AFRINT PROJECT

African food crisis – the Nigerian case study

Cassava farm

Maize cobs

Cassava tubers

Maize farm

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IITA Research to Nourish Africa

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1 BACKGROUND

Africa's enduring food crisis has been a source of serious concern to governments and non-governmental organizations at both national and international levels. The issue features constantly and prominently in international research agenda. In 2002, a Swedish team from Lund University, Sweden, drew inspiration from progress being made on the Asian continent in what has been described as *a state-driven, market-mediated and farmer-based process of increasing yields in food grains and staples* and sought to replicate the same in Africa through capturing the dynamism in African agriculture, and illuminating questions about its driving forces, especially the role of the state and the market in influencing African farmers' production behavior. The project that resulted – "African food crisis – the relevance of Asian models" – is on-going (though in its final stages in many countries) with case studies in eight African countries namely; Ethiopia, Ghana, Kenya, Malawi, Nigeria, Tanzania, Uganda and Zambia.

The Nigeria case study of this project is being implemented in collaboration with the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. To analyze agricultural intensification in Nigeria, the study focused on trends in the productivity of major staples (maize, cassava, sorghum, rice) in the country at both macro and micro levels. At the micro level, the trends in productivity were explained through yields, technological change and commercialization observed among sample farm households. Primary data collection was done at two sites; Kaduna state in the northern Guinea Savanna (NGS) where cereals especially maize dominate other crops, and Osun state in the humid forest agroecological zone where tubers – mainly cassava – are more important than cereals in contributing to both household subsistence and incomes.

Subsequent sections of this report present approach to data analysis, results, discussions and conclusions. Specifically, section 2 presents a brief on steps taken to assure that the data was consistent both within sample areas and within country. In section 3, the descriptive statistics of variables in the survey are summarized in tables and figures. The results of tracing causal relationships between productivity of food grains and staples, on the one hand, and household, village and country factors in econometric models and descriptive statistics are discussed in section 4.

1.1 Survey Methodology and data

The survey was undertaken by IITA in collaboration with the Lund University, Sweden. Two States, Kaduna in the Northern Guinea Savanna (NGS) and Osun in the humid forest (HS) were purposefully selected to meet the requirements of the overall objective of the study. Farming system in Kaduna State is cereal based with significant livestock production (particularly cattle and small ruminants), while Osun state is predominantly root crop based (mainly cassava), though maize production is also important. Livestock farming is not as important as in Kaduna.

Two sets of questionnaires were administered. A village level survey questionnaire and a household survey questionnaire. Drafts of both questionnaires with manual were developed by the team of researchers (Lund team) and later modified by the Nigeria Study team.

1.2 Sampling of survey villages and households

The sampling technique employed in this study can be described as a multistage stratified random technique. The procedure comprised of the selection of Agricultural Development Program (ADP) zones after classifying with respect to their agricultural potential. This was done to ensure dynamism in the areas within each State. The second stage was the selection of villages and selection of households in third stage. Each State is divided into ADP zones for extension delivery and agricultural development purposes. Thus 4 ADP zones in Kaduna State and 6 ADP zones in Osun State were selected.

In compliance with the methodology approach outlined is a separate document provided by the Lund team and available on the study website, villages were identified along the intensification continuum – early, transition and late. Sample villages were selected along this gradent. In Kaduna State, 24 villages and in Osun State, 25 villages were randomly selected. Table 1 indicates the number of sample sizes selected from each village for the household interviews. Each survey village was georeferenced and coordinates of the villages are available with the Lund team or can be obtained from the IITA team. The head of the household, which in most of the cases was the farm manager, represented the household.

1.3 Survey Implementation

1.3.1 Recruitment and Training of Enumerators

The field team comprised of enumerators and supervisors recruited from the Kaduna State ADP for the Kaduna Survey, and from the Ministry of Agriculture, Osun State for the Osun Survey. In each State 14 enumerators and 3 supervisors were recruited. All members of the field team had previous experiences in conducting surveys related to the agricultural sector. The field team was trained by the study team IITA and NISER[1]. The field team was sensitized about the objectives of the study, the approach to the study and on how to complete the questionnaires. The training lasted for three days at each location. As part of the training, the field team was involved in the pre-testing of the questionnaires. Experiences from the pre-test were discussed together with team members participating in providing inputs to solving field level problems.

Table 1. Number of households selected per village in Kaduna and Osun States

Kaduna State			Osun State		
Zone	Village	Number of Households	Zone	Village	Number of households
Lere	Garu	9	Egbedore	Ojo	13
	Binawa	9		Aro	14
	Lere	9		Egbedi	13
	Ukurssa	9		Ekura	13
	Damakasuwa	9		Iwoye	13
	Galma	9	Orolu	Idiroko	13
Birin Gwari	Dutsen Gaiya	9		Okiti	14
	Kujama	9		Owode/disu	13
	Kallah	9		Idoo	14
	Bagoma	9	Oriade	Oke ana	10
	Birnin Gwari	9		Ere Ijesha	10
	Buruku	9		Omo Ijesha	10
Samaru Kataf	Jere	9		Eti Oni (esako)	10
	Gyanikwaturu	9	Ila	Edemosi	10
	Sambam Gida	9		Idi Ogbagbara	10
	Manchok	9		Dindin Obaloja	10
	Matsirga Attat	9		Faje Obalogbo	9
	Kukum Daja	9	Ife North	Akinlanu	10
Maigana	Zabi Kudan	9		Ashikpa	10
	Gazara	9		Eleweran Kajola	10
	Gubuchi	9		Abaigbira	10
	Kuzuntu	9	Ayidire	Iwo railway station	10
	Tsibiri	9		Osun wonyin	10
	Danwata	9		Igbo tente	10
				Ikoyi (Ile Ogbo)	10
	Total	216		Total	279

[1] Nigeria Institute for Social and Economic Research, Ibadan, Nigeria.

The enumerators and supervisors were trained at the same time, though supervisors received extra couching on supervision. Enumerators stayed in the villages during the survey period. Two enumerators were involved in administering the household questionnaires at a time. While one was probing, the other was writing down the answer. Through this, errors in both probing and recording were minimized. Participatory Rural Appraisal techniques were used to administer the village level questionnaire in the selected villages.

1.3.2 Field Supervision

The field supervisors provided full time supervision and ensured that the right respondents were interviewed and that the right information were collected. The Research Assistant from IITA provided on and off supervision and assisted the field supervisors to ensure that the right data were being collected. The two senior research team members (P. Kormawa from IITA and S.O Akande from the Nigerian Institute of Economic and Social Research) monitored field activities. A visit was also made by the Lund team leader, Prof. G. Djurfeldt to monitor and supervise field activities. He visited research villages in both Kaduna and Osun States. Reports of his observations are available on the study website.

1.3.3 Data Entry, Cleaning and Analysis

In Kaduna, the staff of the ADP computer unit were trained by IITA database Manager to enter data in Microsoft Access. This was part of capacity building effort for the ADP. This was not possible in Osun State as there was no such unit in the Ministry assigned for data management as it is in Kaduna ADP. IITA Research Assistant collected the data (electronic form) from the Kaduna ADP as well as all filled out questionnaires. Questionnaires from Osun State were brought to IITA for entry. Staff of the IITA Social Science Lab entered the data from Osun State under supervision by IITA team leader.

2 Proof reading to assure data quality

Following the selection of the study countries, the overall project immediately faced the challenge of designing and conducting these studies such that they were sensitive enough to capture the peculiarities of each country and yet yield comparable data for collective, trans-regional analysis. A methodology workshop was organized to coordinate the design of the survey instrument at both the country and sample area levels because achieving the comparability of data without loosing country specificities depended on the uniformity of design in the different countries.

Two questionnaires containing 542 core variables were used in the Nigeria case study. The Afrint village diagnostics, which was used for collecting information at village level had 105 core variables while the Afrint farm household survey contained the remaining (437) core variables. Twenty-four (24) villages were survey in Kaduna State and 25 in Osun State. A total of 495 households were sampled and interviewed from the above villages (216 households from Kaduna and 279 households from Osun). Data from these surveys were entered in Microsoft Access and maintained in a database in Microsoft Excel. Copy of final data set is available at the Lund University as well as IITA, Ibadan, Nigeria.

Data quality checks were done by going through the following steps

- studying the questionnaires for coverage of research questions;
- obtaining a sample of completed questionnaires and cross-checking values in them against those in the dataset for accuracy of data entry and the handling of zeros and missing values;
- using frequencies, means, maximum and minimum values the variables to check for outliers;
- cross-checking outlier values against values in questionnaire to correct inaccurate data entry or otherwise consider variable as missing value.

The overall impression is that a lot of effort was put in ensuring that the survey instruments were well designed to capture as many of the relevant explanatory variables as possible. Similarly, the high degree of accuracy of data in the completed questionnaires compared to their corresponding values in the dataset point to the fact that qualified and well trained person must have been used for data collection and entry. The above strongly suggest that the dataset is of reliable quality and likely to reflect the production trends in Kaduna state for maize and in Osun state for cassava and some extent maize.

The above checks were done in the data view of the SPSS spreadsheet and the datasets were saved on the CD submitted with this report as "**Household Data**" for the household survey and "**Village Data**" for the village level. These versions of the dataset formed the bases for descriptive statistics and other analysis reported subsequently.

3 Village level determinants of agricultural intensification

The specific village level research questions are as follow.

1 To what extent can differences and trends in yields, technology adoption and crop marketing at household level be explained by (changes in) the following village specific factors?

a) *Agricultural dynamism* (physical endowments and natural resource, market access, irrigation infrastructure, distance to markets and towns, presence of all-weather road and of public transport, land availability)

b) *State initiatives* (presence of input or transport subsidies, marketing price structure, state administered credit, etc)

c) *Markets* (presence of private traders, market outlets and input markets, access to consumer goods, local presence of contract farming); and

d) *Farmers* (presence of farmer organizations, land tenure, credit, demand driven extension and research systems, etc)

2 Are production trends mainly driven by population growth or market demand and/or are state/donor initiated?

3 Which are or have been the main factors facilitating and constraining intensification?

3.1 Physical endowment of villages

Approximate population estimates and agricultural land available to sampled villages is presented in Table 2. The person to land ratio indicates that on average 4 ha and 7 ha are available to one person in Kaduna and Osun States respectively. In relative terms, there is more land available for agricultural extensification in Osun than in Kaduna State.

Table 2. Approximate population and area of villages surveyed

	Kaduna State		Osun State	
	Total	Mean	Total	Mean
Approximate population of village	56679	2362	13064	544
Approximate area of village (ha)	248595	10358	93389	4447
Ratio of man to land	1:4		1:7	

The land use pattern in each state is presented in Table 3. Of the total land available in Kaduna State, 68% is under cultivation while 56.2% is under cultivation in Osun State. Accounting for land under fallow, pasture, and forest, there is a vast amount of land left unused in Osun State than in Kaduna State further confirming land availability for agricultural activities in these state.

Presence of irrigation facilities help encourage farmers to use improved seeds, fertilizers and other productivity enhancing technologies. Of the total land currently under cultivation only 16% and 8% are under irrigation in Kaduna and Osun States respectively. Irrigation in this study was defined as any type of land subject to some kind of artificial water supply. This included measures aimed at improving water supply. Much of the irrigated facilities in the surveyed villages are small-scale and farmer managed (Table 4). The low level of irrigated land compared to Kaduna may be explained by the rainfall fall patterns, which also determine crop choice and cropping pattern. Osun State is located in the humid forest agroecological zone, while Kaduna State is in the northern guinea savanna zone. Rainfall pattern in the humid forest is bi-modal allowing two cropping periods per year. In the northern guinea savanna, rainfall pattern is uni-modal, thus allowing only one cropping season without irrigation. Respondents in both States reported that rainfall during the past three years were sufficient for farming. None of the surveyed villages had experienced drought during the last three years (1999 to 2001). Trend in land under irrigation through the Pre-SAP, SAP and Post-SAP indicates that most farmers have not had access to irrigation during these periods.

Table 3. Land use in Kaduna and Osun States (% proportion)

Purpose	Kaduna	Osun
Cultivation	68.17	56.20
Fallow/pasture	9.92	25.76
Forest/virgin land	6.83	8.24
Marginal land	4.17	3.44
Water bodies	6.02	4.72
Other uses	4.90	1.64
Total	100.00	100.00

Characterization of soil conditions in villages included in the study indicates that most land are suitable (75% and 72% in Kaduna and Osun respectively) for crop cultivation in the two States. Most of the cultivated land are on flat or gentle slope. Agricultural potential in most of the villages (75% in Kaduna State and 62.5% in Osun State) have good agricultural potential. In both States 25% of the villages were classified as having average potential given their agro-ecological position.

Table 4 Assessment of irrigation systems

Small-scale farmer constructed, water control devices managed by	Kaduna	Osun
Individual households	79.17	77.78
Associations of households at local level	16.67	22.22
Supra-village organizations at district or state level	4.17	0

3.2 Infrastructure and markets in selected villages

Rural infrastructure plays an important role in promoting small-scale farmers' use of yield enhancing inputs and thus increasing farm productivity. A good road network in rural areas for instance helps reduce transportation costs of both inputs and farm products. Most survey villages have good access to roads as indicated by distance to all weather roads (Table 5) in Kaduna (0.96 km) and Osun (2.37 km). While villages in Kaduna state are within 4.42 km to such markets, those in Osun are almost within double (8.13 km) that distance. From 1986 - 1999 the Nigeria government embarked on major rural infrastructure development projects. In particular, the Department of Food, Rural Roads, and Infrastructure (DFRRI) was set up to construct or rehabilitate rural feeder roads linked to high agricultural production areas for rice, maize, vegetable oil seeds, cotton, groundnuts, cocoa and tubers. In addition, the world Bank supported Agricultural Development Programs (ADPs) were until late 1990s involved in the construction and maintenance of rural roads.

Table 5 Agricultural dynamism: infrastructure and markets

Distance (km) from the village centre to the nearest	Kaduna State		Osun State	
	All Sample	Actual*	All Sample	Actual*
All-weather road	0.96	2.88	1.78	2.37
Permanent crop outlet (km)	4.42	7.26	5.30	8.13
Town-based and permanent market	11.46	13.87	8.73	9.14
Place has permanent electricity	7.40	17.75	5.54	7.08
Place serviced by permanent or mobile telephone	56.65	56.65	10.82	11.33

*Mean of all responses except zero (those that have market within village); All sample include villages with market outlet in village (indicated by 0km)

The input and output markets in Nigeria are liberalized. Despite this, there is still visible involvement of the federal and state government in the fertilizer delivery system. In both Kaduna and Osun States, sale of inputs through the State government outfit – the ADPs (or similar centers set up by the state government), remain an important source of inputs procurement for farmers (Table 6).

Table 6. Frequency of provision or sale of inputs

State	Outfit	Yes	No
Kaduna	Private dealers	75.00	25.00
	Government shop	29.17	70.83
	NGO/donor project	0.00	100.00
	Farmer organisation/self-help group	4.17	95.83
Osun	Private dealers	83.33	16.67
	Government shop	83.33	16.67
	NGO/donor project	8.33	91.67
	Farmer organisation/self-help group	16.67	83.33

Although private input dealers sell inputs to most of the villages (75% in Kaduna and 83.3% in Osun State), farmers would only patronize the private dealers if their requirements were not supplied through the government source. The State government input sales outlets usually sell the inputs at subsidized rates. However, in most of these sales outlets inputs are not readily available, both in required quantities and on time.

Input dealership, particularly fertilizers is a capital-intensive venture, thus there are few major private importers in the country. As a result of the high capital outlay required, NGOs or donor funded projects on their own can not afford to be in input supply business. However, because of the inefficiency in the market, these private dealers usually order fertilizer on contract for the government. In such cases, the government agencies at the state level are responsible for distribution to farmers. Thus, the private sector network for input marketing is still underdeveloped in Nigeria.

Among the inputs, improved seeds are more readily available in the villages (33.3% in Kaduna and 44% in Osun); while fertilizer is not (Table 7). Most of the improved seeds available to farmers come directly from the agricultural research institute or the ADPs and NGOs. Another source of improved seeds and planting materials to farmers is through "farmer-to-farmer" seed diffusion. Although improved seeds can be made available to farmers through ADP sources, fertilizer the most important complimentary input is mostly not available or when available is expensive. Thus constraining farmers to apply recommended doses that should ensure higher or optimal crop yields.

Table 7 Frequency of availability of modern inputs

State	Input	Yes	No
Kaduna	Artificial fertilisers	29.17	70.83
	Seeds/seedlings	33.33	66.67
	Other agrochemicals	16.67	83.33
Osun	Artificial fertilisers	4.00	96.00
	Seeds/seedlings	44.00	56.00
	Other agrochemicals	24.00	76.00

As regards markets and infrastructure, most of the villages in Kaduna (83.3%) were classified as having physical access to market. However, in Osun state, only 44% of villages have good physical access to market, with equal percent classified as marginal (Table 8).

Table 8 Position of villages in terms of market access

Market access	Kaduna	Osun
Marginal	0.00	12.00
Average	16.67	44.00
Good	83.33	44.00

3.3 Public support to villages

Apart from the provision of rural roads and infrastructure to support agricultural productivity and physical access to markets for agricultural inputs and outputs, the most common State intervention has been the provision of subsidized inputs and credits to farmers. Among the villages studies, only in Kaduna State was subsidized inputs made available to farmers in 2001. In both States, formal agricultural credit is not readily available to farmers. Though there are commercial and agricultural banks, the high interest rates charged (20-25%) scare off most farmers from approaching banks.

Kaduna State is a major cereal producing area in Nigeria. Use of improved seeds and fertilizers is a prerequisite for obtaining higher yield. In promoting cereal production in the State, the provision of subsidized inputs to farmers is a major policy that is still pursued (Table 9). Although the majority of farmers do not have access to the subsidized fertilizers.

Table 9 Frequency of kind of public support or input subsidy

State	Support	Yes	No
Kaduna	Input subsidies	40.00	60.00
	Credit	0.00	100.00
	Others	6.25	93.75
Osun	Input subsidies	0.00	100.00
	Credit	0.00	100.00
	Others	0.00	100.00

3.4 Framer organizations

A noticeable institution that has emerged and playing important roles in promoting agriculture during the post-SAP period is the member-based organizations – farmers groups, CBOs and NGOs. These are gradually providing small-scale farmers services which otherwise were provided by governments. Following the liberalization of agricultural input and output markets, vacuums exist in most communities in the provision of basic agricultural and rural services. This is because; the private sector, which is expected to fill in the vacuum created by the withdrawal of the State in the provision of those services is not yet providing the services. In both States, the most common services provided by these organizations are the provision of extension services (35.7% villages in Kaduna State and 42.9% in Osun State) and inputs (Table 10).

Although the State governments are providing extension services through the ADPs, their scope and coverage have been reduced significantly. Prior to SAP and during the SAP periods, the ADPs provided major agricultural and rural services to farmers. For example, the ADP provided inputs and credits to farmers backed up with well packaged extension packages and information. However, because of under funding and the lack of appropriate human and material capacity, these are operating at sub-optimal levels.

Despite the financial constraints, infrastructures of the ADPs are more widely represented in each State than those of NGOs and donor-supported programs (Table 11). Though inefficient, the ADP extension structures are still visible in each State in Nigeria. Private sector provision of credit is still limited in Nigeria. There are very few large-scale farms that provide extension services to farmers. As indicated in Table 11 only 15% of villages surveyed reported having received extension services from private sources. Agriculture in Nigeria is still dominated by small-scale farmers. It is therefore not surprising that government and the "welfare" based institutions – the NGOs mostly provide extension services

Table 10. Frequency of kind of NGO/donor support received

State	Support	Yes	No
Kaduna	Input subsidies	7.14	92.86
	Input provision	14.29	85.71
	Credit	0.00	100.00
	Extension	35.71	64.29
	Marketing	0.00	100.00
	Conservation farming land mgt	0.00	100.00
	Other	6.25	93.75
Osun	Input subsidies	14.29	85.71
	Input provision	7.14	92.86
	Credit	14.29	85.71
	Extension	42.86	57.14
	Marketing	0.00	100.00
	Conservation farming land mgt	7.14	92.86
	Other	6.250	93.75

Table 11. Frequency of provision of extension services

State	Support	Yes	No
Kaduna	Private	0.00	100.00
	Government	87.50	12.50
	NGO/donor project	29.17	70.83
	Farmer groups/org	12.50	87.50
Osun	Private	15.00	85.00
	Government	36.00	64.00
	NGO/donor project	24.00	76.00
	Farmer groups/org	12.00	88.00

3.5 Land Acquisition

Access to agricultural land by farmers in the two States studied is presented in Table 12. Agricultural land rights are vested in family or communal leaders. The most important source of acquiring farmland is through family or communal head. Outright purchase of agricultural land in both states is feasible. Most of the villages in Kaduna State indicated that buying land from other villages was the most important means of increasing farmland to that village (Table 12).

However, in Osun, where the population density is low, leasing of farm land and clearing of fallow land is still possible for increasing farm land in the villages (Table 13). Compared to the pre-SAP period, acquiring land for expansion of individual farmlands has become more difficult. This could be attributable to, the high population density and the high commercial value that is now attached to land than during the pre-SAP period.

Table 12. Means of obtaining land in village by households

Parameters	Kaduna	Osun
Allocated land not previously cultivated	4.17	8.00
Allocated family land	50.00	76.00
Inherit land already under cultivation	41.67	8.00
Purchase land	0.00	0.00
Borrow/rent land	4.17	8.00

Most farmers in the study villages have formal land registration titles. In Kaduna State 74% and Osun State 64% of farmers were estimated as having formal land registration titles. This shows that farmers are assured of their land holdings and therefore will be willing to invest in land improvement strategies.

Table 13. Means of increasing farm size for households in village

Parameters	Kaduna	Osun
Clearing virgin land	33.33	54.55
Cultivating communal pasture/grazing land	0.00	4.55
Renting/borrowing land	16.67	40.91
Buying land	50.00	0.00

An overall assessment of land availability for agricultural extensification (Table 14) indicates that 36.4% of villages in Kaduna State and only 12.5% in Osun State have exhausted their land frontier and that land are permanently under cultivation. Although 50% of villages in Kaduna State have some land available, however, they perceive that because of population pressure such land will in few years be exhausted. In Osun State, most of the villages (83.3%) indicated that land was still available and that there was no pressure on agricultural land.

Table 14. Overall assessment of land availability (%)

Parameters	Kaduna	Osun
Land frontier exhausted, fields are permanently cultivated	36.36	12.5
Land frontier still open, but can be foreseen to close within few years	50.00	4.17
Land frontier open, no acute pressure	13.64	83.33

3.6 Indicators of intensification at the village level

The proportion of farmers cultivating non-traditional seed varieties, application of yield enhancing inputs, practicing improved animal husbandry and available land for fallow are both related to the choice of crop cultivated and the level of intensification. Kaduna State Maize, sorghum, millet and rice are the most important cereals cultivated. Cassava is the major root crop cultivated in Osun State, although maize is cultivated as intercrop with cassava. In Osun State most of the maize is harvested green for sale.

In both States, the majority of farmers are planting improved maize varieties (Table 15), though the proportion of farmers in Kaduna (87.9%) is higher than those in Osun (60.6%). Cassava is not a major crop in Kaduna, only 14.6% of farmers are cultivating improved cassava varieties. In Osun State, where cassava is a major food and cash crop, 80.6% of the farmers are cultivating improved varieties.

Apart from agronomic reasons that may favor the cultivation of cereals in the drier areas (Kaduna) and the roots and tuber in the moist areas (Osun), the sources of improved technologies also determine availability of improved varieties to farmers. The major root and tuber crops research institutes are located in the southern and eastern parts of Nigeria. Those for cereals and legumes research are located in the northern parts of the country. For example, IITA, IAR&T, the University of Agriculture Abeokuta (UNAAB) and the faculty of Agriculture, University of Ibadan has been developing new cassava varieties and promoting cassava in Nigeria. These are closer to Osun State than Kaduna State. Also, the National Roots Crop Research Institute (NCRI), Umudike develops and test improved cassava varieties at different locations in the country.

The Institute for Agricultural Research (IAR) and IITA are two major technology development institutes active in the northern States. Although improved planting materials originate from the research institutes, the ADPs and NGOs play important roles in the multiplication and wider disseminate to farmers. In particular, the Sasakawa Global 2000 (NGO) has been promoting maize and maize production technologies in Nigeria.

Application of yield enhancing chemicals particularly fertilizer to the staple food (maize) is common among most farmers in Kaduna State (95%). Fertilizer is applied by only 14.7% of farmers in Osun State to the major staple (cassava). This follows a similar trend for the complimentary resource (irrigation). About 33% of farmers in Kaduna have access to some form of irrigation, while only 4% of farmers in Osun have access to some form of irrigation.

Table 15. Proportion of farmers using of improved planting materials

State	Proportion of farmers that	Mean	Std Error	N
Kaduna				
	Currently use non-traditional maize seeds	87.92	4.09	24
	Currently use non-traditional cassava seedlings	14.63	4.96	24
	Currently use non-traditional sorghum seeds	19.61	5.45	23
	Currently use non-traditional rice seeds	40.71	7.47	24
	Regularly apply chemical fertilizer on staple food crops	95.04	1.80	23
	Regularly apply pesticides on staple food crops	34.25	5.06	24
	Have access to some kind of irrigation	33.50	5.60	24
	Keep stall-fed cows	16.57	3.84	23
	Regularly apply animal manure on food crops	38.75	5.87	24
	Regularly put part of their land to fallow	21.29	5.51	24
Osun				
	Currently use non-traditional maize seeds	60.60	8.18	25
	Currently use non-traditional cassava seedlings	80.63	6.79	24
	Currently use non-traditional sorghum seeds	0.00	0.00	11
	Currently use non-traditional rice seeds	33.85	12.64	13
	Regularly apply chemical fertilizer on staple food crops	14.74	6.65	19
	Regularly apply pesticides on staple food crops	14.76	6.01	21
	Have access to some kind of irrigation	4.25	0.98	16
	Regularly apply animal manure on food crops	3.64	3.18	22
	Regularly put part of their land to fallow	76.12	6.96	25

While there is still abundant land available to most farmers (76%) in Osun State to expand production, only 21.3% of farmers in Kaduna State can leave their lands under fallow. Looking at the above variables and those of agroecological potential, and market infrastructure, it can be postulated that most of the villages in Kaduna State can be classified as being in the market-driven intensification stage, while those in Osun are in the population-driven stage.

4 Descriptive and econometric analysis of household data

4.1 Econometric analysis

Objective of the exercise was to answer specific research questions aimed at explaining differences and trends in productivity at household level using sets of village and household level factors within a framework that emphasizes the state, markets and farmers as the key drivers of change, as was found to be the case in Asia. The econometric analysis also aimed to capture the effects of changes over time – exemplified in the Nigerian case study by three periods; i). the period before the Structural Adjustment Programme i.e. pre-SAP period, ii). the SAP period, and iii). the post SAP period.

<u>Household level questions:</u>

1 To what extent can differences and trends in production/yields, technology adoption and crop marketing be explained by (changes in) the following household resources and characteristics?

a) *Natural resources and endowments* (size and type of land; irrigation, types of crops cultivated)

b) *Labor resources* (household labor division and total labor power (gender and age); access to hired labor, tractor, etc)

c) *Social resources and wealth* (wealth of household, non-farm income, age and educational level of farm manager and/or farm decision maker)

d) *Institutional factors* (gender aspects, membership in farmer organizations, NGOs, access to credit, extension, inputs (fertilizers, pesticides, etc), etc)

e) *Market orientation* (types of crops marketed, marketing outlets, involvement in out grower schemes, distance to nearest market outlet, etc)

f) *Technology* (use of modern and traditional inputs; extended technologies e.g. conservation farming and irrigation).

State, markets and farmers' research questions:

2 In addition to but in relation to the above village and household specific factors, what local changes in productivity, technology adoption and crop marketing can be traced back to different interventions by the state over the pre-SAP, SAP and post-SAP periods?

3 What local changes in productivity, technology adoption and crop marketing can be traced back to the different roles and initiatives played locally by the private sector in relation to small-scale farming over the pre-SAP to post-SAP period?

4 What local changes in productivity, technology adoption and crop marketing can be traced back to the (changing) role and production conditions of the small-scale farmers over the pre-SAP to post-SAP period?

4.2 Analytical framework

To address the many and varied research questions required the use of linear, logit and tobit econometric models, as to be justified later. It is important, however, to note that while the questions varied in order to address trends in productivity and intensification using (changes in) yields, technology and commercialization at household level, the central explanatory variables remained those related to state, markets and the farmer. This common thread running through the research questions provided a basis for using a single analytical framework for the econometric analysis even as the application of linear, LOGIT or TOBIT models to specific questions became necessary.

The general empirical model is simply specified as:

$$YTC = f(S_{(1-n)}, M_{(1-n)}, F_{(1-n)}) \qquad \ldots(1)$$

where, *YTC* could be any of yield, technology or commercialization as indicators of household level trends in productivity and intensification; are vectors of state, market and farm household factors capable of explaining them. Most of these factors have been listed earlier in this section.

It is obvious that apart from being dependent variables, yield, technology and commercialization are related and, therefore, also explain each other. For example, users of new technologies are expected to have higher yields and market their "excess" products. In the analysis, they have been used interchangeably both as dependent and explanatory variables bearing in mind that such specifications may sometimes present econometric problems of endogeneity or simultaneous equation bias but concentrating in the meantime on the gains which accrue from using them in that manner to explain causalities.

Having presented the general framework for the analysis, the subsequent sub-section deal with specific models. Nonetheless, since most of the variables are common to the different models and were derived from the same dataset, a brief description of them, which applies wherever else they are used in this report, is given in section 4.2. In section 4.3, parameters are estimated for yields of cassava and maize using linear production functions. Section 4 contains the discussion on how productivity and adoption of new technologies for production have been affected over time – using the pre-SAP to post-SAP periods as tracers and LOGIT as the econometric model. Finally, the TOBIT empirical models used for investigating crop yield differences between 2000 and 2001 and the commercialization of cassava and maize production are described and their results presented in section 4.5.

4.3 Quantitative variables used in econometric models

4.3.1 Household socio-economic characteristics

Quantitative variables in the models include age of head of household (same person as farm manager in more than 99% of the cases), household size, ruminant livestock owned (as a proxy for livestock manuring of farmlands), available household labour, total farm size in 199-2001, maize and cassava farm sizes in 2001 and proportion of total farmland planted to both crops, quantities of chemical fertilizers applied to cassava and maize, total value of farm products from 1999-2001, percentage commercialization of maize and cassava, distance to all-weather road, distance to nearest urban market, village land per household, distance to extension service outlet, etc.

These variables were stratified by location i.e. Kaduna and Osun States and within location by agroecological potential, wealth ranking of households and by level of intensification, summarized in Tables 16-18.

Table 16: Variables in econometric models by Agro-ecological potential

State	Kaduna				Osun					Nigeria				
Variables	Medium	Good	Mean	P>F	Low	Medium	Good	Mean	P>F	Low	Medium	Good	Mean	P>F
Maize yield 2001 (kg/ha)	1650.0	2590.9	2120.4	0.002	900.3	1274.2	1354.9	1176.5	0.007	900.3	1412.4	1961.2	1424.6	0.000
Maize yield 2000 (kg/ha)	1637.6	2555.9	2096.8	0.016	918.9	1461.7	1254.4	1211.6	0.010	918.9	1526.7	1877.6	1441.1	0.000
Maize yield 1999 (kg/ha)	1743.5	2539.2	2141.4	0.039	955.3	1523.6	1310.0	1263.0	0.018	955.3	1603.6	1908.9	1489.2	0.001
Cassava yield 2001 (kg/ha)	12495.2	5871.8	9183.5	0.029	11668.9	12787.5	10823.2	11759.9	0.193	11668.9	12751.7	10043.8	11488.1	0.025
Cassava yield 2000 (kg/ha)	6516.7	3845.8	5181.2	0.040	11012.3	13310.3	10863.0	11728.6	0.082	11012.3	12478.4	9850.9	11113.9	0.036
Cassava yield 1999 (kg/ha)	11628.6	5207.1	8417.8	0.045	10933.5	13728.7	11136.9	11933.0	0.071	10933.5	13505.3	10231.3	11556.7	0.015
Total farm size in 2001 (ha)	2.7	4.8	3.8	0.051	2.4	1.7	2.0	2.0	0.321	2.4	2.1	3.4	2.6	0.025
Total farm size in 2000 (ha)	2.4	4.4	3.4	0.050	2.0	1.6	2.0	1.9	0.629	2.0	1.9	3.1	2.4	0.018
Total farm size in 1999 (ha)	3.0	4.5	3.7	0.082	2.1	1.8	2.0	2.0	0.863	2.1	2.2	3.3	2.5	0.037
Percent maize commercialisation in 2001	48.3	46.3	47.3	0.702	52.9	47.7	52.2	51.0	0.424	52.9	47.9	49.2	50.0	0.520
Percent maize commercialisation in 2000	58.6	49.3	53.9	0.124	53.2	45.1	55.2	51.1	0.030	53.2	49.3	52.4	51.6	0.597
Percent maize commercialisation in 1999	53.6	45.0	49.3	0.256	48.3	55.7	55.9	53.3	0.144	48.3	55.1	50.7	51.4	0.391
Percent cassava commercialisation in 2001	69.7	67.2	68.4	0.863	56.5	54.3	52.4	54.4	0.576	56.5	55.5	54.6	55.5	0.895
Percent cassava commercialisation in 2000	67.5	62.9	65.2	0.791	51.7	52.3	53.4	52.5	0.878	51.7	53.2	54.5	53.1	0.743
Percent cassava commercialisation in 1999	71.2	65.1	68.1	0.688	52.2	51.1	51.9	51.7	0.976	52.2	52.7	53.5	52.8	0.949
Qty of chemical fertilizers per ha of maize farm (kg)	198.4	368.0	283.2	0.005	2.6	20.2	20.5	14.4	0.288	2.6	96.2	213.5	104.1	0.000
Qty of chemical fertilizers per ha of cassava farm (kg)	120.0	86.7	103.4	0.633	0.0	19.8	16.1	12.0	0.626	0.0	33.7	28.1	20.6	0.383
Age of household head (years)	51.0	48.8	49.9	0.423	54.0	52.2	53.7	53.3	0.789	54.0	51.7	51.3	52.3	0.482
Educational status of household head (years)	9.0	6.7	7.9	0.055	3.8	3.8	4.3	4.0	0.809	3.8	6.0	5.5	5.1	0.206
Area of village land per household (ha)	1.4	6.6	4.0	0.002	2.4	8.5	15.8	8.9	0.000	2.4	5.7	10.9	6.3	0.000
Distance to all-weather road from village centre (km)	1.7	0.9	1.3	0.084	1.5	2.5	1.9	1.9	0.271	1.5	2.2	1.4	1.7	0.060
Distance to nearest urban market from centre of village	3.0	12.7	7.9	0.000	9.3	9.1	8.8	9.1	0.863	9.3	6.4	10.8	8.8	0.003
Percent of village land cultivated	81.7	66.2	74.0	0.000	65.0	63.0	52.3	60.1	0.000	65.0	70.2	59.2	64.8	0.000
Total ruminant livestock owned (TLU)	0.7	3.0	1.9	0.117	0.2	0.2	0.4	0.3	0.169	0.2	0.4	1.7	0.8	0.033
Household size (persons)	9.5	14.6	12.0	0.008	10.3	7.5	7.3	8.4	0.003	10.3	8.3	10.9	9.8	0.037
Available household labour	5.5	4.9	5.2	0.462	6.5	4.3	5.8	5.5	0.075	6.5	4.8	5.4	5.5	0.126
Distance to extension outlet (km)	3.5	7.5	5.5	0.148	12.1	8.9	10.4	10.5	0.056	12.1	6.8	9.0	9.3	0.030
Maize farm size in 2001 (ha)	1.5	2.7	2.1	0.091	1.3	0.7	1.0	1.0	0.275	1.3	1.0	1.9	1.4	0.046
Cassava farm size in 2001 (ha)	0.1	0.1	0.1	0.466	1.1	0.7	0.9	0.9	0.089	1.1	0.5	0.5	0.7	0.000
Total value product (TVP) in 2001 (USD)	1846.7	3475.4	2661.0	0.038	768.1	548.6	981.8	766.2	0.249	768.1	1049.3	2205.9	1341.1	0.001
Total value product in 2000 (USD)	1967.8	3604.5	2786.1	0.052	749.8	573.0	1004.8	775.9	0.285	749.8	1111.0	2284.2	1381.7	0.001
Total value product in 1999 (USD)	2109.6	3801.1	2955.3	0.064	791.3	732.0	1242.0	921.7	0.242	791.3	1263.3	2521.5	1525.4	0.001
Total value product/ha in 2001 (USD)	1526.8	2227.0	1876.9	0.343	317.4	382.9	699.1	466.5	0.193	317.4	824.1	1449.2	863.6	0.014
Total value product/ha in 2000 (USD)	1667.4	2458.4	2062.9	0.331	353.1	436.5	774.9	521.5	0.217	353.1	911.3	1603.3	955.9	0.017
Total value product/ha in 1999 (USD)	1846.1	2594.7	2220.4	0.403	400.2	495.7	863.5	586.5	0.239	400.2	1004.6	1731.4	1045.4	0.026
Percent maize value in TVP 2001 (USD)	57.3	59.4	58.3	0.750	31.8	31.5	36.6	33.3	0.203	31.8	41.0	47.7	40.2	0.002
Percent maize value in TVP 2000 (USD)	59.3	60.5	59.9	0.864	30.3	33.2	34.9	32.8	0.429	30.3	43.1	47.2	40.2	0.002
Percent maize value in TVP 1999 (USD)	54.4	62.3	58.3	0.265	32.2	32.9	35.6	33.6	0.570	32.2	40.7	48.7	40.6	0.002
Percent cassava value in TVP 2001 (USD)	11.9	9.1	10.5	0.627	70.6	66.8	66.4	67.9	0.432	70.6	52.6	54.2	59.1	0.003
Percent cassava value in TVP 2000 (USD)	8.4	9.8	9.1	0.826	72.5	66.4	66.5	68.5	0.188	72.5	50.0	54.9	59.1	0.001
Percent cassava value in TVP 1999 (USD)	10.0	12.3	11.2	0.756	69.8	67.5	66.1	67.8	0.573	69.8	51.0	54.8	58.5	0.011

Table 17. Variables in econometric models by the wealth ranking of households

State	Kaduna				Osun				Nigeria			
Variables	Poor	Medium	Wealthy	P>F	Poor	Medium	Wealthy	P>F	Poor	Medium	Wealthy	P>F
Maize yield 2001 (kg/ha)	2155.5	2494.2	3124.2	0.001	1066.7	1284.3	1572.9	0.007	1740.7	1648.3	2339.9	0.000
Maize yield 2000 (kg/ha)	1988.1	2618.1	3084.1	0.003	1098.9	1216.3	1529.7	0.021	1636.3	1632.5	2279.4	0.001
Maize yield 1999 (kg/ha)	1945.7	2682.1	3125.7	0.001	1106.0	1261.8	1679.5	0.004	1629.3	1689.2	2368.2	0.000
Cassava yield 2001 (kg/ha)	6914.8	6475.4	7831.1	0.908	10181.6	11675.4	11578.4	0.329	9420.8	11289.2	10929.8	0.138
Cassava yield 2000 (kg/ha)	4490.6	3872.1	4778.8	0.791	9917.8	11929.7	10886.9	0.128	8694.8	11408.3	9889.7	0.011
Cassava yield 1999 (kg/ha)	7290.9	4010.7	6811.1	0.475	10989.2	11834.1	11416.2	0.735	10092.6	11357.0	10603.6	0.436
Total farm size in 2001 (ha)	2.8	4.9	7.8	0.000	1.3	1.7	3.7	0.000	2.2	2.7	5.7	0.000
Total farm size in 2000 (ha)	2.6	4.3	7.4	0.000	1.2	1.6	3.9	0.000	2.0	2.4	5.5	0.000
Total farm size in 1999 (ha)	3.2	4.3	7.2	0.000	1.3	1.6	4.4	0.000	2.5	2.4	5.7	0.000
Percent maize commercialisation in 2001	45.2	49.4	43.1	0.256	44.3	53.1	52.6	0.053	44.9	51.9	48.1	0.013
Percent maize commercialisation in 2000	47.6	51.0	52.1	0.559	48.5	54.7	54.7	0.180	48.0	53.6	53.5	0.065
Percent maize commercialisation in 1999	44.3	49.6	40.2	0.209	48.4	57.0	55.0	0.051	46.1	54.5	48.8	0.009
Percent cassava commercialisation in 2001	61.6	73.5	74.4	0.386	52.7	54.1	50.0	0.542	55.0	55.4	52.5	0.740
Percent cassava commercialisation in 2000	59.9	83.3	66.4	0.571	53.9	52.9	52.0	0.916	55.2	53.2	54.2	0.811
Percent cassava commercialisation in 1999	67.6	56.3	64.2	0.848	49.0	53.2	48.5	0.354	54.3	53.3	50.8	0.725
Qty of chemical fertilizers per ha of maize farm (kg)	296.8	365.0	424.9	0.046	4.7	23.1	16.8	0.202	203.8	147.8	220.9	0.051
Qty of chemical fertilizers per ha of cassava farm (kg)	132.1	114.2	16.8	0.122	19.6	17.5	4.6	0.599	46.2	26.1	7.0	0.091
Age of household head (years)	48.4	49.1	50.8	0.608	54.1	52.6	55.8	0.302	50.5	51.5	53.4	0.253
Educational status of household head (years)	6.6	7.3	7.4	0.671	3.0	4.3	5.3	0.042	5.3	5.3	6.3	0.254
Area of village land per household (ha)	5.3	5.7	8.1	0.169	15.3	10.7	17.5	0.011	8.5	9.1	12.8	0.027
Distance to all-weather road from village centre (km)	1.3	0.7	0.7	0.133	1.5	1.8	2.9	0.023	1.4	1.4	1.8	0.380
Distance to nearest urban market from centre of village (km)	15.3	8.3	8.1	0.000	7.5	8.5	11.5	0.000	12.4	8.5	9.9	0.001
Percent of village land cultivated	68.3	68.3	67.5	0.957	53.1	56.3	58.2	0.274	62.6	59.8	62.6	0.241
Total ruminant livestock owned (TLU)	1.5	2.7	5.5	0.008	0.2	0.3	0.8	0.000	1.0	1.0	3.1	0.001
Household size (persons)	10.9	14.9	19.7	0.000	5.9	7.8	10.0	0.000	9.0	9.9	14.6	0.000
Available household labour	4.2	5.1	6.7	0.001	4.0	5.5	8.6	0.000	4.2	5.3	7.7	0.000
Distance to extension outlet (km)	5.6	8.4	8.2	0.369	9.1	9.9	13.4	0.000	7.0	9.5	11.1	0.006
Maize farm size in 2001 (ha)	1.4	2.9	4.7	0.000	0.6	0.8	2.0	0.000	1.1	1.5	3.3	0.000
Cassava farm size in 2001 (ha)	0.1	0.1	0.2	0.795	0.6	0.8	1.4	0.000	0.3	0.6	0.8	0.000
Total value product in (TVP) 2001 (USD)	2712.4	3396.7	4504.1	0.035	422.4	718.5	2049.6	0.000	1851.8	1514.1	3210.9	0.000
Total value product in 2000 (USD)	2928.8	3452.4	4552.9	0.093	428.5	739.8	2063.5	0.000	1993.2	1552.4	3254.1	0.000
Total value product in 1999 (USD)	2991.1	3606.2	5117.8	0.031	472.5	816.9	2944.8	0.000	2085.7	1656.1	4019.1	0.000
Total value product/ha in 2001 (USD)	2327.3	2189.2	1774.0	0.698	323.2	511.9	1239.1	0.003	1574.2	1010.2	1492.1	0.094
Total value product/ha in 2000 (USD)	2580.4	2388.2	1964.7	0.700	346.2	563.2	1449.3	0.001	1738.9	1109.9	1698.3	0.082
Total value product/ha in 2000 (USD)	2632.2	2610.2	2200.7	0.848	403.0	622.6	1614.4	0.001	1840.2	1219.7	1900.9	0.103
Percent maize value in TVP 2001 (USD)	52.6	60.4	70.3	0.006	32.7	35.9	36.0	0.574	44.9	43.3	52.8	0.023
Percent maize value in TVP 2000 (USD)	53.1	62.2	72.0	0.004	35.1	34.0	32.8	0.849	46.0	42.4	52.0	0.028
Percent maize value in TVP1999 (USD)	55.5	62.6	71.7	0.026	35.7	34.6	34.2	0.924	48.0	43.0	52.5	0.030
Percent cassava value in TVP 2001 (USD)	14.1	4.2	10.8	0.192	67.4	66.6	68.0	0.882	49.8	58.6	56.2	0.072
Percent cassava value in TVP 2000 (USD)	16.5	2.2	6.6	0.062	66.7	68.0	65.6	0.723	49.4	59.5	54.2	0.033
Percent cassava value in TVP 1999 (USD)	18.4	2.5	14.5	0.071	66.1	68.6	61.6	0.098	49.0	59.8	52.4	0.018

Table 18. Variables in econometric models by the level of intensification

State	Kaduna				Osun				Nigeria			
Variables	Early	Transit	Late	P>F	Early	Transit	Late	P>F	Early	Transit	Late	P>F
Maize yield 2001 (kg/ha)	1896.5	2952.9	1769.6	0.000	1254.6	1365.2	1103.9	0.194	1373.8	2179.2	1503.3	0.000
Maize yield 2000 (kg/ha)	1588.9	3110.7	1529.9	0.000	1246.6	1294.1	1077.4	0.337	1311.1	2206.6	1343.3	0.000
Maize yield 1999 (kg/ha)	1705.0	3036.8	1607.0	0.000	1313.9	1375.4	1045.6	0.126	1389.8	2221.2	1375.5	0.000
Cassava yield 2001 (kg/ha)	7237.5	6919.3	6607.3	0.987	10524.4	10541.2	15511.2	0.000	10413.9	9870.5	13552.4	0.004
Cassava yield 2000 (kg/ha)	4200.0	4299.3	4310.0	0.998	10490.9	10704.0	15194.7	0.000	10272.1	9570.9	13153.8	0.005
Cassava yield 1999 (kg/ha)	9494.4	4973.2	6964.4	0.368	10500.5	11155.9	15542.6	0.000	10455.2	10076.4	13900.0	0.004
Total farm size in 2001 (ha)	3.7	5.0	4.0	0.318	2.2	1.7	2.2	0.232	2.5	3.4	3.3	0.063
Total farm size in 2000 (ha)	3.5	4.3	3.9	0.651	2.2	1.6	1.8	0.232	2.4	3.0	3.1	0.269
Total farm size in 1999 (ha)	4.3	4.4	4.2	0.929	2.4	1.7	1.7	0.140	2.8	3.1	3.2	0.619
Percent maize commercialisation in 2001	51.9	45.9	45.7	0.459	50.4	50.9	56.6	0.305	50.6	48.3	50.0	0.580
Percent maize commercialisation in 2000	51.7	49.4	51.1	0.867	52.2	52.5	59.9	0.117	52.1	50.9	54.9	0.351
Percent maize commercialisation in 1999	48.2	46.9	42.5	0.595	54.7	54.6	55.1	0.993	54.1	50.6	47.5	0.143
Percent cassava commercialisation in 2001	81.7	67.4	64.0	0.637	49.4	55.6	58.6	0.040	50.1	57.8	59.6	0.012
Percent cassava commercialisation in 2000	70.6	62.0	63.6	0.892	51.6	53.7	55.4	0.579	52.0	54.8	56.7	0.394
Percent cassava commercialisation in 1999	76.1	73.0	48.9	0.043	51.4	52.6	51.2	0.914	52.0	55.5	50.7	0.431
Qty of chemical fertilizers per ha of maize farm (kg)	311.6	402.2	255.0	0.004	17.7	11.3	39.3	0.059	91.9	221.8	181.5	0.000
Qty of chemical fertilizers per ha of cassava farm (kg)	41.8	115.2	57.1	0.453	12.0	8.6	42.6	0.107	13.9	29.5	45.5	0.214
Age of household head (years)	47.0	50.4	47.1	0.189	54.1	53.9	50.8	0.362	52.8	52.1	48.5	0.033
Educational status of household head (years)	6.6	6.3	8.7	0.034	3.7	4.3	5.8	0.075	4.2	5.4	7.8	0.000
Area of village land per household (ha)	5.6	7.1	3.7	0.034	19.8	5.5	10.3	0.000	17.0	6.4	6.3	0.000
Distance to all-weather road from village centre (km)	2.8	1.0	0.1	0.000	1.2	2.8	1.1	0.000	1.6	1.8	0.5	0.000
Distance to nearest urban market from centre of village (km)	21.7	13.2	2.3	0.000	11.2	8.8	3.3	0.000	13.3	11.2	2.7	0.000
Percent of village land cultivated	45.0	69.7	75.0	0.000	47.7	58.4	72.5	0.000	47.2	64.2	74.0	0.000
Total ruminant livestock owned (TLU)	5.0	2.8	1.6	0.119	0.5	0.2	0.4	0.055	1.3	1.6	1.2	0.734
Household size (persons)	10.9	14.8	13.6	0.139	7.6	7.1	10.3	0.003	8.2	11.1	12.3	0.000
Available household labour	5.3	4.9	5.2	0.810	6.4	4.7	6.6	0.006	6.2	4.8	5.7	0.004
Distance to extension outlet (km)	5.8	9.2	3.2	0.015	12.2	10.1	6.2	0.000	11.0	9.6	4.4	0.000
Maize farm size in 2001 (ha)	1.6	3.0	2.2	0.108	1.2	0.8	1.2	0.166	1.2	1.9	1.8	0.062
Cassava farm size in 2001 (ha)	0.1	0.1	0.1	0.631	0.9	0.8	1.0	0.070	0.8	0.4	0.5	0.000
Total value product (TVP) in 2001 (USD)	3373.8	4061.0	1649.7	0.000	966.1	796.0	902.3	0.717	1408.4	2475.1	1359.4	0.000
Total value product in 2000 (USD)	3596.9	4184.2	1716.9	0.000	1006.9	835.7	793.0	0.686	1492.5	2572.0	1354.6	0.000
Total value product in 1999 (USD)	3837.2	4393.8	1875.1	0.001	1305.8	992.8	821.4	0.365	1790.5	2785.8	1465.9	0.002
Total value product/ha in 2001 (USD)	2869.5	2645.8	813.8	0.002	627.2	613.1	449.3	0.793	1039.0	1658.5	672.2	0.004
Total value product/ha in 2000 (USD)	3115.1	2940.1	864.7	0.002	722.8	666.6	485.9	0.732	1174.5	1841.2	716.2	0.003
Total value product/ha in 2000 (USD)	3366.1	3093.7	938.9	0.002	889.1	676.8	525.5	0.483	1370.2	1951.5	776.8	0.008
Percent maize value in TVP 2001 (USD)	36.9	63.4	59.9	0.000	35.9	38.1	24.2	0.001	36.1	51.0	45.6	0.000
Percent maize value in TVP 2000 (USD)	32.8	65.1	63.1	0.000	33.2	38.4	24.1	0.000	33.1	52.1	47.0	0.000
Percent maize value in TVP 1999 (USD)	36.8	65.5	63.9	0.000	33.9	39.3	24.4	0.000	34.5	52.9	47.6	0.000
Percent cassava value in TVP 2001 (USD)	8.5	10.0	10.2	0.965	66.5	64.6	75.8	0.004	60.3	52.9	53.3	0.081
Percent cassava value in TVP 2000 (USD)	8.1	11.8	6.8	0.724	67.3	64.1	75.9	0.002	60.9	52.8	52.1	0.047
Percent cassava value in TVP 1999 (USD)	8.8	13.5	11.1	0.847	65.8	63.9	77.6	0.000	59.4	52.7	54.3	0.187

Table 16 shows that by the assessment of the enumerators, the agricultural potential of land in Kaduna ranged from medium to good (i.e. no low agricultural potential rating). In that State, farmers had larger farms in places with better agricultural potential. Maize and cassava constituted about 52% and 3% respectively of the cropped area, pointing to the dominance of cropping system by cereals compared to tubers. This contrasts with Osun State where both crops share the cropped area in practically equal proportions. As expected, clear-cut differences exist in the total value of products per hectare obtained from land with good potential compared to low and medium potentials in both Kaduna and Osun states although less so for cassava in Kaduna state. This could be attributed to cassava not being a very important crop in the northern Guinea savanna (NGS) ecological zone.

Distance to all-weather road and to nearest urban center capture State intervention and the influence of access to market on intensification. On the average, farm households were about 1-1.5 km from an all-weather road. The result showed that good potential land tended to be farther from the cities than lower potential land. This could be explained in terms of the higher probability for land degradation around the cities due to very short or non-existent fallow periods. In real terms, the total value product for all crops has been declining in both states since 1999. This points out that agriculture is becoming less attractive, if measured from total crop income.

The summary of the variables by the wealth ranking of the households in Table 17 confirms that resources available to farm households determine the nature and extent of their participation in agriculture. Very significant statistical differences existed in most the variables with notable exceptions of age of head of household (the nation's agricultural work force consists mostly of old and retired people), cassava and maize farm sizes and proportion of land planted them for Kaduna and Osun respectively, percentage of land under cultivation, distance to extension services, etc. On the other hand, wealthier households had, more land, more people to cultivate the land, higher yields per hectare from ability to apply more external inputs e.g. fertilizers than the poor, and were positioned nearer the outlet for products i.e. urban markets.

By the design of the study, the study locations were selected such that they were somewhere around in the third quarter along an intensification scale i.e. excluding locations too close to cities as to not introduce distortions and those in very early intensification in remote places. In the analysis, we combined availability of all public transportation, distance to all-weather road, telephone and amount of village land per household to develop an intensification score for all households. This score was then partitioned into quartiles as follows; 1st quartile signifying early intensification, 2nd and

3rd quartiles indicating locations in transition and the 4th quartile being for late intensification. Using this criterion, we examined the distribution of the variables among households, summarized in Table 18. It shows almost consistently the locations in transition between early and late intensification were more productive per hectare for maize and for total value of product per hectare. The application of fertilizers per hectare was equally higher in such domains. The result is different for cassava and shows that places in late intensification were significantly more productive for the crop than other areas and this was true for both the sub humid and savanna ecologies represented by Osun and Kaduna states.

4.3.2 Cassava and Maize Production Functions

Using equation 1 as the basic empirical model, linear production functions were specified for cassava and maize using age of household head, household size, cassava farm size, available labor, engaging hired labor, availability of extra land, quantity of chemical fertilizers per hectare, ownership of ruminant livestock for manure, as household factors driving the use of technology and percent commercialization of cassava. State intervention was represented by distance to all weather road, distance to nearest urban market, presence of out grower scheme and distance to extension service.

Two models of the cassava production function are presented (Table 19); one with all the variables (prototype) and the other with only those variables retained after a stepwise

Table 19. Determinants of cassava productivity in Nigeria

	Prototype Model			Constrained Model		
	Coefficient	Std. Error	P[|Z|>z]	Coefficient	Std. Error	P[|Z|>z]
(Constant)	7670.63	5257.94	0.148	9727.56	3138.06	0.003
Age of household head (years)	69.83	53.85	0.198			
Household size (persons)	-289.65	147.62	0.053	-160.30	82.07	0.054
Cassava farm size in 2001	1284.26	674.14	0.060	1608.63	597.02	0.008
Available household labour	212.90	213.24	0.321			
Qty of chemical fertilizers per ha of cassava farm	-2.23	10.12	0.826			
Cassava commercialization in 2000	25.75	31.03	0.409			
Use of improved cassava varieties	-2906.00	1703.99	0.092			
Total ruminant livestock owned (TLU)	-154.71	224.99	0.494			
Distance to all-weather road from village centre	-66.27	251.02	0.792			
Distance to nearest urban market from centre of village	-91.11	230.26	0.693			
Presence of outgrower scheme in village	5735.60	3785.40	0.133	7798.98	3484.56	0.028
Percent of village land cultivated	111.12	49.53	0.027	110.27	37.56	0.004
Distance to extension outlet	-260.12	153.61	0.094	-312.65	108.89	0.005
Extra farm land available to village	-65.79	148.23	0.658			
Dummy for use of hired labour	-2020.87	1807.77	0.267	-2484.61	1451.70	0.090
R^2	0.387			0.344		

Dependent variable = cassava yield in 2001 = 11.49t/ha backward regression procedure. The constrained model shows essentially that household heads or farm managers with large households can harvest higher yield. This may be related to availability of family labor from such households for farm operations such as land preparation, weeding and harvesting, which coincide with labor peak periods in the farming calendar.

Presence of out grower scheme in the village and the percent of village land cultivated significantly affects cassava yields. Presence of out grower scheme in a village may have two effects that support farmers to enhance yield. First farm inputs may be made readily available to farmers; secondly, farmers earn cash in bulk, which can be used to purchase inputs. The lower the percent of land under cultivation the higher the productivity. This is probably related to the phenomenon of population pressure reducing land sizes and inducing intensification, including the increased use of external inputs like chemical fertilizers. The closer a farmer is to extension providers the higher the productivity. The negative, but significant coefficient for use of hired labor shows that those using family labor increased cassava productivity.

Average maize yield for the entire sample during the recent year (2001) was 1.42t/ha (Table 16). However the mean maize yield across States differ, with higher yields (2.1 t/ha) obtained by farmers in Kaduna State than those in Osun (1.8 t/ha). Maize production is more intensified in Kaduna, where most of the farmers apply fertilizers to maize than in Osun State. Using the national data set, results of the maize production model show that age of farmers, household size, quantity of chemical fertilizers applied, maize commercialization and distance to all weather roads significantly influence maize yields. From the constrained model, the age variable indicates that younger farmers are driving maize productivity. Maize production requires more risk and investment than cassava. In reducing risk production technology packages have been developed. These packages include selection of high quality seeds, appropriate planting time and method, proper land preparation, and application of fertilizers/or pesticides. Younger farmers have been found to be more receptive to adopt or try new technologies than older farmers. Coefficient for the household size shows that the larger households harvests higher maize yields (Table 20). Younger farmers are more commercially oriented, thus they go into maize farming a business venture.

The market related variables, shows that commercialization promotes maize productivity. This fits well with the quantity of fertilizer applied to maize and the distance to the nearest all weather road.

Table 20: Determinants of maize productivity

	Prototype Model			Constrained Model		
	Coefficient	Std. Error	P[|Z|>z]	Coefficient	Std. Error	P[|Z|>z]
(Constant)	858.60	484.08	0.078	1205.26	336.42	0.000
Age of household head (years)	-14.07	5.28	0.008	-12.99	5.03	0.010
Household size (persons)	14.92	11.45	0.194	18.56	7.49	0.014
maize farm size in 2001	33.85	27.10	0.213			
Available household labour	3.21	17.50	0.855			
Qty of chemical fertilizers per ha of maize farm	4.05	0.33	0.000	3.88	0.28	0.000
Maize commercialization in 2000	4.57	3.30	0.168	5.32	3.15	0.093
use of improved maize varieties	-37.16	172.79	0.830			
Total ruminant livestock owned (TLU)	-17.37	10.89	0.112			
Distance to all-weather road from village centre	75.46	26.74	0.005	82.60	24.10	0.001
Distance to nearest urban market from centre of village	10.15	8.13	0.213			
Presence of outgrower scheme in village	-381.12	237.90	0.111			
Percent of village land cultivated	2.65	4.27	0.535			
Distance to extension outlet	3.56	9.40	0.705			
Extra farm land available to village	5.30	12.38	0.669			
Dummy for use of hired labour	214.84	169.68	0.207			
R^2	0.565			0.541		

Dependent variable is cassava yield in 2001, 1.42t/ha

Soils in Nigeria are low in fertility, thus fertilizer application is required to increase crop yields. In most maize growing area, maize is cultivated mainly as a cash crop, thus distance to all weather road from village have positive effect on maize yield. This could be related to soil fertility issues. Farmlands farther off from roads are usually less exhausted in soil fertility than those close to roads. Farmlands closer to roads are usually cropped and not left to fallow. In summary the two tables indicates that yield has been affected mainly by agricultural dynamism and market factors.

4.3.3 Constraints to household food production

Factors containing food crops production categorized into market and household related factors by crop and location are presented in Table 21. Most farmers (66%) in Kaduna State reported household related factors as the most important factors limiting maize production. In contrary, about 71% of farmers in Osun State listed market related issues as limiting factors to maize production. The important household related factors listed by maize farmers in Kaduna is the lack of input, while 57% indicated that the high price of yield enhancing inputs (fertilizers, pesticides) constraint production. Road infrastructure in Osun State are less developed than those in Kaduna State. Thus, access to transport for agricultural inputs and products is more difficult in Osun than Kaduna State.

In the major cassava producing State – Osun, 63% of respondent listed market factors as major constraints to crop production. Most importantly, lack of credit facilities as well as the high cost and availability of modern production input constraint food production. Lack of adequate farm labor and capital to pay for land preparation, and lack of funds to purchase inputs were the major household related factors limiting food production in Osun State.

Table 21: Market and household factors constraining food crops production (%)

	Maize		Cassava		Sorghum		Rice	
	Kaduna	Osun	Kaduna	Osun	Kaduna	Osun	Kaduna	Osun
Market related factors								
No constraints experienced	0.50	1.10	6.80	1.10	0.50	0.00	4.40	0.00
Low or fluctuating producer price	2.90	2.20	25.00	1.50	3.70	0.00	7.80	0.00
Untimely payment for crops	1.00	0.40	0.00	0.00	0.50	0.00	1.10	0.00
High transportation costs	3.40	1.10	2.30	0.40	2.10	0.00	0.00	0.00
Unreliable market outlet	0.00	0.00	2.30	0.00	0.50	0.00	1.10	0.00
High price for modern inputs (seeds, fertilisers, pestcides)	57.50	20.30	29.50	12.10	52.40	14.30	44.40	10.00
Modern inputs not available	3.40	10.00	4.50	9.50	6.90	7.10	3.30	0.00
Lack of credit facilities	31.40	64.90	29.50	75.50	33.30	78.60	37.80	90.00
Household related factors								
No constraints experienced	1.90	1.50	0.00	1.80	1.10	0.00	3.30	0.00
Household labour shortage	5.30	6.30	4.50	6.60	7.90	0.00	6.70	10.00
Farm labour too expensive to hire	9.70	30.90	11.40	28.90	10.00	0.00	16.70	40.00
Chronic illness in the family	1.00	0.70	2.30	0.70	0.50	0.00	2.20	0.00
Lack of land to grow crops or insecure land tenure	0.00	0.70	2.30	0.70	2.10	0.00	5.60	0.00
Lack of knowledge about yield improving farming techniques	6.80	0.00	11.40	0.00	6.30	0.00	7.80	0.00
Lack of capital to inputs etc.	60.40	28.30	54.50	25.30	53.70	28.60	41.10	30.00
Lack of capital for land preparation (drought, animals etc)	15.00	31.60	13.60	35.90	18.40	71.40	16.70	20.00
Summary								
Market related factors	34.00	70.80	20.90	63.10	31.50	85.70	24.70	70.00
household factors	66.00	29.20	79.10	36.90	68.50	14.30	75.30	30.00

4.4 Productivity trends and adoption of new technologies

The inclusion of questions requiring farmers to recall events when their households were formed and to compare those with the current situation was creative. Assembling the data, provided a time series data set from 1935 when the oldest household in the survey was formed to 1999 for the latest household formation. To remain realistic, the questions were mainly qualitative and as such the analysis was done using logistic regression technique.

The logit model is of the form:

$Y_n = 1$ {if $I_n \geq I^*_n$ for all the n, $n = 1, 2, 3, ... N$ observations} …… *(2)*

or $Y_n = 0$ {if $I_n < I^*_n$}

where:

$Y_n =$ Same/higher or lower yields of maize or cassava now compared to when household was formed;

$I_n = \Sigma\phi_i D_i + \Sigma\beta_j X_{jn};$

β_j = unknown parameter for the covariates, $j = 1, 2, ..., J;$

X_{jn} = the j^{th} explanatory variable (for village, household and state level factors) for the n^{th} observation, $n = 1, 2., 3, ..., N;$

ϕ_i = unknown parameter for categorical variables (e.g. pre-SAP to post-SAP, Wealth ranking of household), $i = 1, 2, ..., I$; and

D_i = the i^{th} categorical variable.

The entire sample was partitioned as follows:

1. two broad periods namely 2001 compared to all previous periods, using households from both Kaduna and Osun surveys;
2. two broad periods as above but excluding Kaduna in the case of cassava since we did not consider it a very important crop there;
3. three periods namely the period before the structural adjustment programme or pre-SAP i.e. all answers from households formed before 1985; SAP period from 1985 to 1993 inclusive; and post-SAP for the period after 1993.

4.4.1 Trends in productivity of cassava and maize over time

The stratification of the time series data set resulted in five separate models for cassava (Table 22) and six separate models for maize (Table 25). These were used to investigate trends in the productivity of both crops over different periods with distinct policy thrusts. For each model, the dependent variable was a binary variable taking the value 1 if farmers perceived that yield is now higher than during the reference periods (2001, pre-SAP; SAP, and post-SAP).

4.4.2 Cassava productivity during pre-SAP, SAP and post-SAP

The results show that cassava farmers can be classified with 79% to 86% accuracy based on whether cassava yields in their farms are higher or lower now compared to previous times (Table 22). Compared to all previous periods (pooled), farmer that have higher yields now have larger farm size, have access to market, use chemical fertilizers, did not grow cassava from the onset. Such new cassava farmers must be profit oriented, they perceive that cassava prices are deteriorating compared to previous periods. The trend is similar for farmers in Osun State, where cassava is the main food. In general, farmers contend that cassava yield on farms located in areas classified as having low and average potential are declining. Most of the farmers in the sample have been cultivating cassava. Sixty-four percent during the Pre-SAP, 62.3% during SAP and 71% Post-SAP (Figure 1).

Cassava yield differences during the Pre-SAP were driven by new entrants into cassava farming. Cassava farm sizes were smaller during the Per-SAP period than now. Cassava prices were perceived to be higher then now by most of the farmers. In terms of land productivity, farmers believe that, cassava yield on land with average potential were higher then now.

Looking at the SAP period, farm size was the only factor that explains yield differences between now and the SAP period. The farm size coefficient is negative, showing that cassava farms were smaller during the SAP period than now.

Table 23 shows the proportion of respondents' perceptions on changes in average farm area under cassava by period compared to 2001. About 23% of the respondents were not cultivating cassava during the Pre-SAP, with about 8.3 and 13% were not during SAP and Post-SAP periods respectively. Almost 51% of farmers confirmed that cassava farm sizes were smaller during the Pre-SAP, while 55.6% and 65.2% indicated that cassava farm sizes were smaller during the SAP and Post-SAP periods respectively.

None of the variables determining cassava yield difference between 2001 and the post-SAP period are significant. A probably more important reason is that the SAP period and especially the post-SAP period are closer to the year of comparison i.e. 2001 and, therefore, differences are bound to be less distinct.

The increasing land area cultivated to cassava through the three periods, have been accompanied by yield increases. More than 50% of respondents indicated that cassava production have increased compared to the Pre-SAP period. Similarly more farmers indicated that cassava production is higher now than compared to the SAP and Post-SAP periods (Table 24).

Table 22 Logistic regression coefficient of time series data (1935-1999) on cassava yield

Variables	Kaduna & Osun States (2001 compared to all previous periods)		Osun State (2001 compared to all previous periods)		Pre-SAP period (Up to 1985 n=355		SAP period (1985-1993) n=88		Post-SAP period (1994 to 2000) n=46	
	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]
Constant	-0.222	0.785	1.266	0.361	-0.646	0.548	1.450	0.927	0.378	0.894
Age of head of household	0.022	0.095	0.007	0.728	0.025	0.098	-0.011	0.860	0.051	0.466
Sex of head of household (male=1)	-0.481	0.254	-0.913	0.131	-0.057	0.914	-1.876	0.178	-1.947	0.377
Dummy for size of cassava farm	-2.178	0.000	-3.447	0.000	-2.233	0.000	-2.749	0.011	-1.831	0.276
Dummy for growing cassava previously	-1.190	0.023	-1.727	0.017	-1.206	0.054	-0.224	0.895	-6.938	0.873
Dummy for cassava variety	-0.390	0.391	-0.498	0.391	-0.241	0.695	-0.777	0.563	-0.742	0.696
Dummy for use of fertilizers for cassava	1.192	0.014	2.161	0.003	0.730	0.219	2.029	0.181	1.381	0.401
Dummy for use of pesticide for cassava	-0.738	0.556	-1.292	0.310	-0.852	0.511				
Dummy for method of cassava cultivation	0.245	0.750	-0.348	0.734	-0.744	0.486	1.511	0.395	15.581	0.886
Dummy for selling cassava	-0.878	0.173	-0.194	0.801	-1.004	0.185	-8.231	0.894	7.155	0.869
Dummy for cassava price	-1.322	0.042	-1.931	0.018	-1.724	0.023	6.756	0.913		
Dummy for market access for cassava	3.653	0.002	5.546	0.001	3.835	0.002	0.936	0.627		
Dummy for cassava profitability	-1.058	0.301	-2.161	0.158	-0.704	0.502				
Agricultural potential (categorical)										
Low potential	-1.750	0.015	2.589	0.006	0.888	0.297	7.264	0.877	-2.017	0.207
Average potential	-0.265	0.453	1.957	0.015	1.561	0.043	6.439	0.891		
Period										
Pre-SAP	0.402	0.494	-0.093	0.884						
SAP	0.417	0.477	-0.912	0.290						
Model characteristics										
Overall % correct classification	79.20		86.30		80.10		83.10		80.60	
Nagelkerke R Square	0.475		0.653		0.495		0.570		0.470	

[Dependent variable (Y)=1 if yield of cassava is higher now than during farmers' reference year, 0 otherwise].

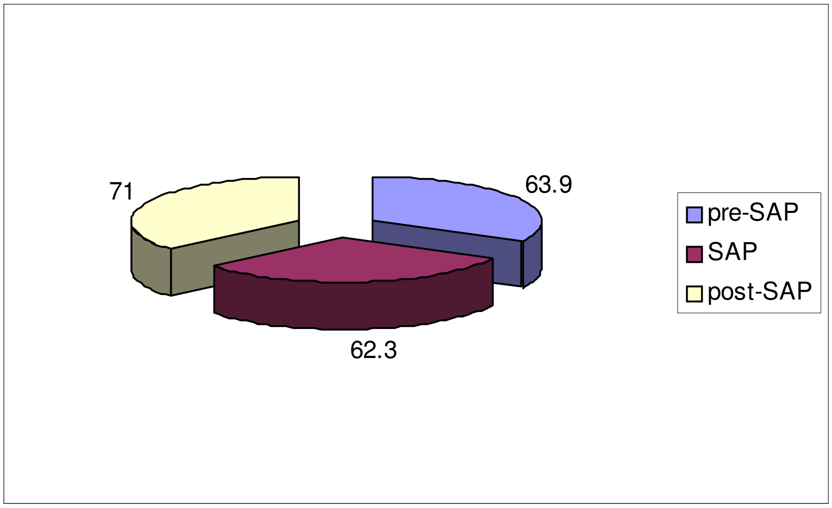

Figure 1. Proportion of farmers growing cassava at different periods

Table 23. Changes in land area under cassava by period compared to the last season

	PERIOD			
	Pre-SAP	SAP	Post-SAP	All Period
Did not grow cassava at that time	23.4	8.3	13	20.6
Same as now	3.6	22.2	8.7	6.4
Larger then	22.1	13.9	13	20.3
Smaller then	50.9	55.6	65.2	52.7
Total	100.0	100.0	100.0	100.0

Table 25. Changes in cassava production from a given size of land compared to now

	PERIOD			
	Pre-SAP	SAP	Post-SAP	All Period
Did not grow cassava at that time	23.3	12.5	4.5	20.4
No difference	1.3	5	4.5	2.1
Larger crop then	23.8	22.5	18.2	23.2
Larger crop now	51.5	60	72.7	54.3
Total	100.0	100.0	100.0	100.0

Even then, it is important to note that the major factor affecting post-SAP yield increases is that less people who grew cassava from the onset are now involved in cassava production. In other words, cassava production is increasing in popularity and attracting new entrants. In the post-SAP period, a number of initiatives to promote cassava production and commercialization are being supported both by the federal government of Nigeria and donor programs. Most important among the initiatives that are encouraging new entrants into cassava production is the Presidential Initiative on Cassava. This initiative aims at promoting cassava as a commercial and export crop. There is also the IFAD funded cassava project that is promoting cassava planting material multiplication and dissemination to farmers in most of the cassava producing states.

4.4.3 Maize productivity during pre-SAP, SAP and post-SAP periods

Table 25 summarizes the finding for comparing differences in maize yield in 2001 compared to the pre-SAP, SAP and post-SAP periods. The model statistics including the overall correct classification of farmers' yields point to robust reliable models. Because maize is important in both Kaduna and Osun States, we are able to run pooled and individual models for both States.

The pooled model (Kaduna & Osun States 2001) shows that, educated female farmers with bigger farm sizes, but have previously been cultivating maize are having higher yields now compared to earlier periods. Maize yields are higher now on potential lands than all previous periods. The variables comparing maize yield now with those obtained by farmers during the pre- and SAP periods, indicate that maize production were lower during the two periods than in 2001 (Table 26). In terms of location, while larger maize farm sizes now explains the maize productivity in Osun State, planting of high yielding varieties is the most significant explanatory variable for the higher yield obtained in 2001 than before.

Table 25 Binary logistic regression analysis of time series data (1935-1999) on Maize yield

Variables	Kaduna & Osun States (2001 compared to all previous periods)		Osun State (2001 compared to all previous periods)		Kaduna State (2001 compared to all previous periods)		Pre-SAP period (Up to 1985 n=355		SAP period (1985-1993) n=88		Post-SAP period (1994 to 2000) n=46	
	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]	Estimate	P[|Z|>z]
Constant	-4.269	0.001	-3.128	0.077	-14.569	0.655	-11.009	0.530	-21.28	0.806	90.694	0.952
Age of head of household	0.017	0.237	-0.008	0.717	0.063	0.046	0.008	0.652	0.144	0.156	0.227	0.099
Sex of head of household (male=1)	-1.398	0.030	-1.890	0.041	-3.589	0.016	-1.361	0.133	-1.703	0.445	-75.005	0.878
Dummy for size of maize farm	1.833	0.000	1.827	0.000	2.324	0.002	2.217	0.000	4.669	0.005	6.593	0.425
Dummy for growing maize	2.937	0.001	2.403	0.015	9.776	0.763	9.985	0.568	10.642	0.902	-2.734	0.998
Proportion of maize farm irrigated	1.515	0.200	0.042	0.978	0.224	0.942	0.333	0.813	26.236	0.036	-4.066	0.847
Dummy for maize variety	0.465	0.193	0.667	0.239	2.645	0.010	0.240	0.618	5.317	0.01	-5.311	0.472
Dummy for use of fertilizers for maize	-0.844	0.018	-0.667	0.222	1.034	0.457	-0.906	0.055	-1.631	0.198	3.784	0.601
Dummy for use of pesticide for maize	0.367	0.564	0.767	0.428	-0.341	0.764	2.027	0.035	-8.001	0.018	-86.584	1.000
Dummy for method of maize cultivation	0.151	0.751	-0.689	0.447	0.731	0.389	-0.233	0.744	4.653	0.013	12.110	0.945
Dummy for selling maize	1.490	0.028	0.962	0.363	4.726	0.004	1.157	0.202	-5.823	0.006	104.991	0.909
Dummy for maize price	0.116	0.817	-0.218	0.773	-0.215	0.842	0.427	0.508			-72.661	1.000
Dummy for market access for maize	-0.355	0.659	0.835	0.539	-3.246	0.054	-0.616	0.564	15.396	0.823	-3.773	1.000
Dummy for maize input price	0.621	0.508	0.347	0.785	0.358	0.902	2.513	0.130	-1.867	0.985	-16.369	0.974
Dummy for maize profitability	-1.135	0.066	-0.948	0.236	-1.765	0.241	-0.933	0.164	-13.264	0.847		
Educational status of household head (years)	0.040	0.203	0.100	0.091	0.038	0.518	0.019	0.655	0.174	0.076	-1.988	0.222
Agricultural potential (compared to good)												
Low potential	-1.708	0.151	-1.641	0.245	1.649	0.074	-1.915	0.203			74.173	0.827
Average potential	1.293	0.001	0.994	0.106			1.353	0.009				
Period (compared to Post SAP)												
Pre-SAP	-1.020	0.054	0.500	0.523	-2.669	0.014						
SAP	-1.408	0.009	-1.207	0.154	-1.772	0.071						
Wealth ranking of household (compared to rich)												
Poor	-0.063	0.883	-0.590	0.359	2.588	0.010	-0.932	0.099			37.561	0.882
Average	0.178	0.640	-0.607	0.242	1.693	0.071	-0.367	0.463			29.636	0.907
Intensification level (compared to high)												
Low	0.030	0.953	1.125	0.157	-5.329	0.005	0.600	0.361			-34.229	0.923
Average	-0.325	0.456	0.679	0.432	-2.003	0.022	0.088	0.883			-27.051	0.939
Model characteristics												
Overall % correct classification	81.90		79.50		89.20		84.60		93.00		89.20	
Nagelkerke R^2	0.410		0.436		0.639		0.524		0.709		0.903	

[Dependent variable (Y)=1 if yield of Maize is higher now than during farmers' reference year, 0 otherwise]

Table 26 Trend in maize production by area (e.g. one acre) compared to now

	PERIOD			All Period
	Pre-SAP	SAP	Post-SAP	
No difference	1.8	10.8	11.8	4.7
More then	38.2	20.0	38.2	34.5
Less then	60.0	69.2	50.0	60.8
Total	100.0	100.0	100.0	100.0

Using the pooled data, 355 respondents cultivated maize during the pre-SAP period (upto 1986). Farm size, application of fertilizer and pesticides are the significant factors explaining productivity difference between the pre-SAP period and 2001. Though farm sizes were larger, farmers were using less fertilizer then now. Table 27 shows the trend in maize farm size during the three periods. More than half of maize farmers indicated maize farm sizes were smaller in Pre-SAP, 64.7% and 61.9% indicated it was smaller during SAP and Post-SAP respectively.

Table 27. Trend in area under maize production compared to recent season

	PERIOD			All Period
	Pre-SAP	SAP	Post-SAP	
Did not farm maize at that time	17.3	8.2	4.8	14.4
Same	4.6	10.6	21.4	7.3
Larger then	25.6	16.5	11.9	22.6
Smaller then	52.5	64.7	61.9	55.7
Total	100.0	100.0	100.0	100.0

Maize productivity during the SAP period was driven by area expansion, irrigation, use of improved varieties, pesticides, and by farmers with previous maize production experience. Market for maize was readily available, which also provided incentives for farmers to cultivate more maize. None of the explanatory variables are significant for the model representing the post-SAP period.

In sharp contrast with the result for cassava, which is shown to be an emerging and popular cash crop attracting new farmers, farmers who are obtaining yield increases in maize have traditionally grown the crop. This is seen from the variable 'grew maize' which has positive signs here compared to the negative sign of its coefficients in the cassava models. The increasing use of new varieties now compared to the past has also resulted in yield increases.

The categorical variables in the maize model were more prominent in comparing and explaining yield differences between 2001 and other periods. The categorical variables in the models are agricultural potential (low, average, high), period (pre-SAP, SAP, post-SAP), State (Kaduna, Osun), wealth ranking of household (poor, medium, wealthy), and level of intensification (low, average, high). Maize productivity is lower now on land with low and average agricultural potential in Kaduna State compared to others and was significantly lower also during the SAP period.

In summary, the significant variables explaining productivity differences for cassava and maize during the periods under study, it is clear that yield differences for both crops during the pre-SAP period were largely driven by natural resource and endowment factors, physical market access and less of market (price) factors. During the SAP period, crop productivity was driven mainly by farm size expansion and less of institutional, technology and market factors. During the post-SAP, which can also be represented by the model for 2001, natural resources and endowment factors (farm size, experience, type of land potential), technology (fertilizer use) and market factors (price and physical market access).

Farm size, irrigation, planting improved maize seeds and method of maize cultivation explain the yield differences between now and during the SAP period. From these variables it could be said that maize farms grew in size during the SAP period but the use of pesticides declined during that period. This is in line with experience during the SAP period when confectionery industries and breweries were forced to look inwards to source materials to replace wheat and barley. Farms for maize and other cereals increased against those of tubers but lack of foreign exchange to import inputs constrained the amount of pesticides, fertilizers and other external inputs. There was a mass campaign to boost agricultural production in the country. Most of the programs made improved seeds and fertilizers available to farmers. The models also show that pesticide use in maize production has not recovered to pre-SAP levels.

It may also be that the need for use of pesticides for maize production has been reduced through developing more pest resistant varieties of maize. In Kaduna State, it is interesting to note that compared to farmers ranked as wealthy the poor farmers reported higher yields in 2001 compared to other periods.

4.4.4 Determinants for cassava and maize technologies adoption

Exponential growth models e.g. logit, probit and tobit are very popularly used in adoption studies. Logit models of the form already described in equation 2 were used to investigate the adoption of technologies for maize and cassava production. The dependent variable, in this case, was defined as Y = 1 if farmer used improved varieties and/or used soil conservation techniques and/or used chemical fertilizers for producing maize or cassava. The explanatory variables were included on the basis of representing household and village level factors as well as indicators of the effects of state intervention. The models are summarized in Table 28 for cassava and Table 29 for maize.

4.4.5 Maize production technology adoption

Table 28 shows the variable estimates and their levels of significance for the maize production technology model. The model results show that the age of the household head, farm size, household size, ownership of ruminant livestock were important household factors in the decision to adopt new technologies or not. Agricultural potential defined at a national level and exemplified by the sub-humid (Osun = 0) and NGS (Kaduna =1) is probably the most important judging by the magnitude of the coefficient of the variable 'State'. This is followed by access to market and it is shown that the higher the access to market the more the adoption of maize production technologies and that within the variable, locations with low or medium access to market have significantly lower adoption rates. It is also interesting to note that among households rated as having medium wealth, the rate of adoption of new maize technologies was significantly higher than both the poor and the wealthy households. This agrees with a similar finding in a study of the adoption of new cowpea varieties in the NGS of Nigeria where the middle class not only had higher adoption rates but were shown to have derived more financial benefit from adoption than other wealth ranks because of assiduous application of necessary external inputs e.g. pesticides during flowering and pod development.

Table 28. Logistic regression estimate of maize production technologies

	PROTOTYPE MODEL			CONSTRAINED MODEL		
	β	s.e.	Sig.	β	s.e.	Sig.
Constant	-8.705	2.613	0.001	-7.177	1.604	0.000
Age of head of household	0.103	0.027	0.000	0.083	0.022	0.000
Farm size in 2001	0.455	0.411	0.268	0.634	0.257	0.014
Maize farm size	-0.764	0.685	0.264	-1.019	0.417	0.014
Household size	0.072	0.048	0.136			
Available extra land (ha)	0.014	0.077	0.857			
Ruminant TLU	0.062	0.035	0.075	0.064	0.030	0.035
Available household labour	-0.289	0.114	0.011	-0.147	0.073	0.045
Dummy for use of hired labour	-1.450	0.987	0.142			
Qty of chemical fertilizers (kg/ha)	-0.004	0.002	0.099			
Use of improved maize varieties	4.984	1.397	0.000	3.702	1.073	0.001
Maize yield in 2001	0.001	0.000	0.019			
Maize commercialization in 2000	0.018	0.016	0.277			
Total value product (Naira/ha)	0.000	0.000	0.684	0.000	0.000	0.043
State (compared to Osun)	-11.060	2.747	0.000	-9.022	1.419	0.000
Agricultural Potential (compared to good)			0.386			
Low potential	1.984	2.157	0.358			
Average potential	1.155	0.921	0.210			
Market access			0.013			0.009
Low access	-4.437	1.626	0.006	-3.608	1.197	0.003
Average access	-1.996	1.319	0.130	-1.205	0.893	0.177
Wealth ranking of household			0.104			0.038
Poor	1.351	0.860	0.116	1.338	0.766	0.081
Average	1.587	0.758	0.036	1.675	0.662	0.011
Distance to all weather road	-0.275	0.145	0.058	-0.286	0.112	0.010
Distance to nearest urban market	-0.090	0.042	0.031	-0.099	0.040	0.014
Presence of out-grower scheme in village	-0.130	0.816	0.873			
Govt. extension service	2.236	2.238	0.318			
Presence of farmers' organization in village	-0.202	0.900	0.823			
Farmer group extension service	0.130	1.213	0.915			
Distance to extension service	0.010	0.052	0.847			
MODEL STATISTICS						
Number of cases in analysis	248			248		
Nagelkerke R^2	0.823			0.799		
Overall % correct prediction	93.1			94.1		

Figure 2 shows the technological changes responsible for increased in maize yield prior to 2001. The figure confirmed that in the dominant maize producing State, fertilizer is the dominant technology responsible for maize yield increase. In the moist humid agroecological zone (Osun), planting of new maize seeds and less of fertilizer has been the technological factor responsible for maize yield increase. Although farmers in general have difficult access to fertilizer in Nigeria, between the two States, it is more difficult for farmers in Osun State than those in Kaduna State. This is because; the few private fertilizer dealers are more located in the northern part of the country, which have more favorable land for cereal production. Also, soils in the northern guinea savanna are more depleted in nutrients than those in the humid forest zone. As such maize cultivation without fertilizer application usually leads to very low yield and some cases zero harvest

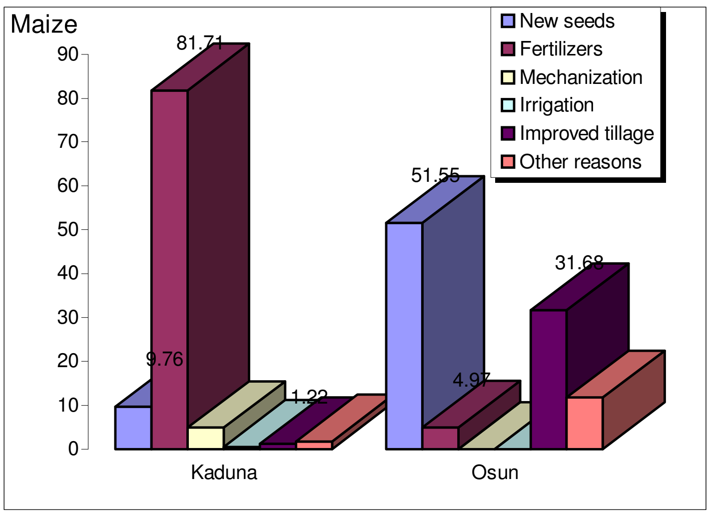

Figure 2 Technology that increased maize yield in Kaduna and Osun States

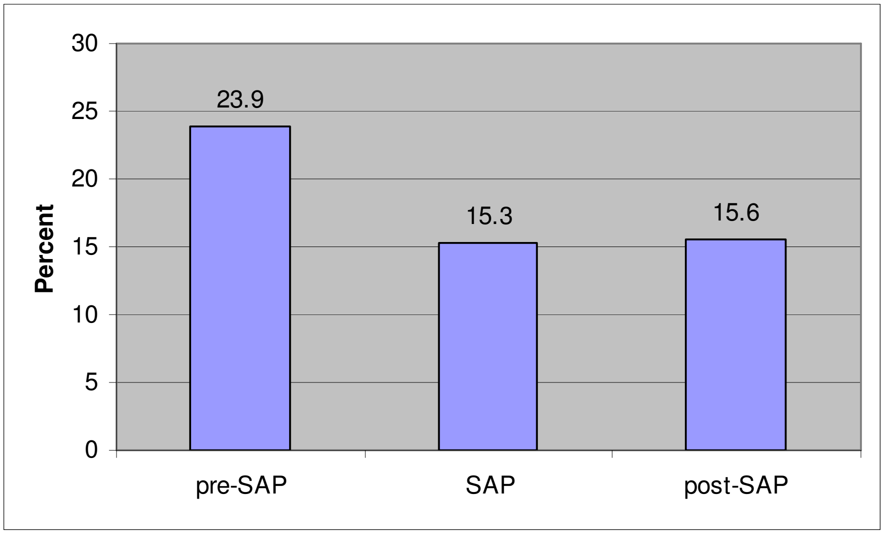

Figure 3. Farmers practicing soil and water conservation technologies

The practice of soil and water conservation technologies is not common among majority of farmers. Figure 3 indicates that 23.9% of farmers were practicing soil and water conservation technologies during the Pre-SAP, 15.3% and 15.6% during the SAP and Post-SAP respectively.

Interestingly, conservation or improved soil tillage methods such as minimum tillage is an important technological change that has contributed to maize yield increase in the humid forest zone. Unlike the savanna zone, this zone has many trees with dense undergrowths. As such land clearing is a major constraint to expansion of farmland as this includes felling of (forest) trees, and clearing of the dense undergrowths and burning. Soil conservation technologies such as alley farming, minimum tillage, were introduced by IITA in the 1980 some farmers modified and adopted some components of the technology. Since the soils in the humid forest are relatively more fertile, farmers obtain higher maize yield than their counterparts in the northern guinea savanna without fertilizers if they plant improved seeds under conservation tillage.

4.4.6 Cassava production technology adoption

Table 29 shows the logistic regression estimates of cassava production technology adoption variables. The model statistics are indicative of a reliable constrained model. Cassava adoption is shown to be affected by age of the farmer, proportion of entire farmland planted to cassava, and distance to an all weather road and distance to extension service. Older farmers were more willing to adopt new cassava growing technologies than younger ones. The negative sign on the nearness to all weather roads indicates that those close to all weather roads would easily adopt new cassava production technologies. This is because, cassava is a bulky and perishable commodity that must be processed within four days or if to be sold must be transported to market, thus the importance of all weather road for cassava technology adoption.

Table 29 Logistic regression estimates of cassava technology adoption

	PROTOTYPE MODEL			CONSTRAINED MODEL		
Variable	β	s.e.	Sig.	β	s.e.	Sig.
Constant	-1.640	3.656	0.654	-3.290	1.809	0.069
Age of head of household	0.046	0.033	0.164	0.061	0.027	0.021
Household size	-0.120	0.108	0.264			
Available household labour	0.046	0.172	0.791			
Dummy for use of hired labour	0.664	1.205	0.582			
Ruminant TLU	0.356	0.195	0.068			
Farm size in 2001	0.114	0.287	0.691			
Available extra land (ha)	0.318	0.218	0.144	0.180	0.138	0.191
Qty of chemical fertilizers (kg/ha)	0.112	0.090	0.213	0.104	0.146	0.478
Proportion of farm planted to cassava	0.109	0.046	0.018	0.062	0.023	0.008
Total value product in 2001	0.000	0.000	0.100			
Cassava yield in 2000	0.000	0.000	0.116			
Cassava commercialization in 2000 (% sold)	0.004	0.016	0.796			
Distance to all weather road	-0.35	0.125	0.005	-0.321	0.091	0.000
Distance to urban market	-0.302	0.123	0.014	-0.107	0.064	0.094
Presence of out-grower in village	-1.906	1.949	0.328			
Govt. extension service	-1.439	1.055	0.173			
Farmer group extension service	-0.73	1.219	0.549			
Presence of farmers' organization in village	0.656	1.140	0.565			
Distance to extension service	0.223	0.104	0.033	0.188	0.077	0.015
Wealth ranking (compared to rich)			0.092			0.110
Poor	-2.156	1.424	0.130	-0.808	0.909	0.374
Average	0.489	1.030	0.635	0.974	0.859	0.257
MODEL STATISTICS						
Number of cases in analysis	135			135		
Nagelkerke R^2	0.585			0.520		
Overall % correct prediction	90.4			91.9		

The distance to extension service that positively affected adoption is not surprising. This is because most of the reasons for farmers to continue to grow cassava in this region have been provided from outside the public extension service providers. The most noted sources of technology are the research stations that have developed improved high yielding, pest and disease-resistant varieties in most cases through participatory farmer evaluations.

Introduced technologies that have facilitated increased cassava yield in both Kaduna and Osun States are presented in Figure 4. While only fertilizer was the most dominant technology in Kaduna for maize yield increases, a combination of three main factors have been responsible for cassava yield increase in the State. First fertilizers, followed by mechanization and the planting of improved cassava-planting materials. Consistent with reasons for maize, planting of improved cassava planting materials and conservation farming such as improved tillage, have are the most important technologies responsible for cassava yield increases in Osun State.

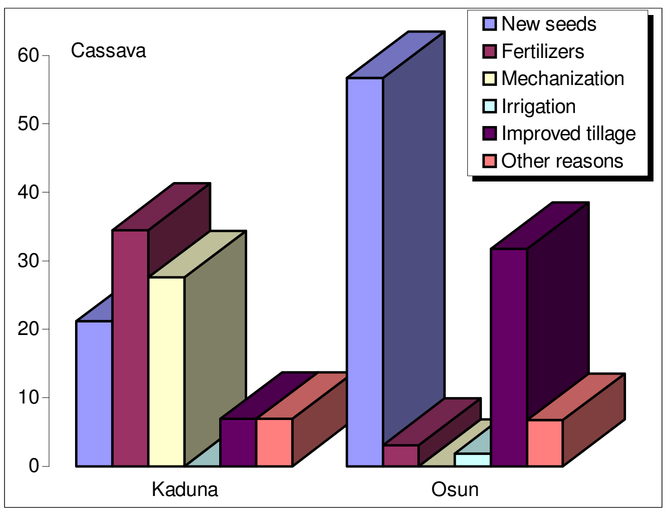

Figure 4 Technology that increased cassava yield in Kaduna and Osun States

The proportion of farmers planting improved cassava varieties has been increasing. While 15% were cultivating improved varieties during the Pre-SAP, 48.6% and 77.3% were cultivating improved cassava varieties during the SAP and Post-SAP periods (Figure 5). Unlike the maize farmers, more cassava farmers (52.8%) were practicing conservation tillage during the Pre-SAP period. During the SAP 37.8% and 59.1% during the Post-SAP are practicing conservation tillage. The increase in the proportion may be related to farmers adoption of previous research on beneficial effects of the practices.

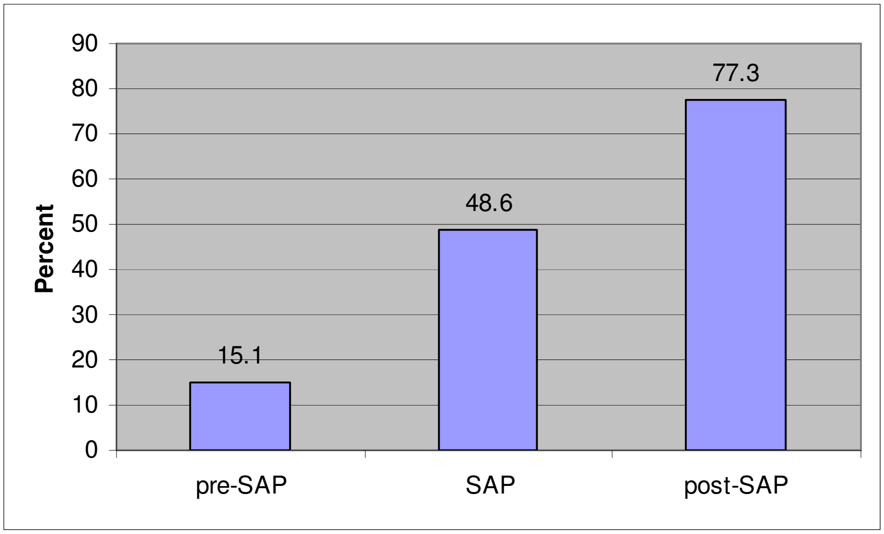

Figure 5. Farmers planting improved cassava varieties

4.4.7 Yield differences and commercialization of cassava and maize

In addition to the linear production function examining the yields of cassava and maize against the various factors, we also investigated whether crop yields were sustained. This was done by calculating the annual difference in yield between year 2000 and 2001 and explaining such differences using a set of household, village and state level factors. Using Tobit models we studied not only the rate of change in yield by year but also the probability that the change will occur, for the entire sample as well as among farmers who were able to sustain and possibly increase their crop yield during the period.

The TOBIT model can be described as follows for this study: Let Y = Change in yield of cassava or maize of a farm holding, Y^* = the solution to the utility maximization problem of yield difference subject to a set of constraints per household and on the condition that such household is above a defined limit, Y_0, which is the minimum difference per household. Since Y_0 is zero for households with zero and negative difference, the TOBIT model may be represented as:

$$Y = Y^* \text{ if } Y^* > Y_0 \qquad (3)$$

$$0 \text{ if } Y^* \leq Y_0 \qquad (4)$$

Adopting the same notations as McDonald and Moffit (1980), equation 2 can be re-stated as:

$$\alpha = X\beta + e \text{ if } X\beta > e$$

$$0 \text{ if } X\beta \leq e \qquad (5)$$

where X is the vector of explanatory variables, β is the vector of coefficients and e is the independently distributed normal random error term with mean zero and variance σ^2. Note that $\alpha = Y$ and may be used interchangeably hereafter.

McDonald and Moffit (1980) decomposed the total change in α associated with a change in an explanatory variable X_i into the change in the probability of being above zero and the change in the values of α, if it is above zero. They show that this marginal effect of an explanatory variable on the expected value of the dependent variable is:

$$\delta E\alpha/\delta X_i = F(z)\beta_i \qquad (6)$$

where $z = X\beta/\sigma$. Based on equation 4, elasticities—useful in comparing the relative size of the effects of significant variables on the total change in α (Y)—were calculated by evaluating each X_i at its mean.

This study is also interested in yield difference as X_i changes among those already using intensive methods as well as in changes in the overall probability of a yield difference occuring as X_i changes. McDonald and Moffit (1980) show that these effects can be calculated from equations 5 and 6, respectively:

$$\delta(Y^*)/\delta X_i = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] \qquad (7)$$

$$\delta F(z)/\delta X_i = f(z)\beta_i/\sigma \qquad (8)$$

where $F(z)$ is the cumulative normal distribution of z and $f(z)$ is the value of the derivative of the normal curve at a given point (i.e. normal unit density).

4.4.7.1 Cassava yield difference

Differences in yield per hectare between the 2001 and 2000 harvests were derived from the questionnaire and censored at zero for farmers that had lower yield in 2001 compared to 2000. From the TOBIT results, the most significant probabilities for improving yield difference lie in commercializing cassava production and use of chemical fertilizers for cassava production (Table 30). The unit of application of fertilizers was kg/hectare and this affected the magnitude of the probability. However, looking at the total change, it is seen that for each extra kg of fertilizer applied per hectare, the yield level of the previous harvest is maintained with an incremental yield of 0.4 kg per hectare. Of course, an incremental application of only 1 kg/ha is not expected to make a huge change. The practical implication is that higher levels of application of chemical fertilizer will not only stabilize yields but also bring incremental productivity. The last column on the same variable shows that the incremental yield will be higher among farmers whose yield differences between 2001 and 2000 were not negative. Almost all farmers (97.7%) during Pre-SAP, 100% during SAP and Post-SAP indicated that cassava yields increased.

Table 30. TOBIT estimates for cassava yield difference (2000 and 2001)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	-3523.078				
State	1035.77	0.32	0.01	109.68	188.71
Agricultural potential of village	-575.18	0.21030	-0.00575	-60.91189	-104.79836
Dummy for use new technology	1080.94348	0.47120	0.01081	114.47191	196.94790
Wealth ranking of household	-0.20015	0.94720	0.00000	-0.02120	-0.03647
Fertilizer on cassava farm (kg/ha)	1.03079	0.11200	0.00001	0.10916	0.18781
Plant improved cassava varieties	-2178.20894	0.13920	-0.02178	-230.67233	-396.86967
Age of household head	40.91030	0.07120	0.00041	4.33240	7.45386
Cassava farm size in 2001	8.43587	0.00000	0.00008	0.89336	1.53701
Out grower scheme in village	-0.37946	0.72990	0.00000	-0.04018	-0.06914
Percent of village cultivated	4.66303	0.81070	0.00005	0.49382	0.84960
Extra land available farming (ha)	0.15546	0.90410	0.00000	0.01646	0.02832
Distance to extension service	-0.39137	0.82070	0.00000	-0.04145	-0.07131
Cassava farm size	-169.47806	0.67170	-0.00169	-17.94773	-30.87890
Maize commercialization in 2001	0.30816	0.66960	0.00000	0.03263	0.05615

σ = 4395.25 ($p \leq 0.0000$)

$f(z) = 0.1826$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.00001\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.1059\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.1822\beta_i$.

Dependent variable = Cassava yield difference

Table 31 shows the most important technological change improving cassava yields during the pre-SAP, SAP and post-SAP by periods. Accesses to new cassava planting materials, conservation farming and improved tillage were the dominant changes fro yield increases during the three periods. Declining soil fertility and increasing pest and weeds are most important factors declining cassava yields. It should be noted that conservation farming was NOT understood in the strict sense of ripping, rip ploughing, but any a method of land use where no tractors and/or animal driven ploughs are used. In most cases, farmers used the hoe to open just where the seed/planting material is to be planted. This method included also minimum tillage.

Table 31. Most important technology improving cassava yields by period

	PERIOD			All Period
	Pre-SAP	SAP	Post-SAP	
Access to new seed varieties	61.8	37.9	27.8	54.5
Chemical fertiliser	7.6	10.3	5.6	7.9
Mechanised land preparation	3.1	13.8	0	4.5
Irrigation	1.5	0	0	1.1
Conservation farming, improved tillage	18.3	31	66.7	25.3
Other	7.6	6.9	0	6.7
Total	100.0	100.0	100.0	100.0

4.4.7.2 Maize yield difference

The Tobit results of yield differences for maize are clearer and more robust than those of cassava as more variables describe ways of avoiding yield decline. The states were coded Kaduna = 1 and Osun = 2. The results show that Kaduna farmers have higher incremental maize yield compared to farmers in Osun (Table 32). There is 10% probability that hypothetically transferring the biophysical and socioeconomic conditions of Kaduna to Osun will result incremental yield of 309 kg/ha. From the model, the introduction of out grower schemes will ensure that maize yields are not only sustained but have a 5% chance of even increasing by up 335 kg/ha. In all cases, the incremental yield in smaller among farmers with a positive yield difference compared to those that had a yield decline between 2000 and 2001. It is not very clear why yields are lower in village with regular access to public transport. This contradicts the expectation that villages closer to urban market outlet for their crops should have higher annual yield difference. Yet, it is in line with the findings of this study that most land with good agricultural potential are located away from all-weather roads and urban centers. Other factors that affect sustenance of yields include the application of chemical fertilizers and the agricultural potential and these are expected to be so.

Table 32. TOBIT estimates for maize yield difference (2000 and 2001)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	-3523.07198				
State	1035.77795	0.32670	0.01036	109.68888	188.71874
Agricultural potential of village	-575.18312	0.21030	-0.00575	-60.91189	-104.79836
Dummy for use of new technology	1080.94348	0.47120	0.01081	114.47191	196.94790
Wealth ranking of household	-0.20015	0.94720	0.00000	-0.02120	-0.03647
Chemical fertilizer on cassava farm (kg/ha)	1.03079	0.11200	0.00001	0.10916	0.18781
Use of improved cassava varieties	-2178.20894	0.13920	-0.02178	-230.67233	-396.86967
Age of household head	40.91030	0.07120	0.00041	4.33240	7.45386
Cassava farm size in 2001	8.43587	0.00000	0.00008	0.89336	1.53701
Presence of out grower scheme in village	-0.37946	0.72990	0.00000	-0.04018	-0.06914
Percent of village cultivated	4.66303	0.81070	0.00005	0.49382	0.84960
Extra land available farming (ha)	0.15546	0.90410	0.00000	0.01646	0.02832
Distance to govt. extension service	-0.39137	0.82070	0.00000	-0.04145	-0.07131
Cassava farm size	-169.47806	0.67170	-0.00169	-17.94773	-30.87890
Maize commercialization in 2001	0.30816	0.66960	0.00000	0.03263	0.05615

σ = 760.590 ($p \leq 0.0000$)

$f(z) = 0.3836$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0005\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.3894\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.3054\beta_i$.

(Dependent variable = Maize yield difference)

4.5 Crop Productivity and commercialization

In the empirical models, commercialization has been defined in terms of the proportion of total production of maize or cassava sold. This varied in the sample from zero to 100%. This data description fits analysis using the Tobit technique. Considering that the Tobit technique is based on the threshold concept, the main concern was with the cut-off point for deciding that the maize and/or cassava production activities of a household are commercialized. For example, will it be for all values above zero or will households need to sell more than 75% of their total production to reach the threshold for commercialization. We chose to investigate three sets of models i) where Y is censored at zero ii) for Y censored at 25% and iii) for Y censored at 50% for 2001 crop output.

Although, the proportions of these products sold in 2000 and 1999 were also available (Figure 6-11), statistical analysis showed no significant difference between the years. As such one single year could be representative of others. Moreover, production input information was available for only 2001.

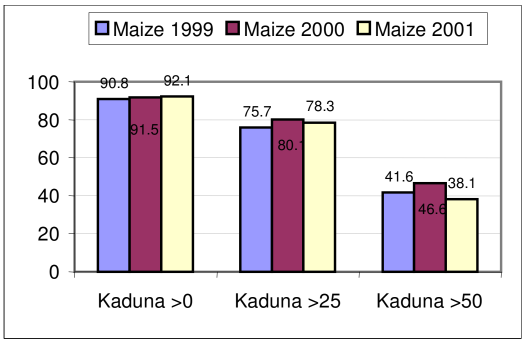

Fig 6. Maize commercialization in Kaduna state (1999- 2001)

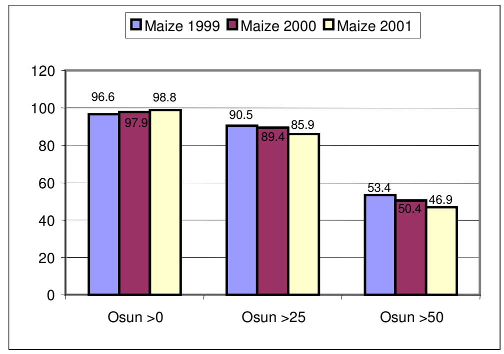

Fig 7. Maize commercialization in Osun state (1999- 2001)

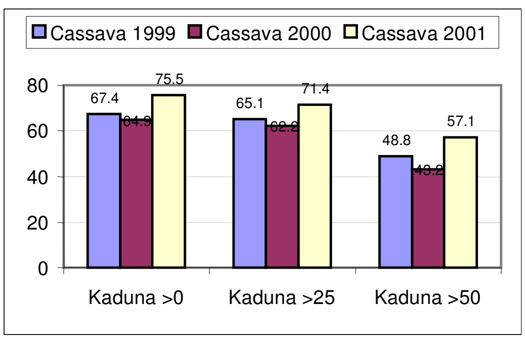

Fig 8. Cassava commercialization in Kaduna state (1999- 2001)

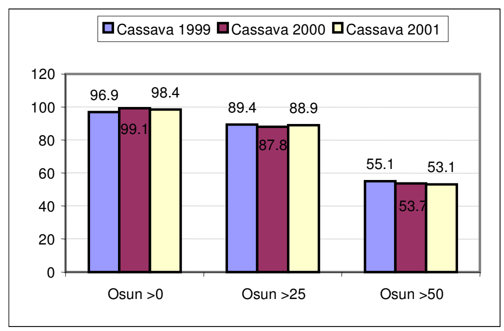

Fig 9. Cassava commercialization in Kaduna state (1999- 2001)

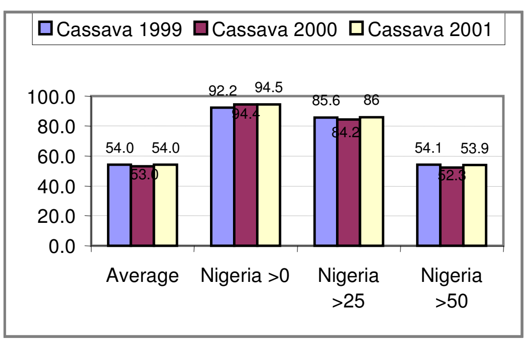

Fig 10. Cassava commercialization in Kaduna and Osun state, Nigeria (1999 -2001)

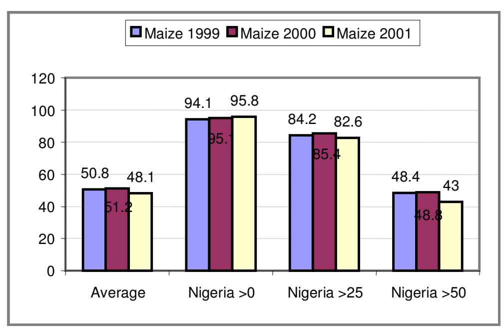

Fig 11. Maize commercialization in Kaduna and Osun states, Nigeria (1999 -2001)

Figure 6-11. Maize and cassava Commercialization in Kaduna and Osun States

4.5.1 Maize commercialization

Table 33 summarizes the results for maize commercialization in Kaduna and Osun states, censored at zero. This model includes all farmers that sold maize (no matter the quantity) in 2001. It does not provide any inference on the proportion of total harvest sold.

Table 33. TOBIT estimates for maize commercialization in 2001 (any quantity)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	-149.83497	0.00000	-1.36350	-81.60012	-58.40567
INTENSII	3.67939	0.31550	0.03348	2.00380	1.43423
State	84.05159	0.00000	0.76487	45.77449	32.76331
AI_CRIT	-7.46920	0.12690	-0.06797	-4.06773	-2.91150
MZTECHFV	9.28836	0.31520	0.08452	5.05844	3.62060
Wealth rank_123	-0.04841	0.01500	-0.00044	-0.02637	-0.01887
Applied fertilizer-H	-0.00899	0.11960	-0.00008	-0.00490	-0.00350
Improved maize variety	6.54598	0.25300	0.05957	3.56494	2.55162
Age of HH	0.06098	0.29640	0.00055	0.03321	0.02377
Education of HH	0.00105	0.88850	0.00001	0.00057	0.00041
Out grower scheme	0.01198	0.38510	0.00011	0.00652	0.00467
Member of farm organization	-0.01212	0.53630	-0.00011	-0.00660	-0.00472
RTLU	0.04351	0.00890	0.00040	0.02370	0.01696
Distance to extension services	0.00211	0.88120	0.00002	0.00115	0.00082
Maize farm size	-0.64333	0.52940	-0.00585	-0.35036	-0.25077
Access to market (distance)	6.77551	0.19990	0.06166	3.68994	2.64109
TVP01HAD	0.00028	0.78530	0.00000	0.00015	0.00011
Maize yield 1	0.00676	0.00150	0.00006	0.00368	0.00263

$\sigma = 43.7800$ ($p \leq 0.0000$)

$f(z) = 0.3965$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0091\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.5446\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.3898\beta_i$.

(Dependent variable = percent of total maize sold 0-100%)

Given this condition, only three variables are significant. These are location of farmer (State), planting improved maize seed varieties, maize yield, ownership of livestock, and wealth rank. The sign of the wealth rank variable indicates that even the poor are selling maize. When commercialization is defined by censoring at 25% meaning only farmers who sold at least 25% of total maize harvested, location is no longer important, but the presence of out grower scheme in the village in addition to planting improved maize seed varieties, farm size and maize yield from previous harvest (Table 34).

Table 34 TOBIT estimates for maize commercialization in 2001 (upto 25%)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	2.82100	0.81290	0.03865	2.00348	1.41417
INTENSII	1.91977	0.31180	0.02630	1.36342	0.96238
STATE	15.14849	0.00000	0.20753	10.75846	7.59394
AI_CRIT	-1.85162	0.49680	-0.02537	-1.31502	-0.92822
MZTECHFV	-0.12094	0.97590	-0.00166	-0.08589	-0.06063
Wealth rank_123	-0.00640	0.58160	-0.00009	-0.00454	-0.00321
MZFERT_H	-0.00352	0.25810	-0.00005	-0.00250	-0.00176
MZ_IMPVR	6.75536	0.02490	0.09255	4.79766	3.38646
AGEHHH	-0.00512	0.86100	-0.00007	-0.00363	-0.00257
EDUC_HHH	-0.00001	0.99760	0.00000	-0.00001	-0.00001
OUTGROW	0.02178	0.00040	0.00030	0.01547	0.01092
RTLU	0.00800	0.37680	0.00011	0.00568	0.00401
EXT_DIST	0.01038	0.16600	0.00014	0.00737	0.00520
MZ_FSZ	1.66508	0.00010	0.02281	1.18254	0.83470
MARTACCS	-1.02859	0.72300	-0.01409	-0.73050	-0.51563
TVP01HAD	0.00044	0.34800	0.00001	0.00031	0.00022
MAIZYLD1	0.00562	0.00000	0.00008	0.00399	0.00282

$\sigma = 25.0100$ ($p \leq 0.0000$)

$f(z) = 0.3429$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0137\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.7102\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.5013\beta_i$.

(Dependent variable = percent of total product sold; censored at below 25%)

Poorer farmers are not selling up to 25% of their total harvest. This confirms that the poor are still producing for subsistent and do not market even a quarter of their total maize harvest.

Table 35 shows that when the threshold is raised further to 50%, two additional variables become significant. The age of the household head and membership in a farmers' organization. The sign for the household head variable is negative, showing younger farmers driving commercialization at this level. As expected, the conditions for being considered commercialized become more difficult to attain, the probability of making incremental sales become smaller along with the proportion of the increase.

In all three models, profitability of maize was not a significant variable for commercializing maize. Profitability measured by total value per hectare has been declining during the last three years. This shows that profitability is not the driving factor for maize commercialization.

Table 35. TOBIT estimates for maize commercialization in 2001 (sold 50%)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	38.06524	0.00200	0.00571	0.00381	12.94218
INTENSII	0.77954	0.66980	0.00012	0.00008	0.26504
STATE	11.83450	0.00110	0.00178	0.00118	4.02373
AI_CRIT	-1.56828	0.56180	-0.00024	-0.00016	-0.53321
MZTECHFV	-3.90143	0.32960	-0.00059	-0.00039	-1.32648
WR_123	-0.00510	0.64830	0.00000	0.00000	-0.00174
MZFERT_H	-0.00319	0.28640	0.00000	0.00000	-0.00108
MZ_IMPVR	5.86334	0.06010	0.00088	0.00059	1.99354
AGEHHH	-0.41972	0.00000	-0.00006	-0.00004	-0.14271
EDUC_HHH	-0.00426	0.26470	0.00000	0.00000	-0.00145
OUTGROW	0.01583	0.10410	0.00000	0.00000	0.00538
FARM_ORG	2.67287	0.08730	0.00040	0.00027	0.90878
RTLU	0.00091	0.91180	0.00000	0.00000	0.00031
EXT_DIST	0.01253	0.13970	0.00000	0.00000	0.00426
MZ_FSZ	1.54933	0.00010	0.00023	0.00015	0.52677
MARTACCS	-1.54050	0.57750	-0.00023	-0.00015	-0.52377
TVP01HAD	0.00026	0.56810	0.00000	0.00000	0.00009
Maize yield in previous year	0.00322	0.00320	0.00000	0.00000	0.00109

σ = 22.2020 ($p \leq 0.0000$)

$f(z) = 0.0033$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0001\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.0001\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.3400\beta_i$.

(Dependent variable = percent of total product sold; range = 0-100% and censored at below 50%)

Changes in prices received by farmers for maize comparing the pre-SAP, SAP and post-SAP periods are presented in Table 36. Majority of farmers believe that prices received for maize have improved.

Table 36 Changes in price received for maize compared to now

	PERIOD			All Period
	Pre-SAP	SAP	Post-SAP	
No significant change	0.9	1.9	3.4	1.4
Worse then	86.4	86.5	86.2	86.4
Better then	12.6	11.5	10.3	12.2
Total	100.0	100.0	100.0	100.0

Physical market access for maize farmers and access to market outlets improved. Most of the respondents indicated that improvement during the SAP was better than during the pre-SAP, while those made during the post-SAP are better than during the SAP periods (Table 37). These improvements are consistent with increasing investments by the Federal Government on rural roads and infrastructure over the years.

Table 37 Changes in farmers access to market outlets for maize by period

	PERIOD			All
	Pre-SAP	SAP	Post-SAP	Period
Same	10.6	1.9	3.3	8.3
Better now	87.2	92.3	96.7	89
Worse now	2.3	5.8	0	2.7
Total	100.0	100.0	100.0	100.0

Perceptions of maize farmers regarding changes in the overall profitability of maize farming in Nigeria during the pre-SAP, SAP and post-SAP periods are presented in Table 38. Farmers (92.5%) indicated that overall profitability improved during Pre-SAP. For the SAP period, 98% of them indicated that profitability improved, while all of them alluded that maize profitability is better during the post-SAP period (Table 38). Improvements in prices as well as the wide spread adoption of high yielding varieties could be responsible for the improvements in profitability. Also, there is a growing industrial demand for maize particularly in the poultry feed industry, brewery, and confectionery industry. Policy has also played a role in protecting the domestic maize market. Maize import is banned in Nigeria. In addition to these, the increasing population in Nigeria is also providing a natural market for maize as food for the teeming population.

Table 38 Changes in overall profitability for maize by period

	PERIOD			All
	Pre-SAP	SAP	Post-SAP	Period
Same	0.5	0	0	0.3
Better now	92.5	98	100.0	94.2
Worse now	7	2	0	5.5
Total	100.0	100.0	100.0	100.0

Although overall maize profitability has increased, most of the farmers contended that prices of modern inputs have increased (Table 39). Fertilizer – the most important input for maize production in Nigeria is imported. However, importation by the private sector has not been regular, due to policy inconsistency by the Federal Government particularly as related to fertilizer subsidy.

Table 39 Price change in modern inputs as measured in maize equivalents

	PERIOD			All
	Pre-SAP	SAP	Post-SAP	Period
No significant change	0.5	2	0	0.8
Prices have gone up	95.7	94	96.7	95.5
Prices have gone down	3.8	4	3.3	3.8
Total	100.0	100.0	100.0	100.0

In response to the increase in prices, most farmers are either not applying or applying inadequate quantities of fertilizers to maize. Among the maize farmers, 79.5% were not applying fertilizer during the Pre-SAP period. During SAP 65.7% were not applying fertilizer while 54.5% were not applying fertilizers during the post-SAP (Table 40).

Table 40 Trend in quantity of artificial fertiliser used on cassava

	PERIOD			All
	Pre-SAP	SAP	Post-SAP	Period
No use at that time	79.5	65.7	54.5	75.1
No difference	1.7	0	4.5	1.7
More then	8	14.3	18.2	9.9
Less then	10.8	20	22.7	13.3
Total	100.0	100.0	100.0	100.0

For those applying fertilizer to maize, less than 10% reported that they were applying higher quantity of fertilizer to maize during the pre-SAP than now. During the SAP, only 14.3% of respondents were applying higher quantity of fertilizer than now, while 18.2% reported that they were applying higher quantity during the earlier years of the post-SAP than now. These figures, confirm that majority of farmers are not applying optimal levels of fertilizer to maize.

4.5.2 Cassava commercialization

Table 41 shows the parameter estimates and their levels of significance, and changes in probability for farmers selling any quantity of cassava in 2001. Similar to the maize model, the State where cassava is cultivated is important. In this case farmers in Osun are more likely to commercialize cassava as their counterparts in Kaduna State. This is a simple fact as Osun is one of the major cassava producing states in Nigeria. Also, the planting high yielding varieties, wealth status of farmer, availability of extra land for cassava cultivation, cassava yield in previous year and farm size are general factors that affect cassava commercialization.

Table 41 TOBIT estimates for cassava commercialization in 2001

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	-70.83664	0.00010	-0.72962	-38.50680	-27.46337
INTENSII	0.58335	0.85310	0.00601	0.31711	0.22617
STATE	13.62614	0.05920	0.14035	7.40717	5.28285
AI_CRIT	-1.16668	0.78120	-0.01202	-0.63421	-0.45232
CSTECHFV	34.24433	0.00000	0.35272	18.61522	13.27653
WR_123	-0.04315	0.01290	-0.00044	-0.02346	-0.01673
CSFERT_H	-0.00302	0.51290	-0.00003	-0.00164	-0.00117
AGEHHH	0.02857	0.53690	0.00029	0.01553	0.01108
OUTGROW	0.00719	0.40240	0.00007	0.00391	0.00279
CSY00_01	0.00166	0.00630	0.00002	0.00090	0.00064
XTR_LAND	0.02004	0.01460	0.00021	0.01089	0.00777
RTLU	0.01781	0.22140	0.00018	0.00968	0.00690
EXT_DIST	-0.00429	0.73900	-0.00004	-0.00233	-0.00166
CS_FSZ	17.06703	0.00000	0.17579	9.27764	6.61689
MARTACCS	5.82544	0.21140	0.06000	3.16671	2.25852
CASSYLD1	0.00217	0.00000	0.00002	0.00118	0.00084

$\sigma = 38.3700$ ($p \leq 0.0000$)

$f(z) = 0.3965$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0103\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.5436\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.3877\beta_i$.

(Dependent variable = percent of total product sold; range = 0-100%

However, for farmers to sell up to 25% of their total cassava output, out grower scheme that guarantee purchase as well as physical access to market adds on the significant factors in Table 42.

Table 42 TOBIT estimates for cassava commercialization in 2001 (sold 25%)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	-32.86212	0.02520	-0.14459	-14.44948	-31.47206
INTENSII	1.28201	0.60540	0.00564	0.56370	1.22778
STATE	5.94837	0.29990	0.02617	2.61550	5.69675
AI_CRIT	-1.26183	0.70440	-0.00555	-0.55483	-1.20845
CSTECHFV	25.08419	0.00000	0.11037	11.02952	24.02313
WR_123	-0.03340	0.01350	-0.00015	-0.01469	-0.03199
CSFERT_H	-0.00610	0.09390	-0.00003	-0.00268	-0.00585
AGEHHH	0.00714	0.84100	0.00003	0.00314	0.00683
OUTGROW	0.00672	0.32470	0.00003	0.00296	0.00644
CSY00_01	0.00113	0.01830	0.00000	0.00050	0.00108
XTR_LAND	0.01577	0.01790	0.00007	0.00693	0.01510
RTLU	0.00705	0.53900	0.00003	0.00310	0.00675
EXT_DIST	-0.00580	0.57300	-0.00003	-0.00255	-0.00555
CS_FSZ	12.82118	0.00000	0.05641	5.63747	12.27885
MARTACCS	5.18256	0.15860	0.02280	2.27877	4.96334
CASSYLD1	0.00163	0.00000	0.00001	0.00072	0.00156

$\sigma = 29.7600$ ($p \leq 0.0000$)

$f(z) = 0.1295$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0044\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.4397\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.9577\beta_i$.

(Dependent variable = percent of total product sold, censored at below 25%)

We also investigated the factors that determine a higher level of cassava commercialization by censoring the proportion of cassava sold by 50% (Table 43). All variables that were significant for the 25% censored data were retained and remained significant. Application of fertilizer cassava and availability of extra land to cultivate cassava became important. The farm size, fertilizer application, available land and market access remained consistently significant in the cassava models. Market access and assured markets are important in promoting cassava commercialization. Farmers will not expand cassava production if they are not sure about market. Although cassava productivity has increased significantly over the years, mainly because of the introduction and promotion of high yielding varieties, a major constraint that is yet to be solved is diversification of use. Presently, cassava is mainly used as food and other uses for example as industrial raw material are not well developed.

As in the maize model, poor farmers could only sell up to 25% of their harvest. For cultivate cassava to sell above 25% of total harvest thy ell up they must have assured market (contract), have access to market. Such farmers must be cultivating improved varieties, and apply fertilizer to cassava. This goes against earlier extension messages, which informed farmers that cassava did not require fertilizer. However, in commercializing cassava farmers must have larger cassava farm sizes, planting improved varieties and applying fertilizer.

The proportion of farmers selling cassava has not significantly changed over the three periods. During the pre-SAP 74.2% of cassava growers were selling cassava. During the SAP and Post-SAP, 72.5% and 73.9% are selling cassava respectively. However, the quantities sold by household have increased. Among cassava growers, 75.3% indicated that more cassava was sold during the Pre-SAP, while 82.8% and 94.1% indicated the quantity sold increased during SAP and Post-SAP respectively.

Table 43 TOBIT estimates for cassava commercialization in 2001 (sold <50%)

VARIABLE	Maximum Likelihood Estimates	P[|Z| > z]	Change in probability $\delta F(z)/\delta x$	Total change $\delta E(Y)/\delta x$	Change among sellers $\delta(Y^*)/\delta x$
Constant	1.45397	0.91540	0.01759	0.33805	0.33703
INTENSII	2.14521	0.35680	0.02596	0.49876	0.49726
STATE	-3.73223	0.49720	-0.04516	-0.86774	-0.86513
AI_CRIT	-4.31267	0.17590	-0.05218	-1.00270	-0.99968
CSTECHFV	21.49796	0.00000	0.26013	4.99828	4.98323
CSFERT_H	-0.00918	0.00890	-0.00011	-0.00214	-0.00213
AGEHHH	-0.01697	0.59370	-0.00021	-0.00395	-0.00393
OUTGROW	0.01412	0.06560	0.00017	0.00328	0.00327
CSY00_01	0.00125	0.01540	0.00002	0.00029	0.00029
XTR_LAND	0.00789	0.18820	0.00010	0.00183	0.00183
RTLU	-0.00229	0.82840	-0.00003	-0.00053	-0.00053
EXT_DIST	-0.01072	0.23920	-0.00013	-0.00249	-0.00249
CS_FSZ	9.79117	0.00000	0.11847	2.27645	2.26959
MARTACCS	6.47094	0.06240	0.07830	1.50449	1.49997
CASSYLD1	0.00125	0.00000	0.00002	0.00029	0.00029

$\sigma = 25.3500$ ($p \leq 0.0000$)

$f(z) = 0.3056$

$\delta F(z)/\delta x = f(z).\ \beta_i / \sigma = 0.0121\beta_i$

$\delta E(Y)/\delta x = F(z)\beta_i = 0.2325\beta_i$

$\delta(Y^*)/\delta x = [1 - zf(z)/F(z) - f(z)^2/F(z)^2] = 0.2318\beta_i$.

(Dependent variable = percent of total product sold; sold 50%)

Most farmers believe that cassava profitability has improved. About 98.7% of cassava farmers indicated that profitability is better now than during Pre-SAP, while all stated that it is better now than during the SAP and Post-SAP periods. This is also in line with improvements in market outlets.

5 Summary and conclusions

5.1 Production gains and trends

Growth in smallholder maize and cassava production based on village and household data show that production was low before the implementation of the adjustment program. However, maize and cassava production increased during the adjustment and post-adjustment periods. It is however not clear from the data whether the production increase was as a result of the adjustment program. Only few farmers have access to irrigation and most production is under rain-fed conditions. Also, input availability particularly fertilizers, pesticides, and credit became a major problem to farmers during the SAP and post-SAP periods. None of the villages studied have experienced drought during the periods under study. Apart from good weather condition, production increase during the adjustment and post adjustment periods has been attributed to expansion of land under cultivation for both crops. During the adjustment period, area under cultivation for both crops increased in response to various government programs that were put in place to boost agricultural production in the country. Also the number of farmers cultivating the crops increased, thus increasing pressure on available farm land.

While additional land for crop production is still available in the humid forest agro ecological zone – represented by Osun State, most of the agricultural land in the northern Guinea Savanna (Kaduna) is under cultivation. About 50% of villages in the northern Guinea savanna agro ecological zone reported that although some land frontier was still open, they foresee this to close within the next few years. This is due to population pressure on the land. On the contrary, majority of villages in Osun State (83.3%) responded that land frontier was still open for agricultural activities.

5.2 Productivity

Looking at the official production data for maize and cassava in the two States and combined with village and household level information, yield increased during the pre-SAP and SAP periods, but declined during the post-SAP period. The introduction and promotion of high yielding crop varieties during the pre- and SAP periods accounted for most of the yield increases. The falling average yields are largely due to the declining use of inputs, though farmers are now growing more of the improved seeds and planting materials. The cost of fertilizer is the most important input expenses to maize farmers as very few farmers are applying fertilizers to cassava. The increase in input prices followed the removal of input subsidies. During the pre-SAP period, older farmers with cassava cultivation experience coupled with higher market prices and access to market were the driving factors that were responsible for yield differences.

Factors noted as constraints to increasing crop productivity in the country relate to high cost of modern yield enhancing inputs, lack of credit, cost of farm labor, lack of access to extension advice and the lack of capital to pay for land preparation. During the post-SAP a combination of expanded area under cultivation of the two crops as well as planting of improved varieties accounts for the increase in productivity. While the government scaled down funding to the Federal/State agricultural extensions service providers, resulting in less activity and contact with farmers, some significant involvement of donors and NGOs have been recorded during the post-SAP period. Both donor and NGO support to agriculture has focused on more on input and credit delivery and less on the provision of credit. Government remains the largest provider of extension services to farmers, while provision of extension services by the private sector is limited only to tobacco and contract seed growers.

5.3 Extent in differences in technology adoption

Adoption of yield increasing technologies has increased through out, from the pre- to the post-SAP periods. There was greater awareness created about the use of high yielding seeds and planting materials, application of fertilizers and pesticides. Also, new land preparation and planting methods were introduced. Since then, farmers have realized to yield advantages of planting improved crop varieties as well as applying yield enhancing products, better soil and crop management practices. Role of the State in providing subsidized inputs, extension services, credit and physical access to markets facilitated adoption by farmers of the new technologies. Role of private extension providers was not significant both during the pre- and post-SAP periods.

Although the role of the State in funding extension has declined and extension activities of the drastically reduced during the SAP and post-SAP periods farmers have more access to new technologies than during the pre-SAP period. This is mainly due to the involvement of more donors and NGOs supporting agricultural production activities. Factors currently determining the adoption of new technologies for cassava include age of household head, (young), proportion of land planted to cassava, closeness to all weathered road and market as well as to extension service providers. Travel time and costs to market is very important for increasing cassava production. Cassava is a low valued and bulky product. In addition to the factors determining cassava technology adoption, availability of extra labor, planting of improved maize varieties, and profitability of maize affects new maize technologies.

5.4 Differences in marketing

Food crop marketing received little or no direct government intervention like price support, or having an agency as buyer of last resort. However, a ban on the importation of most basic foods (maize, vegetable oils, etc.) imposed in 1986 provided opportunity for expanding domestic market for food crops. This lead to higher food prices, proving incentives for food crop producers to increase production mainly through cropland area expansion. Most farmers are selling more crops now (post-SAP period) than during the SAP period. However, profitability is declining due to falling prices (in real terms). In response, farmers are increasing farm sizes and planting improved varieties in order to maintain or at least attain previous income levels. Farmers still complain that farm gate prices they receive for their products are low and have not improved during the last three years (1999-2001). This has been worsened by government withdrawal of input subsidy, decontrol of fertilizer prices leading to inefficient fertilizer market. The resulting increase in input prices or sometimes unavailable depresses production and profitability. This has implication for crop marketing by the poor and rich farmers.

Poor farmers only market a maximum of 25% of total harvest while the rich farmers sell higher proportion of their total harvest. Another source of difference is that the poor sell small quantities of products only when cash is needed, mostly when prices are low, while the rich could negotiate with private traders/contract buyers. Poorer farmers, particularly those located farther from all weather roads and markets usually affected by low or fluctuating product prices. This is more acute for cassava producers, who must either sell products immediately harvest or process into food products. In terms of access to cassava processing equipments this improved significantly during the SAP period over the pre-SAP period. As a result of wide spread dissemination of post harvest technologies during the post-SAP period, access to post harvest and processing technologies have improved. Private investments in small scale, village level processing machines have made this possible. Crop marketing and processing remains the domain of private sector with little or no direct government intervention.