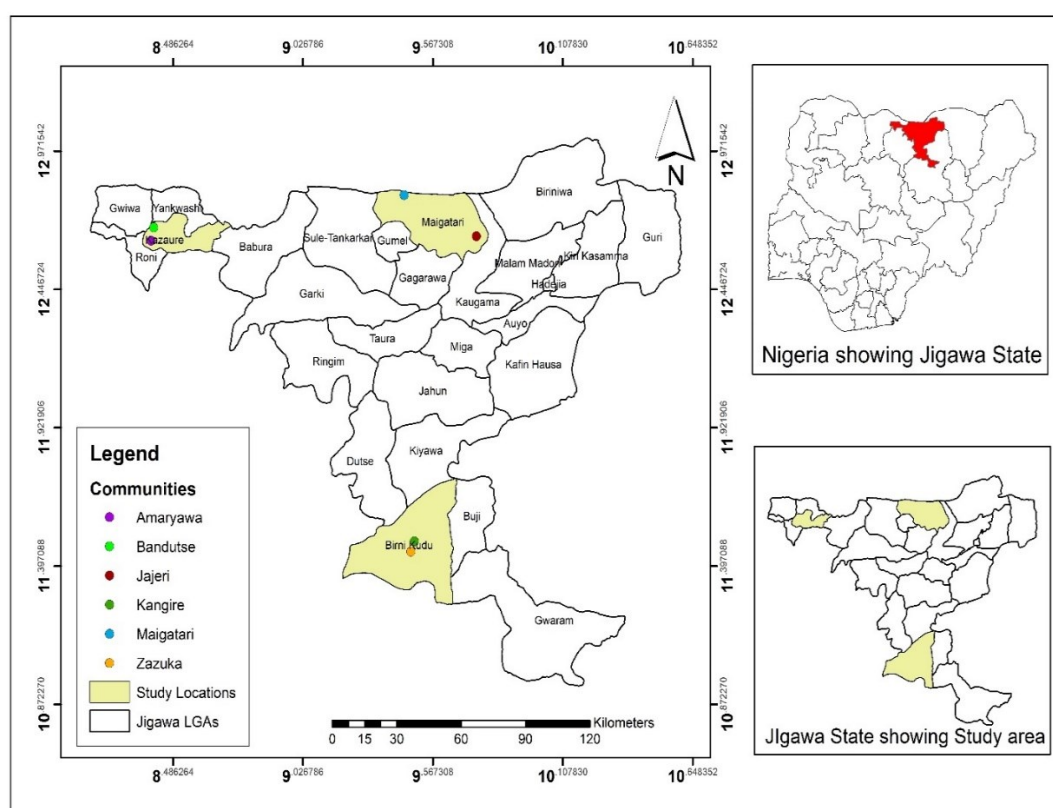


Figure 3.1: Map of Jigawa State showing the study area.

Sampling Procedure

Through a reconnaissance survey conducted in Jigawa State, communities predominantly engaged in pearl millet cultivation were identified and chosen for the study. To select respondents, a multi-stage sampling procedure was implemented. In the initial stage, one Local Government Area (LGA) was purposively chosen from each of the three Agricultural Development Programme (ADP) zones out of the four zones in the State. The selection was based on the prevalence of pearl millet production. Specifically, Birnin Kudu LGA was chosen from zone 1, Maigatari LGA from zone 2, and Kazaure LGA from zone 4.

The subsequent stage involved the random selection of two communities from each of the selected LGAs. These communities include Kangire and Zazuka from Birnin Kudu LGA, Magatari and Jajeri from Maigatari LGA, and Bandutse and Amaryawa from Kazaure LGA, as outlined in Table 1.

To select millet producers, with pearl millet farmers identified as the sampling unit, the Raosoft sample size calculator was employed at 95% level of confidence. This tool calculated the sample size using the estimated number of pearl millet farmers in the selected communities (Table 1). Consequently, the determined sample size for pearl millet producers is 296, farmers were chosen randomly at the fourth stage, ensuring a representative and comprehensive understanding of the pearl millet production in the study area.

Table 1: Sample Frame and Sample Size of Pearl Millet Farmers

LGAs	Communities	Sample frame	Sample Size
Birnin Kudu	Kangire	134	46
	Zazuka	162	48
Maigatari	Maigatari	230	53
	Jajeri	202	51
Kazaure	Bandutse	125	45
	Amaryawa	225	53
Total		1078	296

Source: Field Survey, 2022

Method of Data Collection and Analysis

Primary data were used for this study, using a structured questionnaire which was administered to the respondents by the researcher and trained enumerators. The information collected includes information on the socio-economic characteristics of pearl millet farmers, and their farm commercialization characteristics (such as variety preferences and pearl millet sales). The analytical tools employed in this study include descriptive statistics, multinomial Logit regression, market participation index and double hurdle model.

Descriptive Statistics

The descriptive tools employed in this study include frequency, percentage, mean, standard deviation and charts. This tool was used to achieve objectives i and objective v of the study.

Multinomial Logit Regression (MNL)

The MNL was used to determine factors influencing pearl millet farmer's cultivar choice in the study area. MNL model is based on the utility theory of maximization. That is, the satisfaction derived as a result of profit accrued from a particular enterprise instead of the others that could influence its production. Here, four improved pearl millet varieties and

farmers' seed were identified in the study area, while the factors determining the preference for a particular variety would be determined by the MNL. The 4 varieties and farmer's seed which are the J sets of alternatives were modelled into MNL and formed the choices posed to the farmers. These alternatives are; SUPER SOSAT (J₁), SOSAT C88 (J₂), JIRANI (J₃), and LCIC 9702(J₄). MNL is widely used as it builds on the choices where there are more than two categorical dependent variables. Several studies (Abdalla, 2012; Clark *et al.*, 2019; Benito *et al.*, 2020; Olutumise *et al.*, 2021) have justified MNL as the best alternative to modelling technique for categorical outcomes. Therefore, the study deems it fit to use the MNL to determine the influencing factors for cultivar choice of a particular variety produced by the respondents owing to the fact that each pearl millet farmer is allowed to make a choice. The independent variables were the socioeconomic, farm-level and market-related factors of the farmers. The mathematical equations for the model are stated as:

$$P_{ij} = E(Y_i = j | x_i) = F(\alpha + \beta x_i) \quad j = 1, 2, 3 \quad \dots \dots \dots (1)$$

$$= \frac{1}{1 + \sum_{j=1}^3 e^{-z_i}} \quad \text{where } z_i = \alpha + \beta x_i \quad \dots \dots \dots (2)$$

$$= \frac{e^{z_i}}{1 + \sum_{j=1}^3 e^{z_i}} \quad \dots \dots \dots (3)$$

For easy interpretation, Eq. (1) is differentiated in respect to the independent variables (X) is to give the marginal effects (ME) of the variables (Eq. 2) as it influences the choices made by the farmers. As a function of probability, marginal effect determines the expected change in the pearl millet preference of the farmer with respect to changes in the predictor variables. The ME equation is written as;

$$\frac{\delta Y_j}{\delta X_k} = Y_j(\beta_{jk} - M) \quad \dots \dots \dots (4)$$

The explicit function of the model is written in Eq. (5) below as;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \dots \dots + \beta_{13} X_{13} + \epsilon_i \quad \dots \dots \dots (5)$$

Where

Y = Choice of pearl millet cultivar (1 = SUPER SOSAT, 2 = SOSAT C88, 3 = JIRANI, 4 = LCIC 9702)

X₁ = Age (years)

X₂ = Sex (Male, Female)

X₃ = Marital Status (married, single, divorced)

X₄ = Household Size (number of persons in the farmers households)

X₅ = Education (years of formal schooling)

X₆ = Farming Experience (years)

X₇ = Income (Naira)

X₈ = Membership of Cooperative (Member = 1, Non-member = 0)

X₉ = Extension Visit (Numbers of times visited)

X₁₀ = Access to Credit (Access = 1, No access = 0)

X_{11} = Access to Market Information (Access = 1, No access = 0)

X_{12} = Market Distance (Km)

X_{13} = Farm Size (ha)

β_0 = Constant

$\beta_1 - \beta_{13}$ = Parameters to be estimated

ϵ_i = error term

Household Market Participation Index (HMPI)

The HMPI was used to measure the degree of output market participation by the pearl millet farmers. It ascertains the proportion of pearl millet output harvested for the market purpose and also helps to know how market-oriented the farmers are. The HMPI method as postulated by Govereh *et al.* (1999) and Strasberg *et al.* (1999) was used but modified to estimate an index that measures the level of market participation of pearl millet farmers

$$HMPI = \frac{\text{Output sold in kg (Sik)}}{\text{Total output harvested in kg (Hik)}}$$

$$S_{ik} > 0 \text{ and } 0 < HMPI \leq 1 \dots\dots\dots (6)$$

According to Eq. (6), the MPI is the quantity produced for market purposes (market shares) and it takes values between 0 and 1, inclusive. Following the approach of Endalew, Aynalem, Assefa, & Ayalew, (2020), this study uses the below rule of thumb to categorize farm households under various market orientations.

Decision rule:

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

Double Hurdle 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:

$$Pr(Y_i = 1) = \Phi(X_i' \beta) \dots\dots\dots (7)$$

Where: Y_i represents a dummy outcome variable, which takes the value of 1 if a pearl millet producing household participates in the output market and 0 if otherwise, conditioned on a set of explanatory variables denoted by X_i . β denotes the vector of the parameter to be

estimated, and μ_i represents the error term which is normally distributed with zero mean and constant variance. The explicit form of the model is written as follows;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_{12} X_{12} + \epsilon_i \dots\dots\dots (8)$$

Where

Y = Market Participation (1= participation, 0 = otherwise)

X_1 = Age (years)

X_2 = Sex

X_3 = Marital status (1= single, 2= married, 3= divorced, 4= widowed)

X_4 = Household size (no. of persons)

X_5 = Farming experience (years)

X_6 = Education (years of formal schooling)

X_7 = Non-farm Income (Naira)

X_8 = Extension Visits (number)

X_9 = Access to credits (Yes = 1, No = 0)

X_{10} = Access to market Information

X_{11} = Market distance (km)

X_{12} = Main Varieties produced (1= SUPER SOSAT, 2 = SOSAT C88, 3 = JIRANI, 4 = LCIC 9702)

β = Coefficient to be estimated

ϵ = error term.

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. 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) was employed. This is specified as:

$$E \left(\frac{HMPI_{ij}}{X} \right) = X\beta + \epsilon_i \dots\dots\dots (9)$$

Where $HMPI_{ij}$ represent households' market participation index,

X is a matrix of explanatory variables,

β is a matrix of parameters to be estimated, and

ϵ_i also represents the error term.

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).

The model is explicitly written as

$$Y = a + X_1b_1 + X_2b_2 + X_3b_3 + \dots + X_{12}b_{12} + \epsilon_i \dots\dots\dots (10)$$

Where,

Y = Household Market Participation Index

X₁ = Age (years)

X₂ = Sex (Male = 1, Female = 2)

X₃ = Marital status (1 = Single, 2 = Married, 3 = Divorced, 4 = Widowed)

X₄ = Household size (Number of persons)

X₅ = Farming experience (years)

X₆ = Education (years of formal schooling)

X₇ = Non-farm Income (Naira)

X₈ = Extension Visits (numbers)

X₉ = Access to credits (Access = 1, No Access = 0)

X₁₀ = Access to market Information

X₁₁ = Market distance (Distance in Km)

X₁₂ = Farm Size (ha)

a = Constant

b₁ - b₁₂ = Parameters to be estimated

ε_i = error term

Results and Discussion

Social- Economic Characteristics of Pearl Millet Farmers

The social-economic profiles of pearl millet farmers were presented in Table 2 & 3. The variables identified were age, marital status household size, farm size, level of education, farming experience, distance to market and membership. Table 2 showed that majority of pearl millet farmers fall within the age range of 22-41 years, comprising 61.48% of the farmers with an average age of 39 years. This implies that these farmers are currently in their productive years and thus implies that they are in their economically active age. This shows that there is potential for productivity to be high in the area thus increasing market participation. This is in line with the findings of Egbetokun and Omonona (2012) who revealed that majority 62.6% of the respondents in their study were in the productive age of between 31 and 50 years. Household size is an indicator of amount of family labour that is available for agricultural activities. From the results, households have between 1 and 8 members, constituting 52.36% of the sample. The mean household size is 9 persons. This implied the availability of family labour on the farm which could boost production thereby creating marketable surplus. This aligns with the findings of Nwike and Ugwumba (2015) and Imoka (2020), who observed a prevalence of married individuals with an average household size of six among rice farmers in Anambra State.

Table 2: Quantitative Socio-economic Characteristics (n=296)

Variables	Frequency	Percent	Min.	Max.	Mean	S.D
Age(years)						
22-31	81	27.36	22	66	39	9.63
32-41	101	34.12				
42-51	87	29.40				
52-61	23	7.77				
62-71	4	1.35				
Household Size(No. of persons)						
1-8	155	52.36	1	35	9	6.68
9-16	95	32.10				
17-24	36	12.17				
25-32	8	2.70				
33-40	2	0.67				
Farming Experience(years)						
2-9	125	42.22	2	36	11	6.85
10-17	116	39.20				
18-25	39	13.17				
26-33	15	5.06				
34-41	1	0.35				
Farm Size(ha)						
0.30-1.04	50	16.90	0.30	4	1.91	0.79
1.05-1.79	91	30.75				
1.80-2.54	90	30.40				
2.55-3.29	45	15.20				
3.30-4.04	20	6.75				
Distance to Market(km)						
0.50-2.40	200	67.58	0.50	10	2.32	1.79
2.41-4.31	65	21.95				
4.32-6.22	21	7.10				
6.23-8.13	4	1.35				
8.14-10.04	6	2.02				

Source: Field Survey, 2023.

The result presented in Table 2 indicated that (81.42%) had between 2 and 17 years of experience in pearl millet farming with a mean of 11 years. This suggests that the farmers possessed a reasonably good level of managerial ability. These findings are consistent with the research conducted by Mbanasor and Kalu (2008) and Obare, Nyagaka, Nguvo, and Mwakubo (2010), which demonstrated a positive and significant relationship between years of farming experience and a farmer's economic efficiency. This implies that as a farmer's level of experience increases, their cost efficiency also tends to improve. Moreover, The

findings presented in Table 2 indicated that pearl millet farmers in the study area, on average, cultivated a mean farm size of 1.91 hectares. This indicates that small-scale farmers continue to dominate the agricultural landscape in the study area, and production is primarily carried out on fragmented plots of land. This aligns with the similar findings reported by Awotide, Abdoulaye, Alene & Manyong (2010) who reported that small scale farmers dominate cassava farming in South-West Nigeria. Results from Table 2 also showed that majority of farmers reside relatively close to markets in the study area, with 67.58% living within a distance of 0.50-2.40 kilometres. However, there are also farmers (2.02%) located farther away, with distances of up to 10 kilometres. The mean distance to the market was 2.32 kilometres.

The result presented in Table 3 regarding the sex distribution of pearl millet farmers indicates that majority (96.6%) of the farmers were male, while only (3.4%) were female. This finding suggests that pearl millet farming in the study area is predominantly carried out by males. The dominance of males in pearl millet production can be attributed to the labour-intensive and physically demanding nature of activities involved in its cultivation, this finding is consistent with the research conducted by Olaoye *et al.* (2013), who similarly reported a male-dominated presence in fish farming, with 84.2% of fish farmers being male in a similar study conducted in Oyo State, Nigeria. The result revealed that 79.2% of the respondents were married, 6.8% were single, 7% were divorced and 7% were widowed. Married farmers constitute the majority, this implies that married farmers have more economic and social responsibilities to meet hence engage in production and sell more pearl millet to cater for their needs. These findings are consistent with a report by Agbebi (2012) on the marital status of farmers in Ekiti State, which indicated that the majority of farmers (78.9%) were married.

The results from Table 3 showed that 40.5 % of the farmers had Quranic education, 17.9% had primary education, and 16.6% had secondary education while 25% received tertiary education. About 60% of the farmers had some formal education from primary to tertiary. This shows that the average farmer has at least primary school education and its implication is that farmers with formal education are more market oriented, knowledgeable about prevailing market situations and therefore produce to take advantage of the market environment. The result also reveals that 64.5% of the farmers belonged to cooperative groups. This implies that group membership is beneficial to the farmers as working in a group creates synergy among farmers and enable them to access market information, market their produce jointly which could lower transaction costs, as well as share experiences. Credit is necessary for the acquisition of inputs and payment of casual labour. The results show that only 32.8% of the farmers had access to credits. This shows that pearl millet farmers are challenged in accessing credits and other productive resources due to their low collateral level. This conforms to the observation by Martey, Al – Hassan and Kuwornu (2012) that access to credit is one of the major constraints faced by farmers. Results from Table 3 shows that majority (64.5 %) of the farmers had extension contacts. Extension contact with farmers enhances acquisition of new knowledge, skill and practices

on improved technology by the farmers as well as their innovativeness (Tanko and Olowogbaji, 2009) which is expected to translate into increased productivity of farmers. Contacts with extension agents afford the farmers the opportunity of sharing ideas and information on modern farm production practices by interacting with other farmers (NAERLS & FDAE, 2014).

Table 3: Qualitative Socio-economic Characteristics of the farmers (n=296)

Variable	Frequency (n=296)	Percentage
Sex		
Male	286	96.6
Female	10	3.4
Marital Status		
Single	20	6.8
Married	272	79.2
Divorced	2	7
Widow	2	7
Educational Status		
Quranic	120	40.5
Primary	53	17.9
Secondary	49	16.6
Tertiary	74	25.0
Membership of Cooperative		
Member	191	64.5
Non-Member	105	35.5
Access to Credit		
Access	97	32.8
No Access	199	67.2
Extension Contact		
Contact	191	64.5
No Contact	105	35.5

Source: Field Survey, 2023.

Factors Influencing the Choice of Pearl Millet Cultivar

The statistical significance of LR chi-square (52) and Log-likelihood as presented in Table 4 indicated the model had the goodness of fit and also supported the combined relationship between predicted and predictor variables in the model (Abdalla, 2012). The MNL regression coefficients were presented in the Table 4 because the distribution functions of the MNL regression of the independent variables are nonlinear (Clark *et al.* 2019; Benito *et al.* 2020; Olutumise *et al.* 2021). Age of the farmers, farming experience, household size, marital status and extension visits were the statistically significant factors influencing the choice of variety cultivated by the farmers. The coefficient for age that is significant ($P < 0.1$) and positive relationship with choice of JIRANI variety. This suggests that older farmers

are more likely to prefer JIRANI, potentially due to factors like conservative tastes or familiarity with the crop as they age. Marital status coefficient has a positive and statistically significant ($P < 0.1$) influence on SUPER SOSAT, SOSAT C88 and LCIC 9702 pearl millet varieties, as indicated by the coefficients. This implies that married farmers have more tendencies of cultivar choice in the study area.

Furthermore, the coefficient for household size was statistically significant ($P < 0.05$) for the SUPER-SOSAT and JIRANI varieties, suggesting that larger household sizes are associated with a higher likelihood of preferring these varieties. This implies that a unit increase in household size with more members have more preference for both SUPER-SOSAT and JIRANI cultivars respectively. Meanwhile, the number of years spent in school (education) was positive and significant ($P < 0.05$) in predicting the preference for the choice of SOSAT C88 cultivar. This implies that more educated farmers have more preference for SOSAT C88 cultivar among the farmers in the study area. The result agreed with the findings of Adewusi and Adenegan (2020) who found a positive relationship between peppers producing farmer improve seed choice and years of schooling. In addition, farming experience was statistically significant $P < 0.05$ for the SUPER-SOSAT, SOSAT C88 and JIRANI varieties, suggesting that farmers with more experience are more likely to prefer any of the three cultivars in the study area. Moreover, the coefficient for extension visits was statistically significant ($P < 0.1$) for the SOSAT C88 and LCIC9702 varieties, suggesting that farmers who receive more extension visits are more likely to prefer these varieties. The results shared similar views with the studies of Dessle, Koye, & Abtew (2019) and Olutumise (2020).

Table 4: Results of the Multinomial Logit Regression Model for Pearl Millet Preference. (n=296)

Variable	SUPER-SOSAT			SOSAT C88			JIRANI			LCIC 9702		
	Coeff.	S.E	Sig.	Coeff.	S.E	Sig.	Coeff.	S.E	Sig.	Coeff.	S.E	Sig.
Constant	5.916	3.28478	0.072*	2.9982	3.37	0.374	1.411	3.7356	0.706	2.4786	4.1033	0.546
Age(years)	.0322	.02894	0.266	-0.0012	.03028	0.0968	.06171	.03734	0.098*	-.00598	.04280	0.889
Sex	-1.306	1.0952	0.233	-0.5866	1.0267	0.568	-0.6758	1.3212	0.609	.51423	1.1601	0.658
Marital Status	2.5926	1.2227	0.034**	2.5493	1.254	0.042**	2.2628	1.3018	0.082*	1.3485	1.3864	0.331
Household Size	.08034	.04397	0.068*	.01415	.04446	0.750	.19023	.06249	0.002**	.11237	.07147	0.116
Education(years)	.13113	.06117	0.032**	-.02746	.06457	0.671	.02470	.07360	0.737	-.12864	.08539	0.132
Experience (years)	.08396	.03320	0.011***	.06254	.03460	0.071*	.06195	.03708	0.095*	.03153	.04247	0.458
Income	2.87	9.69	0.767	3.69	1.02	0.719	4.10	1.14	0.719	-1.10	1.31	0.398
Cooperative	.23755	.44853	0.596	.58191	.47754	0.223	.15615	.54075	0.773	.54532	.60732	0.369
Extension Visit	-.02924	.11035	0.791	.22164	.11804	0.060*	.17268	.13544	0.202	.26011	.14975	0.082*
Access to Credit	-.24076	.43282	0.578	-.18046	.46177	0.696	.04318	.52443	0.934	.93183	.68246	0.172
Access to Market Info.	.33589	.40891	0.411	.46280	.43406	0.286	.43239	.49529	0.383	-.82484	.58277	0.157
Market Distance	.04033	.11340	0.722	-.00264	.12175	0.983	-.07330	.14203	0.606	-.09540	.16974	0.574
Farm Size	.12885	.27216	0.636	.41092	.28568	0.150	.28710	.32625	0.379	-.07317	.36730	0.842
LR chi2(52)	87.28											
Prob>(chi2)	0.0016***											
Pseudo R ²	0.1003											
Log Likelihood	-391.383											

Source: Field Survey, 2023

Level of Market Participation of Pearl Millet Farmers

Table 5 provides insights into the level of market participation among pearl millet farmers in the study area, offering a comprehensive view of their engagement with market activities. The Household Market Participation Index (HMPI) was computed individually for each farmer, determining the proportion of their total production that was sold. Result from Table 5 categorizes farmers based on the proportion of their pearl millet production that is sold in the market. Most of the farmers, constituting 55.40%, fall into the low participation category, indicating that a significant portion of their produce is retained for household consumption or other non-market purposes. Furthermore, approximately 28.71% of farmers were found to have a medium level of participation, implying that a moderate proportion (26-50%) of their pearl millet output is sold in markets. These farmers strike a balance between subsistence farming and market-oriented production. However, a least percentage of farmers, comprising 15.89%, exhibit a high level of market participation. The calculated index value of 0.27 showed an aggregate measure of the overall participation level across households in the study area. This index indicates that, on average, households commercialize approximately 27% of their pearl millet production. The result implies that most smallholder farmers produce pearl millet mainly for consumption with a small surplus sold in the market. Result is consistent with the findings of Rebecca, Patience & Paul (2018).

Table 5: Level of Market Participation among Pearl Millet Farmers

Degree of Market Participation	Frequency (n=296)	Percentage
Low (<25%)	164	55.40
Medium (26-50%)	85	28.71
High (51-100%)	47	15.89
Household Market Participation Index	0.27	
Minimum Market Participation Index	0.06	
Maximum Market Participation Index	0.90	

Source: Field Survey, 2023.

Determinants of Market Participation

The double hurdle model (DHM) for the factors determining decision of market participation and the extent of participation of pearl millet farmers were presented in Table 6. The LR Chi² estimated was 303.81 and significant at 1% confidence level; this implies that the model significantly fitted the data. In other words, the independent variables included in the model were jointly important in explaining the variations in the decision of participation in markets and the extent of participation. The pseudo R² is 0.7705 meaning that the factors in the model were able to explain 77% of market participation in the study area. This simply showed that the estimated double hurdle of the decision of market participation and the extent of participation pearl millet farmers were determined by

different processes and therefore the use of double hurdle model (DHM) in place of standard Tobit model was justified.

Table 6: Factors Influencing Market Participation among Pearl Millet Farmers (n=296)

Variables	First Hurdle(Decision Model)			Second Hurdle(Extent Model)		
	Coeff.	S.E	P-value	Coeff.	S.E	P-value
Constant	.30298	.31937	0.343	4.81380	1.55483	0.002***
Age(years)	-.00293	.00463	0.527	.01782	.02476	0.472
Sex	-.19732	.14657	0.178	.03767	.78594	0.962
Marital Status	.02945	.08754	0.737	-.32899	.41547	0.428
Household Size(No.)	-.00399	.00490	0.415	-.03754	.02419	0.121
Experience (years)	.00500	.00602	0.406	-.00797	.03221	0.804
Education	.00106	.02648	0.968	-.03198	.14067	0.820
Non-farm income(₦)	-1.33	6.25	0.033**	-1.74	3.53	0.622
Extension Visit(No.)	-.01079	.01199	0.368	.21445	.07168	0.003***
Access to Credit	.03870	.04867	0.426	.14478	.26621	0.587
Market Information.	.38497	.09661	0.000***	3.3949	.30908	0.000***
Market Distance(km)	.01519	.01295	0.241	.00790	.07732	0.919
Farm Size(Ha)	-	-	-	-.11311	.15948	0.478
Cultivar Choice	.0461	.01942	0.018***			
LR chi2(12)	303.81					
Prob>chi2	0.0000***					
Pseudo R ²	0.7705					
Log likelihood	-45.24960					

Source: Field Survey, 2023. *** Significant at 1% ($p < 0.01$), ** at 5% ($p < 0.05$), * at 10% ($p < 0.10$).

Factors Influencing Decision to Participate in Pearl-Millet Marketing

The results in the first hurdle further indicated that an increase in non-farm income significantly influenced market participation. The coefficient for non-farm income (1.33) was positive and statistically significant at a 5% level of probability, suggesting that higher non-farm income corresponds to a 1.33% rise in market participation among pearl millet farmers. This implies that smallholder farmers who receive non-farm income from non-farm employment are more likely to participate in pearl millet 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 result agrees with the finding of Ola and Menapace (2020) and Andaregie, Astatkie, Teshome & Yildiz (2021) that off-farm activities are an alternative source of agricultural financing to increase input use and productivity to commercialize.

Moreover, the coefficient of market information (0.384) was positive and significant at 1% level of confidence. This implies that as market information increases by one unit, market participation will increase by 38.4%. Market information irrespective of formal or non-formal empowers farmers on the prevailing market prices, opportunities and market demand. This is very important to market participation as farmers who have more access to market information incur less transaction costs. This is similar to the findings of Randela *et al.* (2008) who reported a positive and significant relationship between market information and market participation decision in cotton markets.

Lastly, the analysis of the coefficient of cultivar choice is positive and significant at 5% level of confidence. Implying that making choice for an improve varieties influenced decision of farmers to participate in the market. This can be affirmed considering observations in the field where farmers predominantly cultivate SUPERSOSAT, SOSAT C88, and JIRANI varieties for both consumption and market purposes in the study area. This could be attributed to the fact that the use of improved variety may increase pearl millet yields and consequent marketable surplus above their household consumption needs. The results finding were consistent with findings of Zamasiya *et al.* (2014) and Tafida *et al.* (2022) who found out that, the improved soya bean variety had a positive and significant effect on the farmer's decision to participate in the market.

Factors Influencing Farmers Extent of Market Participation

The second hurdle model in Table 6 also showed the maximum likelihood estimates of truncated regression model for the extent of market participation. The factor that significantly determine the extent of market participation were extension visit and access to market information. The coefficient for extension contact was significantly positive at 1% level of probability. This suggests that with each additional unit of extension visits, the quantity of sales increases by 21%. Extension services serve as a vital information source for farmers, and an increase in the frequency of extension visits is linked to higher levels of market participation. Access to extension is expected to provide farmers with better farm management skills to increase marketable surpluses of farm households in production. This finding is in line with the result of Ahmed, Girma & Aredo. (2016) who found a positive association between extension access and the quantity of potatoes sold. Additionally, the coefficient for access to market information was positive and significant at a 1% level of probability. Access to market information empowers farmers to assess whether market conditions are favorable for selling their crops. This suggests that enhanced access to market information, particularly regarding prices and product demand, is likely to boost the extent of market participation in the study area by 339%. This result is consistent with the findings of Ghambi (2015) on market participation and profitability in cotton production in Malawi.

Conclusion

This study highlighted smallholder farmers' participation in pear millet market as low in the study area. There is variation on cultivar choice for improved pearl millet varieties among farmers in the study area. The cultivar choice was also found to have diverse significant influence by socio-economic factors such as age, marital status, and household size, farming experience, education and access to extension services. Despite a relatively low market participation rate, key factors like non-farm income, access to market information, and the choice of millet varieties were found to positively affect farmers' decision to engage in the market. Meanwhile access to market information and extension contact positively influenced extent of their participation in the market.

Recommendations

- Government should improve access to affordable credit and microfinance services to enable farmers to invest in inputs and technologies that can boost production and market participation.
- Pearl millet farmers should engage in the formation and strengthening of farmer cooperatives to enhance collective bargaining power, reduce transaction costs, and facilitate bulk marketing.
- Promotion of better access to infrastructure like market networks, price information, road and transport facilities to promote market participation among smallholder farmers.
- Jigawa State Agricultural Development Agency (JARDA) should increase the frequency, quality of extension services and training on market-oriented farming practices and promote the adoption of improved pearl millet seed varieties to increase productivity.

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