

Yam Consumption Patterns in West Africa

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Executive Summary

In West Africa, yam consumption runs on three critical fuels among others: population; market; and cultural rites practiced in major producing and consuming centres. Yam consumption is hampered by Stone Age technologies at each link in the yam value chain and by certain physiological properties of the yam tuber. This sketch is developed in this report as a contribution towards unravelling the dilemma which the crop presents to agricultural R and D (research and development) practitioners in West Africa. The dilemma is that farmers continue to invest resources on yam production when they can generate more cash return from cassava and consumers pay premium price for yam when they can get the same food value from cassava at lower cost.

Why Consumption Pattern Analyses for Yam in West Africa

In West Africa, R and D (research and development) effort on yam is low in comparison to other major starchy staples such as cassava and *musa*. Yam production, harvesting and post harvesting handling technologies are rudimentary. Information on the importance of yam in terms of its various values is scanty; documentation of such information is essential for advocacy among researchers, policy makers and donors who are uncertain about the future of yam.

In West Africa, yam has multiple values including the standard food and cash income generation values. Yam consumption is high in Nigeria where it is the fourth most important calorie source after sorghum, millet and cassava and in Ghana where it ranks number five as a calorie source after cassava, plantains, rice and maize. National averages often haze important regional differences and therefore do not, in many cases, reflect real situations.

Yam is a major source of cash income for millions of producing households because it has high market demand and it is easily exchanged for cash in rural and urban markets. In West Africa, yam is a source of foreign exchange because its consumption is more widely dispersed than its production.

Agriculture R and D literature in West Africa is liberal with mention of yam as a ritual article in the culture of producing communities although few elaborated. A section is devoted to the subject of cultural rites practiced in producing areas in order to give it the prominence it deserves in yam consumption in the region.

Objectives

The objectives of this report are to:

- analyse current patterns of yam consumption such as what population groups eat yam and in what forms yam is eaten;
- identify uses of yam beyond food and sale for cash income generation and assess the potential and sustainability of such uses to contribute to increased yam consumption;
- identify the factors that drive and those that impede yam consumption;
- estimate levels of yam consumption in the future;
- identify R and D measures that can be implemented to check impediments to yam consumption in order to surge it.

Methodology

The yam consumption pattern analyses are conducted in four purposely selected countries, namely Burkina Faso, Ghana, Mali and Nigeria to represent West Africa. In 2010, the four countries accounted for more than 70 per cent of the population of West Africa and more than 80 per cent of the West African yam supply. Nigeria and Ghana are the largest and second largest, respectively, yam producers and consumers worldwide; Mali and Burkina Faso are marginal producing and consuming countries.

In each representative country, nationwide food consumption survey was conducted noting the frequency of individual consumption of food staples by administrative region, income group and by gender.

In the major producing countries, i.e. Nigeria and Ghana farmers were interviewed in groups in different yam agro-ecologies. A group was a minimum of ten farmers; farmer age range was wide and included the oldest in the community. Information was sought from the farmers on two subjects, namely yam production, harvesting and post harvesting handling technologies and information on values of yam beyond food and money.

In a major yam market in each country, survey was conducted to assess perfunctorily the volume and determine through interview of merchants the origin of yams available for sale. Relevant food products were purchased to determine retail market prices of yam and its substitutes. All travels within and among the representative countries for interviews and observations were by road to observe movements of yam by merchants and individual consumers through informal channels and to assess the quality of intra and interstate roads and other transport facilities, even if cursorily.

FAOSTAT was the source of past population and trend data on yam production, consumption and trade. Expenditure elasticity estimates for yam are available in literature for population groups in Nigeria and Ghana. Consumption projection was based on annual compound growth rates of population and per capita GNP and expenditure elasticity (proxy for income elasticity) of demand for yam. Production projection was based on past trends, i.e. annual compound rate of production growth from 1995 to 2010.

Observations

West Africa is the sub-region of concentration of yam production. From 2006 to 2010, approximately 50 million tons of yams were produced annually worldwide. West Africa contributed more than 90 per cent and the rest of the world only less than 10 per cent of the global yam production. FAOSTAT records yam export from Ghana and yam import in Mali over the period 1995 to 2010. Records of export or import in Nigeria and Burkina Faso are scanty.

Analyses of yam price competitiveness provide convincing evidence that high yam production cost is a drag on yam consumption through high product prices. The same set of analyses demonstrates that certain physiological properties of the yam tuber are a clog in the wheel of yam consumption. Range of food staples that compete with yam, range of foods prepared from yam and frequencies of yam consumption all vary significantly among representative countries.

Comparison of frequencies of consumption of alternative yam food products with their specific substitutes highlights the impact of physiological properties on the frequency of yam consumption. Among yam consumers in Nigeria pounded yam is ultimate in status food, but wheat and plantain have combined to reduce its consumption frequency. Diabetics avoid pounded yam believing it to be high in carbohydrate, they consume pounded plantain and wheat flour considered by them to be low in carbohydrates. Yam is unstable in cooked or pre-processed form; they lose quality hours after preparation. Therefore yam is cooked in quantities that must be consumed within the shortest period to avoid waste, with implications for yam as restaurant food.

What are the characteristics of the yam consumer? Among the representative countries, the yam consumer can be characterized best by country and income group. A randomly picked West African who consumes yam frequently is likely to be a Nigerian in upper income group than other nationality. Frequency of yam consumption is relatively low in Ghana because of availability of cheaper substitutes for yam. Yam consumption frequency is relatively high in Mali because of proximity to Cote d'Ivoire.

Within a country, the yam consumer is most closely characterized by income group than by gender or by producing or non-producing region; the higher the income group the higher the likelihood that an individual consumes yam frequently. In Nigeria where yam is diversified into a wide range of food products income groups discriminate with regard to yam product consumed; in that country the frequency of consumption of pounded yam increases while the frequency of consumption of *amala* decreases from low through medium to upper income groups.

Difference in yam consumption frequency between producing and non-producing region within a country is low, especially in countries with relatively developed market access infrastructure because of high market demand for the food crop. Men and women eat yam *per se* on about equal frequencies but in countries where yam food products are diversified, men and women eat different yam products at different frequencies.

Conclusions

Two observations stand out clearly in this report,

1. There is direct association between the frequency of yam consumption and consumer's income group and
2. There is inverse association between the frequencies of yam consumption and retail market price of yam relative to the prices of substitutes for yam.

The two observations are dramatic and consistent across the representative countries. The two observations underscore the argument that increase in consumer income in the representative countries or improvement in road network within and among yam producing and consuming countries impact positively on the frequencies of yam consumption.

In the representative countries, yam is not price competitive with substitute staples such as cassava, maize, rice, sweet potato, etc. In the entire representative countries, the retail price of yam is higher than the retail prices of all the substitute staples. The report revealed that yam production technologies did not change in living memory; that situation could be

responsible for high yam prices because high production cost is associated with low production technology.

Approximate years of introduction of most commonly grown yam cultivars are not known to the present generation of farmers and since such information is transferred from generation to generation, the approximate years were not known to the previous generation of farmers, and so on. Few cultivars which were reported introduced in the past 20 years from other producing areas have not made the list of five most commonly grown cultivars in the major producing areas.

Major constraints:

- i) **Seed:** Lack of improved technology for seed yam production, multiplication and storage is a hindrance to the establishment of formal, i.e. private sustainable yam seed system. The formal yam seed system is weak in both Nigeria and Ghana, sometimes depending on the informal traditional system for support instead of the other way. The results of the analyses **call for investments in in development of yam seed technologies to reduce the seed yam cost, reduce cost of yam production, drive down the price of yam to consumers, and improve yam price competitiveness against alternative staples.**
- ii) **Storage:** Each existing yam storage technique has downside; security and enhanced aeration, especially in high humidity environments are the main advantages of storage by tying in racks at home while **high labour requirement** is the major drawback of that method. In less humid environments, storage in thatched hut or in covered heap is preferred because of its less labour need. But this method exposes the yam to pests including rodents. None of the existing storage technics is capable of holding yam from one harvest to another.

The present state of existing yam storage technologies impacts negatively on yam consumption in two ways. i) The inability of the existing technologies to hold yam from one season to another leads to seasonality in yam supply and ii) exposure of the yam in storage to damage by fungus, bacteria, pests, etc. leads to losses. **Therefore improvement in yam storage technology that can eliminate seasonality in yam supply and/or reduce losses due to damage in storage can increase yam supply, reduce cost and drive down the price of yam to consumers and therefore enhance consumption.**

Social-cultural use of yams: Demand for yam for use as a ritual object in cultural rites of passage, thanksgiving, petition and appeasement practiced in major producing and consuming centres is high enough to produce significant effect on yam consumption. This market is sustainable because the rites are sustainable. Although Christian and Islamic civilizations are eroding African culture and civilization, it is noted that yam is also used as ritual object in Christian churches in the yam producing areas. Additionally, the cultural rites have their roots planted in the existence of the people individually and communally and therefore institutionalized.

The influence which the ceremonial yam market may be exerting on redundant yam production technology is uncertain. Farmers focus on production of large-sized yam tubers to satisfy the ceremonial yam market. But it is not known if farmers' reluctance to change production technology has anything to do with their quest to produce the largest yam tubers possible given their environmental conditions.

Discussion of whether there is association between farmers' quest for largest possible tuber size and yam technology development posed several questions. Is emphasis on producing large tubers an impediment to technology change in yam production? Is there conflict between yam technology development and emphasis on producing the largest possible tuber size? Is the need to produce large-sized tubers for cultural rites responsible for farmers' dogmatic adherence to planting yams in mounds? Is there a relationship between yam seedbed type and size of tuber produced?

Niche markets for yams: Growing demand for yam outside West Africa provides hope for increasing demand for non-ceremonial yams because outside West Africa yam has no ceremonial value especially to importers. Would higher demand from such consumers discourage farmers in West Africa from dogmatic adherence to production methods adapted to generating the highest possible tuber-sized yams?

Estimates of future consumption levels show that major yam producing countries will generate significant amounts of surplus yam in the next fifteen years; minor producing countries will generate deficit. **Large surpluses are unlikely to occur in any other West African country other than Nigeria and Ghana given low levels of aggregate production in all the other countries.** In the case of consumption, several other countries in the region like, Burkina Faso and Mali, will be generating deficits which they will be filling with imports from Nigeria and Ghana.

These projections are based on procedure which is limited in robustness and on data that has doubtful credibility yet the value of the estimates as indicators of what future consumption level can be **call for investment in measures to expand yam consumption at home, to expand export opportunities or to do both in major producing countries.** Speeding up the rate of improvement of the West African interstate highways will distribute surplus yams in Nigeria and Ghana to marginal producing countries through export-import trade.

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1. Introduction

In West Africa, yam consumption runs on three critical fuels among others: population; market; and cultural rites of passage, thanksgiving, petition and appeasement practiced in major producing and consuming centres. Yam consumption, which gains momentum following improvement in market access infrastructure such as roads, is hampered by Stone Age technologies at each link in the yam value chain, including production, harvesting, storage and even food preparation and by certain physiological properties of the yam tuber. This sketch is developed in this report as a contribution towards unravelling the dilemma which the crop presents to agricultural R and D (research and development) practitioners in West Africa.

In West Africa, yam shares some cassava agro-ecologies; in an agro-ecology where yam performs well, cassava performs better and carbohydrate is the food value of both crops. In terms of cash income generation, farmers who produce both crops derive more income from cassava essentially because a large percentage of total yams produced is replanted; the edible yam tuber is used as seed. The dilemma is that farmers continue to invest resources on yam production when they can generate more cash return from cassava and consumers pay premium price for yam when they can get the same food value from cassava at lower cost. This report is an attempt to contribute an answer to the question what yam can do that cassava cannot do.

In 2010, West Africa had an estimated population of more than 300 million people who live in the coastal countries such as Nigeria and Ghana and also in the sub-Sahel countries such as Burkina Faso and Mali, of the sub-region. Some of the coastal countries from Nigeria to Cote d'Ivoire house the yam belt of the world. In the period of 2006 to 2010, the 300 million people derived an average of more than 200 kilocalories per person per day from yam. The average figure is based on the entire population, including the people of the sub-Sahel countries who depend more on millets and sorghum, and therefore the average figure is misleading.

Why Consumption Pattern Analyses for Yam in West Africa

In West Africa, R and D effort on yam is low in comparison to other major starchy staples such as cassava and *musa*. Yam production, harvesting and post harvesting handling technologies are rudimentary. Information on the importance of yam in terms of its various values is scanty; documentation of such information is essential for advocacy among researchers, policy makers and donors who are uncertain about the future of yam. Some yam R and D practitioners argue that because of the rudimentary nature of yam technologies, yam does not compete favourably with cassava, a close substitute in terms of carbohydrate supply. But benefit-cost analyses for yam production on the bases of food and income generation is computed with incomplete equation because in the major producing areas yam has profound value in cultural rites of passage, thanksgiving, petition and appeasement, which are foundational to the existence of the people individually and communally.

Yam consumption is high in Nigeria where it is the fourth most important calorie source after sorghum, millet and cassava and in Ghana where it ranks number five as a calorie source after cassava, plantains, rice and maize. National averages often shadow

important regional differences and therefore do not, in many cases, reflect real situations. For example, although in Nigeria yam ranks fourth in importance in terms of national average per capita calorie consumption, yet Nigeria is the largest producer of the crop globally. Millets and sorghum which are produced and consumed in the dry savannah zone of the country haze the true importance of yam in terms of calories consumed in Nigeria. Yam is produced mainly in the derived savannah zones of the country by about half of the population of 150 million people.

Yam is a major source of cash income for millions of producing households because it has high market demand and it is easily exchanged for cash in rural and urban markets. In Nigeria, in cassava producing areas where yam is only a secondary crop, yam contributed 18 per cent of household food crops cash income, second to cassava. Cassava farmers often produce yam for sale for cash to pay high wages for seasonal hired labour in cassava production. In Ghana, yam contributed 16 per cent of AGDP (agricultural gross domestic product) compared to cassava, 22 per cent (Otoo ---).

In West Africa, yam is a source of foreign exchange because its consumption is more widely dispersed than its production. It is exported from West Africa to other parts of Africa where it is not produced and to other parts of the world including Europe, North and South America and Asia where it is consumed by increasing West African immigrant populations. In Ghana, yam ranked tenth in agricultural commodity export in terms of dollar value which amounted to approximately \$US10 million per year in 2006 to 2010 (FAOSTAT).

Agriculture R and D literature in West Africa is liberal with mention of yam as a ritual article in the culture of producing communities, especially Igbo communities of Nigeria although few elaborated (Hahn, et.al. 1987 and Nweke, et al. 1991). Many decades ago, Basden published a seminal book on Niger Ibos in which he gave position of prominence to yam in Igbo culture (Basden 1938). More recently, in a series of essays, Achebe laid emphasis on culture as the foundation of the existence of the Igbo people, individually and communally (Achebe 1988). Below, a full section is devoted to the subject of cultural rites practiced in producing areas in order to give it the prominence it deserves in yam consumption in the region.

Objective of Yam Consumption Patterns Analyses

The objectives of this report are to:

- analyse current patterns of yam consumption such as what population groups eat yam and in what forms yam is eaten;
- identify uses of yam beyond food and sale for cash income generation and assess the potential and sustainability of such uses to contribute to increased yam consumption;
- identify the factors that drive and those that impede yam consumption;
- estimate levels of yam consumption in the future;
- identify R and D measures that can be implemented to check impediments to yam consumption in order to surge it.

Plan of Report

This report is presented in ten sections; methods adopted for the study are reported in the next section. Background information on yam production, consumption and trade in West Africa is presented in Section 3. The yam consumer archetype is identified in Section 4 as someone in upper income category. In Section 5, price competitiveness of yam with substitute staples is discussed showing that yam is not price competitive with most of its substitutes. In Section 6, future yam consumption levels are estimated and discussed. The next two sections, i.e. Sections 7 and 8, are devoted to yam technology, considered the bottom line issue which determines the price competitiveness of yam through cost and therefore is the most powerful influence that can shape the trend lines estimated earlier.

Section 7 is devoted to seed yam technology because seed yam constitutes a large percentage of cost of producing yam and improvement its technology will make massive impact on yam cost reduction. Other subjects in yam technology, namely variety improvement, labour-saving and storage technologies are combined in Section 8. The two sections provide convincing evidence that yam production and storage technologies have not changed from the beginning of yam culture in West Africa. The subject of use of yam in cultural rites which has received less than appropriate attention in yam consumption analyses in West Africa is discussed in Section 9; The highlights of the nine sections are brought together in a brief synthesis in Section 10.

2. Methods of the Yam Consumption Pattern Analyses

The yam consumption pattern analyses are conducted in four purposely selected countries, namely Burkina Faso, Ghana, Mali and Nigeria to represent West Africa. In 2010, the four countries accounted for more than 70 per cent of the population of West Africa and more than 80 per cent of the West African yam supply. Nigeria and Ghana are the largest and second largest, respectively, yam producers and consumers worldwide; Mali and Burkina Faso are marginal producing and consuming counties.

In each representative country, nationwide food consumption survey was conducted noting the frequency of individual consumption of food staples by administrative region, income group and by gender. Time and money available for the entire yam consumption analyses are tight; time is barely four months from November 8, 2012 to March 31, 2013 and financial budget for nationwide food consumption survey is zero. Without nationwide food consumption survey, analyses of yam consumption patterns will be speculative and non-factual because of the scanty information in yam literature for West Africa.

The food consumption surveys were conducted by phone in all four countries. In each country, a number of phone enumerators were engaged: Nigeria, six; Ghana, two; Burkina Faso, two; and Mali, five. Enumerators interviewed people in their phone contacts using a single row structured questionnaire. Information collected were location base, gender and income group of the respondent and number of times the individual respondent ate each of major staples in the previous one week. Some of the staples were broken down into specific food products such as pounded yam, *yam pouno*, *amala*, boiled yam and other for yam in Nigeria. In asking, the staples were taken one by one; location base, gender and income were known to the enumerator because the respondent was a contact. Income is subjective and not unique among enumerators; based on personal knowledge, enumerator assigned a respondent to lower, medium or upper income group. The phone interview which is efficient with short and simple questionnaire guaranteed wide geographical coverage in a cost effective manner.

In the major producing countries, i.e. Nigeria and Ghana, farmers were interviewed in groups in different yam agro-ecologies. A group was a minimum of ten farmers; farmer age range was wide and included the oldest in the community (Figure 1). In Nigeria, the farmer group interviews were conducted in Otuocha known for seed yam production as well as ceremonial yam production along the River Niger basin, Zaki Biam in the derived savannah agro-ecology and in Shaki north of Ibadan celebrated as the largest source of traditional yam flour called *amala*. Farmer groups were interviewed in Kintamkpo in central and in Tamale area in northern Ghana. Information was sought from the farmers on two subjects, namely yam production, harvesting and post harvesting handling technologies and information on values of yam beyond food and money.



Figure 1. Ghana: Farmer group interviewed in Tamale area, December 2012. Source: Survey

In a major yam market in each country, survey was conducted to assess perfunctorily the volume and determine through interview of merchants the origin of yams available for sale. In Ibadan, Nigeria, a processed yam product, namely *poundo yam* (industrially prepared yam flour) and substitutes, namely *semo* (industrially prepared flours of grain) and *gari* (granulated cassava product) were purchased to determine their prices at retail level. The retailers were interviewed for their assessment of purchaser preferences for those products. Prepared food of yam, namely *foutou* (pounded yam) and substitutes, namely *to* (maize meal) and *riz* (rice meal) were bought in a popular restaurant in central Ouagadougou to determine prices. The restaurant operator provided information on the attributes of such prepared foods. In Kumasi, Ghana yam, fresh cassava roots and maize grains were purchased to determine their price at retail level.

All travels within and among the representative countries for interviews and observations were by road. Road travels by bus were undertaken from Lagos through Lome, Ouagadougou, Bamako, Tamale, Kumasi, and Accra and back to Lagos. This intimidating effort was necessary to observe movements of yam by merchants and individual consumers through informal channels because of deficiency in recorded data on trade in yam in West Africa. The effort was also necessary because the importance of market access infrastructure for yam trade demands an assessment of the quality of intra and interstate roads and other transport facilities, even if cursorily.

FAOSTAT was the source of past population and trend data on yam production, consumption and trade. Expenditure elasticity estimates for yam are available in literature for population groups in Nigeria and Ghana. The range of the available estimates is wide, from

0.10 to above 1.0 per cent depending on quality of the estimate, population group, seasonality, etc.; none of the available estimates is negative.

Procedure for Projection of Production and Consumption

For each representative country, yam production and consumption were projected to the year 2025 using recorded actual data from 1995 to the most recent year that data was available in FAOSTAT, i.e. 2010 for production and 2009 for consumption. Consumption projection was based on annual compound growth rates of population and per capita GNP (Gross National Product) and on expenditure elasticity (proxy for income elasticity) of demand for yam. Production projection was based on past trends, i.e. annual compound rates of production growth from 1995 to 2010. The procedure is as follows:

Production of yam in country n in year t

$$P_n(t) = P_n(2010) * (1 + G_n)^T$$

$P_n(2010)$ = year 2010 production trend estimate in country n (tons)

G_n = annual compound rate of growth of yam production in country n during 1995 to 2010 (%)

T = time interval in years between 2010 and t (number)

$$\text{Log}P_n(2010) = a + b * T(2010)$$

$$T(2010) = \text{time interval in years between 1995 and 2020 (15)}$$

Consumption of yam in country n in year t

$$C_n(t) = C_n(2009) * [1 + (L_n + I_n * E_n)]^T$$

$$C_n(2009) = \text{Log}C_n(2009) = a + b * T(2009)$$

$$T(2009) = \text{time interval in years between 1995 and 2009 (14)}$$

$C_n(2009)$ = 2009 trend estimate for country n (tons)

L_n = annual compound rate of growth of population in country n for 1995 to 2010 (%)

I_n = annual compound rate of growth of per capita GNP in country n for 1995 to 2009 (%)

E_n = expenditure elasticity of demand for yam for country n

T = time in interval in years between 2009 and t (number)

Constant expenditure elasticity of demand of 0.05 is used in consumption projections for all four countries because of the diversity and uncertainty of the quality of the estimates found in literature. Projection of production on the basis of past rate of growth is unrealistic assumption. In the projections, high level of accuracy is difficult to achieve because more variables than used in the projections including several uncertainty factors determine production and consumption trends and the accuracy level declines with the projection period. But the projections will provide reasonable indications of gap between production and consumption in each country. This report will lay emphases on discussion of some unquantifiable factors such as cultural practices which also influence the trend lines.

3. Yam Production, Consumption and Trade in West Africa

Yam Production

Although yam is produced in many parts of the world including Asia, the Caribbean, and South America and in some parts of North Africa such as Ethiopia, West Africa is the sub-region of concentration of its production. *Dioscorea* yam specie, i.e. the white yam, is indigenous in West Africa (Coursey 1967). In the past few years, from 2006 to 2010, approximately 50 million tons of yams were produced annually worldwide. West Africa contributed more than 90 per cent and the rest of the world only less than 10 per cent of the global yam production (Figure 2). Within West Africa the yam production is concentrated in Nigeria and Ghana, which two countries produced 75 per cent of the global yam supply from 2006 to 2010, Nigeria, 65 per cent and Ghana, 10 per cent.

In West Africa, yam is one of the principal food crops produced in the sub-humid agro-ecologies which corresponds to the middle zones of the coastal countries of the sub-region from Nigeria to Cote d'Ivoire, the so called yam belt of the world. North of that zone, yam production pales to marginal scale in non-humid agro-ecologies; south of the yam belt, production also pales to marginal in scale in humid forest zone.

From 2006 to 2010, average annual per capita yam production was Nigeria, 214; Ghana, 217; Mali, 5; and Burkina Faso, 3 kg. From 1995 to 2010, in West Africa, per capita yam production increased at an annual compound rate of 0.8 per cent, i.e. growth in yam production barely kept pace with growth in population. This was because of sluggish growth in Nigeria where per capita production increased at an annual compound rate of only 0.3 per cent (Figure 3). In contrast in Ghana, growth in yam production significantly exceeded growth in population with per capita production growth rate of 6.8 per cent per year. Burkina Faso and Mali are marginal in terms of yam production; in such countries per capita production rarely exceeded 4.0 kg per annum (Figure 4).

■ West Africa ■ Rest of the World

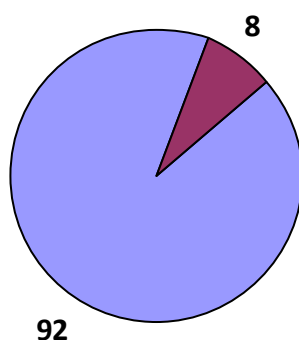


Figure 2. West Africa and the rest of the world: % share of world yam production, 2006 to 2010. Source: FAOSTAT.

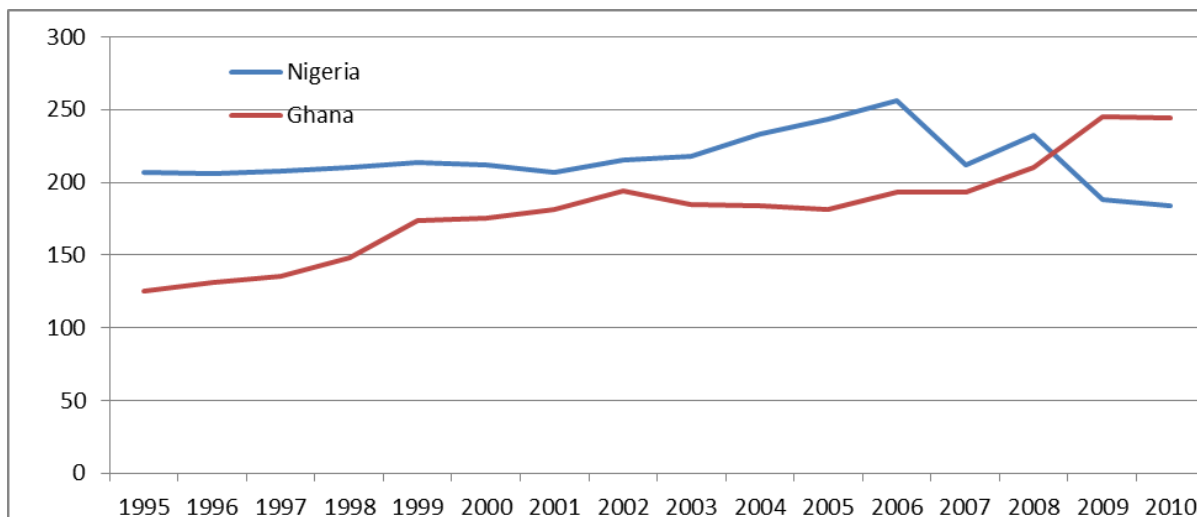


Figure 3. Nigeria and Ghana: Per capita production of yam (Kg/cap/year), 1995 to 2010.
Source: FAOSTAT

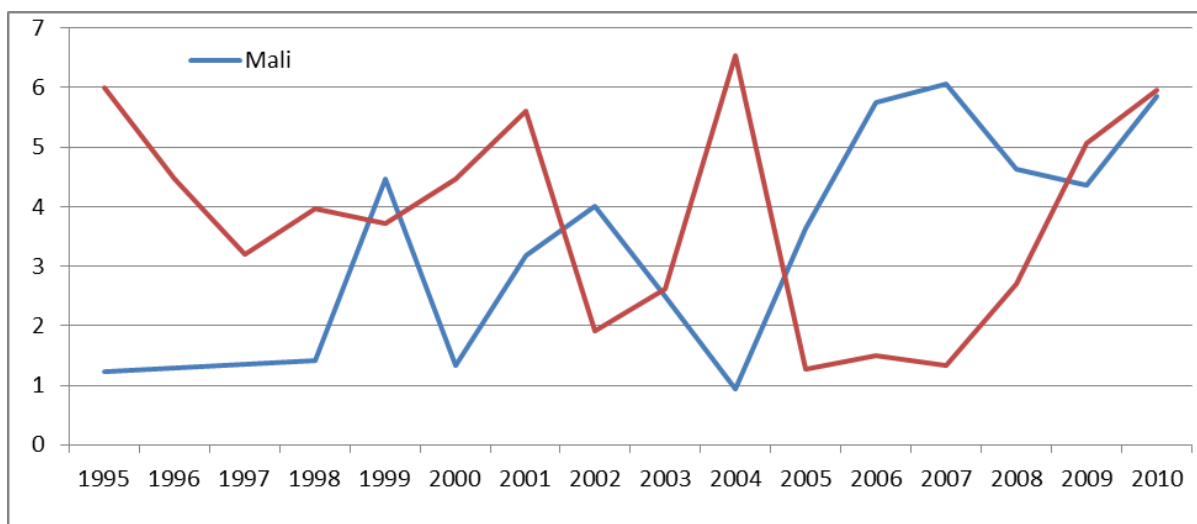


Figure 4. Mali and Burkina Faso: Per capita production of yam (Kg/cap/year) 1995 to 2010.
Source: FAOSTAT

Yam Consumption

From 2005 to 2009, average annual per capita yam consumption was Nigeria, 84.4 kg; Ghana, 127.4; Mali, 5.2; and Burkina Faso, 2.2 kg. From 1995 to 2009 in Nigeria, per capita yam consumption increased at an annual compound rate of 1.2 per cent; Ghana, 2.8 per cent; Mali, 0.6 per cent; and in Burkina Faso, -0.13 per cent (Figures 5 and 6). Growth in yam consumption exceeded growth in population in Nigeria and Ghana, kept pace with population in Mali and was below population growth rate in Burkina Faso. In both Burkina Faso and Mali, per capita yam consumption benefited from civil crisis in Cote d’Ivoire. Refugees from Cote d’Ivoire consumed more yams on per capita basis than the populations of the two countries. This could account for surge in per capita consumption in later years in both countries, especially in Mali.

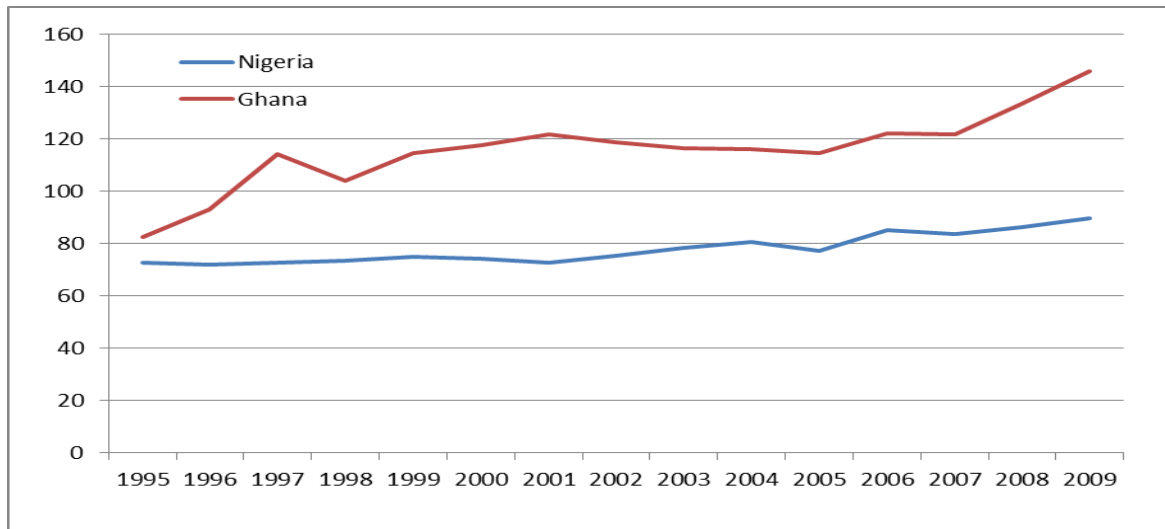


Figure 5. Nigeria and Ghana: Yam consumption (Kg/capita/year), 1995 to 2009. Source: FAOSTAT.

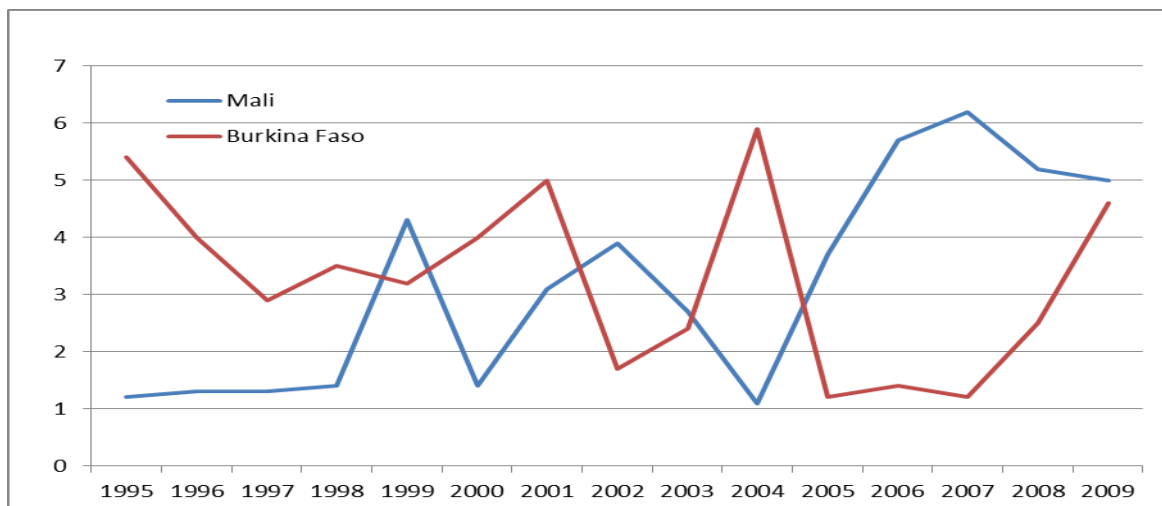


Figure 6. Mali and Burkina Faso: Yam consumption (Kg/capita/year), 1995 to 2009. Source: FAOSTAT.

Trade in Yam

FAOSTAT records yam export from Ghana and yam import in Mali; over the period 1995 to 2010, yam export from Ghana was above yam import in Mali (Figure 7). Records of export or import in Nigeria and Burkina Faso are scanty. Yam produced in West Africa is widely available in Europe, North and South America and in parts of Asia where it is consumed by immigrant African populations. This fact and the results of the surveys for this consumption patterns analyses cast doubt on reliability of the FAOSTAT yam trade data in West Africa.

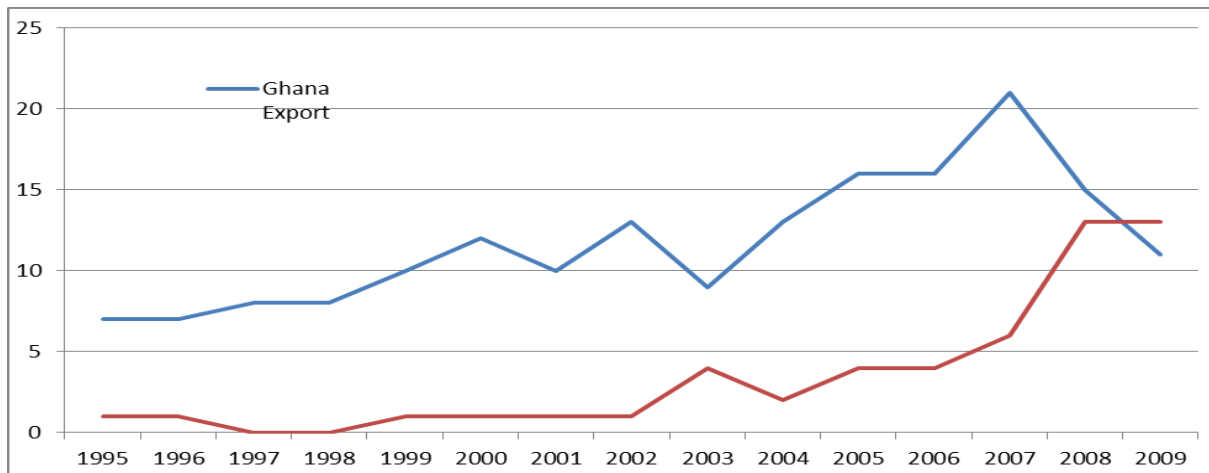


Figure 7. Yam: import in Mali and export from Ghana (000t/year)

On December 4, 2012 at Sankare Yaare market in Ouagadougou, large quantities of yams were on display for sale by merchants (Figure 8). They were mostly white yams, which upon interview the merchants reported that they were entirely imported from Ghana. The merchants further disclosed that yams from anywhere else faced low consumer acceptance in Burkina Faso. A small percentage of the total yam on sale was *alata* which the merchants reported to be produced in the country.



Figure 8. Yam on sale at Sankare Yaare market in Ouagadougou, December 4, 2012. Source: Survey

Similarly, on December 7, 2012 at Soukouni Coura du Medine in central Bamako, large quantities of yams were on display for sale by merchants. But in contrast to Sankare Yaare market in Ouagadougou, the yams displayed Soukouni Coura du Medine were mostly

alata, which upon interview the merchants disclosed were mostly imported from Cote d'Ivoire, a small percentage was produced domestically in Sikasso region.

Consumer preference for white yam or *alata* may not provide full explanation for movements of yam from Ghana and Cote d'Ivoire to Burkina Faso and Mali respectively because Ghana produces *alata* just as Cote d'Ivoire. A more likely explanation could be in differentials in transportation costs. Movement of yam from Kumasi in central Ghana to Bamako by road is through Burkina Faso while movement from Cote d'Ivoire is direct to Mali.

While on survey trip to Shaki, a major yam producing centre north of Ibadan, Nigeria truckloads of yam were seen leaving for Republic of Benin and Togo. Estimation of size of yam trade within West Africa will be an awkward endeavour. The bus travels for the survey for this report exposed the investigator to first hand observation of movements of yam across the borders. Despite custom checks at the various official border posts, baskets of yams were taken across by bus riders and in head loads by pedestrians.

4. Yam Consumer Archetype

What are the characteristics of the yam consumer? In this section, the yam consumer archetype is characterized in terms of country, region of residence within each country (where in the country the respondent resided), gender and income class, which embody the critical variables hypothesized to drive yam consumption, namely market, population, and cultural rites. In this section, the analyses are in form of comparisons of frequencies of yam consumption by country, region of consumer residence within the country, gender and by income class. The comparisons demonstrate without ambiguity that yam consumption is a function of market forces.

Country

In frequency terms, Nigeria is the largest yam consumer among the representative countries (Figure 9)¹. Relatively low frequency of yam consumption in Ghana is surprising. Later in the report, the reason will be provided as high price of yam relative to its substitutes, such as cassava, maize and rice in the country. Also surprising is the relatively high frequency of the yam consumption in Mali for which a possible explanation is proximity to Cote d'Ivoire. These observations suggest that a frequent yam consumer picked randomly in West Africa has a high likelihood to be a Nigerian.

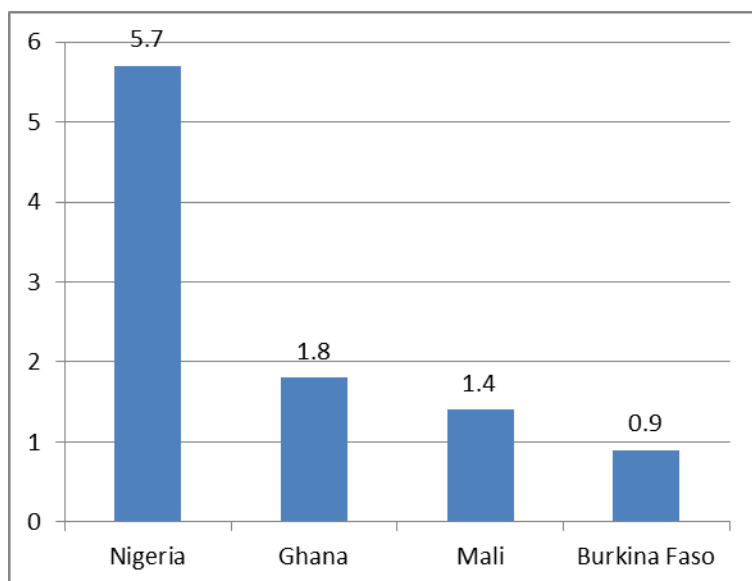


Figure 9. Nigeria, Ghana, Mali and Burkina Faso: Frequencies (number of times/person/week) of yam consumption, December 2012. Source: Survey.

Region

¹ Compared with Ghana, per capita yam consumption is low in Nigeria because national average is misleading.

With the exception of Burkina Faso, in the representative countries, frequencies of yam consumption are about even among regions with few exceptions such as Lagos in Nigeria and Brong-Ahafo in Ghana where the frequencies are lower than other regions in the respective countries (Table 2). Centre-Ouest, Sud-Ouest , Hauts-Bassins, Cascades, Est and Centre-Sud are the yam producing regions in Burkina Faso; the frequencies of yam consumption are higher among those regions than in the other regions surveyed in the country.

The point of above observations is that, depending on condition of market access infrastructure, average frequency of yam consumption is not necessarily higher in producing than in non-producing regions in the representative countries. The observation is most pronounced in Mali where the frequency of yam consumption in Sikasso, the yam producing region, is second lowest while the frequency is highest in Bamako, a non-producing region. Interview of yam merchants in Soukouni Coura du Medine in central Bamako revealed that Bamako region is supplied with yam mainly by import from Cote d'Ivoire although some are supplied from Sikasso.

As already noted, yams sold in Sankara Yaari market in Ouagadougou, Burkina Faso were almost entirely imported from Ghana. Survey travel by bus from Bobo in Burkina Faso to Ghana was on very poor road. On getting to Wa in Ghana, the bus parked; it needed to repair broken axle. After close to five hours of waiting, another bus conveyed the passengers to Kumasi. This experience suggests that yam import from Ghana to Burkina Faso through the same road is at high transportation cost which can bring about price differentials and therefore differences in frequencies of yam consumption among regions. Movement of yam at high cost can cause consumption frequency to be higher in producing than in non-producing regions. Improvement in road network, especially intercity roads will boost yam consumption in non-producing areas and help even out differences in consumption frequencies among regions within a country.

Table 2. Representative countries: Frequencies of yam consumption (number of times per person per week) by region, December 2012. Source: Survey.

Country	Regions	Frequency
Nigeria	Abia	5.50
	Abuja	5.29
	Anambra	4.00
	Lagos	3.69
	Oyo	5.95
Ghana	Ashanti	1.91
	Brong-Ahafo	0.94
	Eastern/Volta	1.83
	Greater Accra	2.20
	Northern	1.67
	Western/Central	2.00
Mali	Bamako	1.71

	Kayes	1.41
	Koulikoro	0.91
	Mopti	1.38
	Segou	1.57
	Sikasso	1.17
Burkina Faso	Cascades	1.29
	Centre	0.69
	Centre-Est	0.83
	Centre-Nord	1.27
	Centre-Ouest	0.92
	Centre Sud	0.65
	Est	1.14
	Hauts-Bassins	1.39
	Nord	0.45
	Plateau-Centre	0.40
	Sahel	0.40
	Sud-Ouest	2.75

The point illustrates the importance of improved market access infrastructure in yam consumption. Improved transportation facilities allow people in non-producing regions equal access to yam with producing areas because yam is produced mostly for sale. S. K. Hahn reported that farmers in yam producing areas sometimes sold their yam and used the money to buy less expensive food like cassava; in other words such farmers could not afford yam they produced². In survey travels for this report, truckloads of yams were common sight along intercity roads within each representative country, especially major producing countries, namely Nigeria and Ghana and along interstate roads among countries in West Africa, delivering yam from producing centres to non-producing areas (Figure 10).

² 2001, verbal discussion.



Figure 10. Truck waiting to be loaded with yam, Zaki Biam Nigeria, January 2013. Source: Survey

Discussion of yam production and storage technologies in later sections will provide evidence that yam production and storage technologies have not changed from beginning of the yam culture in West Africa. Yet yam as a crop has benefitted from technological change in other sectors such as the transportation sector. In West Africa, yam transportation is fully mechanized; in major producing centres, motorized vehicles are used to move yam from the field to place of storage, from storage to farmers' market and from there to distant consumption centres. This development which continues to get better, though not introduced for yam specifically, is the single most critical factor which drives yam consumption presently³.

In West Africa, a program of interstate high way construction is on-going; each West African country is required to construct the road within its borders. Interstate bus travels for this study from Lagos through Cotonou to Lome, Ouagadougou, Bamako and Accra back to Lagos revealed that this program is advancing in all the countries passed through. Some stretches of the roads can be described as fair to good; some are under repair while other stretches are in such poor condition that high cost of wear and tear on transport vehicles is palpable and can be easily seen to be driving up the cost of yam through high transportation costs. Continued improvement of these interstate high ways will certainly help boost yam consumption by driving down transportation cost and thereby price of yam to consumers in importing countries.

³ For staples such as cassava, plantain, grains, beans and peas which are major substitutes for yam in West Africa, mechanized transportation and agro-chemicals may not be considered new technologies. In case of yam it is important to recognize that although those technologies are not new, yam which has not seen any change in variety improvement, agronomic and storage practices from the beginning of time benefits from them.

Gender

In all four representative countries, men and women eat yam at about equal frequencies (Table 1). But where yam food products are diversified such as in Nigeria and Mali, men and women eat different yam products at different frequencies. For example, in Nigeria, men eat pounded yam more frequently than women and women eat *poundo yam* more frequently than men (Figure 11). In Mali, men eat roasted (grilled) yam more frequently than women and women eat other yam, such as fried yam (yam cooked in oil), more frequently than men. Therefore although men and women may prefer different yam food products, gender does not influence yam consumption *per se*.

Table 1. Representative countries: Frequencies of yam consumption (number of times per person per week) by gender in December 2012. Source: Survey for this report.

Country	Male	Female
Nigeria	5.50	5.98
Ghana	1.75	1.77
Mali	1.32	1.40
Burkina Faso	0.91	0.87

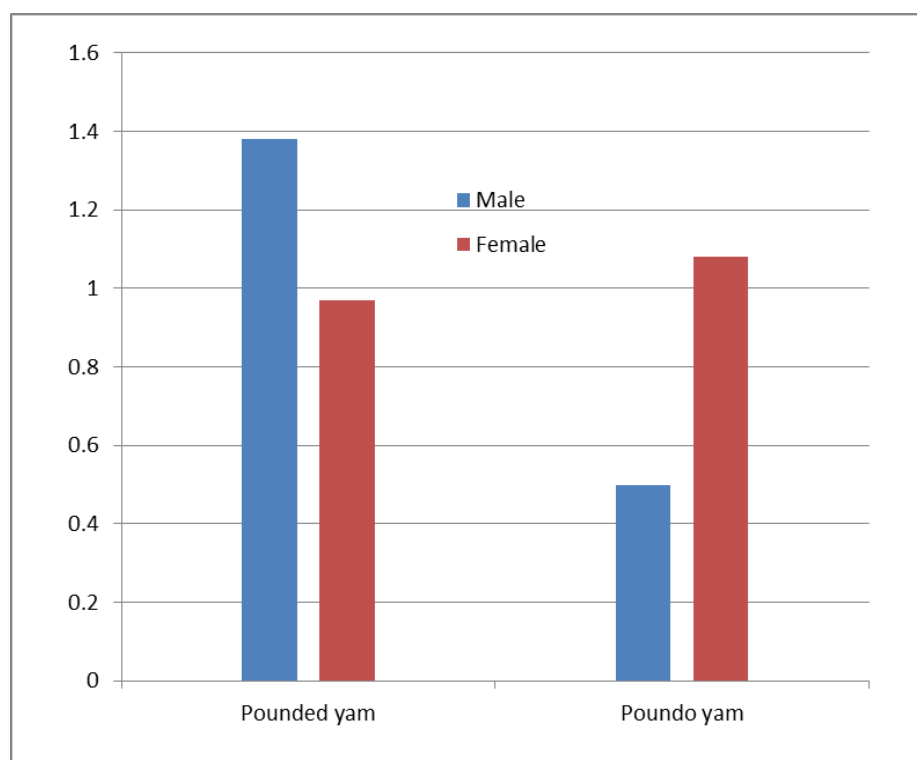


Figure 11. Nigeria: Frequencies of yam consumption (number of times per person per week) by yam food products by gender, December 2012. Source: Survey.

Income

Within a country, the yam consumer archetype is best characterized by income; in all the representative counties, the higher the income group of the consumer, the higher the frequency of his/her yam consumption (Table 3). But Nigerian experience reveals that

income groups discriminate with regard to yam product consumed; in that country the frequency of consumption of pounded yam increases while the frequency of consumption of *amala* decreases from low through medium to upper income group (Figure 12). *Amala* appeals to medium income group because its price (210 Naira/Kg) is half the price of *poundo yam* (420 Naira/Kg) but higher than the prices of *semó* (170 Naira/Kg) and *gari* (also 170 Naira/Kg).

Table 3. Representative countries: Frequencies of yam consumption (number of times per person per week) by relative income, December 2012. Source: Survey.

Country	Low	Medium	Upper
Nigeria	5.63	6.11	5.05
Ghana	1.73	1.52	2.42
Mali	0.86	1.37	2.56
Burkina Faso	0.79	1.37	2.56

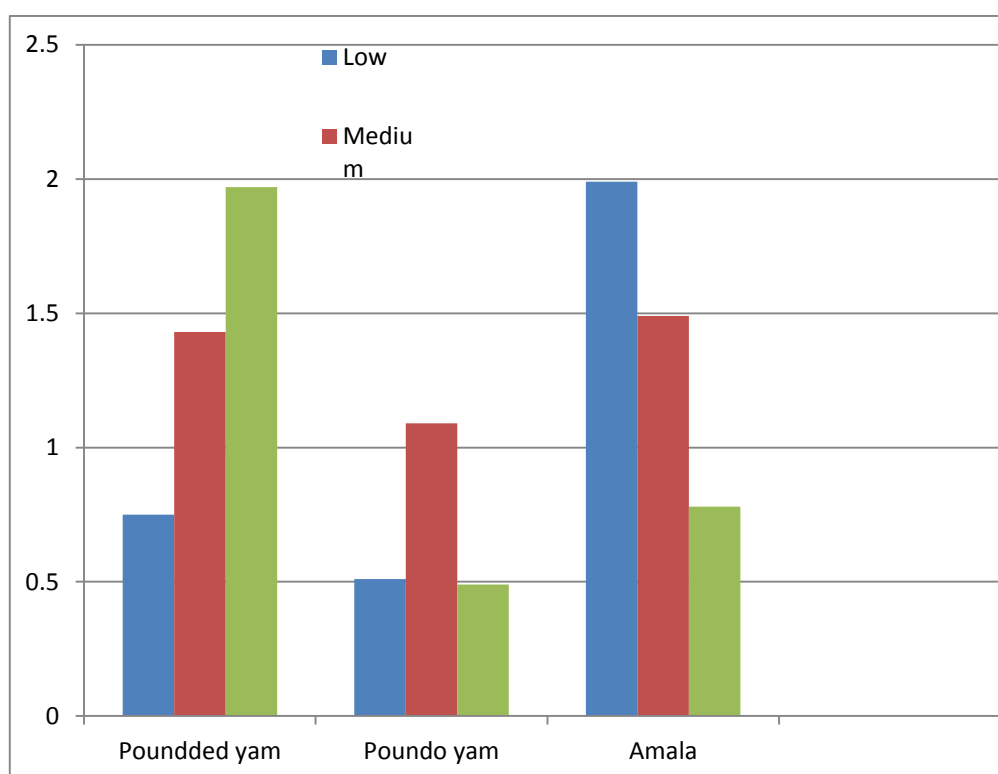


Figure 12. Nigeria: Frequencies of yam consumption (number of times per person per week) by yam food products by relative income group, December 2012. Source: Survey.

There are two sources of yam for *amala*, one source is what S. K. Hahn described as panic use of yam⁴. Yam tuber deeply wounded or seriously damaged by yam pest or disease at harvest, yam in storage showing sign of rot, etc. are cooked, sold or peeled and dried for

⁴ Dr. S. K. Hahn was the leader of root and tuber crop improvement program at IITA from 1971 to 1994.

making *amala* in order to reduce losses. This often results in preparation of *amala* with unwholesome yam (Figure 13).



Figure 13. Wholesome and unwholesome yam being dried for making *amala*, Zaki Ibiam, January 2013. Source: Survey.

The second source of yam for *amala* is a yam cultivar called kokoro in Shaki where production is localized (Figure 14). This yam cultivar is produced for the singular purpose of preparing *amala*. Its production cost should be significantly lower than other yam cultivars, first because tiny tubers that cannot be peeled and therefore have no use are used as seed. In addition, production labour would be lower than other cultivars because kokoro is grown on small tied mounds. Yet the farmers interviewed in Shaki disclosed that satisfactory yields were obtained even under low soil fertility condition.



Figure 14. Kokoro yam used for preparing *amala*, Shaki, Nigeria January 2013.
Source: Survey.

The association between yam consumption frequencies and income groups outlined above lends credence to the earlier observation that yam consumption is driven by market demand. Earlier it was explained that improvement in market access infrastructure would surge yam consumption. **The latest analysis suggests that increase in consumer income will swell yam consumption, particularly in non-producing areas including importing countries.** The latest analysis further suggests that improvement in yam food preparation technology will also lead to more consumption, especially in producing areas.

Summary

- i) Among the representative countries, the yam consumer can be characterized best by country and income group.
- ii) A Nigerian in upper income group is likely to be a frequent yam consumer.
- iii) Frequency of yam consumption is relatively low in Ghana because of availability of cheaper substitutes for yam.
- iv) Yam consumption frequency is relatively high in Mali because of proximity to Cote d'Ivoire.
- v) Difference in yam consumption frequency between producing and non-producing region within a country is low, especially in countries with relatively developed market access infrastructure because of high market demand for the food crop.
- vi) Men and women eat yam *per se* at about equal frequencies but in countries where yam food products are diversified, men and women eat different yam products at different frequencies.
- vii) high yam production cost is a drag on yam consumption through high product prices
- viii) The same set of analyses demonstrates that certain physiological properties of the yam tuber are a clog in the wheel of yam consumption

ix) The retail price information reveals that prices are the main determinant of frequencies of consumption of food staples in Ghana. In February 2013 in Kumasi, the retail price of yam was extremely high; four times that of cassava and more than five times the price of maize⁵. These retail price levels adequately explain the following frequencies of consumption of food staples observed in Ghana: yam, 1.8 times per person per week; cassava, 2.7; and maize, 5.7 times per person per week

⁵ Maize is in dry form; the price differential will be wider if yam and cassava are converted to dry forms.

5. Competitiveness of Yam with Alternative Food Staples

In this section, yam consumption is compared with consumption of alternative staples. Consumption is in terms of frequency, i.e. number of times per week an individual ate yam or alternative staple. In some countries, yam is prepared into different forms, which are different products from consumer point of view. A prepared form of yam can have a different set of substitutes than another form. Yam consumption is compared with other staples which are substitutes to yam as a product and where applicable alternative yam products are compared with their specific substitutes.

This set of analyses provides convincing evidence that high yam production cost is a drag on yam consumption through high product prices. The same set of analyses demonstrates that certain physiological properties of the yam tuber are a clog in the wheel of yam consumption. Range of food staples that compete with yam and range of foods prepared from yam and frequencies of yam consumption all vary significantly among representative countries.

Non-Price Competitiveness of Yam

In Nigeria cassava, rice and plantain are basic substitutes for yam as a staple⁶. In that country, on average, yam is eaten six times a week and cassava seven times. Rice and plantain are eaten less frequently, rice five times and plantain three times a week. In Nigeria, yam is prepared as pounded yam, *poundo yam* (industrially prepared yam flour), *amala* (traditionally prepared yam flour), boiled yam and others. Yam is eaten most frequently as boiled yam, followed by *amala*, pounded yam and *poundo yam*. *Poundo yam*, *gari* (granulated cassava food product) and *semo* (industrially prepared grain flour) are pre-processed products. They are eaten the same way, namely as *fofoo*, and are therefore substitutes for one another. Of the three, *poundo*

⁶ Apart from sorghum and millet which are staples in part of the country with different cultural background

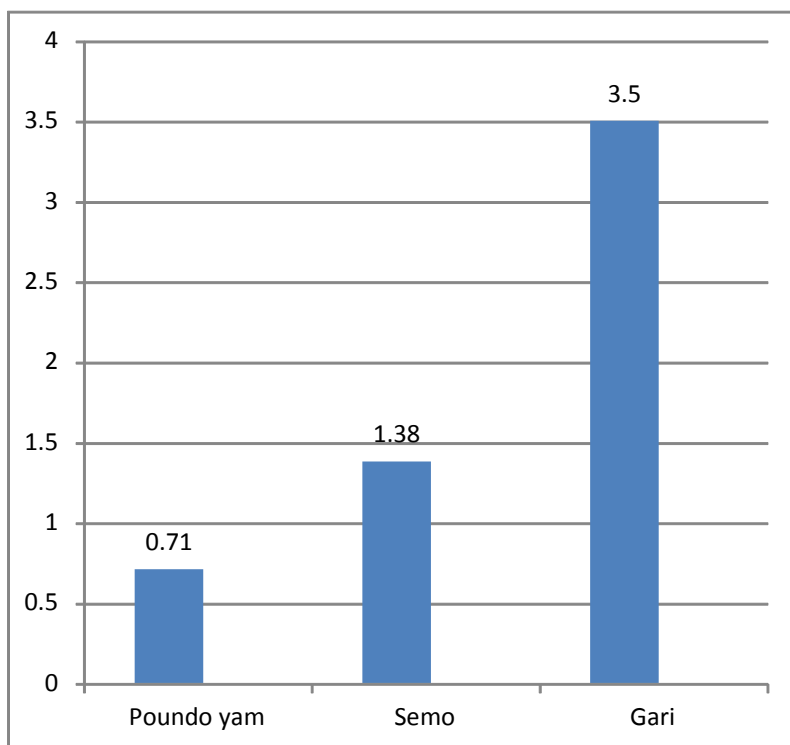


Figure 15. Nigeria: Average frequencies of consumption (number of times/person/week) of *pounded yam*, *semo* and *gari*, December 2012. Source: Survey.

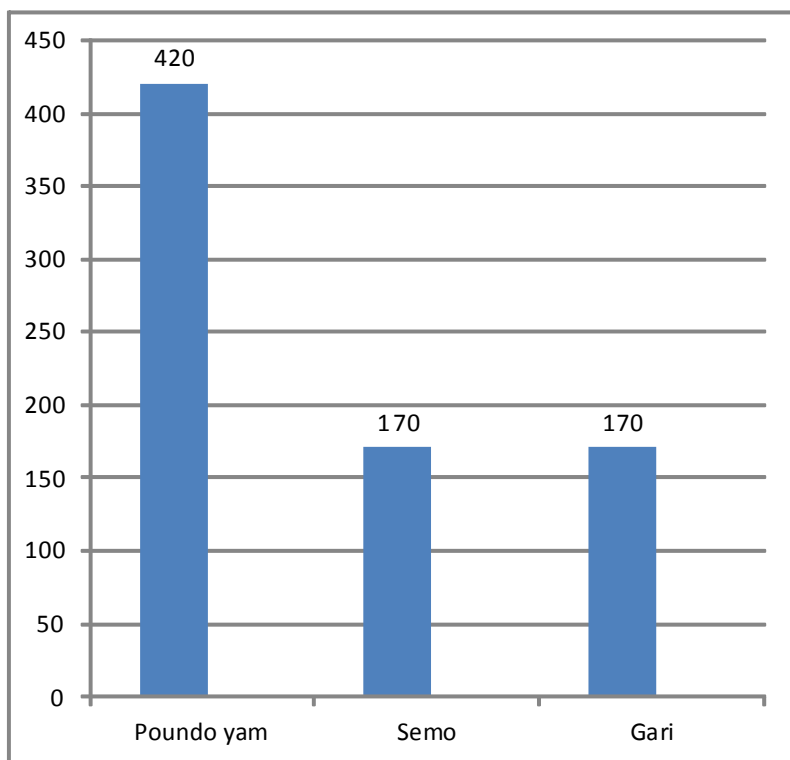


Figure 16. Nigeria: Retail prices (Naira/Kg. 160 Naira=US\$1.00) of *pounded yam*, *semo* and *gari* in Bodija

market, Ibadan, December 2012. Source: Survey.

yam is the least frequently consumed; its price at the retail level is triple the prices of its two competitors (Figures 15 and 16)⁷. The association between prices and frequencies of yam food products and their substitutes is as strong in Burkina Faso as in Nigeria (Figures 17 and 18).

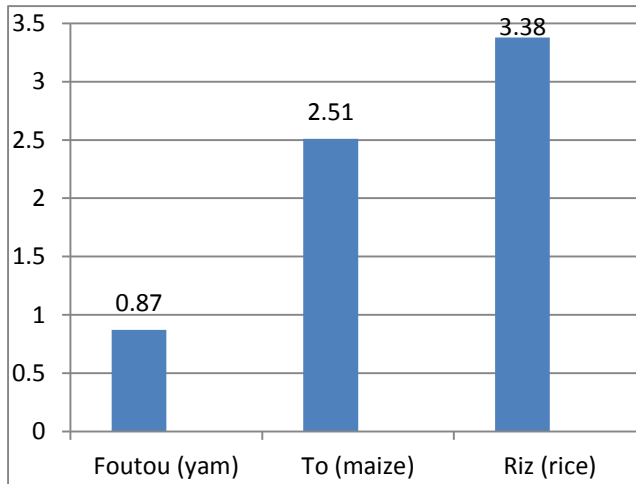


Figure 17. Burkina Faso: Average frequencies of consumption (number of times/person/week) of yam, maize and rice, December 2012. Source: Survey.

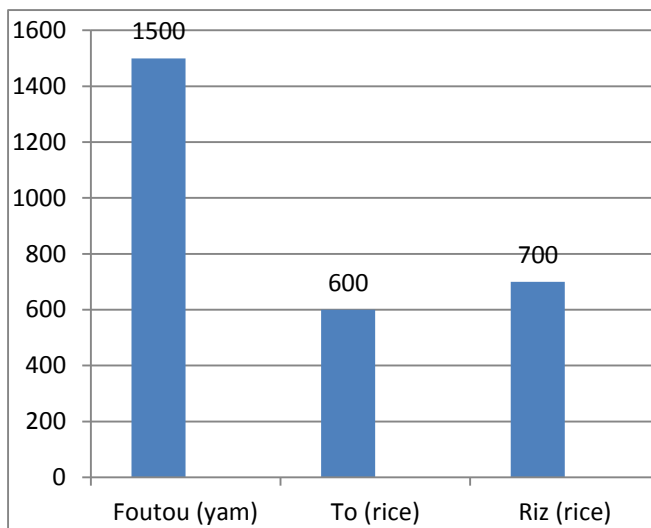


Figure 18. Burkina Faso: Restaurant price (CFA/meal, 150CFA=US\$1.00) of yam, maize and rice meals in Ouagadougou, December 2012. Source: Survey.

In Ghana, food staple price information is illuminating; why should Ghana which produces so much yams consume yam so infrequently compared with other producing countries such as

⁷ A common African food pattern is called *foofoo* in Anglo-phone West Africa, *foutou* in Franco-phone West Africa, and variously called *ugali*

Nigeria (Figure 9)? The retail price information reveals that prices are the main determinant of frequencies of consumption of food staples in Ghana. In February 2013 in Kumasi, the retail price of yam was extremely high; four times that of cassava and more than five times the price of maize⁸. These retail price levels adequately explain the following frequencies of consumption of food staples observed in Ghana: yam, 1.8 times per person per week; cassava, 2.7; and maize, 5.7 times per person per week. The inverse relationship is dramatic (Figures 19 and 20).

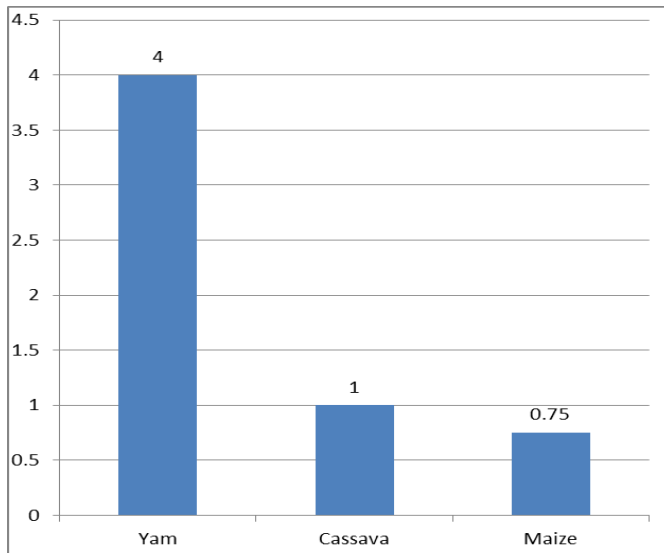


Figure 19. Ghana: Retail prices (GHC/Kg, GHC2=US\$1) of yam, cassava and maize, December 2012. Source: Survey.

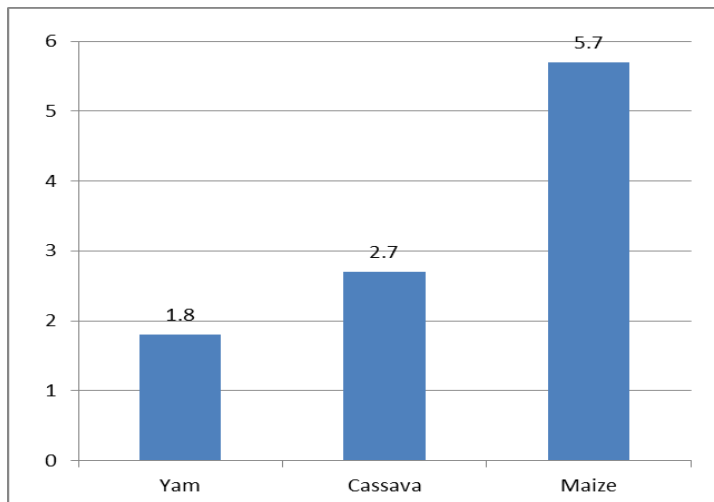


Figure 20. Ghana: Frequencies (number of times/per person/per week) of consumption of yam, cassava and maize, December 2012. Source: Survey.

⁸ Maize is in dry form; the price differential will be wider if yam and cassava are converted to dry forms.

Diversified Food Products and Yam Competitiveness in Ghana and Mali

In Ghana, maize is prepared in two forms, namely *banku* and *kenkey*; cassava is prepared as pounded, *agbalima* and *kokonte* (dried cassava root flour); plantain is pounded in unripe form and cooked in oil in ripped form. Cassava food products, namely pounded cassava, *agbalima* and *kokonte* are eaten in the same way as pounded yam, i.e. as *foofoo*. In Ghana, since yam is rarely pounded, it does not compete with pounded cassava (cassava *foofoo*). Therefore, in Ghana the narrow range of food products impedes the competitiveness of yam relative to alternative substitutes, especially cassava.

The significance of diversification of yam food products for the yam consumption frequency is on display in the comparison of yam consumption patterns between Ghana and Mali. Mali, a marginal producer of yam shows average frequency of consumption close to Ghana, the second largest producer globally. But while in Ghana yam is eaten almost exclusively in one form, i.e. boiled yam, in Mali yam consumption is diversified into boiled, grilled and others such as fried (cooked in oil). In Mali, yam, because it is eaten in diversified forms, competes effectively with alternative staples such as sorghum, millet, beans, sweet potato and potato, in terms of average frequency of consumption per person per week. The average frequencies in Mali are yam, 1.70; sorghum, 1.05; millet, 1.90; beans, 1.34; sweet potato, 1.08; and potato, 1.71.

Physiological Properties of Yam Nigeria

Comparison of frequencies of consumption of alternative yam food products with their specific substitutes highlights the impact of physiological properties on the frequency of yam consumption. In Nigeria, yam in pounded form, plantain and wheat are a different set of substitutes because, in contrast to *poundo yam*, *gari* and *semo*, they are not pre-processed; cooking each of them includes extra preparation cost. For examples, most of the time whole wheat grain is bought and taken to the mill to be milled; cooking yam into pounded form includes laborious peeling and pounding. Plantain is cooked in two alternative forms; ripped plantain which is fried (cooked in oil) and unripe plantain which is boiled and eaten pounded or not. Substitution is among pounded yam, pounded unripe plantain and wheat flour because they are eaten the same way as *foofoo*.

Among yam consumers in Nigeria pounded yam is ultimate in status food, but wheat and plantain have combined to reduce its consumption frequency to an average of a little more than once a week. The average frequencies are pounded yam, 1.24; wheat, 1.21; and plantain, 2.99 per person per week. As status food, pounded yam is served at high class ceremonies and at food joints, but it has dual drawbacks. Diabetics who are often people with means to engage in pounded yam escaped avoid it believing it to be high in carbohydrate. Such people's preference for pounded plantain and wheat flour considered by them to be low in carbohydrates reduce the consumption frequency of pounded yam.

Yam is unstable in cooked or pre-processed form such as *poundo yam*. Cooked yam products, i.e. pounded, boiled, roasted (grilled) and cooked *poundo yam* are unstable; they lose quality hours after preparation. Therefore yam is cooked in quantities that must be consumed within the shortest period to avoid waste, with implications for yam as restaurant food. To eat pounded yam in popular restaurants which serve it, one must go in early

afternoon past which time prepared pounded yam runs out. In hotel restaurants, pounded yam is served as *a la cat*.

Apart from high price discussed above, quality instability is an encumbrance on *poundo yam* consumption. Survey for this report disclosed that packaged *poundo yam* was not common in market shelves in Nigeria; traders explained that demand was low because of high cost and because consumers have access to real thing, namely pounded yam. The traders further revealed that when sale was delayed the product deteriorated because *poundo yam* was more susceptible to weevils and moulding than grain flour.

Summary

To summarize, in the representative countries, yam is not price competitive with substitute staples such as cassava, maize, rice, sweet potato, etc. In the entire representative countries, the retail price of yam is higher than the retail prices of all the substitute staples. The report revealed that yam production technologies did not change in living memory; that situation could be responsible for high yam prices because high production cost is associated with low production technology.

Analyses of yam price competitiveness provide convincing evidence that high yam production cost is a drag on yam consumption through high product prices. The same set of analyses demonstrates that certain physiological properties of the yam tuber are a clog in the wheel of yam consumption. Range of food staples that compete with yam, range of foods prepared from yam and frequencies of yam consumption all vary significantly among representative countries.

6. Estimates of Future Yam Consumption Levels

Prediction of how much yam will be consumed in each of the representative countries in future is the goal of this section. Future is limited to 12 years, i.e. up to 2025 because of low prediction ability of projection procedure outlined in methodology section. The estimates projected for each country can be explained only by population and GDP growth rates for the country and by the income elasticity of demand for yam of 0.05 which were the only bases of the estimates.

The present section will go further to estimate the gap between consumption needs and production in each representative country. FAOSTAT is blank for yam in the seed column for each country. In 2009, the FAOSTAT allocates 32 per cent of gross production to “Other Util” in Nigeria data, 35 per cent in Ghana, 10 per cent in Burkina Faso and 6 per cent in Mali data. However, as will be explained under seed yam technology below, the most common seed yam production technique in Ghana which is regeneration of tuber after milking is likely to be more efficient than the most common technique in Nigeria, namely use of whole tuber. Therefore, projected gross production is discounted for seed by 32 per cent in Nigeria, 25 per cent in Ghana, 10 per cent in Burkina Faso and 6 per cent in Mali to arrive at gap between production and consumption. Farm level literature show that seed could be as much as 50 per cent or more of gross production cost (RTIMP undated and Conye 2010).

Nigeria

The projection estimates show that aggregate yam consumption in Nigeria will rise from 13 million tons in 2010 to 18 million tons in 2025 (Figure 21). Population growth rate of 1.97 per cent per year, GDP growth rate of 4 per cent per year and income elasticity of demand for yam of 0.05 were the sole bases of the consumption projection estimates. Production projection estimates suggest that gross production will soar from 28 million tons in the year 2010 to 57 million tons in 2025; production net of seed will amount to 28 million tons in 2025.

These projections suggest that by 2025 Nigeria will generate a surplus of about 10 million tons which should be available for export. Zero export is recorded for Nigeria from 1995 to 2009 in the FAOSTAT. However, during the survey visit to Shaki, a major yam producing centre north of Ibadan, truckloads of yams were seen leaving for the neighbouring countries of Benin Republic and Togo.

Ghana

In Ghana, consumption projection estimates show that aggregate yam consumption will rise from 3 million tons in 2010 to 4 million tons in 2025 (Figure 22). The consumption is projected on the bases of population growth rate of 1.86 per cent per year, GDP growth rate of 5 per cent per year and income elasticity of demand for yam of 0.05. Production projection estimates suggest that gross production will increase from 5 million tons in the year 2010 to 8 million tons in 2025. Net production after discounting for seed will be about 6 million tons.

In Ghana, there will be a surplus of production over consumption of two million turns which will be available for export. Ghana is a yam export conscious country at present;

government policy encourages yam export, farmers want to produce for export and exporters are ever ready to take yam out of the hands of the farmers. These scenarios mean that yam export will continue to flourish in Ghana.

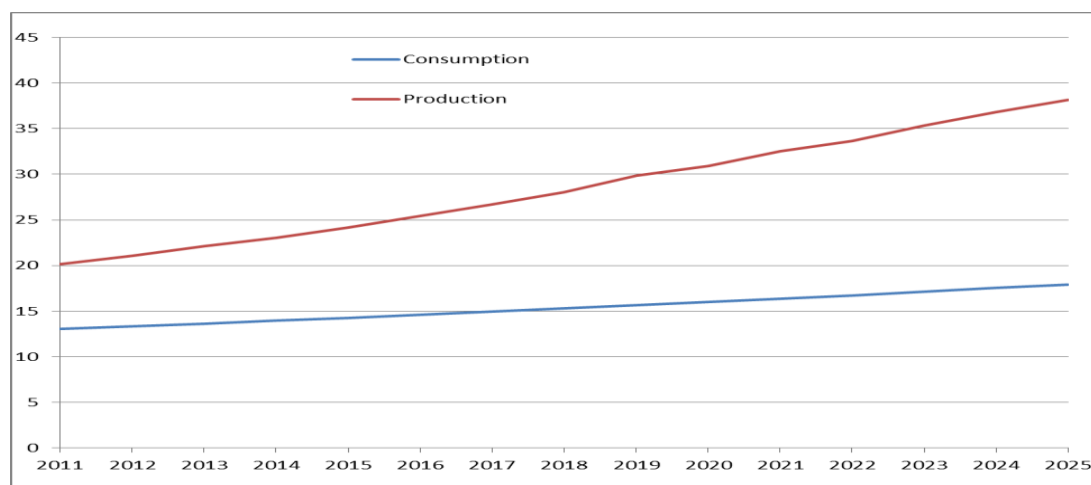


Figure 21. Nigeria: Estimates of yam consumption and production (million tons/year), 2011 to 2015

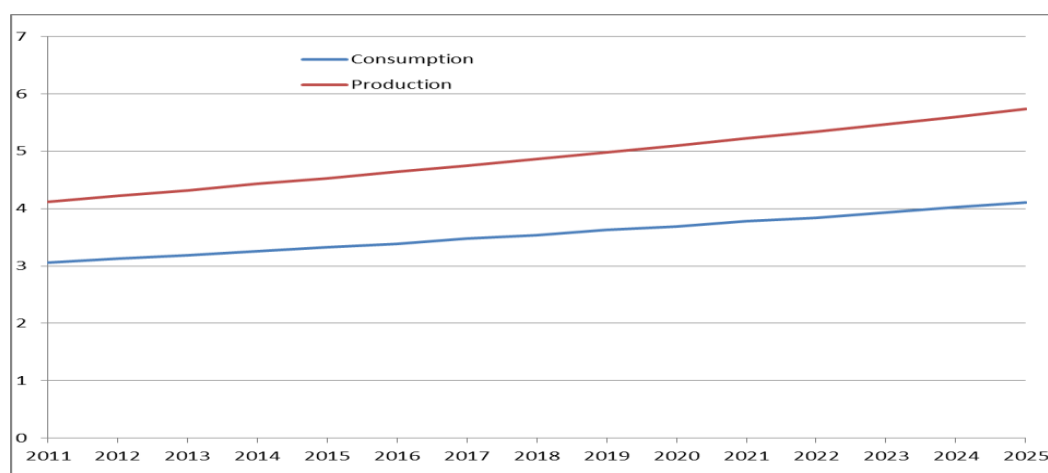


Figure 22. Ghana: Estimates of yam consumption and production (million tons/year), 2011 to 2015

Burkina Faso

The projection estimates show that aggregate yam consumption in Burkina Faso will soar from 40,000 tons in 2010 to 70,000 tons in 2025 (Figure 23). High population growth accounts for this staggering expansion in yam consumption. Population growth rate of 3.1 per cent per year in Burkina Faso is higher than 2.61 in Mali, 1.97 in Nigeria and 1.86 per cent in Ghana. Production projection is flat at about 60,000 tons from 2010 to 2025 following stagnant past production trend. Production net of seed will be even less, 54,000 tons. In 2025 Burkina Faso will generate a deficit of about 16,000 tons, which should be filled from import sources.

The Burkina Faso trend lines are shaped by rapid population growth rate which helps position the consumption trend line at a high angle. The constant past production trend flattens the production trend line.

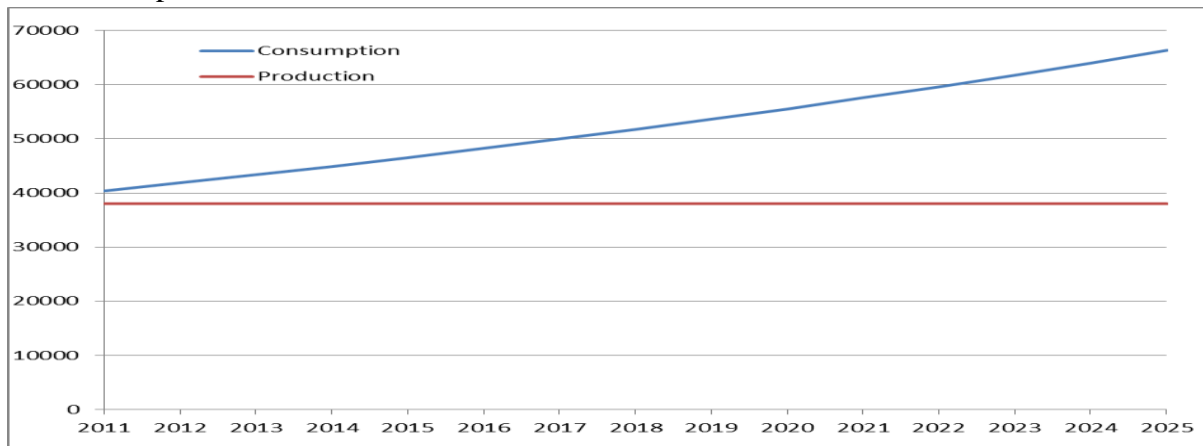


Figure 24. Burkina Faso: Yam consumption and production estimates (tons/year), 2011 to 2025

Mali

In Mali, aggregate consumption, which is projected on the bases of 2.6 per cent GDP per capita growth rate, 2.61 per cent population growth rate and 0.05 income elasticity of demand for yam, will increase from 73,000 in 2010 to 105,000 tons in 2024 (Figure 24). Production will stagnate at about 50,000 tons between 2010 and 2024. Production discounted for seed will be about 47,000 tons, which will mean a deficit of 58,000 tons in 2024.

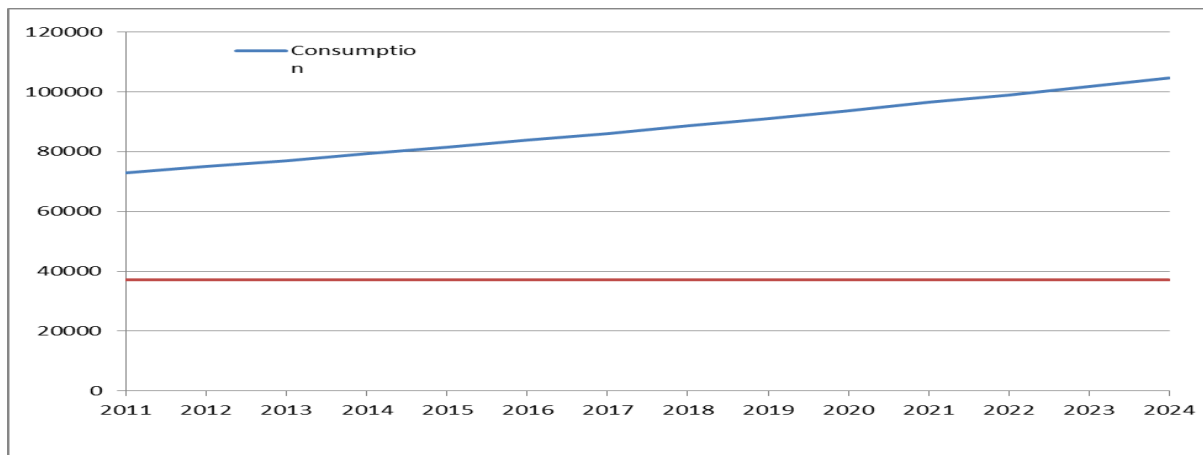


Figure 24. Mali: Yam consumption and production (tons/year), 2011 to 2024

Syntheses

To synthesize, above estimates imply that major yam producing centres will generate significant amounts of surplus yam in the next fifteen years; two minor producing countries will have deficit. Large surpluses are unlikely to occur in any other West African country other than Nigeria and Ghana given low levels of aggregate production in all the other countries. In the case of consumption several other countries in the region like, Burkina Faso

and Mali, that will generate deficits will be able fill such deficits with imports from Nigeria and Ghana.

These projections are based on procedure which is limited in robustness and on data that has doubtful credibility yet the value as indicators of what future consumption level can be call for investment in measures to expand yam consumption at home, to expand export opportunities or to do both. Speeding up the rate of improvement of the West African interstate highways will distribute surplus yams in Nigeria and Ghana to marginal producing countries through export-import trade. This report will turn attention, in the next few sections, to other factors than population and GDP such as technology and cultural rites which are also important drivers of yam consumption in the representative countries.

7. Seed Yam Technology.

How does improved seed yam technology drive yam consumption? Seed yam is the edible tuber and differs from table tuber only in size, seed yam being smaller than table yam tuber⁹. Because of this, seed constitutes an estimated 50 to 70 per cent of total yam production cost (RTIMP undated and Conye 2010). Seed yam technology that can reduce the seed yam cost will reduce cost of yam production, drive down the price of yam to consumers, and improve yam price competitiveness against alternative staples such as cassava, plantain, maize, rice, etc.

Aim of improvement in seed yam technology is to provide farmers access to seed yams of improved varieties or local cultivars with desirable attributes that are free of pests and disease (so called quality declared seed) that gives high yield, at sufficient quantities at affordable prices. This kind of seed yam is generated by a chain of stakeholders beginning with breeders who develop improved varieties or farmer-researchers who select, from exiting stock, local cultivars with farmer desired attributes and clean them of pests and diseases. The seed yam produced at this stage is described as breeder seed yam.

The chain continues with stakeholders described as foundation seed producers, who take the breeder seed yam, usually available in small quantities, and multiply to quantity enough to go to the next link in the chain, namely specialized seed yam farmers. Specialized seed yam farmers multiply the foundation seeds to reach yam farmers in sufficient quantities at affordable prices. The chain goes on to include seed processors and distributors. Under this process which is called formal yam seed system, the stakeholders at the various links in the seed chain function inspection by public seed agencies and under public seed law that has sanctions for non-compliance and only seed certified by an authorised agency under the law can be offered to farmers through approved outlets¹⁰.

In Nigeria and Ghana, yam farmers produce seed yam, most of them as part of their overall yam production operation. Specialization in seed yam or in table yam production is practiced in a few areas. Farmers make significant investments in seed yam production, even as part of their overall yam production operation. This informal yam seed system does not deliver quality declared seed yam or sufficient quantity of seed yam into the production system both in Nigeria and Ghana; in both countries demand for seed yam exceeds supply. Every planting season, farmers commonly use cassava to fill empty seedbeds in yam fields created by shortage of seed yam.

The farmer groups interviewed in the major yam producing centres in Nigeria and Ghana were asked to name and rank their seed yam technology, i.e. what material they use as seed yam. Only three materials were mentioned, namely whole tuber, regenerated tuber from milked yam plant and tuber slice. In Nigeria, material ranked number one in popularity was

⁹ The terms seed yam, yam seed, yam planting material and yam planting set are used interchangeably.

¹⁰ In the representative countries, there are no private consumer protection agencies and the legal systems are weak. The public sector regulatory agencies, not the consumer, hold the producer responsible the label on the product.

determined by purpose of yam production. Farmers in Shaki who produce *kokoro* cultivar for *amala* use mostly milked tubers; farmers in Otuocha who specialize in seed yam production use mostly sliced tuber pieces; and farmers in Zaki Ibiam who produce large ceremonial yams use whole tubers mostly (Table 4). In south-eastern Nigeria where some farmers specialize in seed yam production, extra small tubers or slices of larger tubers are used as seed for producing bigger yam seeds (Figure 25). Others who produce ceremonial yams such as Zaki Biam or River Niger Basin yam farmers use large seed yams because there is positive relationship between seed yam size and size of tuber harvested.

In Ghana, regenerated tuber from milked yam plant was number one material used for seed yam in both centres surveyed. Whereas in Nigeria specialized seed yam producers are able to multiply yam planting materials by slicing table yam into planting set sizes; in Ghana, preferred yam varieties,

Table 4. Nigeria and Ghana: History of seed yam technology (yam material used for seed (ranked in descending order of popularity), December 2012. Source: Survey.

Country	Yam center	Yam material	Rank	Year of 1 st used
Nigeria	Shaki	Whole tuber	2	Not known
		Regenerated tuber	1	Not known
		Sliced tuber	3	Not known
		Other	none	N/A
	Otuocha	Whole tuber	2	Not known
		Regenerated tuber	Not used	N/A
		Sliced tuber	1	Not known
		Other	None	N/A
	Zaki Ibiam	Whole tuber	1	Not known
		Regenerated tuber	Not used	N/A
		Sliced tuber	2	Not known
		Other	None	N/A
Ghana	Tamale	Whole tuber	2	Not known
		Regenerated tuber	1	Not known
		Sliced tuber	3	Not known
		Other	None	N/A
	Kintamkpo	Whole tuber	2	Not known
		Regenerated tuber	1	Not known
		Sliced tuber	3	Not known
		Other	None	N/A

namely Pona and Laribako are not efficient with the Nigerian farmers' technique of planting slices of table tuber. The preferred varieties do not have sufficient nodes (sprouting eyes) over the surface area of their tuber as necessary for the Nigerian farmers' technology. But

farmers in Ghana are still able to grow large ceremonial yams with their common seed yam technology because regenerated bunch of tubers from milked yam plant contains different sized tubers some of which are big enough for ceremonial yam production.



Figure 25. Nigeria and Ghana: Slices and regenerated tubers of yam commonly used as seed yam. Sources: Conye 2010 and Osei- Sarpong n.d.

The farmers' technology in Ghana is to harvest the yam tuber before the plant attains complete senescence and to leave the plant to grow and regenerate a bunch of an average of five small tubers per plant which are used as planting sets (Osei-Sarpong undated). This practice represents significant investment by the farmer. First, there is a yield loss by harvesting the main tuber before senescence when maximum yield is attained (Onwueme 1977). Second, premature harvest reduces the quality of the main tuber in terms of both reduced shelf-life and texture. Third, harvesting labour is increased because of the double harvesting. These costs help explain the very high cost of yam planting material.

The existing "improved" technology for the yam planting material multiplication is the miniset technology, which was developed at the NRCRI in the early 1970s. The miniset technique is an adaptation of the yam seed multiplication practice followed by the Nigerian specialized seed yam producers from far back in time. The technique follows the farmers' practice of slicing yam tuber into small pieces, dressing the cut surface with wood ash and sun drying the cut surface and planting *in situ*. The adaptation includes cutting into extra small sizes and pre-sprouting in a seedbed and later transplanting. The uptake of this technology by farmers has been reported to be low (Ward and Ogbodo 2010).

Of recent, Ghanaian scientists achieved a breakthrough in developing a new technology, which has the potential to enable them adopt the miniset technique in producing yam planting materials of their preferred varieties. The technology involves the use of a combination of growth regenerators, sprouting media and improved agronomic practices to break dormancy and enhance sprouting of slices of preferred yam varieties in Ghana. This technology is new and has not been tested at the farm level (Osei-Sarpong undated).

Another technology for the yam planting material multiplication that is underway in development is the yam vine cuttings technique. In 1972, IITA first successfully rooted vine cuttings of *D. rotundata* using short woody lateral shoots in sand under polythene hoods in the green house (IITA 1995). Recently, Ghanaian scientists advanced this process by

successfully producing tubers from the yam vines under controlled field conditions (Otoo 2010). The above analyses call for intervention in form of investment in measures to develop rapid yam multiplication technology. Such measures will drive down the very high cost of seed in yam production.

When asked about what year the material they use as seed was first used in their area, the farmer groups also greeted the question with derisive laughter. That was not a good question; the investigators should have known that the material was used from the beginning of time. This means that in the seed yam technology research contribution, if any, is not widely adopted by farmers.

In 2005 in Ghana, the CRI released three local selections of yam varieties to farmers but the quantities of the breeder planting materials were insufficient to proceed to the foundation seed multiplication level. The CRI breeders were requested by the Ghana Seed Service to multiply their stock to supply 3,000 sets for the foundation seed the following year. But the CRI was able to deliver less than 900 sets because of the problems of theft in the field and deterioration in storage (RTIMP 2009)¹¹.

Yam planting sets were purchased from farmers and used in place of the breeder seed to produce foundation seed. Why should farmer produced seed in the informal system be used, without cleaning, in place of breeder seed in the formal system? That action is an acknowledgement, on the part of stakeholders in the formal yam seed system, that the informal system is ahead of the formal system in yam seed technology.

To summarize, lack of improved technology for seed yam production, multiplication and storage is a hindrance to the establishment of formal, i.e. private sustainable yam seed system. The formal yam seed system is weak in both Nigeria and Ghana, sometimes depending on the informal traditional system for support instead of the other way. The results of the analyses call for investments in in development of yam seed technologies to reduce the seed yam cost, reduce cost of yam production, drive down the price of yam to consumers, and improve yam price competitiveness against alternative staples.

¹¹ In Ghana the high market value of yam, even small tubers, either as seed yam or as food exposes the crop to theft by humans in the absence of adequate security. Without appropriate storage measures, the Pona and the Laribako varieties deteriorate rapidly in storage.

8. Variety Improvement, Labour-Saving and Storage Technologies

Yam Variety Improvement

In Nigeria, yam variety improvement research is carried out by the IITA and the NRCRI and in Ghana by the CRI. In 1989, IITA began delivering germplasm to national yam research programs in various African countries for on-farm adaptive research (IITA 1993). Up to the year 2011, 17 new yam varieties had been officially released to farmers in Nigeria and one in Ghana. In Ghana one new variety developed at the IITA had been released to farmers officially. The leaders of yam improvement programs in Nigeria and Ghana independently reported that farmers were widely growing various research developed yam varieties, which they adopted through on-farm farmer participatory research¹². Dr Chris Okonkwo further explained that the various research developed white yam varieties were not easily recognized in the farmers' fields because of the difficulty of identifying various white yam varieties by their morphological characteristics.

In the early 1970s, a variety of *D. alata* was introduced into Cote d'Ivoire from Puerto Rico by the Institut de Recherches Agronomiques Tropicales (IRAT) for a yam mechanization project (Dolumbia et al. 2004). Dr Asiedu however reported that the same variety was introduced directly into IITA in Nigeria for breeding purpose at about the same time in the early 1970s. The variety was rapidly adopted by farmers; it spread throughout West Africa including Ghana and Nigeria. This variety variously called asana (matches) in Ghana and sudan in Nigeria is widely grown in the two countries where it is displacing local varieties of *D. alata*.

Farmer groups interviewed in foremost yam producing centres in Nigeria and Ghana were asked to rank five most common yam cultivars which they grew in descending order of how much was grown of each, about what year each was first grown in their area and from where it was introduced. The farmer groups included the oldest yam farmer in the village. The answers to this set of questions which are summarized in Table 5 suggest that the approximate dates of introduction of most commonly grown yam cultivars in Nigeria and Ghana are not known to living farmers. This means that such information was not available, to the previous generation of farmers because such professional information is transferred from generation to generation.

In fact, "Not known" is investigators' best way to record the responses of the farmers; the questions of date of introduction and place of origin generated contemptuous laughter everywhere those questions were posed. Farm level researchers are familiar with such reception of questions considered unreasonable by the farmers.

Some cultivars were reported to have been introduced in the last ten to twenty years and virtually all of them came from other towns. If any of those "new" cultivars originated from research, farmers do not know it. In addition, most of the "new" cultivars have not made

¹² Dr Robert Asiedu, (a long time yam breeder at IITA), Dr Chris Oknokwo (formally IITA's International Yam Trials Manager), Dr John Ikeogu of NRCRI in Nigeria and Dr Emmanuel Otoo of CRI in Ghana

the top of the list of famers' most popular varieties. Conclusion that most popular yam cultivars grown in the major yam centres in Nigeria and Ghana have been there from primitive time is close to correct observation.

Table 5. Nigeria and Ghana: History of five most commonly grown yam cultivars in major yam centers , December, 2012. Source: Survey.

Yam zone	Cultivar	Date of introduction	Place of origin
Shaki, Nigeria	Kokoro (Ihobia)	Not known	Not known
	Amula	Not known	Not known
	Lasiri	Not known	Not known
	Kemi	Not known	Not known
Otuocha, Nigeria	Ekpe	Not known	Not known
	Adaka	Not known	Not known
	Obiaoturugo	10 years ago	Boki
	Agbocha	10 years ago	No agreement*
	Abi	Not known	Not known
Zaki Ibiam, Nigeria	Ogoja	10 years ago	Ogoja
	Danacha	Not known	Not known
	Gbango	Not known	Not known
	Sampeper	10 years ago	Not known
	Gisa	Not known	Not known
Tamale, Ghana	Pona	Not known	Not known
	Lareboko	Not known	Not known
	Chinkoito	Not known	Not known
	Kpagaa	Not known	Not known
	Fugia	Not known	Not known
Kintamkpo, Ghana	Atuchi	15 years ago	Kintamba
	Pona	Not known	Not known
	Afebefua	20 years ago	Not known
	Matches	1985	Cote d'Ivoire
	Lilee	Not known	Not known

- Among farmer group

Labour-Saving Technologies in Yam Production

Labour is the second highest item of cost after seed in yam production (Nweke, et.al. 1991). In Nigeria, farm-level data reveal that among the same farmers yam production labour per ha is higher than cassava; yet in cassava production labour is the single highest cost item (Table 6). The difference in labour input between the two crops is made by farmland preparation: bush clearing and seedbed preparation. Unlike cassava, yam is in all cases grown on fallow fields because of rapid build-up of yam soil borne pests and diseases in yam fields

which declines with increase in years of fallow. But long fallow means high bush clearing labour.

Table 6. Nigeria: Labor input in yam and cassava by farm tasks. Source: COSCA data.

Task	Yam	Cassava
Bush clearing	48	45
Seedbed preparation	60	54
Sowing	32	24
Weeding	40	44
Harvesting	32	40
Total	222	207

Yam seedbed is mound which can be large mound depending on soil type; large mound enhances drainage in poorly drained soils. Size of mound also depends on size of tuber aimed at during planting. Farmers who grow large ceremonial yams plant on large mounds but making yam mounds, large or small, is laboriously backbreaking (Figure 26). Development and dissemination of mechanical labour-saving technology for yam seedbed preparation will reduce yam production cost, drive down price of yam to consumers and improve yam price competitiveness with alternative substitute staples.



Figure 26. Making yam mound manually with hand hoe. Source: Fresco 2012

Table 7. Nigeria and Ghana: History of yam seedbed technology (seedbed type ranked in descending order of popularity), December 2012. Source: Survey.

Country	Yam center	Seedbed type	Rank	Year 1 st used
Nigeria	Shaki	Mound	1	Not known
		Ridge	Not used	N/A
		Other	None	N/A
	Otuocha	Mound	1	Not known
		Ridge	2*	Not known
		Other	None	N/A
	Zaki Ibiam	Mound	1	Not known
		Ridge	Not used	N/A
		Other	None	N/A
Ghana	Tamale	Mound	1	Not known
		Ridge	Not used	N/A
		Other	None	N/A
	Kintankpo	Mound	1	Not known
		Ridge	2*	5 years
		Other	None	N/A

*For seed yam.

Farmer group interviewed for this report in Otuocha, a major seed yam producing centre in Nigeria ranked ridge second to mound in terms of popularity of yam seedbed adopted in their area. Farmer groups interviewed elsewhere in Nigeria and Ghana reported that yam is grown only in mound seedbed. The practice of growing yam in mound seedbed dates back to time unknown to the farmer groups (Table 7). Ridge is easier to mechanize but farmers resist growing yam in it. Investigation is needed to fathom the logic behind farmer's dogmatic adherence to growing yam in mound seedbed.

Labour bottleneck is at the seedbed preparation stage, when that bottleneck is broken attention will be shifted to other tasks such as harvesting, staking, weeding and sowing. In producing areas close to the savannah with abundance sunshine, such as Zaki Ibiam in Nigeria yam is not staked. But yam staking can be elaborate in terms of staking height in less sunny areas such as Otuocha also in Nigeria. Yam staking has material input which in most places is stick and in a few areas rope on which the yam vine grows.

Yam Storage

Under existing yam storage technologies, the crop is not storable from one harvest season to another because it has limited shelf live which vary with cultivar. Yam storage technologies vary from place to place depending on a range of circumstances including security and agro-ecology. Common methods in yam producing centres surveyed for this

report are thatched mud huts with perforated walls, tying on racks and piling up in dry material covered heaps (Figure 27). All the existing storage technics date back to time not remembered by anyone in the farmer group which included the oldest farmer in the area (Table 8). Therefore yam storage technics vary in space but not in time; different yam producing areas have different techniques but technique has not changed in any area.



Figure 26. Yam storage technologies, racks and heap. Source: Conye 2010.

Table 8. Nigeria and Ghana: History of yam storage technology (storage structure ranked in descending order of popularity), December 2012. Source: Survey.

Country	Yam center	Storage structure	Rank	Year 1 st used
Nigeria	Shaki	Rack	Not used	N/A
		Hut	1	Not known
		Heap	Not used	N/A
		Other	2*	Not known
	Otuocha	Rack	1	Not known
		Hut	Not used	N/A
		Heap	Not used	N/A
		Other	None	N/A
	Zaki Ibiam	Rack	Not used	N/A
		Hut	1	Not known
		Heap	Not used	N/A
		Other	None	N/A
Ghana	Tamale	Rack	Not used	N/A
		Hut	1	Not known
		Heap	2	Not known
		Other	None	N/A
	Kintamkpo	Rack	Not used	N/A
		Hut	2	Not known
		Heap	1	Not known
		Other	None	N/A

*Do not store

Each existing yam storage technique has downside; security and enhanced aeration, especially in high humidity environments are the main advantages of storage by tying in racks at home while high labour requirement is the major drawback of that method. In less humid environments, storage in thatched hut or in covered heap is preferred because of its less labour need. But this method exposes the yam to pests including rodents. None of the existing storage technics is capable of holding yam from one harvest to another.

The present state of existing yam storage technologies impacts negatively on yam consumption in two ways. The inability of the existing technologies to hold yam from one season to another leads to seasonality in yam supply and their exposure of the yam in storage to damage by fungus, bacteria, pests, etc. leads to wastage. Therefore improvement in yam storage technology that can eliminate seasonality in yam supply and/or reduce losses due to damage in storage can increase yam supply, reduce cost and drive down the price of yam to consumers and therefore enhance consumption.

9. Cultural Rites in Yam Producing Areas

This section builds on thoughts of both Basden (1938) and Achebe (1988) and analyses the function of yam in Igbo culture focussing on passage rite of marriage. The section goes further to discuss the rites as one of the foremost factors that fuel yam production and consumption in producing areas and the odds that the power of the rites to drive yam production is sustainable. The section poses a thought provoking question: is ceremonial yam market an impediment to technology change in the yam sector?

Among Igbo people, yam is essential object in other rites including rites of thanksgiving, petition and appeasement. Similarly, the use of yam in cultural rites is common among major producing centres in the region. For example, Dagombu people who live near Tamale in northern Ghana celebrate yam in festivals, in chieftaincy titles (enskinning) and in sacrifices to the gods, with marginal differences from the Igbo people. The analyses of marriage rites among the Igbo people will sufficiently demonstrate the impact of cultural rites on yam production and consumption in West Africa. Focus on it will circumvent repetitions that could be uninteresting to the reader, since procedures are close across different rites and across yam producing centres in the region.

In Igbo practice, there are two parts to the rite of marriage, namely ritual and celebration; celebration is party-like which follows after the ritual. As party, drinks and foods, including yam are served, therefore celebrations in performance of rites of passage contribute to yam consumption. Of more interest in discussion of those rites as driving fuel to yam production and consumption is yam as ritual object.

The marriage ritual procedure demonstrates the superiority of communal over private interests. In an Igbo village of Ukpo, Dunukofia, the rituals call for the largest sized yam tubers available in the market (Figure 27). At marriage, a specified number of such yams are supplied by the family of the bridegroom. After the leadership of the bride's extended family confirms the adequacy of the yams in terms of number and size of tubers, the yams are distributed in specified numbers to the bride's family, to oldest members of the extended family, the balance of the yams are cooked along with accompanying animal victim, such as goat for all members of the extended family to share (Figure 28). The procedure demonstrates child raising as communal responsibility; the extended family which helped raise a girl shares in her marriage ritual.

Marriage does not take place without this ritual; the bridegroom must be accompanied by representatives of his extended family and representatives of the bride's extended family must be present to receive them. Both sides must endorse the marriage for it to take place, for a good reason. A side that is not properly represented, the bride or the groom's family, is understood to be complaining that a family member is a defiant. This is how the various rites constitute glue that binds a community together. For the marriage to proceed, family on each side must settle differences with their community.



Figure 28. Nigeria: Extended family leaders celebrate marriage ritual in Ukpo, Dunukofia, Eastern Nigeria. Source: Jeff Oliver.

How large is the ceremonial yam market? Is demand for yam for the various rites of passage, thanksgiving, petition and appeasement large enough to make significant impact on yam consumption? The farmer groups interviewed pointed out the unusualness of people looking for largest yam tubers in the market to cook at home because such is wasteful. In a matter of hours, cut surface of a tuber begins to dry up turning to unusable cake that must be peeled off when next the yam is used. In a few days rot begins from the caked surface and spreads to the rest of the yam (Figure 29). It is rational to cut tubers that must be cooked the same day. But the farmer groups also pointed out the usualness of yam producers to aim at the largest tubers they can get. The farmers' desire for the largest possible tubers driven by ceremonial market demand set against the home consumer preference for medium sized tubers is incontrovertible evidence that the ceremonial yam market is in fact large.

To press further their argument that amounts of yams used for cultural rites each year were sufficient to constitute significant demand, the farmer groups pointed out that each year numbers of marriages, births and funerals in a rural or urban setting are high. These are in



Figure 19. Previously cut yam showing caked cut surface and sign of deterioration.

addition to a litany of heathen shrines that demand and accept tributes daily for thanksgiving, petition, and appeasement. The farmer groups call to testimony the point that rites of passage, thanksgiving, petition and appeasement are also performed in churches. They point at the number of yams presented in each church every Sunday for purposes of petition and penitence and for thanksgiving following marriage, birth and funeral as well as numerous other events which call for thanksgiving.

The size of the ceremonial yam market is convincingly large enough to constitute effective demand for yam. But what about the sustainability of such market over time, i.e. are the cultural practices sustainable in future? In his latest classic, Soyinka laments the erosion of African culture by both Christian and Islamic civilizations (Soyinka 2012). But, as noted above, rites of passage, thanksgiving, petition and appeasement are practiced in Christian Churches and with yam as an object in yam producing areas. In addition, by being used to enforce compliance to communal interests the rites are important in community governance; such practical values of the cultural rites will, no doubt help to sustain them.

What does medal of honour have to do with ceremonial sized yam production among the Igbo people? Interest in production of ceremonial sized yams is institutionalized by practice. In the past in Igbo yam producing communities, *di ji* (master yam farmer) was a community leader whose voice was heard in his community. Elevation to the status derived from size of his yam, in terms of total quantity and size of individual tubers. Today in the area, trade fairs emphasize tuber size; the trophy goes to the largest tuber on display.

Production of Large-Sized Tubers and Yam Technology Development

The discussion of whether there is association between farmers' quest for largest possible tuber size and yam technology development aims to provoke thinking on the topic. In this section, questions are posed without attempt at postulating conclusive or even any answers at all because of lack of empirical information on the subject.

Is emphasis on producing large tubers an impediment to technology change in yam production? Farmer groups interviewed for this report were distinct in their declaration that there has been no change in yam production technology in living memory. Given their environmental conditions including soil structure and fertility, the farmers adopt cultivars and agronomic practices that give largest-sized possible tubers. Is there conflict between yam technology development and emphasis on producing the largest possible tuber size?

Farmers aim at the largest tubers they can produce because of the large ceremonial yam market. They define yield in terms of tuber size and adopt cultivars and agronomic practices likely to give large tuber size. For example, aggregate yield per unit area is positively correlated with plant population (number of yam plants per ha) up to a certain optimum which varies with a wide range of factors including soil type and climatic conditions. Farmers adopt suboptimum population because tuber size has negative correlation with plant population.

Yam cultivars are unequal in their tolerance to diseases and pests. But cultivars that are tolerant to the yam pests and diseases may not yield large-sized tubers. For example, a cultivar called *abii* in Otucha area of Nigeria is known to be tolerant against certain yam nematodes but yields smaller-sized tubers than other white yam cultivars. The *abii*'s small-sized tuber attribute may stand against its use in breeding to take advantage of its nematode tolerant attribute. Table 5 shows that *abii* has not made the list of the top five most popular cultivars grown in the Otuocha area. The group of farmers interviewed stated that they narrowed the cultivars they grow to those with market demand, i.e. large-sized tuber yielding cultivars.

It is explained above that in spite of empirical evidence that planting yam in ridges produces higher aggregate yield per unit area because the practice permits higher plant population, that the practice is labour saving because it facilitates implementation of agronomic practices and that it may be easier to mechanize, farmers everywhere in the region hold on to planting in mounds. Is the need to produce large sized tubers for cultural rites responsible for farmers' dogmatic adherence to planting yams in mounds? Is there a relationship between yam seedbed type and size of tuber produced?

In yam technology development, trade matters because market demand drives technology development for a product. Otuocha area farmers narrowed the cultivars they produce to what market demands. Growing demand for yam outside West Africa provides hope for increasing demand for non-ceremonial yams because outside West Africa yam has no ceremonial value especially to importers. Would higher demand from such consumers discourage farmers in West Africa from dogmatic adherence to production methods adapted to generating the highest possible tuber-sized yams?

Synthesis

Two observations stand out clearly in this report, there is direct association between the frequency of yam consumption and consumer's income group and there is inverse association between the frequencies of yam consumption and retail market price of yam relative to the prices of its substitutes. The two observations are dramatic and consistent across the representative countries. The two observations underscore the argument that increase in consumer income in the representative countries or improvement in road network within and among yam producing and consuming countries impact positively on the frequencies of yam consumption.

Among the representative countries, the yam consumer can be characterized best by country and income group. A Nigerian in upper income group is likely to be a frequent yam consumer. Frequency of yam consumption is relatively low in Ghana because of availability of cheaper substitutes for yam. Yam consumption frequency is relatively high in Mali because of proximity to Cote d'Ivoire. Difference in yam consumption frequency between producing and non-producing region within a country is low, especially in countries with relatively developed market access infrastructure because of high market demand for the food crop. Men and women eat yam *per se* at about equal frequencies but in countries where yam food products are diversified, men and women eat different yam products at different frequencies.

In the representative countries, yam is not price competitive with substitute staples such as cassava, maize, rice, sweet potato, etc. In the entire representative countries, the retail price of yam is higher than the retail prices of all the substitute staples. The report revealed that yam production technologies did not change in living memory; that situation could be responsible for high yam prices because high production cost is associated with low production technology. Conclusion that most commonly grown yam cultivars in the major producing areas have been there since primitive times is close to correct observation.

Approximate years of introduction of most commonly grown yam cultivars are not known to the present generation of farmers and since such information is transferred from generation to generation, the approximate years were not known to the previous generation of farmers, and so on. Few cultivars which were reported introduced in the past 20 years from other producing areas have not made the list of five most commonly grown cultivars in the major producing areas.

Lack of improved technology for seed yam production, multiplication and storage is a hindrance to the establishment of formal, i.e. private sustainable yam seed system. The formal yam seed system is weak in both Nigeria and Ghana, sometimes depending on the informal traditional system for support instead of the other way. The results of the analyses call for investments in development of yam seed technologies to reduce the seed yam cost, reduce cost of yam production, drive down the price of yam to consumers, and improve yam price competitiveness against alternative staples.

Each existing yam storage technique has downside; security and enhanced aeration, especially in high humidity environments are the main advantages of storage by tying in racks at home while high labour requirement is the major drawback of that method. In less

humid environments, storage in thatched hut or in covered heap is preferred because of its less labour need. But this method exposes the yam to pests including rodents. None of the existing storage technics is capable of holding yam from one harvest to another.

The present state of existing yam storage technologies impacts negatively on yam consumption in two ways. The inability of the existing technologies to hold yam from one season to another leads to seasonality in yam supply and exposure of the yam in storage to damage by fungus, bacteria, pests, etc. leads to wastage. Therefore improvement in yam storage technology that can eliminate seasonality in yam supply and/or reduce losses due to damage in storage can increase yam supply, reduce cost and drive down the price of yam to consumers and therefore enhance consumption.

Demand for yam for use as a ritual object in cultural rites of passage, thanksgiving, petition and appeasement practiced in major producing and consuming centres is high enough to have significant effect on yam consumption. This market is sustainable because the rites are sustainable. Although Christian and Islamic civilizations are eroding African culture and civilization, it is noted that yam is also used as ritual object in Christian churches in the yam producing areas. Additionally, the cultural rites have their roots planted in the existence of the people individually and communally and therefore institutionalized.

The influence which the ceremonial yam market may be exerting on redundant yam production technology is uncertain. Farmers focus on production of large-sized yam tubers to satisfy the ceremonial yam market. But it is not known if farmers' reluctance to change production technology has anything to do with their quest to produce the largest yam tubers possible given their environmental conditions.

Discussion of whether there is association between farmers' quest for largest possible tuber size and yam technology development posed several questions. Is emphasis on producing large tubers an impediment to technology change in yam production? Is there conflict between yam technology development and emphasis on producing the largest possible tuber size? Is the need to produce large sized tubers for cultural rites responsible for farmers' dogmatic adherence to planting yams in mounds? Is there a relationship between yam seedbed type and size of tuber produced? Would higher demand from consumers outside West Africa discourage farmers in West Africa from dogmatic adherence to production methods adapted to generating the highest possible tuber-sized yams?

Estimates of future consumption levels show that major yam producing centres will generate significant amounts of surplus yam in the next fifteen years; minor producing countries will have deficit. Large surpluses are unlikely to occur in any other West African country other than Nigeria and Ghana given low levels of aggregate production in all the other countries. In the case of consumption several other countries in the region like, Burkina Faso and Mali, be generating deficits which they will be filling with imports from Nigeria and Ghana.

These projections are based on procedure which is limited in robustness and on data that has doubtful credibility yet the value of the estimates as indicators of what future consumption level can be call for investment in measures to expand yam consumption at home, to expand export opportunities or to do both in major producing countries. Speeding

up the rate of improvement of the West African interstate highways will distribute surplus yams in Nigeria and Ghana to marginal producing countries through export-import trade.

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