Understanding Market Participation Choices and Decisions of Maize and Cowpea Farmers in Northern Nigeria

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Summary

Alleviating poverty and reducing food insecurity have received close critical attention from many researchers in sub-Saharan Africa. Farmers' participation in agricultural markets has been seen as a potent strategy for improving their livelihoods. This paper applies econometrics to farm survey data from Bauchi and Kano states as major maize and cowpea growing areas hit by one of the most important root parasites known as Striga *to determine the factors behind farmers' decisions about participation in the agricultural market and the volume of their output to be marketed. Relevant data was collected from 600 households in both states and results from the Double-Hurdle model indicated that price and non-price constraints played significant roles in determining decisions on participation in the markets for both maize and cowpea. Household and total farm sizes, price and ease of transportation through access to motorized equipment were positively related to decision to participate in the maize market. However, the volume of sale of traded produce was influenced by location-specific variable which underscores socio-economic and population-related factors favoring market access that are present more in Kano than in Bauchi. Age of the household head and total farm size were significantly related to decision to participate in the cowpea market while results of the second stage of the model indicate that access to mobile phone and location variable affect positively the volume of cowpea sold. The role of price was conspicuous in both produce markets as the main incentive for households' participation. The paper concludes with policy implications aimed at providing better market opportunities to farmers thereby improving their welfare in northern Nigeria and other areas with similar socio-economic and bio-physical conditions in West Africa.*

Résumé

Compréhension des choix et des décisions de participation au marché des producteurs de maïs et de niébé du nord du Nigeria

Alléger la pauvreté et réduire l'insécurité alimentaire sont devenus des points d'attention critiques pour de nombreux chercheurs en Afrique sub-saharienne. La participation des agriculteurs aux marchés agricoles a été perçue comme une bonne stratégie pour améliorer leurs moyens de subsistance. Cette étude a appliqué un modèle économétrique à la réalisation d'une enquête agricole dans les états de Bauchi et Kano pour déterminer les facteurs expliquant les décisions des agriculteurs à participer au marché agricole; et la part des récoltes destinées à la commercialisation. Les états de Bauchi et Kano sont les principales zones de culture de maïs et de niébé avec une forte présence du Striga, *un des principaux parasites racinaires des céréales. Les données ont été obtenues auprès de 600 ménages dans les deux états et un modèle «Double-Hurdle» a été utilisé pour analyser les résultats. Cette analyse montre que les facteurs liés et non liés au prix ont joué un rôle majeur dans la prise de décision concernant la participation aux marchés du maïs et du niébé. La taille des ménages et la taille totale des exploitations, le prix et la facilité de transport grâce à l'accès à des véhicules motorisés, ont été positivement corrélés à la prise de décision de participer au marché du maïs. A Kano plus qu'à Bauchi, la quantité de maïs vendue a été influencée par les facteurs socio-économiques et ceux liés à l'accès au marché. L'âge du chef de ménage et la taille totale de l'exploitation ont été significativement corrélés à la décision de participer au marché du niébé. Les résultats de deuxième niveau du modèle indiquent que l'utilisation du*

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téléphone portable et la localité présentent une corrélation positive avec la quantité de niébé vendue. Le prix était considéré dans les deux marchés comme un catalyseur à la participation des ménages. L'étude recommande l'adoption d'une politique visant à offrir de meilleures possibilités de marché aux agriculteurs, en vue d'améliorer leur bien-être dans le nord du Nigeria. Cela pourrait, également, être un modèle pour les autres zones de l'Afrique de l'ouest ayant les mêmes conditions socio- économiques et biophysiques.

Introduction

Most African countries are dependent on agriculture (13) and, maize and cowpea are prominent among these arable crops. Their importance to farming households in Nigeria as staples and economic crops cannot be over-emphasized as the country is one of the largest producers of maize in Africa (19) with about 10 million tonnes out of 1,017 million tonnes produced worldwide (13). Cowpea has been seen as the most economically essential grain legume in Nigeria as the country still the largest producer accounting alone for 44% worldwide (13). Cowpea contributes significantly to food security, income generation, and soil amendment (31). According to Fatokun *et al.* (14), the grain contains about 25% protein and 64% carbohydrate and has great potential for reducing malnutrition. Its high protein content, adaptability to different types of soil, resistance to drought, and ability to improve soil fertility and prevent erosion all contribute to its high status across various agro-ecologies.

However, maize and cowpea production and the returns to the grain producers had been constrained largely by high *Striga* infestation in northern Nigeria (21). *Striga* depresses maize grain productivity by 20–100%, often leaving farmers with little or no food grain at harvest (1). The noxious parasitic *Striga* infects the roots of cowpeas and can cause grain yield losses of up to 50% (3). The losses experienced by the the farmers could be ameliorated if the farmers have ready markets for the products through market participation. Maize price has been on the rise as a result of higher demand and low levels of supply (4).

There is also a big market for cowpea grain and fodder in West Africa (12). Therefore, production of these crops should be market-oriented to realize expected welfare gains by taking advantage of the opportunities provided through specialization and comparative advantage, economies of scale, and the regular interaction and exchange of ideas (24). Also, increasing agricultural output will achieve nothing if it is not supported by markets that effectively synergize the specialized activities of various producers into an integrated national economy. Therefore, participation in agricultural markets could be a strategy thrust to improve farming households' livelihoods. Encouraging and facilitating their participation in maize and cowpea markets will, to a large extent, expand their contribution to food security. Consequently, increasing returns from their outputs could significantly act as an entry point to reducing poverty in the country. In spite of these benefits, several factors have constrained maize and cowpea farmers from participation in the market. Literature is replete with many such factors (including price and non-price) that underlie crop producers' participation and their decisions on volumes of sales (7). However, no known study has investigated these participation decisions, made either singly or simultaneously, with respect to maize and cowpea in northern Nigeria.

This study aims at filling those knowledge gaps by determining the drivers that simulate small-scale farmers market participation and volume sold.

In the first stage, households that produce the crops decide whether or not to sell the grain in the market.

In the second stage, the households that decide to sell determine the extent of their participation – the volume to sell.

This article is organized as follows. In the next section, we present some theoretical and empirical evidence on agricultural marketing. This is followed by some background of the theoretical model. Then the farm survey data and methodologies used are described, before regression results are presented and discussed. The last section summarizes and discusses policy implications.

Agricultural market participation: some theoretical and empirical evidence

Holloway and Ehui (18) defined the agricultural market as the integration of subsistence farmers into the input and output markets of agricultural products to improve their livelihoods especially their income level and to reduce poverty. Heltberg and Tarp (16), while studying agricultural supply response and poverty in Mozambique, observed that participation in agricultural markets by rural households is a fundamental approach to alleviating poverty and enhancing food security in developing countries. Barrett (6) in his study of smallholder market participation in Eastern and Southern Africa held that farming households must have access to productive technologies and adequate private and public goods to produce a marketable surplus. However, such investment requires that households earn enough to save, invest, and generate adequate tax revenue for governments. Omiti *et al.* (25) while working on the determinants of intensity of market participation by smallholders in Kenya found that most farmers in rural areas produce lower volumes of relatively low-value and less perishable marketed surpluses than those in peri-urban areas. They also sell mainly at the farm gate and in rural markets so only a small proportion of the total output is taken to the more lucrative (but distant) urban markets. The study showed that distance indeed confines rural farmers in this way and suggested that farm-to-market roads should be upgraded with equipped retail market centers. In their work on farm productivity and household market participation in Tanzania, Vietnam and Guatemala; Rios *et al.* (28) believed that enhancing market access through the construction of roads may not consistently lead to improvements in agricultural productivity. In contrast, increasing output directly through investments in irrigation equipment and improved seeds is likely to have a more consistent impact on participation.

On market infrastructure and institutional factors, Tung and Costales (37) in the study of smallholder poultry producers in northern Viet Nam found that market infrastructure and the institutional aspects of market access are crucial for improving the opportunities of smallholders to increase their market participation. However, general or local market instability, manifested in unpredictable price fluctuations, has a far larger negative impact on the livelihoods of smallholder producers than the dominance of traders. Fischer and Qaim (15) while investigating the determinants of intensity of participation in marketing asserted that participation could be expected to be driven by a clear personal benefit in terms of higher sale prices. Farmers with lower transaction costs participated in markets and sold more because they were likely to recover their production and marketing costs (17). Distance to markets, or towns, was important and farmers with the means of transportation or more labour were found to participate and sell more products. Population density positively affected market participation and sales as farmers in more densely populated areas faced greater demand for their farm produce (18). Poor infrastructure often increases the transaction costs of smallholders' market participation (7, 22). The ease of flow of market information to the farmers in a way that enhances their information base would improve market access (34). However agricultural marketing may be productivity-enhancing over time. Firms or farms with high productivity have tended to become highly commercialized and export-inclined (40). In developing countries, agrarian rural areas are among the poorest and the largest, so strategies and policies that stimulate their participation in the market will enhance economic growth. However, agricultural households often face imperfect or incomplete markets for some goods and factors which are then non-tradable (30) and decisions on production and consumption are no longer separable. Sadoulet and de Janvry (30) summarize

the sources of such incomplete or imperfect markets including costs resulting from distance to markets, poor infrastructure, high marketing margins, imperfect information and supervision, and incentive costs. These are the reasons for the literature's sustained interest in the effects of transaction costs on market participation (32). As a result, the reduction of transaction costs, as a means of increasing market participation, has been identified as a goal of development policy (11). Significant barriers exist to entry into commercial staple food markets that discourage sales by smallholder producers. Renkow *et al.* (27) observed that the food crop marketing system, including that for maize/cowpea, has been inefficient in most African countries. As a result, owing to such perceived weaknesses, farmers find it difficult to dispose of their produce at attractive prices and in places of their choice. This development reduces any enthusiasm about raising production and improving supply, often steps up food prices to consumers, and restricts any increase in farm income (29). The total industrial demand for maize in Nigeria was forecast at 1.8 million tons in 2013/2014. At present, the price of maize is about 80,000 naira/t. The demand for maize and cowpea is all-year-round while there is shortage of sellers so a policy thrust is necessary that will motivate producers of these crops to participate in the marketing of their products (9).

Theoretical model and empirical specifications

Less or absence of *Striga* may attract a market premium, enhancing sales. Farmers could also make decisions whether to participate in the market in a single or a sequential two-step process. In the sequential process, they decide whether or not to participate and, if they choose to do so, the next step is the decision about the quantity to sell. Simultaneous decision-making means that the farmers make choices about participation and quantity at the same time (2). Increasing research has been done on sequential decisions (7, 49). The last study explicitly tests whether or not farmers make sequential or simultaneous decisions and finds the evidence necessary to support sequential decision-making. None of these studies explicitly tests whether the decision could be made either sequentially or simultaneously, as this study does. Small-scale farmers' decisions to participate in the market can be understood, based on a utility model. In modeling the utility or satisfaction derived from the farmers' participation in maize/cowpea markets as integrated into the smallholder farming system, the economic values or benefits associated need to be considered. A typical smallholder-farming household seeks to participate in the commercial market to maximize a multi-dimensional objective function, including increasing incomes and food security and reducing all forms of risk (35). When there is a change in the economic parameters associated with market participation, the central question is related to how much compensation, whether paid or received, would make the decision-maker uninterested about the change. Thus the change in welfare associated with this development was used as the basis for the economic valuation process. When an individual farmer faces a change in a measurable attribute, for example, higher returns as a result of participating in the market (r), then r changes from r_0 to r_1 (with $r_1 > r_0$). The indirect utility function U after the change becomes higher than before. The *status quo* can be represented econometrically by the equation I.

$$u_{1j} = u_i (y_i, z_j, r^0, \varepsilon_{0j}) \quad \text{I}$$

On the other hand, the changed or final state caused by market participation is shown by Equation II:

$$u_{2j} = u_i (y_i, z_j, r^1, \varepsilon_{ij}) \quad \text{II}$$

Where,

y_i refers to the farmer's income, Z_j is a vector of the farmer's socio-economic variables and attributes of choice, and ε_j is the stochastic error term representing other unobserved utility components. The farmer would decide to participate in markets on the following conditions (Equation III).

$$u_i (y_i - r_i, z_j, \varepsilon_{ij}) > u_0 (y_i, z_j, \varepsilon_{0j}) \quad \text{III}$$

Where:

r_i is the monetary investment associated with market participation.

Since the random components of the preferences are not known with certainty it is possible to make only probabilistic statements about expected outcomes.

Thus, the decision by farmers to participate is the probability that they will be better off if participation improves their welfare. This is represented by the equation IV:

$$Prob\ (Yes_i) = Prob\ [u_i\ (y_i - r_i, z_j, \varepsilon_{ij}) > u_0\ (y_i, z_j, \varepsilon_{ij})] \quad \text{IV}$$

Since the above utility functions are expressed generally, it becomes critical to specify the utility function as additively separable in deterministic and stochastic preferences. Using this argument, the function becomes (equation V):

$$u_i\ (y_i, z_j, \varepsilon_{ij}) = u_i\ (y_i, z_j) + \varepsilon_{ij} \quad \text{V}$$

Where:

The first part of the right-hand side is the deterministic part and the second is the stochastic part. The assumptions that ε_{ij} are independently and identically distributed with mean zero describe the most widely used distributions.

Econometric specification: the Double Hurdle model

According to Tobin (36) decisions on market participation and supply are made simultaneously. Based on a Tobit model, fixed costs associated with market participation do not significantly affect a farmer's decision to participate in commercial markets. It also means that factors affecting market participation and quantity decisions are one and the same, affecting the dependent variable in the same direction.

When thinking of decisions on market participation and maize/cowpea supply as a sequential process, the Double Hurdle (DH) model originally proposed by Cragg (10) is appropriate for analyzing the possibility that the factors influencing a farmer's decision to participate in the maize/cowpea market may not affect the quantity sold. The DH model also allows us to consider that the same factors can potentially affect participation and the amount sold in different ways. We relied on this approach and estimated a DH model using Craggit command (8) in Stata software which combines a Probit estimation with a truncated normal regression in the second step.

In terms of policy relevance, our analysis clearly shows that participation and the level of participation may be different decisions and that an estimation of participation intensity on the basis of factors affecting the participation decision, as implied by other approaches, may be liable to error. The DH model has been extensively applied in several studies (23) but not much in the area of market participation. The DH approach implies that farmers make two decisions with regard to participation in the commercial market. The first is whether they will participate. The second is about the amount of maize/cowpea that they will convey into the market, conditional on the first decision. The importance of treating the two decisions independently lies in the fact that the factors that affect a decision to participate may be different from those that affect the decision on how much to participate. This implies that households must cross two hurdles. The DH model allows for the possibility that these two decisions are affected by different sets of variables. The advantage is that it allows us to understand the characteristics of a class of households that would never participate. Thus, the probability of a household belonging to a particular class depends on a set of household characteristics. The DH model is a parametric generalization of the Tobit model in which two separate stochastic processes determine the decision to participate and the level of participation. The first equation in the DH model relates to the decision to participate and can be expressed as in equation VI:

$$y_i = 1 \text{ if } > \text{ and } 0 \text{ if } \leq 0$$
$$y^* = X_i'\alpha + \varepsilon_i \quad \text{VI}$$

Where:

y_1^* is latent participation variable that takes the value of 1 if a household participates and 0 otherwise, x is a vector of household characteristics and a is a vector of parameters;

The second hurdle, which closely resembles the Tobit model, is expressed in equation VII:

$$ti = t_i^* > 0 \text{ and } y_i^* > 0$$
$$t_i = 0 \text{ otherwise}$$
$$t^* = z_i'\beta + u_i \quad \text{VII}$$

Where:

t_i is the observed response on how much maize/cowpea should be conveyed to market, z is a vector of the household characteristics and β is a vector of parameters.

The decisions whether or not to participate and about how much maize/cowpea to convey can be jointly modelled, if they are made simultaneously by the household; and independently, if they are made separately; or sequentially, if one is made first and affects the other as in the dominance model (23). If the independence model applies, the error terms are distributed as follows: $\varepsilon_i \sim N(0, 1)$ and $u_i \sim N(0,\delta^2)$.

If both decisions are made jointly (the Dependent Double - Hurdle) the error term can be defined as in equation VIII.

$(\varepsilon_i, u_i) \sim BVN(0,Y)$ Where:

$$Y = \begin{bmatrix} 1 & p\delta \\ p\delta & \delta^2 \end{bmatrix} \quad \text{VIII}$$

The model is said to be a dependent model if there is a relationship between the decision to participate and the level of participation. This relationship can be expressed in equation IX:

$$p = \frac{(cov\,\varepsilon_i u_i)}{(\sqrt{var\varepsilon_i}\, varu_i)} \quad \text{IX}$$

If $p = 0$ and there is dominance (the zeros are associated only with non-participation, not standard corner solutions) then the model decomposes into a Probit for participation and a standard OLS for y. Following Smith (33) we assume that the error terms εi and ui are independently and normally distributed and thus we have the equation X:

$$\begin{pmatrix} e_i \\ u_i \end{pmatrix} N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \delta^2 \end{pmatrix}\right] \quad \text{X}$$

And finally, the observed variable in a DH model is $t_i = y_i t_i^*$ and the log-likelihood function for the double hurdle model is given in the equation XI:

$$LogL = \sum_o \ln\left[1 - \Phi\left(x_i'\alpha\right)\left(\Phi\frac{\left(z_i'\beta\right)}{\delta}\right)\right] + \sum + \ln\left[\Phi\left(x_i'\alpha\right)\frac{1}{\delta}\Phi\frac{\left(t_i - z_i'\beta\right)}{\delta}\right] \quad \text{XI}$$

Thus in this study we estimate the decision to participate and the level of participation using a DH model.

To check for multicollinearity in the model, the variance inflation factor for categorical variables was estimated.

Empirical specification

We use a DH model. These decisions are made in a sequential manner and can be subject to two very different decision-making processes.

Therefore, we use a set of explanatory variables largely based on work by Lapar et *al.* (22), Bellemare and Barrett (7), Alene et *al.* (5), and Xu et *al.* (39), who extensively reviewed factors that influence farmers to participate in marketing. The set of independent variables potentially expected to influence participation is grouped into the following classes: household characteristics, physical assets, social capital, transaction costs, livelihood development services, and regional variables.

Demographics are captured by age, education, household size, and numbers of adults and females in the household. The relationship with age is expected to be negative depending on the levels of development. Younger farmers are expected to be progressive, more open to new ideas, and to understand better the benefits of agricultural commercialization. In addition, younger farmers also have higher levels of education and more contacts worldwide. In general, older farmers view farming as a way of life rather than as a business and have a strong emotional or almost biological connection with farming and the land. Intellectual capital as captured by education is expected to play a positive role in influencing market participation. The level of education gives an indication of the household's ability to process information and causes some farmers to have better access than others to understanding and interpreting information. However, the expectation may be reversed when there are competing and more remunerative employment opportunities available in the area requiring skills that are enhanced by more education (22). Household size and number of adults are included as a proxy for the availability of family labour.

Household size may be relevant for attending group meetings while the number of females in the household is relevant for attending market days and transporting maize/cowpea, emphasizing a higher probability of market participation. Therefore a household with a large number of members is expected to produce a larger marketable output. Lapar *et al.* (22) hypothesized that the propensity of a household to participate in the market economy declines with lower numbers.

Farmers' physical assets can catalyze a family to participate in economic activities. A means of capturing the time and cost of transportation is through ownership of a means of transport. Households using motorized equipment are likely to convey their agricultural product to the market easily and at the appropriate time. It is therefore hypothesized that such households are more likely to participate in commercialization and will have a larger quantity of maize/cowpea to transport. Households' access to farm land is a necessary condition for market participation. This variable is measured by the size of the total farm land that the household operates and is likely to be important. The larger the size of land that a household owns, the higher the production levels are likely to be, and the higher the probability of market participation. However, large farms may face high transaction costs and a lack of economies of scale, leading to a lowering of the additional benefits of participation. Another variable used as a proxy for transaction costs is access to information on output markets and prices. Marketing efficiency is hindered by any delay and difficulty in obtaining information which increase transaction costs by raising search and bargaining costs. Therefore mobile phone ownership becomes crucial in capturing the relevant information. Small-scale farmers are often not aware of prices and market opportunities for their maize/cowpea and find it difficult to participate in alternative markets. Access to such information is hypothesized to influence market participation positively.

Membership in any social group is another element of transaction costs as applied in the study. Membership has been linked to a range of outcomes which can improve smallholders' market power and ensure fair benefits sharing and this through networks that information and other resources can be transmitted. Membership strengthens farmers' bargaining and lobbying power and brings together members leading to institutional solutions to some problems. This variable is expected to have a positive impact on market participation. However, membership could be a limiting factor as an indication of other preoccupations that are taking members away from commercialization. This could generate unsuccessful group action (26). Also contact with extension agent is hypothesized to positively related to market participation decisions being a reliable information source. Transaction costs are hypothesized to impede market participation because they impose added cost burdens on the efficient conduct of market entry activities.

Price is expected to influence market participation positively as pointed out by Alene *et al.* (5). The output price is an incentive to sellers to supply more in the market. The final construct of transaction costs applied in the study is the state dummy that is included in the analyses to capture differences that might arise due to diversity in human, economic, and ecological conditions among households located in both states.

In Bauchi and Kano states, *Striga* has invaded cereals and is expected to influence negatively market participation. *Striga* induced reduction in host photosynthesis has been reported as the most important mechanism of growth reduction of the host (38).

Data and results

Using a carefully designed and tested questionnaire for the household survey in November 2011, we conducted structured, household-level interviews with maize/cowpea growers in communities classified as areas with a high potential for *Striga* weed infestation. A multistage, random sampling procedure was adopted to get the total sample size of 600 households in northern Nigeria using the confidence interval approach. The sampling frame including all households in the surveyed villages was developed as a source list by extension agents in collaboration with community heads and this stage involved a random selection of farm households through a random number generator available in Microsoft Excel. The information collected include socioeconomic characteristics, maize and cowpea production data. Others were the production and post-harvest challenges as perceived by respondents.

The production and post-harvest constraints were derived from the respondents' perception using direct questions.

The contexts identified plaguing maize and cowpea growing areas in the study region include *Striga*, stemborer, termites, storage insects, low and erratic rainfall, water logging and inadequate input supply (Table 1). Table 1 shows that *Striga* infestation was the most commonly cited constraint to crop productivity in Bauchi and Kano states. Based on the results from Table 1, it is evident that *Striga* limits the quantity of output harvested and the amount designated for market participation. Subsequently *Striga* infestation could constitute a limiting factor to the extent of farmers' involvement in crop commercialization. In this study, the extent of market participation was captured by the proportion of the quantity of crop produced that was sold by each household. For all households across the study area, about 67% participated in the maize market and 45% in the cowpea market (Table 2).The figures are reflective of the importance of these crops as a main source of income in the region. The average age of the farmers was about 44 years, an indication that most are still economically active with the strength and ability to carry out agricultural activities. Availability of labour for farming (especially family labour) was indicated by the large size (4.31 adults) of households. Illiteracy was widespread as more than half of the farmers did not complete six years of primary education. They cultivated plots of land with an average total size of about 5.6 ha. Some had access to extension services with respect to marketing maize (48%) and cowpea (36%).

The econometric estimation results of output market participation among households are discussed in this section using the Double Hurdle of Cragg (10). Correlates are hypothesized of maize/cowpea market participation (whether a household sold maize/cowpea) and extent of participation (the proportion sold) and are expected variables focused on existent literature of interest which will inform conclusions for this.

The estimation was done separately for each crop. The Probit results on the decision to participate in markets and results of truncated regression analysis on the extent of market participation for the regressions are presented (Table 3).

Participation in the maize market

Household size is an indicator of the amount of family labour that is available for production activities. It had a negative and insignificant effect in influencing participation (Table 3) as opposed to our expectation. This might depict household labour inefficiency where a larger household produces far less than what it needs for household consumption and thus less marketable surplus.

Table 1

Major crop productivity constraints (% of households).

	All	Bauchi	Kano
Maize			
Striga	94.3	93.2	95.3
Stemborer	53.8	41.5	63.5
Termites	73.8	71.7	75.6
Storage insects	62.0	53.0	69.3
Low and erratic rainfall	20.0	20.7	19.5
Water logging (flooding)	19.0	18.8	19.2
Inadequate input supply	63.3	63.8	62.8
Cowpea			
Striga	80.9	85.2	78.1
Alectra	48.4	37.9	53.7
Storage insects	80.2	80.6	79.9
Low and erratic rainfall	18.8	20.3	18.0
Water logging (flooding)	17.1	16.0	17.6
Inadequate input supply	58.8	65.8	54.8

Table 2

Descriptive statistics.

Variables	Symbol	Obs.	Mean	Std. Dev.
Dependents				
Maize market participation (=1 if the household sold maize; 0 otherwise)		600	0.67	0.47
Proportion of maize sold		600	27.30	25.37
Cowpea market participation (=1 if the household sold cowpea; 0 otherwise)		600	0.45	0.50
Proportion of cowpea sold		600	24.11	29.74
Independents				
Age of the household head (years)	AGE	600	43.58	13.00
Education status (=1 if the head has 6 years of schooling or more; 0 otherwise)	EDUCS	600	0.45	0.50
Number of females in the household	FEMALE	600	6.74	3.65
Number of adults in the household	ADULT	600	4.31	2.26
Household size (number)	HSIZE	600	9.20	4.30
Total farm size (ha)	TFSIZE	600	5.62	5.26
Contact with extension agent for improved maize variety (=1 if household has contact; 0 otherwise)	CONT_M	600	0.48	0.51
Contact with extension agent for improved cowpea variety (=1 if household has contact; 0 otherwise)	CONT_C	600	0.36	0.50
Average price at which each unit of maize is sold (Naira/kg)	MPRICE	600	78.83	22.90
Average price at which each unit of cowpea is sold (Naira/kg)	CPRICE	600	103.72	18.82
Member of any social group (=1 if a member; 0 otherwise)	MBER	600	0.36	0.48
Means of transport ownership (=1 if own motorized equipment; 0 otherwise)	MTO	600	0.66	0.47
Mobile phone (=1 if household has access; 0 otherwise)	PHONE	600	0.82	0.39
Striga is a most important production constraint? (1=Yes)	*STRIGA*	600	0.96	0.20
Household location (=1 for Bauchi state and 0 for Kano state)	HLOC	600	0.50	0.50

Total farm size was positively and significantly associated with a higher probability and intensity of participation. This is in agreement with the a priori expectation that farmers with large farms produce beyond what they use for home consumption. An increase in farm size naturally implies an increase in output. These results indicate the constraints that farmers who have farms of smaller sizes face in getting access to markets could be due to their inability to produce a marketable surplus. However, its effect on the volume of sale was not significant. In agreement with a priori expectation, the price for maize was positively and significantly associated with the decision to sell.

This is in agreement with the findings of most authors (5) that the price of a commodity is a great incentive to participate in any market. When the price is high, returns are also expected to be high. Access to motorized equipment was positive and significantly related to the decision to participate. This might be connected with the ease of transportation provided by such equipment as most agricultural crops are produced in distant farmlands with poor road networks.

With regard to location, there is no significant location difference in the probability of participation between Bauchi and Kano state but higher probability of participation is observed in Bauchi. However location was negative and significant in affecting the extent of participation (Table 3).

These underscore the associated socio-economic and population-related factors that are available and evident in both states affecting the demand for the maize crop.

These attributes include the state of industrial development and population density which boost or induce demand for maize that are higher in Kano than Bauchi state with likely much more willingness to enter market in Bauchi.

Participation in the cowpea market

Age of the household head had a negative and significant impact on the decision to participate in the cowpea marketing. This is because many decisions made in the household on whether to sell cowpea or not depend on younger members of the family who tend to be source of key decision that affects the family welfare (Table 4). The rationale behind this might be that money-oriented attitude takes increased prominence in younger people who opt to be risk takers.

Table 3

Estimates of Double-Hurdle Model of Determinants of maize market participation decision and degree of participation.

Maize	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
First Hurdle						
AGE	-0.0047	0.0048	-0.98	0.328	-0.0141	0.0047
FEMALE	0.0608	0.0403	1.51	0.132	-0.0182	0.1398
HSIZE	-0.0688**	0.0347	-1.98	0.047	-0.1367	-0.0008
TFSIZE	0.0316**	0.0148	2.13	0.033	0.0026	0.0607
EDUCS	-0.1801	0.1259	-1.43	0.152	-0.4268	0.0666
CONT_M	0.0150	0.1168	0.13	0.898	-0.2139	0.2440
MEM	0.0287	0.1270	0.23	0.821	-0.2201	0.2776
MPRICE	0.0290***	0.0031	9.31	0.000	0.0229	0.0351
PHONE	-0.0162	0.1604	-0.10	0.920	-0.3306	0.2982
MTO	0.5195***	0.1267	4.10	0.000	0.2713	0.7678
HLOC	0.0472	0.1344	0.35	0.725	-0.2162	0.3107
CONSTANT	-1.7831	0.3893	-4.58	0.000	-2.5462	-1.0200
Second Hurdle						
AGE	-0.0265	0.1007	-0.26	0.793	-0.2239	0.1709
FEMALE	1.1691	1.1150	1.05	0.294	-1.0162	3.3544
ADULT	1.1476	0.9973	1.15	0.250	-0.8070	3.1023
HSIZE	-1.2350	1.1871	-1.04	0.298	-3.5616	1.0916
TFSIZE	0.0027	0.2400	0.01	0.991	-0.4677	0.4732
EDUCS	-3.8637	2.6047	-1.48	0.138	-8.9687	1.2414
CONT_M	-3.2972	2.4828	-1.33	0.184	-8.1634	1.5689
MEM	0.2882	2.6025	0.11	0.912	-4.8126	5.3889
PHONE	0.4356	3.2157	0.14	0.892	-5.8670	6.7382
MTO	3.4536	2.8615	1.21	0.227	-2.1549	9.0620
STRIGA	-4.9140	6.4973	-0.76	0.449	-17.6485	7.8205
HLOC	-9.7132***	2.7387	-3.55	0.000	-15.0810	-4.3454
CONSTANT	48.1054	9.3867	5.12	0.000	29.7077	66.5030
Sigma	21.7022	1.0047	21.60	0.000	19.7331	23.6713
Number of obs	589					
Wald $chi^2(11)$	113.37					
Prob > chi^2	0.0000					
Log likelihood	-2025.039					

Table 4

Estimates of Double-Hurdle Model of Determinants of cowpea market participation decision and degree of participation.

Cowpea	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
First Hurdle						
AGE	-0.0264***	0.0061	-4.32	0.000	-0.0384	-0.0144
FEMALE	0.0393	0.0466	0.84	0.399	-0.0521	0.1306
HSIZE	-0.0363	0.0398	-0.91	0.361	-0.1143	0.0416
TFSIZE	0.0312**	0.0130	2.41	0.016	0.0058	0.0566
EDUCS	0.0089	0.1384	0.06	0.949	-0.2625	0.2802
CONT_C	0.0704	0.1337	0.53	0.599	-0.1917	0.3325
MEM	0.0834	0.1440	0.58	0.562	-0.1988	0.3655
CPRICE	0.0739***	0.0051	14.59	0.000	0.0640	0.0839
PHONE	0.2221	0.1826	1.22	0.224	-0.1358	0.5800
MTO	0.1545	0.1445	1.07	0.285	-0.1287	0.4377
HLOC	-0.0439	0.1492	-0.29	0.768	-0.3363	0.2485
CONSTANT	-7.0115	0.5592	-12.54	0.000	-8.1075	-5.9155
Second Hurdle						
AGE	-0.1707	0.1034	-1.65	0.099	-0.3734	0.0320
FEMALE	1.1536	1.0967	1.05	0.293	-0.9959	3.3031
ADULT	0.6428	0.9429	0.68	0.495	-1.2052	2.4907
HSIZE	-1.3142	1.1548	-1.14	0.255	-3.5777	0.9493
TFSIZE	-0.4344	0.2457	-1.77	0.077	-0.9160	0.0472
EDUCS	-4.8521	2.5600	-1.90	0.058	-9.8696	0.1653
CONT_C	-2.0539	2.5993	-0.79	0.429	-7.1484	3.0407
MEM	-1.4972	2.5733	-0.58	0.561	-6.5409	3.5464
PHONE	10.0169***	3.2424	3.09	0.002	3.6619	16.3718
MTO	4.3595	2.7194	1.60	0.109	-0.9704	9.6894
STRIGA	-1.8323	6.8155	-0.27	0.788	-15.1904	11.5258
HLOC	7.6982***	2.7986	2.75	0.006	2.2131	13.1833
CONSTANT	56.0489	10.1834	5.50	0.000	36.0898	76.0080
Sigma	18.5995	0.8588	21.66	0.000	16.9162	20.2827
Number of obs	589					
Wald chi^2 (11)	228.36					
Prob > chi^2	0.0000					
Log likelihood	-1364.8782					

Total farm size was positively and significantly associated with a higher probability of participation and vice versa. Large land contributes generally to huge output

The price of cowpea was positively and significantly associated with the decision to sell (Table 4). This is in agreement with a priori expectation and similar to maize and that price of a commodity would generally motivate households' participation in any market.

When the price becomes higher, the returns which accrue to households are also higher.

Access to phone influenced positively the decision to participate in cowpea market and was positively and significantly associated with the marketed volumes. Farmers in the surveyed areas access market information on prices of inputs and output through cell phones. Knowledge of input prices enables farmers to make informed decisions in not only entering market but also with quantity designated for sale.

The location variable had different signs with the decision and extent of participation. It was negatively and insignificantly associated with participation decision favoring Kano and positively and significantly related with extent of participation (Table 4). This is inversely similar to the situation with maize market driving the demand for cowpea more in Bauchi than in Kano state. The difference in demand for cowpea could be linked to the lower industrial development in Bauchi state in connection to the uses of cowpea as an important food source prepared as a potherb like spinach, boiled in replacement as rich source of proteins and served to feed animals when green or dry fodder. As expected, the Striga variable was positively, albeit insignificantly, associated with the volume of maize and cowpea marketed. Its statistical significance could be based on the fact that almost all households in the surveyed areas were infested by *Striga* and not enough variation was observed as evidenced by the Table 1.

The estimated coefficient for *Striga* was consistently negative in association with the degree of commercialization of both maize and cowpea in the region and conforms to a priori expectations.

Conclusion and policy implications

This study described the socio-economic characteristics and determined the drivers of market participation among small-scale maize/cowpea farmers in northern Nigeria for whom the two crops are the main sources of income. Market participation was becoming crucial in providing better market opportunities to farmers by motivating them in increasing their output, hence enabling them to earn more income to improve their livelihoods. Price and non-price constraints played a significant role in determining decisions on market participation for both crops. Household and total farm sizes and access to motorized equipment to ease the transportation were positively related to the decision to participate in the maize market. However, the volume of sale of maize was influenced by location-specific variables that underscored socio-economic and population-related factors that are more present in Kano than in Bauchi state.

These socio-economic and population-related characteristics include higher population density and infrastructural and industrial development that could boost the demand for the grains. These same factors in Bauchi favored farmers' participation in the cowpea market.

Moreover access to mobile phone induced the volume of cowpea marketed while age and total farm size affected cowpea market participation decision. However, the role of price was conspicuous in the markets for both crops as the main incentive for households' participation. *Striga* infestation contributed in reducing the volume of cereals marketed. Promoting *Striga* control technologies should be an important goal for research and extension in northern Nigeria.

Henceforth policies that increase returns to households through better prices, good road transportation networks, as well as location-specific socio-economic and population-related factors that induce farmers to commercialize maize or cowpea production should be pursued to promote a marketed surplus for these crop farmers and thereby improve their livelihoods.

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Literature

1. AATF (African Agricultural Technology Foundation), 2008, *Delivering the Promise: Impacting Lives with New Technologies*. Annual Report, 2006, Nairobi, Kenya: AATF. 39.
2. Abdoulaye T. & Sanders J.H., 2005, Stages and Determinants of Fertilizer Use in Semiarid African Agriculture: The Niger Experience, *Agric. Econ*., **32**, 167 179.
3. Aggarwal V.D. & Ouedraogo J.T., 1989, Estimation of cowpea yield loss from *Striga* infestation, *Tropic. Agric*., (Guildford, UK) **66**, 91-92.
4. Ajirenike O.A., 2005, *The effect of Ondo state Agricultural Development Project on Maize production in Akure North local government area of Ondo state.* A project report submitted to the Department of Agricultural Extension and Management, Federal College of Agriculture, Akure, 61.
5. Alene A.D., Manyong V.M., Omanya G., Mignouna H.D., Bokanga M. & Odhiambo G., 2008, Smallholder market participation under transactions costs: Maize supply and fertilizer demand in Kenya, *Food Policy*, **33**, 4, 318-328.
6. Barrett C.B., 2007, *Displaced Distortions: Financial Markets Failures and Seemingly Inefficient Resource Allocations in Low-Income Rural Communities*. Paper presented in Seminar on Resource Allocation among Low-Income Farmers, Cornell University, 12-15 December 2007.
7. Bellemare M. & Barrett C., 2006, An Ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia, *Am. J. Agric. Econ.*, **88**, 2, 324-337.
8. Burke W.J., 2009, Fitting and Interpreting Cragg's Tobit Alternative Using Stata, *Stata J.*, **9**, 4, 584-592.
9. CBN. 2012-2013. *Corn Market Report,* Official Central Bank of Nigeria (CBN) Reports, Commodity Prices, 2012-2013.
10. Cragg J.G., 1971, Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods, *Econometrica*, **39**, 5, 829 844.
11. Delgado C., 1995, *Africa's Changing Agricultural Development Strategies: Past and Present Paradigms as a Guide to the Future,* IFPRI, Washington D.C., USA.
12. Dugje I.Y., Ekeleme F., Kamara A.Y., Tegbaru A., Omoigui L.O., Onyibe J.E. & Teli. I.A., 2008, *Guide on pesticide use for crop production in Borno state, Nigeria*. IITA, Ibadan, Nigeria. 15.
13. *FAO*. 2015. Food and Agriculture Organization of the United Nations. On-line and Multilingual Database http://faostat.fao.org/
14. Fatokun C.A, Tarawali S.A., Singh B.B., Kormawa P.M. & Tamo M., (editors), 2002, *Challenges and Opportunities for Enhancing Sustainable Cowpea Production: Proceedings of the World Cowpea* Conference III held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4–8 September 2000. IITA, Ibadan, Nigeria, 433.
15. Fischer E. & Qaim M., 2011, *Smallholder Farmers and Collective Action: What Determines the Intensity of Participation?* Proceedings of the German Development Economics Conference, Berlin 2011, No. 28. Available at: http://hdl.handle.net/10419/48336
16. Heltberg R. & Tarp F., 2001, *Agricultural Supply Response and Poverty in Mozambique.* Presented Paper at the Conference on Growth and Poverty at WIDER. 25-26 May 2001, Institute of Economics, University of Copenhagen, Denmark.
17. Holloway G.J., Nicholson C., Delgado C., Ehui S. & Staal S., 2000, Agroindustrialization through Institutional Innovation: Transaction Costs, Cooperatives and Milk Market Development in the East African Highlands, *Agric. Econ.*, **23**, 279-288.
18. Holloway G.J. & Ehui S., 2002, *Expanding Market Participation among Smallholder Livestock Producers: A Collection of Studies Employing Gibbs Sampling and Data from the Ethiopian Highlands, 1998-2001. Socioeconomics and Policy Research.* Working Paper 48. International Livestock Research Institute (ILRI), Nairobi, Kenya.
19. IITA, 2012. Maize crop 2012. Downloaded from website: http://www.iita.org/maize
20. *IITA*, 2012. Cowpea crop 2012. Downloaded from website: http://www.iita.org/cowpea
21. Khan Z.R., C.A.O. Midega, A. Hassanali, J.A. Pickett, L.J. Wadhams & A. Wanjoya, 2006, Management of *Striga*, *Striga hermonthica*, and stemborers in sorghum, (*Sorghum bicolor*), through intercropping with green leaf desmodium, *Desmodium intortum*. *Int. J. Pest Manage.*, **52**, 297-302.
22. Lapar M.L., Holloway G. & Ehui S., 2003, Policy options promoting market participation among smallholder livestock producers: A case study from the Philippines, *Food Policy*, **28**, 187-211.

23. Martínez-Espiñeira R., 2006, A Box-Cox double-hurdle model of wildlife valuation: the citizen's perspective. *Ecol. Econ.*, **58**, 1, 192-208.
24. Mathenge M., Place F. Olwande J. & Mithoefer D., 2010, *Participation in Agricultural Markets among the Poor and Marginalized: Analysis of Factors Influencing Participation and Impacts on Income and Poverty in Kenya,* a study report. Tegemeo Institute of Agricultural Policy and Development, Nairobi, Kenya.
25. Omiti J.M., Otieno D.J., Nyanamba T.O. & Mccullough E., 2009, Factors Influencing the Intensity of Market Participation by Smallholder Farmers: A Case Study of Rural and Peri-urban areas of Kenya. *Afjare*, **3**, 1, 57-82.
26. Poulton C., Dorward A. & Kydd J., 2010, The future of small farms: New directions for services, institutions, and intermediation, *World Dev.* **38**,10, 1413-1428.
27. Renkow Mitch, Hallstrom Daniel G. & Karanja Daniel D., 2004, Rural Infrastructure, Transactions Costs and Market Participation in Kenya, *J. Dev. Econ.*, **73**, 1, 349-367.
28. Rios A.R., Masters W.A. & Shively G.E., 2009, *Farm Productivity and Household Market Participation*: Evidence from LSMS Data. http://www.agecon.purdue.edu/staff/shively/RMS _ IAAE.pdf (Accessed May 2010).
29. Rosegrant M.W., Cline S.A., Li W., Sulser T.B. & Valmante-Santos R.A., 2005, Looking ahead. Long-term prospects for Africa's agricultural development and food security. Washington, DC: International Food Policy Research Institute.
30. Sadoulet E. & de Janvry A., 1995, *Quantitative Development Policy Analysis,* The Johns Hopkins University Press. Baltimore and London.
31. Sanda, R.A and Maina, M.I. 2013. Effect of Drought on the Yields of Different Cowpea Cultivars and Their Response to Time of Planting in Kano state, Nigeria. *Int. J. Environ. Bioenerg.*, **6**, 3, 171-176
32. Shilpi F. & Umali-Deininger D., 2008, Market facilities and agricultural marketing: Evidence from Tamil Nadu, India, *Agric. Econ.*, **39**, 281-294.
33. Smith M.D., 2003, On dependency in Double-Hurdle models, *Stat. Pap*., **44**, 4, 581-595.
34. Stifel D. & Sahn D.E., 2003., Employing alternative measures of welfare in the absence of expenditure data. Review of income and wealth, *Int. Food Policy Res. Inst.*, **49**, 463-489.
35. Strauss D., Bednar L. & Mees R., 1989, Does one percent of forest fires cause ninety-nine percent of the damage?, *For. Sci.*, **35**, 319-328.
36. Tobin J., 1958, Estimation of Relationships for Limited Dependent Variables, *Econometrica,* **26**, 24-36.
37. Tung D.X. & Costales A., 2007, *Market Participation of Smallholder Poultry Producers in Northern Vietnam*. Pro-Poor Livestock Policy Initiative (PPLPI) Research Report, March 2007, 14.
38. Watling J.R. & Press M.C., 2001, Impacts of infection by parasitic angiosperms on host photosynthesis, *Plant Biol.*, **3**, 244-250.
39. Xu Z., Burke W.J., Jayne T.S. & Govereh J., 2009, Do Input Subsidy Programs Crowd In or Crowd Out Commercial Market Development? Modeling Fertilizer Use Decisions in a Two-Channel Marketing System, *Agric. Econ.*, **40**, 1, 79-94.
40. Zhang X. & Fan S., 2004, How Productive is Infrastructure? A New Approach and Evidence from Rural India, *Am. J. Agric. Econ.*, **86**, 2, 492-501.

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