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Research Article
Root's Supply Response for Smallholder Farmers Supplying Cassava to Commercial Starch Processors in Nigeria

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Abstract

Background and Objective: This study analyzes the roots' supply capacity and response for smallholder cassava farmers supplying commercial starch processors in Nigeria. Among the specific objectives were to identify the key production and marketing challenges and examine the factors driving roots' flow from farmers to processing factories. **Materials and Methods:** A multi-stage random sampling technique was used to select 96 farmers from the enlisted clusters in eight cassava-growing states. Data were analyzed using descriptive and inferential statistics and multivariate regression techniques. **Results:** Initial characterization revealed that 22.9% of all farmers were women, 32.3% into full-time farming and 97.9% married. About 80.0% of the farmers' total produce was sold to various markets but only 61.1% of farmers supplied part of their produce to the starch factories. Yield ($p<0.01$), experience ($p<0.01$), farm size ($p<0.01$), commercialization ($p<0.01$), varieties type ($p<0.01$), factory gate price ($p<0.01$) and training ($p<0.01$) had significant positive influence on marketed surplus while the influence of open market price ($p<0.01$) was negative. Production cost, transport and logistics, dearth of fertilizer, labour and capital were the key production challenges while transport cost, distance and small size of markets were the key marketing challenges. **Conclusion:** Policies and programmes capable of promoting high yield and output, targeting farmers with proven experience, large farm sizes and demonstrated will to commercialize and offering competitive factory gate prices were ways of increasing flow of roots to starch processing factories. The significant negative effect of the open market price implied that inasmuch as the starch processors' price remained less attractive and competitive vis-à-vis the price elsewhere, the problem of roots' leakage would persist and the factories would continue to operate below capacity. The study recommended provision of best farm management package of practices including improved cuttings, regular training and retraining, agro-inputs' credit, relevant extension and monitoring support services to promote farmers' efficiency and roots' flow. As big-time investors, the starch processors should show more commitment to cassava value chain development through direct assistance to farmers in opening of lands, purchasing or leasing of tractors and subsidizing transport facilities especially during harvesting, so as to curtail the farmers' tendency to divert roots to alternative markets.

Key words: *Manihot esculenta*, smallholder farmers, starch processors, supply response, value chain, Nigeria

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cassava (*Manihot esculenta* Cranz) is a food security crop variously grown by rural farming households in Nigeria. With a production volume of close to 40 million Metric Tonnes (MT) in 2010, Nigeria is considered the world's highest producer of cassava. Her production was about one-third more than that of Brazil and almost doubled the production of Indonesia and Thailand[1]. They also observed that cassava production in other African countries, including the Democratic Republic of the Congo, Ghana, Madagascar, Mozambique, Tanzania and Uganda was small compared to Nigeria's considerable output[1]. The share of Nigeria's cassava production in the world and Africa totals following available FAO data[2] is presented in Fig. 1. It revealed evidence of rising trend, especially since the mid-1980s. Both trend lines had positive slopes of 0.34 and 0.27 for the share in Africa and world totals, respectively.

Ironically, Nigeria has not been an active participant in the cassava global market. This is primarily because about 90% of the country's production was for subsistence and used domestically as food, leaving only 5-10% for processing into secondary industrial products, used mostly as animal feed[3]. Among other things, the Presidential Initiative on Cassava (PIC) launched in 2003 brought the potentials of cassava to national limelight by identifying the root crop as a viable foreign exchange earner for the country. It also sought to develop the cassava industry to sustain the national demand and earn foreign exchange for the country. As part of its approaches in developing a vibrant cassava market locally and internationally, the Cassava Master Plan identified ethanol, flour and pellets as potential earners in the domestic market[3]. It also identified starch as a potential industrial product for the export market. This could be achieved by encouraging joint venture partnership in the cassava starch industry to facilitate access to international market and fast track Nigeria into the global context for competition in the commodity. UNIDO[3] put the world's starch production at about 60 million MT in 2005 and identified the United States as the largest producer with 25.2 million MT (42.0%). Other acknowledged producers include Asia (19.8 million MT or 33.0%), Europe (12.2 million MT or 20.3%), Latin America (1.8 million MT or 3.0%) and Brazil (1.0 million MT or 1.7%). Also, it identified the major raw materials used for starch production as corn (75.0%), sweet potato (13.0%) and cassava (12.0%). Thus, African and indeed Nigeria was not identified among the active players in the global starch supply and demand market notwithstanding that it had been adjudged the world's largest producer of cassava with production volumes rising by over 39.0% between 2000 and 2008[4]. Instead, the nation has a high demand for starch estimated at 230,000 MT annum^{-1} [3]. It has only two functioning large-scale cassava starch processing factories, none of which is operating at up to one-third of installed capacity.

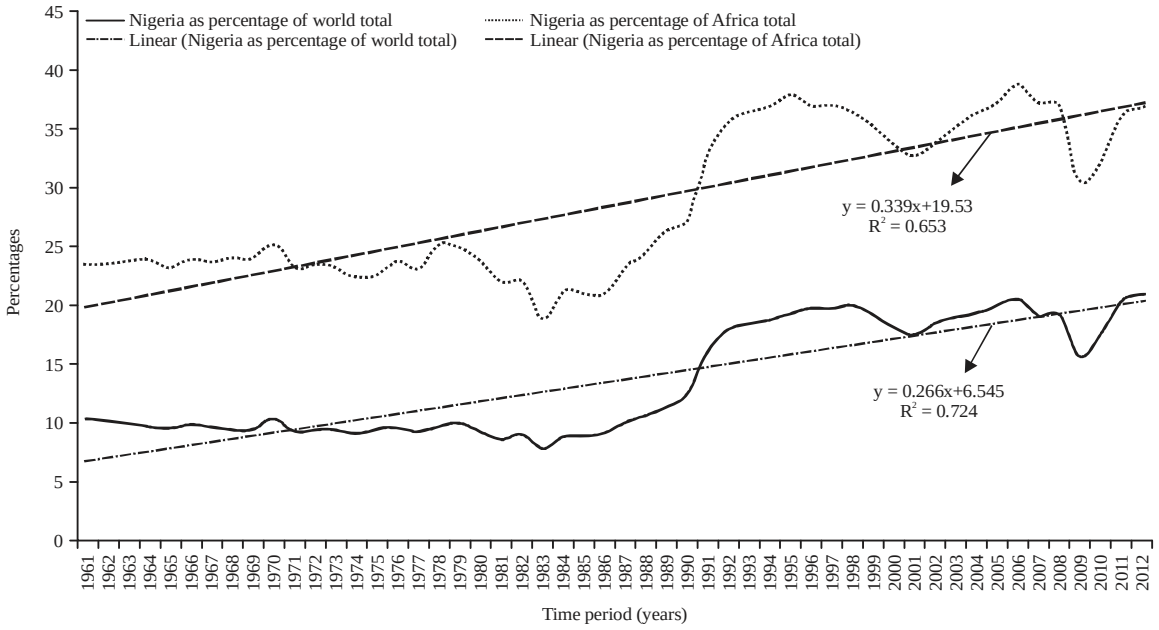

Fig. 1: Share of Nigeria's cassava production in world and Africa totals, 1961-2012, Source: FAO (2012)

The major factor responsible for the inability of the existing starch processing factories in Nigeria to operate close to their installed capacities was shortage of raw materials, that is cassava roots. Preliminary interactions with top management of the two existing commercial starch processors revealed that each of the factories was operating below 30% capacity. They had identified shortage of cassava roots as the main reason for their low performance and showed willingness to partner with development projects and programmes to tackle this key problem. The perishable nature and bulkiness of cassava roots, coupled with bad road networks, long distance to remote areas and locations of most cassava farms are among the factors that contribute to the increasing cost of making fresh roots available in the hinterlands.

The forgoing has been a major constraint in the efforts to develop and promote the cassava value chain in Nigeria. Most recently, the efforts were at encouraging commercial transformation of cassava, which hitherto was grown for subsistence because commercial agriculture was an indispensable pathway to economic growth and development[5,6]. Commercialization was likely to result to welfare gains through the realization of comparative advantages, economies of scale and dynamic technological, organizational and institutional change effects that arise from the flow of ideas due to exchange-based interactions[5,7]. Also, it enhances the link between the input and output sides of agricultural markets[5], which has remained one of the major challenges of the Nigeria's cassava industry. Elsewhere, it had been succinctly argued that although cassava production and processing had been on the increase in Nigeria, there was still a large gap to be filled in meeting the food and raw material needs of the country in terms of cassava products and by-products[8].

In response to the supply gap in cassava roots that currently exists in the Nigerian starch factories, Nestlé Foods Nigeria Plc designed a cassava productivity and value chain support programme for implementation in some selected states in Nigeria through the multiplication and distribution of IITA improved cassava planting materials. The programme was initially to cover the periods April, 2010-June, 2013 and aimed at providing support to smallholder farmers clustered around the two major starch-processing factories in Nigeria (Matna Foods Company, Ogbese, Akure, Ondo state and Nigeria Starch Mills (NSM) Limited, Uli, Ihiala, Anambra state). This is to meet the supply requirements of Nestlé Foods Nigeria Plc, a company which annually buys starch worth about US $6 million manufactured from cassava and maize. The inability of these factories to supply adequate quantities of starch to Nestlé was associated with the fact that the processors could not get sufficient raw materials from the farmers.

It was against this background that Nestlé Foods Nigeria Plc entered into collaboration with IITA to multiply and distribute high yielding cassava varieties to farmers within the catchment or buying areas of Nestlé's cassava starch suppliers using the Creating Shared Value (CSV) approach. The idea was to produce enough cassava at a competitive price, resulting from yield increases, to enable Nestlé Foods Nigeria Plc suppliers to meet the companys' cassava roots requirements and by extension the companys' starch demands. This approach would enable the company have the opportunity of buying all its cassava starch locally, thereby creating income opportunities for farmers in line with the commitment of Nestlé to Africa, which aimed at sourcing its raw material needs locally in the countries where it operates. The purpose of the project was to: (a) facilitate the multiplication and dissemination of improved, high-yielding, commercially-viable and disease-resistant planting materials to clustered farmers and out-growers, (b) introduce smallholder farmers in target communities to improved cassava management practices, which will address common agronomic errors that had kept root yields below 12 t ha^{-1}, including the efficient use of inputs such as timely application of fertilizers/herbicides and use of harvesters to reduce the drudgery currently experienced by farmers in harvesting and (c) create effective linkages that would guarantee the sustainable supply of raw materials to the starch factories.

The prevailing problem was the fact that the starch processing factories, which were established to depend wholly on cassava as basic raw materials were woefully operating below their installed capacities due to the existing wide gap between cassava roots demand of the processors and available supply from smallholder farmers. There was need to investigate the cassava supply potentials of these smallholders vis-à-vis their personal characteristics and market factors with a view to identifying the driving factors and key challenges involved. Therefore, the purpose of this study was to analyze the capacity of the smallholder cassava farmers to supply raw materials to the starch processing factories in the southeast and southwest zones of Nigeria. The specific objectives were to examine the socio-economic and personal characteristics of smallholder cassava farmers; identify the major challenges to roots production and marketing among enlisted farmers and examine the factors influencing the flow of cassava roots from farmers to the processing factories. The results of the

investigation would be used to perfect the cassava supply chain model that would be capable of eliminating the supply-gap and facilitate the value chain promotion efforts in Nigeria' cassava industry.

SUPPLY RESPONSE OF AGRICULRURAL CROPS IN NIGERIA

Agricultural productivity growth is recognised as a critical determinant of rural welfare as well as an engine of overall economic growth and development in developing countries, including Nigeria[9]. In addition to guaranteeing food sufficiency for the household, increased farm productivity enhances availability of surplus output of crops for sale in the market for household income enhancement. The term "market orientation" describes the extent to which a producer uses his or her knowledge of the market like knowledge about the customers and prices to make decisions on what to produce, how to produce and how to market[5]. It is the degree of allocation of resources, including land, labour and capital, to the production of agricultural goods that are meant for exchange or sale[10]. Basically, it is a production decision issue influenced by both production conditions and market signals[10,11].

For a given crop, the smallholder farm supply response measures the degree to which the level of production/marketable/marketed volume of the crop changes in response to stimuli provided by interplay of factors in the immediate environment[12]. Rao[13] identified three different levels at which supply response could be considered, depending on the type of resource use question the policy-maker intended to answer: Aggregate agricultural output, commodity composition of output or the marketed surplus. Marketable surplus refers to the portion of farm output the farmer has made available for sale in the output market. It is the residual production of agricultural produce left with the producer after meeting the requirements of family consumption, farm needs for seed and feed, in-kind payments and quantity added to end-of-year stocks[14]. Aside from contributing to the improvement in the standard of living of farmers and other key players, making available industrial consumer goods and capital formation in the agricultural sector by fetching the requisites of agricultural production, marketable surplus also contributes to capital formation in the non-agricultural sector of the economy[14]. Marketed surplus is a practical ex-post concept referring to that part of the marketable surplus that is actually made available to the market or to the disposal of the non-farm rural and urban population[15]. It follows that there is a high level of correlation between market orientation and both marketable and marketed surplus of agricultural produce because a commercial-oriented producer is more likely to release higher proportion of the farm produce to the market. In the same vein, the estimation of the marketed surplus can suffice that of the supply response. Abebe[16] observed that the primary concern of the agricultural supply response is about marketed surplus, which varies with levels of production or consumption or both.

In Nigeria, there has been some recent studies that analyzed farmers' market orientation/level of commercialization and marketable/marketed surplus in different crops value chains, including vegetables, maize, rice[17] and cassava[10,18]. In the study of vegetables in Kwara state it was found that farmers' education level, farming experience and spoilage of produce at farm significantly influenced commercialization decision of farmers[19]. In the case of maize in Osun state, Falola *et al.*[20] found that occupation of the farmer, use of modern technology and maize output were significant positive determinants while cost of transportation was a significant negative determinant of marketable surplus. In their investigation of rice in Cross River state, Tiku and Ugbada[17] established that quantity of rice for gift, quantity of rice consumed, quantity of rice reserved for replanting, quantity reserved for uncertainty, level of education, house-hold size, quantity of rice produced, cost of transportation, cost of production and farmers' socio-economic characteristics positively influenced the quantity of rice sold in the area. For cassava, a study in Ile-Ife area of Osun state also revealed that quantity of cassava output and family size had positive influences on marketable surplus while losses, quantity consumed, farm size and in-kind payments had negative influences on it[18]. Also on cassava, investigations by Adenegan *et al.*[10] found that age, education, gender and distance to nearby market significantly influenced the smallholder cassava farmers' market orientation in Nigeria. In a special study that analyzed the determinants of smallholder farmers' commercialization by estimating the aggregate commercialization index based on several number of crops each farmer was producing, Agwu *et al.*[21] found that none of the crops studied attained a ratio above 30% commercialization index. Cassava had the highest ratio of 29.58%, while water yam was the least with 13.55%. It revealed further that income, farming experience, farm size, membership of society and access to credits had significant

positive effects on commercialisation while household size and distance to market had significant negative effects.

In this study, the interest is on smallholder cassava farmers' and their roots' supply capacity to commercial starch processors in the Southeast and Southwest zones of Nigeria. Thus, the researchers used the term marketed surplus restrictively to describe the volume of roots the farmers had supplied to the processing factories during the period under investigation. Suffices to note that the investigation is justified because, according to Heltberg and Tarp[22], modelling the decision to enter the output market is potentially important in situations where many households rely on subsistence farming, which reflects the situation in the study area.

MATERIALS AND METHODS

Study area: The study was conducted in the eight IITA-Nestlé Foods Nigeria Plc Cassava Starch Project States. The project partitioned the states into two axes: South East (SE) axis and South West (SW) axis (Fig. 2).

The SE axis as defined comprised of five states that provided clusters around the NSM factory. These are Abia, Anambra, Enugu and Imo states (from Nigeria's South East geopolitical zone) and Delta state, which although falls into the South-South zone has substantial number of its citizens sharing boundary, culture and a lot of other things in common with the South East. Abia state is located at latitude 5.41667°N and longitude 07.5000°E. It has a land area of 6,320 km^2, 17 Local Government Areas (LGAs) and a population of 2,845,380 (50.27% male and 49.73% female) based on the 2006 National Population Census. Anambra state, located at latitude 6.33333°N and longitude 07.0000°E, has 21 LGAs, a land area of 4,844 km^2 and a population of 4,177,828 (50.70% male and 49.30% female). Delta state with its administrative headquarters at Asaba is located at latitude 6.2000°N and longitude 6.7300°E. It has a land area of 17,698 km^2, 25 LGAs and a population of 4,112,455 (50.32% male and 49.38% female). The fourth SE state, Enugu is located at latitude 06.5000°N and longitude 07.5000°E. It has 17 LGAs, a land area of 7,161 km^2, a population of 3,267,837 (48.84% male and 51.16% female) going by the 2006 National Population Census, a rainfall range of 1520-2030 mm annum^{-1}. The fifth state, Imo is located at latitude 5.4800°N and longitude 07.0300°E. It has 27 LGAs, a population of 3,927,563 (50.32% male and 49.68% female) and land area of 5,100 km^2.

The SW axis has Ekiti, Ondo and Osun states that provided clusters around Matna starch factory. Ekiti state has its administrative headquarter in Ado-Ekiti, located at latitude 7.6200°N and longitude 05.2200°E. The state has a land area size of 6,353 km^2, 16 LGAs and a population of 2,398,957

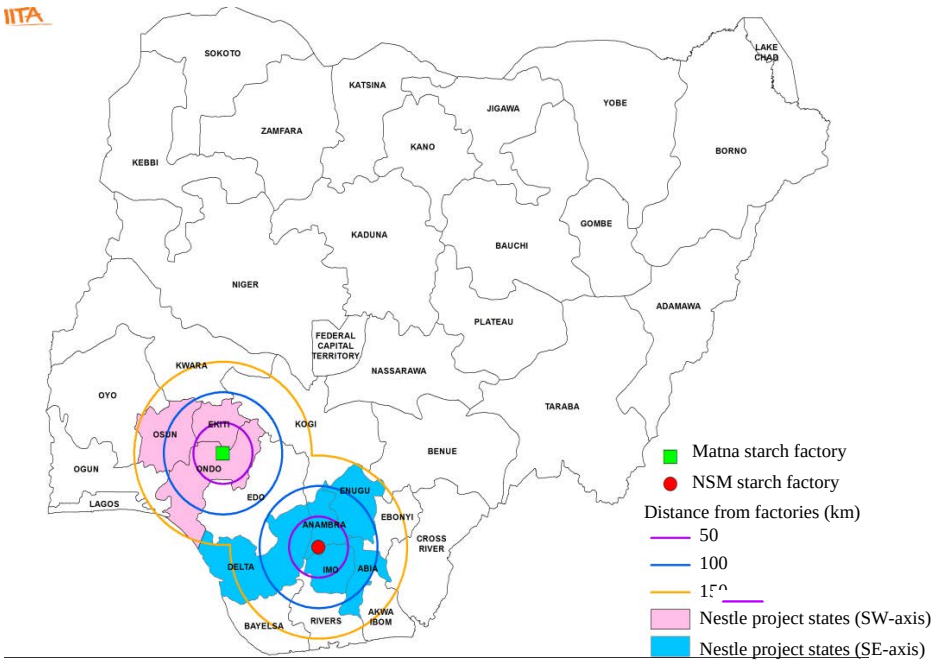

Fig. 2: IITA-Nestlé Cassava Starch Project States and processing centres in SE and SW axes, Source: IITA Geospatial Laboratory in 2013

(comprising of 50.67% male and 49.33% female). The second state, Ondo with capital and administrative headquarters in Akureis located at latitude 07.2500°N and longitude 5.1900°E. It has an area size of 15,500 km^2, 18 LGAs and a population of 3,460,877 people (consisting of 50.42% male and 49.58% female). The third SW state is Osun with its capital city and administrative headquarters at Osogbo located at latitude 7.7500°N and longitude 4.5610°E. The 2006 National Population Census gave the population of Osun state as 3,416,959 (50.75% male and 49.25% female). It has 30 LGAs and a land area size of 9,251 km^2.

One common feature of the project states is that they are endowed with fertile land that is good for the production of several food security and cash crops. Among the food security crops produced in these states are cassava, yams, maize, plantain/banana, cocoyam and sweet potatoes. The cash crops include palm produce, kolanuts, cocoa and mangoes. The areas are endowed with abundant natural resources that include rivers, lakes, coal, lead, zinc, fine sand, limestone and petroleum, which can be spotted as movement is made from one state to another. As shown in Fig. 2, the project states and locations were within at most 150 km^2 to the processing centres they were targeted to service.

Sample and data collection: This survey was conducted in the 8 project states, which were chosen because of their cassava production potentials in Nigeria. The sample comprised of selected farmers. A multi-stage random sampling technique was used to select the sample from the already formed clusters. A cluster was made up of an average of 10-20 members and three clusters were selected from each state. Four members were randomly selected and interviewed from each cluster. In all, 96 farmers were interviewed using a structured and pre-tested questionnaire. Information gathered from the farmers on the average on-farm yield of cassava roots was confirmed by an on-farm yield sample harvesting of 25% of the total cassava farms in the study area (32 farms). This was done on a 4 m×5 m spacing bases (20 m^2) and the yield was calculated for 1 ha (10,000 m^2). The study used primary data collected using pre-tested structured questionnaire. Data were collected on farmers' socio-economic characteristics, status of cassava production and roots' flow and challenges to cassava production and marketing. The collected data relate to the 2012/2013 production season.

Analytical techniques: The study used a combination of descriptive and inferential statistics and multivariate regression techniques. Descriptive statistics, including mean, percentages, charts and frequency distribution were used to analyze the socioeconomic and demographic characteristics of respondents. The J-B statistics were calculated on the basis of calculated coefficients of skewness and kurtosis for each variable. It was used in testing the null (joint) hypothesis that the skewness and kurtosis was zero against the alternative that they were not zero:

$\mathbf{H_0}$: Skewness and excess kurtosis = 0

$\mathbf{H_1}$: Skewness and excess kurtosis ≠ 0

Significant value of J-B implies that the Ho is rejected and variable in question was not normally distributed.

A multiple regression technique was used to examine the nature of the relationship between an endogenous variable and two or more exogenous variables. The technique usually produces estimators of the standard error and a coefficient of multiple determinations. Suppose a variable (y_i) assumes some values determined by values of other set of variables (x_i). In implicit form, the statement that a particular variable of interest (y_i) is associated with a set of the other variables (x_i) is given in Eq. 1 as:

$$yi = f(x_1, x_2, ..., x_k) \quad (1)$$

where, y_i is the dependent variable and x_i (for i-1,⋯k) is a set of k explanatory variables.

The coefficient of multiple determination measures the relative amount of variation in the dependent variable (y_i) explained by the regression relationship between y and the explanatory variables (x_i). The F-statistics tests the significance of the coefficients of the explanatory variables as a group, that is the null hypothesis of no evidence of significant statistical regression relationship between y_i and the x_is against the alternative hypothesis of evidence of significant statistical relationship. The critical F-value has n and n-k-1 degrees of freedom, where n is the number of respondents and k is the number of explanatory variables.

The standard error is the measure of error about the regression coefficients. The z-statistics is used for testing the null hypothesis that the parameter estimates are statistically equal to zero against the alternative hypothesis that the parameter estimates are statistically different from zero[23]. If the computed z-value exceeds the critical value, the null hypothesis is rejected with the conclusion that the parameter estimates differ significantly from zero.

Empirical cassava roots' supply response model: A multiple regression technique was used to examine the nature of the

relationship between the endogenous variable and two or more exogenous variables. Our choice of the explanatory variables considered for inclusion in the empirical cassava roots' flow model was guided by theory, evidence from past studies on cassava roots' flow behaviours and hypothesized relationships with the dependent variable. The variables were then screened to ensure that only the plausible ones were retained for inclusion in the empirical model. Following Manyong *et al.*[24], analysis of bivariate correlation matrix was used to verify the explanatory variables pair-wise to ensure that only the plausible ones were retained. As Udoh[25] also affirmed reduction in the number of explanatory variables or interactions help to ease computation, reduce the risk of multicollinearity and ensure that only the economically meaningful and theoretically plausible variables are retained for analysis. Only variables that were not highly correlated with $|r|<0.5$ were retained for inclusion in the empirical cassava roots' flow model[24].

Consequently, the researchers specified the empirical model of cassava roots' flow from the smallholder farmers to the starch processing factories in the area in Eq. 2 as:

$$y_i = \beta_0+\beta_1x_1+...+\beta_{13}x_{13}+\zeta_t \quad (2)$$

Where:

y_t (CRF) = The dependent variable, defined as the respondents' cassava roots' flow given as the actual quantity of roots that was supplied to starch factory by the farmer in the preceding year and measured in tonnes

β_0 = Constant and intercept of the Eq. 2

x_1 (YLD) = Average yield of cassava, given in t ha^{-1} ($b_1>0$)

x_2 (EXP) = Cassava farming experience, measured in years ($b_2>0$)

x_3 (EDU) = Level of education attained by respondent, 0 = no formal education, 1 = primary level of education, 2 = junior secondary education, 3 = senior secondary education, 4 = tertiary education attempted and 5 = tertiary education completed ($b_3>0$)

x_4 (FMS) = Farm size, land area cultivated by respondent during the period, in hectares ($b_4>0$)

x_5 (COM) = Extent of commercialization, entered the model as a dummy variable, 0 if quantity sold was less than 50% of total produce; 1 if quantity sold was 50% and above ($b_5>0$)

x_6 (VAR) = Variety type planted by farmer, dummy defined as 1 if improved and 0 if not ($b_6>0$)

x_7 (TRA) = Previous exposure to training (dummy: 1 = exposed to training, 0 = otherwise) ($b_7>0$)

x_8 (PCR) = Processor credit support to farmers during the preceding season, 1 = supported, 0 = not supported, ($b_8>0$)

x_9 (HMT) = Method of harvesting, 1 = mechanical method, 0 = manual method ($b_9>0$)

x_{10} (HSE) = Harvesting season, 1 = rainy season, 0 = dry season, ($b_{10}>0$)

x_{11} (RAC) = Road access, 1 = accessible, 0 = not accessible ($b_{11}>0$)

x_{12} (FGP) = Factory gate price of roots, measured in naira per tonne ($b_{13}>0$)

x_{13} (OMP) = Open market price of roots, measured in naira per tonne ($b_{12}<0$)

ζ_t = Stochastic error term

Considering the purpose of this investigation, which is to establish a causal relationship between the levels of cassava roots' flow and the identified explanatory variables in the model, the linear form of the regression was run. The ordinary least square technique was used to estimate the parameters of the model. This was because with the normality assumption in the error term, ζ_t, the OLS estimators are normally distributed and are called the best linear unbiased estimators or BLUE[23]. Standard Eviews software was used for descriptive analysis and for estimation of the regression parameters. All the functional forms were analyzed but the linear model was reported because it produced the best fit based on the estimated values of the coefficient of multiple determinations (R^2) and F-statistics.

RESULTS

Socioeconomic and demographic characteristics of respondents: The descriptive information of some socio-economic characteristics of the respondents are presented in Table 1. Among others the Jarque-Berra (J-B) statistics for each variable was reported.

The J-B statistic is the goodness-of-fit measure of departure of the respective variables from normality in distribution. The average age was 48.06 years for all respondents; the ages ranged from 22 years (minimum) to 75 years (maximum). The averages were 48.92 years for the South East and 46.64 years for the South West. This meant that the average sampled farmer from the SE was 2 years older than the counterpart from the SW axis. The distribution of respondents by gender showed that 74 farmers or 77.08% were men while the rest 22 famers or 22.92% were women. The percentage of men farmers in the SE axis was 73.33% while that in the SW axis was 83.33%.

Table 1: Descriptive statistics of variables

Items	CRF	YLD	AGE	EXP	EDU	FMS	COM	VAR	TRA	PCR	HMT	HSE	RAC	FGP (Naira)	OMP (Naira)	GDR	HHS	MST	OCC
Mean	10.983	12.302	48.062	15.875	2.874	3.155	0.198	0.792	0.718	0.062	0.031	0.458	0.323	8392.86	15804.17	0.229	7.410	2.274	0.320
Median	8.000	10.000	48.000	14.500	3.000	2.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	8000.000	15000.00	1.000	7.000	2.000	0.000
Maximum	30.000	30.000	75.000	55.000	6.000	20.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	14000.00	22000.00	1.000	15.000	5.000	1.000
Minimum	0.000	4.000	22.000	3.000	1.000	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7500.000	8000.000	0.000	1.000	1.000	0.000
Standard deviation	8.537	6.387	9.533	10.507	0.853	2.949	0.400	0.408	0.452	0.243	0.175	0.501	0.470	1342.725	4178.439	0.422	3.197	0.892	0.470
Skewness	1.060	1.779	0.167	1.144	0.243	2.769	1.516	1.436	-0.973	3.615	5.388	0.167	0.757	3.446	-0.436	-1.289	0.473	2.686	0.760
Kurtosis	2.929	4.756	3.188	4.399	3.860	13.578	3.299	3.063	1.947	14.067	30.032	1.028	1.574	13.694	2.346	2.661	2.705	8.476	1.570
Jarque-Bera	5.440	63.013	0.591	28.799	3.864	570.301	37.149	33.026	19.586	698.951	3387.488	16.003	17.316	188.848	4.759	27.035	3.893	232.920	17.32
Probability	0.066	0.000	0.744	0.000	0.145	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.093	0.000	0.143	0.000	0.000
Sum	318.500	1181.000	4614.000	1524.000	273.000	302.900	19.000	20.000	69.000	6.000	3.000	44.000	31.000	235000.00	1517200.00	74.000	704.000	216.000	31.000
Sum square deviation	2040.621	3875.740	8633.625	10488.50	68.484	826.097	15.239	15.833	19.406	5.625	2.906	23.833	20.989	4.67E+07	1.66E+09	16.958	960.989	74.884	20.990

CRF: Cassava roots' flow (quantity supplied to starch processor), YLD: Yield of cassava, AGE: Age of respondent, EXP: Years of (farming) experience, EDU: Level of educational qualification, FMS: Farm size, COM: Extent of commercialization, VAR: Variety type (dummy), TRA: Training (dummy), PCR: Processor credit support (dummy), HMT: Harvesting method (dummy), HSE: Harvesting season (dummy), RAC: Road access (dummy), FGP: Factory-gate price of roots, OMP: Open market price of roots, GDR: Gender of respondent, HHS: Household size, MST: Marital status and OCC: Occupation. Exchange rate of the naira (Nigeria local currency) to the USA dollars was US $1/₦150, Source: Field survey data in 2012

The finding relating to gender confirmed that the activities of cassava production, marketing and processing in most rural Nigerian communities were complementarily performed by men and women. It agreed with Ezumah and Di Domenico[26] who argued that men and women had complementary obligations for providing food for the Nigerian rural household. Also, Das[27] and Anayakoha and Ozoh[28] argued that the rural Nigerian women were actively involved in all aspects of primary food production. The average farm area cultivated by respondents was 3.15 ha and ranged from 0.2-20 ha with standard deviation of 2.94. Majority of the farmers (28.13%) cultivated from 0-1 ha against 23.96% who cultivated 1-2 ha, 18.75% with 2-3 ha, 9.38% with 3-4 ha and 7.29% with 4-5 ha. Over 70% of all farmers cultivated below 3 ha confirming them as mostly smallholders. Majority (46.88%) of respondents had secondary education. Those with primary and post-primary education were 27.08 and 19.79%, respectively. The remaining 6.25% did not have formal education. The average cassava farming experience of respondents was calculated as 15.87 years. Majority (22.92%) had experiences ranging from 20-25 years. This is in comparison to about 50% with at most 14 years experience and 13.54% whose experiences were above 25 years. Given the average cassava farming experience of respondents, it is expected that they would have been exposed to the use of the improved cassava varieties and new technologies, including best farm management and agronomic practices that were capable of getting them better equipped to be efficient.

The average household size was calculated as 7 persons for all respondents. Household membership ranged from 1-15 with a standard deviation of 3.20. The distribution is somewhat normal as shown by the J-B statistics. The household size was 7 persons for the SE and 6 persons for the SW, which corroborated the finding elsewhere that the average household size in Southeast Nigeria was about 7 persons[29]. Breakdown of occupation shows that only 32.29% of respondents were into full-time farming. The remaining majority (67.71%) share their time between farming and other occupations, including petty trading (buying and selling), civil service, general businesses and contracts works. This finding could be linked to some of the challenges to cassava production and marketing identified by respondents to include lack of government support, lack of incentives and low investments, which compelled most farmers to engage in other means of livelihood and coping strategies.

The average price received by respondents from processors during the period was ₦8,392.86 t^{-1}

Table 2: Cassava production challenges

Description	Frequency	Percentage	Ranking
Shortage and high cost of improved planting materials	19	39.4	5th
Shortage and high cost of labour	23	47.7	3rd
Inadequate capital/credit facilities	32	66.3	1st
Shortage of fertile cultivatable farm land	15	31.1	6th
High cost of hiring tractor and other mechanization equipment	20	41.5	4th
Destruction of farms by cattle, pests and diseases	9	18.7	7th
Non-availability of fertilizer, herbicides and other basic agro-inputs	29	60.1	2nd
Inadequate extension services	7	14.5	8th
Lack of government support/incentives	3	6.2	9th

Source: Field survey data in 2012

of fresh roots or about US $55.95 t^{-1} with minimum and maximum values of ₦8,000.00 t^{-1} (about US $53.33 t^{-1}) and ₦14,000.00 t^{-1} (about US $93.33 t^{-1}) respectively. The farm gate price deviated substantially from the open market price that prevailed, which during the period recorded an average of ₦15,804.17 t^{-1} (about US $105.36 t^{-1}), with minimum and maximum values of ₦15,000.00 t^{-1} (about US $100.00 t^{-1}) and ₦22,000.00 t^{-1} (about US $146.67 t^{-1}). The existing disparity between the farm-gate and open market prices of fresh roots had remained a very critical issue in delivering cassava value chain projects using the out-growers' scheme arrangements in Nigeria.

The averages for the dummy variables reflect proportions, which when multiplied by 100 gives the respective percentages. It follows that from Table 1, the respondents who used improved varieties was 79.20% while those who had acquired training at some point in time was 71.80%. Also, 3.1% of respondents attempted mechanical harvesting, 6.2% had at some point in time received credit facility from the processors and 32.3% had accessible road from farm to the factory. In terms of the season for harvesting, 45.80% of respondents confirmed they harvested during the dry season comparing to over 50% who harvested during the rainy season.

Quantity of roots sold by farmers: The average on-farm yield of respondents from sample harvesting of selected fields in each of the project states was calculated to be 12.3 t. Relating to the general market orientation and capacity to supply to the starch processors, respondents confirmed that on the average, they could only sell about 80% of their cassava produce while the remainder (20%) was used for home sustenance and gifts. Of the 80% sold annually, about 61.1% of respondents confirmed selling part to the commercial starch processors, implying that the rest depended on the open markets for sale of roots. The farmers disclosed that they could not depend entirely on the factories because they offered low prices. Among the farmers who even related with the factories, it was disclosed that they could only release a limited chunk of their output to the processors while selling the rest elsewhere and more especially in the open market. They confirmed that they would on an average day prefer supplying to the open market where the price per tonne was much higher. This suggested that there was a big need for proper orientation of the rural farmers if the goal of establishing a strong synergy among them and the processors in order to promote cassava value chain with greater efficiency would be realized. In terms of actual volumes, the average roots supplied was 10.98 t. It ranged from minimum supply of 0.0 t to a maximum supply of 30.0 t with a standard deviation of 8.53.

Cassava production challenges: The production challenges faced by cassava farmers in the study area were identified by the farmers themselves (Table 2).

As revealed in the Table 2, lack of capital and access to credit facilities was ranked as the most serious challenge having been separately identified by 66.3% of farmers. Coupled with the fact that most of the smallholders have low capital base they also usually find it difficult to get access to credit due to high interest rate, lack of collateral and unwillingness on the part of microfinance and commercial banks to grant credit to smallholders. The second pressing problem identified by 60.10% of farmers was non-availability of fertilizer, herbicides and other basic agro-inputs while the third was shortage and high cost of labour. Listed in their order of severity, other identified challenges are: High cost of hiring tractor and other mechanization equipment (by 41.5%), shortage and high cost of improved planting materials (by 39.4%), shortage of fertile cultivatable farm land by 31.1%, destruction of farms by cattle, pests and diseases (by 18.7%), inadequate extension services (by 14.5%) and lack of government support and general incentive for cassava farming (by 6.2%). The respondents noted that the persistence of the identified challenges had been negatively affecting their efforts in cassava production while the associated frustration and hardships had led many to abandon their farm

work and take to other means of livelihoods. Also, they were partly responsible for the increasing number of part time farmers in the study area.

Cassava roots' marketing challenges: The identified marketing challenges are presented in Table 3.

It is shown in Table 3 that high cost of transportation identified by 98.9% of respondents was ranked above other challenges. Other identified challenges are low price of roots (97.9%), small size of market (55.2%) and distance between farms and the market (31.2%). Among the reasons identified for high cost of transportation were poor road access, bad road, high cost of vehicle maintenance and service spare parts and payment to local revenue collectors.

Famers' cassava roots' supply response: The output of multivariate regression analysis to determine factors influencing the inflow of roots to the starch factories is presented in Table 4.

The output in Table 4 revealed that the coefficients associated with yield (p = 0.0017), farming experience (p = 0.0046), farm size (p = 0.0001), commercialization (p = 0.0042), varieties planted (p = 0.0000), training intervention (p = 0.0011), factory gate price (p = 0.0145) and open market price (p = 0.0093) are statistically significant at less than 5% levels. The associated t-values: 11.06, 1.85, 4.18, 7.29, 10.91, 5.52, 1.95 and 2.43 respectively exceed the critical t-value read from the table as 1.660, thus confirming the significance of the eight variables. Of these significant variables farmer's yield, farming experience, farm size, commercialization, variety type, training and factory gate price returned positive signs meaning that cassava flow related positively to them. Only the open market price of roots had a negative sign showing that roots' flow decreased with increase in the variable. Table 4 reveals further that the remaining five variables level of education, credit support from processors, harvesting method, harvest season and road access were not significant as shown both by their p-value and the t-test at 95% level of confidence. Also, the regression coefficients associated with level of education (-0.0037), credit support (-7.6837), harvest method (-0.0058) and road access (-0.0052) were negative indicating a negative relationship with cassava root flow, thus this means that as these variables decrease the root flow increases.

For the significance of the model, the p-value (0.0002) of the ANOVA (Table 5) was less than 0.05 and the F-ratio (5.21) was greater than the critical value of F (2.2) at 5% error of probability at 13 and 47 degree of freedom, the null hypothesis was rejected and the authors concluded that the model was statistically significant.

The R-squared statistic indicates that the model as fitted explains 78.7% of the total variation in cassava roots' flow by the regression of root flow on the associated inputs. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables was 77.3% showing that the 13-variable model explained more than 70% of the variance of roots' flow. The Mean Absolute Error (MAE) of 3.13163 was the average value

Table 3: Cassava marketing challenges

Description	Frequency	Percentage	Ranking
High cost of transportation	95	98.9	1st
Small size of market	53	55.2	3rd
Distant of market to farms	30	31.3	4th
Low price of cassava roots	94	97.9	2nd

Source: Field survey data in 2012

Table 4: Factors affecting flow of cassava roots (n = 96)

Variable	Code	Expected sign	Estimate	Standard error	z-statistic	p-value
Constant	CON	-	4.11397**	1.55939	2.64	0.0113
Average yield	YLD	Positive	61825.6***	5591.07	11.06	0.0017
Farming experience	EXP	Positive	0.10263***	0.17693	1.85	0.0046
Level of education	EDU	Positive	-0.00369^{ns}	0.01227	-0.30	0.7648
Farm size	FMS	Positive	0.05225***	0.01249	4.18	0.0001
Commercialization	COM	Positive	5.80863***	0.797052	7.29	0.0042
Varieties planted	VAR	Positive	7.95113***	0.738623	10.91	0.0000
Training attended	TRA	Positive	5.93281***	1.07676	5.52	0.0011
Processors credit support	PCR	Positive	-7.68311^{ns}	0.65234	-0.3422	0.1166
Harvest method	HMT	Positive	-0.00578^{ns}	0.02778	-0.21	0.8361
Harvest season	HSE	Positive	0.00697^{ns}	0.01077	0.65	0.5208
Road access	RAC	Positive	-0.00521^{ns}	0.00776	-0.67	0.5058
Farm gate price	FGP	Positive	0.11215**	0.24765	1.95	0.0145
Open market price	OMP	Negative	-0.00527***	0.01227	2.43	0.0093

R-squared: 0.787, Adjusted R-squared: 0.773, D-W statistic: 1.73956 (p = 0.1056), ***Significant at 1%, **Significant at 5%, ns: Not significant, Source: Field survey data in 2012

Table 5: Analysis of variance

Source	Sum of squares	Df	Mean square	F-ratio	p-value
Model	2.93976	13	0.41997	5.21	0.0002
Residual	3.79071	47	0.08065		
Total (Correlation)	6.06860	60			

Df: Degree of freedom, Source: Field survey data in 2012

of the residuals. The p-value of Durbin-Watson statistics (0.1056) was greater than 0.05 indicating that there was no indication of serial autocorrelation in the residuals at 95% confidence level. This implies that the error terms are independently distributed across the observations and they are strictly random.

DISCUSSION

This investigation has found that the flow of cassava roots from the smallholder farm to the factory gate of the processor is positively related to yield. This finding is in conformity with the a priori expectation. Increase in yield is expected to result to increase in cassava produce/output for each farm and consequently impact positively on the farmer's supply to the processor. Findings of some previous studies confirmed this positive effect. For example, in the study of wheat, gram and tur in Madhya Pradesh, India, AERC[15] found that yield had a significant positive effect in the marketed surplus for wheat and tur. Its effect on gram was also positive although not significant. Elsewhere, Falola *et al.*[20] also revealed a postive association between output and volume of maize sold in a study conducted in Osun state, Nigeria while Adesiyan *et al.*[18] established a similar result in another study of cassava in Ile-Ife area also of Osun state.

The farming experience of the household head was also found to have a significant positive effect on cassava roots' flow to processors. The suppliers with more years of experience in cassava farming released more produce to the factories than those with less farming experience. This supports the a priori expectation and could have resulted from the fact that the older farmers, having worked with the factories for a relatively longer time had developed more confidence in the existing business relationship and would prefer to sell to the processors rather than take produce to the open market. Contrarily, the less experienced farmers were still more inclined to selling in the less organized open market for immediate cash gains. This corroborated previous findings in separate studies that years of experience had positive effect on commercialization of farm produce[19,21].

Each of farm size and the extent of commercialization had a significant positive effect on the flow of cassava roots to the processing plants. These conform with our initial expectations. Other things being equal, farmers with larger farms will harvest larger volume of cassava and have surplus to sell during the harvesting period. With large farm it will be more rational and cost effective for farmers to adopt best yield-boosting agronomic practices, like mechanization, application of fertilizer and use of herbicides. Consequently, such farmers tend to be more equipped to explore the numerous advantages associated with large-scale farming for commercial rather than subsistence purposes. Continuous use of these modern technologies will make the farmers more efficient and with the processors providing available market to mop up the roots, they will be more willing to sell higher portions of their output. The positive effect of farm size on marketed surplus is corroborated by Agwu *et al.*[21] in their study of aggregated crops, although Adesiyan *et al.*[18] found a negative relationship in another study.

This investigation also found variety type and exposure to training as equally having positive effects on roots' flow to starch processors. In the case of the former as farmers' orientation tends more towards the use of improved high yielding, early maturing and disease resisting varieties as against the local and quasi improved ones, they tend to have more roots to supply to processors. This is in line with our a priori prediction and can be linked to the positive effect of adoption of these improved varieties and associated management practices within the package on cassava yield and output. In the analysis of the marketed surplus of maize in Osun state, Falola *et al.*[20] also found that improved varieties of maize had positive effect on marketable surplus of maize farmers. For the latter, it showed that farmers who had had the opportunity of undergoing trainings or attending workshops on improved cassava production, farm management and marketing techniques, supplied more than farmers who did not. This is likely to follow from the direct effects of awareness creation through training and workshops on adoption of improved cassava varieties earlier reported in the area[30]. Elsewhere, the influences of education and training in promoting adoption of improved innovations had also been widely reported[31,32].

Also in line with our a priori prediction, the factory gate price of roots had a positive effect on roots flow to the factories. This is expected since it follows the direct rule of supply theory, which says that higher prices attract higher supply and vice versa. At the other end, the open market price of roots also produced an expected negative sign. As the price of roots become more attractive at the open market farmers respond by diverting their produce to the open market for

direct sale to buyers who are often the small-scale processors of different local cassava-based products, like gari, fufu, lafun, abacha and okpookpo gari among others. Other operators at the demand end of fresh roots in Nigeria are middlemen and women who assemble cassava from different farmers often for resale to other end-users of the product in the chain. These are business-minded individuals whose activities are usually induced by the profit margin on the trade and often will not wish to offer very attractive prices to the farmer. Except in urgent need of cash, the average farmer may prefer to sell directly to small-scale processors of cassava in the open market to selling to the middlemen and women.

The revelation from this study is that encouraging the use of improved varieties, higher yield and by extension output, targeting farmers with proven farming experience, large farm sizes and demonstrated will to commercialize, constant training and retraining of farmers and offering competitive factory gate prices are ways of increasing flow of roots to starch processing factories. The significant but negative effect of the open market price of roots implies that so long as the prices offered by these processing factories remained less attractive and competitive compared to what obtains at the open market, the latter would continue to be a major source of roots' leakage. The implication is that there is the risk of these factories being left to operate below capacity for a longer time.

CONCLUSION

The susceptible nature of cassava coupled with its bulkiness is a justification for the creating share value clustering model. Among other things, the findings from this baseline investigation have revealed that although the farmers enlisted into the IITA-Nestlé project had substantial level of experience, they were still achieving low productivity and had high propensity to refuse supply of roots to the starch factories at the prices offered by the processors. High cost of production, transport and logistics, lack of access/capacity to use fertilizer, shortage of labour and low capital base were identified among the challenges to production while distance to and small size of markets joined to high cost of transport were among the key marketing challenges. It was observed that the flow of roots was highly and positively responsive to changes in yield, extend of commercialization, varietal type and training. Other factors like farming experience, farm size and price of roots equally determined the quantity of roots farmers take to the market. The researchers observed that the identification and availability of high-yielding and disease-resistant varieties, use of herbicides and best farm management practices were fundamental to realizing the desired increases in productivity and profitability of the cassava farm enterprises in Nigeria.

Apart from intensifying efforts at creating adequate awareness of these realities, there was also need to encourage backward integration to ensure greater industrial utilization of cassava roots. Every stakeholder in the cassava value chain is expected to be an active player capable of assuming some level of responsibility in the development of the chain. The government, financial institutions, NGOs, donor agencies and other actors in the private sector should direct more efforts, including resources, at ensuring adequate provision and accessibility of basic agro inputs, including fertilizer, herbicides and microcredit because these are drivers to actualizing the purpose of the cassava value chain.

Among other things, this study found that the success of the value chain promotion initiative, which emphasizes clustering of cassava farmers and establishing out-growers' scheme around a commercial agro-processor with high capacity for roots' use, would depend to a large extent on the farmers' willingness and capacity to integrate into the scheme and play by the rules. To achieve this, the scheme should be structured in a way as to be able to close the existing gap between the processor's factory gate price and the open market price to remove the price inducement that drives the farmer to sell to the open market. There should be concerted efforts at offering competitive prices for farmers' roots. The commercial starch processors as big-time investors should show more commitment to the success of cassava value chain efforts through provision of certain incentives, like direct assistance to farmers in opening of lands, purchasing or leasing of tractors and subsidizing transport facilities especially during harvesting, so as to absolve aspects of the costs incurred by the farmers and curtail the tendency of these farmers to divert roots to alternative markets for immediate cash gains. With competitive price guaranteed or costs reduction assured, the ownership of the farms indirectly shifts to the processor thereby ensuring proper monitoring and direct control over the produce.

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