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R&D Interventions vs. Constraints in Africa's Root and Tuber Crops Sector

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Abstract
In recent years, there has been a significant increase in research and development investment directed at the African cassava sector. This paper examines the history of technological improvements in cassava across different regions of Africa, as well as major market constraints, and concludes that a more strategic approach is needed that recognizes the interdependence and hierarchy of constraints across distinct segments of the cassava value chain. Interventions that fail to address a primary constraint generally have little impact. The paper shows how primary constraints are dynamic and sequential, changing as new technical components are introduced, such that resolving one constraint increases output only up to the point that the system encounters what was previously a second order problem. And these patterns differ across regions. Cassava output in West Africa expanded after the commercialization of mechanized processing technologies only following the later broad adoption of higher yielding and disease resistant cassava varieties. Production in that region is now limited by high harvesting labor costs. But progress to develop and commercialize small, low cost mechanized harvesting equipment remains blocked by policy makers who do not see mechanization as appropriate for smallholders. In contrast, in Central, East and Southern Africa cassava production remains at the same stage that West Africa was several decades ago, with processing having been mechanized but lacking high yielding planting material. The necessary next step in this region is the development of improved well adapted varieties and investment in seed and extension systems to get improved materials out to farmers at scale. In both regions, long term growth in the cassava sector will depend on diversification of end use. Because of the low income elasticity of demand for cassava consumed directly as food in the East and Southern Africa regions, greater use of domestically produced cassava in making bread and other confectionary products, as animal feed and for industrial starch must be explored. But to be competitive with imported products in each of these end uses will require significant R&D investments to reduce unit costs across the cassava value chain.

Keywords: *Africa, Cassava, Research and Development. Technological Constraints, Market Constraints, Seed Systems*

1. Introduction

Despite a long history of neglect, there has been a significant increase in research and development (R&D) in the root and tuber crops sector of Africa. Public intervention in the cassava sector originally started when colonial governments encouraged smallholders to grow the crop because they saw cassava's unique potential as a famine reserve crop. They also urged (and sometimes compelled) smallholders to grow it as food source for laborers in plantations and mines (Jones 1959). R&D attention to the root crops sector for development purposes was given a large boost when IITA established its Root, Tuber and Banana/Plantain Research Program in 1971. More recently, an uptick in R&D attention , for example the CGIAR's Research Program on Roots, Tubers and Bananas which was approved in 2016, reflects the fact that many of the most binding constraints in each root or tuber sector have not yet been satisfactorily resolved.

Cassava, yam, sweet potato and cocoyam are the major African root and tuber crops. Constraints differ among the crops and at the same time for each crop across different settings. To adequately discuss the multiple constraints of all the root crops in all settings would be a lengthy undertaking. For that reason, this paper focuses only on constraints in the cassava sector, and in two broad settings, namely West Africa on one hand, and Central, East and Southern Africa on the other hand. Cassava is the most widely produced of all the root and tuber crops in Africa (FAOSTAT) . Several factors can constitute constraints in the cassava sector, including certain farm level conditions, adverse environmental factors, unfavorable government policies, inappropriate and/or low productivity technologies, low market demand, etc. This paper focuses on the most important technological and market constraints.

Methods of Collecting Information

This paper is based on knowledge gained from studies conducted over time. The methods of the most relevant three of those studies are summarized below:

1. COSCA studies (Collaborative Study of Cassava in Africa) were a major cassava study funded by the Rockefeller Foundation and carried out from 1989 to 1997 by the International Institute of Tropical Agriculture in collaboration with national agricultural research systems and several international organizations and universities (Nweke, Spencer and Lynam 2002). COSCA researchers collected primary data at village, household, and field levels from 281 villages in six African countries where roughly 70 percent of the total cassava in Africa is produced: the Congo, the Cote d'Ivoire, Ghana, Nigeria, Tanzania, and Uganda. This information included cassava production systems, processing and food preparation methods, market prospects, and consumption patterns. The information is designed to help develop improved food policies and research and extension programs in order to accelerate the cassava transformation and ultimately increase food security and incomes of the people of Africa.

2. Seed Systems of Vegetatively Propagated Crops study was funded by the Bill and Melinda Gates Foundation and conducted in 2010 (Nweke, Akoroda and Lynam 2011). Cassava, yam, potato, sweet potato and Musa (bananas and plantains) were covered. The study was carried out in Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Tanzania and Uganda as case studies. In the late 2000s, these seven countries accounted for more than 50 percent of the population of sub-Saharan Africa and 65 percent of cassava production, 80 percent of yam, 30 percent of potato, 70 percent of sweetpotato and 50 percent of Musa productions in the region.
Documented information on on-going Vegetatively Propagated Crops seed projects in the seven countries were assembled, studied and important lessons drawn from their approaches, strengths and weaknesses. Personal interviews were held with key stakeholders in projects. During the field work, the investigators inspected field plots, laboratories and green houses in the national research programs, international research centers and in the private sectors where applicable.

A stakeholder consultation workshop was organized in Nairobi, Kenya by the Bill and Melinda Gates Foundation to discuss a draft report and provide inputs. Invited were Selected VPC seed systems key players from IARCs, NARIs, CBOs, farmer groups, local and regional NGOs, governments, donor funded projects, regional seed trade associations and private sector were invited.

3. Mid-term reviews of four Bill and Melinda Gates Foundation cassava seed systems grants were conducted in 2014 by an external reviewer in collaboration with the implementers of each project (Nweke 2014). Three of the projects were in Tanzania, namely Cassava Community Phtosanitation, New Cassava Varieties and Clean Seed to Combat Cassava Brown Streak Disease and Cassava Mosaic Disease and Piloting Commercializing Cassava Seed Systems and one, namely Sustainable Cassava Seed Systems was in Nigeria. The Gates Foundation needed the mid-term review to efficiently deploy project resources for the second half of the grants.
The review report was based on information provided by the project implementers and on information collected through interviews, meetings and site visits. Field trips to project facilities were undertaken together by the external reviewer and project implementers. Meetings with grass root stakeholders were participatory. Protocols were observed everywhere the review team visited with courtesy calls made to government officials and political leaders at all levels of governance. Site visits in Tanzania and Nigeria respectively were concluded with a wrap up session which in each case was attended by top officers in the grantee agency and invited public officials and representatives of relevant private businesses.

The information from these studies was supplemented with time series data made available by the Food and Agriculture Organization of the United Nations as well as with information from other secondary sources.

Technological Constraints

For ease of exposition, four technology packages are distinguished, each with increasing levels of technological improvement:

1. Traditional varieties, manual harvesting, manual processing
2. Improved varieties, manual harvesting, manual processing
3. Improved varieties, mechanical harvesting, manual processing
4. Improved varieties, mechanical harvesting, mechanical processing

These are depicted in Figure 1, where:

a) A box of solid borders represents a technological package
b) A pair of parallel solid vertical lines represents optimal R&D investment under each technological package
c) A pair of parallel solid horizontal lines represents output under each technological package in combination with optimal level of R&D investment
d) A pair of parallel broken vertical lines represents over investment in R&D under the technological package below each pair of broken vertical lines
e) Under investment varies from no R&D investment to inadequate investment on the constraint.

The sequence of packages presented here reflects a stepwise adoption of individual components of a complete technological package (Johnson and Masters 2002).

Under the least improved technological package 1 (traditional varieties, manual harvesting and manual processing) output is low because of low yield. With this package, area expansion is generally unprofitable because the low yield does not pay for the extra cost of labor and land.

Under package 2 (high-yielding varieties, but manual harvesting and manual processing) output can be increased through yield increase. But the return to additional investment in R&D aimed at further increasing yields is strictly limited by binding labor constraints at harvest, which in turn limits the size of potential increases in output.

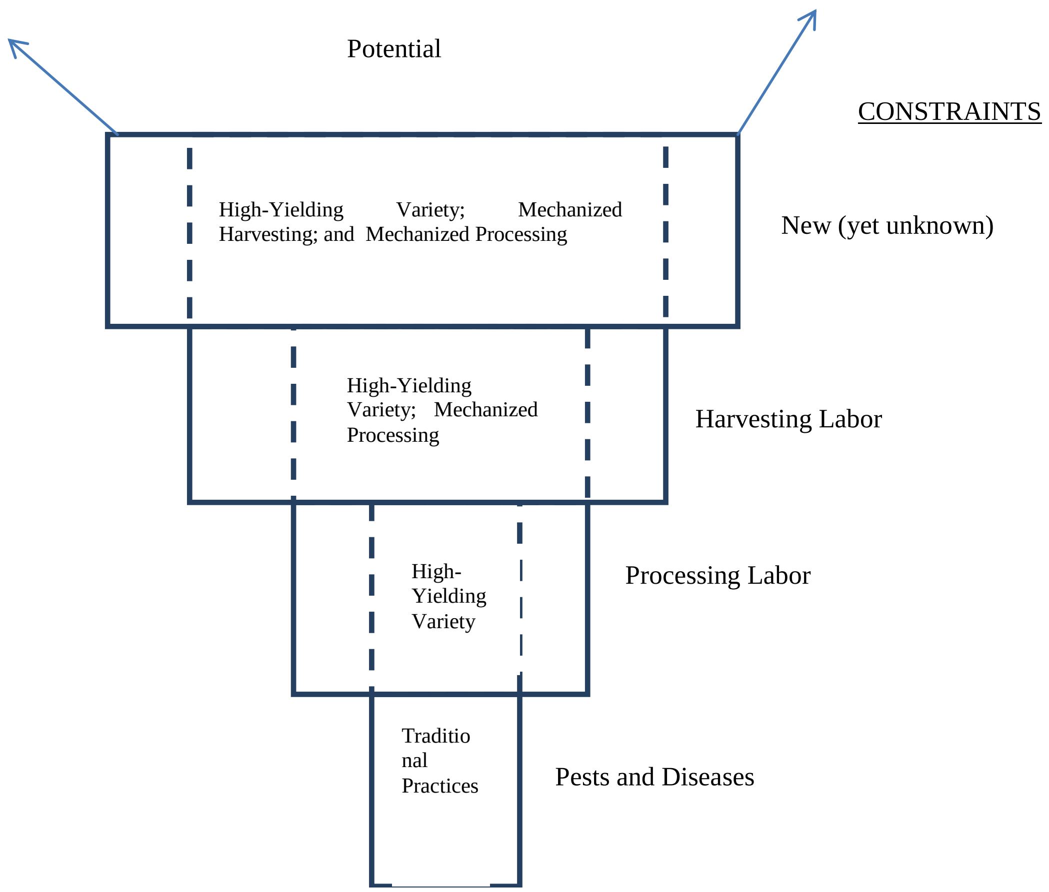

Figure 1. The concept of technological constraints in the African cassava sector.

Under technological package 3 (high-yielding varieties, labor-saving mechanized harvesting, manual processing) the area planted and thus output can be further increased because the use of mechanical harvester helps resolve the labor bottleneck at harvesting. But the potential land area expansion is in turn limited when farmers realize that they cannot process the additional output due to the hand processing labor constraint. And without rapid processing, the additional harvested cassava would quickly be lost to spoilage.

This last processing labor constraint is addressed with technological package 4 (high-yielding varieties, mechanized harvesting and mechanized processing). Only at this stage does the return to R&D investment to generate further high yield become fully attractive .

Note that the action of resolving one primary technical constraint increases output only up to the point that the system encounters another secondary constraint, just as the solution to one technological problem generally illuminates the presence of the next second or third order problem.

Market Constraints

Market constraints in the African cassava sector can be illustrated by examining various end uses of the crop (Figure 2). Cassava is consumed almost exclusively as food in Africa; it is produced and processed for sale in rural and urban markets as food in end use forms for which demand is greatest (Figure 3). In contrast, in Asia cassava is used both as food and for export, whereas in South America it is used primarily as livestock feed with a smaller share as food. Moreover, in Africa, income among low and middle income consumers generally determines the level of effective demand for a crop such as cassava which is often replaced in the diets of higher income consumers especially in East and Southern Africa by maize, rice and other foods with higher income elasticities. Though rising slowly, incomes remain low and highly skewed in most of the countries of Central, East and Southern Africa (Table 1). Also, whereas cassava may be an important source of calories in many parts of the major producing countries in West Africa, in East and Southern Africa the crop is of secondary importance to maize. In Central Africa where the crop is the primary staple, income is particularly low for most consumers. Therefore with low and only slowly growing purchasing power for a majority of the population, low effective demand for cassava as food continues to depress market demand. These patterns illustrate the need for greater end use diversification uses if cassava production is to be sustainably increased across each of the major producing regions of Africa.

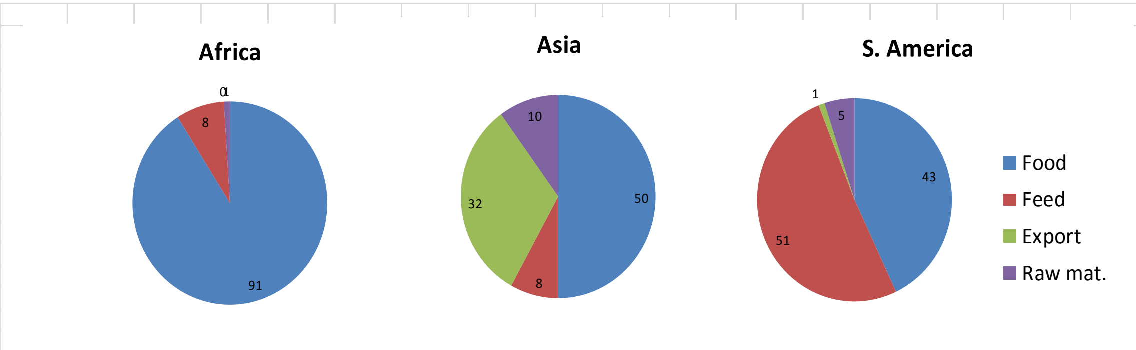

Figure 2. Africa, Asia and South America. Percentage distribution of total cassava production by uses. Source: Nweke 2004.

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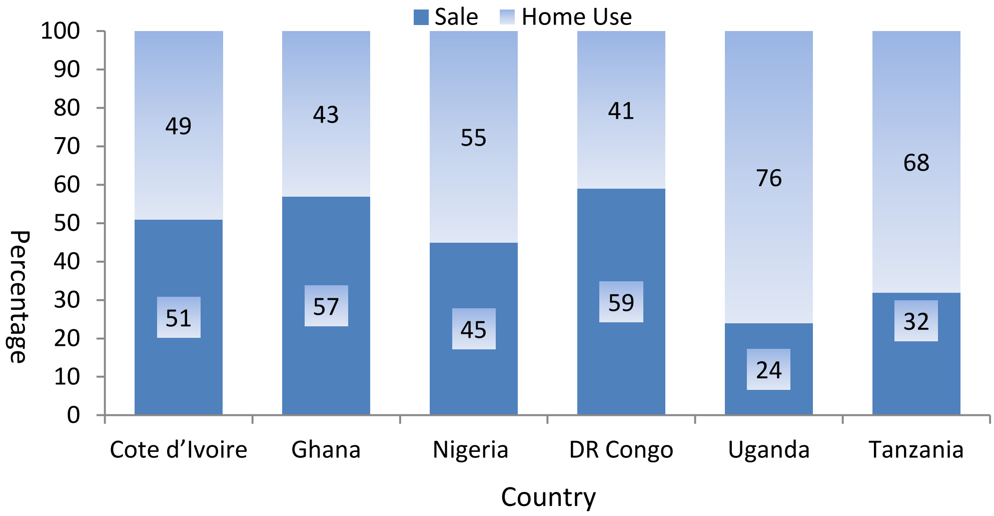

Figure 3. Major cassava producing countries in West, Central, East and Southern Africa: Percent of cassava fields planted for sale. Source: Nweke, Spencer and Lynam 20002.

In Nigeria legislative efforts were made to incorporate cassava flour into bread making and other confectionary products as a local substitute for imported wheat. But Dr Adeyinka Onabolu, Senior Advisor on Food Security & Nutrition to the Honorable Minister of Agriculture reported that "the cassava bread endeavor failed!" [1] In the country government effort to promote the use of cassava as wheat substitute in bakery began 34 years ago in 1982 when the Federal Government gave a directive that cassava flour should be included in bread making. But the directive faded away with change of government in 1983. In 2004, President Obasanjo resumed the initiative but again his effort failed with the exit of his government. Another effort was made in 2014 by the Minister of Agriculture and Rural Development at the time, Dr. Akinwumi Adesina. Dr Adesina's initiative suffered from shortage of cassava raw material. Mr. Paul Gbededo, Group Managing Director, Flour Mills Nigeria Limited reported that his company was unable to get enough cassava for processing flour[2]. *Gari* processors were paying higher prices than flour millers which were offering farmers N80,000 per ton while the cost of production was well over N100,000 (Popoola 2016)[3]. But Dr Onabou added that that the biscuit (cookie) industry is now taking up a lot of the cassava flour being produced. An investigation by Nweke and Komawa revealed that for several decades in West Africa, a wide range of snack foods have been prepared with 100 percent dried cassava root flour or cassava starch by farmers at the household level (Nweke and Komawa 1995). The snack foods have a ready market in nearby urban market centers where they are sold as party snacks and to travelers who find them convenient. Industrialization is impeded by high cost and inadequate supply of the cassava raw material.

Although the potential is great, the current use of cassava as livestock feed remains low in Africa, at less than 10 percent of total production (compared with South America with more than 50 percent). This is because at present African livestock industries are generally small scale and household based (Table 2). Unlike in Europe and North America, in Africa most of the chickens and pigs are raised on free range basis. Expansion of cassava use as livestock feed in Africa depends on expansion and intensification of production system in the livestock industries which in turn depends on improvement in consumer incomes. With rising incomes in the growing urban middle class of many African countries, growth in industrial livestock production is already taking off, though still at relatively low levels.

Cassava export from Africa is negligible because high production costs make African cassava non-competitive in the international market. The very small amount of cassava exported outside Africa is mainly as food for the African diaspora in Europe and North America.

High costs also limit African demand of locally produced cassava for industrial purposes. African countries currently depend on starch imports for more than 90 percent of the industrial raw material that cassava could supply. For example,

[1] Email message, January 18, 2017.
[2] Flour Mills Nigeria Limited is the largest flour mill in Nigeria.
[3] *Gari* is a staple cassava food product.

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nearly 90 percent of the 242,000 tons of starch used in Nigeria in 2012 was maize starch imported from Europe, and only about 10 percent was cassava starch produced locally[1]. In Lagos, Nigeria the wholesale price of Nigerian cassava starch was three times greater than maize starch imported from Europe (Nweke 2004). In Uganda, the entire 369 tons of starch used was maize starch imported from Europe (Graffham et al. 2000).

Table 1. Major cassava producing countries in Africa: Some income indicators.

Country	Poverty Head Count Ratio[1]	GDP/Cap (US$)[2]	GDP/Cap Growth Rate (%) 2014[3]
Nigeria	53.47	3,082	3.5
Ghana	25.15	1,871	1.4
DR Congo	77.18	388	6.3
Uganda	33.24	623	1.9
Tanzania	46.60	719	4.5
Mozambique	68.74	593	4.5

1. % of population at US$1.90/day, 2011. Source: World Bank Development Research Group based on primary household survey data.
2. IMF World Economic Outlook database. Latest year for which data is published.
3. IMF Regional Economic Outlook, sub-Saharan Africa.

In short, the second major market constraint facing the development of the cassava sector in Africa, apart from low effective demand for the commodity as food, is lack of price competitiveness in the industrial raw materials market. African cassava is not price competitive in the industrial raw materials market because of the high cost of production in Africa compared with most of the other parts of the world. In Europe and North America considerable amounts of public and private investments in R&D, combined with agricultural and export subsidies, have reduced unit production costs of maize,

Table 2. Major cassava producing counties in Africa and selected countries in South America and Asia: numbers of chickens and pigs per capita respectively, 2011. Source: FAOSTAT.

Country	No. Chickens/Cap	No. Pigs/Cap
Nigeria	0.9	0.04
Ghana	2.11	0.02
Uganda	1.07	0.07
Tanzania	0.07	0.01
Mozambique	0.9	0.06
Brazil	6.44	0.2
Thailand	3.62	0.12

compared with African cassava. In the United States and Europe, the main cost elements in maize production are land, machinery, chemical and seed inputs. In Africa, the main factor cost in cassava production is labor. Whereas, in North America a couple can operate a 500 ha maize farm with high-yielding varieties and machinery, in Africa an extended family operates less than one ha of mostly low-yielding traditional cassava varieties with hand hoe and machete.

Historical Evidence of "False Start" Technical Changes[2]

Early technological changes in the African cassava sector demonstrate the interdependence of constraints across the value chain. In West Africa, for example, the introduction of labor-saving mechanical processing technologies preceded the introduction of high-yielding varieties in the cassava sector. The French introduced mechanical graters in Benin (formally Dahomey) in the 1930s to teach farmers how to prepare *gari* and *tapioca* for export (Jones 1959). The replacement of hand grating with the mechanized grater reduced the cost of making *gari* by 50 percent (Nweke, Spencer and Lynam 2002). The adoption of the mechanical grater at the processing stage, however, did not result in significant growth in total production through area expansion owing to labor constraints and low yielding traditional varieties that farmers were planting. Nigeria remained the third largest cassava producing country in the world after Brazil and the DR Congo from early 1960s to late 1980s when its farmers were planting traditional varieties (Figure 4). During the same period, when Ghanaian farmers were planting low-yielding traditional varieties Ghana remained the sixth largest producing country in Africa after Nigeria, DR Congo, Tanzania, Mozambique and Uganda (Figure 5).

[1] DOREO PARTNERS. Nigeria has strong demand for starch.

[2] The phrase is taken from False Start in Africa (Dumont 1969).

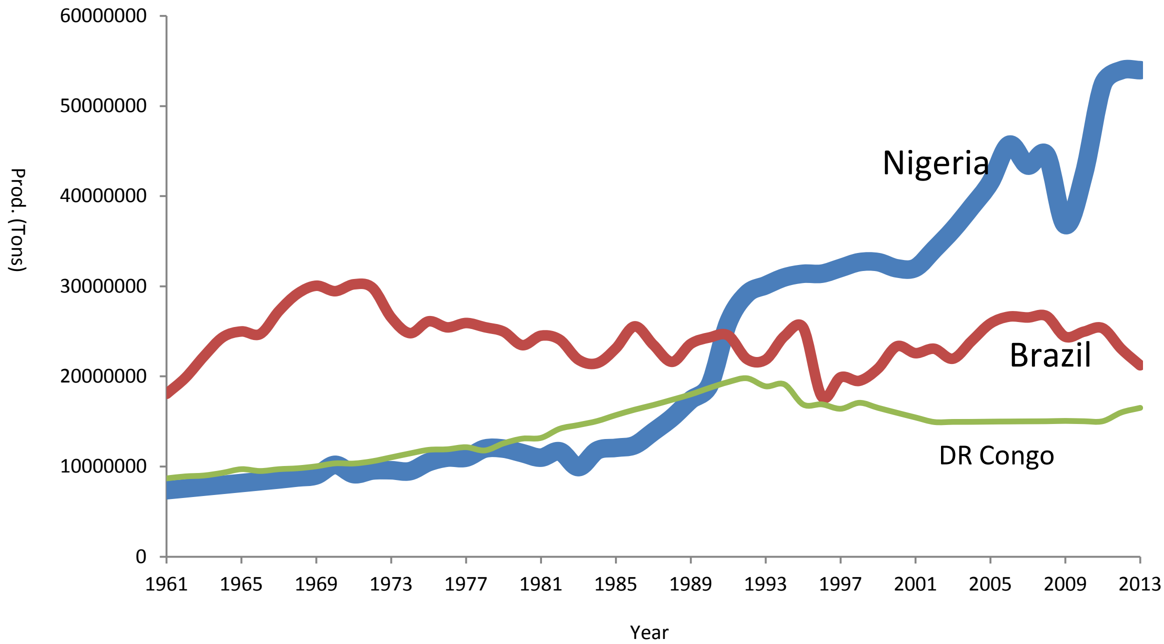

Figure 4. Nigeria, Brazi and Democratic Republic of Congo: Annual cassava production from 1961 to 2013. Source: FAOSTAT.

In 1977 IITA released the first generation of high-yielding mosaic resistant TMS (Tropical Manioc Selection) cassava varieties to farmers in Nigeria (IITA 1978). The farm-level yield of the TMS varieties was 40 percent higher than that of the traditional varieties (Nweke et al. 1999). Adoption was rapid and production soon took off, as Nigeria advanced from third largest to the largest producing country worldwide by the early 1990s. In 1988, the Government of Ghana imported the TMS varieties from IITA and the country progressed from being the sixth largest to the second largest producer in Africa after Nigeria beginning in the early 2000s.

Subsequently, however, the high yields obtained using the TMS varieties shifted the primary production constraint from low yield to labor at harvesting, the most labor-intensive field task (Table 3). This not only impeded further expansion of production in both countries, but also contributed to rising wages for farm labor. During the rapid diffusion of the TMS varieties in Nigeria, from 1984 to 1992, cassava production per capita increased and cassava prices to consumers fell dramatically. Within an interval of 10 years (from 1991 to 2001), the farm wage rate more than doubled while the nominal price of gari increased by less than 40 percent. This situation made it difficult for farmers to expand production by planting more high-yielding varieties with hired labor. Therefore, farmers who planted the TMS varieties as a cash crop for urban consumption sometimes suspended cassava planting because they could not find sufficient hired labor to harvest and process earlier planted fields (Nweke 2004).

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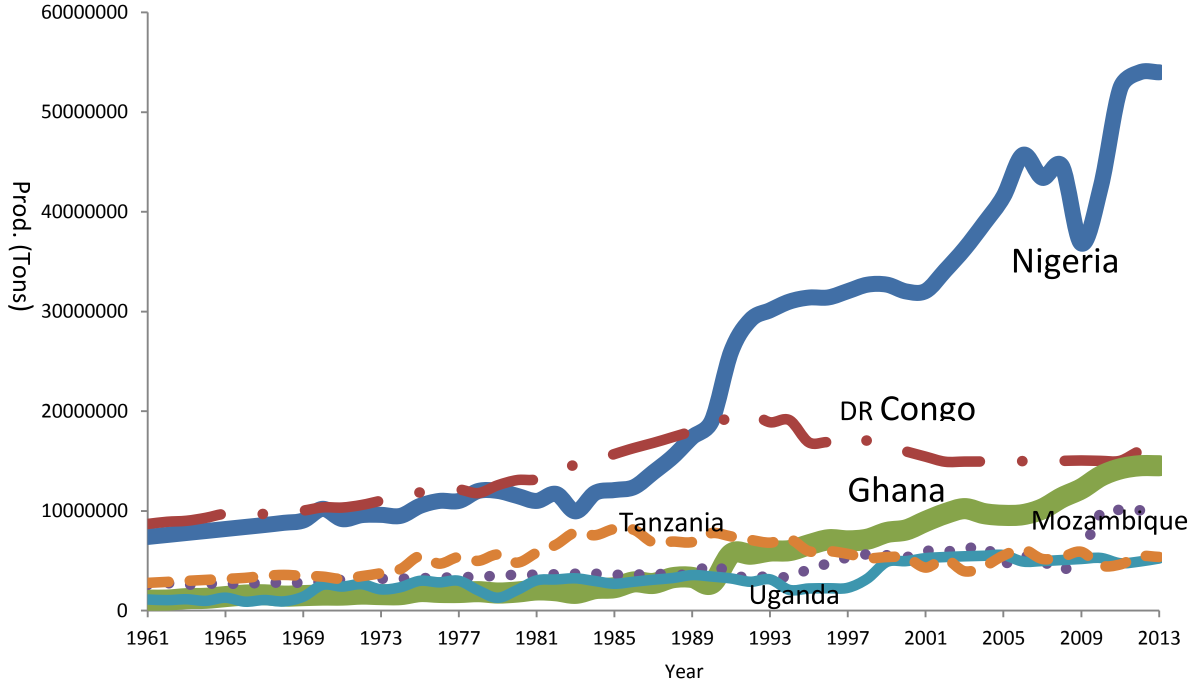

Figure 5. Six leading cassava producing countries in Africa: Annual production fron 1961 to2013. Source: FAOSTAT.

Table 3. Major cassava producing countries in Africa: Cassava production and harvesting labor (person days/ha) by task.

Task	Congo	Cote d'Ivoire	Ghana	Nigeria	Tanzania	Uganda
Land Clearing	66	53	44	40	54	50
Seed Bed Prep.	21	29	31	41	27	31
Field Planting	39	22	28	32	27	28
Weeding	27	28	34	38	28	32
Harvesting	48	44	53	62	46	47
TOTAL DAYS	201	173	191	222	182	187

Source: Nweke, Spencer and Lynam (2002).

The situation just described for West Africa, is quite different in the rest of Africa. In Central, East and Southern African regions, low yields caused by pests and diseases are still the most important constraint to the development of the cassava sector. Similar to West Africa, labor-saving mechanized milling machines, have already been widely adopted in Central, East and Southern African countries. Small scale hammer mills were introduced in sub-Saharan Africa in the early 1920s and they are available in virtually every urban and peri-urban center throughout sub-Saharan Africa where they are used to convert dried food crops such as maize, beans and dried cassava roots into flour (Nweke, Spencer and Lynam 2002). COSCA researchers found that cassava milling machines were available in more than 70 percent of representative cassava producing villages in Uganda in 1989 (Enete and Nweke 1999)[1]. The mechanized milling machines are used to convert dried cassava roots into flour, the form in which cassava is most popularly consumed in the regions. But the introduction of mechanized mills has not resulted in expanded cassava

[1] COSCA (Collaborative Study of Cassava in Africa) is a pan Africa cassava study funded by the Rockefeller Foundation and conducted by the International Institute of Tropical Agriculture in six countries namely Cote d'Ivoire, Ghana, Nigeria, DR Congo, Uganda and Tanzania from 1989 to 1997.

production in these regions because of the continued planting of traditional low yielding varieties. The result is an almost flat trend in the national aggregate production curves in the DR Congo, Tanzania, Mozambique and Uganda from 1961 to 2013 compared to Nigeria and Ghana, both of which experienced spikes in national production, Nigeria beginning in the late 1980s and Ghana from early 2000s. In short, , the major producing countries in Central, East and Southern Africa have not made significant advances in cassava production primarily owing to lack of progress in replacing low yielding traditional varieties, which continue to be the most binding constraint in those cassava systems.

The major lesson from these historical analyses is that an intervention that fails to address a primary constraint generally produces low impact, and that primary constraints are dynamic, changing as new technical components are introduced. Furthermore, these patterns vary by region. Cassava output in both Nigeria and Ghana was able to expand after the early broad adoption of mechanized processing technologies was later followed by the introduction of high yielding TMS material. However, growth has slowed owing to high labor costs at harvest. In contrast, although mechanized milling was introduced years ago in Central, East and Southern Africa, the impact on total production was negligible due to planting of low yielding traditional varieties, and limited area expansion due to high harvest labor costs.

Approach to Constraints in Present R&D Initiatives

In West Africa, presently the key binding constraint in the cassava sector is harvesting labor; the harvesting labor constraint is now at a similar stage to grain harvesting in the United States at the beginning of the nineteenth century (Johnson 2000, p.6). The invention of first the reaper and later the combine led to the reduction of grain harvesting labor by 70 percent and dramatically increased the profitability of area expansion and ultimately grain production in the United States. Without question, a mechanical revolution is now needed to break the labor constraint in cassava harvesting among farmers in West Africa most of whom are now planting high-yielding varieties.

Unfortunately, most current research on cassava in West Africa remains focused on generating high yield while little attention is given to labor-saving technology since the introduction close to a century ago of the mechanical grater in West Africa. But harvesting labor has now emerged as the most serious constraint to expansion of planting of high-yielding varieties in West Africa because labor for cassava harvesting increases in direct proportion to yield. Not surprisingly, farmers who plant TMS varieties have sometimes had to reduce their planted area because they are unable to hire sufficient labor to harvest previously planted cassava fields (Nweke 2004). Resolving the critical problem of harvesting labor constraint will significantly improve the productivity and competitiveness of the West African cassava sector by driving down unit production costs. This in turn will help African cassava compete successfully in feed and industrial raw materials markets – both domestic and international -, raise farm incomes, and reduce cassava prices to consumers, thereby reducing both rural and urban poverty.

The failure of the Green Revolution to take root in much of Africa calls for a re-evaluation of that approach in African agriculture. Certainly an agricultural revolution is needed in Africa, but after 50 years of efforts to reproduce the Green Revolution approach it is time to re-examine where the primary constraints lie, and for cassava this means to determine where and under what circumstances the primary constraints are yield, or labor costs - either at harvest or processing –, and thus when and where there is a need to pivot towards a mechanical revolution. In Africa, mechanization has to be selectively targeted to crops and activities for which labor shortage is the primary constraint to expanding production. This is now clearly the case of cassava harvesting in West Africa. Mechanization of cassava harvesting to work in Africa must be based on the reality on the ground. This means that mechanization initiatives should not be based on imported tractors alone, but also on improved hand tools that are more compatible with African agriculture systems consisting of small and poorly capitalized smallholders who cultivate small fragmented plots, and fragile soils, etc. Prototypes of such improved hand tools have already been designed in Africa and are available in national research centers and in private engineering workshops in a number of African countries (Nweke, Spencer and Lynam 2002).

In West Africa, an immediate priority is for action research to test these prototypes on farm, modify them as necessary, and then fabricate and commercialize them to farmers. A 2013 proposal by one of the co-authors of this paper to implement this action was rejected by an international donor organization whose R&D focus is on poverty alleviation among smallholder farmers. Their reason was that mechanization, even in the form of improved hand tools, is not appropriate for smallholders, which is highly questionable reason given the small scale and low cost of these

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technologies, and their effectiveness in addressing the binding labor constraints faced by many smallholder farm families. There was also a needless argument on weather on-farm testing of the prototype machines is research or extension activity. The same proposal was rejected by a university research department in 2012 as an extension activity and by an African based international agricultural development organization in 2016 as a research activity. The decision to reject was made by decision makers who drew arbitrary lines between research and extension.

In Central, East and Southern Africa, pest and disease problems, especially the problem of brown streak disease which reduces cassava yields and increases production risk, is presently the main technological constraint. Measures to improve seed systems in those sub-regions are some of the most common R&D initiatives aimed at breaking the constraint[1]. The measures include supplying farmers with clean seed of either improved or their preferred traditional varieties; encouraging them to adopt phytosanitary production practices; encouraging them to engage in commercial seed production; and teaching them to process and package cassava products in order to expand market.

Improvement in the cassava seed system requires transition from the still dominant informal to formal seed systems. This implies a continuous production and flow of clean seeds of new or farmer preferred traditional varieties; public regulatory functions of certification, standards and coordination; and farmer ability and willingness to pay for quality seed. The three preconditions must all be in place before the system can improve (Figure 6). The on-going measures to improve the cassava seed system incorporate these preconditions but their impact will be reduced because of broader institutional constraints intrinsic to how cassava development programs are currently designed and implemented.

[1] New Cassava Varieties and Clean Seed to Combat Cassava Brown Streak Disease (CBSD) and Cassava Mosaic Disease (CMD); Piloting Commercializing Cassava Seed Systems; Community Action in Cassava Brown Streak Disease Control Through Clean Seed; Great Lakes Cassava Initiative; Cassava Value Addition in Africa; Cassava component of Support to Agricultural Research for Development of Strategic Crops in Africa; etc.

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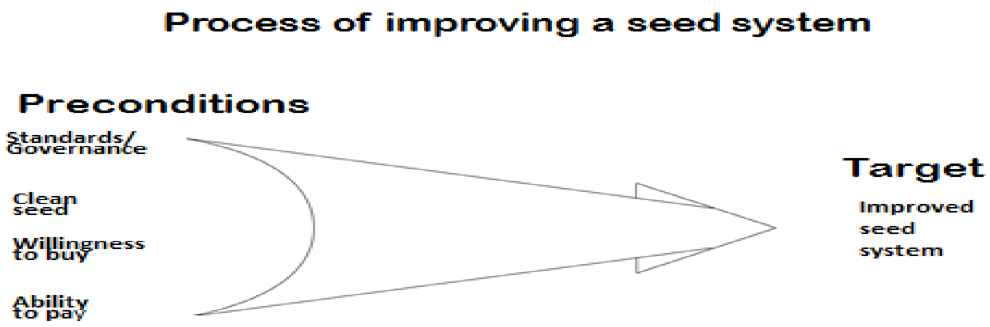

Figure 6. Preconditions for improved cassava seed system.

Current projects in Central, East and Southern Africa to improve the cassava seed systems are generally inadequate in terms of both time frame and financial resources[1]. The time frame is usually four or five years which is insufficient to generate and disseminate clean seed at scale. Moreover, government regulatory systems in countries where they exist require considerable effort and resources to help them function efficiently. And in countries where there is no system in place, it takes time consuming legislative and regulatory efforts to establish them.

A farmer may have the willingness to buy but not the ability to pay for seed and *vice versa*. A farmer is willing to buy if he or she is convinced that additional yield from purchased seed compensates for the incremental cost of the seed. However, the farmer's ability to pay depends on the profitability of the production enterprise, which as we have argued above, means the ability to reduce unit costs that, in many contexts, requires more than simple improvement in yield, but also improvements in other segments of the value chain.

Summary and Conclusion

R&D interventions in the African root crops sector are often targeted to problems without consideration for the hierarchy of constraints, all in attempt to achieve quick results. Program officers are often given short four or five year project time frames to show impact without giving adequate regard to second order constraints that may emerge during implementation that will in turn limit impact. In the past, R&D interventions in the root crops sector made greater impact in Africa when they were focused on primary constraints. In West Africa, cassava breeding in the 1970s produced considerable impact because it addressed the primary constraint in the cassava sector at the time - yield. To expand that impact, however, it will be necessary to successfully address the next constraint, namely the high cost of harvesting labor. In Central, East and Southern Africa the impact of R&D actions that are now trying to address the pest, disease and yield constraints will, even if successful, have limited impact due to low effective demand for cassava.

Agricultural R&D initiatives that focus poverty alleviation programs on smallholder farmers too often ignore the effect of pervasive poverty among urban consumers. Unless African producers reduce unit costs to compete in international markets – through exports or import substitution - producers will remain in poverty so long as effective demand is constrained by low disposable income among poor consumers. Where improved higher yielding planting materials are already available, the focus should be on mechanical labor-saving technologies in harvesting and processing that can help to lift smallholders out of poverty by reducing production costs and reducing consumer prices. But these technologies are too often incorrectly overlooked by international donor organizations, national political leaders and policy makers as non-smallholder technologies because those decision makers fail to consider how the hierarchy of constraints differs across different smallholder contexts.

[1] The current projects in Central, East and Southern Africa include (1) New Cassava Varieties and Clean Seed to Combat Cassava Brown Streak Disease (CBSD) and Cassava Mosaic Disease (CMD); (2) Piloting Commercializing Cassava Seed Systems; (3) Community Action in Cassava Brown Streak Disease Control Through Clean Seed; (4) Great Lakes Cassava Initiative; (5) Cassava Value Addition in Africa; and (6) Cassava component of Support to Agricultural Research for Development of Strategic Crops in Africa; etc.

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