Country Crop Profile

Provitamin A Cassava in Nigeria

July 2010

HarvestPlus Country Crop Profiles provide background information that informs the development of crop delivery strategies. These profiles are internal HarvestPlus documents that are distributed to interested stakeholders and collaborators for informational purposes.

HarvestPlus is a global alliance of research institutions and implementing agencies that have come together to breed and disseminate biofortified crops for better nutrition. HarvestPlus is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). HarvestPlus is an initiative of the Consultative Group on International Agricultural Research (CGIAR).

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<td>ADP</td>
<td>Agricultural Development Programs</td>
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<td>CEAN</td>
<td>Cassava Exporters Association of Nigeria</td>
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<td>CEDP</td>
<td>Cassava enterprise development project</td>
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<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
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<td>CIAT</td>
<td>International Center for Tropical Agriculture</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>FoEN</td>
<td>Friends of the Earth Nigeria</td>
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<td>FMAWR</td>
<td>Ministry of Agriculture and Water Resources</td>
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<td>FMCI</td>
<td>Ministry of Commerce and Industries</td>
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<tr>
<td>GMO</td>
<td>Genetically Modified Organism</td>
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<td>ICP</td>
<td>Integrated Cassava Project</td>
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<td>IFAD</td>
<td>International Fund for Agriculture Development</td>
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<td>IFC</td>
<td>International Finance Corporation</td>
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<td>IFPRI</td>
<td>International Food Policy Research Institute</td>
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<td>IITA</td>
<td>International Institute for Tropical agriculture</td>
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<td>NACRDB</td>
<td>Nigeria Agriculture Credit Rural Development Bank</td>
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<td>NARES</td>
<td>National Agriculture Research and Extension System</td>
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<td>NCFN</td>
<td>National Committee on Food and Nutrition</td>
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<td>NCGA</td>
<td>Nigeria Cassava Grower Association</td>
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<td>NGN</td>
<td>Nigerian Naira</td>
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<td>NGO</td>
<td>Nongovernmental Organization</td>
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<td>NRCRI</td>
<td>National Root Crops Research Institute</td>
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<td>NSCGA</td>
<td>Niger State Cassava Grower Association</td>
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<td>NSS</td>
<td>National Seed Service</td>
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<td>PIC</td>
<td>Presidential Initiative on Cassava</td>
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<td>RMRDC</td>
<td>Raw Materials Research and Development Council</td>
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<td>RTEP</td>
<td>Root and Tuber Expansion Project</td>
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<td>SME</td>
<td>Small and medium enterprises</td>
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<td>UPoCA</td>
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<td>VRC</td>
<td>Variety Release Committee</td>
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<td>WFP</td>
<td>World Food Program</td>
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EXECUTIVE SUMMARY

Globally, vitamin A deficiency is an important micronutrient deficiency, especially in Asia and Sub-Saharan Africa, affecting women and children. According to a national nutrition survey from 2001–2003, the prevalence of vitamin A deficiency among children under five in Nigeria is about 30 percent. Cassava holds great potential for providing substantially increased amounts of vitamin A to Nigerian diets as existing cassava varieties have beta-carotene concentrations between less than 1 μg/g and more than 15 μg/g. Cassava with high beta-carotene can be visibly distinguished from normal cassava by its yellowish color.

Nigerian cassava production and consumption is by far the largest in Sub-Saharan Africa and even in the world. Cassava production has steadily increased to 45 million tons in 2006, a 44 percent increase since 1999. The increase started in 2002 with the launching of the Presidential Initiative on Cassava (PIC). Production has recently experienced a decline due primarily to falling cassava prices. Cassava is mainly produced in the South-South, South-East and Central-North zones. The growth cycle for cassava is generally longer than one year, but improved management has lead to harvesting once a year. Yields are stagnant at an average of about 10 tons per hectare (t/ha). Cassava is a nationally consumed food with high consumption in both rural and urban areas. Cassava is mainly consumed as garri, a grated and roasted form of cassava, and fufu, a fermented wet paste. While most cassava is locally consumed, about 16 percent of cassava is processed for industrial use, and at least 1.5 percent of cassava production is exported regionally.

A differentiation is made between push (supply) and pull strategies for delivery. The push strategy is supply oriented and focuses on the supply of biofortified rootstocks. The pull strategy is demand oriented. By creating effective demand, a chain for production and consumption of biofortified varieties is put in place. A combined approach is proposed for Nigeria with a marked emphasis on the pull strategy.

The full range of possible activities to ensure adequate supply and create effective demand is grouped into program pillars:

- Rootstock supply and marketing
- Farmer support services
- Processing and market development
- Consumer communication
- Strategic advocacy

A distinction is made between program pillars that are of critical importance for the success of the program and those that are less critical.

The following priority pillars are defined:

- **Rootstock supply and marketing** is an absolute prerequisite for the success of the delivery program. It is the major thrust of the supply strategy.
• **Processing and market development** is the most essential element of the pull strategy. It is aimed at developing a range of products involving small and medium enterprises and creating initiatives of vertical integration at the decentralized (state) level that are linked to improved extension, rootstock supply, financing, and marketing. Market development should be the priority for stimulating productivity and processing.

• **Strategic advocacy** comprises a range of advocacy activities that are needed to mobilize and maintain high-level, effective support of the program.
I. HARVESTPLUS PRODUCT DELIVERY PROFILE: BACKGROUND AND OBJECTIVES

Harvest Plus
In late 2002, the Consultative Group on International Agricultural Research (CGIAR) Micronutrients Project was selected to be one of three pioneer CGIAR Challenge Programs. In 2004, the HarvestPlus Challenge Program was officially launched when it became the first recipient of funding for biofortification research granted by the Bill and Melinda Gates Foundation. HarvestPlus has since emerged as a global leader in developing biofortified crops and currently works with more than 200 agricultural and nutrition scientists around the world. It is co-convened by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI).

The year 2009 marks the beginning of the HarvestPlus product development and delivery program. The second phase will bring nutrient-rich staple crops from the laboratories of the National Agriculture Research and Extension Systems (NARES) and CGIAR to the fields of farmers around the world. Based on the breeding research and nutrition studies done in the past years, the first biofortified products in some crops are now ready, and in others will soon be ready to be rolled out in large volumes. As a result, benefits to the health of large numbers of people and the financial situations of numerous farmers can now start to be realized.

HarvestPlus aims to support initiatives of governments, research organizations, non-profit organizations and private companies to reduce hidden hunger and provide micronutrients to one billion farmers and consumers through the staple foods they eat. This is achieved by a process called biofortification, which entails breeding higher levels of micronutrients directly into key staple foods (HarvestPlus 2009). Figure 1 shows the ten country crop combinations that have been selected, for which profiles will be developed.
Purpose of the country crop profile
The country crop profiles are the first step of the delivery work in the second phase of the HarvestPlus (see Figure 2). The next step (also referred to as the development phase) entails the preparation of a full program document. This will be done by making use of the program pillars, as presented in the country crop profile. The program document will be the basis for advocacy and fundraising activities. Only after the full program is prepared, and support and adequate funding are secured, the implementation phase starts.

The country crop profile provides a description and analysis of the existing situation with respect to the value chain, and then provides a strategic framework for starting off the process of developing a country program. The strategic framework is presented in the form of pillars. For each pillar of the program, a set of priority activities is defined. The country crop profile covers the first four years of dissemination.
The profiles do not aim to provide a detailed description and analysis of farming systems, value chains, or markets with respect to the biofortified crops. Rather, the profiles are a functional document aimed at starting off the delivery phase. During Step 2, action plans will be developed, with responsibilities and a budget, and thus the program document will gradually emerge.

Developing the country crop profiles, as well as the ensuing program, is also a process of involving relevant stakeholders and assessing the potential for strategic partnerships and effective dissemination. Joint collaboration with stakeholders from both the agriculture and health sectors will be key to the success of HarvestPlus, since agricultural products are used as “carriers” of micro-nutrients to realize nutrition and health benefits.

**The development of a country crop profile**

The profile starts with an assessment of the value chain dynamics and the main actors involved. It may also include organizations that are not yet involved in the value chain, as a way of identifying opportunities and potential partners for extensive and strategic scaling up. Finally, the pillars of a dissemination strategy will be presented. (See Appendix 1 for guiding principles for the delivery program.)
II. PRODUCT DELIVERY PROFILE: PROVITAMIN A CASSAVA IN NIGERIA

Target country and crop context

Poverty status and vitamin A deficiency

Nigeria is placed 151 out of 174 countries on the Human Development Index (HDI) and 114 out of 135 countries on the Human Poverty Index (HPI) (UNDP 2009). These indicators are indeed poor, and the country is ranked among the low human development countries. There is high unemployment and underemployment, especially among the youth, and high levels of poverty throughout the country. It is estimated that 43% of the population live below the national poverty line, with over 70 percent of the people earning less than US $1 a day (UNDP 2009).

Globally, vitamin A deficiency is an important micronutrient deficiency, especially in Asia and Sub-Saharan Africa, affecting women and children. Globally, about 5 million children and about 10 million women have measurable eye damage due to vitamin A deficiency (HarvestPlus 2008). Annually, an estimated 250,000 to 500,000 children go blind from this deficiency, and about two-thirds of these children die within months of going blind (HarvestPlus 2008). Vitamin A deficiency also affects the immune system so that people with vitamin A deficiency are more susceptible to various diseases. Trials in developing countries have shown that vitamin A supplementation reduces mortality rates and reduced maternal mortality (HarvestPlus 2008).

According to a national nutrition survey conducted from 2001–2003, the prevalence of vitamin A deficiency among children under five in Nigeria is about 30 percent. This figure did not vary significantly by agroecological zone¹ or by urban or rural residence. Malnutrition for children under five, however, is highest in the dry savanna zone, then declining towards the other two zones. Among mothers and pregnant women, vitamin A deficiency rates were 13 percent and 19 percent, respectively. Changes by zone show a similar pattern among this group as among children under five (Maziya-Dixon et al. 2004).

¹ The three agroecological zones are dry savanna, moist savanna, and humid forest.
Nigeria has carried out vitamin A supplementation programs, but these campaigns are expensive and coverage is low. Moreover, no effects of the immunization campaigns could be detected during the most recent health survey of 2008.\textsuperscript{2} This suggests that the immunization campaigns are not effective in overcoming vitamin A deficiency. Vitamin A is an essential nutrient needed in small amounts for the normal functioning of the visual system and for maintaining cell function for growth, epithelial integrity, red blood cell production, immunity, and reproduction. In the past decade, vitamin A supplementation gained momentum as it was added to annual immunization campaigns, especially against poliomyelitis, that have since continued as national child health week campaigns during which vitamin A is distributed.

**Seed breeding progress**

In 2002, the International Institute of Tropical Agriculture (IITA) in Nigeria raised concern about a new strain of the cassava mosaic disease in Africa. IITA rapidly developed varieties that were resistant to this virus, and these were introduced through a fast-track approach of releasing new varieties, and a massive approach of reaching out to farmers. This campaign has overall been successful. The improved varieties were not only resistant to the virus but also performed better than previous varieties, especially producing more than 40 percent higher yields without fertilizers. The most important traits of this new variety are:

- Mosaic virus resistance,
- Multiple pest resistance / tolerance,
- High and stable yields (minimum 11 t/ha, optimum 20–30 t/ha), and
- High dry matter content (minimum 24%, optimum > 30%).

Any new varieties, including those with higher beta-content levels, must meet all of the characteristics listed above in order to be acceptable for the National Seed Service (NSS) and farmers growing cassava.

Breeding of improved cassava varieties has also been stimulated by the Presidential Initiative on Cassava (PIC). From 2005 to 2007, 10 new cassava varieties were released. Existing cassava varieties show considerable variation in levels of beta-carotene, between less than 1 μg/g (or parts per million, ppm) to more than 15 μg/g. (NRCRI 2006). In 2008, a new variety was released with 3–4 μg/g of beta-carotene. This variety was said to be appreciated by farmers in the southern part of the country because of its yellow color. There are now a few new varieties with beta-carotene levels higher than 5 μg/g that are in the pre-release phase and ready for testing. Once these varieties have been fully tested, they could be released within a year.\textsuperscript{3} It is expected that other varieties will be developed in 2010 with potentially higher beta-carotene content. The main problem is that the trait of high beta-carotene content (up to 15 μg/g) could be connected with the trait of low dry matter content. This is also the general perception of farmers who for that reason may

\textsuperscript{2} Personal communication, Dr. Bussie Maziya-Dixon, IITA.

\textsuperscript{3} Personal communication, Chiedozie Egesi, NRCRI, 2009.
disfavor yellow cassava varieties. Also there are indications that high beta-carotene content does not seem to be stable when tested in uniform yield trials.

There is also believed to be a relationship between high beta-carotene content and perishability (shelf life); since beta-carotene is an antioxidant, it reduces the oxidation process causing deterioration. High dry matter content also enhances oxidation. Thus, the challenge in breeding is to break the connection between high beta-carotene content and low dry matter, while also enhancing shelf life. Ongoing trials within IITA and the National Root Crops Research Institute (NRCRI) are focused on this issue.

Acceptable cassava varieties with higher than 7–8 μg/g beta-carotene content will most likely be available in 3–4 years; they are even not in the pre-release phase.

Cassava with high beta-carotene can be visibly distinguished from normal cassava, at least when it is peeled and cooked. In root from, yellow cassava is more difficult to distinguish from normal cassava.

The HarvestPlus cassava breeding program is operating alongside the bio-cassava project, which uses genetic modification to create provitamin A-rich cassava varieties. This parallel approach of two different projects with the same objective causes confusion, especially since genetically modified organisms (GMOs) are controversial in Nigeria.

The cassava value chain in Nigeria

Basic data

Cassava production and consumption

Nigerian cassava production and consumption is by far the largest in Sub-Saharan Africa and even in the world. Cassava production has steadily increased by 44 percent between 1999 and 2006 to 45 million tons, but total production in 2007 declined to 34 million tons (FAO 2009). The underlying reason for this decline is falling cassava prices, discouraging farmers from growing it. From 1999–2009, the area cultivated with cassava showed a continuous but modest increase of 12 percent, reaching 3.8 million hectares in 2006. Thus, the production increase, which started in 2002 with the launching of the Presidential Initiative on Cassava, is largely a result of increased yields.

Cassava production is concentrated in the North-Central zone as well as the southern zones (South-South, South-West, and South-East). While the average national per capita cassava production in 2002 was 0.32 tons per year (t/yr), production was higher in North-Central (0.74 t/yr), South-East (0.56 t/yr) and South-South (0.47 t/yr) (IITA 2004). Cassava production per state varies considerable with some states showing high production levels (these are generally said to be states with cassava production potentials and limited commercial alternatives).

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4 Personal communication, Chiedozie Egesi, NRCRI, 2009.
Cassava is a nationally consumed food with high consumption in both rural and urban areas. Cassava is consumed in two ways: *gari* (the most common preparation method), grated and fermented cassava that is consumed on its own or with a sauce, and *fufu*, a fermented wet paste. In the northern zones, fresh cassava is also eaten peeled and cooked or steamed or occasionally eaten raw; however, these uses are not common in the rest of the country. Cassava consumption per capita is twice as high in the southern zones as in the north of the country (data are from 2002, IITA 2004). It seems that cassava consumption in the north is increasing, but there are no supportive data. Data about cassava consumption per capita show small differences between rural and urban areas.

According to FAOStat, total cassava consumption is around 14 million tons (1999–2003) and does not show a clear trend. This would be around 30–40 percent of total production. Estimates from 2001 show that 16 percent of national cassava root production was used as an industrial raw material: 10 percent was used as animal chips, 5 percent was processed into a syrup concentrate, and less than 1 percent was processed into high quality cassava flour (IITA 2004). Although in recent years much emphasis has been placed on cassava processing, volumes of cassava being processed have not changed much. The remaining 84 percent (29 million tons) would be used for food consumption, which is twice as high as the FAO estimates. There seems to be a need for a good national survey on cassava consumption and trade (IITA 2004).

In Nigeria, cassava production has been strongly promoted following a Presidential Initiative on Cassava (PIC) in 2002 (following a similar initiative in Ghana in 2001). The objectives of the PIC set to be achieved by 2007 were:

- Enhance cassava production to 150 million tons and area grown with cassava to 5 million hectare (average yield of 30 t/ha);
- Produce 37.5 million tons of processed cassava products, also for export markets;
- Organize export of cassava and processed cassava products for income generation;
- Earn about US$ 5 billion (~ US$ 130/t) annually from exporting cassava-processed products.

One main catalyst for achieving these objectives was the policy to mix flour with 10 percent cassava meal. However, this policy has not been realized, mainly because of resistance by flour millers. The PIC objectives have not been met, but the PIC is generally considered a success because (1) it focuses on agriculture in rural areas, (2) cassava production has increased, and (3) a variety of new processed cassava products are being produced and marketed. Also, the image of cassava has changed from a traditional poor man’s crop to a crop with potential for the national economy. It is generally stated that currently more people eat cassava, but this statement is unproven. In 2003, cassava production was being promoted as a poverty fighter across Africa by the Pan-Africa Cassava Initiative (IFAD 2008), with several African countries taking steps to follow the Nigerian example.
Trade flows, imports, and exports

There are no cassava imports into Nigeria, but there are important regional exports. Nigeria exports large quantities of processed cassava to neighboring countries. Most importantly, the annual trade of cassava products (gari and cassava chips) from Dawanau market in Kano to other Sahel countries, especially Niger, is estimated at the equivalent of 500,000 tons of fresh cassava (about 1.5 percent of national cassava production) (Ezedinma et al. 2007).

It is difficult to gain quantitative insight in the destination of cassava and the trade flows involved towards final consumers. The following are some available data:

Box 1: Data on cassava trade flows

- Cassava is primarily produced in the South-South, South-East and North-Central zones from where it is also exported to other parts of the country for local consumption; cassava produced in other parts of the country is generally consumed locally (IITA, 2004);
- Nationally, about 70 percent of cassava is processed into gari (IITA, 2004);
- In Enugu and Benin city (South-South and South-East), about 90 percent of processed gari is taken to urban markets (Ezedinma et al. 2007);
- Nationally, about 16 percent of cassava is processed for industrial use (IITA, 2004);
- At least 1.5 percent of cassava production is exported regionally (Ezedinma et al. 2007).

Expected trends

The various reports and interviews lead to the following qualitative trends:

Box 2: Expected qualitative trends

- There is a general trend of increasing consumption of cassava products due to population growth increasing consumption by urban consumers. This trend is expected to continue. The PIC has also contributed to increased production and consumption of cassava.
- Regional trade in cassava products is expected to remain important. Exports of processed cassava products are still small but are expected to increase as a result of continuous promotion as can be observed from recent programs and initiatives.
- There is increasing cassava consumption in the north, and thus increased transport of cassava products from southern to northern Nigeria (Personal communication, Maziya-Dixon). This trend is also expected to continue.
Structure of the cassava value chain

Cassava is mainly consumed as gari or fufu. An estimated 70 percent of the cassava produced in Nigeria is processed into gari, followed by some other products of which fufu is the most important. The associated value chain follows basic elements and is illustrated in more detail in Figure 4. In principle the value chain for rural and urban consumption are the same, though the latter is slightly longer.

Figure 4: Commercial cultivation of cassava for urban areas

Fresh cassava deteriorates within 48 hours of harvesting. Therefore, transport should be quick and/or over short distances. Apart from that cassava is a bulky product, containing up to 60 percent water, and therefore expensive to transport. These are disadvantages for marketing and processing and would seem to favor processing of gari and fufu in local small-scale processing units. Large-scale industrial production of cassava, on the contrary, is generally not feasible. Medium scale processors often have difficulty managing their raw material supply.

Small and medium enterprises for cassava processing and wholesalers are found mainly in the Southern part of the country. Some medium- and large-scale gari and cassava starch producers have started contract farming activities to overcome the supply problems.

Figure 5: Cassava value chain (Ezedinma et al. 2007).

*Market service providers include: packaging/baggage handlers, stall owners, market associations, local government, and others.

Prices

Cassava root prices show much variation. By region, prices are generally lowest in the south (with the exception of highly industrialized or urbanized states).

There is no substantial seasonal variation in cassava pricing because it can be harvested at any time of the year. This is one of cassava’s greatest attributes. Likewise, the price of gari does not show much variation throughout the year.
However, prices tend to be lower in the wet season when harvesting is easier (Ezedinma et al. 2007).

Cassava farm gate prices have shown an increase by about 25 percent between 2001 and 2005 mainly (to about 20 NGN per kg). This could be explained by increased promotion of cassava following the PIC. However, the price collapsed after 2006 (as low as 3 NGN per kg) obviously due to an excess supply following high prices. This may explain the strong decline in cassava production by 2007. After that, prices increased again in 2009 following less supply. These two to three year price cycles are well known for cassava, as markets are unable to absorb supplies when farmers produce more as a response to high prices (Ezedinma et al. 2007). Thus, the challenge to ensure a stable supply and price level still remains.

There are some case studies, including indicative costs, available on the value chain of cassava production and processing (IITA 2004; Ezedinma et al. 2007). Cassava production costs are basically labor costs since most of the time no inputs are used. While costs of production would be around 2,500 NGN per ton, farm gate price would be around 8,000 NGN per ton (data from 2002, IITA 2004). Estimates are that cassava processing into *gari* or *fufu* would lead to a doubling of the value.

Subsequently, primary wholesalers transport processed products to urban markets, and secondary wholesalers sell the products to consumers. The available data suggest an overall three-fold increase of value, implying that primary producers take about 33 percent of the value, increasing to 50 percent if they do the processing (Figure 6). Ezedinma et al. (2007) conclude that between 2003 and 2005, the changes in the economy of the marketing system have been favorable to local producers, as well as processors and primary wholesalers.

**Figure 6: Value addition within the chain (analysed from IITA 2004 and Ezedinma et al. 2007)**

<table>
<thead>
<tr>
<th>Prices in Nigerian Naira* per Ton</th>
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<tbody>
<tr>
<td>Retail</td>
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<tr>
<td>Wholesale (primary and secondary)</td>
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<tr>
<td>Processed Product (<em>gari</em>, <em>fufu</em>)</td>
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<tr>
<td>Farm Gate Price</td>
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</tbody>
</table>

* Exchange rate in 2009: 150 NGN = US$ 1

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5 Personal communication, Paul Ilona, IITA, 2009.
In the South-South and South-East zones where cassava consumption per capita is highest, yellow *gari* has a slightly higher price than white cassava, which suggests its preference. In other parts of the country, however, this is not the case.

**Input system characteristics**

Cassava is propagated from stem-cuttings rather than planted from seed. Smallholders can propagate their own cuttings, meaning the crop is accessible to even the poorest farmers. In some cases, farmers purchase stems from local markets. In 2002, the average price of planting material was 100 NGN per bundle (an estimated 25 bundles are required for one hectare). Many farmers will continue to use their own stems even if these are affected by pests or diseases. The availability of large volumes of good quality planting material is a significant problem limiting the dissemination of new varieties.

New cassava varieties are being produced continuously in order to improve the desirable traits of cassava and as a response to threats such as the cassava mosaic virus. New varieties are tested through a well-structured process, involving farmers and commercial farmers to produce high quantities of root stocks of the new varieties. However, their numbers are small. The initial target of the PIC to produce rootstocks of new cassava varieties has by far not been met.

Although it is stated that new varieties have been successfully released, and indeed the spread of the cassava mosaic virus has been avoided, it is acknowledged that the proportion of farmers actually adopting new cassava varieties is rather low (at most 40 percent) and probably much lower in the northern parts of Nigeria.

**Beta-carotene cassava and genetically modified organisms (GMOs)**

The Bio-Cassava Program is conducting ongoing trials with genetically modified cassava in Nigeria. These tests are done with cassava varieties containing 30 times as much beta-carotene as its normal counterpart (up to double the levels found currently in HarvestPlus developed varieties). The aim is also to increase levels of iron, protein, zinc and maybe even vitamin E that will meet the minimum daily allowance in a 500 gram meal. Some NGO’s are of the opinion that the proposed trials by the NRCRI must be halted. They warned that GM crops are a “breach” of the Cartagena Protocol on Biosafety, which Nigeria is signatory to, that seeks to protect biological diversity from the potential risks posed by modified organisms. They also state that genetic modification has dangers to the health of Nigerians who depend on cassava as a staple (FoEN 2009).

It seems important that this controversy is addressed and solved because it may affect the willingness of organizations and individuals to collaborate with the HarvestPlus program.

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6 Personal communication, Chiedozie Egesi, NRCRI, 2009.
Farming systems parameters

Production characteristics
Cassava has a number of characteristics which make it suitable for growing by small-scale farmers under poor conditions:

- It can be grown on soils with low fertility without fertilizers.
- It is drought tolerant.
- Once it reaches maturity, it can be left in the soil for months without serious risk of degradation.

Most farmers in the southern and north-central states grow cassava. The number of farmers growing cassava is estimated at 5 to 8 million. The average cassava field in Nigeria is less than one hectare and contains about 8,000 cassava plants (Curran and Cook 2009). Cassava requires limited land preparation and weeding, as compared to other crops. Cassava can also be planted throughout the rainy season, which is an advantage compared to many other crops. It is generally not much fertilized as it can grow well under natural (low) soil fertility conditions. No pesticides are used. While cassava can grow in poor soils, its continuous cultivation will significantly deplete the soil. Its efficient extraction of nutrients makes it difficult to use intercropping techniques to maintain soil quality (Curran and Cook 2009).

The cassava growth cycle takes generally more than a year, but improved management leads to harvesting once a year. Until recently, yields were stagnant at an average of about 10 tons per hectare (t/ha), but the variation between regions is considerable. The target is to increase yields to at least 15 t/ha. There are reports stating that yields have increased in recent years to 10–15 t/ha following the PIC. However, there are also indications that this target has not been reached. For example, an evaluation of the International Fund for Agriculture Development (IFAD) country program concluded that even though average cassava yields have reportedly increased from 10 t/ha in 1997 to 15 t/ha in 2006, many small farmers are still achieving yields of only 8 to 10 t/ha, partly because the problem of marketing larger outputs in periods of surplus is a disincentive to produce more (IFAD 2009).

Available FAO statistics show that yields have not consistently increased in recent years and due to low production, dropped again in 2007 to less than 9 t/ha. Average yields in other cassava growing countries are generally higher. With excellent practices and application of fertilizers, average yields can reach 20 t/ha and even up to 40 t/ha (in Thailand). IITA has a list of 11 “commandments” for improved cassava production, which address the causes of low yields and includes fertilizer use and mechanization.

Cassava is increasingly grown by large-scale commercial farmers to supply industrial processing industries. These farmers make use of tractors and use considerable amounts of fertilizer and some pesticides, thus enabling them to reach yields of up to 50 t/ha. In fact, in on-station trials, cassava yields can reach up to 80

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t/ha. High-yielding varieties will only give high yields if fertilizers are used, unless soils are very good. It is generally acknowledged that most farmers do not use any fertilizers for growing cassava.

There are projects in Nigeria that allow farmer groups to acquire loans to intensify cassava production, including the acquisition of tractors for mechanization. However, as long as cassava prices are rather low and markets for processed products not expanding, it is questionable whether this will be sustainable. The question remains if farmers equipped fertilizers and tractors will use fertilizer on cassava, as long as other crops (maize in the south and sorghum in the north) may gain a higher or more stable price.

**Land availability and land tenure**

As stated above, cassava can be grown on poor soils and lands susceptible to drought, although yields will be low. The IITA (2004) study on the cassava industrial revolution states that an increase in cassava production and marketable cassava can be grown without competition with other crops (maize, millet, sorghum, yams). This presupposes adoption of good agronomic practices, use of fertilizer, and use of existing high-yielding cassava varieties. However, another study mentions that cassava expansion has lead to the withdrawal of land and other resources for growing crops such as cowpea and maize (Sanogo and Adetunji 2008). Land availability is not a problem in the North-Central zone, which has large stretches of land designated for agricultural use. However, in the densely populated southern areas of the country, the situation is less favorable. The IITA study indicates that the best potential for cassava production is in a number of states in the South-West, South-South, and North-Central zones. Criteria for cassava production potential include: relatively low population density, relatively high cassava yields, good roads, and potential industries, located near cassava production areas.

It is suggested that where land is still available and not designated for other purposes, there are no problems on land tenure. However, women do have less access to land.

**Processing and trade**

An estimated 70 percent of the cassava produced in Nigeria is processed into gari. The market chain for gari consists of three channels. First, there is the flow from village producers to rural (primary) wholesalers to the rural consumer. Second is the trade from primary to long-distance (secondary) wholesalers sold to urban consumers, which can also include regional trade. Third is direct selling to secondary traders.

Most processors fall into the category of household level (not employing any outside labor). There are also several small- and medium-scale enterprises for this

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8 Personal communication, NRCRI, 2009.
product. Producing gari is a time-consuming process that provides low incomes and involves peeling roots, washing, soaking, wet sieving, pressing and then roasting. Several projects and IITA have recently developed and disseminated cassava processing technologies.

Cassava is the most important crop for domestic consumption, but the PIC has promoted cassava production for industrial uses in order to contribute to the national economy. Potential industrial uses include: flour, animal feed, starch, and ethanol. These developments are being supported by investments in processing technology, credit systems, and capacity building.

Cassava quality and processing
Cassava quality varies by region and by soil and moisture conditions. While there is little systematic data on this, it is commonly stated that cassava in the relatively dry North-Central zone of Nigeria has higher dry matter content. This is a very important characteristic for large-scale processing, such as starch production, since drying of cassava is the most energy-intensive part of the processing chain. Thus, a slight difference in dry matter content can have major consequences on the profitability of a cassava-starch processing factory.

Storage capacity
As stated above, the shelf life of fresh cassava is short requiring transport to be quick and/or over short distances. In addition, cassava is a bulky product, containing up to 60 percent water, and therefore expensive to transport. These are disadvantages for marketing and processing and would seem to favor production of gari and fufu in local small-scale processing units. However, as producers cannot store cassava and sell it in large quantities to wholesalers, large-scale processing units, with potential economies of scale, will have difficulty establishing a constant supply of cassava.

Consumption
Cassava is no longer a poor man’s crop in Nigeria—it is increasingly part of the diet of both rural dwellers and urban elites. Cassava gari appears to be a “food of choice” even with alternative food options available in urban areas (Maziya-Dixon et al. 2004). In 7 out of 12 surveyed states, cassava is consumed by 30 percent of the respondents more than four times a week (IITA 2004). As stated above, there seems to be a shift towards more eating of cassava in the north and by urbanized communities, but there are no statistics to support this claim.

Sustainability issues
Gender issues
Much information is available on gender roles in cassava production and value chain. According to the IITA cassava study, women typically carry out 70 percent of the work. However, it is suggested by IITA staff that these roles may be changing in recent years as a result of the boost in industrial processing of cassava.
Cassava fields are prepared using manual labor, and because of physical demands, men provide about 85 percent of the labor. Plowing is also mainly a man’s job (65 percent), but women take care of the planting (60 percent). Women’s high involvement in planting cassava requires local propagation markets to be responsive to women’s concerns, e.g. by working through informal networks and women’s farmer organizations and increasing their access to credit.

As labor becomes mechanized, more men tend to be involved, and women have less land tenure security, thus leading to lower investments in land fertility and lower productivity. This is not necessarily a problem for cassava production (Curran and Cook 2009).

Women are mostly responsible for weeding, although limited weeding is required. Harvesting is also primarily a woman’s job. Agricultural extension systems tend to overlook the importance of women’s social networks for information diffusion. As a result, untargeted dissemination is more likely to benefit men and wealthier households. Women may not have access to traditional extension messages due to low levels of literacy and education. Diffusion of information takes place only in part through formal extension services, which implies that social networks are an important resource that remains underutilized. Gender-sensitive, participatory approaches would be expected to have positive impacts on women farmers.

Women provide the majority of labor in processing cassava for both household consumption and market sale. Processing may be done at household level or in organized processing units. In both cases, mostly women are involved. Producing *gari* or *fufu* is grueling work including 14 steps—it is time-consuming, provides low yields, and requires storage, which is often not available. It also requires attention to detail because the cyanide should be adequately washed out of the root tubers.

Several initiatives have been introduced to reduce the workload of women and introduce mechanical equipment. When introducing such equipment, care should be taken to ensure that women have access to credit facilities to purchase the equipment and do not lose income from the loss of manual labor.

Women play an important role in the cassava market chain. They are often the wholesalers and owners of the transport facilities. It has been observed that where programs to promote this avenue are successful, men tend to take over.

*Pro-poor*

Consideration needs to be taken when selecting the target groups for a biofortification program with beta-carotene cassava. In general, malnutrition for children under five is highest in the northern, dry savanna zone (58 percent stunting, 12 percent wasting, 35 percent underweight), then declining towards the southern zones (26 percent stunting, 8 percent wasting and 15 percent underweight). For mothers and pregnant women, vitamin A deficiency rates at the national level are 13 percent and 19 percent, respectively. The rates of deficiency are twice as high in the dry savanna zone as in the moist savanna zone and the humid
forest zone (Maziya-Dixon, B., et al. 2004). Thus, populations in the north would appear to be the primary target group of the HarvestPlus program. In the South, especially in the coastal zone, there are important pockets of concentrated malnutrition. Consumption of cassava is not common in the north where it is limited to an urban population who can afford to buy cassava products traded from the south, where is a staple of the diet.

Another important pro-poor consideration is the fact that institutes and programs, in their efforts to promote cassava production for export markets, tend to select the most productive farmers. For example, large-scale commercial farmers have been identified to multiply rootstocks. While this might be the most efficient approach, it clearly puts these farmers in an advantageous position compared to small farmers.

Finally, an important pro-poor consideration is the fact that intensification of cassava through the use of agrochemicals and mechanization will benefit large-scale farmers over poorer ones.

**Environmental**

There are some risks associated with the project, especially the potential increase of cassava production (with or without higher levels of beta-carotene). The risks are two-fold and will depend upon the approach taken to boost cassava production:

- Cassava intensification is the preferred option currently being promoted and involves increasing the use of fertilizers and other agrochemicals that could substantially boost production. With this approach, there is a risk of increased pollution by excessive use of agrochemicals and of land degradation from increased mechanization.
- Increasing production by expanding land for growing cassava may affect land for other crops or land now occupied by forests or other valuable ecosystems. It has been suggested that there is plenty of land available in Nigeria, but this obviously varies by regions. Expansion of land for growing cassava should be based upon good land-use planning.

Processed *gari* should meet health standards. It is stated that environmental inspectors have minimal influence on *gari* traders or restaurants. However, it is suggested that *gari* traders have an internal control system to guarantee a minimum quality.

**Socioeconomic**

There are some socioeconomic risks associated with a strategy to boost cassava production and processing of cassava products for export. These risks are basically that small-scale farmers and poor farmers will not necessarily benefit.
III. STAKEHOLDERS AND THEIR RATIONALE

Introduction
The emphasis of the country crop profile is to identify key actors in the cassava value chain and find opportunities for them to participate in the dissemination phase of the HarvestPlus program. For each category of actors, it is therefore important to understand their rationale and the way they are being influenced in order to identify opportunities and risks for their involvement as strategic partners. For cassava in Nigeria, emphasis is on the value chain for cassava processed into gari and consumed in urban areas, as this appears to be the most important destination of cassava involving the largest number of consumers. Apart from that, it may be useful to develop cassava products for which yellow cassava can be an opportunity fetching a premium price, encouraging farmers to grow yellow cassava varieties.

Dynamics
Based on the available information, the different actors in the value chain of gari for urban centers are shown in Figure 7. Note that in the commodity chain, the stage of secondary wholesalers may be skipped. Characteristic for the cassava commodity chain is the fact that the number of processors and primary wholesalers is relatively large, as cassava is processed locally due to its high degree of perishability and need for quick processing.

Figure 7: Actors in the value chain (Aidenvironment 2009)

The value chain can also be characterized on the basis of the degree of integration between the links. Vertical integration does not exist within the cassava value chain in Nigeria, nor is there private-sector led direct sourcing. Currently, some farmers’ organizations are becoming engaged in direct sourcing agreements with large-scale...
processors (see the section “Production”). The cassava market chain is characterized by fragmentation of producers and wholesalers and a lot of small, local, and informal linkages. This is strengthened by the fact that cassava is difficult to store.

Figure 8: Linkages

In the following sections, key issues related to the cassava *gari* market value chain will be discussed and key actors identified.

**Input Supply**

*Release of new varieties*

The supply of new cassava varieties follows a well-defined procedure (Figure 9).

Figure 9: Cassava variety release process in Nigeria (Dixon et al. 2008)

IITA and NRCRI are the primary institutions developing new cassava varieties. The variety release process in Nigeria takes several years of testing materials on station, followed by about two years of out-station trials, and then presentation to the Variety Release Committee (VRC). The National Coordinated Research Project on Cassava then conducts trials at four levels: (i) on station, (ii) inter-institute collaborative research, (iii) multi-location testing, and (iv) on-farm research. The VRC officially releases genotypes after data from several years of testing has been approved. IITA or NRCRI then pass on to the National Seed Service (NSS) enough
materials of each variety to plant one hectare. Some of the materials may then also get to farmers who collaborate with IITA or NRCRI. The NSS multiplies the materials and passes on the new varieties to contract farmers and Agricultural Development Projects (ADPs), which fall under the States authority, for further multiplication.

Since the above procedure takes several years, a fast-track, participatory-selection approach was adopted for introducing mosaic-resistant cassava varieties in the event of a virus outbreak. This approach was devised by the Integrated Cassava Project, which began fieldwork in 2003. In essence, the fast-track approach differs from the normal approach by carrying out the various trials in parallel instead of in sequence and by starting the multiplication before the variety is officially released. With the fast-track approach, there are three types of trials: on-farm, demonstration, and multi-location. In 2003, the trials were carried out in 12 states in southern Nigeria, with about 66 on-farm trials per state. The decision on where to conduct the trials was made by the ADP workers in each state with the aim of having representative trials. Evaluations on a range of standard variables was carried out by teams, and farmers' preferences are assessed separately. The multitude of data was assessed with the use of appropriate software. The whole process including trials thus took only two years instead of the estimated 6–8 years, while simultaneously rootstocks had already been multiplied and were ready for dissemination as soon as new varieties were released. While at first all tested varieties were multiplied, later on only the most promising ones were selected for multiplication (Dixon et al. 2008).

It has been suggested to apply the fast-track approach in subsequent cases of testing new cassava varieties. The fast-track approach is, however, very demanding and involves intensive resources, including staff, to carry out extension, testing, and farmer support. Also, it requires an official waiver to be able to bypass the normal system. It was stated that the system for cassava variety release has been rather over-stretched in recent years as a result of the mosaic virus outbreak and pressure from higher levels. Currently, the system would not be able to handle more than two new varieties to be tested and released annually.¹⁰

**Multiplication**

Cassava is regenerated in a vegetative manner. Multiplication of cassava root stocks is comparatively slow and therefore can be a bottleneck. Multiplication of new varieties is normally done at farms associated with the state-based ADPs. All ADPs, in principle, have multiplication farms with contract farmers. However, these farms have variable performance depending upon funds, human resources, and ADP functioning within the different states. Another avenue for multiplication is through clusters of farmers associated with the Nigeria Cassava Growers Association (NCGA). Again, while these are found in every state, their functionality seems to vary.

¹⁰ Personal communication, P. Kulakow, 2009, IITA.
Through the fast-track approach, it has been possible to speed up the multiplication process in different ways: (i) by starting multiplication well before the new variety has been officially released (pre-release) and (ii) by involving a large number of other stakeholders and farmers, such as women’s groups, NGOs, and religious organizations. The NRCRI now works with outgrowers and commercial farmers to enhance the rate of multiplication. They, however, request appropriate credit systems to perform their tasks. This shows that multiplication of cassava stems to disseminate new cassava varieties is a bottleneck that remains to be solved. Alternatively, IITA states that multiplication could also be done by handing out new variety root stocks to farmers free of charge (vouchers) and encouraging them to distribute the varieties. If the variety appears to be productive and acceptable, multiplication will take off by itself.¹¹

A rough indication of the multiplication rate of cassava through rootstocks at the farmers’ level is between 5x (theoretical maximum) and 2x (practical achievable) per annum. NRCRI has a manual for farmers to develop two-node stem cuttings, which includes the use of pesticides to treat the stems. By this approach, farmers would be expected to realize a multiplication rate of 4–5x. Institutes such as the IITA indicate that they could realize a maximum multiplication rate of 50x. However, this would require high levels of training and continuous support. A more realistic average level of multiplication would be 10x.

Cassava rootstock market
Cassava rootstocks are intensively marketed at local markets, generating an income for many farmers. Once released, rootstocks of improved varieties will need to be sold to farmers and not given free-of-charge because this would cause distribution in the local market, affecting women in particular, and because free products are not considered of credible value. Therefore, vouchers should only be used to test new varieties. Vouchers might also be used to target specific resource-poor producer groups, such as marginalized communities and/or women.

<table>
<thead>
<tr>
<th>Potential partners for strengthening input supply:</th>
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<tbody>
<tr>
<td>• IITA</td>
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<td>• NRCRI</td>
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<td>• ADPs</td>
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<td>• Variety Release Committee (VRC)</td>
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<td>• NCGA</td>
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<tr>
<td>• National Seed Service (NSS)</td>
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<tr>
<td>• Cassava commercial farmers and outgrowers</td>
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<td>• Local credit supply institutions or arrangements</td>
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Production
Available data show that initially the PIC lead to a significant increase in cassava production. The production increase has been supported by ADPs to a degree

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depending upon the state. However, it is reported that producers have lost their enthusiasm due to a number of constraints, including:

- Low availability of planting materials of improved cassava varieties;
- Processing and marketing constraints;
- Limited extension support for improved agronomic practices;
- Poor credit systems to enable producers to buy input packages for improved production; and
- Poor targeting of women producers.

Regarding women, there may be a need to reform the land tenure systems in some cassava producing communities.

In Nigeria, cassava growers are organized in the Nigeria Cassava Growers Association (NCGA). Most of the state-based growers’ associations were established recently and have played a central role in implementing the PIC. The NCGA is the link between farmers and the government stakeholders.

According to the NCGA, the main obstacles to achieving the PIC targets are inadequate funding and poor equipment leading to poor cassava production and low yields. As a result, the cassava market remains largely traditional and is not market oriented.

Members of the NCGA have recently taken measures to contribute to improved cassava production. For example, members of the NCGA are practicing cluster farming. There are currently about 500 groups, and each group has about 30 hectares under cultivation. These groups want to implement improved farming practices, such as tractor use and pesticide use, but they do not seem to be very successful as yields remain low (NRCRI 2006). These initiatives are localized, and the successes are not known.

Another ongoing effort to address the lack of market information is the National Plan of Action on Food Security, in which market information systems for agricultural commodities are a priority (All Africa 2009b; Modern Ghana 2009; Cassavabiz 2004). There could be successful examples for other agricultural commodities that come as a result of this effort.

Access to credit
Access to credit is often mentioned as a bottleneck to improve cassava production and processing systems. The NCGA has, therefore, assisted its members in gaining access to agricultural credit. It appears that the results vary greatly by state. There have been credits supplied by UNDP and the UBA Bank. The success appears to depend largely upon the support by the governor in each state. There are also a number of microfinance systems with the primary mandate to provide credits to farmers, falling under the Nigeria Agricultural Credit Rural Development Bank (NACRDB).
However, the traditional system includes many informal credit systems and institutions that support the informal trade in gari and other commodities. The gari trade system involves primarily women. There is usually no collateral attached but guarantors of high standing serve as sureties. Informal credit systems mainly operate on the basis of mutual trust. Advantages of the informal system are the reduced paperwork and responsiveness to the needs of the poor. Formal credit systems have failed to reach the relatively poor, predominantly female gari traders. For any programs aimed at influencing the gari trade system, it is important to build on the strengths of the traditional institutions, which are largely built on trust, rather than the formal systems, which are not effective and not trusted. The latter is particularly relevant for formal credit and security systems.

Transport is an important cost item. Fresh cassava roots are not frequently transported because of the high moisture content and weight. But even gari is a bulky product. Transport fees are relatively high, including unofficial tolls at police checkpoints.

**Extension system**
Agricultural extension is the responsibility of the state-based ADPs. Within each state, ADPs are organized by zone and then local cells. While well-organized, ADPs are often under-resourced and under-staffed. According to NRCRI, they are not effective, and one could better by-pass the ADPs. During the campaign to avoid the spread of cassava mosaic virus, the government and USAID made use of a variety of agencies and networks to reach farmers and disseminate the improved varieties. The most important were the NCGA, the Women in Agriculture program, the organized private sector, schools, and religious organizations. The approach has been to organize clusters around demonstration trials and processing centers so that raw materials were readily available for processing plants.

To improve the productivity of cassava, the main extension messages are the use of fertilizer, nitrogen-fixing legume intercropping, and use of improved high-yielding varieties. However, as stated before, to purchase these farmers need credit systems. There is also a problem of fertilizers in Nigeria not being adapted to requirements of cassava crop.

### Potential partners for strengthening production:
- ADPs
- Ministry of Agriculture and Water Resources
- Nigeria Agricultural Credit Rural Development Bank (NACRDB)
- Women in Agriculture
- NCGA
- NGOs
- NRCRI
**Transport, storage, processing and retail**

**Government agencies**

The Presidential Initiative on Cassava was initially coordinated by the Ministry of Agriculture and Water Resources (FMAWR) and the Ministry of Commerce and Industries (FMCI). Within the FMAWR, a cassava desk officer was placed. The Root and Tuber Expansion Project (RTEP) is an agency of the FMAWR, financed as a loan program by World Bank and IFAD. During the first phase, it focused on the multiplication of planting materials. During the second phase, it focused on the processing of cassava.

Within the FMAWR, the Raw Materials Research and Development Council (RMRDC) is in charge of training small and medium enterprises in processing cassava into different products. RMRDC organized workshops and seminars to inform cassava producers and processors on new developments.

The FMCI leads policy formulation to encourage exports of cassava products through the export expansion grant scheme. This scheme is approved to support the development of export crops with the potential of local value addition and helped establish the Cassava Exporters Association of Nigeria (CEAN) to catalyze cassava processing and export.

**Gari processing market chain**

As stated before, processing of *gari* is the main market chain of cassava. The market chain is illustrated in Figure 10.

**Figure 10: Gari market chain (Ezedinma et al. 2007)**
Cassava processing may be done by household producers themselves, or cassava tubers may be sold to rural processors who convert it into *gari*. Household processors will sell their produce to primary wholesalers, who may also be retailers in the case of rural markets. Rural processors are too fragmented, and the quantity of *gari* produced is too little to warrant travelling to urban markets. The processors cannot make any reasonable income if they have to travel long distances to sell small quantities of *gari* in urban markets. The farmers and processors who bring their *gari* to the urban markets are those who live close to the market. There are also some urban processors who buy fresh cassava tubers from the farmers.

There are two types of wholesale traders. The first are those who travel to rural processors or markets, bulk *gari* in large bags, and transport these to urban markets. In Ebonyi state, this is the most common type (70 percent of *gari*). The second group is that of travelling wholesalers. They purchase in bulk from the primary wholesalers and sell to consumers in distant markets.

Retailers buy from wholesalers and sell to urban or rural consumers. Retailers can be divided into those who own the stall and those who rent stalls. The first are relatively rich. Most *gari* traders have to sell in open space markets as they do not have access to stalls because stalls are routinely sold to richer, well-connected retailers.

*Gari* traders are relatively poor as compared to traders of other agricultural commodities, such as wheat, beans, or rice, because the trade of *gari* is generally over small distances and therefore does not require much capital. Therefore, one might encounter a rice trader also trading *gari* but not the other way round. Likewise, *gari* traders are less organized, and there are no traders’ associations. However, there do exist several types of local interest groups relevant to the *gari* commodity chain, such as transport associations, security associations, and *gari* trader or market associations in certain towns (Ezedinma et al. 2007). These are very important informal networks.

*Gari* prices are relatively stable (see above) and vary by level of demand and supply and *gari* quality. There is no evidence of deliberate action to control volumes or prices. However, wholesalers appear to have some control over the prices in urban markets if they decide to sell limited quantities in the rainy season when prices drop. The extent to which they are successful in influencing markets is unknown since market information is passed on through informal networks (Ezedinma et al. 2007). However, there is also a need for a better market information system to improve the dissemination of market information to cassava farmers, marketers, and end users throughout the country.

Historically, *gari* of low quality was characterized by high moisture content, high fiber content resulting from poor sieving, and large coarse texture. In recent years, increasing demand has lead to increasing competition based on preferred qualities, and each processor strives for higher quality, as determined by above criteria.
mainly. Certain locations seem to become known for their high quality *gari*. This can be seen as a sort of ‘branding’.

**Processing initiatives associated with projects**

In recent years, several initiatives have supported processing of cassava by small and medium enterprises. The typical equipment of a small-scale processing facility includes a chipping machine, a drying platform, packaging devices, a peeler, a grater, a press, a grinder/milling machine, and a starch collection vat. Some of these have been available since the 1970s. Two major projects have supported cassava processing, both focusing on the main production zones in the south:

- The root and tuber expansion program (RTEP) using a loan from IFAD to end by March 2010.
- The cassava enterprise development project (CEDP) financed by USAID, Shell, and IITA, which together with the campaign to avoid the spread of the mosaic virus is referred to as the Integrated Cassava Project (ICP).
- The regional program called “Unleashing the power of cassava in response to the food price crisis in Africa” (UPoCA) financed by USAID and spanning two years (2009–2010). The UPoCA project is managed from IITA Sierra Leone and covers seven countries in Africa: the Democratic Republic of Congo, Ghana, Malawi, Mozambique, Nigeria, Sierra Leone, and Tanzania. UPoCA emphasizes hands-on training enabling participants to empower producer groups, agro-processors, and entrepreneurs with technical knowledge and skills required to provide adequate supplies of cassava food and industrial products. The program undertakes regional exchange visits.

Both programs began by enhancing the use of improved cassava varieties by farmers. It is reported that by 2009 about 300,000 farmers were planting improved varieties covering an area of 23,000 hectares. This is, however, very few compared to the total area grown with cassava (less than 1 percent). It is stated that the cassava yield of these farmers is at average 25 t/ha (Tarawali et al. 2009).

The second phase focused on enhancing processing of cassava and making improved equipment available for small- and medium-scale enterprises. A market information system was also promoted. The ICP review states that nearly 500 processing enterprises and over 10,000 new permanent jobs were created, with over US$ 50 million generated from gross sales of cassava products such as mash, *gari*, odorless fufu, high quality cassava flour for bread making, cassava chips, cassavita (a cassava product fortified with soy bean protein), starch, and ethanol (Tarawali et al. 2009).
Box 3: Review of RTEP results

The following are conclusions from a country program evaluation of the RTEP IFAD program (IFAD 2009):

- There are concerns with regard to the relevance of the second phase (cassava processing and marketing), as insufficient attention was given to involving the private sector and financial institutions. Neither was adequate consideration given to the viability of investments in processing activities, the competitiveness of trade, and the limitations in market demand for cassava.
- Effectiveness was constrained by the lack of emphasis on business development training for farmers, on agro-processing, on access to rural finance, and on market linkages for cassava production. The emphasis was on enhancing production and less on access to input and output markets. There has been limited emphasis on value addition of crops, which has constrained sales and incomes to farmers.
- The key factors underpinning efficiency at the farm level are high costs of operations, narrow gross margin, low net returns, poor benefit-cost ratios, and a high break-even point. Most of the cassava processing is unlikely to be viable and sustainable. The shift towards encouraging grower groups to process the cassava appears to be based on unrealistic assumptions of technical and financial feasibility and end-product marketability. For example, many small- and medium-sized cassava-processing mills are not functioning at full capacity, and new ones are not taking off because of the lack of markets and/or marginal profitability or outright loss.

Private sector large-scale processing

The PIC has put much emphasis on potential industrial uses of cassava. These include: flour, animal feed, chips, starch, and ethanol. These potential uses all require cassava with high dry matter content and would benefit from a long shelf life.

The mixing of wheat flour with 10 percent cassava meal is an official, but unmet, target of the PIC to stimulate cassava production. The underlying reason is that production was not profitable due to low wheat prices, low import levies on wheat imports, and insufficient cassava meal supply of good quality. Moreover, there is a powerful lobby by interest groups in the wheat sector (Flour Millers Association of Nigeria). Currently, a low proportion of cassava flour is being mixed with wheat flour due to increasing wheat prices on the international market. However, this is not an interesting option for HarvestPlus, as the proportion of cassava mixed with flour will always remain low, and nutritional benefits of the mix would be questionable, even when biofortified cassava flour is used.

Large-scale processing initiatives of other products, such as animal feed and starch, have not been very successful so far. In the late 1990s, some medium- and large-scale enterprises were operating in processing starch. However, many of these

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closed down because they were working at low or seasonal capacities (IITA 2004). Important underlying factors are the inability to source a reliable stream of good quality cassava root, market vagaries, and trade policies.

Three large-scale cassava processing industries are mentioned: Nigeria Starch Mills, Ekha-Agro, and Matua Foods. They all produce starch and cassava flour and are in search of large and reliable quantities of good quality cassava.

Ekha-Agro Farms has built the largest glucose syrup factory in Africa with cassava as its major raw material. However, this factory ran into problems due to unreliable delivery of cassava. With support from the UPoCA project, an agreement was recently been signed between Ekha-Agro Farms and the Niger State Cassava Growers Association. The agreement stipulates that the Niger State Cassava Growers Association (NSCGA) will cultivate 5000 hectares of cassava for the 2009/2010 season using improved varieties from IITA. Ekha-Agro agrees to buy 200 tons of fresh cassava roots per day for one year at the agreed farm gate price (i.e., about 70,000 tons in one year). So far, the farmers have secured 200 hectares from each of the 25 local government areas of the state, acquired 10 tractors out of the 40 required, and identified sources to procure TMS 30572, one of IITA’s improved cassava varieties. UPoCA will introduce 10 additional new varieties to expand the options available to farmers and enable them to diversify. Meanwhile, the possibilities are explored to provide a loan facility by Bank PHB (IITA 2004). This is a win-win situation for both farmers and the factory (Okechukwu 2009). However, such agreements have often failed in the past because farmers (temporarily) find better markets. With this agreement, farmers will also be supported by IITA to grow cassava in a competitive way. To do so, they will acquire tractors and new cassava varieties, while a loan agreement with a local bank is under negotiation.

This example shows that agreements about vertical integration can be made with the following ingredients:

- Agreement between private company and state-based cassava growers association,
- Farmer support agency, such as IITA, and
- Credit supply system.

Recommendations to improve cassava utilization and processing from a review of the PIC highlight the following needs:

- Increased research for development in the area of cassava utilization and processing;
- Government investments for the establishment of farm gate processing centres;
- Partnerships between Nigerian and foreign investors; and
- Formal legislation to facilitate compliance with PIC objectives, such as mixing of cassava in baking flour (Sanogo and Adetunji 2008).
Branding
Branding will not be an issue for high beta-carotene cassava varieties and derived products. For one, the markets are largely informal, and branding will not work. Second, there are many different types of gari varying in quality and also in intensity of yellow color. In time, the type of gari obtained from high beta-carotene cassava will evolve and become widely known for its color and other distinctive traits.

The conclusion is that wholesale and retail traders of gari are key actors in the cassava market chain. As compared to other commodity chains, they are relatively poor and predominately female. Traders operate within well-organized but informal market institutions even though formal government (state and local government) institutions exist.

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<th>Potential partners for strengthening storage, transport, and processing:</th>
</tr>
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<tbody>
<tr>
<td>• NCGA</td>
</tr>
<tr>
<td>• Industrial processors, like Akha-Agro</td>
</tr>
<tr>
<td>• Projects like CEDP and ICP</td>
</tr>
<tr>
<td>• State governments</td>
</tr>
<tr>
<td>• Ministry of Agriculture and Water Resources (FMAWR)</td>
</tr>
<tr>
<td>• Raw Materials Research and Development Council (RMRDC)</td>
</tr>
<tr>
<td>• Ministry of Commerce and Industries (FMCI)</td>
</tr>
<tr>
<td>• Cassava Exporters Association of Nigeria (CEAN)</td>
</tr>
</tbody>
</table>

There are many different ways of eating cassava. In the northern part of the country, cassava is eaten raw, which is safer since the variety grown in this area has a low cyanide content. Cassava processed into gari is the main consumption product. Cassava products such as gari may contain cyanides if not well processed, which can cause health problems.

It is widely believed that the addition of palm oil has a detoxifying effect and thus reduces potential health problems of consuming gari. In southern Nigeria, gari is therefore commonly mixed with some palm oil, which gives it a yellow color. Thus, in the South, the yellow color is associated with a better quality and is also reported to have a slightly higher price than white gari. However, the addition of palm oil and the hygroscopic nature of gari may make it more susceptible to microbial attack during storage, causing a preference for the white variety (Ezedemna et al. 2007).

Therefore, yellow gari is preferred when it will be shortly consumed but not when it must be stored or transported over long distances. Clearly, preferences for yellow gari throughout Nigeria should be further explored. There is also a question whether yellow-colored flour when mixed with yellow cassava is accepted.

There is still insufficient knowledge of the behavior of beta-carotene in cassava during food preparation and consumption. It is generally assumed that when gari is
processed, 50–60 percent of beta-carotene is lost, while with preparation of *fufu*, 30–50 percent is lost. Thus, the average level of loss is 50 percent.\(^{13}\) This level corresponds to the assumptions of the HarvestPlus program of 50 percent losses and still supports the claim that the biofortified cassava has many health benefits when consumed after processing.

These estimates are based upon tests of cassava with low levels of beta-carotene. It is unknown how cassava with high levels of beta-carotene will behave in terms of uptake, retention, and stability. For example, there are suggestions that high beta-carotene cassava when processed might turn into a blackish color.

Note that the addition of palm oil (containing high levels of beta-carotene) to *gari* does not have a major nutrition effect because they are cooked for a long time, causing most of the beta-carotene to be lost.

The NRCRI has developed a range of processed products that can be made from cassava, ranging from cookies and cakes to doughnuts, chips, or salted strips. These products have been distributed since 2005 in demonstration villages around the NRCRI. The uptake of these products has so far not been surveyed, and no initiatives have been taken to raise interest among the private sector or other market players.

Consumer preferences may be summarized as generally preferring yellow cassava and yellow *gari* due to its association with palm oil. This is the case in the southern zones. In the north, consumers have probably never seen yellow cassava; they are expected to be indifferent, and HarvestPlus is planning to test this idea in late 2010/early 2011.

In order to reach women and young children, systematic behavior change communication approaches are fundamental. In addition to considering individual health beliefs and practices, plans to promote nutritional improvements should also address, as appropriate, the policy environment, local traditions and household dynamics, and the quality and availability of services and products. Audiences should be carefully segmented, messages and materials pre-tested, and both mass media and interpersonal channels used to achieve defined behavioral objectives (Ohiokpehai 2010).

**Policy context and government programs**
The Joint National Committee on Food and Nutrition (NCFN) in Nigeria is the ideal starting point to involve government institutions in the HarvestPlus program. The ministries involved in this program are diagrammed in Figure 11.

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\(^{13}\) Personal communication, Dr. Bussie Maziya-Dixon, IITA, 2009.
Also involved in the NCFN are several international and national NGOs and research institutes. Private sector is not involved.

Relevant government policies and programs include the following:

- National policies to reduce malnutrition / National Program on Food and Nutrition
- National policies on improvement of agricultural production
- Overview and importance of state-based programs on improved nutrition and improved agricultural production
- National policies on GMOs
- National policies on gender awareness and programs to reach women in agricultural projects, Ministry of Women’s Affairs
- National programs to support food and nutrition within institutions such as schools, medical centers, and the army

There are several government programs that could support the introduction of biofortified cassava, especially school feeding programs in secondary schools that exist throughout Nigeria and have a lot of experience. While such programs may have an impact on effective demand and stimulate supply, it is not expected to affect consumer preferences outside these institutions.

In a meeting with the NCFN, it was clearly stated that the HarvestPlus program should align with the BioCassava Plus program, as both seem to have the same objectives and are preparing a dissemination phase in parallel. The NCFN is highly skeptical about the BioCassava Plus program due to its use of GMOs, and the HarvestPlus program should make clear how it differentiates itself both in terms of products and dissemination process. It has been especially confusing that the BioCassava Plus program has also started to develop a dissemination program in parallel with HarvestPlus.
Role of NGOs
At the national level, some NGOs are involved in the NCFN. These are mainly social development-oriented NGOs, involved in the health and nutrition sector; environmental-oriented NGOs are not involved.

At the local level, there are numerous NGOs, and these organizations must be involved in any cassava dissemination programs. The quality and scope of NGOs varies greatly, so selection of suitable NGOs will have to be based upon experience and a critical inventory. NGOs will be highly instrumental in reaching out to the intended target groups and will also be relevant to take into account the cross-cutting sustainability issues of gender, environment, and pro-poor.

Friends of the Earth Nigeria (FoEN) will need to be involved and well informed from the beginning to create buy-in, as they are strongly opposed to any activity that has any linkages with or resemblance to genetic modification.

IV. TOWARD A CROP DELIVERY PROGRAM

Push and pull strategy
Introduction
Two main different delivery strategies can be distinguished. Push strategy is supply oriented. It assumes that by introducing new seed varieties and by focusing on seed multiplication and distribution as well as crop production (through extension and input supply), biofortified crops will be adopted by farmers and as a consequence reach consumers. By flooding the market with new varieties one pushes biofortified crops in the market.

Pull strategy is demand oriented, focusing on the demand for biofortified crops or processed products. This demand can be created by end consumers, processing industries and/or food distribution programs. Consumer communication plays a major role in creating consumer demand. A pull strategy assumes that by creating a strong demand, the supply will automatically follow.

The emphasis on push or pull will vary for each country. Yet, in most situations a combination of both push and pull strategies will be combined.
Elements of push strategy

The following push factors apply in Nigeria:

Figure 12: Push factors

Three prerequisites are required for a successful push strategy. One is the supply of adequate amounts of biofortified rootstocks. This is currently lacking due to the nature of vegetative multiplication, the lack of a large-scale private sector rootstock supply system, and low uptake by farmers of new varieties (due to the poor extension system). The other prerequisite is increased productivity and higher yields, which would also be supported by a proactive extension system. The third prerequisite is good infrastructure and transport facilities to transport bulky cassava primary products. The most important positive and negative push factors are:

- (positive) Several improved varieties have been released in recent years, and a fast-track process has considerably reduced the time between testing and dissemination. However, this fast-track process can only be applied under certain conditions and requires massive resources.

- (negative) The actual uptake by farmers of new cassava varieties is quite low. The relatively slow rate of wide-spread dissemination of improved cassava varieties is due to several factors: the slow multiplication rate through rootstocks and absence of commercial large scale rootstock multiplication; the absence of benefits for farmers due to low cassava prices; and the absence of higher yields if input packages are not supplied. Thus, rootstocks of improved varieties must be accessible to farmers, and there must be market incentives for farmers to select these improved varieties.

- (negative) The rate of multiplication is low, probably at maximum a factor 10, if a wide range of farmers are involved, and high quality extension support is given. This is unlikely so the real multiplication factor is probably around a factor 5. It can thus be estimated that to reach out to 5 million cassava farmers in Nigeria will take at least 6–8 years (probably half for a limited number of selected states)

- (negative) Cassava yields have not substantially increased in spite of measures to improve yields. Underlying problems are: cassava markets and prices showing (cyclical) variation, absence of strong markets for processed products, poor credit systems to purchase the input supply package, and poor extension services. Although there are reports of improved yields, overall yields show stagnation, especially among poor farmers. Thus,
increased cassava production is mainly due to area expansion. This creates risks for other food crops or environmentally sensitive areas.

- (positive) Cassava has a high status since the release of the PIC in 2002. As a result, production and consumption have increased overall. The PIC was mainly oriented at cassava processing and income generation through industrial uses and exports. Although generally considered successful, this main objective has not been met. Several projects have helped disseminate improved cassava varieties and support processing of cassava by small and medium enterprises. Although successes have been achieved, there is not wide-spread adoption. Many SME cassava-processing mills are not functioning well, and new ones are not taking off because of the lack of markets and/or marginal profitability.

- (positive) Cassava growers (Nigeria Cassava Growers Association) and the extension service (ADPs) are well organised. However, their effectiveness varies by state and locality due to human and financial resources. Programs aimed at massive dissemination and challenging targets tend to bypass these institutions.

**Elements of pull strategy**

The following *pull factors* apply:

**Figure 13: Pull factors**

Nigeria has a relatively strong tradition on food processing and marketing. However, the cassava sector is mainly informally organized with limited food processing for organized (export) markets. There is a high product differentiation and important initiatives of stimulating vertical integration at the local level, which could be strengthened as part of a pull strategy. However, the emphasis should be on involving and supporting small and medium enterprises, which are led by women. The most important (positive and negative) push factors are:

- (positive) There are good potentials for large-scale processing of cassava into starch, biofuels, animal feeds, and flour. Such initiatives have difficulty surviving mainly because of insecure supply. Success can be achieved if a range of stakeholders are involved, including the private sector, the NCGA, state authorities, IITA / NRCRI, and financial (credit) institutions.
Appropriate credit systems are crucial for farmers to adopt input packages, which will allow them to gain higher yields.

- (positive) Various new products using processed cassava have been developed by organizations such as the NRCRI. Some of these might have a potential for wide-reaching dissemination and might include yellow cassava varieties. However, the private sector has so far not been involved, and no market studies have been carried out.

- (variable) Cassava is a poor man’s crop, but its status is improving and urban markets appear to be expanding. Most cassava is for home consumption (50 percent), much is locally traded to urban markets (25 percent), some is traded to more distant markets (e.g., from southern to northern Nigeria or to neighboring countries) (10 percent), while about 15 percent is processed industrially (of which only a fraction is exported). The importance and profitability of trading cassava products (mainly gari) from southern to northern Nigeria should be researched.

- (negative) The domestic cassava market is characterized by many informal structures (trade, credit, transport), relatively small and poor traders who are most female, short transport lines, and low profits. In addition, there is suspicion of government influence making any changes to the cassava market difficult.

- (negative) One reason explaining the unstable and small market for cassava products is the short shelf life of cassava and low value by volume. A high dry matter content and reducing the perishability of cassava are important issues for improving markets for processed products. The issue of shelf life is researched by NRCRI.

- (negative) The contribution of high beta-carotene cassava in combating malnutrition is difficult to assess because it is unknown how beta-carotene in cassava behaves when cooked and how much is taken up when consumed. Nutrition trials are required.

**Conclusions**

In Nigeria, a *pull strategy* will clearly be most important to develop, as illustrated by the number of pull factors. The case for a *push strategy* is less strong, especially in view of the slow rootstock supply process and low productivity though market development is expected to improve and promote this. We propose a **combined strategy**, with an explicit emphasis on the pull strategy. The push strategy would run in parallel to the pull strategy.

**Conditions and targets**

We think it is important to specify important conditions for a successful dissemination program of biofortified cassava and be more specific about the target groups.

Conditions for a successful dissemination program include the following:

- One condition to be met in order to proceed with the dissemination program of provitamin A cassava in Nigeria is to clearly define how this program relates to the BioCassava Plus program. It has been especially confusing that
the BioCassava Plus program has also started to develop a dissemination program in parallel with HarvestPlus. Within government institutions, there is confusion and therefore a sense of suspicion.

- In addition, there is need to establish a forum involving all relevant stakeholders of the HarvestPlus program. This forum would normally be derived from the National Committee on Food and Nutrition (NCFN) and also include some relevant private sector agencies would could play a role in cassava product dissemination, as well as IITA and NRCRI representatives. This forum would need to be involved in preparing and validating the dissemination program and could result in the development of a central organizing group to lead biofortified cassava efforts in Nigeria.

The selection of targets for the HarvestPlus program in Nigeria have been widely discussed and two issues have been raised.

- One is the target group of the program. The highest proportion of malnourished people can be found in the northern zones. However, cassava is not the main product being consumed in this region, and yellow cassava is not widely known. In the southern zones, there are important pockets of malnourished people, especially in coastal areas, who already consume cassava on a daily basis and appreciate yellow cassava due to its relation with palm oil mixing. This would suggest that the HarvestPlus program should take two approaches in tandem: select a number of states in the north and the south to be targeted for delivery. These states may be selected based on their willingness to collaborate, importance of cassava production, and potential for efficient processing and marketing, as well as on existing studies (IITA, 2004) and meetings with state authorities.

- The second issue is the selection of cassava variety with different levels of beta-carotene to be disseminated. A cassava variety with expected beta-carotene content of 7–8 μg/g can be released and disseminated by the end of 2011. It is very uncertain when a variety with higher beta-carotene content can be released, especially due to unclear performance of these varieties with respect to other preferred characteristics such as high yields and high dry matter content, but it most likely will not be released for another 3–4 years. It is proposed to disseminate the 7–8 μg/g variety as this is already a great improvement and will allow the program to set in place and test various dissemination strategies.

**From strategy to delivery: Partnership management and coordination**

For effective delivery, there are different roles stakeholders can play. The approach of HarvestPlus is to promote national and local ownership from the beginning and work through these partnerships. The box below provides an overview of the major activities in this domain during the first 3–4 years of program delivery:
Box 4: Partnership management and facilitation

- Ensure the **program secretariat**.
- Create **working groups** for the different pillars, falling under the responsibility of the steering committee.
- Establish a **steering committee** composed of representatives from the different components of the program. The National Committee on Food and Nutrition should serve as a starting point for creating this committee.
- Set up a system to ensure **exchange and coordination among development of biofortified seeds, nutrition, impact, and the delivery program** components. Likewise, ensure frequent exchange and coordination between the agriculture and health sectors, as the two main pillars of the program.
- Define an effective monitoring and evaluation system (including outcome and impact indicators), agree upon a reporting system with donors agree, and develop a **learning and knowledge management** component (including exchange between countries).

To stimulate national coordination, the formation of a central organizing group responsible for biofortified crops could be considered. Government agencies and international organizations are expected to play a major role in the implementation of the second phase of HarvestPlus. This situation could gradually evolve into one in which the private sector plays a leading role, while government limits itself to creating a conducive environment. To achieve such a situation, the program should involve the private sector and farmers’ organizations from the beginning.

The steering committee will have an operational focus and will be involved in planning operations and supervising implementation. The main implementing organizations in the delivery program will be members of the steering committee.

The institutions at the state level will play a major role in the implementation of the program. Therefore, a number of states will be selected to be involved, and it is expected that the decentralized institutions can play a crucial role in pilot activities, such as smallholder seed multiplication, demonstration plots, nutrition campaigns, marketing infrastructure, and branding.

**Pillars**

*Introduction*

The major program pillars of the program are presented in Figure 14. Each pillar is a potential program component consisting of a series of activities leading to specific results.
Associated with each program pillar there are a number of organizations to be involved as stakeholders, leading to the preparation and implementation of program components. Within the framework of this country crop profile, so far only partner organizations are mentioned.

Table 1: Preliminary time schedule

<table>
<thead>
<tr>
<th>Pillar</th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rootstock supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Farmer support services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Processing and market development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Consumer Communication</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>5. Strategic advocacy</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Rootstock supply

Ensuring adequate rootstock supply is a critical condition for program success in Nigeria. For that reason, input supply is considered a separate program pillar, rather than as part of farmer support services. The assumption is that the program will start off within the next year with the cassava variety that is currently being tested for release (with an expected beta-carotene content of 7–8 µg/g). In another 3–4 years, a further improved variety may be available for release with even higher beta-carotene content. The aim of this program pillar is to ensure that a large quantity of rootstocks of the improved variety is available for uptake by farmers. This will be done through channels that have been tested and used in previous delivery programs, involving commercial farmers. Input supply will, however, involve smallholder and female farmers as much as possible.
### Table 2: Pillar 1 strategy: Rootstock supply

<table>
<thead>
<tr>
<th>Threats</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low rate of cassava rootstock multiplication; it is estimated that to reach out to all cassava farmers in selected states will take 3–4 years.</td>
<td>• Experience speeding up multiplication of cassava rootstocks, involving commercial farmers, even before new varieties are officially released.</td>
</tr>
<tr>
<td>• Improved cassava varieties (7–8 μg/g beta-carotene) to be released within the next year; better varieties still far from available.</td>
<td>• Improved cassava varieties are believed to perform at least as good on all preferred traits, thus voluntary multiplication by farmers is expected to take place.</td>
</tr>
<tr>
<td>• The impact / effectiveness of previous delivery campaigns of new varieties (uptake by farmers) is unknown.</td>
<td>• There is a strong drive within institutions to support cassava varieties with higher beta-carotene contents.</td>
</tr>
<tr>
<td>• Rootstock multiplication will be costly if carried out by contracted commercial farmers to speed up outreach.</td>
<td>• Experience delivering rootstocks of new varieties to farmers involving a variety of actors, including local NGOs.</td>
</tr>
<tr>
<td>• Need to have a credit system to stimulate uptake of new varieties by target groups.</td>
<td></td>
</tr>
</tbody>
</table>

**Socioeconomic compliance**

- Women are strongly involved in cassava growing and multiplication. Care should be taken to ensure that women effectively have access to the improved rootstocks. This could be partly arranged by involving gender-sensitive NGOs. Government agencies do not seem to be very gender oriented.
- While the involvement of commercial farmers may speed up multiplication, there is a risk that they will take over the market of cassava rootstocks, which is now a source of income for small farmers.
- The environmental impact of cassava rootstock multiplication is expected to be insignificant.
- No negative social impacts are expected if gender considerations are effectively integrated in the program pillar.

**HarvestPlus activities**

1. As part of the steering committee to be established, create a core group of partners for this program pillar: NRCRI, IITA, VRC, and NSS. From selected states, NCGA groups, ADPs and NGOs must be selected and take the lead.
2. Define priority target groups for uptake of rootstocks produced in line with the agreed strategy and aimed at targeted states.
3. Develop and agree upon a strategy for widespread rootstock multiplication of new cassava varieties, the involvement of small as well as commercial farmers, and the way to address sustainability problems to ensure access to rootstocks for targeted farmers within a set time period. This includes training and coaching of (smallholder) farmers.
4. Implement the strategy prior to the official release of the new varieties (to win time). Both NRCRI and IITA have experience in multiplication activities, training, and involving different categories of farmers.
5. Agree on a credit system to support uptake of new rootstocks. This will be critical for success, and there are some experiences in Nigeria.
6. Gain insight and develop mechanisms to ensure that women are reached. This should be done in collaboration with gender-oriented NGOs and be specific for different regions.
7. Develop a mechanism for quality control.
### Opportunities and Indicators

**Success factors and indicators**
- Quantity of biofortified cassava rootstocks produced and made available to farmers to meet targets for roll out phase.
- Number of male and female farmers involved in smallholder rootstock multiplication.
- Number of farmers using new biofortified cassava rootstocks (men, women).
- Time it takes to deliver new varieties to 20 percent of target groups in selected states.

### Farmer Support Services

The territorial administration is responsible for the organization of agricultural extension services through the ADPs. Farmer support services can consist of training, advice, and supply of materials. The effectiveness of ADPs varies considerably. ADPs also appear to be oriented mainly at intensification programs, such as mechanization, use of agrochemicals, and markets. The outreach capacity of ADPs is very limited. It is unclear to what extent cassava is a priority for ADPs. Members of the NCGA take measures to contribute to improved cassava production, through cluster farming.

#### Table 3: Pillar 2 Strategy: Farmer Support Services

<table>
<thead>
<tr>
<th>Nigeria Provitamin A Cassava</th>
<th>Pillar 2. Farmer Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong> To produce a desirable volume of high beta-carotene cassava.</td>
<td><strong>Opportunities</strong></td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td><strong>opportunities</strong></td>
</tr>
<tr>
<td>- Extension services at the state level are largely ineffective, and coverage is low, thus need to set-up parallel structures.</td>
<td>- <strong>Ongoing programs</strong> that include improvement of extension services, in collaboration with private sector market access and credit programs.</td>
</tr>
<tr>
<td>- Agricultural extension services are mainly oriented at intensification of cassava, of which applicability to small farmers is uncertain.</td>
<td>- Priority issues to be addressed and improved to increase cassava production are well known.</td>
</tr>
<tr>
<td>- Input supply is inadequate.</td>
<td>- Some NGOs have experience in agricultural extension activities.</td>
</tr>
<tr>
<td>- Credit facilities are not available or are not tailored to farmers needs.</td>
<td>- Farmers’ organizations may be willing to provide support services.</td>
</tr>
<tr>
<td>- Land access for women is a bottleneck, reducing space available for cassava cultivation by women.</td>
<td>- Microcredit could be made available as effective demand develops; there are some ongoing experiences and pilots.</td>
</tr>
<tr>
<td>- Current use of different cassava varieties and uptake of new varieties by farmers is largely unknown.</td>
<td></td>
</tr>
</tbody>
</table>

### Socioeconomic Compliance

- An explicit focus on female farmers is a precondition for success. Female farmers and female-headed households (smaller, financially less stable, high labor input) are a specific target group. This presupposes understanding of effective ways of reaching these groups.
- The pro-poor focus will be ensured by defining the target group, focusing on smallholder farmers, and assuring that this focus is put in practice.
- Cassava intensification with high levels of agrochemicals inputs and mechanization has risks for the environment through pollution and land degradation. These risks must be avoided, and intensification may be beyond the reach of small farmers.
**Nigeria Provitamin A Cassava**

<table>
<thead>
<tr>
<th>Pillar 2. Farmer Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A precondition for ensuring the collaboration of NGOs is clarification of the HarvestPlus and the BioCassava Plus programs, the latter with assumedly high environmental and human safety risks.</td>
</tr>
</tbody>
</table>

**HarvestPlus activities**

1. There should be agreement on a cassava production improvement strategy that is suitable for small farmers, as well as one that aims for production intensification and producing large volumes of high beta-carotene cassava—these might not be the same. This strategy should be specific for different selected regions and should be developed by relevant institutions (IITA, NRCRI) together with NCGA, credit supply agencies, and NGOs.
2. Decide whether extension will make use of newly established parallel structures, in order to evade the inefficient ADP structures, and/or will make use of ADP structures. The first approach will not be very sustainable; the second will require more effort.
3. Develop and implement an effective approach to improve cassava production with an emphasis on women (based on existing extension service and/or new communication means).
4. Develop a mechanism for training, monitoring, and quality control.
5. Develop a credit supply component in parallel with the extension service component, as part of a comprehensive program. Test different credit supply systems on a pilot basis, as part of comprehensive programs.
6. Develop commercial support services in order to improve service delivery in a sustainable way.

Supporting farmers to grow cassava is a difficult domain given that the constraints to product intensification are well known but advances are difficult to realize. In any case, failures made in the past should be avoided, and lessons should be learned. HarvestPlus should be cautious before investing in this program pillar.

**Success factors and indicators**

- Volume and proportion of biofortified cassava produced by different farmer categories
- Volume and proportion of biofortified cassava marketed
- Income generated from producing biofortified cassava
- Premium price for biofortified cassava

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**Trade, processing, and market development**

Cassava products like especially *gari* are an important traded crop within Nigeria as well as the larger region. Trade is largely informal, fragmented, and not controlled. Women play an important role. Formal information systems are lacking. Export markets are small and largely linked to a few large-scale commercial enterprises. Improvements that can be made in trade relate to finance, quality of storage and processing, labor conditions, and efficiency by buying new equipment, but the main condition for success is access to markets. The program can contribute to this by supporting existing markets and creating new ones for biofortified (yellow) cassava products, developing credit facilities to purchase new equipment, and linking producers to other value chain actors. While there is currently much attention on export markets for processed cassava products, there is a need to develop products for the domestic market, specifically for vitamin A deficient children and women, the target population for HarvestPlus. This would need to be done in close collaboration with private sector companies who will undertake promotion activities based on their own interests.
Table 4: Pillar 3 strategy: Trade and processing

<table>
<thead>
<tr>
<th>Nigeria Provitamin A Cassava</th>
<th>Pillar 3. Trade and Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong> Improving existing and creating new markets for cassava products to stimulate investments in improved storage, transport, and processing.</td>
<td></td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td><strong>Opportunities</strong></td>
</tr>
<tr>
<td>• Largely informal and fragmented trade of and markets for cassava products.</td>
<td>• Demand from institutional clients, such as schools, could kick start trade in yellow cassava products.</td>
</tr>
<tr>
<td>• Insufficient insight into current markets, consumer preferences, and recent trends.</td>
<td>• Demand can be further increased if government nutrition policies include biofortified cassava products.</td>
</tr>
<tr>
<td>• Poor storage conditions due to high perishability of harvested cassava.</td>
<td>• A range of products can be produced using cassava, some of which may be marketed at a large scale.</td>
</tr>
<tr>
<td>• Low viability of small and medium enterprises involved in cassava processing, due primarily to poor markets and low profitability.</td>
<td>• Creation of new cassava products using biofortified (yellow) cassava should be possible and could open up new markets and thus trigger production.</td>
</tr>
<tr>
<td>• Current consumption and preference for biofortified (yellow) cassava not yet clearly established.</td>
<td>• There are good integrated programs promoting production of and markets for cassava products, involving credit facilities, extension, and private sector—however, these focus on export markets.</td>
</tr>
<tr>
<td>• Institutions involved in developing new cassava products do not interact with businesses.</td>
<td></td>
</tr>
<tr>
<td>• Absence of market studies on cassava products.</td>
<td></td>
</tr>
<tr>
<td><strong>Socioeconomic compliance</strong></td>
<td></td>
</tr>
<tr>
<td>• Current domestic trade in cassava products is dominated by women. There are mainly informal structures. It will be difficult to influence and upgrade these structures. Support to female organizations is essential to influence existing markets and trade. The focus should be on SMEs with high involvement of women.</td>
<td></td>
</tr>
<tr>
<td>• There is a risk that opening up new markets will negatively affect informal trade and processing structures of which women are an important part.</td>
<td></td>
</tr>
<tr>
<td>• Many rural traders have limited access to capital and make use of informal credit facilities. Equity in trade can be promoted by a focus on this group. Apart from that, new financial mechanisms will need to be put up.</td>
<td></td>
</tr>
<tr>
<td>• Care should be taken to ensure that new cassava products address markets that are eventually accessible to the poor.</td>
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<tr>
<td>• New cassava processing technologies are generally designed to be gender friendly.</td>
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<tr>
<td>• No significant environmental impact is expected, especially as long as cassava processing remains small or medium scale.</td>
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<tr>
<td>• No negative social impacts are expected if equity issues are addressed.</td>
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<tr>
<td><strong>HarvestPlus activities</strong></td>
<td></td>
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<tr>
<td>1. Create a subgroup of partners for this program pillar, including private sector agencies, representatives of traders, wholesalers, and retailers. Other core members could be government agencies that might make use of large-scale institutional programs to disseminate and market biofortified cassava, such as within school feeding programs or through the World Food Programme (WFP).</td>
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<tr>
<td>2. In close collaboration with private sector, define which end products of beta-carotene (yellow) cassava meant for domestic markets may have an added value as well as a potentially high market share (e.g. certain types of biscuits).</td>
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<tr>
<td>3. Define how small and medium enterprises can be involved in acquiring access to existing and</td>
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new markets for yellow cassava products. This will require the rapid development of suitable credit facilities, linkages to reliable markets, and capacity building.

4. Prepare partnership pilot programs for linking producers with SMEs in cassava processing and wholesalers for new cassava markets. This pilot program will involve the creation of a supply chain for new products using biofortified (yellow) cassava from the source to the retailer.

5. Involve and ensure active support of health and nutrition sectors in developing such pilot programs.

6. Undertake nutrition trials to know beta-carotene retention for preferred products and processing / preparation processes.

7. By the end of HarvestPlus phase II, supply chains for certain ‘yellow cassava’ products are expected to be in place. These are crucial for the roll out of HarvestPlus phase III. Strengthening and expanding these chains throughout the country will have to continue during this phase.

8. No significant environmental impact is expected, especially as long as cassava processing remains small or medium scale.

Processing and trade of cassava is highly fragmented and effective representation through a branch organization does not exist. This makes it difficult to create an effective core group for this program pillar. It is possible that private companies may take the lead if they are willing to go for vertical integration in line with HarvestPlus objectives. It is expected that HarvestPlus will need to play an active role in coordination and brokerage between different market players, producers, and retailers. The main aim during the four-year period would be to develop yellow cassava market chains with premium prices if possible. Such markets will create a strong pull for farmers to produce biofortified cassava and for processors to make necessary investments. It will be relevant to immediately start working on this program pillar even if biofortified cassava is not yet available because it is expected that building up alliances and partnerships, undertaking preparatory studies, and developing and testing out common strategies will take some time.

**Success factors and indicators**

- Quantity / proportion of processed and traded biofortified cassava
- Income from processing and trading biofortified cassava
- Number of rural processors, traders, wholesalers, retailers involved
- Number of products marketed with preferential use of yellow cassava
- Geographical spread of the consumption of products using biofortified (yellow) cassava

**Consumer communication: Health and nutrition**

The preparation of consumer communication should start even if biofortified cassava products are not yet available for consumption. During this phase, HarvestPlus can begin testing communication channels and collaboration with different stakeholders. High beta-carotene cassava is visibly different, but consumer preferences for this yellow variety are not well known. Excellent collaboration with health and nutrition agencies is essential.

In order to reach women, it is important to target messages to them as mothers, identifying ways that provitamin A cassava will promote healthier children who will have fewer illnesses and perform well in school (Ohiokpehai 2010)
Table 5: Pillar 4 strategy: Consumer communication

<table>
<thead>
<tr>
<th>Nigeria Provitamin A Cassava</th>
<th>Pillar 4. Consumer Communication</th>
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</thead>
<tbody>
<tr>
<td><strong>Objective: Targeted consumers are effectively reached</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td><strong>Opportunities</strong></td>
</tr>
<tr>
<td>• Relatively limited power of federal government.</td>
<td>• Existence of the National Committee on Food and Nutrition, which is quite active.</td>
</tr>
<tr>
<td>• Knowledge of nutritional issues is low; insufficient insight into beta-carotene retention after processing and cooking.</td>
<td>• Existence of states with active local governments, motivated to improve nutrition in their state.</td>
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<tr>
<td>• Consumer preferences for yellow cassava are largely unknown; therefore, specific demand for yellow cassava products is unknown.</td>
<td>• The nutrition policy offers entry points for nutrition programs; school feeding programs offer opportunities.</td>
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<tr>
<td>• General education levels in Nigeria for target groups are low, limiting the use of written materials.</td>
<td>• A dense network of rural and urban radio stations has the potential of reaching large groups.</td>
</tr>
<tr>
<td><strong>Socioeconomic compliance</strong></td>
<td></td>
</tr>
<tr>
<td>• Consumer communication efforts will have women and children under five as the most important target groups. It is assumed that the target groups will be more specifically defined at the onset of the development phase.</td>
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<tr>
<td>• Consumer communication should focus on the desirability and superiority of biofortified (yellow) cassava and its derived products. While in some parts of the country a preference for yellow cassava is already there, this preference will vary among social groups and by season and region.</td>
<td></td>
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<tr>
<td>• Consumer communication activities will need to have a specific focus on rural and urban women.</td>
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</tr>
<tr>
<td>• This program pillar has no environmental impact.</td>
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<tr>
<td>• No negative social impacts are expected.</td>
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<tr>
<td><strong>HarvestPlus activities</strong></td>
<td></td>
</tr>
<tr>
<td>1. Create a core group of partners for this pillar, including public institutions, private sector companies, and NGOs. The members of the National Committee on Food and Nutrition could form a starting point for developing this group.</td>
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<tr>
<td>2. Undertake a national survey to gain insight into consumer preferences for yellow cassava.</td>
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<tr>
<td>3. Develop and test dedicated communication programs aimed at the promotion of yellow cassava and targeted to pregnant women and young mothers.</td>
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<tr>
<td>4. As part of a partnership with a private company, develop a promotion campaign of yellow cassava product/s for the general public. Such campaigns could involve a combination of radio stations and support through decentralized government services. Consumer communication will start midway through HarvestPlus phase II and will continue throughout HarvestPlus phase III.</td>
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<tr>
<td>5. Develop and implement education programs for school children at schools with school feeding programs.</td>
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<tr>
<td>6. Undertake nutrition trials and consumer preference studies to know beta-carotene retention for preferred products and processing / preparation processes.</td>
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Availability of biofortified cassava will be a serious limiting factor during the second phase of the HarvestPlus program. Thus, it will not be possible to launch national campaigns during the coming phase. Rather, pilot programs could start in selected states from year three onward. As a preparation for the roll-out phase, it is essential to build up experience with different delivery channels and with partnering with public institutions, private sector, and NGOs.
**Table 6: Pillar 5 strategy: Strategic advocacy**

<table>
<thead>
<tr>
<th>Nigeria Provitamin A Cassava</th>
<th>Pillar 5. Strategic Advocacy</th>
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<tbody>
<tr>
<td><strong>Objective:</strong> Strategic partners are aligned and implement a joint strategy.</td>
<td></td>
</tr>
<tr>
<td><strong>Threats</strong></td>
<td><strong>Opportunities</strong></td>
</tr>
<tr>
<td>• Large number of partners and other stakeholders may lead to slow progress and lack of focus.</td>
<td>• Existing National Committee on Food and Nutrition can be used as a basis for strategic advocacy.</td>
</tr>
<tr>
<td>• High dependence on activities of stakeholders, as opposed to self-implemented activities.</td>
<td>• Expected strong government support and support from specific states.</td>
</tr>
<tr>
<td>• Controversy and lack of trust between certain stakeholders.</td>
<td>• Potential for strong support from multilateral institutions and bilateral programs and projects.</td>
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**Socioeconomic compliance**
- Pro-poor targets and socioeconomic compliance considerations will guide the activities in this program pillar.

**HarvestPlus activities**
1. Become member of and participate in sector working groups; ensure clarity of the objectives of the HarvestPlus program and its relation with the BioCassava Plus program.
2. Investigate how private sector can be more strongly involved in the program.
3. Launch the HarvestPlus program with strategic stakeholders.
4. Create core groups of partners for pillars 1–4 and ensure coordination and progress on each of these pillars.
5. Create a core group of partners for strategic advocacy.
7. Lobby for adoption of policies that support the production and consumption of biofortified cassava products.
8. Inform all strategic partners and stakeholders on a regular basis of progress made in Nigeria and other HarvestPlus biofortification efforts.

The identification of relevant stakeholders and keeping them informed about the program is an essential element. This will allow identification of other strategic partners, creation of a sense of ownership, and information sharing with policymakers and other influential actors (avoiding surprises). Being transparent on successes and failures is an important element of effective communication.

The official launch of the program in Nigeria will be one of the first visible activities of HarvestPlus in the country. It will mark the start of a continuous strategic lobby program that seeks the adoption of HarvestPlus priorities in the programs of the private sector, donors, and NGOs and in government policies.

**Success factors and indicators**

- Number of stakeholders becoming partners in the program
- Number of programs in which HarvestPlus priorities are being incorporated
- Number of policies adopted by government favorable to the production and consumption of biofortified cassava products.
APPENDIX 1. GUIDING PRINCIPLES FOR THE DELIVERY PROGRAM

Introduction
In late 2002, the Consultative Group on International Agricultural Research (CGIAR) Micronutrients Project was selected to be one of three pioneer CGIAR Challenge Programs. In 2004, the HarvestPlus Challenge Program was officially launched when it became the first recipient of funding for biofortification research granted by the Bill and Melinda Gates Foundation. HarvestPlus has since emerged as a global leader in developing biofortified crops and currently works with more than 200 agricultural and nutrition scientists around the world. It is co-convened by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI).

The year 2009 marks the beginning of the HarvestPlus product development and delivery program. The second phase will bring nutrient-rich staple crops from the laboratories of National Agriculture Research and Extension Systems (NARES) and CGIAR to the fields of farmers around the world. As a result of the breeding research and nutrition studies done in the past years, the first biofortified crops are now ready to be rolled out in large volumes, which will benefit the health status of large number of people and impact the income situation of numerous farmers.

HarvestPlus aims to empower governments, research organizations, nonprofit organizations, and private companies to reduce hidden hunger and provide micronutrients to one billion farmers and consumers, directly through the staple foods that they eat. This is achieved by a process called biofortification which entails breeding higher levels of micronutrients directly into key staple foods.

Approach of extensive and strategic scaling-up
For dissemination of new products, an “intensive approach” would entail setting a successful example and then stimulating widespread replication. In the case of HarvestPlus, this would entail making contracts with large numbers of producers, traders, and retailers, undertaking a mass promotion campaign, and finding ways to address millions of consumers. This would be an enormous task requiring many resources.

Rather, an extensive and strategic scaling-up approach is adopted, which makes clever use of a variety of existing programs and networks with potential for replication and scaling up. This will be done through strategic partnerships with private sector, civil society, and governmental organizations, based on principles of complementarity and mutual gain. The extensive approach is one whereby HarvestPlus aims to launch the delivery process and create momentum, expecting the strategic partners will then take over and realize greater impacts. This approach will vary by country, depending upon the opportunities and threats, potential strategic partners, and their responsiveness.

By means of the country crop profiles, HarvestPlus will:
1. Identify and make use of existing opportunities to realize large-scale uptake.
2. Identify and work with influential strategic partners that are prepared, based on their own interest, to create momentum and realize these opportunities.

At least initially, HarvestPlus will maintain a degree of control over critical program components, either through funding or by direct implementation. The fundraising strategy, yet to be developed, will reflect this objective.

**Cross-cutting issues**

In developing the country programs for product delivery, care will be taken to ensure that all components of the program comply with a set of cross-cutting issues. These may be defined as “sustainability criteria.” In relation to these criteria, the HarvestPlus program follows two basic principles: do no harm—that is, complying with criteria to avoid negative impacts; and do more good—that is, ways and means of orienting the program in such a way as to realize desirable benefits.

The following sustainability criteria are adopted in defining the pillars:

1. *Gender aspects.* Women should benefit at least equally from the program. Whenever possible, the program must have a positive impact on the position of women—for example, ensuring preferred access to biofortified seeds as producers and to biofortified beans as consumers.
2. *Pro-poor focus.* The program components must ensure involvement of the poor and positive impacts on the poor, be they producers or consumers.
3. *Social impacts.* There will not be any negative impacts on social issues (for example, through increased workload, poor labor conditions, low prices, etc.). Where possible, positive social impacts will be realized, such as lower workload, better working conditions, better prices, capacity building of farmer cooperatives, etc.
4. *Environment.* There will be no negative impacts on the environment, such as increased pollution through transport, more use of agrochemicals, expansion of cropland areas, etc.

**Strategy for crop delivery**

There will be no blueprint strategy for crop delivery, as contextual conditions and opportunities vary by country. The pillars constitute the first step toward a concrete program for crop delivery and will together form the strategy for crop delivery. We expect a limited set of strategic options to emerge from the pillars that together constitute a strategy for large-scale uptake. These options will gradually be developed and refined, as programs for product delivery are being prepared and planned.

The following key issues determine the proposed strategy for crop delivery:

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14 Based on the International Finance Corporation’s environmental and social performance standards
1. Can the biofortified crop be visually distinguished from the “normal” crop? Does it have desirable traits to distinguish it from the normal crops (for example, yield, taste, growth cycle, disease resistance, drought tolerance, better storage)? If so, these traits can be used in a communication strategy. It should be noted, though, that the visible characteristic may also be considered undesirable.

2. Can the nutritional superiority of the improved crop effectively be used to get the health sector on board and stimulate demand?

3. Does large-scale seed production exist (either commercial or government-led), or is it small scale and community based? In the latter case, scaling up can take place either through farmers’ organizations or through vertical integration by private companies involved in the market chain.

4. What role do nongovernmental organizations play, and how can they be effectively involved in the program? Will they participate in widespread delivery, or should they focus on issues like accountability and quality control?

5. Is the policy and institutional context favorable? Are relevant policies centralized or decentralized? This will determine the entry points of the strategy and whether government or private sector agencies can be strategic partners.

6. Are there opportunities for large-scale delivery through existing programs, such as government programs (school feeding, hospitals, army) or preferred urban market chains? If so, these can be targeted to set an example, raise awareness, and create a momentum.

In terms of timing, a major variable is whether biofortified crops and seeds are already available. If available, program components can be started that cover the whole value chain (as in the case of beans in Rwanda). If not, activities will have an exploratory character, awaiting the availability of biofortified crop seeds.

**Sustainability and spin-off**

HarvestPlus aims to change the way of thinking about strategies to address problems of micronutrient deficiencies. Through research, delivery programs, and enabling policies, crops can be developed as “carriers” of micronutrients and used to target certain population groups. HarvestPlus aims to set successful examples of delivering biofortified crops and also anchor and sustain this strategic approach in existing institutions. Agriculture and health are the key sectors and institutional partners in this strategic approach.

Different types of spin-off can be expected once a delivery program is well on its way or has been successfully completed. One is the delivery of new crop varieties as better varieties, with higher micronutrient levels or overall better performance, are being developed. Another may be the introduction of other biofortified crops, benefiting from the experiences and established structures gained through delivery of the first biofortified crop.
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