

## Evans School Policy Analysis and Research (EPAR)

**Sweet Potato Value Chain: Nigeria**  
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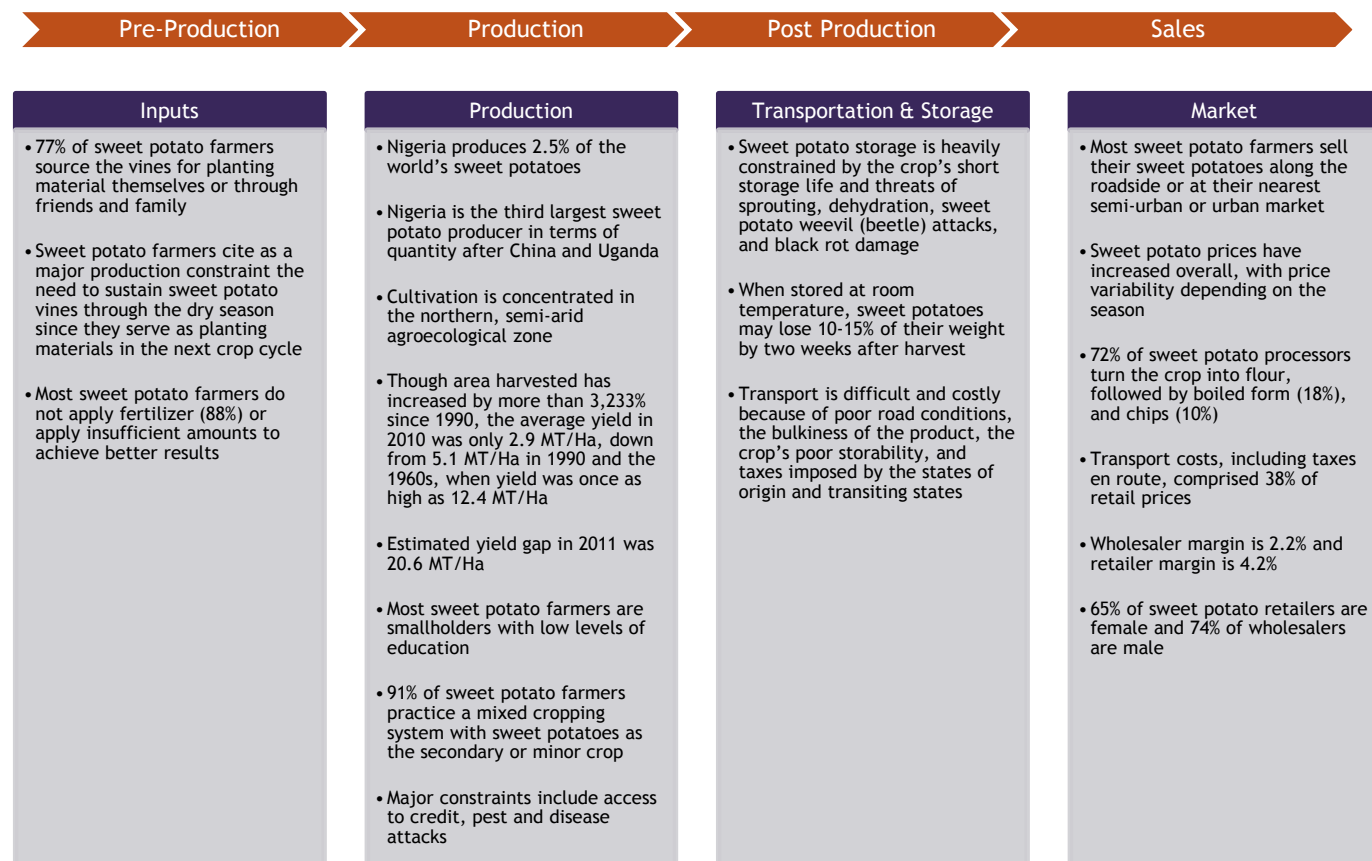
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This report provides a general overview of the markets for sweet potatoes in Nigeria. The first section describes trends in sweet potato production and consumption and international trade since 1990. The second section summarizes the varieties grown in Nigeria and their uses, followed by a discussion of the importance of sweet potatoes for food security and as a source of nutrition and household income. The following section reviews and presents details about the production and marketing systems for sweet potatoes in Nigeria, including environmental and gender considerations.

### Nigeria Sweet Potato Value Chain Highlights

The below figure summarizes key findings along the different stages of the sweet potato value chain in Nigeria.



NOTE: The findings and conclusions contained within this material are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.

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## Overview of Data Discrepancies

Estimates of sweet potato production, area harvested, and therefore yields vary substantially between the FAO and CountrySTAT Nigeria (National Bureau of Statistics (NBS) of the Nigerian government, Ministry of Agriculture and Rural Development), and various other sources. To the extent possible, substantive differences between the reported estimates will be cited in the text or footnotes. Agricultural statistics reported by the Nigerian government are historically unreliable.<sup>1</sup> Nigeria is a member of a global partnership, the Global Strategy to Improve Agricultural and Rural Statistics, led by the United Kingdom's Department for International Development and the FAO, to implement a national strategy to improve the country's capacity to produce quality statistics in alignment with international best practices.<sup>2</sup>

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### Key Statistics about Sweet Potatoes in Nigeria

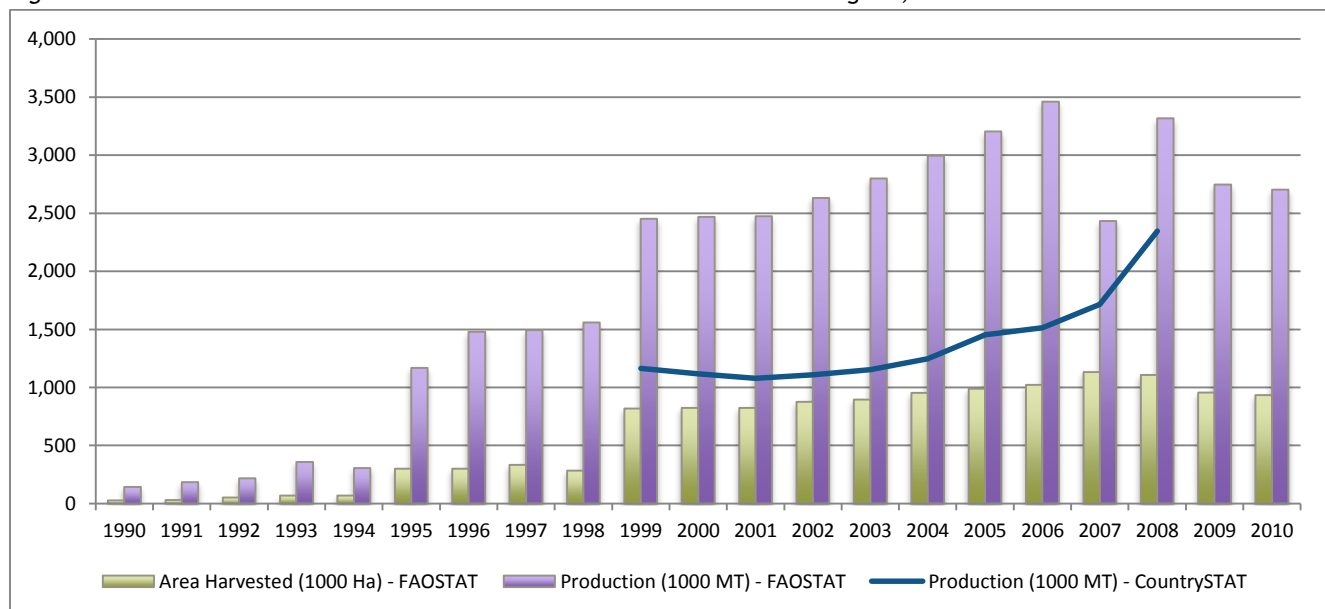
#### Production

##### *Sweet Potato Production Levels are High but in Decline and Continue to Reflect Significant Yield Gaps*

Nigeria is the third largest producer of sweet potatoes in the world in terms of quantity, after China and Uganda. In 2010, Nigeria produced 2.5% of the world's production of sweet potatoes. However, sweet potatoes are still considered a minor crop in the country. In 2010, sweet potatoes had the tenth highest production level of any single food crop in Nigeria (after cassava, yam, oil palm fruit, maize, sorghum, millet, paddy rice, and plantains). In 2010, the gross agricultural production value for sweet potatoes was \$954 million USD and accounted for 1.73% of total agricultural production value for all crops.

The data suggest that sweet potato production has increased tenfold over the last 20 years, although some observers suggest that the data reflect the state of disarray of Nigeria's agricultural statistics rather than actual growth in production.<sup>3</sup> FAOSTAT data show that area harvested has increased rapidly through the past 20 years though it has been somewhat in decline since 2007; in addition, production expanded greatly until 2006, after which production has also been quite erratic (see *Figure 1*).

**Figure 1: Estimates of Area Harvested and Production of Sweet Potatoes in Nigeria, 1990-2010**



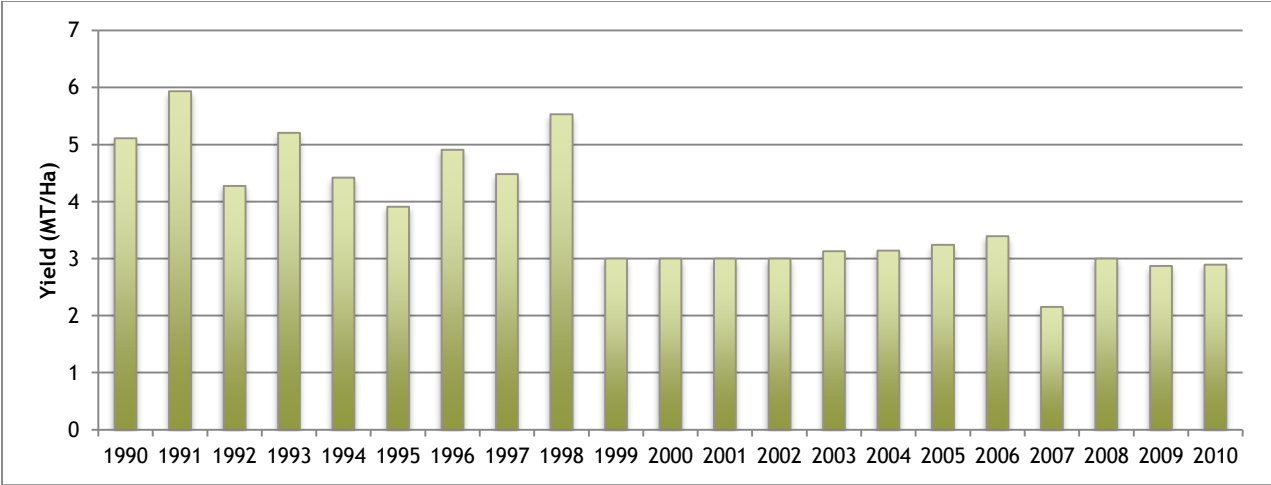
Sources: FAOSTAT and CountrySTAT Nigeria (National Bureau of Statistics (NBS), Federal Ministry of Agriculture and Rural Development)

Note: FAO estimates are reported for 1990-2010, while estimates from Nigeria's NBS are reported for 1999-2008. CountrySTAT Nigeria does not display statistics on Area Harvested for sweet potatoes.

Sweet potato production continues to reflect significant yield gaps and stagnant productivity. While the area harvested increased by more than 3,233% from 28,000 Ha in 1990 to 933,500 Ha in 2010, yields have shown a notable decline over that

same period (see *Figure 2*). The yield for sweet potatoes was 2.9 MT/Ha in 2011, down from 5.1 MT/Ha in 1990. In the 1960s, sweet potato yields were as high as 12.4 MT/Ha.

**Figure 2: Sweet Potato Yield Estimates, 1990-2010**



Source: FAOSTAT

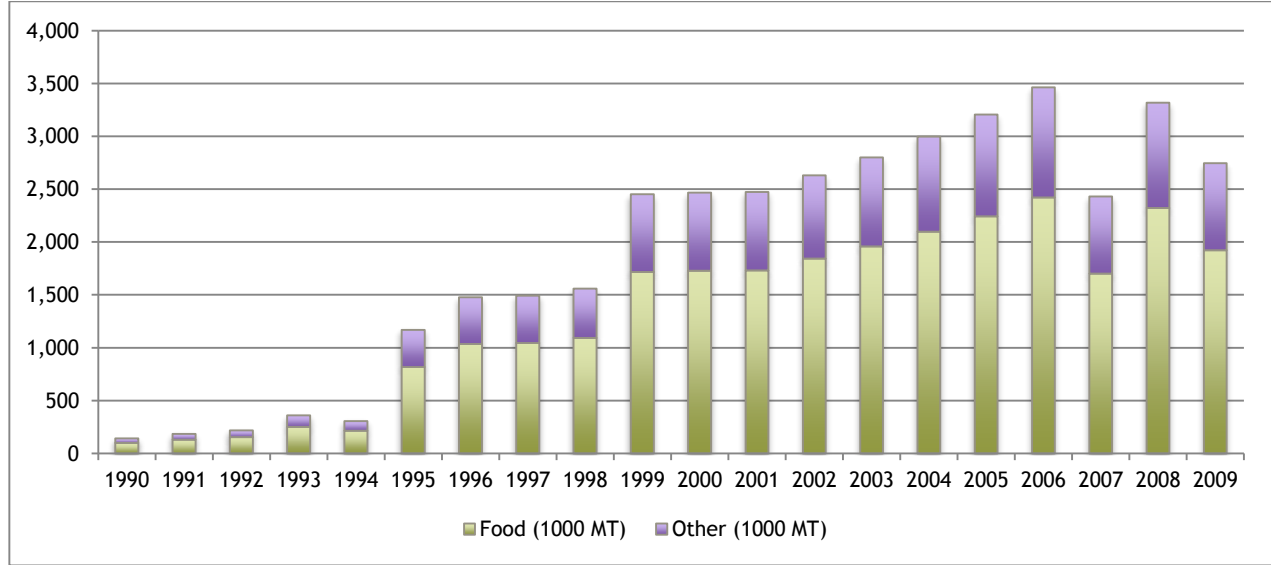
The negative association between area harvested and yield is common to sweet potato data in Sub-Saharan Africa, not just Nigeria.<sup>4</sup> Walker et al (2011) indicate that one explanation is that sweet potatoes were planted on more marginal land. Walker et al believe it is more likely that decision makers releasing sweet potato statistics manipulated the yield downward (without any empirical evidence).<sup>5</sup>

Consumption

*Sweet Potato Consumption has Expanded Rapidly*

Domestic consumption has increased significantly since 1990; according to FAO estimates, consumption grew from 143,000 MT in 1990 to 2,746,000 MT in 2010 (see *Figure 3*). The proportion of sweet potatoes used for food consumption has risen steadily and now accounts for 47.6% of total consumption, compared to 35% in 1990. The “other” category presumably includes diverse industrial uses and waste, but FAOSTAT does not detail the full components of this category.

**Figure 3: Domestic Sweet Potato Consumption by Type of Use, 1990-2009**



Source: FAOSTAT

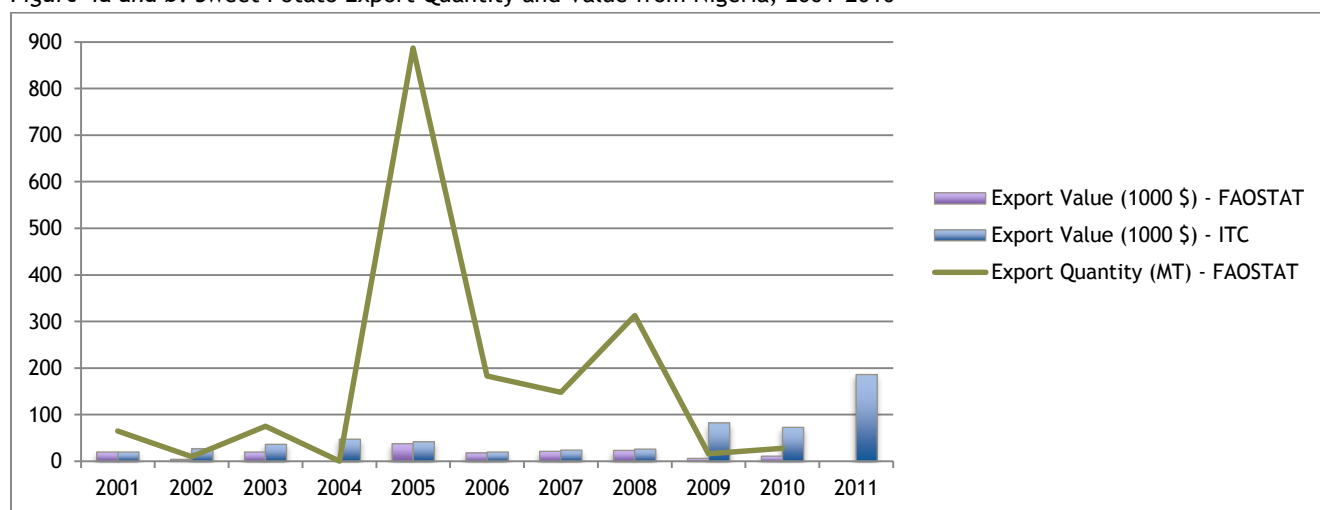
## Trade

### *Nigeria Exports a Limited Quantity of Sweet Potatoes*

Although Nigeria is the world's third largest sweet potato producer, it only exports a limited quantity of sweet potatoes (see Figure 4a and b). The overall export value of sweet potatoes is marginal. This trend reflects Nigeria's overall agricultural export market, which has not been fully utilized since the country's discovery of oil. We could not find information to explain the spike in sweet potato exports in 2005. According to the International Trade Centre (ITC), Nigeria ranks 33<sup>rd</sup> in world sweet potato exports.<sup>6</sup> In 2011, Nigeria's sweet potato exports totaled 2,401 MT and represented 0.1% of world sweet potato exports.

Major countries that import Nigerian sweet potatoes are not listed by FAOSTAT. There is a recognized long-standing sweet potato trade relationship between Nigeria and northern neighboring countries Niger and Chad, with Nigeria as the supplier and Chad and Niger as buyers.<sup>7</sup> The ITC also reports export quantities and values of sweet potatoes and importing countries. Niger and South Africa were major Nigerian sweet potato importers in 2011. Other reported importing countries since 2001 include Canada, France, Germany, Italy, Japan, the Netherlands, Singapore, Thailand, the United Kingdom, and the United States.

Figure 4a and b: Sweet Potato Export Quantity and Value from Nigeria, 2001-2010



Source: FAOSTAT, ITC Trade Map

Note: FAOSTAT only reports export quantity and value from 2001-2010. ITC reports the total sweet potato export quantity for Nigeria for 2011 is 2,401 MT. ITC reports use UN COMTRADE statistics. It is unclear why there is a large difference between FAOSTAT and ITC/UN COMTRADE export value data in 2004 and since 2009.

## Prices

### *Sweet Potato Prices Have Risen Overall and Fluctuate Depending on the Time of the Year*

A Sweetpotato Support Platform for West Africa (SSP-WA) (2012) study states that farmgate prices of sweet potatoes range from N 2,100 to N 2,500 (\$13.12-\$15.63) per 125 kg bag. Sweet potato prices also fluctuate over the course of the year. At the peak of harvest between July and January, prices are lower. Between February and June, when sweet potatoes are scarce, market prices are much higher. Figures 5 and 6 show how weekly prices from 2004-2006 fluctuate depending on the time of year and across different regions of the country. Sweet potato prices increased overall in the second year of monitoring prices, with prices in the very southern part of the country priced the highest. In 2007, the national average price for sweet potatoes was \$0.26 USD/kg from April-June, \$0.36 USD/kg from July-September, and \$0.35 USD/kg from October-November.<sup>8</sup>

Orange-fleshed sweet potatoes, which have been effectively marketed for their nutritional value, now sell at higher prices than white-fleshed varieties.<sup>9</sup>

A 2003 study comparing 1990-1994 market prices for different staple crops in Oyo State in southeastern Nigeria found that sweet potatoes were similarly priced to maize, priced lower than yams, but higher than cassava tubers.<sup>10</sup> The following table compares available 1994 price data from the southeast with 2006 price data from the south. The data from 2006 shows that sweet potatoes are priced higher than yams.

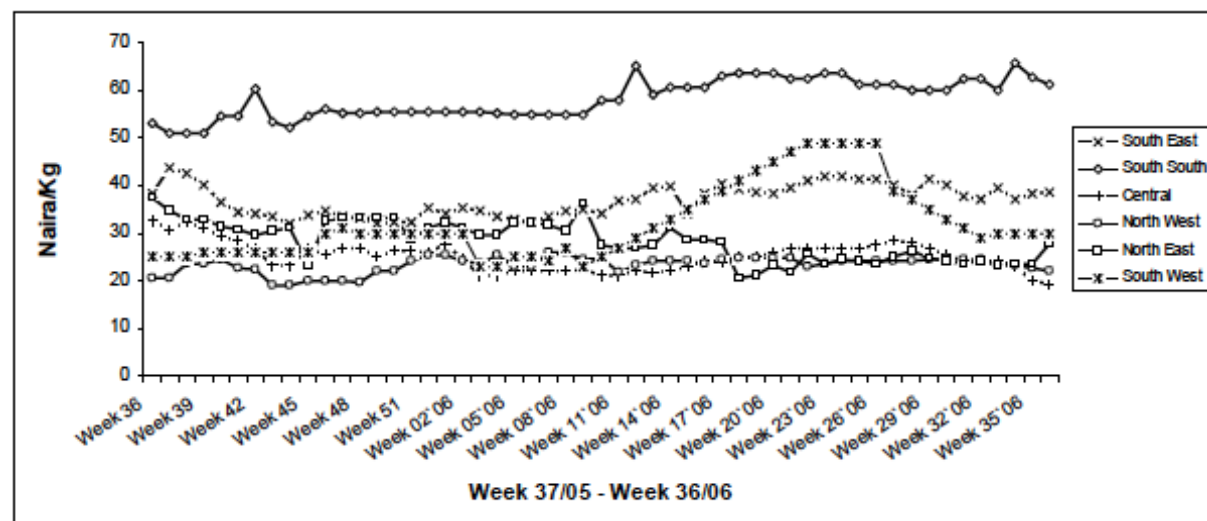
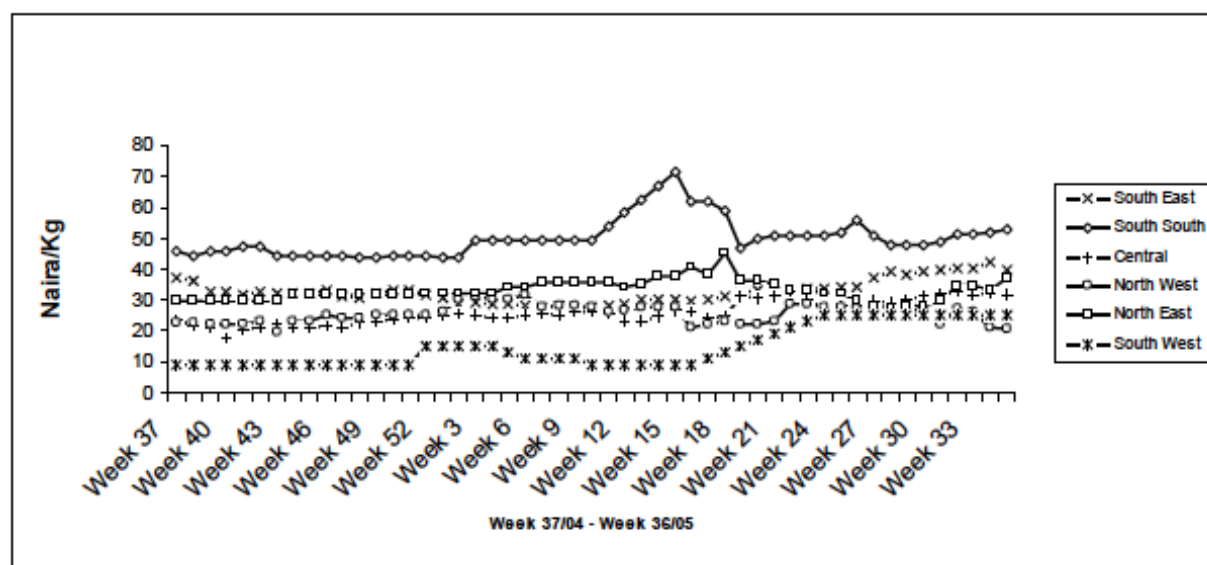
**Table 1: Average Market Prices for Different Staple Crops in 1994 (southeastern region) and 2006 (southern region) in USD/kg**

| Crop                  | 1994   | 2006   |
|-----------------------|--------|--------|
| Sweet Potatoes        | \$0.28 | \$0.30 |
| Yams                  | \$0.48 | \$0.15 |
| Maize (white-shelled) | \$0.26 | --     |
| Cassava               | \$0.12 | \$0.15 |

Sources: Tewe, Ojienyi, and Abu (2003), Akoroda (2009), Daniels et al (2011), CountrySTAT Nigeria

Notes: The author converted all prices from Naira to USD. The author could not find 2006 farmgate prices for white-shelled maize.

**Figures 5 and 6: Weekly Prices of Sweet Potato Tubers (in Naira/kg) Averaged Across Markets in Six Geo-Political Zones of Nigeria, 2004-2006**



Source:

Paul Obasi, International Institute for Tropical Agriculture, Ibadan, Nigeria, 2008; Akoroda 2009

## Sweet Potato Varieties Grown and their Uses

Depending on the variety, sweet potatoes (*Ipomea batatas*) range in level of sweetness (very sugary to bland), level of dryness (watery to floury) and in color, from white or red to yellow or deep purple. The most commonly cultivated sweet potato varieties in Nigeria are white and yellow/orange-fleshed. Initiatives have spawned to encourage the production and consumption of orange-fleshed sweet potato varieties that are rich in beta-carotene (a carotenoid or plant pigment responsible for the yellow and orange coloration of some tuber varieties) and help fight vitamin A deficiencies.<sup>11</sup> In Nigeria, most of the sweet potato landraces (local varieties developed by natural processes and adaption to the local environment) have white-fleshed roots with negligible amounts of beta-carotene.<sup>12</sup> Ijeh and Ukpabi (2004) showed that a popular local yellow-fleshed landrace (known as Ex-Igbariam) has an appreciable quantity of beta-carotene, though still relatively limited when compared to the orange-fleshed varieties. Nigeria's National Root Crop Research Institute (NRCRI) has officially released three improved, high-yielding white-fleshed varieties: TIS 87/0087, TIS 8164, TIS 2532-OP-1-13.<sup>13</sup> The International Potato Center (CIP), International Institute for Tropical Agriculture (IITA) and the NRCRI are currently testing clones of local and orange-fleshed varieties.

Sweet potatoes are most commonly used for human consumption, animal feed, and diverse industrial uses. Sweet potatoes are usually consumed fresh but prepared in many different ways. Most commonly, the fresh root is peeled and boiled, roasted, or fried into chips (fries). The leaves are often boiled and incorporated into soups and stews or stir fried with chili and minced dried shrimps.<sup>14</sup> Sweet potatoes are also commonly fed to infants and young children. Sweet potatoes are cooked together with cowpea, lima beans, sesame, millet and/or other root and tuber crops to make a traditional porridge. Sweet potato dough is incorporated with other root and tuber crops to create two staple dishes in the country: *fufu*, a stiff, gelatinous dough prepared by pounding boiled tuber pieces in a mortar; and *amala*, a thick porridge that is often served with soup.

In the north and central regions of Nigeria, sweet potatoes can be peeled, sun-dried, and milled into flour that is used for sweetening local dishes or for preparing a fermented drink called *kunu*. Sweet potatoes are already a staple crop in northern Nigeria, where most of the crop is produced.<sup>15</sup> However, the high level of sweetness remains the greatest barrier to sweet potato uptake in the south, where most of the country's population is concentrated. The NRCRI is developing high dry matter, non-sweet, easy to pound varieties that would appeal to this large population segment.<sup>16</sup>

Sweet potatoes have a number of additional agricultural and industrial uses as well. Sweet potato vines, leaves and roots are used for animal feed for sheep, goats, and rabbits.<sup>17</sup> Recent studies found that animals that are fed sweet potato vines actually produce less methane gas than animals given other types of feed, suggesting that sweet potato animal feed can help contribute to reducing global emissions.<sup>18</sup> Sweet potatoes are also processed industrially into fried snacks like sweet potato fries (chips), candy, starch, noodles, and flour. There is high demand in urban areas for fried sweet potato crisps.<sup>19</sup> Sweet potatoes can also be exploited for ethanol and biofuel production. Sweet potatoes can be processed to yield about 137 liters of ethanol per MT of sweet potato tubers.<sup>20</sup>

In Kwara state in southwestern Nigeria, sweet potatoes play a particularly important role in cultural traditions, where the crop's harvest season is celebrated with feasting and cultural dances.<sup>21</sup> Sweet potatoes also have limited traditional medicinal purposes; sweet potato leaves are boiled in water to make tea to cure problems ranging from mouth and throat tumors to asthma and diarrhea.<sup>22</sup>

## Importance of Sweet Potatoes

### Sweet Potatoes are Important for Income Generation and Food Security

Sweet potatoes present diverse industrial uses, some of which are potentially highly profitable, such as sweet potato snacks.<sup>23</sup>

Sweet potatoes are extremely adaptable to adverse environmental conditions; they can help increase food security in times of drought and famine, particularly in post-conflict areas for displaced persons.<sup>24</sup> Sweet potatoes produce carbohydrates much faster and require less labor than other crops. Sweet potatoes are used to restore access to food for resetting populations and alleviate future agro-climatic or political shocks. The challenge with using sweet potatoes in emergency response situations is the crop's low multiplication rate. Vine material needs to be ready to go and mechanisms in place to distribute vine materials to needy farmers.<sup>25</sup>

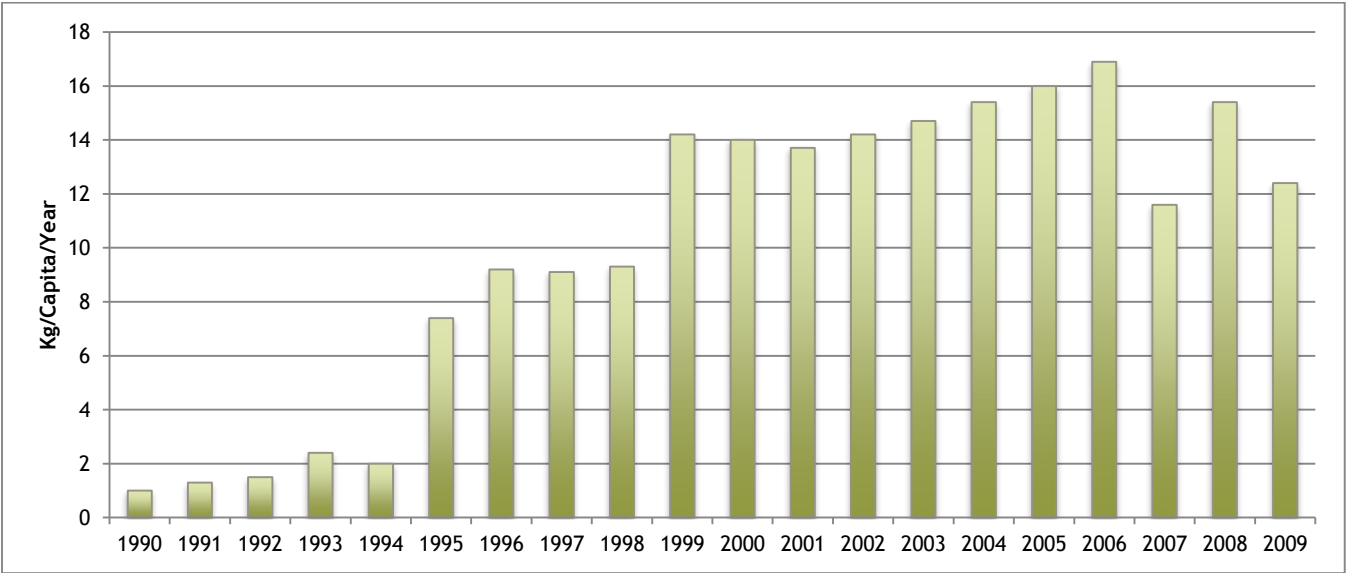
Sweet Potatoes are an Important Source of Nutrition

A number of initiatives in Nigeria encourage consumption of orange-fleshed sweet potatoes, which contain beta-carotene and help fight vitamin A deficiency, which can result in blindness for pregnant women and children and even death for 250,000-500,000 children per year.<sup>26</sup> In Nigeria, estimates suggest 29.5% of all children under the age of five are vitamin-A deficient.<sup>27</sup>

A comparison of sweet potatoes to maize, potatoes and cassava shows that sweet potatoes yield more calories per hectare than maize or potatoes and nearly as much as cassava. Sweet potatoes also yield larger amounts of protein in kilograms per hectare than cassava.<sup>28</sup>

Per capita sweet potato consumption has sharply risen overall, from 48.9 kg/year in 1990 to 89.7 kg/year in 2009 (see Figure 7).

Figure 7: Per Capita Sweet Potato Consumption as Food, 1990-2009



Source: FAOSTAT

As sweet potato consumption has increased, its role in the nutritional status of the average Nigerian has also increased. Table 1 shows that sweet potato intake accounted for a higher percentage of total daily intake of calories, protein, and fat in 2009 than it did in 1990. However, these national averages likely mask a lot of regional variation, especially in areas where sweet potato consumption is higher.

Table 1: Daily Macronutrient Intake from Sweet Potatoes, 1990 and 2009

|      | Per capita caloric intake from sweet potatoes<br>(% of total caloric intake) | Per capita protein intake from sweet potatoes<br>(% of total protein intake) | Per capita fat intake from sweet potatoes<br>(% of total fat intake) |
|------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------|
| 1990 | 3.0 kcal/day<br>(0.1%)                                                       | 0.0 g/day<br>(0.0%)                                                          | 0.0 g/day<br>(0.0%)                                                  |
| 2009 | 33.0 kcal/day<br>(1.2%)                                                      | 0.4 g/day<br>(0.6%)                                                          | 0.1 g/day<br>(0.1%)                                                  |

Source: FAOSTAT

Sweet potato leaves have added nutritional value, with greater amounts of protein and crude fiber. The leaves and tender shoots of sweet potatoes are also eaten and are very nutritious, unlike potato leaves, which are toxic. Table 2 shows the nutritional value of sweet potato tubers and leaves. The method of preparation, for example boiled versus deep-fried, affects the final nutritional status, as the amount of oil used inhibits bioaccessibility (the amount of an ingested nutrient that is available for absorption in the gut after digestion) to beta-carotene in the food.<sup>29</sup> The skin is edible and has high nutritional value. One hundred grams of fresh sweet potato leaves contain more iron, vitamin C, folates, vitamin K, and potassium but

less sodium than the tuber.<sup>30</sup> The tubers have a high level of carbohydrates for daily energy production. Sweet potatoes are appropriate for meeting the nutritional needs of malnourished children and elderly populations who need high-energy foods that are also suitable for small stomachs.<sup>31</sup>

**Table 2: Nutritional Value of Sweet Potatoes (Raw, Uncooked) and Sweet Potato Leaves**

| Component (per 100g portion)    | Sweet Potatoes (Raw, Uncooked) | Sweet Potato Leaves (Raw) |
|---------------------------------|--------------------------------|---------------------------|
| Water                           | 77.28                          | 86.81                     |
| Energy (kcal)                   | 86                             | 42                        |
| Protein (g)                     | 1.57                           | 2.49                      |
| Fat (g)                         | 0.05                           | 0.51                      |
| Carbohydrates (g)               | 20.12                          | 8.82                      |
| Fiber (g)                       | 3.0                            | 5.3                       |
| Sugar (g)                       | 4.18                           | not specified             |
| Calcium (mg)                    | 30                             | 78                        |
| Iron (mg)                       | 0.61                           | 0.97                      |
| Magnesium (mg)                  | 25                             | 70                        |
| Phosphorus (mg)                 | 47                             | 81                        |
| Potassium (mg)                  | 337                            | 508                       |
| Sodium (mg)                     | 55                             | 6                         |
| Zinc (mg)                       | 0.3                            | not specified             |
| Vitamin C (mg)                  | 2.4                            | 11                        |
| Thiamin (mg)                    | 0.078                          | 0.156                     |
| Riboflavin (mg)                 | 0.061                          | 0.345                     |
| Niacin (mg)                     | 0.557                          | 1.130                     |
| Vitamin B6 (mg)                 | 0.209                          | 0.190                     |
| Folate (mcg)                    | 11                             | 1                         |
| Vitamin (IU)                    | 14187                          | 3778                      |
| Vitamin E (mg)                  | 0.26                           | not specified             |
| Vitamin K (mcg)                 | 1.8                            | 302.2                     |
| Beta-carotene (mcg)             | 8509                           | 2217                      |
| Saturated fatty acids (g)       | 0.018                          | 0.111                     |
| Monosaturated fatty acids (g)   | 0.001                          | 0.020                     |
| Polyunsaturated fatty acids (g) | 0.014                          | 0.228                     |

Source: USDA National Nutrient Database for Standard Reference, 2011

Note: USDA does not specify the sweet potato variety that was analyzed.

## Overview of Sweet Potato Production in Nigeria

### Sweet Potato Production is Concentrated in the Northern Arid and Semi-Arid Zones

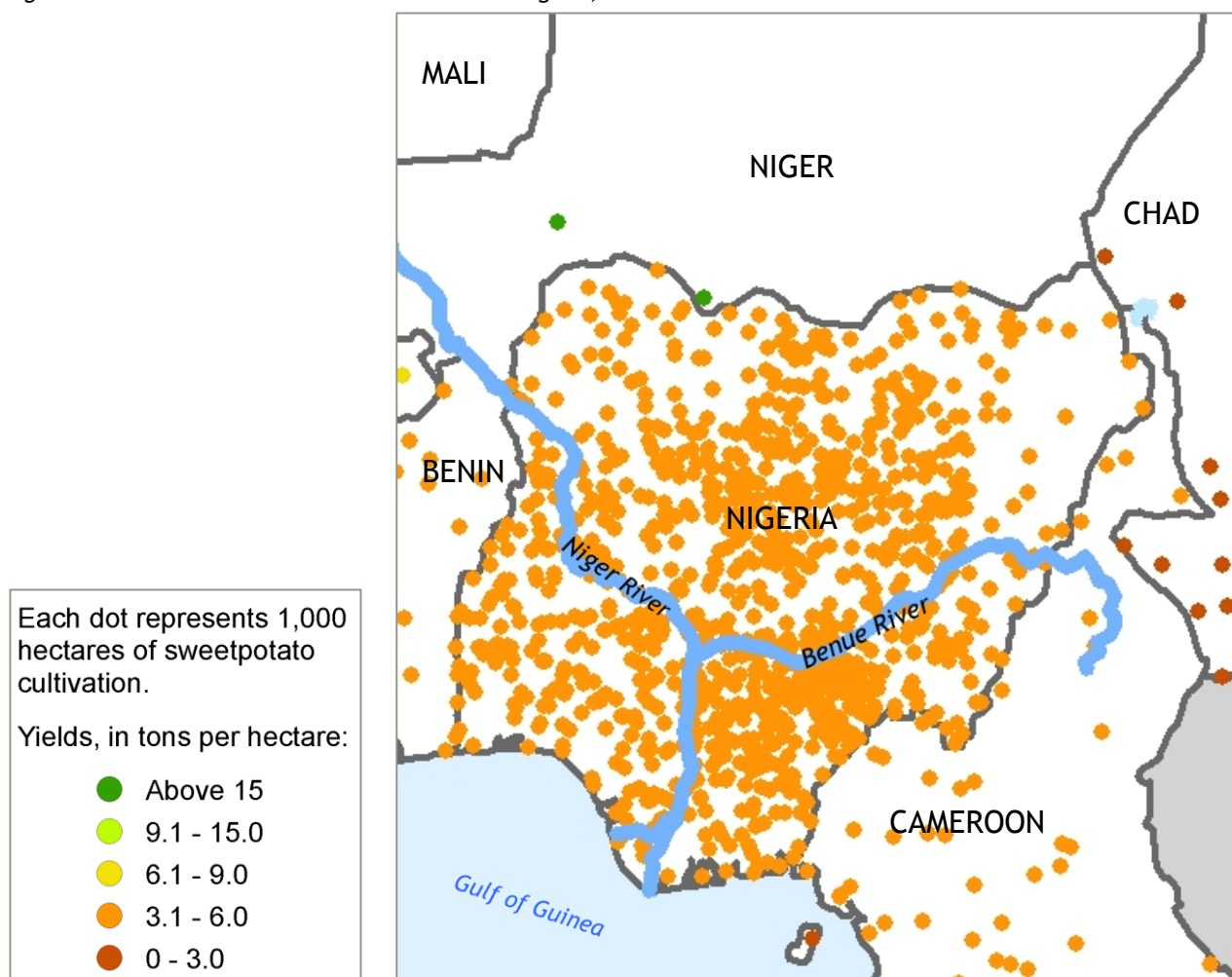
Sweet potatoes are grown in all parts of the country in diverse agroecological zones, from tropical rainforest to semi-arid and arid zones. While sweet potatoes are considered a cash crop in certain parts of Nigeria (for example, Kwara state),<sup>32</sup> in most areas, sweet potatoes are grown as a secondary crop. They are a staple crop in northern Nigeria where most sweet potatoes are produced.<sup>33</sup>

The concentration of sweet potato production has shifted since 1971 from the sub-humid zones of Kwara, Plateau, Niger and Benue states to northern semi-arid agroecological zones, where Kaduna, Kano and Bauchi states are leading production states.<sup>34</sup> Commercial sweet potato production appears concentrated in these same semi-arid northern states. Irrigation makes year-round cultivation possible in the north, where farmers grow less sweet and more floury varieties that are in high demand in major urban markets.<sup>35</sup>

Sweet potatoes are adaptable to marginal environments; flexible in mixed farming systems; and have a short maturation period (3-8 months depending on the variety), which allows for two or more crop cycles in a year. Sweet potatoes generally require less labor inputs, and have lower rainfall and soil fertility requirements than other crops like yams.

Figure 8 shows sweet potato cultivation and yield estimates based on FAO figures. Yield estimates are similar for all regions in Nigeria at 3.1-6.0 MT/Ha. The green dots on the border of Nigeria and Niger suggest that much higher yields are possible, potentially up to 30 MT/Ha.<sup>36</sup> Recent multi-site trials show yields are much higher in the north than in the southern part of the country.<sup>37</sup>

Figure 8: Sweet Potato Cultivation and Yields in Nigeria, 2004-2006



Source: International Potato Center, CGIAR n.d.;

<https://research.cip.cgiar.org/confluence/display/WSA/Sweetpotato+and+Malnutrition+in+Africa>

Note: This map is cropped from a larger map of Africa's Sweet Potato Cultivation and Yields. Sweet potato cultivation estimates are composites from FAO estimates from 2004 to 2006.

Land area for sweet potato cultivation varies by agroecological zone (see Table 3). The semi-arid, arid, and derived savanna zone located in the northern part of the country has the largest cultivated areas. Major production states also vary by region (see Table 4).

Table 3: Sweet Potato Cultivated Area by Agroecological Zone in Nigeria

| Agroecological zone                                    | Semi-arid/Arid | Derived Savanna* | Humid forest | Mid-altitude | North Guinea Savanna | South Guinea Savanna | Land with no data | Total Area |
|--------------------------------------------------------|----------------|------------------|--------------|--------------|----------------------|----------------------|-------------------|------------|
| Area of cultivated sweet potatoes in square kilometers | 26.809         | 25.037           | 9.905        | 2.764        | 11.302               | 13.306               | 1.264             | 90.388     |

Source: Alabi (2008). Geo-Spatial Laboratory, International Institute for Tropical Agriculture, Ibadan, Nigeria.

Note: Derived savanna zone is an area of grassland with scattered individual trees that results from people clearing the land for cultivation.

Table 4: Major Sweet Potato Producing States

| Zone          | Major Production States                             |
|---------------|-----------------------------------------------------|
| South South   | East Cross River, Delta, Akwa Ibom, Rivers, Bayelsa |
| South East    | Imo, Enugu, Anambra, Ebonyi                         |
| South West    | Osun, Oyo, Ekiti, Lagos                             |
| North Central | Kaduna, Benue, Kwara, Niger, Plateau                |
| North East    | Taraba, Adamawa, Bauchi, Yobe, Borno                |
| North West    | Sokoto, Kebbi, Katsina, Zamfara                     |

Source: SSP-WA (2012), Tewe et al (2001)

Note: Source does not detail how they determine whether a state was a major production zone.

### Various Contextual Factors Explain Nigeria's Rapid Growth and Acceptance of Sweet Potatoes

Different authors cite different reasons for sweet potatoes' rapid growth and acceptance in recent decades. Goldman (1996) explains that cropping challenges over the past 50 years, particularly diseases threatening the production of other major crops like cassava, groundnuts, cocoyams, bananas and plantains, caused Nigerian smallholders to diversify production to include sweet potatoes. Crissman et al (2011) cites other possible reasons to explain the crop's rapid expansion. Failures of other crops have caused farmers to switch to sweet potatoes. Cassava and sweet potatoes are often grown on the same farm or same region, and farmers frequently turn to sweet potatoes when cassava fails due to pest and disease attacks. Moreover, a decline in government support for maize production caused farmers to seek other low-cost alternatives. Finally, the impact of HIV/AIDS and large migration of rural males to urban areas reduced family labor options for agricultural production; remaining family members chose to plant crops that were required less risk, cost, and labor, such as sweet potatoes.<sup>38</sup>

### Sweet Potato Production Cycle

Despite the appearance and name of "sweet potatoes", they are root crops, unlike potatoes which are tuber crops. Sweet potatoes are trailing or climbing plants with vines.

Sweet potato production is determined by rainfall. The best yields occur in areas with 750 to 1,000 millimeters of annual precipitation, with at least 500 mm falling during the growth season.<sup>39</sup> However sweet potatoes do not grow well in water logged soil as it may cause tuber rots and reduce storage roots if aeration is poor.<sup>40</sup>

Rainfed sweet potatoes can be cultivated twice a year (i.e. April to August and August to December).<sup>41</sup> In general, planting takes place from February through July in the central and south, where rainfall is heavier. But planting along rivers in the central part of the country or swampy areas in the north can extend the planting season from September to December.<sup>42</sup>

Most farmers grow sweet potatoes on plots of land less than one hectare in size. Sweet potatoes are often intercropped as the secondary or minor crop. In the south and central parts of the country, sweet potatoes are intercropped with other root and tuber crops (yams, cassava, cocoyams) and in the north they are intercropped with cereals like maize and millet. Sweet potatoes provide soil cover and leave vegetative residue that can be incorporated into the soil after harvest, which also contributes to the primary crop's production.

The sweet potato production cycle in Nigeria involves the following major activities, which are derived from Table 4.2 on sweet potato production inputs in Tewe, Ojeniyi, and Abu (2003):

- 1) *Land clearing, packing, and burning*: Land preparation can be manual or mechanized.
- 2) *Tilling/plowing and mounding or ridging*: Tilling/plowing helps create loose soil for optimal sweet potato production performance. Ridge planting is the most common method of growing sweet potatoes in Nigeria.
- 3) *Processing of planting materials*: Vines serve as planting materials.
- 4) *Planting*: Planting begins at the onset of the rainy season and continues until two months before rains stop.<sup>43</sup> Sweet potatoes may be planted on mounds, ridges, beds, or on flat ground. The crop performs best on mounds and poorest on flat ground.<sup>44</sup>
- 5) *First weeding*: Most sweet potato farmers practice hoe weeding. Sweet potatoes confront weed problems only during the first two months of growth. After this period, intense vine growth causes rapid and effective coverage of the ground, smothering the weeds present. Most small-scale farmers do not bother to weed sweet potato plots at all,

due to this recognized pattern. However, Akobundu (1987) recommends at least a single weeding three weeks after planting.<sup>45</sup>

- 6) *Fertilizer application*: Sweet potato farmers typically do not apply fertilizer. However, studies show application significantly improves tuber yields.
- 7) *Second weeding*: Hoe weeding is recommended a second time to ensure weeds to not prevent tuber growth.
- 8) *Harvesting*: Harvesting occurs 3-8 months after planting, depending on the sweet potato variety. Harvesting entails cutting off shoots, carefully digging out tubers while avoiding bruises, using a fork shovel, long wooden sticks, metal rod with flattened ends, and hoes. Harvest time is flexible and often staggered.<sup>46</sup> However, harvesting at the earliest maturation period is recommended to avoid attacks from weevils (beetles) as moisture in the soil decreases. In times of adverse conditions, only mature tubers are harvested for consumption or market sale. Small tubers are left to continue growing. Knowing when to harvest enables farmers to obtain tubers with a desirable dryness composition. Farmers often leave storage roots in the field during the dry season in the soil and harvest when food supplies are short.<sup>47</sup>

Sweet potato production generally follows the activities listed above but the timing varies by region and agroecological zone. *Table 4* outlines these differences in timing. *Table 5* summarizes sweet potato production, utilization, and marketing by agroecological zone.

**Table 4: Sweet Potato Production Patterns by Region**

| Region    | States                                     | Activity/Time                                                                       |
|-----------|--------------------------------------------|-------------------------------------------------------------------------------------|
| Northwest | Sokoto, Kano, Kebbi, Katsina, Kaduna       | Planting July to August<br>Possible second crop irrigated from November to December |
| Northeast | Jigawa, Yobe, Borno, Adamawa, Bauchi       | Planting May to July                                                                |
| Central   | Niger, Kwara, Kogi, Benue, Plateau, Taraba | Ridges made from May to July<br>Vines planted July through August                   |
| Southwest | Oyo, Osun, Ondo, Ogun, Lagos, Delta, Edo   | Planting from March to August                                                       |

Source: Tewe et al 2001

**Table 5: Sweet Potato Production, Marketing, and Utilization by Agroecological Zone**

| Agroecological Zone | Major Sweet Potato Producing Areas                                                                   | Clones Available                                                                 | Production Techniques                                                                                             | Marketing Methods                                                             | Utilization                                                                                                                                             |
|---------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Humid               | Obbomoso, Oyan, Ijabe, Okuku, Saki, Ibadan                                                           | Orange-fleshed local and improved clones (CIP, IITA, NRCRI)                      | Rainfed, mixed cropping with maize                                                                                | Farm collectors by directly from farmers who bring harvest to weekly markets  | Snacks, <i>lafun</i> (sweet potato flour), vines and leaves as livestock feed, especially for rabbits                                                   |
| Sub-Humid           | Ajassepo, Dokobo, Agbamu, Offa, Bookos, Jos, Bass, Wuse, Oturpo, Vandeikya, Makurdi                  | Local clones (Tomude, Anomo, Igangan)                                            | Planted with millet (mixed cropping)                                                                              | Farm collectors buy directly from farmers who bring harvest to weekly markets | <i>Fufu</i> , vegetables, boiled, <i>usinsin dankah</i> (sliced and sundried roots that are preserved, boiled with rice and beans, or eaten as a snack) |
| Semi-Arid           | Toro, Balanga, Dass, Kukawa, Marte, Gwosa, Biu, Ashira Uba, Zango Kataf, Jema, Igbai, Talata, Mafara | Clones such as Bombom, local varieties with pink skin, white flesh, yellow flesh | Usually <i>fadama</i> cropping (irrigable land; aquifer-supported, low-lying plains along Nigeria's major rivers) | Roadside sales of sweet potatoes are common                                   | Boiled for food, sweetener, dried forage as livestock feed especially during the dry season                                                             |

Source: Tewe, Ojeniyi, and Abu 2003

Note: This data was collected in 2002 so some of this information may now be outdated or incomplete.

### Most Sweet Potato Farmers are Male Smallholders with Limited Levels of Educational Attainment

Several studies have been conducted on sweet potato farmers in Nigeria that include questions about sociodemographic characteristics (see *Table 5*). The authors of this brief reviewed 12 studies involving sweet potato producers and/or traders in Nigeria. The author selected a sample of four studies that primarily examined sweet potato production systems and production efficiency. This sample serves as the base for building a sociodemographic profile of a Nigerian sweet potato farmer.

These surveys do not clearly indicate the gender breakdown of sweet potato farmers. Nwaru, Okoye, and Ndukwu, 2011

(Survey 3) only surveyed sweet potato farmers (not just heads of households as done in Surveys 1 and 2) and found the slight majority is female (53.33%). Another study not included in this sample surveyed 270 sweet potato farmers regarding modern production technology adoption and found that 51.11% of sweet potato farmers were male and 48.89% were female.<sup>48</sup> Baker (n.d.) states that most sweet potato farmers are female.<sup>49</sup>

The majority of sweet potato farmers also have little or no formal education and are relatively old. Three out of four sampled surveys indicated that the average age of the sweet potato ranged from 47-52 years old. Authors attribute the average older age of the sweet potato farmer to the rural-urban drift prevalent among Nigeria's youth. Available evidence suggests that the farming population is aging, with the average age of 47 years and life expectancy of 47-50 years in 2008, concurrent with a steady decline in recent years of young people involved in agricultural activities.<sup>50</sup> Most sweet potato farmers are smallholders with average landholding size of 1-3 Ha or less.

**Table 5: Comparison of Methods and Findings about Sweet Potato Farmer Sociodemographics from Four Surveys**

|                                 | <b>Survey 1: Adewumi and Adebayo 2008</b>                                                                                                                                                                      | <b>Survey 2: Fawole 2007</b>                                                              | <b>Survey 3: Nwaru, Okoye, and Ndukwu 2011</b>                                                                                                                                                          | <b>Survey 4: Theophilus 2011</b>                                                                                              |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>Geographic Area</b>          | Kwara state, central western Nigeria                                                                                                                                                                           | Kwara state, central western Nigeria                                                      | Imo state, southeastern Nigeria                                                                                                                                                                         | Delta state, southwestern Nigeria                                                                                             |
| <b>Survey Dates</b>             | 2006                                                                                                                                                                                                           | Not specified                                                                             | 2008                                                                                                                                                                                                    | Not specified                                                                                                                 |
| <b>Gender</b>                   | 100% male (study only surveyed household heads)                                                                                                                                                                | 90% male and 10% female (only surveyed household heads)                                   | 46.67% male and 53.33% female                                                                                                                                                                           | Average gender of household: 0.7 (not clearly defined)                                                                        |
| <b>Age</b>                      | Average age: 52 years (range 25-75 years); Majority of respondents 41-75 years (88%). 12% under 40 years.                                                                                                      | Majority of respondents 21-49 years (97.8%). 50 years and above (2.2%).                   | Average age: 47.38 years (range 29-70 years)                                                                                                                                                            | Average age: 48 years.                                                                                                        |
| <b>Education</b>                | Majority of respondents no formal education (63.16%). 36.84% some formal education.                                                                                                                            | Majority of respondents formal education (52.2%). 47.8% no formal education.              | Average years of formal education: 10.34 years (range 0-18 years).                                                                                                                                      | Average years of formal education: 11 years.                                                                                  |
| <b>Average Landholding Size</b> | 1.05 Ha<br>Majority of respondents 0.10-0.99 Ha (68.48%) grown below average.                                                                                                                                  | Majority of respondents 1-3 Ha (52.2%). 4-6 Ha (34.4%), 7-10 Ha (13.3%).                  | 0.056 Ha cultivated sweet potato area (range 0.05-0.15 Ha)                                                                                                                                              | 0.83 Ha                                                                                                                       |
| <b>Sampling Methods</b>         | Purposive and two-stage random sampling of 160 farmers: 8 sweet potato farming households randomly selected from 20 villages in 2 highest sweet potato producing Local Government Areas (LGAs) in Kwara state. | Administered questionnaire to 90 farmers. Random sampling: 10 farmers from 9 communities. | Administered questionnaire to 120 farmers. Multi-stage sampling: 120 sweet potato farmers were selected randomly from 8 communities in 4 LGAs in 2 agricultural zone with the help of extension agents. | Administered questionnaire to 100 sweet potato farmers. Random sampling: 10 farmers selected randomly 10 villages from 1 LGA. |

#### Intercropping is Common in Sweet Potato Production

Sweet potatoes are often intercropped as the minor or secondary crop along with one or more primary crops, such as cassava, yams, maize, cocoyams, sorghum, or rice, depending on the part of the country. Sweet potatoes are also often grown with other minor crops including groundnut, cowpeas, melon, okra, pepper and some leafy vegetables. One study found that 91.1% of sweet potato farmers surveyed practiced a mixed cropping system.<sup>51</sup> According to Tewe, Ojeniyi, and Abu (2003), intercropping and mixed cropping of sweet potatoes has a negative effect on the crop's output. However, as the country's population has grown, the government has promoted intercropping systems as a way to improve land use.

Several studies have looked at sweet potato intercropping systems and examined the effect of different combinations on yield, in the hopes of determining the optimal combination for sweet potato cropping systems. Intercropping sweet potatoes with papayas was found extremely disadvantageous to papaya yield but actually enhanced sweet potato yield.<sup>52</sup> Babatunde, Dantata, and Olawuyi (2012) conducted a field experiment to study the performance of sweet potato and soybeans under different sequences during the rainy seasons of 2007, 2008, and 2009 in Bauchi, Nigeria in the northern Guinea savannah agroecological zone. They found that sweet potato yields did not vary statistically within the same season and monocrop yields for sweet potato were much higher than yield from any intercrop systems. However, it is highly

unlikely that farmers would only plant sweet potatoes. For better sweet potato tuber and grain yields, the study recommended that sweet potatoes be transplanted a week or two before soybeans are planted.

Babatunde et al (2007) surveyed 98 sweet potato farmers in Kwara state and used a linear programming model to determine that sweet potato/cassava systems have the best gross margin in Naira/Ha out of the three prominent sweet potato cropping systems practiced in the communities studied (which are sweet potato/cassava/maize; sweet potato/cassava; and sweet potato/yam).

Ojore, Bwala, and Amaka (2012) conducted field experiments during the 2009 and 2010 cropping systems at the University of Agriculture in Makurdi, Nigeria to study the productivity of cassava/sweet potato intercropping systems with different lengths of cassava cutting lengths sown into the sweet potato plots. Results showed that the greatest intercrop yields of cassava and sweet potato were obtained when a cassava cutting length of 30 cm was planted in the mixture. This also gave the highest land equivalent ratio (LER) value, indicating that greater productivity per unit area was achieved by growing the two crops together than separately. This LER value signified that 53.5 % of land was saved in 2009 and 2010, which could have been exploited for other agricultural purposes.

Ijoyah and Jimba (2011) also conducted field experiments in the 2009 and 2010 planting seasons at a research farm at the University of Agriculture in Makurdi, Nigeria to study the effects of planting methods, planting dates, and intercropping systems on sweet potato-okra yields. The study showed that to achieve optimal intercrop yields of sweet potatoes and okra, both crops should be planted at the same time using the ridging planting method (over the raised flattened top bed method).

Njoku et al (2007) conducted a field experiment at the National Root Crop Center Research Institute to evaluate the productivity of three sweet potato cultivars with three okra cultivars. The authors calculated land equivalent ratios and found that growing both crops together achieved higher productivity per unit area. Intercropping increased okra plant height while intercropping with a specific sweet potato cultivar (TIS 2532 OP.1.13) significantly increased the number of pods per okra plant than intercropping with other sweet potato cultivars. Tuber yield in sweet potato was higher with TIS 87/0087 than other cultivars but both okra pod and tuber yields were not affected by intercropping.

Some research has shown that sweet potato and maize intercropping can be efficient. Sweet potatoes are intercropped with maize often in July after the melon harvest.<sup>53</sup>

Egbe and Idoko (2009) evaluated sweet potato and pigeonpea intercropping among farmers in southern Guinea savanna agroecological zone. His results show a decrease in the total fresh root and saleable root yield of sweet potatoes when mixed or intercropped with pigeonpea. However, pigeonpea benefited and the LER was above one, indicating productive use of land area. The majority of farmers surveyed in the study (80%) seemed open to the idea of intercropping sweet potatoes and pigeonpea.

#### Women Currently Play a Large Role in Production but their Role May be Limited as Large-Scale Systems Develop

Sweet potatoes are traditionally viewed as a “women’s crop,” grown predominantly by women farmers on small plots.<sup>54</sup> It is also often viewed as an “orphan crop” because there is less widely accessible information on its benefits.<sup>55</sup> Nwaru, Okoye, and Ndukwe (2011) determined that female sweet potato farmers were more technically and economically efficient than male sweet potato farmers—an encouraging result given the high percentage of rural farmers that are females and the fact that female farmers are increasingly taking over farm tasks and enterprises which traditionally belonged to their male counterparts.<sup>56</sup> Female participation is increasing mainly in response to the rural-urban migration of men, which increases pressure on women to ensure the family’s survival by participating more fully in agricultural production activities.<sup>57</sup>

As sweet potato production expands and market demand increases, Baker (n.d.) anticipates that more men will adopt sweet potato production and there will be increased large-scale, intensive production systems for sweet potatoes. While such a transition would contribute to the overall availability of sweet potatoes and potentially improve food security in the country, such large-scale production systems usually exclude or limit women’s involvement.<sup>58</sup>

Adewumi and Adebayo (2008) report that sweet potato production is a household endeavor. Female family members are usually engaged in activities like applying fertilizer, fetching water to spray onto the plots, and transporting harvested sweet potatoes from the farm to the roadsides for selling. The male family members are usually the farm owners and heads

of households and are involved in more strenuous activities, such as land clearing, mounding/ridging, and harvesting, relative to their female counterparts.<sup>59</sup>

### Sweet Potato Yields in Nigeria Face Diverse Constraints

White-colored sweet potato varieties commonly grown by farmers in the southern Guinea savanna zone are characterized by low yields of 3000-9000 kg/Ha.<sup>60</sup> Multi-site field trials for improved varieties in Nigeria registered 23.5 MT/Ha yield across seasons and locations.<sup>61</sup> If this figure represents the achievable sweet potato yield in Nigeria, the estimated yield gap in 2011 was 20.6 MT/Ha (average yield was 2.9 MT/Ha). Farm yields continue to fall well below yields obtained from research plots with improved varieties, which have registered up to 30 MT/Ha in research fields.<sup>62</sup>

According to one study, sweet potato farmers' perceived constraints to production include: high labor costs, limited access to credit, inadequate government aid, limited access to improved technologies, and high incidence of pests and diseases.<sup>63</sup> Other main constraints include the need to sustain sweet potato vines through the dry season since they serve as planting materials in the next crop cycle, and consumption preferences of other crops over sweet potatoes (cassava, yams, plantain, rice, and cowpeas in the south and cassava, yam, sorghum, rice, millet, and cowpeas in the north).<sup>64</sup>

### *Sweet Potato Farmers Practice a Mix of Traditional and Improved Technologies*

Sweet potato farmers are using a mix of traditional and improved technologies. Fawole, 2007 (Survey 2) found that 63.3% of sweet potato farmers used improved varieties, while 36.7% cultivated local varieties.<sup>65</sup> Access to these technologies most often comes in the form of extension agents. Several studies note that sweet potato farmers are regularly in contact with extension services and benefit from their knowledge sharing and tools.<sup>66</sup>

Ekwe and Onunka (2006) surveyed 150 sweet potato farmers in Abia state to evaluate their adoption of improved technologies jointly developed by IITA and the NRCRI that were first introduced to farmers in the state over 10 years ago. The study found that only 47% of respondents were aware of improved, available varieties and technologies. Of those who were aware, there was a medium-level uptake of improved technologies and medium-level uptake of related component technologies, such as better knowledge about importance and efficient practice of timing of planting, fertilizer application, improved varieties, intercropping systems, and harvesting technique; there was low uptake of improved planting space and planting pattern techniques.<sup>67</sup>

Ezeano (2010) reveals more promising results regarding modern technology use in sweet potato production. *Table 6* shows results from the study involving 144 farming households in southeastern Nigeria. It indicates that several improved technologies have been adequately communicated through extension agents and translated into practice in the area.

**Table 6: Rate of Adoption of Improved Production Technologies Among 144 Farming Households in Southeastern Nigeria**

| Technologies for Farmers                                            | Percentage of Farming Households Reporting Use |
|---------------------------------------------------------------------|------------------------------------------------|
| Correct spacing (30-50 cm apart)                                    | 92.4                                           |
| Earthening-up (plowing or aerating the soil before planting)        | 92.4                                           |
| Cutting of the vine from base at maturity to prevent weevil attack  | 90.3                                           |
| Rolling and typing of vines at the base to increase tuber size      | 89.6                                           |
| Organic fertilizer application                                      | 81.3                                           |
| Inorganic fertilizer application                                    | 74.3                                           |
| Correct length of vine cuttings (2-5 nodes)                         | 71.5                                           |
| Harvesting in bits and detopping to encourage more tuber production | 50.0                                           |
| Stand geometry (stand erect)                                        | 47.2                                           |
| Use of seeds/leaf buds for planting                                 | 47.2                                           |
| Use of compatible intercrop                                         | 36.8                                           |
| Use of sprouts for planting                                         | 36.8                                           |
| Use of insecticide/fungicide                                        | 36.8                                           |
| Storage in pits with ash and dried grass                            | 30.6                                           |
| Use of herbicide (weed control)                                     | 26.4                                           |
| Use of tractors for cultivation                                     | 25.0                                           |
| Use of oxen for cultivation                                         | 3.5                                            |

Source: Ezeano (2010)

Mbanaso et al (2012) also examines the extent of adoption of modern or improved sweet potato production technologies in southeastern Nigeria and found that 79.63% of the sweet potato farmers were aware the technologies the interviewers asked about (ranging from land preparation methods like ridging and mounding to timely harvesting), while 20.37% were not. The majority of the farmers had adopted all the improved sweet potato production practices except plant spacing.<sup>68</sup>

Sweet potato farmers in the same study also identified major constraints to modern or improved sweet potato production technology adoption. Identified challenges included: difficulty in integrating sweet potato production technology into existing production system; low consumer preferences for sweet potato products and lack of market for sweet potato products; unavailability of sweet potato vines/planting materials; high cost of available sweet potato vines and unavailability of inorganic fertilizer; and scarcity of land.<sup>69</sup> Most rural farmers were unwilling to adopt any innovation that was too complex. Mbasano et al recommend that extension services in the area should focus on simple, clear ways of explaining the advantages of adopting and demonstrating technology use.

#### *Sweet Potato Farmers Rely on Family and Hired Labor to Carry out Key Production Activities*

Survey 1 and Survey 3 results show that most smallholder farmers have large families.<sup>70</sup> Survey 1 found that 61.84% of sweet potato producing households had 6-10 family members and 26.32% households had 11-15 members. Survey 2 reported an average of 7.1 family members per sweet potato producing household. Large family size helps reduce the cost of labor; however, farmers still rely on hired for more labor-intensive production tasks. Survey 2 found that 52.2% of farmers only depended on family labor while 43.3% hired some labor.<sup>71</sup>

Survey 1 found that only 2.63% of farming households used “only family labor” while 28.95% only “hired labor”. The majority (68.42%) used a “combination of the two” for their sweet potato farming activities. For households employing a mixed labor force, family labor was generally employed in less laborious activities such as planting, fertilizer application and harvesting, while hired labor was used mainly for land clearing, ridging, and weeding. However, a majority of the respondents said there often was not enough hired labor to perform land clearing and ridging, so the family had to participate in those tasks as well.<sup>72</sup>

#### *Planting Materials are Easily Sourced, though their Quality is Determined by Adequate, Consistent Maintenance*

Most sweet potato farmers source the vines for planting material themselves or through friends and family. Survey 1 reported that 40.79% acquired planting material from their own farm, 35.53% secured material from friends and relatives, and 19.75% acquired sufficient materials through a mix of one’s own farm and friends and relatives. Only 3.93% of sweet potato farmers purchased their planting materials from the local market. Survey 2 found that 54.4% acquired planting material from post-harvest vines from the last crop cycle, 31.1% from friends, and 14.4% via extension service.<sup>73</sup>

While input costs are low for farmers who source planting materials from their own farms, the quality of the vines, which influences ultimate yields, can sometimes be poor. Vines require sufficient and regular maintenance and protection from weevil infestation throughout the dry season. If they are not regularly attended and the farm is located in a weevil-prone area, it is recommended that the vines be dipped in insecticide before being re-planted.<sup>74</sup> Belonging to a farmer cooperative can help farmers access quality inputs.<sup>75</sup>

#### *Manure and Fertilizer Use is Recommended but Uncommonly or Incorrectly Practiced*

Studies show that fertilizer and manure application can be advantageous to productivity. Agbede and Adekiya (2011) evaluated the effect of different tillage methods and poultry manure application to sweet potato tuber yields and found that conventional tillage and 5 MT/Ha of poultry manure improved tuber yield of sweet potatoes significantly (by 116.7% and 42.7% respectively) when compared to manual clearing alone and conventional tillage alone.<sup>76</sup> Agbede (2010) conducted field experiments over two cropping seasons to evaluate the effect of tillage method and fertilizer type on soil property and sweet potato yield. The study concluded that conventional tillage in combination with Nitrogen Phosphorus Potassium (NPK) fertilizer and poultry manure gave the highest tuber yield of sweet potatoes and improved the soil’s physical and nutritive quality.<sup>77</sup> Asawalam and Onwudike (2011) evaluated the use of cow dung and fertilizer to improve sweet potato yields. The results from their experiment show that some combination of both inputs is recommended for sweet potato production in the two analyzed locations in southeastern Nigeria.

Okpara, Okon, and Ekeleme (2009) conducted field experiments in 2005-2006 to evaluate the effects of nitrogen on light

interception, weed production, and yield of white and orange-fleshed sweet potatoes in southeastern Nigeria. Most agricultural soils in the area have insufficient amounts of nitrogen for adequate sweet potato growth and excessive application of fertilizer is harmful to the environment and economically wasteful. This study attempted to determine the optimum rate of nitrogen fertilizer application for maximum storage root yield without producing negative ecological impacts on the soil. Their results show that the application of 40-80 kg of N per Ha, depending on the background fertility level of the soil, can achieve up to 27.2 MT/Ha yields for white-fleshed variety TIS87/0087 and up to 24.8 MT/Ha yields for orange-fleshed variety Ex-Igbariam. Nitrogen application also reduced weed growth.<sup>78</sup> Ukom, Ojimelukwe, and Alamu (2011) also found nitrogen application at a rate of 40-80 kg N per Ha increased beta-carotene content for these same varieties, a useful finding in directing efforts to encourage application to improve the crop's nutritional value and help address vitamin A deficiency in consumers.<sup>79</sup>

Despite the advantages of fertilizer application reported by the studies above, Adewumi and Adebayo, 2008 (Survey 1) found that 88.16% of sweet potato producing households did not use fertilizer in production, and when they did use it, the fertilizer was applied incorrectly or insufficient quantities were used.<sup>80</sup> This may suggest some barriers to accessing this input and/or accessing information about its importance and correct application.

#### *Pest and Disease Attacks are Considerable Constraints to Production*

Survey 3 reported 60% of sweet potato farmers cited high incidence of pests and diseases as a major production constraint.<sup>81</sup> Pests and diseases attack the leaves, vines, and tubers after harvest, en route to the market, and within market stores before sales. Two frequently cited constraints to sweet potato production and storage are weevils and virus complex.<sup>82</sup>

Weevils threaten sweet potato production systems, attacking tubers planted in shallow soil or fully matured tubers protruding from the soil. Adult weevils lay eggs on stems and tubers. The hatched larvae dig into tubers, pupate on stems, and are transferred on shoots. Once established in a crop, they are difficult to control. Clearing the land or planting another crop after each sweet potato helps break weevil incidence cycles. Eggs develop into adult weevils within 25 days. Therefore, careful scheduling of harvesting dates helps reduce weevil damage even if eggs have already been laid on the tubers.<sup>83</sup>

Sweet potato weevils (beetles) are most harmful during significant dry periods, causing losses in the range of 60% to almost 100% during periods of severe drought.<sup>84</sup> Weevils are expected to become an even more serious problem as climate change is anticipated to prolong the dry season.<sup>85</sup> Weevil-resistant varieties have been developed by CIP in Kenya and Uganda but have not yet been introduced to Nigeria.<sup>86</sup>

Ehisiana et al (2011) conducted field experiments to evaluate the effect of tillage method and harvest time on yields and level of sweet potato weevil damage. The study found that sweet potato weevils infested all sweet potatoes, regardless of the location they were planted, variety, tillage method applied, and time of harvest. Interestingly enough, while root yields were higher when planted with ridges or mounds versus flat ground, weevil infestation was also higher. The dryness of the mounds also significantly affected the level of infestation; more soil cracks gave weevils easier access to roots to feed on.<sup>87</sup> The study also found that sweet potato vines easily carry the weevil from one field to another. Ehisiana et al recommends that vines are treated with insecticides before being planted in areas where significant weevil damage is likely.

Sweet potato virus complex comprises another major challenge to producers.<sup>88</sup> The Sweetpotato Virus Disease Complex (SVDC) has four viruses (mosaic, mottle, feathery mottle, and vein-clearing) that inhibit yields and distort tubers, especially when sweet potato vines are repeatedly re-planted from the same infected source. Other prominent pests include root knot nematodes, which are responsible for sweet potato production losses of 20%-30%.<sup>89</sup> Fawole and Cole (2000) found several types of nematodes on sweet potato tubers in mixed cropping systems with maize and or cassava. Nematodes damage tuber quantity, which in turn affects tuber prices. However, Fawole and Cole did not conclude that nematodes seriously constrained sweet potato production in southwestern Nigeria.<sup>90</sup>

#### *Weed Control is Another Potential Constraint and More Farmers are Integrating Weeding into their Production Regimes*

Weed problems are greatest during the first two months of growth, after which vigorous vine growth causes rapid and effective coverage of the ground surface and smothers the weeds that are present. For this reason, Iyagba (2010) believes that most smallholders do not bother to weed their sweet potato plots.<sup>91</sup> However in a study on adoption of improved production

technologies, Mbasano et al (2012) found that 80% of sweet potato farmers practiced the recommended one major weeding at 4-6 weeks after planting.<sup>92</sup>

Weeds cause sweet potatoes to compete for nutrients, reducing the soil's fertility and overall crop yield, and ultimately impacting quality of the roots and market price for the crop.<sup>93</sup> Weeding, if it practiced at all, is typically done manually by hoe. According to Akobundu (1987) sweet potatoes are a root crop for which chemical weed control appears most promising because the crop only deals with weed problems for a short time.<sup>94</sup>

Koriocha et al (2011) found that effective weed control in sweet potato production in southeastern Nigeria could be achieved through application of atrazine/metolachlor at a rate of 1.5 kg - per Ha. They recommend this method over other weed control treatments that the study experimented with because it also produced the highest total yield.<sup>95</sup> Nitrogen application has also been found to reduce weed growth 12 weeks after planting.<sup>96</sup> Ezeano (2010) found that 26.4% of sweet potato farmers used herbicides for weed control.<sup>97</sup> The study did not explain why only a minority of farmers used herbicides. Nigerian smallholders in several studies conducted across three agroecological zones in the country identified constraints to herbicide adoption were the scarcity, cost, and the uncertainty and difficulty in correctly applying the product.<sup>98</sup>

#### *Sweet Potato Producers Access to Credit Appears Limited*

Studies are mixed as to whether smallholder sweet potato farmers have access to credit to purchase inputs that would support the scale up and profitability of production. A farmer with access to credit may be willing to adopt riskier but potentially more profitable technologies, or to plant a more drought prone but higher value crop.<sup>99</sup>

Adewumi and Adebayo (2008) found that 84.21% of sweet potato finance production themselves from personal savings, 7.24% from friends and family savings, 5.26% cooperative society, 3.29% cooperative/personal savings.<sup>100</sup> Another study found that an average of 26.67% of female sweet potato farmers had access to credit and 35.83% were members of cooperatives/organizations.<sup>101</sup> The same study found that 5.92% of all sweet potato farmers were members of a cooperative and 30.26% farmer's association. Sixty-four percent did not belong to any associations or cooperatives.<sup>102</sup> However, Theophilus (2010) observed about 63.5% of sweet potato farmers had access to credit while 60.3% belonged to a farmer cooperative.<sup>103</sup> One of the biggest advantages of belonging to a farmer cooperative or association is gaining access to credit from a larger resource pool, but becoming a member often requires a small contribution that some farmers are unable to afford.

#### *Environmental Considerations for Sweet Potato Production*

Sweet potato intercropping or mixed cropping systems improves land use. Njoke, Akinpelu, and Nwokocha (2007) found sweet potato production to be a profitable soil conservation strategy in Abia state.

There are concerns that climate change will prolong the dry season, reducing the moisture in the soil, which make sweet potatoes more prone to weevil damage.<sup>104</sup>

#### *Sweet Potato Breeding Efforts Consider a Wide Range of Varieties and Clones for Adaptability and Acceptability*

Sweet potato breeding efforts are underway to match consumer preferences for sweet potatoes. Most consumers prefer less sweet, drier varieties that are easier to pound, similar to the consistency of yams. The IITA, CIP, and NRCRI, and short-term initiatives like Sweetpotato Action for Security and Health in Africa (SASHA) and the Sweetpotato Alliance for a Green Revolution in Africa (AGRA) are working together to develop and test varieties that would ideally meet several or all of the following criteria: high fresh root yield; high beta-carotene content; bland taste; sweet potato virus disease and weevil resistance; high dry matter content; high starch content; and high flour content.<sup>105</sup> Orange-fleshed varieties are of particular interest due to their higher beta-carotene content, which can help fight vitamin A deficiency, when compared with the commonly cultivated white-fleshed varieties.

## Post-Harvest Practices and Challenges for Sweet Potato Farmers

### Sweet Potato Storage Practices are Limited and Unreliable

Long-term storage is not commonly practiced since sweet potatoes can be cultivated year-round and can be harvested piecemeal as needed.

Sweet potato storage is heavily constrained by the crop's short storage life and threats of sprouting, dehydration, sweet potato weevil (beetle) attacks, and black rot damage. When stored at room temperature, sweet potatoes may lose 10-15% of their weight by two weeks after harvest.<sup>106</sup> Fully matured sweet potatoes generally cannot be left unharvested for extended periods of time due to weevil damage, which can result in losses of 12-90%.<sup>107</sup> However, in the arid north, farmers face better storage conditions. Farmers can store sweet potatoes for two to three months in pits lined with dried grass, followed by a layer of sweet potatoes treated with wood ash, followed by another layer of dried grass or leaves, and at least five centimeters of topsoil to protect against weevils. This practice allows northern farmers to store their sweet potatoes in order to maintain a famine reserve or to sell the sweet potatoes later in the sale season when the crop is scarce and the crop is priced higher. In general, in non-arid climates, traditional storage practices only allow sweet potatoes to be stored for up to a month.<sup>108</sup> One study cites plant extracts can be used to reduce storage rot.<sup>109</sup> Otherwise, prompt processing of fresh tubers into dry, storable forms to be reconstituted into other food, feed, or industrial products is encouraged to diminish post-harvest tuber losses.<sup>110</sup>

### Marketing Systems

#### Nigeria's Sweet Potato Value Chain Typically Involves Multiple Actors and Stages

Nigeria's sweet potato value chain involves many participants. Some actors take on multiple roles. The main sweet potato market participants include:

- *Producers*: farmers who produce sweet potatoes
- *Farmgate Middlemen* (also known as *Transporters/Rural Assemblers*): serve as the link between rural producers and urban markets; purchase sweet potatoes from farmers in large, bulk quantities and move sweet potatoes from production sites to markets to sell to semi-urban and urban market wholesalers; sometimes engage in sweet potato storage
- *Wholesalers (Urban and Rural)*: with the help of middlemen, purchase sweet potatoes from farmers in large, bulk quantities to sell to retailers and consumers; sometimes engage in sweet potato storage
- *Urban Retailers*: directly sell sweet potatoes in small quantities to consumers in semi-urban and urban markets; serve as the link between wholesalers and consumers
- *Rural Retailers*: directly sell sweet potatoes in small quantities to rural consumers
- *Urban Consumers*: buy sweet potatoes from urban retailers or wholesalers
- *Rural Consumers*: buy sweet potatoes from rural retailers or wholesalers

The sweet potato marketing system functions through many middlemen working in both rural and urban markets. *Figure 9* shows the various alternate paths that sweet potatoes take from the producer to the final consumer.

Figure 9: Marketing Channels for Sweet Potatoes in Nigeria

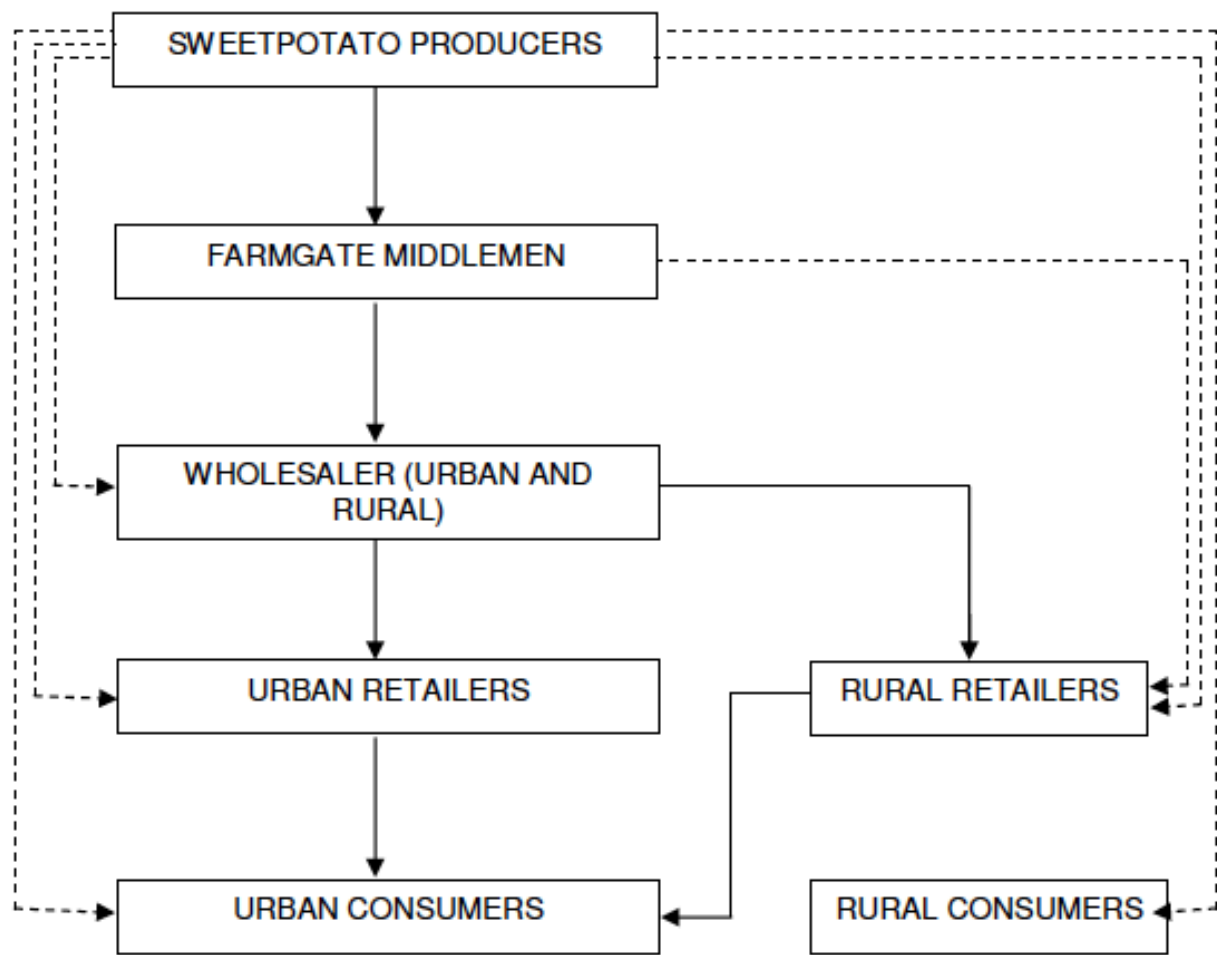


Fig 1: Sweet potato marketing channels in south-east agro-ecological zone.

—————> Major flow  
- - - - -> Minor flow

Source: Field Survey data, 2010

Source: Anyaegbunam and Nto (2011)

Anyaegbunam and Nto (2011) distinguish between single and multi-stage channels and major and minor flows in the Nigeria sweet potato value chain. A single channel consists of sweet potatoes that flow directly from the farmer to the consumer, without any intermediaries. Multi-stage channel marketing systems include middlemen or intermediaries. Major links include rural assemblers, transporters, urban and rural wholesalers, and then the retailers. All of these intermediaries can be bypassed if the farmer chooses to sell directly to a wholesaler or retailer (minor flow). One implication of a multi-stage channel system is that as the sweet potatoes pass through more intermediaries, marketing costs tend to increase. The consumers often assume these costs.<sup>111</sup>

In West Africa, sweet potatoes are usually sold wholesale in rural markets in baskets or sacs that weigh between 20 and 70 kg.<sup>112</sup> Urban traders sometimes contract local farmers to produce tubers. Traders buy the sweet potatoes in bulk and transport them in vehicles weighing less than 10 MT to urban markets. In Osun state in southeastern Nigeria, sweet potatoes are usually transported in trucks, trailers, or pick-up vans and marketed in fresh form.

Farmers or middlemen traders, who buy sweet potatoes from various, dispersed farms during staggered sweet potato harvests, bring the tubers to rural village markets to sell on local market days. Farmers often sell directly to customers, which include urban traders who come from large markets in Ibadan, Lagos, Abeokuta, Ijebu-Ode and Ile-Ife, and commission agents who are generally women.<sup>113</sup> Commission agents broker transactions between farmgate middlemen or rural assemblers and retailers and charge a flat rate per bag of sweet potatoes.<sup>114</sup>

In Nigeria it is difficult to ascertain who is a wholesaler or retailer in the market because some distributors are engaged in both wholesaling and retailing activities at the same time and place.<sup>115</sup> However, categorization of wholesalers and retailers are based on the quantity and more pronounced activity that the wholesaler or retailer performs; wholesalers generally deal with larger quantities of sweet potatoes and are less likely to produce sweet potatoes themselves. Retailers often have no access to long-term storage and sell sweet potato tubers in heaps or containers.

In West Africa, sweet potato tubers are often not sorted and not graded for quality.<sup>116</sup> There is often no way to relate tuber prices to quality. They are displayed for sale on the ground. Sweet potatoes of different sizes, shapes, skin colors and varieties are mixed together. In general, larger-sized tubers are priced higher. Small or disfigured tubers are valued at lower prices and generally comprise 20-33% of tubers for sale.<sup>117</sup> Akoroda (2009) predicts that uniformly sized tubers packaged in bags or cartons will be the future sweet potato marketing form.<sup>118</sup>

Farmgate prices depend on various factors including the time and season, accessibility of the road network to demand centers or markets, local production costs, and labor availability.<sup>119</sup> One study reported rural and urban market prices for sweet potatoes had increased between 1990 and 1994 due to inflation and rising market prices for competing cereals and other root crops.<sup>120</sup>

#### Sweet Potato Markets Encounter Diverse Constraints

Sweet potatoes compete with more popular tuber crops, particularly cassava and yams.<sup>121</sup> Attitudinal surveys conducted in Kwara state in southeastern Nigeria found that 98.9% of sweet potato marketers and processors cited high labor costs and limited government aid as major constraints.<sup>122</sup> Limited access to credit (72.7%), poor storage (71.2%), access to poor market outlets (66%), limited access to improved technologies (63.3%) and high incidence of pest and diseases (60.0%) were other identified major barriers.<sup>123</sup> The crop's short storage life presents another commonly cited challenge. Also, bruising during transport and marketing reduces the quality of the crop for sale and predisposes the product to attack by pathogens.<sup>124</sup>

#### Sweet Potato Processing Present Numerous Opportunities

High-quality and accessible processing technologies and product diversification are cited as potential mechanisms for bolstering Nigeria's sweet potato market.<sup>125</sup> Processing is advantageous because it reduces the risk of post-harvest losses and diminishes the bulky weight of the product that typically increases transportation costs and space.<sup>126</sup> Immediately after being harvested, sweet potatoes can be processed into *spari*, toasted dry granules, which are then ground into a fine flour or prepared as a fried snack when mixed with maize flour and sugar. In this dry form, sweet potatoes can be stored for over a year without its food value deteriorating. They can also make up a food reserve in preparation for lean times.<sup>127</sup>

Fawole (2007) surveyed sweet potato processors in Kwara state in southeastern Nigeria and found that 83.8% used traditional processing techniques. These techniques are labor intensive and time-consuming, with the use of crude tools that often result in intermediate finished processed products. Seventy-two percent processed sweet potatoes into flour, followed by boiled form (17.8%) and chips (10%).<sup>128</sup> Fawole presumes that the large proportion of sweet potatoes processing the food into flour is due to the greater presence of confectionary factories in the study area and the popularity of preparing *amala*, a traditional local dish that calls for sweet potato flour.<sup>129</sup>

Despite the fact that chips is the least popular processed form for sweet potatoes in the study noted above, chips and other sweet potato snacks like potato crisps are growing in popularity, particularly in urban areas, and present income generation opportunities for women.<sup>130</sup>

The potential exists to further diversify sweet potato use. Afuape (2011) cites sweet potato breeding efforts to create varieties that are easier to turn into flour and using orange-fleshed sweet potatoes to make juice.<sup>131</sup> Adeleke and Odedeji (2010) showed that blending sweet potato flour with up to 20% wheat flour produced samples that can be used to make baked goods with improved functional properties, including reduced staling rates and baking time.<sup>132</sup> Ukpabi, Ekeledo, and Ezigbo (2012) explore the potential to use orange-fleshed sweet potato roots in the production of beta-carotene rich chips that Nigerian consumers would appreciate. These chips could potentially serve as a mechanism for addressing vitamin A deficiencies in endemic communities.

Sweetpotato Support Platform for West Africa (SSP-WA) conducted a preliminary sweet potato value chain study in Nigeria (2012) and identified the strengths, weaknesses, and constraints of key players, such as NGO, schools, rural and urban vendors, bakeries and chain restaurants, that are engaging in new sweet potato processed products including: sweet potato crisps, fries (chips), glucose syrup, puree, sweetener, and flour.

According to the same study, fried sweet potato snacks are in high demand by women and school children. Urban residents like sweet potatoes because they are filling and relatively cheaper than yam and potato fries (chips).<sup>133</sup> There is growing interest in serving sweet potato products in fast food restaurants.

Another potential sweet potato use is related to Nigeria's recent instant noodle craze. According to SSP-WA (2012), more than 12 million Nigerians are consuming instant noodles made from wheat and many more are expected to begin consumption. Also in 2007, Nigeria ranked as the 13<sup>th</sup> largest consumer of instant noodles in the world.<sup>134</sup> China uses sweet potato flour to make noodles. Therefore SSP-WA cites noodles as another viable option for exploiting and diversifying the crop's use.

#### Marketing Costs and Margins Show Difficulty in being Highly Profitable through Sweet Potato Marketing

According to Akoroda (2009), profitability from sweet potato production in West Africa fluctuates depending on the level and quality of inputs and the prices of these inputs and tubers that serve as planting materials. Farm gate prices depend on the season, accessibility of roads to greater demand centers such as larger urban markets, local production costs, and the availability and type of labor employed (hired versus family). Akoroda states it has been challenging to accurately assess total production cost plus the cost of capital invested in sole-crop sweet potato production, mainly because so few farmers in West Africa only grow sweet potatoes.<sup>135</sup>

The SSP-WA (2012) value chain study conducted field/market surveys in various states (Kwara, Nasarawa, FCT, Oyo, Lagos, and Osun states) in southeastern Nigeria and found that Farmgate prices represented 55% of retail prices in major markets in and around Lagos and FCT states. Transport and handling costs accounted for 22%. Taxes imposed by the states of origin and transiting states comprised 16% of retail prices. Therefore the urban traders' profit margin was -7% of prices paid by consumers in retail markets. The wholesaler margin was 2.2% and retailer margin was 4.2%.<sup>136</sup>

The same study calculated the cost of production per MT of sweet potatoes to equal \$79.64 USD. Farmgate prices ranged from \$13.12–15.63 USD per 125 kg bag. Price per MT ranged from \$105-125 USD. Gross margins ranged between \$25.26-452.60 USD per MT. The rate of return ranged from -31.7% to 56.7%.<sup>137</sup> Farmers ranked sweet potatoes lower only to yams in terms of profitability. Consumers ranked sweet potatoes lower than yams and cassavas but higher than potatoes and cocoyam in terms of availability and affordability.<sup>138</sup>

Fawole (2007) found that 89% of sweet potato farmers accrued less than 10,000 Naira after every planting season, which is equivalent to \$75.50 USD. The remaining 11% make a profit between 10,000-20,000 Naira, or \$75.50-151.00 USD.<sup>139</sup>

Tewe, Ojeniyi, and Abu (2003) compared production costs and revenue for sweet potatoes, cassava, yam, and maize in southeastern Nigeria and found that sweet potatoes had a higher profit margin than cassava, yam, and maize.<sup>140</sup> Furthermore, Anyaegbunam and Nto (2011) studied net returns, marketing margins and efficiencies between 240 sweet potato retailers and 120 wholesalers across 24 markets in different states in southeastern Nigeria. They concluded that overall the sweet potato marketing system is inefficient, but lucrative.<sup>141</sup> To address such inefficiencies, the authors recommend efforts to diversify sweet potato usage in order to reduce spoilage and improve access to processing and storage facilities for marketers.

### Consumer Preferences Affect Underutilization of Sweet Potatoes

Sweet potatoes are not extensively grown and utilized for food in Nigeria because they are sweet and moist when cooked. Sweet potato varieties that taste similar to yams— blander, less sweet, and more dry-textured when boiled—are generally preferred.<sup>142</sup> Some communities in Kwara state in southeastern Nigeria are struggling to generate income when they produce the sweeter, white-fleshed varieties.<sup>143</sup>

Sweet potatoes are widely accepted as a daytime snack in schools and offices.<sup>144</sup> The crop has had difficulty crossing over to be considered a viable staple food or main dish component.<sup>145</sup> Fried sweet potatoes are becoming more popular in urban areas because they are cheap and very filling.<sup>146</sup>

Traditional taste preferences for sweet potatoes vary from bland to very sweet, and this depends a lot on age. Children prefer sweet foods like sweet potatoes while older Nigerians often prefer blander varieties.<sup>147</sup> The yellow color of some varieties appeals to schoolchildren.<sup>148</sup>

### Women's Role in Sweet Potato Marketing can be Further Expanded

Women play a large role in sweet potato trading and marketing. In Nigeria, women are responsible for processing a majority of the country's root crops, including sweet potatoes.<sup>149</sup>

Akinpelu and Adenegan (2011) describe the socioeconomic characteristics of sweet potato traders in Umuahia market, Abia State in southwestern Nigeria. Seventy-four percent of wholesalers are male while 26% are female. In contrast, 65% of retailers are female while 35% are male.<sup>150</sup> The authors believe that the gender specificity found in these market roles implies that women may be more efficient in sweet potato retailing than men who will generally source sweet potatoes for sale in bulk from the rural areas.

Fried sweet potato snacks are considered a viable option for income generation for rural women in Nigeria.<sup>151</sup>

### **Supply and Demand Projections**

Walker et al (2011) found that the actual growth performance of sweet potatoes until 2004 exceeded IMPACT modelers' projections for Sub-Saharan Africa made in 1990. Revised projects indicate total sweet potato production for Sub-Saharan African will peak at about 19 million MT in 2040 and production of sweet potatoes, yams, and cassava will increase at about 1.75% annually until 2040.

### **Literature Review Methodology**

This review was conducted using Google Scholar, University of Washington Libraries and accompanying search engines, and the websites of the International Potato Center, National Root Crops Research Institute, International Institute for Tropical Agriculture, Nigerian Ministry of Agriculture and Rural Development, IFPRI, and the FAO with combinations of the following search terms: sweet potatoes, yield, production, consumption, exports, prices, intercropping, value chain, market, marketing channel, processing, and Nigeria.

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<sup>1</sup> Hamadu, Okafor, and Ogbojafor 2012, p. 403; Omekwu 2003, p. 444

<sup>2</sup> *This Day*, 9 April 2012, <http://allafrica.com/stories/201204100155.html>

<sup>3</sup> Walker et al 2011, p. 12

<sup>4</sup> Walker et al 2011, p. 12

<sup>5</sup> Walker et al 2011, p. 12

<sup>6</sup> International Trade Centre Trade Competitiveness Map, <http://www.trademap.org>; UN COMTRADE

<sup>7</sup> Akoroda et al 2007, p. 159

<sup>8</sup> Central Bank of Nigeria 2007

<sup>9</sup> Njoku, Mbabu, and Umoh n.d., p. 2

<sup>10</sup> Tewe, Ojeniyi, and Abu 2003, p. 23 (Table 3.3); Oyo State Agricultural Development Programme 1995

<sup>11</sup> Anderson et al 2007, p. 4

<sup>12</sup> Ukpabi, Ekeledo, and Ezigbo 2012, p. 180-182

<sup>13</sup> SSP-WA 2012

<sup>14</sup> Tewe, Ojeniyi, and Abu 2003, p. 51

<sup>15</sup> Amienyo and Ataga 2007, p. 167

<sup>16</sup> Afuape 2011

<sup>17</sup> Tewe, Ojeniyi, and Abut 2003, p. 24

<sup>18</sup> International Potato Center (CIP) Sweetpotato Facts and Figures, <http://cipotato.org/sweetpotato/facts>

<sup>19</sup> Akoroda et al 2009, p. 158

<sup>20</sup> Akoroda 2009, p.27

<sup>21</sup> Onumah 2012, p. 1; Agbo and Ene 1993

<sup>22</sup> Adewumi and Adebayo 2008, p. 107; Ezeano 2010, p. 37

<sup>23</sup> Odebode 2008; SSP-WA 2012

<sup>24</sup> Andrade et al 2009, p. 50

<sup>25</sup> Andrade et al 2009, p. 50

<sup>26</sup> Anyaegbunam and Nto 2011 p. 478; WHO n.d., <http://www.who.int/nutrition/topics/vad/en/>

<sup>27</sup> SSP-WA 2012, p. 7

<sup>28</sup> Rehm and Espig 1991 as cited in CIP World Sweetpotato Atlas-Nigeria n.d., <https://research.cip.cgiar.org/confluence/display/WSA/Nigeria>; Crissman et al 2011, p. 4

<sup>29</sup> Burri 2011, p. 122

<sup>30</sup> USDA National Nutrient Database for Standard Reference 2011

<sup>31</sup> Abubakar et al 2010, p. 414

<sup>32</sup> Fawole 2007, p. 23

<sup>33</sup> Amienyo and Ataga 2007, p. 167

<sup>34</sup> SSP-WA 2012, p. 8; CIP World Sweetpotato Atlas-Nigeria n.d., <https://research.cip.cgiar.org/confluence/display/WSA/Nigeria>

<sup>35</sup> SSP-WA 2012, p. 9

<sup>36</sup> Akoroda and Echendu n.d., p. 12

<sup>37</sup> NRCRI 2007 as cited in Akoroda and Echendu n.d., p. 12

<sup>38</sup> Crissman et al 2001, p. 6-7

<sup>39</sup> Tewe, Ojeniyi, and Abu 2003, p. 36

<sup>40</sup> Rufai and Omonona 2012, p. 50

<sup>41</sup> Ehisianya et al 2011, p. 166

<sup>42</sup> CIP World Sweet Potato Atlas-Nigeria n.d., <https://research.cip.cgiar.org/confluence/display/WSA/Nigeria>

<sup>43</sup> Akoroda 2009, p. 10

<sup>44</sup> Kimber 1970 as cited in Ehisianya et al 2011, p. 178

<sup>45</sup> Iyagba 2010, p. 54

<sup>46</sup> Tewe, Ojeniyi, and Abu 2003, p. 20

<sup>47</sup> Akoroda 2009, p. 18

<sup>48</sup> Mbasano et al 2012, p. 128

<sup>49</sup> Baker n.d., p. 1

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- <sup>50</sup> Akpan 2010, p. 1
- <sup>51</sup> Fawole 2007, p. 24
- <sup>52</sup> Aiyelaagbe and Jolaoso 1992, p. 9
- <sup>53</sup> CIP World Sweet Potato Atlas-Nigeria n.d., <https://research.cip.cgiar.org/confluence/display/WSA/Nigeria>
- <sup>54</sup> Baker n.d., p. 1
- <sup>55</sup> Tomlins and Low n.d., p. 1
- <sup>56</sup> Nwaru, Okoye, and Ndukwu 2003, p. 315
- <sup>57</sup> Baker n.d., p. 1
- <sup>58</sup> Baker n.d., p. 2
- <sup>59</sup> Adewumi and Adebayo 2008, p. 111
- <sup>60</sup> Benue State Agricultural and Rural Development Authority 2007
- <sup>61</sup> Tewe, Ojeniyi, and Abu 2003, p. viii
- <sup>62</sup> Akoroda and Echendu n.d., p. 12
- <sup>63</sup> Fawole 2007, p. 25
- <sup>64</sup> Agbo and Ene 1994
- <sup>65</sup> Fawole 2007, p. 24
- <sup>66</sup> Adewumi and Adebayo 2008; Nwaru, Okoye, and Ndukwu 2011; Fawole 2007
- <sup>67</sup> Ewke and Onunka 2006, p. 95-96
- <sup>68</sup> Mbasano 2012, p. 132
- <sup>69</sup> Mbasano 2012, p. 124
- <sup>70</sup> Adewumi and Adebayo 2008, p. 112; Nwaru, Okoye, and Ndukwu 2011
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- <sup>72</sup> Adewumi and Adebayo 2008, p. 113
- <sup>73</sup> Fawole 2007, p. 24
- <sup>74</sup> Tewe, Ojeniyi, and Abu 2003, p. 17; Akoroda 2009, p. 16
- <sup>75</sup> Okike 2000 as cited in Nwaru, Okoye, and Ndukwu 2011, p. 315
- <sup>76</sup> Agbede and Adekiya 2011, p. 171
- <sup>77</sup> Agbede 2010, p. 31
- <sup>78</sup> Okpara, Okon, and Ekeleme 2009, p. 889
- <sup>79</sup> Ukom, Ojimelukwe, and Alamu 2011, p. 136
- <sup>80</sup> Adewumi and Adebayo 2008, p. 115
- <sup>81</sup> Fawole 2007, p. 25
- <sup>82</sup> Akoroda 2009, p. 15
- <sup>83</sup> Akoroda 2009, p. 16
- <sup>84</sup> Anderson and Low 2007, p. 15
- <sup>85</sup> Anderson and Low 2007, p. 15
- <sup>86</sup> *Standard Reporter*, 7 October 2011, <http://www.standardmedia.co.ke/?articleID=2000044301&pageNo=1>
- <sup>87</sup> Ehisiana et al 2011, p. 179
- <sup>88</sup> Akoroda 2009, p. 15
- <sup>89</sup> Tewe, Ojeniyi, and Abu 2003, p. 35
- <sup>90</sup> Akoroda 2009, p. 17
- <sup>91</sup> Iyagba 2010, p. 24
- <sup>92</sup> Mbasano et al 2012, p. 131
- <sup>93</sup> Koriocha et al 2011, p. 73
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- <sup>95</sup> Koriocha et al 2011, p. 75
- <sup>96</sup> Okpara, Okon, and Ekeleme 2009, p. 888
- <sup>97</sup> Ezeano 2010, p. 39
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- <sup>100</sup> Adewumi and Adebayo 2008, p. 115
- <sup>101</sup> Nwaru, Okoye, and Ndukwu 2011, p. 311
- <sup>102</sup> Nwaru, Okoye, and Ndukwu 2011, p. 311
- <sup>103</sup> Theophilus 2010, p. 166
- <sup>104</sup> Akoroda 2009, p. 15
- <sup>105</sup> Afuape 2011, p. 2
- <sup>106</sup> Akoroda 2009, p. 19
- <sup>107</sup> Tewe, Ojeniyi, and Abu 2003, p. 36
- <sup>108</sup> Etejere and Bhat 1986, p. 34
- <sup>109</sup> Amienyo and Ataga 2010, p. 169

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<sup>111</sup> Anyaegbunam and Nto 2011, p. 481  
<sup>112</sup> Akoroda 2009, p. 19  
<sup>113</sup> Tewe, Ojeniyi, and Abu 2003, p. 22  
<sup>114</sup> Andrade et al 2009, p. 119  
<sup>115</sup> Anyaegbunam and Nto 2011, p. 481  
<sup>116</sup> Akoroda 2009, p. 19  
<sup>117</sup> Akoroda 2009, p. 19  
<sup>118</sup> Akoroda 2009, p. 19  
<sup>119</sup> Akoroda 2009, p. 21  
<sup>120</sup> Tewe, Ojeniyi, and Abu 2008, p. 22  
<sup>121</sup> Andrade et al 2009, p. 110  
<sup>122</sup> Fawole 2007, p. 25  
<sup>123</sup> Fawole 2007, p. 26  
<sup>124</sup> Tewe, Ojeniyi, and Abu 2003, p. 17; Agbo and Ene 1994  
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<sup>126</sup> Andrade et al 2009, p. 109  
<sup>127</sup> Akoroda et al 2007, p. 160-161  
<sup>128</sup> Fawole 2007, p. 24  
<sup>129</sup> Fawole 2007, p. 24  
<sup>130</sup> SASHA n.d. p. 1; Odebode 2008  
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<sup>132</sup> Adeleke and Odedeji 2010, p. 537  
<sup>133</sup> SSP-WA 2012, p. 11, 26, 31  
<sup>134</sup> SSP-WA 2012, p. 6  
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