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Profitability of Cassava Production: Comparing the Actual and Potential Returns on Investment Among Smallholders in Southern Nigeria

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Abstract
An analysis was conducted of the productivity of smallholder farmers enrolled into an out-growers' scheme to supply cassava to commercial starch processors under the Nestlé-IITA cassava starch value chain project. Under the project, improved cassava varieties–cloned to be high-yielding, early maturing and disease-resistance–would be supplied to the farmers without charge. Also, to be provided would be training on good agronomic and farm management practices, like land preparation, soil management, stem-cutting habits, treatment of planting materials, fertilizer and herbicides quantity, time and method of application, and number, time and methods of weeding. It was envisaged that combined use of certified planting materials and good practices would substantially lead to increased yield and profitability. The actual performance based on baseline data was compared with the projected profitability under the project. The study was carried out using a sample of ninety-six farmers randomly selected from the eight states that participated in the project. Designed feedback form was used to assemble data on the farmers' characteristics, previous cassava production state of affairs, including yield, experiences, and constraints to farming and marketing, input acquisition and use, and output flow and prices. Data were analyzed using descriptive statistics, inferential statistics and budgetary techniques. Results revealed ₦277400 (about US$1,840) as the baseline gross revenue, but this could have risen by over 114% to ₦596000 (about US$3947), if farmers adopted the package of practices recommended under the project. The gross margin, calculated as ₦150536 (US$1003.57) could have increased by about 120% to ₦330536 (or US$2189). Also, the return on variable cost investment calculated as 0.33 under the prevailing farmers' practice could have risen to as high as 1.25, reflecting a return of ₦1.25 (rather than ₦0.33) on every ₦1 investment in the variable cost. Even though cassava production was a viable farm initiative, the farmers' adoption and complementary use the recommended package of practices would guarantee higher yield, profitability and return on investment.
Keywords: Cassava production, farm management, package of practices, profitability, smallholders, Nigeria.

1. Introduction

Cassava (*Manihot Esculenta* Crantz) is among the main vitality providers for many African citizens (Hahn, 1984). Empirical studies affirmed that "in the 1980s, after rice, maize, and sugarcane, cassava was the fourth most important dietary source of calories produced within the tropics and it probably still holds that position due to its great importance in the diet in Africa" (Cock, 2012). In Nigeria, apart from being a unique energy supplier, several other benefits of cassava come in the areas of delivering food security, job and employment, raw materials, foreign exchange, and boosting national income growth. In addition to the traditional food recipes, which include *garri*, *foo-foo*, *lafun*, and tapioca (Ezedinma et al., 2007) cassava can be processed into other products like dried chips and pellets, starch, glucose syrup, ethanol, high quality cassava flour (HQCF), and glue for industrial use. Through promoting vertical and horizontal integration among agro-based small businesses, cassava supports the overall growth and development of the Nigerian economy.

Nigeria leads the world in cassava production (FAO, 2017; Nnadozie, 2015; UNIDO, 2006). Going by the available FAO data (FAO, 2013), the country's production volume for 2015 was 57.64 million metric tonnes, representing 37.3% of Africa's or 20.8% of the world's total production for that year. However, literature evidence confirms that the increasing output is driven more by increases in land area cultivated rather than by yield growths (Ojiako et al., 2013). The national average yield of cassava was still very low at about 13.63 metric tons per hectare reflecting a shortfall of 65.9% away from the potential yield put at about 40.0 metric tons per hectare (FAO, 2017). *Thus, a significant positive step aimed at raising the actual yield close to the potential yield at both the smallholders' and national levels would be a giant stride. With increased yield and output, attention would shift to processing and value-addition, as well as creating sustainable marketing strategies that are also fundamental to maximizing the gains from the cassava industry in Nigeria. In relation to this,* the value chain promotion initiatives of the past decade, emphasized the use of farmers' clustering and out-growers' schemes to drive development of the Nigeria's cassava industry. This was considered important in an effort to ensure shift of emphasis from subsistence to commercial production and from "farming for food" to "farming for business".

The two pioneer companies that provided commercial cassava off-take market because of their involvement in cassava-based industrial starch processing in Nigeria were the MATNA Foods Company, Ogbese, Akure, Ondo State and the Nigeria Starch Mills (NSM) Limited, Uli, Ihiala, Anambra State. Each of the companies operated woefully below its installed capacity due mainly to acute shortage of raw materials. There became an urgent need for a stratagem to ensure constant inflow of cassava roots into these processing plants, to curtail the prevailing fissure. It was in that light that the Nestlé Nigeria Plc entered into a partnership with the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria to promote cassava value chain development. Nestlé Nigeria engages in the manufacturing, marketing, and distribution of beverages and other food products, including "maggi", an elite food-seasoning product. The company buys and utilizes cassava-based and maize-based starch worth over US$6 million annually for its operations and maintained policy of sourcing its raw materials from around their operational locations. IITA is a non-profit research for development (R4D) institution that had since its establishment in 1967 generated agricultural innovations, including improved cassava varieties and improved farm management practices. It also works in partnership with other development institutions (private, public, NGOs, non-profit and civil societies), national agricultural research systems (NARS), and extension services systems across sub-Saharan Africa, in its effort to improve livelihoods, enhance food and nutrition security, and create employment while preserving the natural resource integrity.

The partnership on cassava starch project between the two organisations, 2011-2015, aimed at supporting small-scale cassava farmers working in clusters under out-growers' schemes designed around MATNA Foods and the Nigerian Starch Mills starch processors. The strategy was for Nestlé Nigeria Plc to fund IITA to multiply and disseminate high-yielding cassava stem cuttings alongside best cassava farm management practices to enlisted farmers within the Nestlé catchment areas, using Nestlé's Creating Shared Value (CSV) approach. The idea was to boost yield and increase production volume at a competitive price to enable starch processors meet their cassava roots requirements and Nestlé's starch demands. Consequently, Nestlé Plc could conveniently source its raw materials locally, thereby creating income opportunities for farmers in line with its commitment to Africa.

IITA commenced the process of the project implementation by enlisting farmers and establishing clusters and facilitating formation and registration of farmers' groups in the rural cassava farming areas within 150 km around each of the two factories. The enlisted farmer were to be trained in the recommended agronomic and farm management practices. Demonstration farms were also to be established in each cluster to provide the platform for practical demonstration of the technologies and management practices. Throughout the project, IITA would provide adequate guidance, technical support and monitoring and supervisory services required to enhance the capacity of the enlisted farmers. The prediction of the project is that an average enlisted farmer that replicates the recommended cassava production technology and farm management practices should be able to achieve a minimum of at least 3 kg per cassava stand or 30 tonnes/hectare on his/her farm. Also under project IITA should conduct a baseline survey to determine the pre-project status of the farmers and the database on which the project impact would be assessed.

Based on the baseline data collected, the general objective of this paper is to analyse the profitability of cassava production among smallholder farmers supplying roots to the starch processors under the Nestlé-IITA Cassava Value Chain project in Nigeria. The specific objectives are: (a) to determine the farmers' gross margin; (b) analyse the returns on investment among the farms; and (c) compare the actual gross margin and returns on investment with the potential projected by the project. The results of findings is expected to assist the various stakeholders in decision making during the course of the project implementation. It will also guide the government, agriculture ministry, agencies, sponsors and implementers of cassava value chain programmes in directing their future activities in the industry.

2. Conceptual Framework and Literature Review

2.1 Conceptual framework.

Agricultural productivity is synonymous with farm resource productivity (Itam et al., 2014) and defined as the relationship between physical inputs and physical output (Block, 1994). In calculating agricultural productivity reference is made of inputs and the resultant output of a farm enterprise. For example, while Syverson (2011) explained productivity in terms of efficiency in production, OECD (2001) defined it as "a ratio of a volume measure of output to a volume measure of input use" while de Mey et al. (2011) viewed "productivity growth" as "output quantity change relative to input quantity change". Among other things, increasing the productivity of the farm helps to ensure availability of more food, poverty alleviation, more prospects for national growth and competitiveness in the agricultural market, income distribution and savings, and labour migration (Itam et al 2014). OECD (2001) outlined five main purposes of measuring productivity growth as to: trace technical change, identify changes in efficiency, identify real cost-savings in production, compare productivity measures for specific production processes so as to identify inefficiencies, and assess standards of living through labour productivity measurement.

There is an inextricable linkage between agricultural productivity and agricultural profitability (Itam et al. 2014). Obasi et al. (2016) regarded the two as related but distinct concepts often used when analysing several facets of a farm's performance to ascertain its state of health. Also, they reiterated the argument that more productive farm business is usually also more lucrative wth speedier productivity transforming into quicker profitability advancement (Ismam et al., 2011; Obasi et al. 2016). Profitability is influenced by the margins between costs and returns per unit of production and the number of units sold, meaning that it is closely tied to efficiency and scale (Itam et al. 2014). However, it is difficult to decompose variation in profitability into variation in productivity and efficiency because the relationship between productivity and profitability is not linear (Obasi et al., 2016).

In general, explaining the farm enterprise's performance involves a thorough understanding of the farm, the objectives set by its owner(s) and factors influencing the objectives (Kahan 2010). Measures of physical and financial performances of the farm enterprise are among the indicators of performance. The "physical indicators" relate to production outcomes or yields, physical inputs, productivity (yield per unit, and input per unit), and production efficiency that measures the relationships between yields and inputs. The "financial indicators" relate to profitability or earning capacity, liquidity (short-term financial stability), and solvency (long-term financial stability) of the farm enterprise (Wilson et al. 2005). Direct estimation of the physical units, like tonnes of maize, tonnes of cassava, etc., is an approach to capturing the output of agriculture or an agribusiness enterprise. Although theoretically sound, this approach is not always considered feasible because of the heterogeneous nature of agro-based activities (Machek and Špička, 2014; Block, 1994). Consequently, alternative approaches are used to capturing productivity, including computation of monetary values of the output (either as gross output or as value added, defined as the difference between the value of the production and the value of intermediate inputs); and the use of the final output measure, defined as the value of the gross output minus the value of the agricultural inputs (Machek and Špička, 2014).

2.2 Literature review.

Extensive work had been done at analysing the productivity and profitability of farm enterprises around the globe. Most productivity investigations analyzed efficiency using either of the nonparametric and parametric frontier models (Dharmasiri, 2012). The Data Envelopment Analysis (DEA) is an example of the nonparametric model commonly used in efficiency analysis (as in Chepng'etich et al., 2014 and Kelly et al., 2012). The parametric tools included the Stochastic Frontier Analysis (SFA) − with frontier production, cost and profit functions as examples (as in Ike and Inoni 2006; Bifarin et al., 2010; Enwerem and Ohajianya, 2013; Oguntari, 2010). The studies converge on their definition of a technically efficient farming enterprise as one located on the frontier while the inefficient enterprise is located away from the frontier (Chepng'etich et al. 2014; Okoruwa et al. 2009; Greene 2007; Coelli et al., 2002).

Most profitability studies focused on budgetary analysis, including evaluations of gross margin and returns on investments among farming enterprises of different value chains in different countries. For example, in an investigation of the potentials of wheat, barley and oat for grain yield carried out in Pakistan, Gurmani et al. (2006) found that wheat recorded the maximum grain yield and higher cost-benefit ratio while oat produced higher cost-benefit ratio for fodder production than wheat and barley. In China, Huang et al. (2013) sought to evaluate and compare the social, economic and ecological benefits of artificial transplanting rice (ATR), mechanical transplanting rice (MTR) and direct seeding rice (DSR) under wheat-rice double-late mode (late rice harvest and late wheat sowing) cropping patterns. The study established that MTR and DSR achieved obvious social benefits and that the cropping pattern of combining the wheat-rice double-late mode with the ATR was a better choice in mitigating and adapting to climate change. Also in Kenya, Katungi et al. (2011) examined the profitability of farmer-based common bean seed production and found it to be a profitable enterprise that was less sensitive to price fluctuations. However, compared with the certified common bean seed production, the study established that the net profit margins were five times higher for the latter, reflecting the effect of use of the certified seed on farmers' welfare. With the current varieties, profitability depends on access to irrigation and good agronomy.

In Nigeria, studies had also been carried out in different crops value chains in different states and agro-ecological zones. Some of the value chains and the focal states are plantain in Bayelsa and Anambra (Ayawari and Ugwumba, 2015; Olumba, 2014), yam in Osun State (Okeke, 2016), catfish farming in Anambra (Ugwumba and Chukwuji, 2010), cotton in Taraba (Alam et al., 2013), groundnut in Borno (Madaki et al., 2016), and commercial broiler production in Nasarawa (Mamman et al., 2016). All these studies reported profitability and positive returns on investment ranging from 0.12 on one-naira investment in commercial broiler production in Nasarawa State (Mamman et al., 2016) to 2.3 on one-naira investment in plantain production in Anambra State (Olumba, 2014).

On the cassava value chain, Daud et al. (2015) calculated the benefit-cost ratio of cassava production in Saki-west Local Government Area of Oyo State as 1.7, and concluded that cassava production in the area was highly profitable. They identified farm size and family labour as having significant positive influence on the farmer’s revenue. Toluwase and Abdu-raheem (2013) analyzed costs and returns on cassava production in Ekiti State, Nigeria and equally found cassava production to be profitable with a cost-benefit ratio of 1:2.19 reflecting a return of two naira nineteen kobo on every one-naira invested in the production of the crop. The study observed that the farmers used little or no insecticides and herbicides due to lack of capital, low incidence of diseases' and insects' attack on cassava farms. In Benue State, Nigeria, Odoemenem and Otanwa (2011) analyzed the economics of cassava production and found investing in the enterprise as a profitable venture. The study is one of the few that included the transportation as a variable cost of production, but unfortunately did not include the cost of planting materials and other post-planting farm maintenance activities. Itam et al. (2014) examined the determinants of cassava production and profitability in Akpabuyo Local Government Area of Cross River State, Nigeria. They found that while education and farming experience exerted more positive influence on cassava output, cassava cuttings and labour exerted more negative influence. In general, they concluded that cassava production was profitable, but recommended use of policies that were capable of enhancing farmers' output. Ogisi et al. (2013) studied productivity and profitability of cassava in Ika South and Ika North East Local Government Areas of Delta State, Nigeria. The authors calculated the cost-benefit ratio of 0.40 and concluded that the enterprise was viable.

Abila (2012) took investigated profitability of cassava farming from a different perspective by examining the effects of the use of various prevailing labour arrangements: family-hired-contract labour, family-hired labour, family-contract labour, and only family labour options on the profitability of cassava enterprises in Oyo North Area of Oyo State, Nigeria. He found that the returns on a one-naira variable cost investment was ₦3.04 when family-hired-contract option was used, ₦3.66 when family-hired labour option was used, ₦2.37 when family-contract labour option was used, and ₦2.61 when only family labour was engaged. The study while observing that combining family and hired labour yielded the highest marginal return per unit of man-day and one naira spent compared to other arrangements recommended the application of labour-saving technologies to reduce labour cost in cassava production. On their part, Muhammad-Lawal et al (2013) dwelled on processing and assessed the rates of returns on investment in four major processed cassava products, namely *garri*, *fufu*, *lafun* and starch, in Kwara State, Nigeria. The results revealed the rates of 30.88% for *garri*, 31.47% for *fufu*, 41.39% for *lafun* and 20.91% for starch and the authors concluded that lafun had the highest potential for income diversification i the study area.

It is worth mentioning that the list of studies presented here is very far from being exhaustible. Perhaps, with few exception (like Ebukiba, 2010), a common remarkable shortcoming of the majority of these studies on profitability of cassava production is underestimation of the production costs by exclusion of some pertinent, yet often-forgotten cost elements, which are included in the recommended package of practices (POPs). These include but are not limited to additional labour costs of: (a) resupply (gap-filling), (b) fire-tracing, (c) farm maintenance through regular slashing of weeds to keep the cassava farm neat at all times thereby minimize easy entry by rodents and other animals into the cassava farm. Of course, there is also the unavoidable cost transportation of inputs and output. In this study, efforts are made to incorporate as many cost elements as possible in order to obtain a benefit-cost ratio that is to a large extent conservative. Consequently, "transportation" and "miscellaneous cost" are included as cost titles for these extra expenses that are somewhat unavoidable and are included in the cassava production PoPs.

3. Research and Methods

3.1 Study area

The International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria implemented the cassava starch value chain project supported by Nestlé Nigeria Plc from 2011-2015. The project, which sought to build clusters of smallholder cassava farmers under out-growers' scheme around two major private sector-managed commercial starch processing factories, Matna Foods and Nigerian Starch Mills Limited, was implemented in eight cassava-farming states of Nigeria. Within the states the project locations were selected to fall within 150 kilometre radius around the processing centres the farmers supply cassava under the project. This study was conducted in all eight states that participated in the project. Five of the states were classified into the south-east project axis (SEPA) while three were in the south-west axis project axis (SWPA). The description of the study area is presented in Table 1.

Table 1. Description of study area

Project zone	State	Number of LGAs	Administrative headquarter (Capital city	GPS location		Land area (sq. km)	Population (million)+	% male	% female
				Latitude (°N)	Longitude (°E)				
SEPA	Abia	17	Umuahia	5.4167	7.5000	6,320	2,845,380	50.27	49.73
SEPA	Anambra	21	Awka	6.3333	7.0000	4,844	4,177,828	50.70	49.30
SEPA	Delta	25	Asaba	6.2000	6.7300	17,698	4,112,455	50.32	49.38
SEPA	Enugu	17	Enugu	6.5000	7.5000	7,161	3,267,837	48.84	51.16
SEPA	Imo	27	Owerri	5.4800	7.0300	5,100	3,927,563	50.32	49.68
SSPA	Ekiti	16	Ado-Ekiti	7.6200	5.2200	6,353	2,398,957	50.67	49.33
SSPA	Ondo	18	Akure	7.2500	5.1900	15,500	3,460,877	50.42	49.58
SSPA	Osun	30	Osogbo	7.7500	4.5610	9,251	3,416,959	50.75	49.25

+ Population figure is based on the 2006 National Population Census; SEPA=South-east project axis; SWPA=South-west project axis; LGAs=Local Government Areas

Among the common features of the study area is that like other southern states of Nigeria they have a minimum average annual rainfall ranges that exceed 1000 millimetres (Table 2). FEWS Net (2016) noted that the rainfall trends and patterns in southern Nigeria have not recorded much change over the last 35 years from 1981-2015.

Table 2: Average range of annual rainfall May-October in the project states, 1981-2015

State	Rainfall range (mm)				
	1,001-1200	1201-1400	1401-1600	1601-1800	Above 1800
Abia				√	√
Anambra			√	√	√
Ekiti	√	√			
Delta			√	√	√
Enugu		√	√	√	
Imo				√	√
Ondo	√	√			
Osun	√	√			

Another common feature of the states is that they have fertile lands that are good for the production of food and cash crops. Cassava, yams, maize, plantain and banana, cocoyam, and sweet potatoes are common food security crops produced in this area while palm produce, kolanuts, and cocoa are among the common cash crops. In addition, the states are endowed with other natural resources like rivers, lakes, coal, limestone, lead, zinc, fine sand, limestone and petroleum, which can be spotted moving from one state to another.

3.2 Sampling technique

The selection of 8 states was purposive being the states in which the IITA- Nestlé Nigeria Plc cassava value chain project was implemented. A multi-stage random sampling technique was used to select the sample among the cassava farmers from different clusters established under the project. A cluster was made up of 10-20 members and three clusters were selected from each state. Next stage was random selection of four farmers from each cluster to give a total of 96 farmers to whom the survey instrument were administered. Information gathered from the farmers on the average on-farm yield of cassava roots was confirmed by an on-farm yield sampling of 0.2% of each sampled farmer's cassava farm on a 4m x 5m ($20m^2$) spacing basis and the yield calculated for 1 hectare ($10,000m^2$).

3.3 Method of data collection

The study used primary data collected using pre-tested structured questionnaire. Data were collected on farmers' socio-economic characteristics, status of cassava production, quantity and cost of inputs, roots' flow, output quantity and price, and challenges to cassava production and marketing.

3.4 Methods of data analysis

Data were analysed using descriptive, inferential statistics and the budgetary techniques, including analysis of gross margin and profitability ratio (return-on-investment). Nandi et al. (2011) observed that the budgetary analyzes enable the estimation of the total costs as well as total revenue accrued to an enterprise within a specific production period.

3.4.1 Farm gross margin[1] and return on investment

Farm gross margins (GM) analysis is a straightforward method for comparing the performance of enterprises with similar requirements for capital and labour. The gross margin is calculated as follows:

$$GM = GR - TVC$$

where GM=gross margin; GR=gross revenue or gross income; and TVC=total variable cost.

$$TVC = TOC + TLC$$

where TOC=total operating cost; and TLC=total labour cost.

The total cost of production (TC) is defined as:

$$TC = TVC + TFC = TOC + TLC + TFC$$

where TFC=total fixed cost; and TVC, TOC and TLC are as previously defined.

The farm net margin (NM) and the return on investment (ROI) are calculated as:

$$NM = GM - TFC \text{ ; and}$$

$$ROI = \frac{NM}{TC}$$

where NM=net margin; ROI=return on investment; and GM, TFC and TC are as previously defined.

For this study, the basic elements of the gross margin (GM) were calculated using data on cassava yield, output, basic inputs, input and output prices, including cost of planting materials, quantity and value of fertilizer (NPK-15-15-15), quantity and price of chemicals, labour cost at different levels of operations, transport and logistics cost, miscellaneous costs etc. The processes for determining the enterprise revenue and costs of production and operations are further explained below.

3.4.2 Determining revenue

The gross revenue calculations were based on tonnes per hectare equivalent of cassava output of the farmers. The gross revenue (GM), also called gross income (GI) is calculated as the product of quantity (Q) and price (P). The unit of cassava sales in tonnes and factory prices for each tonne supplied by farmers were used. A second contributor to the gross revenue is sale of cassava stems. Sale of stems should be appropriately timed for realization of the maximum benefits from the source. However, it is typical of some farmers to argue that they find it difficult to realize the anticipated revenue from sale of stems for one or more of the following reasons: (a) most farmers start planting cassava within the same period of the year (planting season) and harvest almost during the same period making it impossible to get buyers for the stems since almost every farmer has surplus; (b) in most cases harvestings are carried out during the dry season when the price of roots is relatively high and there are higher chances of losing the stems to the dry/harsh weather; and (c) most farmers in their bid to abide by the standard best practice will insist on getting their planting materials direct from source (i.e. through institutions and agencies with the national/international mandate to develop and disseminate improved technologies, including planting materials), and thus may be less willing to recycle stems from other farmers. Notwithstanding the basis of these arguments, stem multiplication has remained a good business and reliable source of revenue for many farmers in the study area.

3.4.3 Determining expenses.

The reason why some farmers would deviate from the recommended practices is to avoid incurring additional cost. Each activity or operation in the recommended package of practices (PoPs) has its associated cost implication and the farmer’s failure to adopt the PoPs is simply explained as an attempt to avoid incurring additional costs in operations. The key cost elements include expenses on land acquisition and preparation, purchase of planting materials, fertilizers and herbicides, and procurement of labour services for treatment of planting materials, application of fertilizer, resupply, weeding/chemical application and rendering other complementary services as may be necessary. Others are transport and logistics cost, offsetting aspects of fixed cost of production, harvesting and post-harvest expenses**.** Also, farmers procure and use basic farming apparatuses like machetes, axes, spades, hoes, baskets and basins, however, as argued by Toluwase and Raheem (2013), it is possible to each of these kits for operations in different agribusiness enterprises and for several years, hence the additional to expenses may be somewhat insignificant and negligible.

3.4.3.1. ***Land preparation.*** This consists of the expenses on the mechanical operations of first ploughing, second ploughing/harrowing and ridging activities. Cost of land preparation was ₦10,000.00 (about US$66) for each operation amounting to ₦30,000.00 (about US$198) for the three operations.

3.4.3.2. ***Planting materials.*** The planting materials are stem cuttings from improved cultivars, cloned to be high-yielding, early maturing, and resilience to attacks from pests and diseases (Ojiako et al., 2016). These included the varieties TME 419, TMS (2) 1425, TMS 98/0505, TMS 98/0510, TMS 98/0581, TMS 98/0068, and TMS 30572, which were all developed and available at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Other improved cuttings include NR 930188 and NR 87184 that were cloned and provided by the National Roots' Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria. The yield potential of each of these varieties is above 20 t/ha while the starch potential exceeded 60% (Dixon et al., 2010). Whether for cassava starch or cassava flour production, the commercial processors of cassava lay emphasis on the starch content of roots; they usually measure starch content of roots supplied by farmers and make payments based on the starch content of roots. Sixty bundles of cassava stems, each containing 50 stems of length 1.0 m each is recommended for 1.0 ha of farm. It is always recommended that planting materials should be sourced from cassava plants of 10-12 months of age.

3.4.3.3. ***Treatment of planting materials.*** Expenses are incurred for the cutting and treatment of cassava stem (stakes) with available insecticides or fungicides at recommended rates. This operation involves measuring out the required quantity of the insecticide into a container, adding some water to the container, ensuring thorough mixing, and inserting the stakes into the solution, allowing to stay for about 10 minutes before removing.

3.4.3.4. ***Fertilizer and application***. Fertilizer application/treatment is recommended for two months after planting (MAP). Fertilizer recommendation should be usually based on the level of soil fertility. By implication, soil analysis is essential and form part of the recommended package of practices (POPs). Inorganic fertilizer can be applied at 4-8 bags of 50 kg each (i.e. 200-400 kg) per hectare. Farmers may or may not combine with organic fertilizer, such as compound manure. When combined additional expenses are incurred.

3.4.3.5. ***Weeds control/herbicides and application.*** Weeds control operation is essential to ensure optimal yield of cassava. Weeds can be controlled manually, but herbicides application is a less tedious form of weeds control. For a planted cassava field first weeds control operation starts from 3-4 months after planting (MAP). Pre-planting, pre-emergence, and post-emergence herbicide application are among the popular forms of weed control operations.

3.4.3.6. ***Labour cost.*** Almost all operations involve use of labour and consequently attract labour cost. This, alongside the continually fees for man-day's work, partly explains why labour expenses contribute a large proportion to the total cost of cassava production in Nigeria (Ettah and Angba, 2016; Nandi et al., 2011; Yusuf et. al., 2014)

3.4.3.7. ***Transport and logistics cost.*** **T**ransportation is a very big challenge to cassava farming and promotion of cassava value chain in Nigeria. Inaccessible road, high cost of vehicle spare parts and maintenance, instability in price of fuel (petrol/diesel), government revenue collectors, tariffs imposed by National Union of Road Transport Workers (NURTW), among others are some of the reasons responsible for high cost of transportation.

3.4.3.8. ***Harvesting (including packing) and post-harvest expenses***. Included in this are the harvesting labour, harvesting equipment costs, and packaging materials, labour for packaging and cooling or storage expenses. Harvesting and packaging costs can be calculated on per packaging unit basis, then multiplied by the number of units per hectare.

3.4.3.9. ***Fixed cost.*** Costs of basic implements like cutlass, hoes, cutlasses, knives, baskets and basins are considered infinitesimal since once purchased they are used for long period of time and for different purposes.

3.4.3.10. ***Others/miscellaneous expenses***. Included here are the additional labour costs incurred for farm supervision, resupply of planting materials (gap-filling), fire-tracing, intermittent supplemental weeding/slashing of farm and expenses for supervision and general farm maintenance.

5. Results and Discussion

5.1. Characteristics of the enlisted farmers.

The summary of information on the enlisted cassava growers' characteristics is in Table 3.

Table 3. Summary of information on farmers' socio-economic characteristics

Characteristic	Measurement	Descriptive
Oldness	Years	Growers' mean age is 48.06 years with 22-75 years ranges;
Sex category	Dummy (1=women, 0=men)	Men (77.08%), women (22.92%);
Area planted	Hectares	Mean size of farm holding is 3.15 ha ranging from 0.2-20 ha.
Degree of farming involvement	Years	Mean years of growers' involvement in farming 15.87 years with over one-half getting involved for at least 14 years.
Schooling profile	Ordinal scale (0=no education; 1=Primary education; 2=Secondary education; 3=Tertiary education	Over 93.75% had at least a primary education considered as the basic of education in Nigeria
Exposure to skill acquisition/training	Dummy (0=not exposed, 1=exposed)	Only 28.1% confirmed they were exposed to farm management skill acquisition/training.
Number residence in household	Number	The mean number of persons residence in the farmers' households were 7 persons
Connubial position	Dummy (0=not ever married; 1=in marriage or once married)	Farmer that confirmed to have ever married constitutes 88.52%.
Time devoted to farming	Dummy (0=Part-time; 1=Full time)	Only 32.29% were into fulltime farming while the rest 67.71% confirmed being actively involved in other occupations and means of livelihoods.
Improved varieties use status	Dummy (0=Not only improved is used; 1=only improved)	Only 20.8% of farmers confirmed to have used only the improved cassava varieties
Fertilizer use status	Dummy (0=Not used; 1=used)	Majority 54.2% confirmed that they used some dosage of fertilizer.
Processor credit support	Dummy (0=credit support not received; 1=received)	Only 6.2% revealed they received and used credit support from the cassava processor
Accessibility of road network	Dummy	Majority (67.7%) reported the problem of poor road network and bad terrain
Harvesting technique	Dummy	Manual harvesting predominated at 97%.

Source. Compiled using information from Field Survey

Apart from the factors examined in Table 3, the fertilizer application by the farmers averaged 2.3 bags (or 115 kg) per hectare representing only 58% of the recommended minimum quantity of 4 bags. The quantities applied ranged from 0-8 bags (or 0-400 kg). The mean farmers' expenses on fertilizer was ₦7,152 while the mean expenses on improved stems and herbicides were ₦21,000 and ₦6,360 respectively.

5.2. Stem sources.

The breakdown of respondents by their responses to the enquiry on source of the planting materials they planted on their farms is presented in Table 4.

Table 4. Farmers' sources of planting materials

Source description	No. of farmers	Percentage	Cumulative percentage
Agricultural Development Programme (ADP)	30	31.25	31.25
Research institutes, including IITA	25	26.04	57.29
Other farmers and friends	5	5.21	62.50
Own farm and open market	36	37.50	100.00
Total	96	100.00	

Source. Compiled using information from Field Survey

The proportion of the respondents that obtained their planting materials through friends and other farmers was minimal at 5.2% compared to 85.5% observed by Nandi et al. (2011) in their study in Obubra area of Cross River State, Nigeria. The study also found that 21.7% of farmers received information from government agencies, but this study has found that 31.3% obtained planting materials through the ADP, which is a government supported programme. Also in Benue State, Odoemenem and Otanwa (2011) found that majority of the cassava farmers did not have access to inputs from government agents with only 8.62% obtaining planting materials, 13.80% herbicides and 10.34% fertilizer.

5.3 Cropping patterns.

The respondents were requested to respond to the question relating to whether or not they intercropped cassava with other crops on their farms. The summary of the responses obtained in each of the 8 states is presented in Table 6.

Table 6. Cropping pattern of respondents.

State	Percentage of respondents		
	Intercropped (%)	Not intercropped (%)	No response (%)
Ekiti	33.33	66.67	
Ondo	33.33	66.67	
Osun	0.00	100.00	
Abia	50.00	41.67	8.33
Anambra	75.00	25.00	
Delta	25.00	58.33	16.67
Enugu	33.33	66.67	
Imo	16.67	83.33	
Total (all respondents)	33.33	63.54	3.13

Source. Compiled using information from Field Survey

It reveals that 33% of respondents intercropped cassava with other crops. Intercropping is a common farming system in the southern area of Nigeria. Another previous study of cassava farmers in Saki, in the Oyo north area of Oyo State, Nigeria revealed that 93.4% of the cassava farmers in the study area adopted multiple cropping systems while the remaining 6.6% adopted sole cropping system (Daud et al., 2015). The percentage of farmers that practiced mixed cropping is very high compared with the 33% revealed by the current study. Although most cassava value chain development projects had discouraged intercropping of cassava, it has been very difficult to obtain farmers' cooperation in this regard. In this study, only data that related to cassava plant were collected and analyzed, as though cassava was planted as a sole crop by the farmers.

5.4. Productivity of the farmer enterprises.

The sample mean yield was computed as 12.3 t/ha. Compared with the minimum 30.0 t/ha being targeted, a yield shortfall to the tune of 17.7 t/ha prevailed. However, the computed sample mean was slightly higher than the national average reported elsewhere as 10.2 tonnes/ha from 1961-2008 (Ojiako et al. 2014). This slight difference might have resulted from some of the farmers' use of improved varieties as confirmed by 20.8% of the sample. Notwithstanding, it is expected that adoption and complementary use of the recommended POPs would lead to increased yield and higher return on investment for cassava farmers under the project.

5.5. Profitability of the farm enterprises.

The profitability discussions are based on the calculation of the gross margin and the return on investment (benefit/cost ratio) using the actual baseline data collected during the survey. Also, acknowledging that the farmers were not fully applying the recommended package of practices being promoted by the project thereby returning low yield, a comparative analysis of the actual and potential profitability if the farmers were using the recommended (best farm management) package of practices and adopting the. The results of calculations are presented in Table 7.

Table 7. Actual and potential profitability of cassava farming enterprises

Description		Unit	Measure	Unit price (Naira)	Actual (farmers' practice , 12.3 t/ha) (Naira)	Potential under "Best practice" (30 t/ha) (Naira)
Revenue (GR): (a) Sale of roots	A1		Tonnes	18000	221,400	540,000
(b) Sale of stems	A2	160	bundles	350	56,000	56,000
Gross Revenue	**A*=(A1+A2)**				277,400	596,000
Operating Costs: Land preparation (3 key activities)*		3	number	10000	30,000	30,000
Fertilizer		2	bags	3576	7,152	
		4	bags	3576		14,304
Stem cuttings		60	bundles	350	21,000	21,000
Herbicide		5	litres	1272	6,360	6,360
Total Operating Cost	B				64,512	71,664
Labour Costs: (a) Planting		9	man-days	1200	10,800	10,800
(b) Resupply (gap-filling)		5	man-days	1200	-	6,000
(c) Fertilizer application		8	man-days	1500	12,000	12,000
(d) Herbicide spraying		2	man-days	2000	4,000	4,000
(e) First weeding		10	man-days	1500	15,000	15,000
(f) Second weeding		10	man-days	1500	15,000	15,000
(g) Supplementary weeding		10	man-days	1500	15,000	15,000
(h) Harvesting and processing of stems		5	man-days	2000	10,000	10,000
(i) Harvesting of roots		13	man-days	2000	26,000	26,000
(j) Miscellaneous expenses		1	lump sum	50,000		50,000
Logistics/Transportation		1	lump sum	30,000	30,000	30,000
Total labour, transportation/logistics cost	**C**				143,800	193,800
Total variable Cost (TVC)	D (= B+C)				208,312	265,464
Gross margin (GM=GR–TVC)	E (= A*-D)				69,088	330,536
Fixed cost: (a) Depreciation		1	lump sum	2500	2,500	2,500
(b) Land renting		1	lump sum	5000	5,000	5,000
Total Fixed Cost (TFC)	F				7,500	7,500
Total Cost (TC=TVC + TFC)	G (=D+F)				209,812	272,964
Net Margin (NM=GM –TFC)	H (= E-F)				67,588	323,036
Return on variable cost (R0I1=GM/TVC)	**K (=E/D)**				0.33	1.25
Return to total cost (ROI2=NM/TC)	**J (= H/G)**				0.29	1.18

*Activities are 1 bag of 50 kg fertilizer (NPK 15-15-15); exchange rate of Naira to the dollar at the time of study is ₦151/US1; miscellaneous expenses include labour for fire-tracing, farm cleaning/maintenance, supervision)
Source: Source. Compiled using information from Field Survey

5.5. Analysis of gross revenue.

The farmer's gross revenue was calculated as ₦277, 400 (about US$1,840). The revenues resulted from sale of roots (79.8%) and sale of stems (20.2%) as presented in (Table 6). Farmers sold cassava stems to the tune of 160 bundles, which is about 67% of the total harvested stem bundles estimated at 240 bundles/ha. The unsold 33%% were either recycled by farmers as planting materials for another planting season, given out as gifts to friends or lost due to shortage of demand or harsh weather.

Table 6. Contribution of roots and stems to gross revenue

Source of revenue	Contribution to revenue (%)
Sale of roots	79.81
Sale of stems	20.19

Source: Calculated using Field Survey Data, 2011

The gross revenue reported by this study is very close to the revenue of ₦299, 250 (US$1,980) reported by elsewhere by Ebukiba (2010). That study also reported the contribution of stems to gross revenue as 12.0%, which is less than the 20.2% from this investigation.

5.6. Costs analysis.

The percentage contribution of the different cost components to the TVC and TC is presented in Table 7.

Table 7. Cost breakdown by components

Description	Contribution to variable cost (%)	Contribution to total cost (%)		
Land preparation (Clearing, ploughing, harrowing/ridging)	14.83	14.34		
Fertilizer	3.54	3.41		
Stem cuttings	10.38	10.01		
Herbicide	3.14	3.03		
Total Operating Cost			30.75	
Labor, transportation/logistics cost (excluding harvesting)	50.32	48.52		
Harvesting expenses	17.79	17.16		
Total labour, transport/logistics (including harvesting)			65.68	
Total variable Cost (TVC)				96.43
Fixed cost				3.57

Source: Calculated using Field Survey Data

The actual average TVC of cassava farming to farmers is ₦208,312 (about US$1,379). It consists of the total operating cost of ₦64,512 (or US$427) and the total expenses on procuring the different services of labour, transportation and logistics of ₦137,800 (or US$912). The TVC accounted for 96.4% of the TC while the fixed cost accounted for the remaining 3.6%. The share of labour expenses, excluding harvesting labour, in the TVC was 50.3% while labour expenses for harvesting of roots and cutting and processing of stems for sale accounted for 17.8% to the TVC. Other contributors to the TVC were land preparation (14.8%), fertilizer (3.5%), stem cuttings (10.4%) and purchase of herbicides (3.1%). In a similar study in Cross River State, Nigeria, Ettah and Angba (2016) gave the cost breakdown of TVC components to include expenses on cassava cuttings (12.8%), land (8.98%), labour (48.45%), fertilizers (7.40) pesticides (5.58%), and herbicides (11.9%). Both studies agreed that labour was the highest contributor to the TVC of cassava production in Nigeria.

The contribution of the total expenses on labour, transport and logistics to the TC is 65.7% as against 30.7% attributed to the operating expenses. Nandi et al. (2011) found that labor accounted for about 65.2% of the total production cost of cassava in Obubra area of Cross River State, Nigeria. Also, Table 7 gives the contributions to TC of land preparation activities, planting materials, and purchase of fertilizer and agro-chemicals as 14%, 10%, 45 and 3% respectively.

5.7. Gross margin and net margin.

The gross margin is presented in Table 5 as ₦75, 088 (or US$501). After accommodating the TFC, the resultant net margin is given as ₦67, 588 (US$444). This is slightly higher than the gross margin of N61, 901 (US$410) reported by Ogisi et al. (2013) in their study of cassava farming in Ika area of Delta State, Nigeria. However, Ebukiba (2010) found a gross margin that was twice as large (₦141,950 or US$940) in her economic analysis of cassava farming in Akwa Ibom State, Nigeria while Daud et al. (2015) reported a higher GM of ₦162,487.07 (or US1,076) in another study carried out in Oyo north area, Nigeria.

5.8. Returns on investment.

The benefit-cost ratio was calculated and reported in Table 5 as 0.37 on variable cost and 0.32 on total cost investment. This implies that for every one naira invested on the variable cost the farmer returned ₦0.37. The farming enterprise is profitable, but with a low margin, which was partly as a result of the high cost of labour, transportation and logistics. This finding corroborates similar finding by Ettah and Nweze (2016) who stated that the profitability index for every naira invested was 0.30 for the non-adopters of improved cassava production business and 0.50 for the adopters. Nevertheless, many other studies had reported different profitability indexes (for example, Zaknayiba et al., 2014; Ogisi et al., 2013; Toluwase and Abdu-raheem, 2013; Nandi et al., 2011; Odoemenem and Otanwa, 2011; Ebukiba, 2010). These results should not be surprising given that most of the studies were conducted in different parts of Nigeria under different circumstances, which could have partly accounted for the variations in the findings. While acknowledging the major findings from this study, it should be noted that there is a great potential for higher gross margin and returns on investment in cassava production with the adoption of the recommended package of practices as demonstrated in the following section.

5.9 Profitability estimations using the package of practices.

The gross margin and benefit-cost ratio was calculated for farmers under the recommended package of practices (Table 8). The basic difference is that average yield is predicted to increase to as much a 30 t/ha, that is conservative estimate of 3 kg per stand and 10,000 stands per hectare. This is achievable using 1 m x 1 m plant spacing with appropriate gap-filling and adopting good farm management attitude. The yield will definitely exceed 30 t/ha with a more plant population density (for example using 0.8 m x 1 m spacing) backed up by good agronomic practices. Another area of difference is the provision for additional (miscellaneous) cost for labour expenses for gap-filling, fire-tracing, farm cleaning, maintenance and supervision. Of course, also, the quantity of fertilizer is estimated at the minimum recommended 4 bags as against the average of 2 bags applied by the farmers.

Consequently, the gross revenue could rise by more than 114% from ₦277400.00 (about US$1840) to ₦596000 (about US$3947) while the associated TVC increased by mere 27.4% from ₦208312 (or US$1,379) to ₦265464 (or US$1,758). The difference in TVC was accounted for by the additional cost of labour for gap-filling, fire tracing, and the general supervision of the farm. In addition, there was the difference of two additional bags of fertilizer for ₦7152 (US$47.61) to make up the minimum 4 bags/ha recommended for the farmer's use. The effect is that the gross margin increased by 378% from ₦69088 (about US$457.54) to ₦330536 (or US$2189). The calculated return benefit-cost ratio on investment was 1.25 (on variable cost) and 1.18 (on total cost). This implies that every ₦1.00 invested in the variable cost would return ₦1.25, implying that the farm enterprise is highly profitable. This is a significant improvement over the condition under the farmers' practice where each ₦1.00 invested only returned ₦0.33 (or 33 kobo). Therefore it is more rational for the farmer to adopt the best practice to reap the economic benefits associated with it.

6. Conclusion

This study analyzed the gross margin and the returns on investment for small-scale cassava growers linked with the Nestlé-IITA cassava starch value chain project, and consequently compared the outcomes with the potential performance being predicted for the registered farmers. The results show that there is a yawning gap in profitability and returns on investment between the actual and potential for the cassava enterprises. Ultimately, this gap needs to be closed as a key step towards realization of the full benefits of self-sufficiency and economic sustainability through investment in the value chain. While price instability remains an unresolved issue due to the uniqueness of the cassava crop, inability of farmers to achieve optimal yields is the major contributor to poor performance of the cassava industry. Aside from being very susceptible, the enterprise is also becoming capital intensive, with continuously-increasing cost of production necessitated by the general inflationary trend in the economy. The farmers should be guided through the adoption and use of the recommended package of practices to promote yield and increase return on investment. Arguably, the application of the package would lead to a slight increase in the production cost, but the marginal gain more than compensates for the additional investment.

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Notes.

[1] Odoemena and Otanwa (2011) outlined some benefits of use of gross margin analysis to include: helping to determine the net farm income; serving as a budgeting tool for comparing the profitably of different farm enterprises; being highly applicable to subsistence system of farming involving small fixed capital component; being easy to compute and interpret; and serving as a guide for selecting enterprises by comprising their margins.