

Cassava Value Chain in Nigeria: A Review of the Literature to Inform the Integration of Vitamin A Cassava

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Emily McNulty and Adewale Oparinde

ABSTRACT

Cassava is the main staple crop in Nigeria. While it is inexpensive and a good source of carbohydrates, it lacks nutritional value, as it is a poor source of protein, vitamins, and minerals. Nigerians who are restricted to the consumption of a cassava-based diet are at risk of micronutrient malnutrition, which can cause blindness, stunting, and increased susceptibility to disease.

To combat hidden hunger, HarvestPlus and its partners have bred provitamin A-rich yellow cassava varieties. Through literature review, this paper explores the value chain of Nigerian cassava, looks for potential market entry points for provitamin A-rich yellow cassava varieties, and makes suggestions for where demand-pull mechanisms could be featured in the chain. Among other findings, it is established that cassava value chains are characterized by a lack of market information flow; economies of scale in cassava processing are restricted by the unreliable supply of cassava from farmers, seasonal glut, financing difficulties, and inferior infrastructure; and transport is the most costly link in the value chain due to poor road conditions.

The large domestic cassava market, the potential for exporting high-quality cassava products, the increasing urban population growth, and the existence of farmers who supply fresh tubers to high-quality cassava flour processors all represent possible entry points and pull mechanisms for provitamin A-rich yellow cassava varieties if the varieties are accepted and consumed by target populations. This paper suggests methods by which the cassava value chain could be made more hospitable to the new varieties through the implementation of incentive-based programs and public-private partnerships that can promote contract farming.

A special thanks to Ekin Birol, Dorene Asare-Marfo, and Abdoul Murekezi for their guidance and invaluable comments and suggestions.

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1. INTRODUCTION

Cassava (*Manihot esculenta* Crantz), a starchy root crop, is a major source of food security in Africa because of its ability to grow in low-quality soil, its resistance to drought and disease, and its flexible cultivation cycle (Meridian Institute 2013; Sanni et al. 2009). Cassava's harvestable portion, the tubers, can be stored underground until needed, making it an ideal food security crop (Nweke 2003). Cassava is the most widely consumed food staple in Nigeria (Sanni et al. 2009).

Nigeria is the world's leading cassava producer, with about 21 percent share in the global market (FAO 2013). A small fraction of cassava output in the country is produced for commercial use in the livestock feed, ethanol, textile, confectionery, and food industries, while the majority is produced by smallholder farmers for subsistence or small-scale processing (Knipscheer et al. 2007).

The main traditional cassava products in Nigeria are *gari*, *fufu*, and *lafun*. *Gari* is roasted cereal with a slightly fermented taste. It is made from yellow-fleshed varieties or from white roots fortified with red palm oil to make it yellow in color; otherwise, it is creamy white. *Gari* processing in Nigeria is on the rise because it is seen as a convenience food; it is quick and easy to cook and can be stored. In both urban and rural markets, *gari* competes with rice and cereals due to its low price and high convenience. *Fufu*, a fermented paste, is similar to *gari* in its importance in a

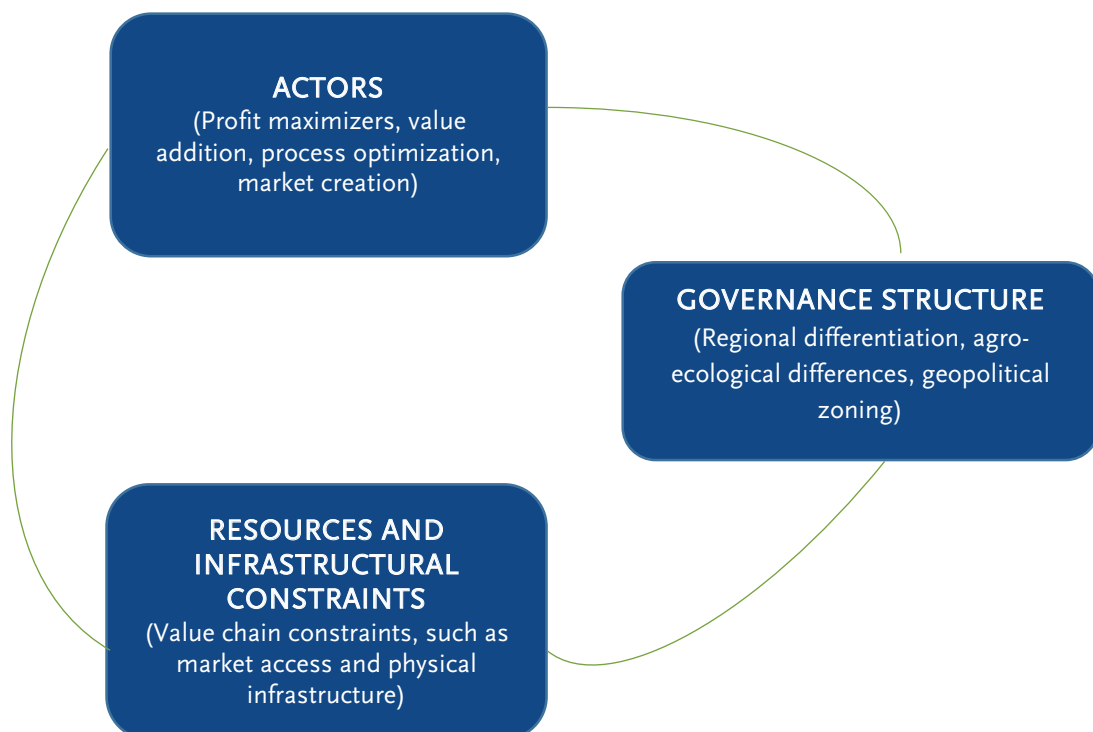
household's diet. Instant *fufu* is gaining popularity because it is easy to prepare, has a long shelf life, and is packaged compactly. *Lafun* is fermented, dried cassava that is turned into flour and then into a stiff paste to be eaten with sauce.

Fresh cassava is also popular; after being boiled, soaked, or sundried to remove cyanogens, it can be boiled or fried similar to Irish potatoes. High-quality cassava flour (HQCF) has recently become a major product in the food sector as it is milled from dried cassava and used as a substitute for wheat flour in bakery goods. Cassava starch is widely used as an industrial raw material in thickening or binding agents, and parts of the cassava plant are used for livestock feed (DoA 2013). Value chains of industrial and animal feed products from cassava will not be investigated, as the focus of this paper is on the value chains of cassava products for human consumption.

Cassava is an inexpensive and dependable source of carbohydrates, but the crop lacks nutritional value and is a poor source of protein, vitamins, and minerals (Phillips et al. 2004). In Nigeria, HarvestPlus and its partners have introduced several varieties of provitamin A-rich yellow cassava, with the vision that cultivation and consumption of the biofortified variety will spread, leading to a decrease in vitamin A deficiency among the target population.

The overall objectives of this research paper are to (1) provide a comprehensive overview of the value chains for cassava planting material, fresh cassava tubers,

Figure 1: Framework for Reviewing the Cassava Value Chain in Nigeria



and cassava products, and (2) suggest entry points and potential pull mechanisms for provitamin A-rich yellow cassava varieties in these value chains.

2. A FRAMEWORK FOR ANALYZING THE NIGERIAN CASSAVA VALUE CHAIN

Several cross-disciplinary perspectives have emerged over time for understanding agricultural value chain analysis in developing countries. From a global perspective, a value chain can be viewed as a vehicle through which technologies, logistics, labor processes, and organizational relations and networks interact to create commodity values for markets (Trienekens 2011). From the utilization of available resources and infrastructure, value-added products and services created along the chain are traded within the sphere of the institutional environment, which defines associated possibilities and constraints. Therefore, a value chain can be segmented into actors, social networks or interactions among actors, flows of products and services or the supply chain, and institutions.

Most of the studies reviewed for assessing the cassava value chain in Nigeria have focused on the supply chain perspective (e.g., Collinson et al. 2000; Sanni 2005). For the purpose of addressing the objectives of this paper, three key components are considered as applicable to the understanding of the Nigerian cassava value chain in the consumption market. These components are shown in the framework presented in Figure 1. This framework serves as a guide in reviewing the literature and synthesizing the findings on the Nigerian cassava value chain. The first component is the supply chain structure, which involves the interactions between smallholders (who are the major producers of cassava in the country), transporters, middlemen, processors, traders, and consumers. The second component involves the resources and

infrastructural constraints, such as access to market information, roads, etc. These two components are influenced by the nature of the governance structure, which in turn explains the nature of the value chain (see Figure 1).

3. CASSAVA VALUE CHAINS BY REGION

Cassava is mainly grown in the North-Central, South-South, and South-East regions of Nigeria. Table 1 shows cassava production by geopolitical zone.

Consumption of cassava is high in both urban and rural areas, but the products consumed differ. Table 2 shows consumption among urban and rural Nigerians. Urban consumers' access to fresh cassava is limited by the crop's rapid loss of quality after harvest. Therefore, urban consumers prefer convenient, easy-to-prepare, long shelf-life products, like *gari*, *fufu*, and *lafun* (Nweke 2004). Rural consumers are able to supplement these products with fresh cassava.

Four out of five rural Nigerians eat a cassava-based meal at least once a week (Ezedinma et al. 2007), 226 kilocalories of cassava are consumed per person per day (FAO 2012), and yearly per capita consumption of cassava is about 102 kilograms (kg) (FAO 2012). Table 3 shows cassava consumption broken down by state, with cassava being most frequently consumed in states within the southern geopolitical zones (Osun, Akwa-Ibom, Bayelsa, and Imo). Given Nigeria's annual population growth rate of 2.5 percent in 2011, and annual urban population growth rate of 3.97 percent in 2010 (World Bank 2013), the human food market holds the biggest potential for the cassava sector (Phillips et al. 2004).

Table 1: Raw Cassava Tuber Output by Zone, 2000-2002 (tons)

<i>Region</i>	2000	2001	2002
South-West	4,993.380	5,663.614	5,883.805
South-South	6,268.114	6,533.944	6,321.674
South-East	5,384.130	5,542.412	5,846.310
North-West	2,435.211	2,395.543	2,340.000
North-Central	7,116.920	7,243.970	7,405.640
North-East	165.344	141.533	140.620
Total	26,363.099	27,521.016	27,938.049

Source: PCU 2004 (copied directly from source).

Table 2: Daily Consumption of Cassava (in raw form equivalent) per Capita

	<i>Grams per person per day</i>
National	226.93
Dry savannah zone	131.16
Moist savannah zone	192.37
Humid forest zone	284.42
Rural	239.74
Semi-urban	220.53
Urban	213.76

Source: Ministry of Health and Nutrition of Nigeria 2004 (copied directly from source).

Table 3: Frequency of Cassava Consumption by State

State	<i>Percent of respondents that consumed cassava in a week</i>		
	1–2 times	3–4 times	>4 times
Osun	29	36	33
Akwa Ibom	29	36	33
Bayelsa	21	15	51
Edo	21	25	53
Imo	24	21	43
Kaduna	77	18	4
Kano	57	37	4
Kebbi	84	15	0
Kwara	27	38	35
Nassarawa	57	28	13
Borno	65	28	4
Taraba	37	25	33

Source: Phillips et al. 2004 (copied directly from source).

3.1 Stems

The value chain for cassava stems, the planting material from which cassava is grown, is not well established. Stem cuttings are bulky and rot quickly, drying up just a few days after harvest (Nweke 2004). Since farmers do not specialize in producing cassava planting materials for sale, stems are largely sourced from farmers' own cassava plots or from neighbors and family. Reliable access to high-quality cassava stems is uncommon, and there are few, if any, stem quality control mechanisms.

3.2 Fresh Cassava

As fresh cassava roots deteriorate rapidly in quality, becoming inedible five days after harvest, their value

chain (Figure 2) is characterized by speed and efficiency. At the local level, farmers may sell directly to consumers, but for greater distances, traveling traders are involved. Traders negotiate prices directly with the farmers, or they may contact local agents to locate an adequate amount of cassava tubers before arriving in the area. These local agents serve only to find the product; they do not purchase or sell the cassava, as indicated by the dashed lines in Figure 2.

Traditionally, an entire plot's worth of cassava is purchased before the crop is uprooted, leaving the traders at risk of overpaying for a lower yield than expected. While transporting the truckload from farm to market, traders are susceptible to local levies, and often need to pay bribes at police road blocks. Once at market, the traders

generally pass the responsibility of sale onto market-savvy commission agents. These agents either sell in the market in which the truckload arrived, or transport the product to smaller selling venues (Collinson et al. 2000, 2003).

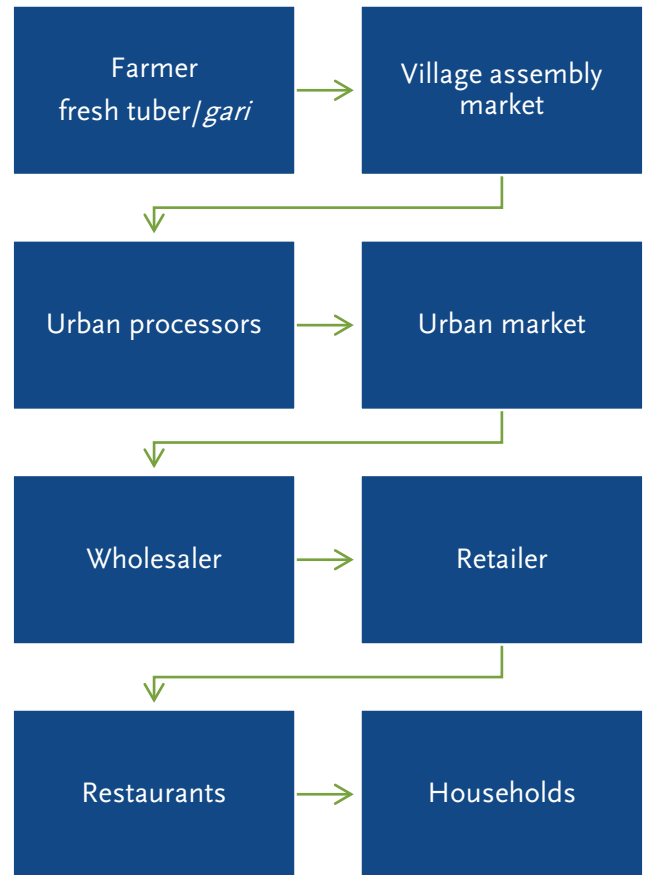
Figure 2: Fresh Cassava Value Chain



Source: Collinson et al. (2003) (copied directly from source).

who are mostly women, and who bring the *gari* to urban markets. At the market, *gari* retailers purchase the product and sell it to the end consumer. *Fufu* and *lafun* have value chains very similar to that of *gari*, except that they require additional processing, which is usually done at the village or processing center level (Collinson et al. 2000; Kambewa and Nyembe 2008).

Figure 3: Gari Value Chain for Benin City and Enugu New Market



Source: Mitchell, Keane, and Coles 2009 (copied directly from source).

3.3 Gari, Fufu, and Lafun

Although preferences for different cassava products vary across Nigerian states and even from village to village, *gari* is overall the most popular cassava product. *Gari*, *fufu*, and *lafun* are especially valued by urban Nigerians for their convenience and ease of storage.

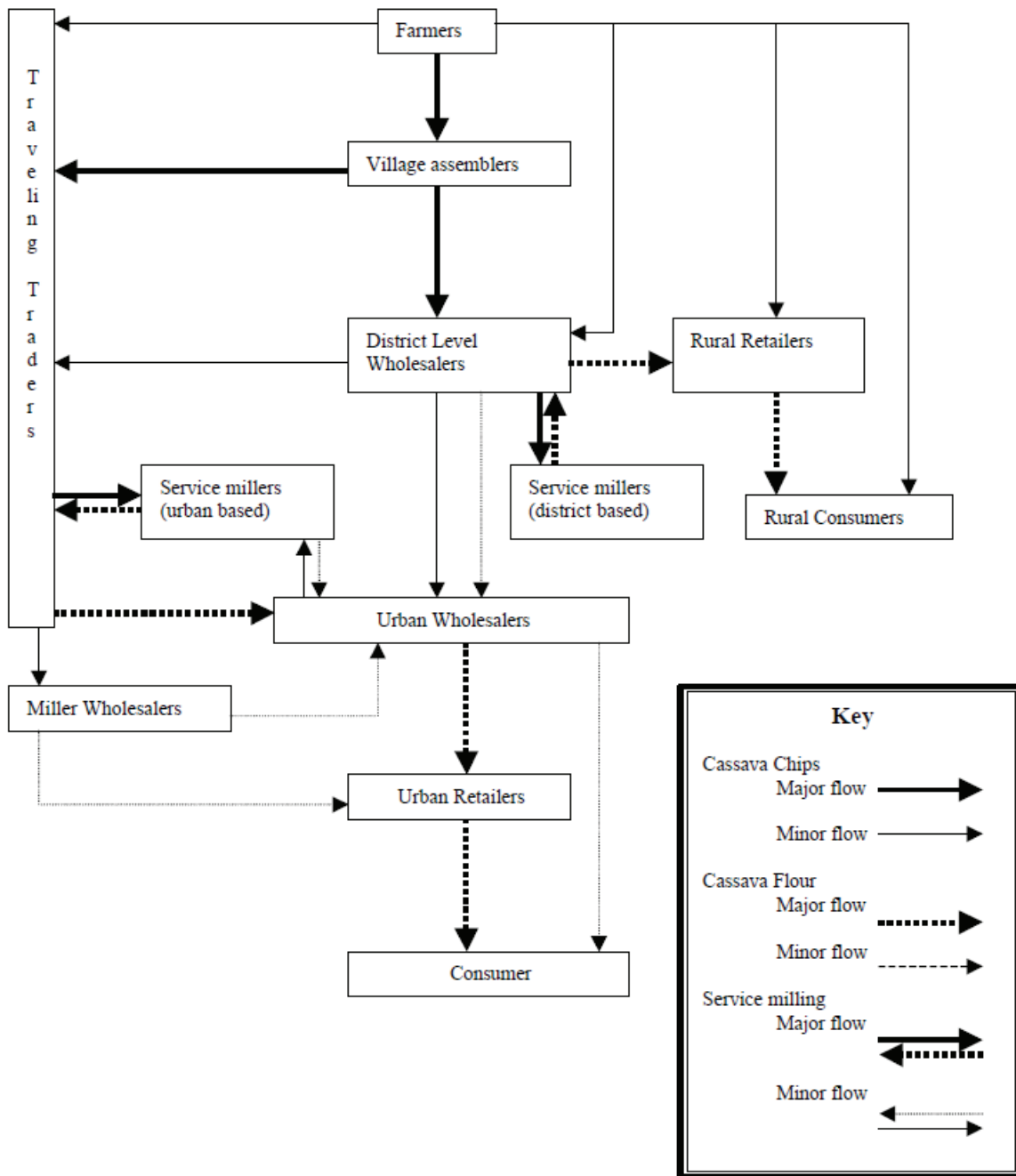
Figure 3 shows the value chain for *gari* in Benin City and Enugu New Market in Edo State in southern Nigeria, which is similar to *gari* value chains across the country. After being processed in village homes or processing centers, the *gari* is loaded into 25-kg sacks and transported to the local market. Cassava farmers sell 10–40 sacks per week on average, adjusting their production level according to demand. Ninety percent of this *gari* is bought by traders,

3.4 High-Quality Cassava Flour

HQCF is used as a substitute for wheat flour in bakery and pasta products. Only a 10 percent substitution can be made without consumers noticing a difference in taste or other qualities, while substituting more than 50 percent of HQCF for wheat flour will result in brittleness in the products (Phillips et al. 1999). However, the higher the quality of the cassava flour, the more substitutable it becomes. (Gensi et al. 2001; Ferris et al. 2002).

In Nigeria, there are two large-scale HQCF processors capable of processing more than 50 tons per day. One medium-scale HQCF processor exists within the country that has a processing capacity of five tons per day. Additionally, 103 small-scale HQCF processors operate in Nigeria with processing capacities of one to two tons per day (Cassava Action Plan 2012). As shown in Figure 4, the HQCF value chain is particularly different from the *gari* value chain (Figure 3), notably due to the inclusion of service millers and miller wholesalers that indirectly supply to urban markets.

Figure 4: High-Quality Cassava Flour Value Chain



Source: Collinson et al. 2000 (copied directly from source).

4. MAIN ACTORS

Sanni (2005) provides a thorough overview of the actors involved in the *gari* markets of Benin City and Enugu New Market in southern Nigeria. These actors are the same in the fresh cassava, *fufu*, *lafun*, and HQCF value chains, except that the processors engage in different activities to make the different products. A description of the actors in the value chain is given in Table 4. The first node of the value chain, the farmers, is not shown; the table begins with the traveling traders, or wholesalers, who purchase the cassava directly from farmers or processors.

Nigerian cassava growers, who are the first actors in the value chain, are mostly small-scale farmers with fewer than two hectares of land; they hold about 90 percent of the country's land and produce more than 90 percent of the agricultural commodities (DoA 2013). Farmers have the poorest access to information in the value chain, while traveling traders are the best informed, resulting in exchanges characterized by distrust (Collinson et al. 2000). However, this transaction cost is minimized when buyers and farmers have a long-standing business relationship (Collinson et al. 2000). Cell-phone information systems or daily radio broadcasts may be good options for improving

Table 4: Key Actors in the *Gari* Markets of Benin City and Enugu New Market

Key actor	Local term	Role	Gender	Ethnic group	Relative wealth/poverty
Wholesalers	Nrekota n'ukwu	Buy large quantities, usually for several processors	Men, women, youth, widows	Igbos, Binis, Itshekiri, Urhobo, Yoruba, Hausa, Ijaws	Relatively poor, very low ability to absorb disasters
Porters/loaders	Ndi oburu, barrow	Pack, load, and unload goods	Men, youth. Women are involved in packaging	Igbos, Binis, Itshekiri, Urhobo	Poor
Drivers	Okwo ugbo	Transport <i>gari</i> from assembly markets to urban markets	Mainly men for motorized transport	Igbos, Binis, Itshekiri, Urhobo	Poor for nonmotorized, increasing wealth with level of motorized transport
Processors		Convert roots to <i>gari</i>	Men, women, youth at different stages of processing	Igbos, Binis, Itshekiri, Urhobo	Relatively poor
Retailers	Ewmekew en	Buy small quantities, sometimes in a deferred payment arrangement with a wholesaler or processor	Men, women, youth	Igbos, Binis, Itshekiri, Urhobo	Relatively poor
Restaurant/bukateria owners	Ulonri	Buy and cook <i>gari</i> for sale to customers	Men and women	All tribes	Poor–rich
Families		Buy <i>gari</i> for home consumption	Men, women, youth	All tribes	Poor–rich
Stall owners	Ahia	Provide space for sellers to keep wares temporarily or long term	Mainly men for motorized transport	Igbos and Binis	Rich
Trader associations	Out	Negotiate and dictate prices	Men and women	All tribes	Poor–rich
Market administrators		Collect tolls and taxes, set regulations	Men and women	Igbos and Binis	Rich
Local government	Ochichi obodo	Build markets, road, tolls, taxes and utilities	Men	Igbos and Binis	Rich
Unions		Dictate transport fares and taxes on goods to be transported	Men	Igbos and Binis	Poor
Security outfit		Maintain security at markets	Men	Igbos and Binis	Poor

Source: Sanni 2005 (copied directly from source).

market communications along the value chain by enabling farmers to assert their bargaining power.

Duties are divided in the cassava value chain along gender lines. These lines vary slightly between ethnic groups, but women are generally responsible for weeding, planting, and harvesting. One consequence of this gender-differentiated participation in the cassava value chain is that women seeking to improve their economic standing through cassava production may have limited opportunities to do so because of gender discrimination. Likewise, women could be left behind in innovation capture, as cassava production is becoming increasingly mechanized and commercialized. This issue is compounded by women having great difficulty securing capital for investments (Meridian Institute 2013). HarvestPlus and its partners should consider this a priority when implementing strategies to disseminate and integrate vitamin A-enriched yellow cassava in the Nigerian cassava value chain. Improved involvement of women across all facets of the value chain could enhance the process of equitably improving the livelihoods of cassava-producing men and women.

The scale of cassava processing in Nigeria is limited by the inconsistent supply of raw tubers. Eighty percent of the country's cassava is grown by smallholders who sell only their small surpluses (Oyebanji, Oboh, and Omueti 2010). Medium- and large-scale processors can only operate seasonally, and struggle to be efficient because of the low supply (Knipscheer et al. 2007).

5. TRANSPORT & STORAGE

The cassava sector would benefit greatly from improved roads and less costly transportation. Farmers get their produce to market by trucks driving on heavily used and poorly maintained roads. Therefore, a large portion of the consumer price paid for cassava is due to high transportation costs caused by frequent accidents, road closures, and numerous security checkpoints (Phillips et al. 2004).

5.1 Distance between Nodes

Due to the rapid deterioration in the quality of cassava root, there can be no storage period before processing (Collinson et al. 2000, 2003). One implication of this for HarvestPlus and its partners in their effort to promote provitamin A-rich yellow cassava is that the amount of time the root spends unprocessed could affect the provitamin A levels in the biofortified varieties.

The distance from farm to processor is usually minimal because local processors are mostly used, but the distance between processor and market can be significantly greater.

In light of this, traders and transporters may represent an entry opportunity for HarvestPlus in the cassava value chain. These actors travel great distances and rush to get their product sold before it rots. As a strategy to integrate provitamin A cassava in the value chain, HarvestPlus may need to work closely with these actors. One of several ways is to enhance their access to market by creating a critical mass of supply and demand for yellow cassava by locality. Farmers, traders, and transporters can be organized into groups of yellow cassava growers and traders. Farmers can be encouraged to grow yellow cassava at the same time of the year where a critical mass of supply can occur and traders can maximize this opportunity, taking advantage of already existing federal-assisted mobile processors. This may reduce traders' perception of market participation risk. As value chain actors, traders can safeguard against the risk of middle men capitalizing on the advantage of processing urgency through joint investment and specific organizational arrangements promoted by HarvestPlus and its partners.

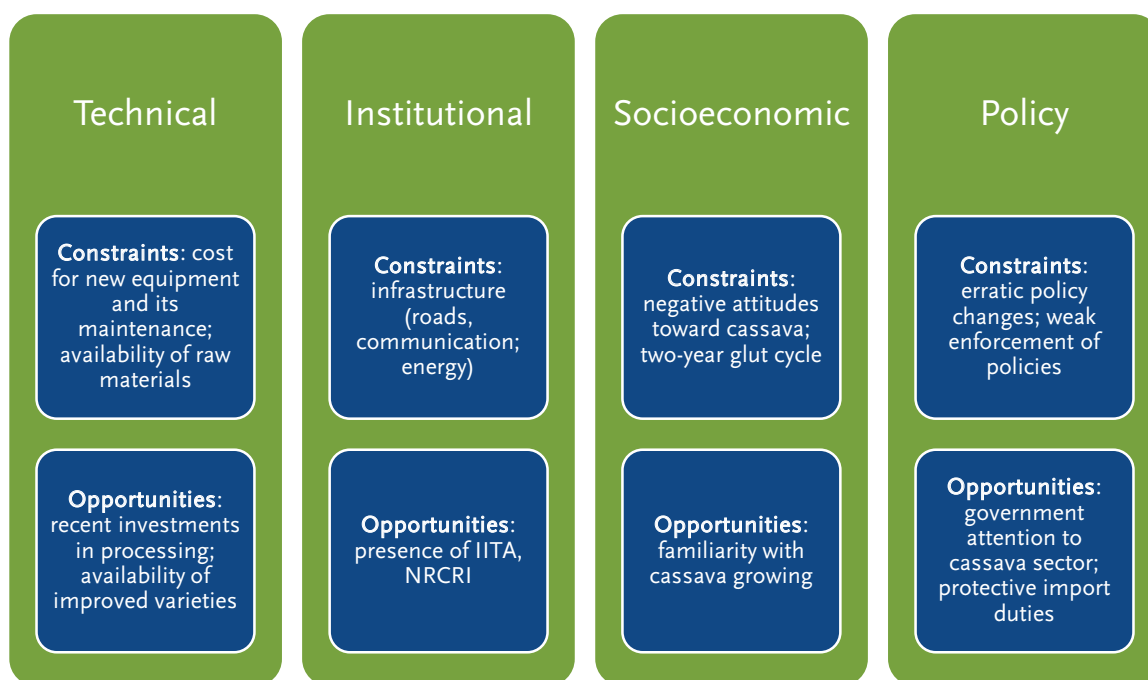
5.2 How Goods are Stored

Fresh cassava is inconvenient to store and transport due to its bulkiness and lack of uniformity. No time can be wasted between harvest and final sale, because the tuber quality deteriorates rapidly. For the export market, tubers are coated with wax immediately after harvest to deter the release of the embittering compounds and preserve the quality of the product (Collinson et al. 2000, 2003). Similarly, a value-adding opportunity may exist for yellow cassava growers to preserve raw tubers which would allow traders to travel longer distances, to areas which HarvestPlus and its partners could research. Innovation capture is crucial, since there could be existing local knowledge among small-scale traders who supply the large- and medium-scale HQCF processors. For example, one HQCF processor (Thai Farm) located in Ogun State receives a majority of its raw tuber supply through traders and transporters from Edo State (247.6 kilometers from Lagos—the nearest city to the farm). Thus, HarvestPlus and its partners may need to integrate raw tuber preservation technology to incentivize yellow cassava growers and traders.

6. CONSTRAINTS & FACILITATING FACTORS

The Nigerian cassava value chain is affected by numerous constraining and facilitating factors. A survey taken during the International Workshop on Cassava Competitiveness in Nigeria (RUSEP 2002) revealed technical, institutional, socioeconomic, and policy factors that affect the cassava sector (Figure 5).

Figure 5: Constraints and Opportunities in the Nigerian Cassava Sector



Source: RUSEP 2002

Note: IITA = International Institute of Tropical Agriculture; NRCRI = National Root Crops Research Institute.

6.1 Constraints

Many constraints exist in each step of the cassava value chain (Meridian Institute 2013; DoA 2013; Sanni et al. 2009; Collinson et al. 2000; UNIDO 2006; Cassava Action Plan 2012; Phillips et al. 2004), which are summarized below.

Production constraints

- As cassava is considered a food security crop, it is generally planted in poor soils without fertilizer. A shift in attitudes toward cassava and easy access to fertilizer could increase yields.
- Despite improved and resistant varieties, pests and diseases are still a challenge for many smallholders. Seventeen cultivars have been recently released, but only five have been made available to farmers, and two varieties—TMS 30572 and 4(2)1425—dominate the region.
- Extension services tend to be inefficient and ineffective.

Fresh cassava value chain constraints

- The perishability of fresh cassava makes even minor delays in transport very costly; infrastructure is inadequate and post-harvest technology needs to improve.

Dry cassava value chain constraints

- Processing is almost exclusively small scale; it is limited by irregular tuber supply and seasonal glut.
- The bulk and rapid deterioration of cassava tubers force processors to locate themselves near rural villages.
- The practice of sun drying cassava for chips and flour is inefficient and limits production scale.
- Processing is labor intensive, thus creating a demand for small-scale mechanization.

General market constraints

- Value chain actors do not coordinate well, and there is a lack of trust among them.
- There is a lack of market information flow.
- Competition is so high that profits are squeezed out. Most sellers operate at the margin, and there is room to improve cost efficiency.
- Poorly coordinated and inconsistent government policies regarding import substitution and support of the cassava industry have tampered with cassava prices and driven investors away. The government

policy of 10 percent HQCF substitution in bread has been poorly enforced and has resulted in a collapsed demand for HQCF. The government policy has since been revised to 5 percent substitution, but enforcement is still an issue.

- High-quality cassava has the potential to earn a premium, but there is no grading system in place.
- Loans for inputs or technological advancement are difficult to obtain and have stiflingly high interest rates.
- Innovation in the marketing chain is uncommon, as entrepreneurial spirits are quickly crushed by scarcity of capital, high transport costs, and lack of market information flow.
- Investors in the sector are discouraged by high operation costs due to poor infrastructure, inadequate energy supply, difficult bureaucracy, and subpar telecommunications. This investment premium is estimated to be 25 percent above the total standard cost of production.

6.2 Facilitating Factors

The cassava value chain is facilitated by only a few factors (Phillips et al. 2004; Collinson et al. 2000), which are summarized below.

Production

- Nigeria offers investors a large low-cost labor pool and vast natural resources.

Marketing

- A quality price premium is paid for the freshest cassava tubers.
- The lack of seasonality in cassava cultivation means that after the tubers reach a marketable size, they can be harvested and sold at any time of the year.
- As Africa’s most populous nation with about 170 million people, most of whom eat cassava regularly, Nigeria has a very large domestic market.

7. PRICING & VALUE ADDITION

The Food and Agriculture Organization of the United Nations publishes producer price information for raw cassava tubers, as shown in Table 5. Figure 6 also compares the monthly prices of cassava root, *gari*, and maize. As shown in the SWOT analysis reported in Appendix I, the low prices of cassava substitutes (other tubers, rice, grains, and beans) represent an important threat to cassava production in Nigeria. This is corroborated by Figure 6, which shows that over the years, the price of *gari* has been consistently greater than that of maize.

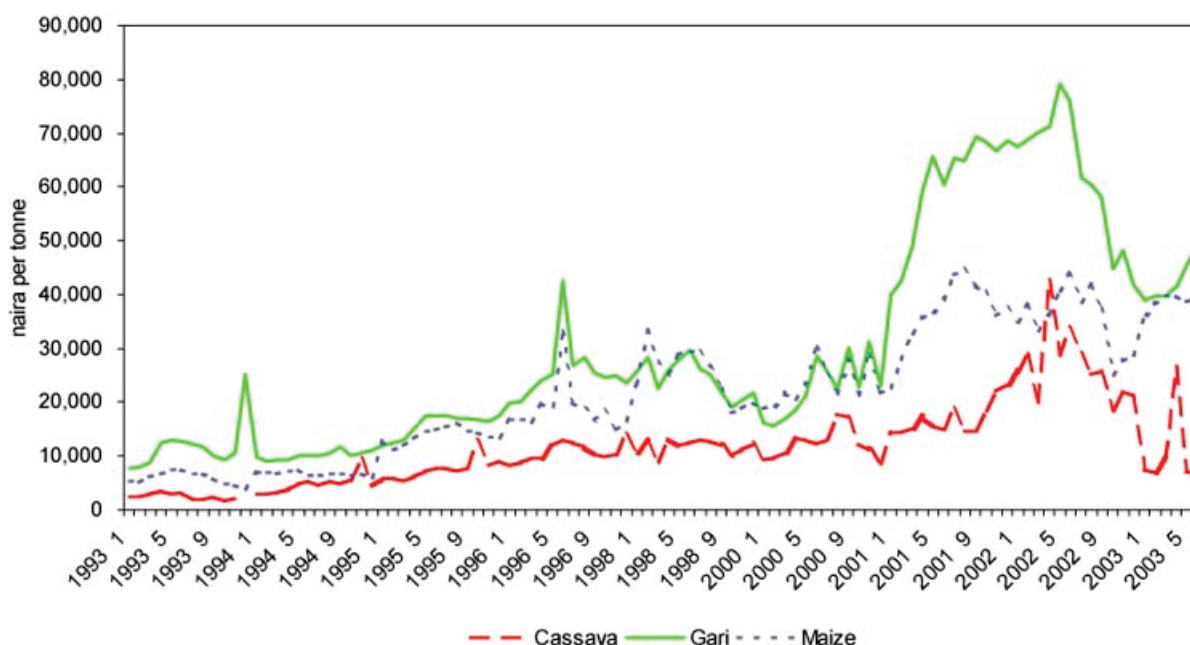
While such price information could help inform market entry strategy for yellow cassava, unfortunately, current detailed pricing information for Nigeria could not be found in the literature. Ebewore, Ukwuaba, and Egbodion (2013) report the mean prices of a 50-kg bag of *gari* in six Delta State markets, as shown in Table 6.

Table 5: Raw Cassava Tuber Producer Prices, 2003-2008

<i>Producer Prices</i>	2003	2004	2005	2006	2007	2008
Producer price (Naira/metric ton)	22,010	19,340	21,920	24,090	21,960	33,646
Producer price (US\$/metric ton)	170.30	145.50	167	188.80	174.70	283.80

Source: FAO 2013

Figure 6: Monthly Cassava, *Gari*, and Maize Prices, 1993-2003



Source: Phillips et al. 2004 (copied directly from source).

Table 6: Mean Prices of *Gari* in Six Delta State Markets

Market	N	Mean price (in Naira)	Standard deviation	Min.	Max.
Abavo	30	3,650	126,93	3,500	3,800
Ogbe-ogonogo	30	3,560	241,29	3,000	3,800
Oghara	30	3,630	94,86	3,500	3,800
Ughelli	30	3,360	291,35	2,800	3,700
Efurun	30	3,360	225,09	3,000	3,500
Oleh	30	2,920	311,98	2,500	3,400
Total	180	3,400	337,48	2,500	3,800

Source: Ebewore, Ukwuaba, and Egbodion 2013 (copied directly from source).

Producers, consumers, and other value chain stakeholders lack means of transmitting market information, so production activities are not coordinated with consumer demand (Awoyinka 2009). This, compounded by the fact that post-harvest storage of cassava is very difficult, causes surpluses in the market and high fluctuation of cassava prices between seasons (DoA 2013). Meanwhile, information on the cost of producing various value-added cassava products is scanty in the literature. Those available are outdated and do not reflect the current cassava sector, thus they are not reported here.

8. PRODUCT DIFFERENTIATION

Preferences for different cassava traits tend to vary along the value chain. Cassava that is disease and pest resistant, as well as drought tolerant, is attractive to farmers, but cassava with these traits is bitter and unappealing to consumers who, depending on the region, may prefer the taste of sweet, yet less resilient, varieties (Collinson et al. 2000). Cassava with thick skin is easier for traders to transport without causing damage to the tubers, but it is more difficult for processors and consumers to peel than the thin-skinned varieties.

For fresh cassava, most consumers in the northern regions prefer medium-sized, thinner-skinned, sweet varieties (Collinson et al. 2000), while those in the southern regions prefer the bitter varieties. *Gari* is divided into quality grades by color: in the South-South and South-East regions, yellow is the highest, creamy white is in the middle, and very white is the lowest. Yellow *gari* is made by adding some palm oil for color during roasting and demands a price premium in most regions. For instance, in Benin City, yellow *gari* costs twice that of white *gari*, and slightly more than creamy white *gari*. Traders in this market sell about 80 percent yellow *gari*, 15 percent creamy white *gari*, and 5 percent very white *gari* (Sanni 2005). In the rural South-West region, however, white *gari* is considered to be of the highest quality, and yellow is the lowest. Nigerians in Oyo State generally consume *gari* directly after soaking it in cold water; cassava with palm oil additives are not popular because of the oily film this creates in the water.

For cassava flour to be of high quality, it must be thoroughly dried. During the dry season, dry cassava production is relatively easy, so the flour is inexpensive and of good quality. However, in the wet season, when it is more difficult to dry the tubers, and because there is little inter-seasonal storage, the price of HQCF goes up.

Table 7 shows several improved cassava varieties available for cultivation in Nigeria and their characteristics. While all have been released to the public, TMS 30572, NR 8082, and TMS 4(2)1425 have become most prevalent (DoA 2013). The success of these three varieties is due to distribution by the government and other groups, while the remaining varieties have not yet been multiplied and distributed on a large scale. Farmers not only suffer from a lack of access to planting materials, but also from an inability to properly store planting materials once they are obtained (DoA 2013). Therefore, training in agronomic methods to store stems may be beneficial to farmers in this regard.

Table 7: Attributes of 17 Cassava Varieties Released for Cultivation in Nigeria

<i>Cassava variety</i>	<i>Branching habit</i>	<i>Canopy development</i>	<i>Ecological adaptation</i>	<i>Pest and disease tolerance</i>	<i>Fresh root yield (tons/ha)</i>	<i>Dry matter yield (80C24h)</i>	<i>Gari yield (%)</i>	<i>Starch yield (%)</i>	<i>HCN in products (mg/100g)</i>
TMS 90257	profuse	moderate	wide	high	43	25	23	23	15,5
TMS 84537	moderate	sparse	wide	high	35	28	18	27	6,3
TMS 82/00058	profuse	moderate	wide	high	35	28	21	26	6,4
TMS 82/00661	profuse	moderate	wide	high	39	30		26	4,1
NR 8212	profuse	moderate	wide	high	27	37	25	21	high
NR 8082	profuse	profuse	wide	high	32	32	22	19	high
TMS 50395	moderate	moderate	wide	moderate	36	29	24	12	high
TMS 30001	moderate	moderate	wide	moderate	16	28	23	22	low
NR 8208	profuse	moderate	wide	moderate	26	32	25	23	high
NR 8083	profuse	moderate	wide	high	31	43	36	25	high
NR 83107	profuse	moderate	wide	high	22	31	22	19	high
TMS 8 1/00110	profuse	moderate	wide	high	28	31	24	25	4,5
TMS 91934	moderate	sparse	wide	moderate	32	34	26	21	high
TMS 30572	profuse	profuse	wide	moderate	27	34	25	24	750
TMS 4(2)1425	moderate	profuse	savanna	moderate	26	36	25	22	31
TMS 30555	moderate	profuse	wide	moderate	17	32	24	20	high
NR 41044	moderate	profuse	forest	moderate	37	34	25	23	high

Source: DoA 2013 (copied directly from source).

Note: The HCN (hydrocyanic acid) content of the products was determined quantitatively by the enzymic method. Where this was not available, it was determined by the picrate leaf method and, therefore, reported as either high or low.

9. CERTIFICATION

The quality certification system for cassava in Nigeria is weak and poorly enforced. There are Cassava Trade Shows and National Cassava Fair award prizes for quality, but there are no quality labeling systems recognizable by consumers. At Enugu New Market, *gari* processors, retailers, and wholesalers gather monthly for their association's meeting. The members share market and transport information, provide informal credit, and manage the *gari* marketing system by regulating pricing, quality, and quantity (Sanni 2005).

10. POINTS OF ENTRY INTO VALUE CHAINS

Introducing and increasing production of biofortified cassava will depend not just on push factors like government support and encouragement of farmers, but also on pull factors like consumer demand, industrial demand, positive attitudes, and favorable markets (Phillips et al. 2004). The aforementioned large domestic cassava market, a potential for exporting high-quality cassava products, a growing urban population, the potential for cassava processors to realize their full production capacity, and the existence of farmers who supply fresh tubers to HQCF processors all represent potential entry points and pull mechanisms for provitamin A-rich yellow cassava varieties. HarvestPlus and its partners could explore these potential pull mechanisms if the biofortified varieties are accepted and consumed by the target population. To aid in acceptance, public relations tools need to be implemented to increase consumer demand and inspire positive attitudes surrounding new products made from yellow cassava varieties.

For provitamin A-rich yellow cassava varieties to successfully enter Nigeria's cassava value chain, the value chain must be strengthened and made more accessible to new actors. One way this can be achieved is through PPPs that promote contract farming since findings from this review suggest an uncertain business environment. An agent theory, such as the use of contract farming, suggests the minimization of transaction costs, the transfer of risk to the supplying agent, and measure the behavior of the agent may be appropriate where institutional enforcement regimes are weak (Ruben, van Boekel, and van Tilburg 2007).

Contract farming has the potential to overcome the cassava value chain challenges of market information flow, product transport, finance, agricultural inputs, extension services, returns to scale, and quality grading. A reliable supply of cassava tubers and large-scale processing facilities need to be developed concurrently, and PPPs

that promote contract farming may be the best solution (Phillips et al. 2004; Knipscheer et al. 2007; Ezedinma et al. 2007; Chitundu, Droppelmann, and Haggblade 2009; Zhang and Whitney 2012).

HarvestPlus and its partners are working to diffuse biofortified maize into the Zambian market by giving incentives to millers who process the provitamin A-rich orange maize varieties. Inserting such a pull mechanism into Nigeria's cassava market could be an effective way of creating demand for the provitamin A-rich yellow cassava varieties, but only once sustainable medium- and large-scale processing businesses are established. Providing incentives to the hundreds of small-scale processors would be unmanageable and not worth the administrative costs. Currently, the majority of Nigerian cassava is processed at the farm or village level, and very little is processed at large facilities because tuber supply is erratic and seasonal. However, contract farming would provide processors with a reliable supply of cassava, allowing them to exploit economies of scale and take part in an incentive program.

Contract farming could also improve market information flow to farmers by encouraging them to form farmers' associations. Generally, successful contract farming schemes do not deal with farmers on an individual basis, but rather with clusters of farmers in associations. These farmers' groups keep themselves well informed of market conditions and assert their bargaining power.

Agricultural inputs, extension services, and quality grading could all be worked into a contract farming PPP to increase yields and profits for farmers and expand the adoption of provitamin A-rich yellow cassava varieties. Chemical fertilizers are necessary for provitamin A-rich yellow cassava varieties to realize their full yield and nutrient potential, but fertilizer use among Nigerian cassava farmers is very low (Ezedinma et al. 2007). Therefore, a method for improving farmers' access to fertilizer is a desirable strategy to enhance the uptake of provitamin A-rich yellow cassava varieties.

The type of vertical integration that contract farming provides may be able to solve the cassava transport issue, especially if backed by the public sector. A PPP could fund the type of outgrower scheme similar to that of the Dutch Agricultural Development and Trading Company, using Automated Mobile Processing Units to collect cassava from farmers and process it immediately to avoid post-harvest losses. Furthermore, large processors would have regular amounts of product to send out in registered trucks potentially resulting in economies of scale.

HarvestPlus and its partners have already begun some contract farming with seed and stem multipliers in all

its target countries. In Nigeria, the four states targeted by HarvestPlus and its partners are Akwa-Ibom (South-South), Benue (North-Central), Oyo (South-West), and Imo (South-East). The contract farming, already in place, should be enhanced to promote equitable stakeholder participation in the production and marketing of provitamin A-rich yellow cassava.

In the four states mentioned above, HarvestPlus–Nigeria and its partners coordinated with nongovernmental organizations and state governments' agricultural extension programs to contract with farmers to multiply stems for dissemination in mid-2013. The dissemination of these stems will present opportunities for more contract farming. Therefore, pull mechanisms could be created by developing incentive-based contracts between rural smallholder farmers and processors. These contracts could solve the issue of vast seasonal price fluctuations by providing purchasing agreements at a determined price. One of the risks of price agreements in contract farming is that if the market price of a good is higher than the contract price at the time of sale, farmers may side-sell—that is, engage in extra-contractual marketing (FAO 2011). To prevent side-selling, an incentive-based pricing method could be developed to ensure that farmers come out ahead in the early stages of the relationship, until adoption is firmly secured. A buy-back system could also be introduced, allowing farmers to sell excess cassava (not provided for in the contract) to HarvestPlus and its partners, which will then sell it to urban and international markets.

Contract farming schemes in these four states could provide a more secure link between smallholder cassava farmers and processors. Farmers would have a guaranteed market and selling price, making them less risk averse and more amenable to adopt provitamin A-rich yellow cassava varieties. Processors would also have a steady flow of high-quality raw tubers, allowing them to expand their processing activities and reap the benefits of economies of scale.

If the provision of inputs and extension services is included in the contracts, HarvestPlus and its partners will have a direct channel for introducing the provitamin A-rich yellow cassava varieties to farmers. Contracted extension agents would inform growers of the agricultural requirements of the improved varieties, as well as the nutritional benefits to promote home consumption. Farmers should be encouraged by extension agents to share or sell the provitamin A-rich yellow cassava stems with others to further adoption rates. Additionally, contract farming for provitamin A-rich yellow cassava could:

- Improve flow of nutritious cassava products to urban areas because of increased processing from a steady supply of raw tubers.
- Decrease post-harvest losses because roots will be purchased by the processors in a timely manner.
- Improve the livelihoods of cassava-farming women, as long as the contracts do not discriminate against them.
- Improve market information transmission.
- Increase credit availability if contracts provide for microfinancing.
- Provide an avenue for product certification (contracted farmers could be trained in techniques and monitored for compliance with regulations).

Lastly, financing is a major challenge for Nigeria's cassava value chain. At both the farmer and the processor levels, credit is scarce. Loans are either unavailable or offered at unaffordable interest rates, making investments in technology and agricultural inputs impossible for most farmers. Credit programs may serve as a strong incentive to reward farmers who plant or process biofortified cassava.

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APPENDIX I: A SWOT Analysis of Cassava Production in Nigeria

The following SWOT (strengths, weaknesses, opportunities, and threats) analysis by Sanni et al. (2009) provides a closer look at the potential growth of Nigeria's cassava sector:

Strengths

- Suitable land is available.
- Substantial national and international markets exist.
- Cassava can grow in poor soil conditions.
- Water resources are available.
- Rural labor is abundant (more than 70 percent of Nigerians are involved in agriculture).
- Improved varieties are available.
- Processing labor is abundant, especially as sourced from women.

Weaknesses

- Productivity is low, subsistence farming is widespread, and mechanization is rare.
- Infrastructure is inadequate: power supplies are erratic and costly, lack of potable water raises processing costs, and difficult road conditions impact all stakeholders.
- Small- and medium-sized enterprises lack entrepreneurial skills and business training: plans are unclear, and profits and losses are often not recorded.
- Market information is not well circulated: news about market trends spreads slowly between growers, processors, and consumers, resulting in a supply-demand imbalance.
- Credit is unavailable or available at unreasonably high rates, which discourages investment in processing facilities.
- Production inputs—like capital, stems, and fertilizer—are difficult to obtain.
- Agencies involved in rural and agricultural development are poorly coordinated.
- Processing is inefficient, and economies of scale are not exploited.
- Women have limited ability to purchase processing machinery due to gender discrimination.

Opportunities

- Underemployed youth could be recruited to develop human capital.
- Investment through public–private partnerships (PPPs) could be increased.
- Presence of research institutes—like the National Cereals Research Institute, International Institute of Tropical Agriculture (IITA), National Root Crops Research Institute, Federal Institute of Industrial Research, and Raw Materials Research and Development Council in the region—offers opportunities.
- High-yielding varieties are available; they just need to be distributed and adopted.
- Exportation of cassava and its products could be expanded.
- Further cassava products could be developed, especially for urban consumers, and existing products could be made more accessible.

Threats

- There is competition from cassava-exporting countries.
- There is conflict in meeting industrial and traditional human consumption demands.
- Potential for elite capture and political interference threatens the livelihoods of rural poor.
- Labor costs for harvesting are high.
- Prevalence of elderly farmers is an obstacle to innovation and farming enterprises.
- Inadequate funding slows development programs.
- Prices of cassava substitutes (other tubers, rice, grains, and beans) are low.
- There is gender disparity in the cassava value chain.
- Climate change threatens production.