INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
sustainable solutions for ending hunger and poverty

Supported by the CGIAR

NSSP Report 1

Trends and Drivers of Agricultural Productivity in Nigeria

Omobowale Oni
Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria
Ephraim Nkonya
International Food Policy Research Institute, Washington, D.C.
John Pender
International Food Policy Research Institute, Washington, D.C.
Dayo Phillips
University of Agriculture, Abeokuta, Nigeria
Edward Kato
International Food Policy Research Institute, Washington, D.C.

Nigeria Strategy Support Program (NSSP)
Report 001
December 2009

IFPRI-Abuja
International Food Policy Research Institute
c/o International Center for Soil Fertility and Agriculture Development
Plot 18A Colorado Close
Maitama, Abuja
Nigeria
Tel: +234 (9) 413-5960
Fax: +234 (9) 4130873
E-mail: ifpri-nigeria@cgiar.org
www.ifpri.org

IFPRI HEADQUARTERS
International Food Policy Research Institute
2033 K Street NW
Washington, DC 20006-1002 USA
Tel. +1-202-862-5600
Fax +1-202-467-4439
E-mail ifpri@cgiar.org
www.ifpri.org

THE NIGERIA STRATEGY SUPPORT PROGRAM (NSSP)

ABOUT NSSP/APSF

The Agricultural Policy Support Facility (APSF) is an initiative to strengthen evidence-based policymaking in Nigeria in the areas of rural and agricultural development. Facilitated by the **Nigeria Strategy Support Program** of the **International Food Policy Research Institute** (IFPRI) in collaboration with the Federal Ministry of Agriculture and Water Resources and funded by the Canadian International Development Agency, APSF supports the implementation of Nigeria's national development plans by strengthening agricultural-sector policies and strategies through:

Enhanced knowledge, information, data, and tools for the analysis, design, and implementation of pro-poor, gender-sensitive, and environmentally sustainable agricultural and rural development polices and strategies in Nigeria;

Strengthened capacity for government agencies, research institutions, and other stakeholders to carry out and use applied research that directly informs agricultural and rural polices and strategies; and

Improved communication linkages and consultations between policymakers, policy analysts, and policy beneficiaries on agricultural and rural development policy issues.

ABOUT THESE REPORTS

The Nigeria Strategy Support Program (NSSP) reports contain preliminary results of ongoing research. They are circulated in order to stimulate discussion and critical comment.

This paper received support from the Agricultural Policy Support Facility (APSF), funded by the Canadian International Development Agency (CIDA).

Trends and Drivers of Agricultural Productivity in Nigeria

By

Omobowale Oni
Department of Agricultural Economics, University of Ibadan, Ibadan, Nigeria
Ephraim Nkonya
International Food Policy Research Institute, Washington, D.C.
John Pender
International Food Policy Research Institute, Washington, D.C.
Dayo Phillips
University of Agriculture, Abeokuta, Nigeria.
Edward Kato
International Food Policy Research Institute, Washington, D.C.

Table of Contents

Introduction/Problem Statement

Agriculture is the economic mainstay of the majority of households in Nigeria (Udoh, 2000) and is a significant sector in Nigeria's economy (Amaza, 2000). The important benefits of the agricultural sector to Nigeria's economy include: the provision of food, contribution to the gross domestic product (GDP), provision of employment, provision of raw materials for agro-allied industries, and generation of foreign earnings labor(until the early 1970s; agricultural exports were the main source of foreign exchange earnings).

A sectoral analysis in 2006 of the real GDP indicated that the agricultural sector contributed to about 42 percent of the GDP compared with 41.2 percent in 2005 (CBN, 2006). The growth rate of the contribution of the agricultural sector to the GDP at 1990 constant basic prices grew from 4.2 percent in 2002 to 7.2 percent in 2006. The agricultural sector also employed over 60 percent of the total labor force in Nigeria in 1999 (Adeoti, 2002).

The advent of oil in the early 1970s made Nigeria highly dependent on oil revenue, with the performance of the agricultural sector adversely affected over years. Though the growth rate in the agricultural sector in Nigeria increased from an average of about 3 percent in the 1990s to about 7 percent in mid 2000, the food security/sufficiency status of Nigerians continued to decline. (Adeoti 2002)

The dismal performance of the agricultural sector in terms of its contribution to Nigeria's yearly total revenue in the last three decades prompted the government to initiate several agricultural schemes and programs to enhance agricultural productivity in Nigeria, which include the following: the River Basin Development Authorities, the National Accelerated Food Production Project, the Agricultural Development Project, Operation Feed the Nation, the Green Revolution, the National Directorate of Food, Roads and Rural Infrastructure, the Agricultural Credit Guarantee Scheme Fund, the National Special Programme for Food Security, Root and Tuber Expansion Project, and the National Fadama I and II program.

Similarly, a series of studies have been carried out to assess agricultural productivity and its drivers in Nigeria, which include: Adebayo (2006), Adeoti (2002), Ajani (2002), Ajibefun et al. (1996), Ajibefun and Abdulkadri (1999), Ajibefun and Daramola (2003), Amaza (2000), Awotide (2004), Ogundele (2003), Ogundele and Okoruwa (2006), Okike (2000), Oredipe (1998), Rahji (2003), and Udoh (2000). None of the aforementioned studies, however, has assessed productivity within the context of agro-ecological zones. This paper intends to examine productivity trends and patterns in Nigeria as well as the drivers of such trends in the last several years, specifically during 1995-2006.

Theoretical and Conceptual Framework

"Agricultural productivity" may be defined in general terms as the ratio of the value of total farm outputs to the value of total inputs used in farm production (Olayide and Heady, 1982). Since one of the main objectives of any society is the attainment of an optimal standard of living with a given amount of effort, any increase in productivity of resources employed in farm production amounts to an increase in the standard of living.

Increases in agricultural productivity will therefore contribute to the well-being of the economy as a whole. The ultimate objective of the interest of economists in productivity should be to find ways of increasing output per unit of input and of attaining desirable inter-firm, intra-firm, and intersector transfers of production resources, thereby providing the means of raising the standard of living. The input-output process of farm production according to Olayide and Heady (1982) is important in at least four major problem areas: 1) the distribution of income; 2) the allocation of resources; 3) the relation between stocks and flows; and 4) the measurement of efficiency or productivity.

A meaningful assessment of productivity depends upon a clear and precise definition of inputs and outputs in such a way that their movements over time are not equal. Determining which inputs and outputs are consistent with the particular concept of productivity in question is important. Sometimes one is faced with separate and distinct conditions when measuring labor, capital, or land productivity. In other words, “resource productivity” may be defined as an individual resource input or a combination of such inputs. In this paper, the concept of “labor/land productivity” or “yield” shall be defined as the ratio of total output of a particular crop to labor/land inputs (i.e., average production concept). Using this definition as a bench-mark, a change in productivity over time will depend upon changes in the types and quantities of inputs. Maximum resource productivity will imply obtaining the maximum possible output from the minimum possible set of inputs. In this context, optimal productivity of resources implies an efficient utilization of resources in the production process. This means that productivity and efficiency are synonymous in this context, and these concepts are used interchangeably in the literature review and the results sections of this paper.

An increase in farm output will result from one of three forces: 1) an increased quantity of inputs, with no change in output per unit of input; 2) an increased productivity of inputs with no change or a decrease in quantity of inputs; or 3) a combination of changes in inputs and productivity. This situation makes the concept of efficiency a central issue in production economics.

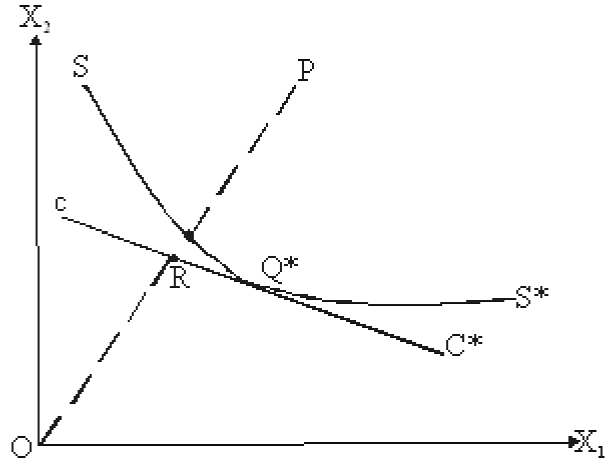
It is important to mention the noted theoretical frameworks on efficiency, which include Coelli (1996), and Battesse (1992), and Farell (1957). Farrel defined “efficiency” in three related terms. First, he defined “technical’ efficiency” as the measure of a firms’ success in producing maximum output from a given set of inputs. This indicates all the undisputed gains that can be obtained by simply organizing management better. Second, he defined “price efficiency” as the measure of a firm’s success in choosing an optimal set of inputs. This is an indication of the gains that can be obtained by varying the input ratios on certain assumptions about the future price structure. Third, he defined “overall efficiency” as the simple product of the technical and the price efficiencies. As shown in Figure 1, the graphical presentation of Farrel’s definitions assumes an “efficient” isoquant which is SS*. Given the efficient isoquant and the isocost line CC*, the three efficiency measures of Farrel were given as:

$$TE = \frac{OQ}{OP} \longrightarrow \text{Technical Efficiency}$$

$$PE = \frac{OR}{OQ} \longrightarrow \text{Price Efficiency}$$

$$OE = \frac{OQ}{OP} . \frac{OR}{OQ} = \frac{OR}{OP} \longrightarrow \text{Overall or Economic Efficiency}$$

Figure 1: Farel's Efficiency Measures



Farrel's measure of efficiency assumed the existence of an efficient production function with which the observed performance of a firm could be compared. A production function based on the "best" practical results would have to be used as a reference of measuring an individual firm's performance. Hence, for practical purposes, Farrel suggested that it was better to compare actual performance with a "best" obtained result than with an unrealizable ideal. He then obtained from a scatter of diagram of several firms' input-output data, as isoquant which satisfied the least exacting efficiency assumption of convexity to the origin and non-positive slope at any point.

Literature Reviewed

The literature reviewed for this paper included studies from local and international researchers that focused on the following factors empirically identified as determinants of technical efficiency (productivity).

Age

The age of farming household heads was observed to have an inverse relationship with productivity of farmers in studies from Adeoti (2002), Ajibefun and Abdulkari (1999, 2004), Ajibefun and Daramola (1999), Ajibefun et al. (2002 ,2006), Coelli and Battesse (1996), Idjesa (2007), and Ogundele (2003). All of these studies were carried out in the humid forest, dry savannah, and moist savannah regions of Nigeria, except for the Coelli and Battesse study, which was carried out in India. This was understandable since it is expected that as a farming household head becomes older his or her productivity will decline.

Years of farming experience is another factor that enhances productivity among farming households Years of farming experience in Nigeria increases as age of the farmer increases. It is within this context that years of farming experience and age of farmers were discussed together in this section of the report. Age is also positively correlated with productivity, older farmers have also been observed to have higher productivity than younger farmers. For example, Ajani (2000), Ajibefun and Abdulkadri (1999, 2004), Ajibefun et al (2002, 2006), and Idjesa (2007) observed that productivity in the humid forest and moist savannah agro-ecological zones of Nigeria was positively associated with more experience in farming.

Residency Status

As observed by Adeoti (2002), the residency status of a farming household head positively influenced productivity in the dry savannah agro-ecological zone of Nigeria. This was likely because non-residents were likely to have problems managing their farms effectively, while resident farming household heads, who lived very close to their farms, did not have this problem.

Land Ownership

Closely related to the factor of residency status is the land ownership status of farming households. Adekanye (1988), Ajani (2000), Akinseinde (2006), Babalola (1988), and Olawoye (1988) showed that farmers that owned parcels of land on which they farmed were more productive than non-landowning farming households. This was understandable since farmers that owned land on which they farm were ready to make huge investments on such land through the adoption of new technological packages which enhance productivity levels. Adekanye (1988) provided empirical evidence showing that women had a lower level of productivity than men because they had far less access to land and other productive inputs.

Education

Education is one of the key assets needed to foster productivity in any profession. Findings of Adetiba (2005), Adeoti (2002), Ajani (2000), Ajibefun and Abdulkadri (1999, 2004), Ajibefun et al. (2002, 2006), Amaza (2000), Bravo-Ureta and Rieger (1991), Idjesa (2007), Idumah (2006), and Kehinde (2005) confirmed that education was key to enhanced productivity among farming households in the humid forest, dry savannah and moist savannah agro-ecological zones of Nigeria and in New England. This was likely because good education propels heads of farming households to adopt new innovations and technologies that are vital to enhancing farm productivity.

Social Network

Another key factor vital to enhancing farm productivity is social networks or social capital. Adeyeye (1986) and Idumah (2006) observed that social capital enhanced productivity among crop farmers in the humid forest, dry savannah, and moist savannah agro-ecological zones of Nigeria. This was likely because social capital tends to promote membership welfare and reduce conflict, which is important for enhancing productivity of farming households.

Oil Spillage, Gas Flaring and Effluent Discharge

Oil spillage, gas flaring, and effluent discharge were factors identified by Idjesa (2007) and Idumah (2006) as detrimental to the productivity of farming households. The negative implication of effluent discharge, oil spillage, and gas flaring were quite noticeable in the crop and livestock sub-sectors in the Niger Delta region of Nigeria, where these factors have lead to considerable unrest.

Farm Size

The effect of farm size on farm productivity is inconclusive. Lau and Yotopolus (1971) using the profit function equation found that small farms attained higher productivity levels than larger farms in India. Sahidu (1974) adopted the Lau-Yotopolous model to sample India wheat farms and came up with a contrary conclusion showing large and small farms exhibiting equal levels of productivity. Khau and Maki (1979) using the Lau-Yotopoulous model in Pakistan observed, however, that large farms were more efficient than small farms. Using a normalized profit function and stochastic frontier function, Ajibefun et al (2002) and Mbata (1988) showed that large farm size enhanced productivity among farmers in the dry savannah and humid forest agro-ecological zones of Nigeria.

Crop Mix, Rotation, and Diversification

The issue of crop mix, rotation, and diversification and how it affects agricultural productivity were considered by Amaza (2000), Idjesa (2007), Idumah (2006), Mijindadi (1980), and Udoh (2000). Findings showed that crop mix, rotation, and diversification, when properly adopted, promoted productivity among crop farmers in the dry and moist savannah agro-ecological zones of Nigeria.

Irrigation

Adeoti (2002) and Onyenwaku (1994) considered how irrigation can affect agricultural productivity. Using the Cobb-Douglas production function and stochastic frontier model, both studies observed that productivity was higher on irrigated farms when compared to non-irrigated farms in the humid forest and dry savannah agro-ecological zones of Nigeria.

Gender

The connection between agricultural productivity and gender were well documented in the studies of Adekanye (1988), Babalola (1988), and Odii (1992), and Olawoye (1988). Odii (1992) observed that the contribution of female farmers to agricultural productivity was highly significant. Adekanye (1988) offered evidence of gender differentials in agricultural productivity in Nigeria with women's lower productivity arising from their weak bargaining position within the family and in the labor market. Further support for this gender bias in Africa derives from the fact that women have far less access to land and other productive inputs (Babalola, 1988, Olawoye, 1988).

Dependency Ratio

A high dependency ratio and high ratio of female adult were factors identified by Akinseinde (2006) as detrimental to productivity. Using data envelopment analysis and the Tobit model, the study showed that the higher the dependency ratio and the higher ratio of female adults to all adults living on the farm in the humid forest agro-ecological zone of Nigeria, the lower the farming household productivity.

Labor

Adebayo (2006), Ajibefun and Abdulkadri (2004), Ajibefun et al (2002), Amaza and Olayemi (2002), Dittoh (1991), Ogundele and Okoruwa (2006), and Tella (2006) all assessed how labor affected farm productivity in the dry savannah and humid forest agro-ecological zones of Nigeria. Using analytical tools such as the Cobb-Douglas production function, the normalized profit function approach, and the stochastic frontier model, Amaza and Olayemi (2002), Dittoh (1991), and Tella (2006), observed that the use of hired labor reduced productivity when not properly utilized. Adebayo (2006), Ajibefun and Abdulkadri (2004), Ajibefun et al, (2002), and Ogundele and Okoruwa (2006), however, showed that hired labor contributed positively to farm productivity.

Outside Nigeria, Mochebele and Winter-Nelson (2002) investigated the impact of labor migration on technical efficiency performance of farms in Lesotho. Using stochastic frontier production, the study found that households that sent migrant labor to South African mines were more efficient than households that did not, with a mean technical efficiency of 0.36 and 0.24 respectively. Similarly, Nkonya et al. (2005) observed that pre-harvest labor positively affected crop production in Uganda.

Access to Fertilizer, Agro-Chemicals and Improved Seeds/Planting

Access to fertilizer, agro-chemicals, and improved seeds/planting materials has been proven as an important driver of agricultural production and productivity among farmers in Sub-Saharan African. Using stochastic frontier model, Mbata (1988) and Ogundele and Okoruwa (2006) observed that the use of fertilizer increased agricultural productivity of crop farming in the dry savannah and humid forest agro-ecological zones of Nigeria. Nkonya et al (2005) also alluded to the positive impact of fertilizer. The use of herbicides according to Mbata (1988), Ogundele and Okoruwa (2006) had a positive correlation with technical efficiency or productivity of farmers. However, Tella (2006), using the Timmer and Kopp indices, revealed that the use of chemicals contributed to productivity negatively if not properly utilized.

The use of improved seeds/planting materials on agricultural productivity were also documented in studies of Adewuyi (2002), Idjesa (2007), Ogundele (2003), Ogundele and Okoruwa (2006), and Tella (2006) in the humid forest, moist savannah and dry savannah agro-ecological zones of Nigeria. Findings of Idjesa (2007), Ogundele (2003), and Ogundele and Okoruwa (2006) using the stochastic frontier model revealed that the use of improved seed had a positive impact on the technical efficiencies of crop farmers. This finding was consistent with Nkonya et al (2005), who also showed that purchased seeds had a positive impact on a farmer's productivity in Uganda. Tella (2006), however, showed that improved planting materials when not utilized in the recommended proportion could reduce a farmer's productivity. However, the positive contribution to efficiency of farmers having access to improved planting materials could be reversed if the costs were relatively high and out of the reach of farmers. Adewuyi (2002) using the linear programming and Tobit models observed that the high cost and inadequate supply of input (plant material inclusive) negatively affected productivity.

Access to Roads and Transport

Access to roads and transport is also important to improving productivity. According to Adewuyi (2002) poor roads negatively affected farming households' productivity. Using a related factor, Okike (2000) used the stochastic frontier model to show that the high cost of transportation reduced productivity of livestock farmers in the dry savannah and humid forest agro-ecological zones.

Access to Credit

Another important factor that has been empirically proven to influence productivity is credit. Akinseinde (2006), using data envelopment and the Tobit model, showed that having access to credit facilities contributed positively to a household's production efficiency in the humid forest agro-ecological zone of Nigeria. Similarly, Obwona (2000), using the translog production function, showed that access to credit contributed positively towards the improvement of efficiency among tobacco farmers in Uganda.

Access to Extension Services

Access to extension services has been identified as key to farm productivity in a series of studies. Obwona (2000), using the translog production function, demonstrated that access to extension services by tobacco farmers improved their productivity in Uganda. In contrast, Bravo-Ureta and Rieger (1991) using the stochastic efficiency decomposition model based on Kopp and Diewert's deterministic methodology, concluded that extension services did not markedly affect productivity of farmers in New England. However, the studies of Adewuyi (2002), Ajani (2000), Amaza (2000) and Awotide (2004) all reported that extension services enhanced farmers' productivity in the humid forest and dry savannah agro-ecological zones of Nigeria.

Availability of Nonfarm Income

Akinseinde (2006), using data envelopmental analysis and the Tobit model, showed that nonfarm income earnings affected farm productivity. Specifically the higher the nonfarm income of farming households, the higher the inefficiency of these households in crop farming in the humid forest agro-ecological zone of Nigeria.

Table 1 presents the factors driving productivity and their related studies.

Table 1. Summary of reviewed literature by key factors driving efficiency/productivity.

Factors	Study Area	Author(s)	Impact of factors on Productivity
Age /Years of farming experience	Humid forest Dry savannah Moist savannah India Dry savannah	Idjesa (2007) Adeoti (2002) Ajibefun and Daramola (1999) Ogundele (2003) Coelli and Baltese (1996), Ajibefun and Abdulkadri (1999,2004) Ajibefun et al (2002,2006)	Both factors raise productivity
Residency Status Education	Dry Savannah	Adeoti 2002) Kehinde (2005) Idumah (2006) Idjesa (2007) Adetiba (2005) Ajani (2000) Bravo-Ureta and Rieger (1991) Ajibefun and Abdulkadri (1999, 2004) Ajibefun et al. (2002, 2006) Adeoti (2002) Amaza (2000)	Factor raises productiviyty Factor raises productivity
Social Network	Humid forest, moist and dry savannah	Adeyeye (1986) and Idumah (2006)	Factor raises productivity
Oil spillage, gas flaring and effluent discharge	Moist savannah and humid forest	Idumah (2006) Idjesa (2007) Akinseinde (2006)	Factors reduces productivity
Farm size	Dry savannah humid forestforest India Pakistan South Africa New England	Mbata (1988) Ajibefun et al (2002) Lau and Yotopolous (1971) Sahidu (1974), Khan and Maki (1979)	Factor has inconclusive impact.
Crop mix,rotation, and diversification	Dry savannah Moist savannah	Idumah (2006) Idjesa (2007) Amaza (2000) Mijindadi (1980) Dittoh (1991) Udoh (2000)	Factors raises productivity

Factors	Study Area	Author(s)	Impact of factors on Productivity
Gender	Humid forest	Adekanye (1988) Olawoye (1988) Babalola (1988) Odii (1992)	Factor impact is inconclusive
Labor	Dry savannah humid forestforest Lesotho	Adebayo (2006) Ajibefun et al (2002) Ajibefun and Abdulkadri (2004) Amaza & Olayemi (2002) Ogundele and Okoruwa (2006) Mochebele and Inter Nelson (2000) Mijindadi (1980) Dittoh (1991) Tella (2006)	Factor impact is inconclusive
Availiability of Irrigation	Humid forest	Onyenweaku (1994) Adeoti (2001)	Factor raises productivity
Availiability of Fertilizer	Humid forest	Mbata (1988) Ogundele and Okoruwa (2006)	Factor raises productivity
Availiability of Chemical	Humid forest Dry savannah	Mbata (1988) Ogundele and Okoruwa (2006)	Factor raises productivity
Improved seeds/planning materials	Humid forest Dry savannah Moist savannah	Ogundele and Okoruwa (2006) Ogundele (2003) Idjesa (2007) Tella (2006)	Factor raises productivity
Roads and transport		Adewuyi (2002) Okike (2000)	Factor raises productivity
Access to Credit	Humid forest Uganda	Akinseinde (2006) Obwona (2000)	Factor raises productivity
Extension service	Uganda, New England, Humid forest Dry savannah	Obwona (2000) Bravo-Ureta and Rieger (1991) Ajani (2000) Adewuyi (2002) Amaza (2000) Awotide (2004)	Factors raises productivity
Availability of Nonfarm income	Humid forest	Akinseinde (2006)	Factors reduces productivity
Land Ownership	Humid Forest	Adekanye (1988), Ajani(2000), Akinseinde(2006), Babalola(1988), Olawoye(1988)	
Dependency Ratio	Humid Forest	Akinseinde(2006)	Factors reduces productivity

Overview of the Study Area and Methods

Description of the Study Area

Nigeria is a country with a population of over 140 million (NPC 2006). It is divided into six geopolitical regions: North Central, North West, North East, South West, South East and South South. It can also be divided based on the agro-ecological zones the dry savanah, (North East, North West and part of North Central), the humid forest (parts of South West, South East, North Central and South South) and moist savannah (some parts of South West, South East, and mainly South South). The fourth agro-ecological zone, the mid-altitude is mainly a small part of the North Central Nigeria (IITA, 2000).

Nigeria lies on the West Coast of Africa and occupies approximately 923,768 square kilometers of land and shares borders with Chad, Cameroun, and Benin. The country is made up of 36 states and Abuja, the Federal Capital Territory. The states and the Federal Capital Territory are divided into approximately 774 local government areas. The spatial distribution of the population is uneven, with the majority (63 percent) of the population living in rural areas and the remaining population living in urban areas.

Unlike many other Sub-Sahara African countries, Nigeria has several major urban areas distributed across the entire country. The southwestern region of the country is the most urbanized. However, the northern region is home to the largest city in the country, Kano, with a population of over 3 million. Maiduguri, Kaduna, and Zaria are large cities in the northern part of the country. They provide a large market for farmers in these regions that are far away from the most urbanized southern region. The distribution of Nigeria's major cities is presented in Table 2 below.

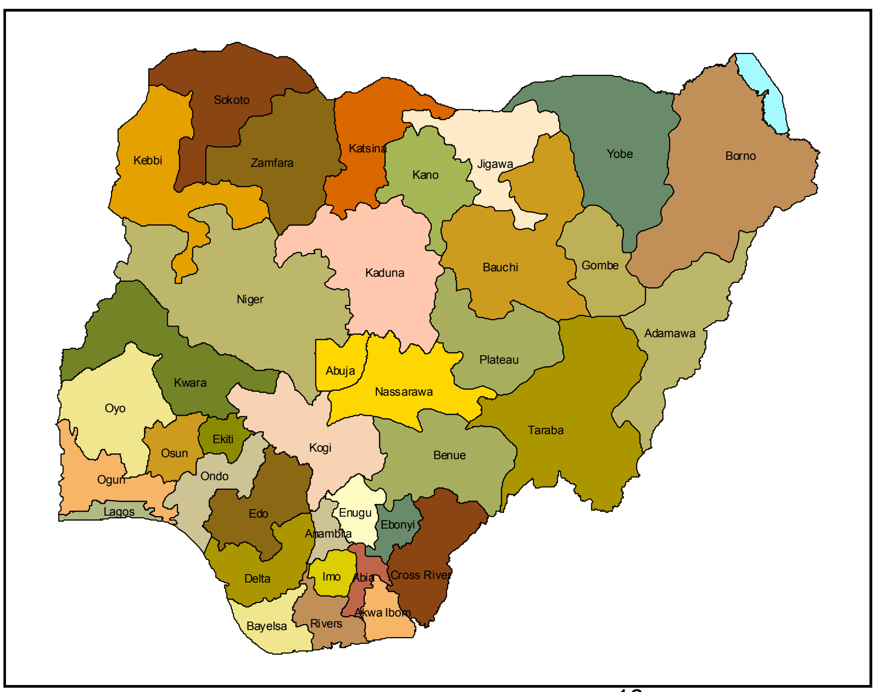
Table 2 Cities and their population and distribution

City	Population	Region
Lagos	8,029,200	Southwestern
Kano	3,248,700	North
Ibadan	3,078,400	Southwestern
Kaduna	1,458,900	North
Port Harcourt	1,053,900	Southwestern
Benin	1,051,600	South-central
Maiduguri	971,700	Northeastern
Zaria	898,900	North-central
Aba	784,500	Southeast
Ilorin	756,400	Southwest
Jos	742,100	North-central
Ogbomosho	726,300	Western
Oyo	620,400	Southwestern

Source: OPM, 2004

With a wide range of climatic, vegetation and soil conditions, Nigeria possesses the potential for wide range of agricultural production. The country is blessed with minerals, forest, and water resources (United Nations, 2004).

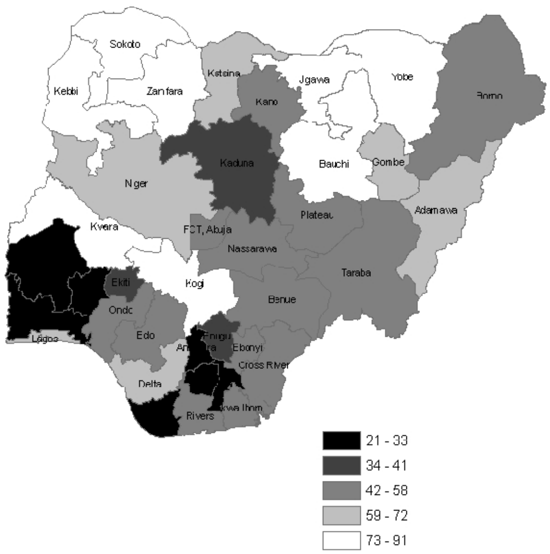
Figure 1. Map of Nigeria



Given that poverty is the overriding challenge that major government programs (such as the National Economic Empowerment and Development Strategy)face, it is interesting to discuss the geographical distribution of poverty within the agricultural sector in Nigeria, as agricultural production is the dominant sector on which the majority of the poor depend. Figure 2 show that the incidence of poverty is highest in northern Nigeria.

The incidence of poverty in southern Nigeria is the lowest. Surprisingly, when Ojowu, et al. (2007) compared the severity of poverty across gender, female-headed households were found to be better off and their level of education was higher than those of male-headed households. Part of the reason for these puzzling results is that the female heads of households were single or widowed women who were more empowered to make decisions. Their higher level of education also contributed significantly to their lower level of poverty.

Figure 2. Incidence of poverty in Nigeria



Source: Ojowu, et al., 2007

These results are contrary to what has been observed in other countries, where female-headed households were always reported to be worse off in poverty rankings (Quisumbing et,al., 2004).

Crop production in Nigeria is dominated by cereal and tuber crops. The most commonly grown crop is the sorghum (guinea corn), which is grown mainly in the northern states. The National Living Standard Survey in 2004, as shown in Table 3, showed that about 28 percent of farmers grew sorghum but 38 percent of the poorest quintile of farmers grew the crop, suggesting this is the crop of the poor. Even though the crop was grown by a large number of farmers, it accounted only for 8 percent of the total daily food consumption.

Cassava is the second most commonly grown crop in Nigeria and is grown both in the northern and southern states. In 2003, cassava contributed the largest share of daily per capita food consumption (1.6kg) in Nigeria (FAOSTAT, 2003). Nigeria is the largest producer of cassava in the world even though production of the crop has remained largely for the domestic and regional markets. Interestingly, in the National Living Standard Survey of 2004, a larger share (40 percent) of farmers in the richest quintile grew cassava compared to only 11percent of the poorest quintile. About 8 percent to 11 percent of farmers also reported to grow beans, yams, maize and millet.

In 2004, Maziya-Nixon reported that maize was the most frequently consumed crop. FAOSTAT (2003) showed that the cereal was the ninth most important contributor to daily food consumption in Nigeria. The importance of maize has been increasing – reducing the dominance of the tuber crops in diets of Nigerians.

Rice is the third most frequently consumed crop in households but it is the sixth most important contributor to daily per capita consumption of food (FAOSTAT 2003). Due to its increasing importance as a food crop, especially to the urban population, the government has designed a number of strategies to reduce the importation of rice. The crop is among the presidential initiative crops.

There are a limited number of farmers who report growing export crops like cocoa, cotton, rubber, palm oil, and ground nuts. Only 2.3 percent of farmers reported to grow cocoa and less than 1 percent grew cotton (FAOSTAT,2003) This underscores the domestic orientation of the agricultural production in Nigeria. Such an orientation is justified by the large urban market in Nigeria, which is one of the most urbanized countries in Sub-Saharan Africa. However, the need to increase production of export crops is also apparent given the high agricultural potential in the country and the dependency of the poor on the agricultural sector.

Table 3 Crops grown across poverty quintiles

Poverty quintile							**% of households consuming per week**
	1	2	3	4	5	Overall	
Percent quantile							
Sorghum	7.8	31.9	27.5	19.3	12.7	28.0	
Cassava	11.2	17.4	22.3	29.9	36.9	21.3	16.5
Beans	16.3	13.2	8.6	6.1	5.3	10.8	
Maize	8.2	8.8	8.9	9.2	11.2	9.0	20.1
Yam	5.6	6.6	10.1	12.8	13.4	8.9	10.4
Millet	1.9	9.7	8.5	5.5	2.6	8.5	
Groundnuts	3.8	4.5	4.3	3.9	3.2	4.0	11.1
Cocoa	1.1	1.6	2.2	3.5	5.3	2.3	
Rice	0.6	1.8	2.0	1.8	1.5	1.5	14.9
Oil palm	0.3	0.9	1.4	1.4	2.1	1.1	
Cotton	0.8	0.9	0.5	0.5	0.6	0.7	
Avocado pears	0.8	0.9	0.4	0.2	0.9	0.6	
Bananas	0.1	0.2	1.0	1.1	1.0	0.6	5.9
Mango	0.3	0.3	0.4	0.5	0.7	0.4	
Leafy Vegetables	0.1	0.0	0.2	0.7	0.5	0.3	
Okro	0.2	0.2	0.4	0.5	0.2	0.3	
Pepper	0.5	0.1	0.2	0.1	0.1	0.2	

Source: National Living Standard Survey, 2004.

* Maziya_Nixon, et al., 2005. The crops with no data were not reported by the source.

Given the discussion above, this report will analyze the four most important staple crops: cassava, maize, rice, and yams. Millet and sorghum are also analyzed, which are key staple crops in the northern states.

Methods

The data source for this paper is from the International Institute of Tropical Agriculture, Ibadan and includes panel data from all 36 states and the Federal Capital territory from 1995 to 2006. Livestock data were not readily available and therefore not analyzed in this report.

Trends of crop productivity were analyzed using graphical methods. Productivity was assessed using land and labor, i.e., the quantity of crop produced per unit area and per labor force. The analysis was done across the three agro-ecological zones in order to identify areas where each crop is best suited. The trend analysis helped to determine the changes across time in order to advice policy makers on the steps needed to ensure food security.

This graphical analysis was complemented by econometric methods to determine the factors that drive productivity over time. The production and factor inputs were reported at the state level. It was not possible to determine the labor and input allocation to specific crops. Hence all crops were converted into a total value of production. The independent variables used were the following: share of female family labor, total family labor, cost of fertilizer used per hectare, cost of seed purchased, share of crop area, and total crop area.

Selection of these explanatory variables was based on other studies of the production function (Prasad, et al., 2006, Reardon and Vosti 1995, Carter and Barrett, 2006). These models showed that crop yield is a function of production technology used; biophysical characteristics (rainfall intensity and pattern, soil characteristics, altitude and/or temperature, etc.); household human, social and physical capital endowment; and access to agricultural services (extension services, markets, etc). Production technologies used were represented by the value of purchased seeds and fertilizer. Human capital endowment was represented by the family labor while crop area and total area were represented the household capital endowment. However, data on many socio-economic characteristics were not available or not relevant at the state level. The agro-ecological zones were used to account for the biophysical factors. The following is the general functional form of the models:

$$Y_{ti} = \square 0 + \square 1 X_{ti} + \square 2 Z_{ti} + e_{ti} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where Yti is a vector of value of production per unit factor i, i = 1, 2. The factors considered in this study were land and labor:

Xti = a vector of random explanatory variables (labor, fertilizer, seeds, area)

Zti = a vector of fixed factors (agro-ecological zones)

eti = a vector of error terms for equation, i = 1, 2.

b1= a vector of factors associated with explanatory variables.

The model was tested to see if it was better with fixed effects (agro-ecological zones) than without random effects

$$Y_{ti} = b_0 + b_1\ b_1 X_{ti} + e_{ti} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The Breusch-Pagan random effects test showed that the model with random effects was biased. Hence the fixed effect model results are used in the discussion.

Equation (1) is a cross-sectional time series model since time series data were available for each of the 36 states and the federal capital territory. A double log model functional form was used. This addressed the skewed distributions that were common for all continuous variables.

The first order autocorrelation was tested and found to be significant at $p = 0.01$ for all models considered. Heteroscedasticity was also significant at $p = 0.05$ for the fixed effect model and at $p = 0.01$. Hence the generalized least square (GLS) approach was used to addresses both heteroskedasticity and autocorrelation. The advantage of GLS is that it is not necessary to know the nature of autocorrelation or heteroskedasticity.

The initial model assumed the change in productivity was linear, therefore, a time trend from 1994 – 2005 was included. Results of this model would help to determine the rate of productivity change each year. However, if the results show that such changes are non-linear a model that included each year as a dummy variable will be run without a constant variable.

Results and Discussion

This paper examines the trends in and drivers of agricultural productivity in Nigeria between 1995 and 2006. For the trend analysis, six staple food crops were selected on the basis of their importance in providing food security: maize, cassava, rice, yams, millet, and sorghum. Cassava and rice are among the presidential initiative crops. The other presidential initiative agricultural commodities are vegetable oil, tree crops, livestock, fisheries, and aquaculture. Additional crops were used for the panel regression analysis: beans, sorghum (guinea corn), cocoyam, melon, cotton, and groundnut. The trend data for crops are discussed within the temporal and spatial contexts. As discussed earlier in the theoretical framework of this paper, "productivity" was defined as resource productivity (using the concept of average production methodology, i.e., output/hectare estimates) and also interchangeably used with the word "efficiency.". This paper therefore first analyzes the trends in land productivity of selected crops, then discusses labor productivity, and ends with the panel regression analysis.

Land Productivity

As shown in Figure 3, with respect to land productivity of yams, the dry savannah and the humid forest agro-ecological zones were the two zones that made the best use of land over the 12 years considered. The dry savannah agro-ecological zone, however, had a slight advantage over the humid forest agro-ecological zone during the 2001-2002 farming year. The humid forest agro-ecological zone had a slight advantage in the use of land for yam production over the other two agro-ecological zones during the farming periods of 1995-1999 and 2003-2006.

One of the main reasons for the efficient use of land for yam production in these two zones is probably because yam is widely cultivated in the North Central geopolitical zone of Nigeria (a key part of the dry savannah agro-ecological zone) and some parts of southwestern and eastern Nigeria (which are main constituencies of the humid forest agro-ecological zones). These areas have weather and soil characteristics that support the cultivation of yam. However a cross-sectional data collected in 2007 from 12 states representing all agro-ecological zones showed that the moist savannah farmers reported the highest yam yield (Table 4). Even though these results are based on cross-sectional data, they reflect better land productivity since the data used had labor and other input allocations to each crop. The results also imply that yam is suitable in all three agro-ecological zones. This is expected given that yam is a drought tolerant crop. It should be noted however that in terms of output, the North Central zone of Nigeria ranked in the top bracket of producers of yam.

Regarding the use of land for maize production, the humid forest agro-ecological zone comprising of mainly the South West and South East geopolitical zones of Nigeria stood out over the years considered except for the years 1995 and 1997 when the moist savannah agro-ecological zone recorded the highest maize productivity per hectare. The Fadama II/IFPRI data that linked all inputs to outputs also showed the humid forest zone having the highest maize productivity per hectare (Table 4). However, the humid forest accounted for only 13 percent and the rest of the maize was produced in the dry savannah (NBS raw data, 2005). The results are not surprising given the humid forest zone has high organic matter soils and high rainfall.

In terms of land productivity assessments of cassava by agro-ecological zone, the humid forest zone recorded the highest cassava yield per hectare. Its productivity value was greater than other agro-ecological zones by an average of one ton/hectare over the years considered in the study. The main reason for this is that efforts of farmers in the zone have been greatly aided by the humid climate and soil characteristics of the humid forest agro-ecological zone as well as the efforts of agricultural research institutions and universities located in this zone with mandates of developing high-yielding cassava varieties.

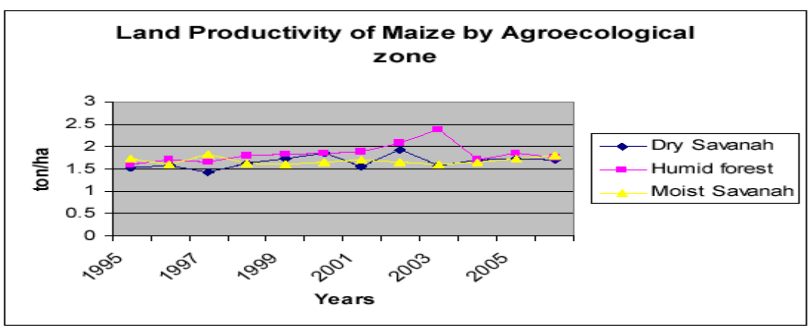
However, the Fadama II/IFPRI data showed that the moist savannah zone reported the highest cassava yield and the humid forest zone reported the second highest yield. The high yield in the moist savannah could have been due to the drought tolerance of the cassava. Farmers in the moist savannah also produce crops using supplemental irrigation in the lowland floodplains (fadama). The floodplains also receive eroded nutrients from upstream, which enriches the fertility of soils in the savannah zones. Fadama II/IFPRI data were collected from the fadama (lowland flood-plains) and could explain the better performance of cassava producers compared to those in the humid forest.

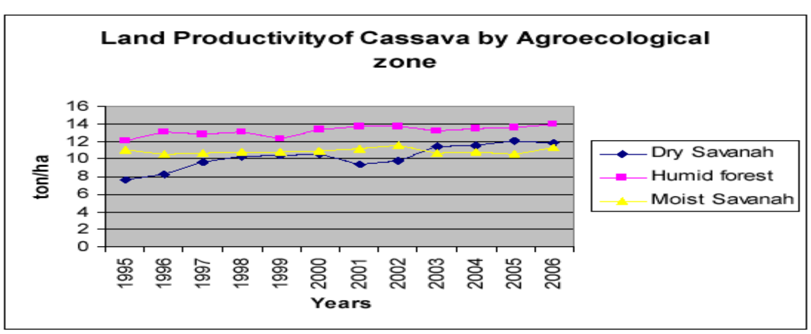
The moist savannah agro-ecological zone of Nigeria made the best use of land for the production of rice among the three agro-ecological zones of the country. However, the humid forest agro-ecological zone during the years of 1995, 1998, 1999, 2002, 2004, and 2005 was almost as efficient as the moist savannah zone in the use of land for the production of rice. This is because these two areas support upland and wetland rice production practices, which are also complemented by humid weather and soil characteristics that support the cultivation of rice.

In reviewing the productivity of millet, the dry savannah agro-ecological zone made the best use of land for millet production among the three agro-ecological zones. However, the humid forest agro-ecological zones showed slight promises in terms of the use of land for millet cultivation from 2003 to 2006.This is because millet is widely consumed in the northern part of the country and also because the weather and soil characteristics of the dry savannah zone suit the cultivation of millet.

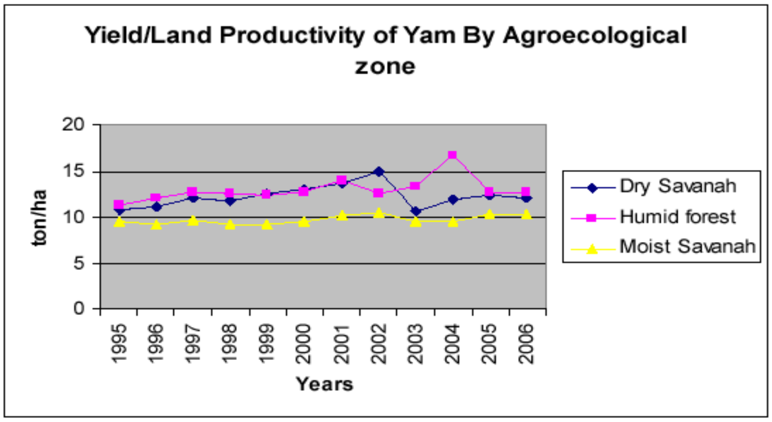
In reviewing the productivity of sorghum within the agro-ecological zones, the dry savannah agro-ecological zone made the best use of land for sorghum production among the three agro-ecological zones. This is because sorghum is widely consumed in the northern part of the country and the weather and soil characteristics of the dry savannah zone suit the cultivation of sorghum. The above-mentioned findings are represented in Figure 3 below.

Figure 3: Land productivity of maize, cassava, rice, yam, millet, and sorghum by agro-ecological zone

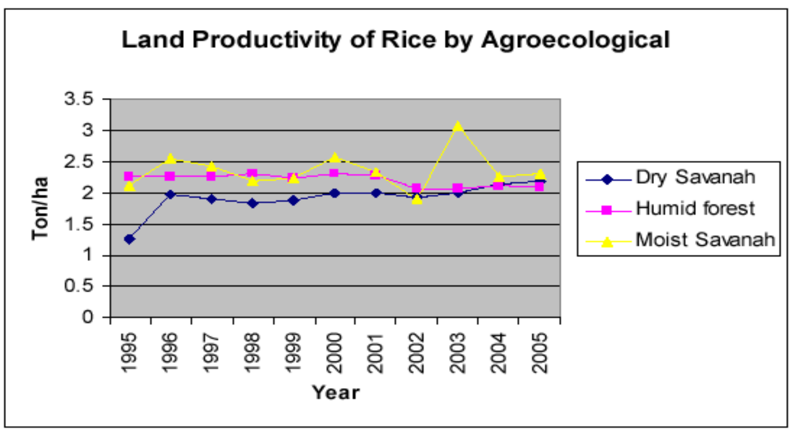




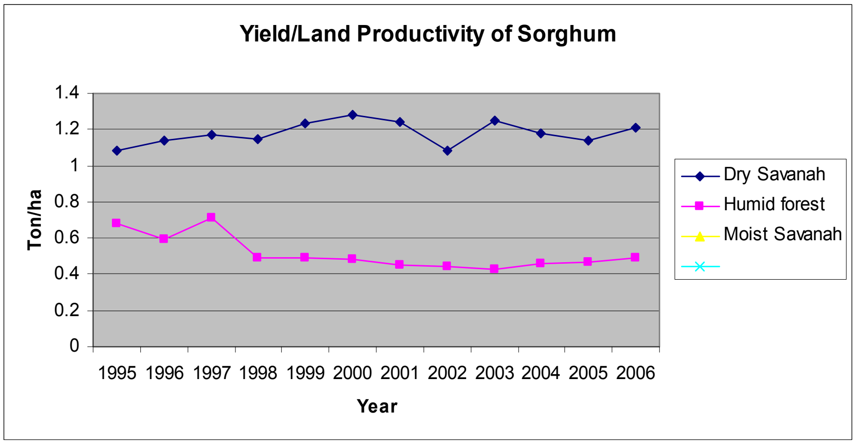
Source: Land Productivity estimates. IITA, 1995-2006



Source: Land Productivity estimates. IITA, 1995-2006



Source: Land Productivity estimates. IITA, 1995-2006



Source: Land Productivity estimates. IITA, 1995-2006

Table 4 Value of crop produced/hectare across agro-ecological zones

Crop	Full sample	Humid forest	Moist savannah	Dry savannah	Pairwise Mean Comparisons
Maize	38,107 (n=905)	46,800 (n=78)	40,860 (n=223)	35,968 (n=604)	
Rice	88,175 (n=520)		49,943 (n=114)	97,590 (n=401)	
Cassava	91,474 (n=307)	97,046 (n=145)	128,966 (n=98)	21,439 (n=64)	Bc
Yam	210,466 (n=222)	135,772 (n=60)	247,816 (n=133)	193,711 (n=29)	

Key: a= difference between humid forest and moist savannah is statistically significant (p<0.05

b =difference between humid forest and dry savannah is statistically significant (p < 0.05)

c = difference between moist savannah and dry savannah is statistically significant (p < 0.05)

Source: Fadama II/IFPRI impact assessment survey data

Labor Productivity

Theoretically, labor is one of the important inputs that must be considered when discussing agricultural production in Nigeria. Land, because it is scare, is arguably the most important input in production. Thus, land and labor are essential inputs in any study of agricultural production, as such, assessing the labor productivity of the six crops was considered essential in this study. This paper therefore discusses the labor productivity of the six selected crops over a 12-year period. It must be noted, however, that the study did not have access to estimates of labor used for each crop enterprises. Therefore, in interpreting the results, caution must be taken to interpret labor used as output/labor employed if all labor were made available to each crop.

Results of labor productivity for yam by agro-ecological zones revealed that the dry savannah agro-ecological zone had the highest labor productivity estimates from 1997 to 2003. The humid forest agro-ecological zone however had the highest labor productivity estimates for yam between 2004 and 2005. These two agro-ecological zones had the same/best labor productivity estimates in 1996 and 2006. This is because inhabitants of the North Central geopolitical region of Nigeria (a key region of the dry savannah agro-ecological zone) and the South West geopolitical region of Nigeria (a key region of humid forest agro-ecological zone) possess high quality education, and the human capacity potential is complemented with research efforts of several agricultural-related research institutes, universities, and colleges of agriculture located in these two zones with the mandate of improving yam production. Examples of such institutions include the Universities of Agriculture, Abeokuta and Makurdi, the Faculties of Agriculture, University of Ibadan and Obafemi Awolowo University, the Colleges of Agriculture in Ibadan and Akure, and the Institute for Agricultural Research and Training in Ibadan.

The implication of this result is that the dry savannah and humid forest agro-ecological zones would make better use of labor than the moist savannah agro-ecological zones if all farm labor in Nigeria over the 12 years considered were made available only to yam production.

Findings also showed that the dry savannah agro-ecological zone was the most productive in terms of labor use for maize production among the three zones. The humid forest zone was the next in terms of efficient use of labor in producing maize behind the dry savannah agro-ecological zone. The moist savannah agro-ecological zone was the least productive in terms of the use of labor for maize production.

The low use of labor for yam, maize, and rice in the moist savannah zone can be traced to the fact that labor in the Niger delta region, which constitutes mainly the moist savannah region, has a high opportunity cost, since the agricultural sector in this zone has to compete with other high-paying sectors of the country such as oil for labor.

The trend in labor use among the three agro-ecological zones for cassava was not the same as observed in the use of labor for maize and yam. Results showed that the humid forest agro-ecological zone led the other two zones in the use of labor for cassava production. The dry savannah and the moist savannah agro-ecological zones competed with each other in the use of labor for cassava--the moist savannah zone was a better user of labor for cassava from 1995 to 1997, while the dry savannah region was better in the use of labor for cassava from 1998 to 2001 and from 2002 to 2006. This laboris because most natives of this agro-ecological zone depend on foodstuffs derived from cassava as their staple food.

As the case was with yam and maize, the dry savannah agro-ecological zone made the best use of labor resources when production of rice was taken into consideration among the three agro-ecological zones. The humid forest agro-ecological zone was next (in distant second) in terms of efficient use of labor for rice production.

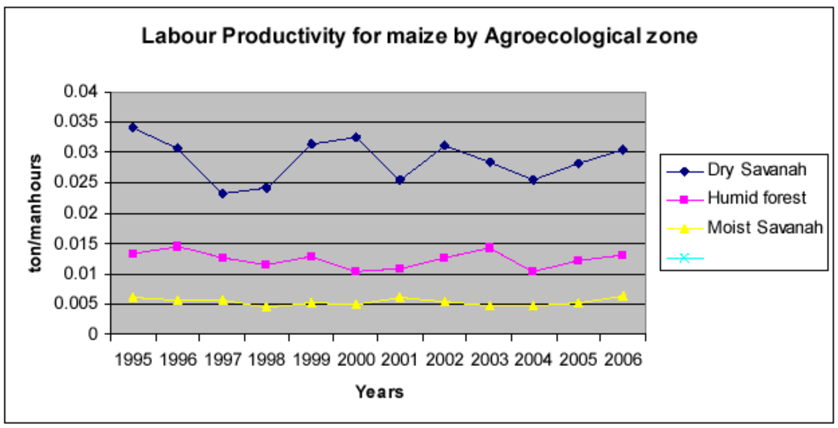
Though rice is widely consumed among the three agro-ecological zones, one reason that might account for the dry savannah region being the most efficient user of labor is the fact that this agro-ecological zone is blessed with a vast expanse of land suitable for the cultivation of rice as well as sound infrastructural support (such as irrigation and processing facilities provided by Fadama and other related projects). The value for rice labor productivity in the moist savannah region could be traced to negative effects of effluent/oil spillage activates of oil-prospecting firms in the Niger Delta region as well as the high opportunity cost of labor in this region.

Results regarding the labor productivity of millet showed that the dry savannah agro-ecological zone reported the highest labor productivity for millet production in Nigeria. This result was expected since this crop is widely consumed in the North East, North West and North Central regions of Nigeria that largely makes up the dry savannah region. The use of labor for millet in the humid forest agro-ecological zone was very low all through the years considered except between 1995 and 1996. This is due to the low production of millet in the humid zone since the zone is densely populated. Since labor productivity was computed by simply dividing the total production by the number of labor, the labor productivity was low. This is one of the weaknesses of computing labor productivity using aggregate labor data that do not show labor allocation to specific crops.

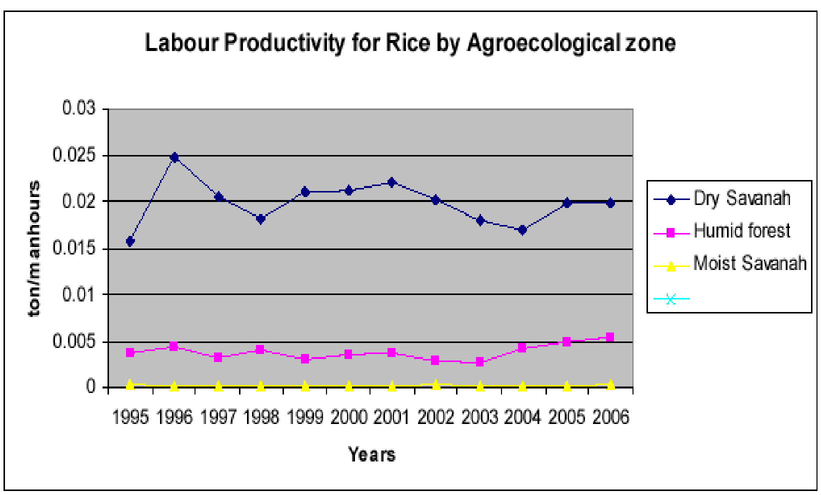
With respect to labor productivity for millet, the dry savannah agro-ecological zone had the highest labor productivity estimates for sorghum production in Nigeria. This result was expected since this crop is widely consumed in the North East, North West and North Central zones of Nigeria that largely makes up the dry savannah region. The use of labor for sorghum in the humid forest agro-ecological zone was relatively low during the years considered except in 1995 and 1996. This is due to the low production level of sorghum in the humid zone. It should be noted that the moist agro-ecological zone had no estimates of labor productivity since sorghum is hardly cultivated in this zone.

In summary, it was found that labor was best utilized for production of yam, rice, maize, sorghum, and millet in Nigeria by the dry savannah agro ecological zone, while the use of labor for cassava was best achieved in the humid forest agro ecological zone. The moist savannah agro- ecological zone was lacking behind over the years studied in terms of use of labor for the six crops. The above-mentioned findings are represented in Figure 3 below.

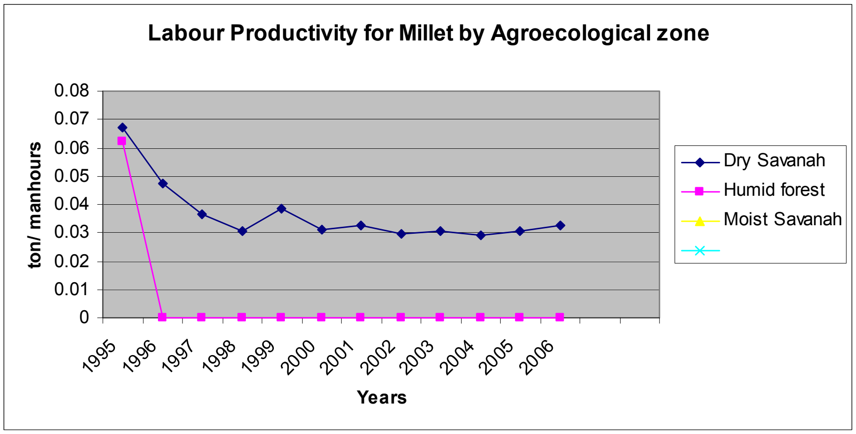
Figure 4. Labor productivity for maize, cassava, rice, sorghum, and millet by agro-ecological zone



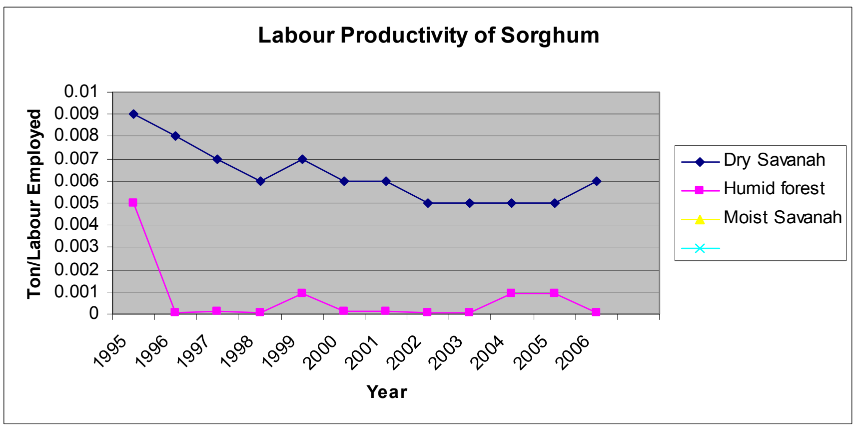
Source of labor Productivity estimates. IITA, 1995-2006



Source of labor Productivity estimates. IITA, 1995-2006



Source of labor Productivity estimates. IITA, 1995-2006



Source of labor Productivity estimates. IITA, 1995-2006

Regression Analysis Results (Drivers of Productivity)

Consistent with other studies (Barrett, 1996; Lamb, 2003; Nkonya, et al., 2005), the regression analysis found an inverse relationship between farm area and crop productivity. The findings suggest that small land-holding farmers have higher land productivity, and that large land-holding farmers face constraints (agricultural market imperfections, e.g., labor and input markets, access to credit, etc.) that limit them to achieve optimum use factors of production (marginal cost of factor of production =price of output). This suggests the need to improve rural services in order to help farmers with larger farms to increase productivity of their land and labor. The results also suggest the need to improve access to land for smaller farms, which under the current market imperfections, are more efficient than the larger farms. However, the higher productivity that the small land-holding farmers achieve may not mean that they have higher income than the large land-holding farmers. For example, even though Nkonya, et al., (2005) observed the inverse relationship between farm area and productivity, they also observed that farm area was inversely associated with per capita household income.

The analysis also showed that the share of the female labor was positively associated with productivity suggesting higher productivity of the female labor. This is consistent with other studies that have shown higher productivity of female labor for staple food crops (Quisumbing, et al., 2005; Ojowu, et al., 2007). The results confirm the important role that female farmers play in food production and ensuring food security. The share of female family labor, and total labor did not significantly affect crop productivity for the model without the linear time trend. As expected however, total labor productivity was positively associated with productivity for the linear time trend model. Reasons for the nonsignificant impact of the total family labor are not clear.

Fertilizer use was positively associated with productivity but the association was not significant at p= 0.10. The non-significant impact of fertilizer on crop productivity is also not clear.

Table 5. Log value of crop production per ha

	Without time trend			**With time trend**		
Explanatory variables	OLS random effects	OLS fixed effects	GLS with Fixed state effects	OLS random effects	OLS fixed effects	GLS with Fixed state effects
Log crop area	-0.078**	-0.095***	-0.054**	-0.067*	-0.047	0.013
	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.03)
Share female labor	0.472**	0.509**	0.159	0.624**	0.814***	0.415**
	(0.22)	(0.24)	(0.21)	(0.24)	(0.26)	(0.21)
Log total labor	0.094	0.033	-0.06	0.305***	0.318***	0.189***
	(0.07)	(0.10)	(0.08)	(0.07)	(0.09)	(0.06)
Log fertilizer cost per ha	0.028	0.015	0.005	0.037*	0.018	0.005
	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)
Log seed cost per ha	0.244***	0.294***	0.322***	0.544***	0.628***	0.775***
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)
Share of crop area (Cf Maize):						
Cocoyam	-0.086	0.071	-0.035	-0.594	-0.542	-0.448
	-0.471	-0.477	-0.32	-0.519	-0.538	-0.322
Melon	-0.503	-0.655	-0.451	-1.647***	-1.753***	-0.900***
	(0.58)	(0.58)	(0.32)	(0.64)	(0.64)	(0.33)
Rice	0.769**	0.789***	0.656***	0.611*	0.642*	0.427
	(0.31)	(0.30)	(0.24)	(0.34)	(0.34)	(0.27)
Cassava	0.274	0.272	0.739***	-0.266	-0.311	-0.04
	(0.35)	(0.36)	(0.26)	(0.39)	(0.40)	(0.28)
Cotton	-0.994	-1.398	-0.062	-1.517	-2.295	-0.543
	(1.35)	(1.36)	(0.93)	(1.47)	(1.52)	(1.17)
Yam	0.830**	0.980**	0.813***	-0.558	-0.57	-0.831***
	(0.40)	(0.43)	(0.29)	(0.41)	(0.44)	(0.27)
Bean	-0.825**	-0.863**	-0.857***	-1.118***	-1.404***	-1.548***
	(0.36)	(0.37)	(0.25)	(0.40)	(0.42)	(0.28)
Groundnut	-0.397	-0.467	-0.418	-0.890*	-1.085**	-0.886***

	(0.42)	(0.43)	(0.26)	(0.46)	(0.48)	(0.29)
Sorghum	-0.865**	-0.858**	-0.855***	-1.003**	-1.278***	-1.394***
	(0.35)	(0.37)	(0.23)	(0.39)	(0.42)	(0.26)
Millet	0.025	0.027	0.01	-0.221	-0.538	-0.733***
	(0.32)	(0.34)	(0.23)	(0.36)	(0.38)	(0.28)
Agro-ecological Zones (Cf Humid forest)						
Dry savannah	-0.353			-0.135		
	(0.29)			(0.31)		
Moist savannah	0.008			-0.098		
	(0.18)			(0.20)		
Year (Trend)				-0.021***	-0.017***	-0.008**
				(0.00)	(0.01)	(0.00)
Y1994	13.213***	13.827***	14.209***			
	(0.69)	(0.95)	(0.74)			
Y1995	13.007***	13.631***	14.000***			
	(0.69)	(0.96)	(0.74)			
Y1996	13.123***	13.751***	14.124***			
	(0.70)	(0.97)	(0.75)			
Y1997	13.249***	13.873***	14.241***			
	(0.70)	(0.97)	(0.76)			
Y1998	13.202***	13.830***	14.193***			
	(0.70)	(0.97)	(0.75)			
Y1999	13.187***	13.823***	14.216***			
	(0.70)	(0.98)	(0.76)			
Y2000	13.066***	13.707***	14.109***			
	(0.70)	(0.97)	(0.76)			
Y2001	13.015***	13.654***	14.063***			
	(0.70)	(0.97)	(0.75)			
Y2002	12.973***	13.621***	14.027***			
	(0.70)	(0.98)	(0.76)			
Y2003	12.926***	13.583***	13.966***			
	(0.71)	(0.99)	(0.77)			
Y2004	12.853***	13.513***	13.902***			
	(0.71)	(0.98)	(0.76)			
Y2005	12.756***	13.422***	13.827***			
	(0.71)	(0.98)	(0.76)			
Constant				56.678***	47.534***	30.360***
				(7.66)	(8.67)	(6.16)

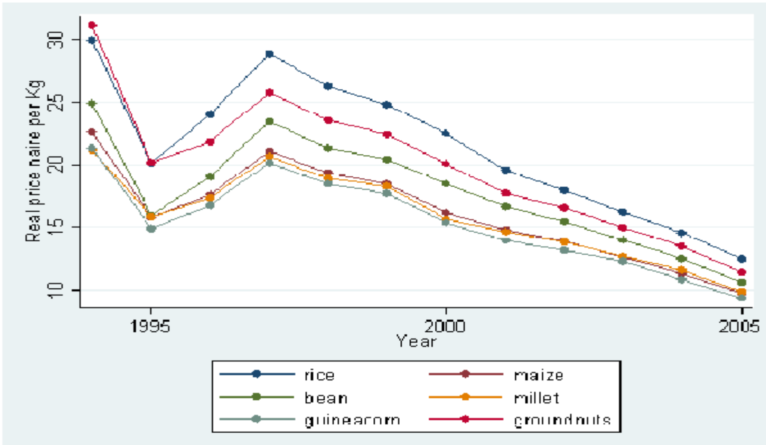
Number of observations	431	431	431	431	431	431
Hausman test (P-value)		0.555			0.013***	
Breusch-pagan LM random effects test (P-value)	0.000***			0.000***		
Wooldridge test Ho: No first-order autocorrelation (p-value)	0.000***	0.000***		0.000***	0.000***	
Breusch-pagan test Ho: Homoscedasticity (P-value)	0.019**	0.000***		0.083*	0.000***	

The time trend regressions also showed a significant negative productivity trend (-0.8 percent per year in the GLS model, which is the preferred model due to significant autocorrelation and heteroskedasticity). The time dummies regressions also showed a negative time trend. The reason for this could have been due to falling real agricultural prices in Nigeria. (Figure 6). However, recent food prices have increased dramatically. Hence, there is a need for using more recent price data to validate this trend. The negative time trend of productivity could also be due to the falling agricultural productivity due to declining soil fertility and expansion into marginal areas (Ojowu, et al., 2007).

The results of the models with year dummies show that crop area had a slightly negative and significant association with the value of production. Hence, a 1 percent increase in crop area reduced productivity only by 0.054 percent. Results also showed that as seed cost per hectare increased so did the value of production. However, compared with crop area, seed cost per hectare had a higher return since a 1 percent increase led to a 0.322 percent increase in productivity. This result might imply that Nigerian farmers are likely to be more efficient in the use of seed than land for selected crop production during the specified years.

On the competitiveness of the selected crop, results showed that rice, cassava, and yams recorded higher value of production per unit area than maize. Both rice and cassava are among the presidential crops and maize is not. The results justify the inclusion of rice and cassava in the presidential initiative crops. However, given the growing importance of maize, there is a need for increased investment in the production of maize in Nigeria. Results also show that the value of production per hectare for maize was higher than that of beans and sorghum. This demonstrates the economic importance of maize and the need to invest more in the cereal to respond to the growing demand and the recent price increase of maize due to the bioenergy and other factors.

Figure 5. Trend of real price of crops from 1995 – 2005.



Source, IITA 1995-2006

Conclusions and Policy Implications

The agricultural sector in Nigeria has grown in the past decade, mainly due to area expansion (Ojowu, et al., 2007) and to a limited extent improved agricultural productivity. The government has designed a number of policies and strategies to reduce poverty and improve food security. Nigeria has the potential to improve food security given its diverse agro-ecological zones, the large and well-distributed urban market, and an oil sector that could create forward linkages with agriculture. The National Economic Empowerment and Development Strategy (NEEDS II) plans to eliminate food imports by 2011 and significantly reduce poverty. Achievement of this strategy requires the adoption of improved production technologies by removing the constraints that limit the use of improved technologies.

Results from our study suggest that the share of female family labor increases agricultural productivity, suggesting the need for increasing agricultural services among women. For example, a study in Nigeria showed that male extension agents tended to provide extension services to male farmers rather than to female farmers (Lahai et al. 2000). This significantly limits women's access to extension services. As expected, female extension agents tended to provide advisory services to women rather than to male farmers (Ibid). However, the number of female extension service providers is much smaller than the case of male providers. This calls for the need to increase the number of female extension service providers, who in turn will increase advisory services to women farmers.

The relationship between farm size and productivity suggests that small-scale farms are efficient and therefore need to be facilitated to have access to land and agricultural services. Similarly, the low productivity of large-scale farms implies imperfect factor and credit markets and the need for improvements in these areas. To minimize costs and increase returns to a myriad of rural development investments, such efforts should be well-coordinated and taken in conjunction with other agricultural and nonagricultural programs and strategies. For example, public investment in agriculture in Nigeria remains low (Mogues, et al., 2008) and will definitely not address the needs of the farmers without substantial increases in the current budget and/or coordination with other non-agricultural programs.

This study also shows that cassava and rice, two of the presidential crops, have higher returns than maize. These results justify the inclusion of cassava and rice in the presidential initiative. However, exclusion of maize in the presidential initiative also needs to be reconsidered given the increasing demand for it and the current efforts to use maize to produce ethanol. The price of maize has increased dramatically and has likely increased its competitiveness compared to the presidential initiative crops.

This study also observed that the humid forest and dry savannah agro-ecological zones of Nigeria are more efficient in the use of land for the production of yam, sorghum, and millet, while land is best used for the production of cassava and rice in the humid forest and moist savannah agro-ecological zones. It was also concluded that maize can be cultivated widely among the three agro-ecological zones. With respect to labor use, the humid forest and dry savannah zones are more efficient in the use of labor for the production of yam, maize, cassava, rice, sorghum, and millet.

Table 6. Consumption of food (grams/person/day)

	1969-1971	1979-1981	1990-1992	1993-1995	1995-1997	2001-2003	Share of total consumption
1.Cassava & products	233	211	330		364	318	0.21
2. Yams	210	78	182		218	208	0.13
3. Vegetables, other & prod	123	92	109		130	133	0.09
4. Sorghum & products	137	98	109		131	120	0.08
5. Millet & products	118	77	102		110	97	0.06
6. Rice & prod (milled eq.)	12	49	66		60	74	0.05
7. Citrus fruit nes & prod.	65	65	64		65	63	0.04
8. Fruit, other & products	67	64	64		63	58	0.04
9. Maize & products	43	19	98		87	57	0.04
10. Wheat & products	17	47	16		24	50	0.03
11. Plantains	56	44	41		45	47	0.03
12. Sweet potatoes	6	3	4		26	40	0.03
13. Sugar & prod. (raw eq.)	8	31	16		20	30	0.02
14. Pulses, other & prod.	25	15	24		26	26	0.02
15. Tomatoes & products	11	13	10		14	20	0.01
16. Pineapples & products	29	23	22		19	18	0.01
17. Roots&tubers,oth & prod.	15	2	5		7	18	0.01
18. Palm, oil	28	21	18		18	17	0.01
19. Milk, whole	10	20	9		10	14	0.01
20. Onions, dry	21	17	15		14	14	0.01
21. Groundnut, oil	8	3	11		10	11	0.01
22. Pelagic fish & products	2	23	5		9	10	0.01
23. Eggs & products	6	7	10		8	9	0.01
24. Potatoes & products	1	1	1		2	9	0.01
25. Groundnuts (shelled eq.)	7	7	6		7	8	0.01
26. Soyabeans & products	2	2	4		6	7	0.00
27. Meat & products, bovine	11	15	6		8	6	0.00
28. Nuts & products	9	7	5		5	6	0.00
29. Palm kernel, oil	0	2	5		6	6	0.00

30. Meat & prod, sheep&goat	2	4	5		5	5	0.00
31. Demerseal fish & prod.	6	20	17		7	4	0.00
32. Freshwater fish & prod.	5	5	3		4	4	0.00
33. Meat & products, pig	2	2	3		4	4	0.00
34. Meat & products, poultry	3	6	5		5	4	0.00
35. Milk, skim	12	20	8		6	4	0.00
36. Oilcrops, other oil	1	2	4		4	4	0.00
37. Oilcrops, others	2	2	4		5	4	0.00
38. Meat & prod, other anim.	6	4	3		3	3	0.00
39. Cereals,others &products	1	1	1		1	2	0.00
40. Coconuts & copra	3	2	1		1	2	0.00
41. Offals, edible	2	2	2		2	2	0.00
42. Spices, other	0	0	2		2	2	0.00
43. Crustaceans & products	0	0	0		0	1	0.00
44. Fats, animals, raw	0	1	1		1	1	0.00
45. Marine fish, oth & prod	1	1	2		1	1	0.00
46. Pimento	2	2	1		1	1	0.00
47. Sugar cane	1	1	3		1	1	0.00
48. Sweeteners, other & prod	0	1	1		1	1	0.00
49. Whey & products	2	2	3		4	1	0.00
Total daily consumption (grams/person/day)						1545	

Source: FAOSTAT. 2003. Food Security

References

Adebayo, E.F. (2006) Resource use efficiency and multiple production objectives of dairy pastoralists in Adamawa state, Nigeria. Unpublished PhD thesis, University of Ibadan.

Adekanye, T.O. (1988) Women in African Agriculture. *African Notes*, Special No. 3. Women Research and Documentation Centre, Institute of Africa Studies, University of Ibadan, Nigeria.

Adeoti, A.I. (2002) Economic analysis of irrigation and rainfed production systems in Kwara state, Nigeria. Unpublished PhD thesis, Department of Agricultural Economics, University of Ibadan.

Adetiba, T.O. (2005) Productivity and technical efficiency among small scale fish farmers in Ibadan metropolis. Unpublished MSc. thesis, Department of Agricultural Economics, University of Ibadan.

Adewuyi, J. (2002) Resource-use productivity on food crop production in Kwara state, Nigeria. Unpublished PhD thesis,Department of Agricultural Economics, University of Ibadan.

Adeyeye, V A. (1986). Relative economic efficiencies in farm organizations. A comparative study of co-operative and non-cooperative farms in Oyo and Kwara state Nigeria. Unpublished PhD Thesis, Department of Agricultural Economics, University of Ibadan.

Ajani, O.I.Y. (2000) Resource productivity in food crop farming in the northern area of Oyo state, Nigeria. Unpublished PhD Thesis, Department of Agricultural Economics, University of Ibadan.

Ajibefun I. A. and A. O. Abdulkadri. (2004) Impact of size farm operation on resource use efficiency in small scale farming: Evidence from south western Nigeria. Journal of Food, Agriculture and Environment Vol. 2, No. 1, pp. 359-364.

Ajibefun J. A., G. E. Battese and A.G. Daramola. (1996) Investigation of Factors Influencing Technical Efficiency of Small Holder Croppers in Nigeria. CEPA Working Paper. No. 10/96. Department of Econometrics, University of New England, Amidale, Australia.

Ajibefun, I. A. and A.G. Daramola. (1999) Efficiency of Micro-enterprise in the Nigerian Economy. Research Paper No 134, African Economic Research Consortium Nairobi, Kenya.

Ajibefun, I. A. and O. A. Abdulkadri (1999) An investigation of technical efficiency of farmers under the National Directorate of Employment in Ondo state, Nigeria. Applied Economics Letter, Issue 6, pp.111-14, Routledge, London.

Ajibefun, I. A., Battesse G. E. and A.G. Daramola. (2002) Determinants of technical efficiency in small holder food crop farming: Application of stochastic frontier production function. Quarterly Journal of International Agriculture Vol. 41, No. 3, pp. 225-240.

Akinseinde. (2006) Nonfarm activity and production efficiency of farm household in Egbede local government of Oyo state, Nigeria. An unpublished MSc project, Department of Agricultural Economics, University of Ibadan.

Amaza P.S. (2000) Resource use efficiency in food crop production in Gombe state, Nigeria. Unpublished PhD thesis, Department of Agricultural Economics, University of Ibadan.

Amaza, P. S. and J. K. Olayemi. (2002) Analysis of technical inefficiency in food crop production in Gombe state, Nigeria. Applied Econs Letter Vol. 9, No. 1, pp. 51-54.

Awotide O.D. (2004) Resource use efficiency and inputs institutions in upland rice production in Ogun State, Nigeria. Unpublished PhD Thesis, Department of Agricultural Economics, University of Ibadan.

Babalola, A.S. (1988) Tobacco Farming and Women in Rural Community in Nigeria. African Note, Special Number 3, Women Research and Documentation Centre, Institute of African Studies University of Ibadan, Nigeria.

Battesse. G.E (1992) 'Frontier Production Function and Technical Efficiency 'A Survey of Empirical Applications in Agricultural Economics'. *Agricultural Economics* Vol 7: 185-208.

Barrett, C.B. 1996. On price risk and the inverse farm size-productivity relationship. Journal of Development Economics, Vol 51, pp. 193-215.

Benin, S. and, J. Pender. (2006) Collective action in community management of grazing lands: The case of the highlands of northern Ethiopia. Environment and Development Economics Issue 11, pp.127-149.

Bravo-Ureta, B.E. and Rieger, C. (1991) Diary farm efficiency measurement using stochastic frontier and neo-classical duality. American Journal of Agricultural Economics Vol 73, No 1, pp 421-428

Carter, M.R. and C.B. Barrett. 2006. The economics of poverty traps and persistent poverty: an asset-based approach. Journal of Development Studies Vol 42, No. 2, pp. 178-199.

Central Bank. (2006). Annual Report and Statement of Accounts for the year ended 31st December 2006

Coelli, T. J and G. E. Battesse. (1996). Identification of factors which influence the technical efficiency of Indian farmers. Australian Journal of Agricultural Economics Vol 40, No,1, pp103-128

Collier P. (1987) Macroeconomic effects of oil on poverty in Nigeria. IDS Bulletin, Vol. 18, No. 1,pp. 50-60.

Dittoh, J.S. (1991) Efficiency of agricultural production in small and medium scale irrigation in Nigeria. In Issues in African Rural Development, C. R. Doss and C. Olson (eds) pp. 152-174. Arlington, Winrock International.

Federal Republic of Nigeria. (2006) Official Gazette of National and State Provisional 2006 Census Population.

Gbayege A.O. (2006) Access to improved farm inputs and productivity among food crop farmers in Oyo North of Oyo state, Nigeria. An unpublished MSc thesis, Department of Agricultural Economics, University of Ibadan.

Gebremedhin, B. and S. Swinton. (2002) Sustainable management of private and communal lands in northern Ethiopia. In Natural Resources Management in African Agriculture: Understanding and Improving Current Practices, C.B. Barrett, F. Place, and A. Abdillahi (eds), Wallingford: CAB International.

Idjesa, E.N. (2007) Small holders' land management practices and technical inefficiency in maize production in Ken-Khana Local government area of Rivers state, Nigeria. Unpublished MSc thesis. Department of Agricultural Economics, University of Ibadan.

Idumah,. F.O. (2006) Productivity differentials among food crop farmers in the Niger Delta. Unpublished PhD thesis, Department of Agricultural Economics, University of Ibadan.

Kehinde. L..K. (2005) Efficiency of sawn wood production and distribution in Ondo State, Nigeria. Unpublished PhD thesis, Department of Agricultural Economics, University of Ibadan.

Khan, M.H. and D.R. Maki. (1979) Effects of farm size on economic efficiency: The case of Pakistan. American Journal of Agricultural Economics .Vol 61, No1, pp 64-69.

Lahai, B., P. Goldey, and G.E. Jones. (2000) The gender of the extension agent and farmers' access to and participation in agricultural extension in Nigeria. Journal of Agricultural Education and Extension Vol. 6, No. 4, pp.223-233.

Lamb, R.L. (2003) Inverse productivity: Land quality, labor markets, and measurement error. Journal of Development Economics Vol 7, No. 11, pp71-95.

Lau, L. J. and P.A. Yotopolous. (1971) A test for relative efficiency and application to India agriculture. American Economic Review Vol 61, pp 92-109.

Mbata J. N. (1988) An evaluation of the performance of agro-service center in Imo state. Unpublished PhD thesis, University of Ibadan.

Mijindadi N. B. (1984) Efficiency differentials in the traditional agriculture of northern Nigeria. Agricultural Systems No. 14, pp. 213-228.

Mochebele, M.T. and A. Winter-Nelson.. (2002) Migrant labor and farm technical efficiency in Lesotho. World Development, Vol. 28, No.1, pp 143-153.

Mogues, T. M. Morris, L. Freinkman, A. Adubi, and S. Ehui. (2008) Agricultural Public Spending in Nigeria. IFPRI Discussion Paper (forthcoming).

United Nations. (2004) Millennium Development Goals Report: Nigeria. Geneva, UN.

National Population Commission. (2006) Census Figures for Nigeria.

Nkonya, E., J. Pender, P. Jagger, D. Sserunkuuma, C. Kaizzi and H. Ssali. (2004) Strategies for Sustainable Land Management and Poverty Reduction in Uganda. Research Report No. 133, Washington, D.C., International Food Policy Research Institute.

Nkonya .E, J Pender, C Kaizzi, E. Kato, and S. Mugarura. (2005): Policy Option for Increasing Crop Productivity and Reducing Soil Nutrient Depletion and Poverty in Uganda. IFPRI ETP discussion paper 134. Washington, DC, International Food Policy Research Institute.

Nkonya, E., D. Phillip, T. Mogues, M. Yahaya, G. Adebowale, J. Pender, T. Arokoyo and E. Kato. (2008a.) From the Ground Up: Impacts of a Pro-poor Community-driven Development Project in Nigeria, World Bank Agriculture and Rural Development Department Discussion Paper #40. Washington D.C, World Bank.

Obwona,M. (2000) Determinants of technical efficiency among small and medium scale farmers in Uganda: A case of tobacco growers. Final report presented at the AERC Biannual Research Workshop, Nairobi, Kenya.27 May-2 June.

Odii, M.A.C.A. (1992) Gender consideration in resource allocation and food security behaviour of farming households in south eastern Nigeria. Unpublished PhD thesis in the Department of Agricultural Economics, University of Ibadan.

Ogundari K.S., O. Ojo, and I. A. Ajibenfun. (2006). Economies of scale and cost efficiency in small scale maize production: Empirical evidence from Nigeria. Journal of Social Sciences, Vol. 13 No. 2 pp. 131-136.

Ogundele, O.O. (2003) Technology differentials and resource use efficiency in rice production in Kaduna state, Nigeria. Unpublished PhD Thesis, Department of Agricultural Economics, University of Ibadan.

Ogundele, O. O. and V. O. Okoruwa. (2006) Technical Efficiency Differentials in Rice Production Technologies in Nigeria. African Economic Research Consortium Research Paper No. 154.

Ojowu, O., H. Bulus and B. Omonona. (2007) Nigeria Poverty Assessment. Abuja, World Bank .

Okike, I. (2000) Crop-livestock interaction and economic efficiency of farmers in the savannah zones of Nigeria. Unpublished PhD thesis, University of Ibadan.

Olawoye, J.O. (1988) Factors Affecting the Role of Rural Women in Agricultural Production: A survey of Rural Women in Oyo State, Nigeria. African Notes, Special No. 3 Women, Research and Documentation Centre, Institute of African Studies, University of Ibadan, Nigeria.

Olayide, S. O. and E. O. Heady. (1982) Introduction to Agricultural Production Economics. Ibadan University Press, University of Ibadan, Ibadan, Nigeria.

Onyenweaku, C. E. (1994) Economics of irrigation in crop production in Nigeria". In . Issues in African Rural Development 2, Doss, C. R. and C. Olson (eds), pp 129-137. Winrock International, Arlington Virginia.

Oxford Policy Management. (2004) DFID Rural and Urban Development Case Study – Nigeria. London: OPM.

Oredipe, A.A. (1998) An analysis of efficiency and productivity gaps among farmers adopting improved maize technology in Ogun state, Nigeria. Unpublished PhD. Thesis, Department of Agricultural Economics, University of Ibadan.

Prasad, A., L. Chai, R. Singh, M. Kafatos. (2006) Crop yield estimation model for Iowa using remote sensing and surface parameters. International Journal of Applied Earth Observation and Geoinformation Vol, 8 No.1, pp 26-33.

Rahji, M.A.Y. (2003) An analysis of the production efficiency of broiler firms in Ibadan area of Oyo state Nigeria. Tropical Journal of Animal Science Vol. 6, No. 2, pp. 103-109.

Reardon, T. and S. Vosti. (1995) Links between rural poverty and the environment in developing countries: Asset categories and investment poverty. World Development Vol 23, No 9, 1495-1506.

Quisumbing, A., J. Estudillo and K. Otsuka. (2004) Land and Schooling: Transferring Wealth Across Generations. Baltimore, Johns Hopkins University Press.

Scherr, S. and P. Hazell. (1994) Sustainable Agricultural Development Strategies in Fragile Lands. Environment and Production Technology Division Discussion Paper No. 1. Washington, DC, International Food Policy Research Institute.

Sahidu.S.S (1974) "Relative Efficiency in World Production in Indian Punjab", American Economics Review Vol 64. No4, pp 55-69.

Shiferaw, B. and S. Holden (2000) Policy instruments for sustainable land management: the case of highland smallholders in Ethiopia. Agricultural Economics, Vol. 22, pp. 217-232.

Tella A.T. (2006) Technical efficiency of cassava production in Afijio local government area of Oyo state. Unpublished MSc thesis, Department of Agricultural Economics, University of Ibadan.

Torero, M., and J. Escobal. (2005) Measuring the impact of asset complementarities: the case of rural Peru. Cuadernos de Economia No.42, pp.1-26.

Udoh, E.J. (2000) Land management and resource-use efficiency among farmers in South-Eastern Nigeria. Unpublished PhD thesis in the Department of Agricultural Economics University of Ibadan.