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Exploring the potential of cassava in promoting agricultural growth in Nigeria

Sanzidur Rahman *, Brodrick O. Awerije

School of Geography, Earth and Environmental Sciences, University of Plymouth, Drake Circus, Plymouth, United Kingdom

Abstract

Cassava is one of the major food crops in Nigeria, with multiple uses from human consumption to industrial applications. This study explores the potential of cassava in Nigerian agriculture based on a review of cassava development policies; performs a trend analysis of the cultivation area, production, productivity, and real price of cassava and other competing crops for the period 1961–2013; identifies the sources of growth in production; and examines the production constraints at the local level based on a survey of 315 farmers/processors and 105 marketers from Delta State. The results revealed that several policies and programmes were implemented to develop the cassava sector with mixed outcomes. Although cassava productivity grew at 1.5 % per annum (p.a.) during the post-structural adjustment programme period (1993–2013), its real price declined at a rate of 3.5 % p.a. The effect of yield is the main source of growth in production, contributing 76.4 % of the total growth followed by the area effect (28.2 %). The cassava sector is constrained by inadequate market infrastructure, processing facilities, and lack of information and unstable prices at the local level. The widespread diffusion of improved tropical manioc selection technologies and investments in market and marketing infrastructure, processing technologies, irrigation/water provision and information dissemination are recommended to enhance the potential of the cassava sector to support agricultural growth in Nigeria.

Keywords: cassava sector, constraints on cassava, Nigeria, sources of growth decomposition, trend analysis

1 Introduction

Although Nigeria is an oil-rich economy, agriculture remains an important economic sector that serves as a major source of raw materials, food and foreign exchange, and it employs over 70 % of the labour force (Liverpool-Tasie *et al.*, 2011). Cassava is an important crop that has great potential to support agricultural growth in Nigeria due to its wide range of uses from human consumption to industrial applications (CMP, 2006). Africa produces 40–50 % of the global cassava output (FAO, 2005; Nang'ayo *et al.*, 2007), and Nigeria is one of the leading producers (Nweke, 2004; Knipscheer *et al.*, 2007; Ayoade & Adeola, 2009). Demand for cassava derivatives, such as starch, gari (a type of processed cassava), tapioca, etc., have doubled over the last two decades (Nweke, 2004), and in recent years, the establishment of the Cassava Bread Development Fund (CBDF) and the Cassava Transformation Project by the Nigerian government have further raised hopes for improving the cassava sector (Natsa, 2014).

However, the current cassava yield is only 12.3 t ha^{-1}, whereas the potential yield is 28.0 t ha^{-1} (Nkonya *et al.*, 2010), and the yield of improved varieties at research stations range from 13–40 t ha^{-1} (Eke-okoro & Njoku, 2012). Furthermore, the results of the trends in production of cassava and other major competing crops in Nigeria are mixed. For example, both Nweke (2004) and Echebiri & Edaba (2008) noted that cassava production in Nigeria has increased substantially since the 1990s (i.e., 1986–2003), and they emphasized that cassava

* Corresponding author
School of Geography, Earth and Environmental Sciences, University of Plymouth, Drake Circus, Plymouth, PL4 8AA, United Kingdom; Email: srahman@plymouth.ac.uk
Phone: +44-1752-585911; Fax: +44-1752-584710

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should be given priority because of its high starch content, which provides a greater proportion of energy to low income households than any of the other food crops in Africa. Liverpool-Tasie *et al.* (2011) noted that the production of millet, yam, maize and rice were stagnant or declining while cassava saw a modest increase during the period from 1994–2006 and claimed that food crop production in Nigeria is far below its potential with demand outstripping domestic supply. In contrast, Ojiako *et al.* (2007), examining production trends of cassava, sweet potato, yam, cocoyam and ginger in Nigeria for the period of 1961–2005, noted that the output of all crops increased substantially during the Structural Adjustment Program (SAP) period (1986–1998); cassava experienced its lowest growth rate, and the rate of the growth of production declined for all crops during the post-SAP period (1999–2005).

Given the contrasting evidence presented above, an accurate systematic analysis of the cassava sector in Nigeria covering a wide range of issues does not currently exist (e.g., cassava development programmes and their outcomes; trends in cultivation area, production, productivity, and prices of cassava and other major crops over a long period of time; sources of the growth in production; constraints of the cassava sector). All of the aforementioned studies analysed only one or a few of the issues outlined above, and none considered trends in the real prices of these crops, which could be a major incentive for farmers to improve productivity. Furthermore, none of the existing research has attempted to decompose and explain the sources of the observed growth in the production of major crops. On methodological grounds, all of these studies ignored the cyclical nature of time-series data (e.g., Gupta *et al.*, 2009) and instead fitted growth regressions to the actual annual production, area and/or yield data. If there is a high level of annual fluctuation in the time-series, which is actually the case, the result could be inaccurate growth rate estimates, as seen from the figures presented in Nweke (2004), Echebiri & Edaba (2008), Ojiako *et al.* (2007), and Liverpool-Tasie *et al.* (2011).

In this study, we aim to overcome the aforementioned shortcomings and present a systematic analysis of the cassava sector including the constraints faced at the local level by the cassava farmers/processors and marketers, which will be a valuable source of information for policy makers, academics, development agencies and other key stakeholders, because there is great potential to develop the cassava sector to support agricultural growth in Nigeria. For example, cassava production is expected to double and reach 76 million t by 2020 (CMP, 2006). Eke-okoro & Njoku (2012) noted that 33 improved varieties of cassava, which are high yielding/early maturing/pest and disease resistant and whose mean yields range from 13–40 t/ha, were released by 2010 through collaborations between the International Institute of Tropical Agriculture (IITA) and the National Root Crops Research Institute (NRCRI). Similarly, Nweke (2004) noted that cassava is a powerful tool to fight poverty in Africa, but enhancing this role faces numerous challenges.

Given this backdrop, the specific objectives of this study are to (a) conduct a review of the various cassava development policies and programmes undertaken in Nigeria from 1961–2013; (b) examine the trends in the area, production, productivity and real prices of cassava and four major, competing crops (i.e., groundnut, maize, millet and sorghum), the government outlay for agriculture and the share of agriculture in Nigeria's national income in Nigeria over a 52-year-period (1961–2013) separated into pre-SAP, SAP and post-SAP stages; (c) identify the sources of the growth in the production of cassava and other crops (i.e., yam, cocoyam, sweet potato, potato, and ginger); and (d) identify the constraints faced by the farmers, processors and marketers of cassava and its products at the grassroots level based on an in-depth farm level survey conducted in 2008 in three regions of Delta State, Nigeria, a major cassava growing area.

The paper is organised as follows: Section 2 presents a review of the agricultural and cassava development policies and programmes in Nigeria; Section 3 presents the methodology, including a description of the data; Section 4 presents the results, and Section 5 discusses the results, provides conclusions and outlines policy implications.

2 A brief on the agricultural policy developments in Nigeria

The importance of agricultural policy in boosting food production and accelerating agricultural development cannot be over emphasised (OECD, 2010; Olowu, 2011; Akpan, 2012). However, the observation of declining gross receipts for farmers from 28 % in 2005 to 23 % in 2009, which arose from agricultural policy support in the OECD countries, drove developing economies to discourage agricultural growth (Walkenhorst, 2007; Awoyinka, 2009; OECD, 2010). Adubi & Okunmadewa (1999), Okoh & Dominic (2004), and Nweke (2004) traced agricultural policy and programme imple-

mentation as a product of both pre- and post-colonial administrations and concluded that Nigerian agricultural policy evolved in overlapping phases that were not explicitly delineated but could be inferred from the various programmes that were implemented. However, Ugwu & Kanu (2012) noted that agricultural policies in Nigeria followed a series of strategies: (a) an 'exploitative strategy' during the 1950s that mainly taxed farmers producing export crops, such as cocoa, groundnut, palm and cotton; (b) an 'agricultural project strategy' until 1968 that aimed to develop backward and forward linkages in the sector, including the establishment of agricultural extension and research institutions; (c) a 'direct production strategy' during the early 1970s that primarily deepened government intervention and investment in agriculture; and (d) an 'integrated rural development strategy' from the mid-1970s onward that realised agriculture to be a part of the overall rural sector and that embarked on multipurpose development schemes and the establishment of a number of implementing institutions. Ugwu & Kanu (2012) also identified phases of 'minimum government intervention' (1960–1969), 'maximum government intervention' (1970–1985), 'SAP and post-SAP periods' (1986–1998), and the 'new millennium agricultural policies' (1999–2009) and concluded that the effects of all of these economic reforms on the agricultural sector have been minimal and unsatisfactory due to instability, inconsistency, and a lack of transparency and coordination of the policies.

2.1 Development of cassava in Nigeria

Cassava development in Nigeria is an outcome of several activities undertaken through government policies, research institutions, agricultural development agencies, donors and non-governmental organisations. Eke-okoro & Njoku (2012) divided cassava development into four stages: the incipient cassava development period (1940–1953); the medieval cassava development period (1954–1967); the national and international collaboration of cassava development period (1970–2010); and an overlapping pre-emptive Cassava Mosaic Disease (CMD) cassava development period (1995 to date). Within the incipient cassava development period, the first cassava hybrid, called the Gold Coast Hybrid, was developed in 1942 and generated a mean yield of 8.9 t ha^{-1}. It was followed by another, called Oloronto, in 1953 with a mean yield of 13.6 t ha^{-1} (Eke-okoro & Njoku, 2012). During the medieval period (1954–1967), three crosses of these aforementioned varieties were released with mean yields of 15.0–16.4 t ha^{-1}. However, during the 1970s, research was focused on developing disease-resistant varieties due to the severe cassava bacterial blight (CBB) crisis, and the IITA released a number of Tropical Manioc Selection (TMS) varieties during this period, which are disease resistant and high-yielding (Akoroda *et al.*, 1985, cited in Eke-okoro & Njoku, 2012; Nweke, 2004). During the pre-emptive-CMD cassava development period, the thrust was on improving productivity as well as disease resistance when five new TMS varieties were released, each of which contained high levels of starch and were characterised by a very high average yield of 35–40 t ha^{-1}; they were developed jointly by the IITA and the NRCRI (Eke-okoro & Njoku, 2012). Similarly, Nweke (2004) classified the development of cassava into four distinct periods: mechanisation of the cassava grater (1961–71); development and release of the TMS varieties (1972–1983); diffusion of the TMS varieties (1984–1992); and hand harvesting of the high-yielding TMS varieties (1993–2001).

Cassava received continued policy support from the government from as early as 1975 onward, which has led to diversified uses. The Presidential Initiative on Cassava, launched in 2003 and continued for five years, aimed at increasing cassava production to meet domestic demand and export, and it focused its activities on the development of production, processing, and the marketing of the processed products (IITA, 2009 cited in Asante-Pok, 2013; CMP, 2006). The Cassava Transformation Project/Agenda (2011–2015), which had a tentative budget of Naira 4 billion for four years, was launched in 2011 with the goal of doubling average cassava productivity from 12.5 t ha^{-1} to 25.0 t ha^{-1}, raising the incomes of 1.8 million farmers by USD 450 per year, generating 1 million jobs per year in rural areas, and strengthening value chains and market institutions by involving the private sector (CTA, 2011). The government also initiated the Cassava Bread Development Fund with an investment of Naira 10 billion during 2013, and it aimed to substitute wheat flour with cassava flour, which in turn is expected to save billions of Naira by reducing the importation of wheat flour (Natsa, 2014). The government also launched the three-year Cassava Mechanisation and Agro-processing Project (CAMAP) in late 2012 as the pilot of a major public-private partnership initiative aimed at enhancing the contribution of cassava production and processing technologies by upgrading and expanding traditional planting, harvesting and processing techniques (AATF, 2012). The government also initiated a Presidential Committee on Cassava for Export Promotion in 2004 to ensure increased production, processing, packaging and export of cassava and cassava products to satisfy both domestic and export markets (Asante-Pok, 2013).

At various times, all of these drives to improve the cassava sector also had the financial backing of the FAO, USAID, GTZ, UNDP, IFAD, IITA and other donors (Nweke, 2004; Eke-okoro & Njoku, 2012; Asante-Pok, 2013). Additionally, the dissemination of information on cassava to the grassroots level was promoted through the production of various research manuals, extension guidebooks and targeted farmer trainings that have mainly been provided by IITA and NRCRI over the past four decades.

3 Methodology

3.1 Data sources

The primary data used for this study were drawn from three regions of Delta State, Nigeria, which is situated in the southern (Niger Delta) part of the country: the North, Central and South Delta regions, which have different agro-ecological characteristics. The major foods grown in Delta State are cassava (leading producer), yam, plantain, maize, and vegetables (MANR, 2006). Delta state was selected as the case study area for this research because it has the ideal climatic and soil conditions for the cultivation of cassava, which is a very important staple crop for the state.

Farm sampling was based on the cell structure developed by the Agricultural Developmental Programme. First, nine local government areas (LGAs) of a total of 25 LGAs in the state were randomly selected. Next, 35 cassava growers from each LGA were selected using a stratified random sampling procedure with the size of the cassava farm operation as the strata. The cut-off points for farm size followed nationally defined categories (Apata *et al.*, 2011): marginal farms up to 1.00 ha, small farms from 1.01 to 2.00 ha, medium farms from 2.01 to 10.00 ha and large farms >10.01 ha. This provided a total of 315 cassava farmers as the sample size for the study. In addition, a survey of cassava marketers (i.e., wholesalers/retailers) was also conducted within the same three sampling regions. First, 35 marketers of cassava and cassava products were randomly selected from each region (i.e., 10–12 marketers from each of the nine LGAs). This provided a total sample size of 105 marketers (39 marketers from the Delta Central, 40 from the Delta South and 26 from the Delta North regions) spread across 20 markets in the three regions. The criteria used for selecting markets were that (a) markets must trade cassava and/or cassava products, and (b) markets must operate at least once a week. The average frequency of the market day was estimated to be 4 days (i.e., every 5^{th} day is a market day with a range of 1–7 days).

To collect the primary data, two sets of structured questionnaires were administered containing both open and closed type questions, one for the farmers and the other for the marketers. A team of two research assistants was trained by one of the authors, and all three members were involved in collecting primary data through face-to-face interviews. The farmer survey included information on demographic and socio-economic characteristics, the size of the cassava farm operation, the inputs used and outputs received, the amount of cassava processed, and the constraints related to farming and processing cassava. The marketer survey included information on demographic and socio-economic characteristics, the quantities of cassava and its products that are purchased and marketed, the purchase and sale prices of each product, the cost of marketing, and the constraints on marketing. The surveys were conducted from September to December 2008.

The principal data for the trend analysis of the Nigerian agricultural sector were taken from the FAOSTAT database. The data included area cultivated (ha), total production (t), yield ($kg\,ha^{-1}$) and current prices (Naira/metric ton) of five major crops (i.e., cassava, groundnut, maize, millet and yam) covering the 52-year period (1961–2013). The information also included the share of agriculture in the GDP and the total government expenditure on agriculture for the period of 1970–2009. All the price data were then converted to constant 2010 prices using a GDP deflator for Nigeria from the Index Mundi (Index Mundi, 2015) to reflect real price changes over time.

Time-series data covering such a long period (e.g., 1960–2013) are likely to be unreliable for developing economies, and Nigeria is no exception. For example, Ammani *et al.* (2010) conducted an experiment comparing published maize production data from Nigeria for the period of 1992–2007 and an expected production based on twice the developing country average growth rate for maize production and noted that the official published data were significantly overstated. Jerven (2014) noted that the agricultural production data series for developing countries (i.e., Nigeria, Malawi, and India) are weak because they are subject to political pressure, particularly when governments subsidise agricultural inputs. Nevertheless, in the absence of suitable alternatives, we utilised FAOSTAT because it is widely used despite its limitations, but the interpretation of the results should account for the issue of data quality.

3.2 Analytical methods

A range of methods were applied, including trend analysis, the estimation of growth rates and the decom-

position of the sources of the growth in the production of cassava and the other competing crops under consideration. The purpose was to provide a comprehensive picture of cassava performance over time in relation to the other crops to judge its potential.

Average annual compound growth rates were computed to determine the rate of change of the variable of interest using a semi-logarithmic trend function: $\ln Y = \alpha + \beta T$, where Y is the target variable; T is time; ln is natural logarithm, and β is the growth rate. To control for the cyclical nature of the time-series data, we used 3-year moving averages to compute the average annual compound growth rates (e.g., Gupta *et al.*, 2009), which is an improvement over previous studies (e.g., Nweke, 2004; Echebiri & Edaba, 2008; Ojiako *et al.*, 2007; Liverpool-Tasie *et al.*, 2011).

We have analysed the changes in the area planted, total production, productivity and the real prices of five major crops (i.e., cassava, groundnut, maize, millet, and yam) at the national level for the 52-year period (1961–2013). All of the analyses were classified by the SAP stages to examine whether this major policy instrument has any influence on the performance of cassava and the other crops under consideration. The 1961–1985 period depicts the pre-SAP stage; the 1986–1993 period depicts the main SAP implementation stage, and the 1994–2013 period depicts the post-SAP stage. This is because, the three main elements of SAP are: "(a) pursue macroeconomic stability by controlling inflation and reducing fiscal deficits; (b) open economies to the rest of the world through trade and capital account liberalisation, and (c) liberalise domestic product and factor markets through privatisation and deregulation" ("Washington Consensus" as summarized by Gore, 2000, p.789–790). The main argument in favour of SAP is that openness, trade liberalisation and free market operation will boost production in agriculture. Since Nigeria also adopted SAP in 1986 and subsequently removed subsidies, deregulated and reduced state control in agriculture to a large extent, it is important to examine whether SAP has any discernible impact, an approach also adopted by Ugwu & Kanu (2012) and Ojiako *et al.* (2007).

To identify the sources of the observed growth in production of all of the crops, we applied a decomposition method to examine the relative contribution of the growth in the cultivated area and the growth in the yield of the individual crops. The basic method of decomposing sources of the growth in production depends on the identity:

$$P\,(\text{Output}) = A\,(\text{area planted}) * Y\,(\text{yield}) \qquad (1)$$

Using the subscripts 0 and t for the base year and terminal year, respectively, the relationship between the two production levels can be expressed as

$$P_t/P_0 = (A_tY_t)/(A_0Y_0) = (A_t/A_0) * (Y_t/Y_0) \qquad (2)$$

Eq. (2) is known as the Venegas-Ruttan (V-R) method, which demonstrates that the total output can be explained in terms of changes in the area planted and productivity (Alauddin & Tisdell, 1991). A few extensions of this basic method have been provided by others (see Alauddin & Tisdell, 1991 for details), but we select the method proposed by Wennergren *et al.* (1984), hereafter named the Wennergren, Antholt and Whitaker (W-A-W) method. This is because the W-A-W method decomposes the growth of individual crop output into four components as follows:

$$\begin{aligned}&\text{Change in total output}\,(P_t - P_0) =\\ &\text{Area effect}\,(V) + \text{Yield effect}\,(S) +\\ &\text{Cropping pattern}\,(R) + \text{Interactions}\,(U)\end{aligned} \qquad (3)$$

where

$\text{Area effect}\,(V) = Y_0[A_t(1 + C_0 - C_t) - A_0]$

$\text{Yield effect}\,(S) = [A_t(1 + C_0 - C_t) * (Y_t - Y_0)]$

$\text{Cropping patternt}\,(R) = [A_t * Y_0(C_t - C_0)]$

$\text{Interactions}\,(U) = [A_t(Y_t - Y_0) * (C_t - C_0)]$

and C = the proportion of the gross cropped area under the crop, and the other variables were defined above.

The advantage of the W-A-W method is that it includes the influence of the change in cropping pattern as well as the interaction between the change in cropping pattern and individual crop yield, which was not available in the V-R method. The implicit assumption of this method is constant returns to scale in terms of the output, which is reasonable.

4 Results

4.1 Trends in area, production, productivity and the real price of cassava and its competitors

Table 1 presents the mean values of area, production, productivity and the real prices of five major crops: cassava, maize, millet, groundnut and yam covering the period 1961–2013 and classified as the pre-SAP, SAP and post-SAP periods. The average area allocated for cassava was quite low during the pre-SAP period, and it only picked up during the post-SAP period, although millet area remained highest throughout. The total crop production increased due to a combination of increases in area as well as increases in yield, although the exact

Table 1: *Area cultivated, total production, productivity and real prices of cassava and other crops in Nigeria*

Panel	*Variables*	*Mean values of 3-year moving averages*			
		Pre-SAP (1961–1985)	*SAP* (1986–1993)	*Post-SAP* (1994–2013)	*Overall* (1961–2013)
			Area cultivated (‘000 ha)		
A	Cassava	1011.26	1761.84	3441.39	2071.86
	Groundnut	1387.08	819.38	2205.28	1608.81
	Maize	1023.15	4013.29	4065.01	2703.95
	Millet	3683.14	4102.62	4686.04	4151.49
	Yam	786.83	1173.62	2741.80	1598.18
			Total production (‘000 t)		
B	Cassava	9956.46	19079.05	39355.20	22715.55
	Groundnut	1153.31	1051.00	2913.15	1792.22
	Maize	1016.26	5061.62	6505.60	3778.46
	Millet	2854.59	4334.14	5897.28	4240.22
	Yam	6563.83	11379.57	30363.46	16502.91
			Productivity (kg/ha)		
C	Cassava	9852.33	10939.99	11376.42	10584.59
	Groundnut	850.16	1291.12	1330.54	1093.01
	Maize	1039.94	1289.31	1601.94	1285.64
	Millet	872.79	1069.90	1247.65	1040.66
	Yam	8593.03	9245.12	11035.71	9676.29
			Prices (Naira/t)		
D	Cassava	921.05	958.30	752.34	865.21
	Groundnut	1384.41	2889.32	1739.99	1796.70
	Maize	1023.07	1498.10	1512.13	1293.43
	Millet	985.37	1475.27	1356.69	1214.68
	Yam	1432.74	2022.29	1990.15	1749.83
			Government outlays		
E	Agriculture’s share of GDP (%)	25.91	28.16	39.16	31.66
	Agriculture’s share of government expenditure (%)	4.28	2.40	3.11	3.44

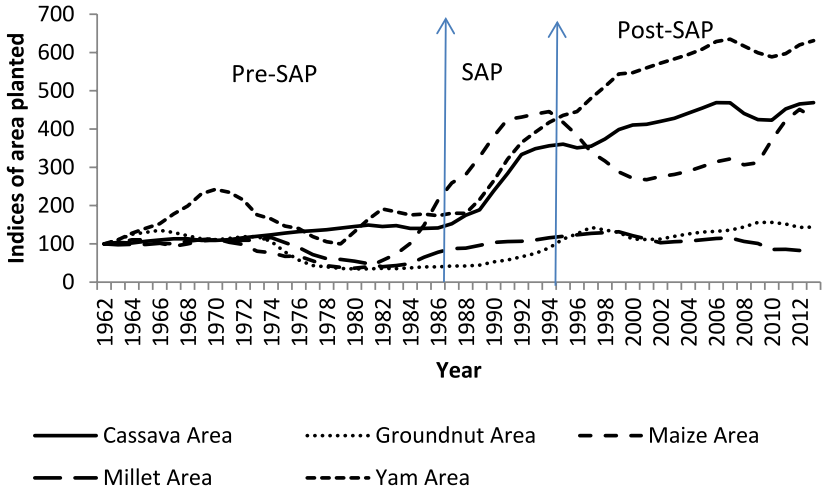
Note: Price data are from 1967–2008; Agriculture’s share of GDP and government expenditure is from 1970–2009.
Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

contribution of these sources of growth cannot be identified here. The analysis of the sources of the growth in production is relegated to the next section, but the average real prices of these crops were highly variable throughout the period. The growth in the overall yield level of cassava was very low, increasing from 9.8 t ha^{-1} to 10.6 t ha^{-1} over the 52-year period.

Figures 1 to 4 present the trends in the 3-year moving averages of the area indices, production indices, yields and real prices of the five major crops: cassava, maize, millet, groundnut and yam for the period 1961–2013. It is clear from the figures that the trends are highly variable with respect to all of the indicators for all of the crops during the period under consideration. Cassava area steadily increased from 1986 onward (i.e., from

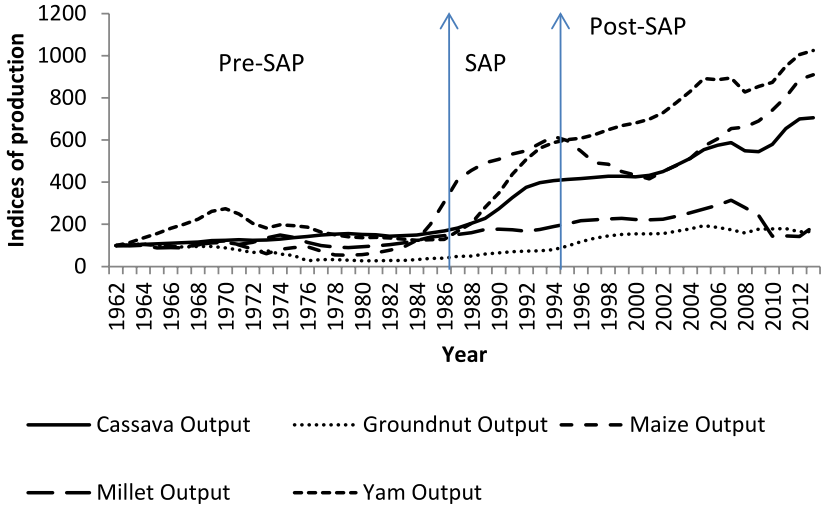
the beginning of the SAP period) although the rate of increase is lower than for yam area, which is another major staple in Nigeria (Figure 1). Similarly, total cassava production also increased steadily during the same period but lagged behind yam (Figure 2). In terms of productivity, cassava yield was largely stable, showing very little improvement compared to the other major crops, which experienced high levels of fluctuation (Figure 3). The trend in the yield increase in cassava is only apparent during the past few years, which may be due to renewed interest in boosting cassava yield through various projects (e.g., Cassava Transformation Project) and the influence of the TMS variety developments noted by Eke-okoro & Njoku (2012).

The trend in real prices (i.e., at constant 2010 prices) of these major crops presents an interesting contrast (Figure 4). With the exception of cassava, the prices for all major crops rose sharply during the SAP period, then fell sharply during the post-SAP period and kept falling. However, the level of fluctuation in cassava price is relatively low among the five crops under consideration (Figure 4).



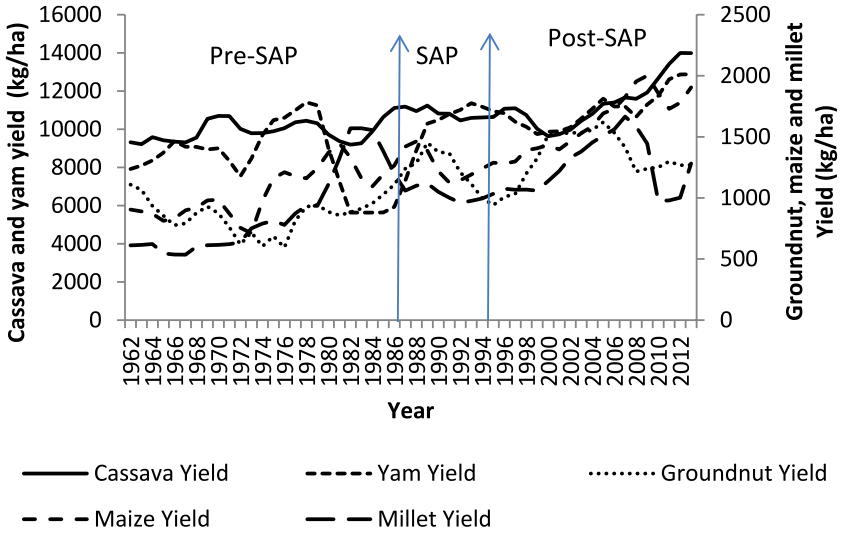
Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

Fig. 1: *Three-year moving average indices of the area planted under major crops.*



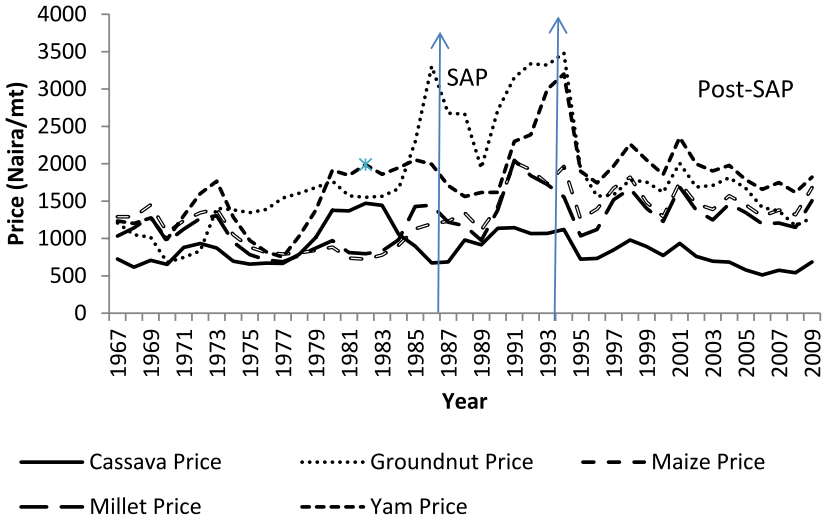
Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

Fig. 2: *Three-year moving average indices of the total production of major crops.*



Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

Fig. 3: *Three-year moving average of major crop yields (kg/ha).*



Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

Fig. 4: *Three-year moving average prices of the major crops (Naira/t) in Nigeria.*

The annual compound growth rates from the 3-year moving averages of these data series are presented in Table 2, which displays interesting contrasts. For example, during the pre-SAP period, the area under cassava increased at 1.8 % p.a. while the area under maize, millet and groundnut experienced a significant decline at highly variable rates. During the SAP period, however, all of the crop areas increased at a very high rate led by cassava at 14.5 % p.a. Finally, during the post-SAP period, the growth rates fell sharply with millet area even experiencing a decline at 2.1 % p.a. The observed growth in total cassava production during the pre-SAP and SAP periods is due to increases in area, and the productivity of cassava and the other crops, except millet, experienced a low rate of growth during the post-SAP period.

The growth in the real prices of these major crops also presents interesting contrasts. The real prices of cassava grew significantly during the pre-SAP and SAP periods but then significantly declined at 3.5 % during the post-SAP period, resulting in no growth in real prices over the 52-year period. In contrast, despite the high level

Table 2: *Growth rate estimations from 3-year moving average data for Nigeria.*

Panel	*Variables*	*Mean values of 3-year moving averages*			
		Pre-SAP (1961–1985)	*SAP* (1986–1993)	*Post-SAP* (1994–2013)	*Overall* (1961–2013)
			Area cultivated		
A	Cassava	0.018 ***	0.147 ***	0.015 ***	0.037 ***
	Groundnut	–0.070 ***	0.085 ***	0.017 ***	0.010 **
	Maize	–0.028 **	0.122 ***	0.005	0.039 ***
	Millet	–0.039 ***	0.053 ***	–0.021 ***	0.003
	Yam	0.004	0.135 ***	0.019 ***	0.037 ***
			Total production		
B	Cassava	0.020 ***	0.137 ***	0.030 ***	0.042 ***
	Groundnut	–0.071 ***	0.100 ***	0.029 ***	0.023 ***
	Maize	–0.007	0.085 ***	0.028 ***	0.055 ***
	Millet	0.007	0.028 **	–0.010	0.020 ***
	Yam	–0.009	0.235 ***	0.029 ***	0.044 ***
			Productivity		
C	Cassava	0.002	–0.009 **	0.015 ***	0.005 ***
	Groundnut	–0.001	0.019	0.011 *	0.013 ***
	Maize	0.021 ***	–0.034 *	0.024 ***	0.015 ***
	Millet	0.048 ***	–0.029 **	0.008	0.016 ***
	Yam	–0.011 *	0.100 ***	0.010 ***	0.007 ***
			Prices		
D	Cassava	0.036 ***	0.073 ***	–0.035 ***	–0.004
	Groundnut	0.044 ***	0.024	-0.036 ***	0.011 ***
	Maize	–0.030 ***	0.075 ***	–0.008	0.012 ***
	Millet	–0.012 ***	0.063 *	–0.003	0.011 ***
	Yam	0.029 **	0.068 **	-0.021 **	0.014 ***
			Government outlays		
E	Agriculture's share of GDP (%)	–0.051 ***	0.048 **	0.011 ***	0.014 ***
	Agriculture's share of government expenditure (%)	0.109 ***	–0.174 **	0.039	–0.003

Note: *** significant at the 1 % level (p<0.01); ** significant at the 5 % level (p<0.05); * significant at the 10 % level (p<0.10)
Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

of fluctuations during the SAP period, the real prices of the remaining four crops increased significantly at 1.1 %–1.4 % over the 52-year period under consideration. The lack of overall growth in the real price of cassava may act as a disincentive to the producers to boost cassava performance.

The last two rows of Tables 1 and 2 present the contribution of agriculture to the GDP and government expenditure on agriculture. These two sets of figures exhibit a clear mismatch between the contribution of the sector to national income and the corresponding support by the government to maintain the sector. While agriculture contributed approximately 30 % of the GDP on average, government expenditure was only 3.5 %, and Table 2 also shows that, even though the contribution of agriculture to the GDP continued to grow during the SAP and post-SAP periods, the corresponding government expenditure, which was already very low, showed no sign of growth.

4.2 Sources of the growth in production

In this section, we examine the sources of the growth in the production of individual crops using the W-A-W method, as in Eq. (3). The results are presented in Table 3, and it is encouraging to note that the yield effect is the dominant source of the growth in cassava production, contributing 76.4 % of the total growth followed by an area effect that contributes 28.2 %. The contribution of the change in cropping pattern is negligible. Groundnut also experienced a similar pattern whereas the growth in the production of maize, millet and yam is mainly due to the area effect and the change in cropping pattern with a negative contribution from the yield effect. The implication is that, compared with the other four crops, cassava has the potential to support the growth of agriculture in Nigeria.

4.3 Constraints in the cassava sector

A number of constraints on cassava production and productivity have been identified by many authors. For example, Addy *et al*. (2004) and Nweke (2004), among others, have argued that the efficient use of inputs, improvements in technology (including irrigation, pesticides, cuttings and storage methods), the provision of market information, and the determination and dissemination of the adequate numbers of cassava planters, harvesters, peelers, hydraulic presses and dryers would all improve efficiency in cassava production. The Cassava Master Plan noted that the primary challenge faced by the cassava sector is low productivity due to Nigeria's subsistence cassava farming culture with its large but rudimentary and underdeveloped industry. The plan also noted that Nigeria has the potential to earn revenue

Table 3: *Sources of the growth in production of major crops in Nigeria (1961–2013).*

Crops	*Sources of growth using the W-A-W method*				
	Area effect	*Yield effect*	*Cropping pattern*	*Interactions*	*Total*
Cassava	28.20	76.39	–4.71	0.12	100.00
Groundnut	38.14	64.53	–3.18	0.52	100.00
Maize	128.82	–50.47	21.12	0.53	100.00
Millet	129.56	–58.92	27.15	2.21	100.00
Yam	144.94	–59.18	17.58	–3.34	100.00

Source: Computed using the FAOSTAT database (FAOSTAT, 2014)

Table 4: *Infrastructure constraints affecting the cassava sector.*

Constraints	*Average value of farmers' responses on a 5-point Likert scale*				
	Delta Central	*Delta South*	*Delta North*	*All Regions*	*Weighted Ranking*
Water Provision	3.49	3.82	2.51	3.27	1
Processing Facilities	3.70	3.54	2,41	3.22	2
Electricity Provision	4.05	2.38	2.83	3.09	3
Marketing Facilities	3.79	2.52	2.90	3.07	4
Credit Facilities	3.69	2.37	2.42	2.83	5
Road Network	3.82	1.88	2.70	2.80	6
Extension Services	3.39	1.94	2.72	2.69	7
Information Provision	3.24	1.85	2.66	2.58	8

Likert scale ranking: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agreed, 5: Strongly Agree
Source: Field survey in Delta State, Nigeria, 2008.

of USD 5 billion from cassava products if the existing bottlenecks along the cassava value chain are resolved (CMP, 2006).

We present a detailed analysis of the constraints to the cassava sector in Nigeria according to the responses of 315 cassava farmers/processors and 105 retailers/marketers collected from three regions of Delta State, Nigeria, in December 2008. Approximately 68.3 % of the 315 farmers/processors are marginal or small farmers with farm sizes <2.01 ha, and the average farm size of the entire sample is only 2.05 ha. Based on a Likert scale analysis of the ranks of individual responses for each of the eight infrastructure elements evaluated, the provision of water, which is mainly meant for irrigation and the washing and processing of cassava into gari, was ranked as the greatest constraint affecting the cassava sector followed by adequate processing facilities and electricity provision (Table 4). Ayoade & Adeola (2009), in their study investigating the constraints to domestic industrialization of cassava in Osun State in southwest Nigeria, also stated that inadequate processing equipment, high processing costs and ineffective linkages between farmers and processors were the most important factors constraining cassava production. Naziri *et al.* (2014) noted that the physical loss of cassava in southwest Nigeria is estimated at 481,258 ton per year accounting for 6.7 % of total production and 82 % of the physical loss takes place during processing stage alone. The main reason is delay in processing which in turn is due to shortage in peeling capacity and mechanical peeling. In fact, the economic loss of cassava production in southwest Nigeria is estimated at more than USD 20 million per year (Naziri *et al.*, 2014).

Farmers were also asked about the constraints to adding value to cassava through processing, and they identified a lack of transportation and adequate information as the top two constraints (Table 5). Approximately 91.5 % of the processors agreed that transportation of cassava root tubers from the farm/market to the processing site is costly as the average distance from the farmers/processors to the nearest marketplace is estimated to be 2.93 km (±3.13 km) with a maximum distance of 15 km. In fact, distance is a major factor that adversely affects the cost and efficiency of processing, which was also supported by Akinnagbe (2010) and Tonukari (2004).

Similarly, when asked about constraints to marketing cassava and cassava products, all of the marketers (i.e., retailers and wholesalers) noted inaccessible markets, unstable prices and the high costs of marketing as the main obstacles (Table 6). Rahman & Awerije (2014) noted that increases in the purchase price of cassava and cassava products as well as marketing costs per unit significantly reduce profit margins.

Table 6: *Marketing constraints to the cassava sector.*

Constraints	*% of marketers/retailers responding*
Market Accessibility	100
Unstable Prices	100
High Cost of Marketing	100
Lack of Market Infrastructure	98.1
Storage Problems	65.7
Lack of Information	61.9

Source: Field survey in Delta State, Nigeria, 2008.

Table 5: *Constraints to adding value in cassava through processing.*

Constraints	*% of farmers responding*	*Rank*
Transportation Difficulties	91.5	1
Lack of Adequate Information	91.4	2
Too Many Buyers for Limited Raw Materials	76.6	3
Lack of Processing Equipment	76.2	4
High Cost of Raw Materials/Processing Equipment	72.4	5
Lack of Adequate Infrastructure	70.5	6
Others	23.8	7

Source: Field survey in Delta State, Nigeria, 2008.

5 Conclusions and policy implications

The principal aim of this study is to explore the potential of cassava to support agricultural growth in Nigeria based on a review of the development of cassava; perform a trend analysis of the area planted, production, productivity and the real prices of cassava and major competing crops (i.e., yam, maize, millet and groundnut) covering a 52-year period (1961–2013); identify sources of the growth in production; and examine key constraints in the cassava sector at the local level based on a survey of 315 farmers/processors and 105 marketers/retailers from three regions of Delta State, Nigeria, conducted in December 2008.

The results revealed that although the average cassava yield only increased from 9.8 t ha^{-1} to 10.6 t ha^{-1} over a 52-year period, cassava productivity grew by 1.5 % during the post-SAP period, which may be a reflection of the use of improved TMS varieties developed by IITA and NRCRI during the pre-emptive–CMD cassava development period. A decomposition of the sources of the growth in cassava production confirmed that the yield effect is the dominant source, contributing 76.4 % of the total growth, followed by the area effect (28.2 %). The lack of growth in the real price of cassava over the study period and a significant decline of 3.5 % p.a. during the post-SAP period is a major obstacle to driving the cassava sector forward. It is important to note that the cassava sector was relatively more stable in terms of area, production, productivity and real prices compared to the other crops during the period under consideration. Therefore, considering all of these factors, it can be concluded that the cassava sector has the potential to support the growth of Nigerian agriculture if managed properly. This is because all of the other crops experienced significant fluctuations in all the indicators during the same period, thereby providing less confidence in their potential to support agricultural growth. Naziri *et al.* (2014) noted that innovations to extend shelf-life of fresh root cassava through technologies, such as waxing, paraffin coating and high humidity storage can be tried as such measures were successful in other economies. Also, use of mechanical peeling could substantially improve processing capacity.

Another point to note is the neglect of the agricultural sector by the government, as oil has become the main source of income in the Nigerian economy. This is evident from the fact that, although the contribution of the agricultural sector to national income grew consistently, the government did not provide proportional, corresponding support to maintain the sector; there is a clear mismatch that is largely responsible for the poor growth performance of cassava and other major crops over time. Ojiako *et al.* (2007) also noted a lack of expenditure support for the growth of roots and tubers in Nigeria. The Comprehensive African Agricultural Development Program (CAADP), founded on a declaration by African Head of States at Maputo in 2003, set the target to devote 10 % of their national budget to the agricultural sector by 2008, which very few countries actually achieved (Poulton *et al.*, 2014). However, as mentioned earlier, time-series data covering a long period are likely to be unreliable for the developing countries including data from Nigeria. Therefore, interpretation of the findings of this study should take into account such limitation although we have used data supplied by FAOSTAT, which is the most widely used source of such data.

A host of constraints affect the cassava sector at the local level, of which poor market and marketing infrastructure; the lack of irrigation/water provision, processing facilities, transportation and information on market prices; and unstable prices are the dominant factors as identified and prioritised by the farmers, processors and marketers surveyed from Delta State.

A number of policy implications can be drawn from the results of this study. The first is the need for investment to improve market and marketing infrastructure because although the price for cassava in Nigeria is determined by market forces, high fluctuations in price indicate that the market is not functioning properly (Rahman & Awerije, 2014), which is also reflected in Table 6. Improvements in market and marketing infrastructure will address these issues. Second, the improved TMS varieties developed by research stations with high potential yields need to be diffused widely to increase cassava productivity at the farm level. Asante-Pok (2013) noted that the favourable policy environment established by the government encouraged cassava development, leading to a new orientation in the research-extension-farmer linkage (e.g., Cassava Multiplication Programme and the Roots and Tubers Expansion Programme), which are positive steps that should be enhanced further. Third is the need for investment in improving cassava processing facilities and utilities that can also contribute to reduced fluctuations in prices. A key driver of prices in the Nigerian cassava economy is the relative price of gari; Rahman & Awerije (2014) noted that the price of gari is 2.81 times higher, estimated at Naira 79.84 per kg, compared with the price of raw cassava (Naira 28.41 per kg) in Delta State. This serves as an incentive to process cassava into gari provided that the processing costs do not outweigh the additional revenues. The Raw Material Research and Development Council funds research projects on the

fabrication of cassava processing equipment (Asante-Pok, 2013), and such measures need to be enhanced further to improve processing technologies, which in turn will reduce processing costs. Fourth is the need for investment in irrigation infrastructure and/or water provision, which was identified as a major constraint by local farmers/processors (Table 4). Finally, improvements in the dissemination of information ranging from technological expertise to the production, processing and marketing of cassava and cassava products through mass media, agricultural extension services and digital technologies.

Although meeting all of these policy options is formidable, the effective implementation of these broader policy measures will drive the cassava sector forward and support agricultural growth in Nigeria.

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References

AATF (2012). Public-private partnership project on cassava mechanisation, agro-processing launched. African Agricultural Technology Foundation (AATF). URL `http://www.aatf-africa.org/node/451` (last accessed: 26.08.2015).

Addy, P. S., Kashaija, I. N., Moyo, M. T., Quynh, N. K., Singh, S. & Awalekhwa, P. N. (2004). *Constraints and Opportunities for Small and Medium Scale Processing of Cassava in the Ashati and Brong Ahafoa Regions of Ghana*. International Centre for Research in Agriculture (ICRA), Netherlands.

Adubi, A. A. & Okunmadewa, F. (1999). *Price, Exchange Rate Volatility and Nigeria's Agricultural Trade Flows: A Dynamic Analysis*. African Economic Research Consortium, Nairobi, Kenya.

Akinnagbe, O. (2010). Constraints and strategies towards improving cassava production and processing in Enugu north agricultural zone of Enugu State, Nigeria. *Bangladesh Journal of Agricultural Research*, 35, 387–394.

Akoroda, M. O., Gebremeshel, I. & Oyinlola, A. E. (1985). *Impart of IITA Cassava varieties in Oyo State of Nigeria*. IITA, Ibadan, Nigeria. p. 105

Akpan, S. B. (2012). Analysis of food crop output volatility in agricultural policy programme regimes in Nigeria. *Developing Country Studies*, 2, 28–35.

Alauddin, M. & Tisdell, C. (1991). *The Green Revolution and Economic Development: The Process and Its Impact in Bangladesh*. Macmillan, London.

Ammani, A., Sani, B. & Alamu, J. (2010). Challenges to the reliability of officially published statistics for extension work. *Journal of Agricultural Extension*, 14, 48—52.

Apata, T. G., Folayan, A., Apata, O. M. & Akinlua, J. (2011). The economic role of Nigeria's subsistence agriculture in the transition process: implications for Rural Development. Paper Presented at the 85th Agricultural Economics, UK Conference at Warwick University During 18–20 April 2011.

Asante-Pok, A. (2013). Analysis of Incentives and Disincentives for Cassava in Nigeria. Monitoring African Food and Agricultural Policies project (MAFAP), FAO, Rome, Italy. URL `http://www.fao.org/3/a-at582e.pdf` (last accessed: 26.08.2015).

Awoyinka, Y. A. (2009). Cassava Marketing: Option for Sustainable Agricultural Development in Nigeria. *Ozean Journal of Applied Science*, 2 (2), 175–183.

Ayoade, A. R. & Adeola, R. G. (2009). Constraints to domestic industrialization of cassava in Osun State Nigeria. *Ozean Journal of Social Sciences*, 2 (2), 1–5.

CMP (2006). Cassava master plan 2006 A Strategic Action Plan for the Development of the Nigerian Cassava Industry. UNIDO, Geneva.

CTA (2011). Action plan for a cassava transformation in Nigeria (draft). URL `http://unaab.edu.ng/attachments/Cassava%20Report%20Final.pdf` (last accessed: 26.08.2015).

Echebiri, R. N. & Edaba, M. E. I. (2008). Production and utilization of cassava in Nigeria: prospect for food security and infant nutrition. *Production Agriculture and Technology*, 4, 38—52.

Eke-okoro, O. N. & Njoku, D. N. (2012). A review of cassava development in Nigeria from 1940–2010. *ARPN Journal of Agricultural and Biological Science*, 7 (1), 59–65.

FAO (2005). A review of cassava in Africa with country cases studies on Nigeria, Ghana, united Republic of

Tanzania, Uganda and Benin. Proceedings of the Validation Forum on the Global Cassava Development Strategy, vol. 2. International Fund for Agricultural Development and Food and Agricultural Organisation of the United Nations, Rome, Italy.

FAOSTAT (2014). FAOSTAT database on Nigeria. URL http://faostat3.fao.org/home/E (last accessed: 15.07.2015).

Gore, C. (2000). The Rise and Fall of the Washington Consensus as a Paradigm for Developing Countries. *World Development*, 28 (5), 789–804.

Gupta, D., Sahu, P. K. & Banerjee, R. (2009). Forecasting jute production in major contributing countries in the world. *Journal of Natural Fibres*, 6, 127–137.

IITA (2009). Processing potential for cassava production growth in sub-Saharan Africa. COSCA working paper No 11, Collaborative Study of Cassava in Africa, Nigeria.

Index Mundi (2015). GDP deflator of Nigeria 1960–2013. URL http://www.indexmundi.com/facts/nigeria/gdp-deflator (last accessed: 25.08.2015).

Jerven, M. (2014). The political economy of agricultural statistics and input subsidies: evidence from India, Nigeria and Malawi. *Journal of Agrarian Change*, 14, 129–145.

Knipscheer, H., Ezedinma, C., Kormawa, P., Asumugha, G., Mankinde, K., Okechukwu, R. & Dixon, A. (2007). *Opportunities in The Industrial Cassava Market in Nigeria*. International Institute for Tropical Agriculture (IITA), Surrey, UK.

Liverpool-Tasie, L. S., Kuku, O. & Ajibola, A. (2011). Nigeria Strategy Support Program. Working Paper # 21. International Food Policy Research Institute, Washington, D.C.

MANR (2006). Agricultural development policy report. Ministry of Agriculture and Natural Resources (MANR), Delta State, Nigeria.

Nang'ayo, F., Odera, G., Muchiri, N., Ali, Z. & Werehire, P. (2007). A strategy for industrialization of cassava in Africa. Proceedings of a Small Group Meeting, 14–28 November 2005, African Agricultural Technology Foundation, Ibadan, Nigeria. URL http://aatf-africa.org/userfiles/CassavaProceedings.pdf (last accessed: 15.11.2014).

Natsa, R. T. (2014). Turning the cassava dream into reality. Leadership Newspaper, April 2014. URL http://leadership.ng/business/368405/turning-cassava-dream-reality (last accessed: 25.08.2014).

Naziri, D., Quaye, W., Siwoku, B., Wanlapatit, S., Phu, T. V. & Bennett, B. (2014). Diversity of post harvest losses in cassava value chains in selected developing countries. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 115 (2), 111–123.

Nkonya, E., Pender, J., Kato, E., Omobowale, O., Phillip, D. & Ehui, S. (2010). Enhancing Agricultural Productivity and Profitability in Nigeria. Nigeria Strategy Support Program, Brief # 19. International Food Policy Research Institute, Washington, D.C.

Nweke, F. (2004). *New Challenges in the Cassava Transformation in Nigeria and Ghana*. International Food Policy Research Institute (IFPRI), Washington, D.C.

OECD (2010). *Economic importance of agricultural for sustainable development and development and poverty reduction: findings from a Case study of Indonesia*. Organisation for Economic Co-operation and Development (OECD), Paris, France.

Ojiako, I. A., Asumugha, G. N., Ezedima, C. & Uzokwe, N. E. (2007). Analysis of production trends in the major root and tuber crops in Nigeria, 1961–2005. *Research on Crops*, 6, 371–380.

Okoh, S. O. & Dominic, O. (2004). Economics of cassava production in a developing economy: a case study of Akwa Ibom State of Nigeria. *Nigerian South-East Journal of Agricultural Economics and Extension*, 6, 22–25.

Olowu, A. U. (2011). *Agricultural financing and performance in Nigeria: A case study of the Agricultural Credit Guarantee Scheme (ACGS)*. Master's thesis, Stellenbosch University, South Africa.

Poulton, C., Berhanu, K., Chinsinga, B., Cooksey, B., Golooba-Mutebi, F. & Loada, A. (2014). The Comprehensive Africa Agriculture Development Programme (CAADP): Political Incentives, Value Added and Ways Forward. Futures Agricultures Working Paper # 077. URL http://www.future-agricultures.org/publications/research-and-analysis/1833-the-comprehensive-africa-agriculture-development-programme-caadp-political-incentives-value/file (last accessed: 08.12.2015).

Rahman, S. & Awerije, B. O. (2014). Marketing efficiency of cassava products in Delta state, Nigeria: a stochastic profit frontier approach. *International Journal of Agricultural Management*, 4, 28–37.

Tonukari, N. J. (2004). Cassava and the future of starch. *Electronic Journal of Biotechnology*, 7, 5–8.

Ugwu, D. S. & Kanu, I. O. (2012). Effects of agricultural reforms on the agricultural sector in Nigeria. *Journal of African Studies and Development*, 4, 51–59.

Walkenhorst, P. (2007). *Distortions to agricultural incentives in Nigeria. World Bank Agricultural Distortions Working Papers # 37*. World Bank, Washington, D.C.

Wennergren, E. B., Antholt, C. H. & Whitaker, M. D. (1984). *Agricultural Development in Bangladesh*. Westview Press, Boulder, Colorado.